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US Department of Energy Office of Environmental Restoration & Waste Management

Office of Technology Development

Office of Research and Development
Office of Demonstration, Testing, and Evaluation

1994 Mid-Year Program Review

March 8–9, 1994

Gaithersburg Marriott Washingtonian Center

MASTER

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U.S. Department of Energy
Office of Environmental Restoration and Waste Management
Office of Technology Development
Research, Development, Demonstration, Testing and Evaluation

1994 MID-YEAR PROGRAM REVIEW

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Agenda

Tuesday, March 8, 1994 – Ballroom Salon C

8:00 am - 8:15 am	Opening Remarks	Clyde Frank, EM-50
8:15 am - 8:45 am	Overview of Research, Development, Demonstration, Testing and Evaluation	Bill Schutte, EM-55
8:45 am - 9:05 am	A New Approach to DOE Environmental Research and Technology Development	Gerald Boyd, EM-50
9:05 am - 9:25 am	Overview of Groundwater and Soils Investment Area	Jef Walker, EM-541
9:25 am - 9:45 am	Overview of Waste Retrieval and Processing Investment Area	Stan Wolf, EM-542
9:45 am - 10:15 am	Break	
10:15 am - 10:35 am	VOCs in Non-Arid Soils Overview	Kurt Gerdes, EM-551
10:35 am - 10:50 am	Savannah River Economic Development Program	Kurt Gerdes, EM-551
10:50 am - 11:25 am	Volatile Organic Compounds in Arid Soils Integrated Demonstration	Dave Biancosino, EM-551
11:25 am - 12:00 pm	Mixed Waste Landfill Integrated Demonstration	Skip Chamberlain, EM-551
12:00 pm - 1:30 pm	Lunch (on your own)	
1:30 pm - 1:55 pm	Uranium in Soils Integrated Demonstration	Mike Malone, EM-551
1:55 pm - 2:40 pm	Characterization, Monitoring, and Sensor Technology Integrated Program	Caroline Purdy, EM-541 Eric Lightner, EM-541 Al Tardiff, EM-541
2:40 pm - 3:10 pm	Break	
3:10 pm - 3:50 pm	In Situ Remediation Technology Development Integrated Program	Jef Walker, EM-541
3:50 pm - 4:15 pm	Minimum Additive Waste Stabilization (MAWS) Program	Grace Ordaz, EM-541
4:15 pm - 4:35 pm	Resource Recovery Project	John Mathur, EM-551
4:35 pm - 4:55 pm	Heavy Metal Contaminated Soil Project	John Mathur, EM-551
2:00 pm - 5:30 pm	Exhibits and Poster Sessions in Ballroom Salons F and G	

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Agenda

Wednesday, March 9, 1994 – Ballroom Salon C

8:00 am - 8:10 am	Opening Remarks	Steve Lien, EM-54
8:10 am - 8:50 am	Buried Waste Integrated Demonstration	Jaffer Mohiuddin, EM-552
8:50 am - 9:30 am	Underground Storage Tank Integrated Demonstration	Sherry Gibson, EM-552
9:30 am - 10:00 am	Decontamination and Decommissioning of Facilities Integrated Demonstration	Jerry Hyde, EM-551
10:00 am - 10:30 am	Break	
10:30 am - 11:05 am	Efficient Separations and Processing Integrated Program	Teresa Fryberger, EM-542
11:05 am - 11:45 am	Mixed Waste Integrated Program	Paul Hart, EM-542
11:45 am - 12:00 pm	Waste Management and Technologies Analytical Database System (WMTADS)	Paul Lurk, EM-552
12:00 pm - 1:30 pm	Lunch (on your own)	
1:30 pm - 1:50 pm	Rocky Flats Compliance Program	Jim Taylor, EM-552
1:50 pm - 2:10 pm	Supercritical Water Oxidation Program	Jaffer Mohiuddin, EM-552
2:10 pm - 2:30 pm	U.S. DOE/U.S. Air Force Memorandum of Understanding Program	Miles Dionisio, EM-552
2:30 pm - 3:00 pm	Break	
3:00 pm - 3:40 pm	RDDT&E Innovation and Support	Susan Weber, EM-541
3:40 pm - 4:20 pm	Robotics Technology Development Program	Lin Yarbrough, EM-551
4:20 pm - 4:45 pm	Closing Remarks	Clyde Frank, EM-50
8:00 am - 3:00 pm	Exhibits and Poster Sessions in Ballroom Salons F and G	

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Office of Environmental Restoration and Waste Management
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Research, Development, Demonstration, Testing and Evaluation**

1994 MID-YEAR PROGRAM REVIEW

Exhibits and Poster Sessions

Tuesday, March 8, 1994 – 2:00 pm - 5:30 pm

Wednesday, March 9, 1994 – 8:00 am - 3:00 pm

Ballroom Salons F and G

Clean Up of VOCs at Non-Arid Sites–Savannah River Site

Savannah River Economic Development

VOC Arid Integrated Demonstration

Mixed Waste Landfill Integrated Demonstration

Uranium Soils Integrated Demonstration

Characterization, Monitoring and Sensor Technology Integrated Program

In Situ Remediation Integrated Program

Minimum Additive Waste Stabilization (MAWS)

Resource Recovery Project

Buried Waste Integrated Demonstration/Characterization Technologies

Underground Storage Tank Integrated Demonstration

Disposal/Storage Technologies

Decontamination and Decommissioning Integrated Demonstration

Efficient Separations and Processing Integrated Program

Mixed Waste Integrated Program

Treatment Technologies:

Thermal Desorption

Microwave Solidification for Mixed Waste

Two Stage Advanced Oxidation Reduction Unit for Mixed Waste

U.S. DOE/U.S. Air Force Memorandum of Understanding

Robotics Program

Advanced Identification of Robotics Integration

Industrial Partnerships–Morgantown Energy Technology Center

DOIT Program

Cost Saving Analysis Program

Heavy Metal Contaminated Soil Project

- **Headquarter's Program Manager (DOE-HQ):** S.P. (John) Mathur
- **Operations Office:** Pittsburgh (PETC)
- **Laboratory Site:** MacKay School of Mines,
Univ. of Nevada at Reno
- **EM-50 Division:** DT&E
- **Principal Customer:** EM-40
- **Applications Areas:** Soil and Groundwater
- **Joint Participants:** Univ. of Nevada at Reno,
U.S. Naval Academy,
Fernald, Hanford, INEL,
LANL, NTS, EPA-NAREL,
Mound, Martin-Marietta,
APT, Inc., Trans Mar, Inc.,
and MSE, Inc.

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Heavy Metal Contaminated Soil Project

- **Objectives :**
 - Evaluate physical separation technologies for remediation of soils contaminated with heavy metals at DOE sites
 - Transfer demonstrated remediation technologies nationally and internationally
- **Scope:**
 - Treatability study to evaluate seven* technologies' capability to effectively and economically remove heavy metal from contaminated soils
 - Technology demonstration performed at the University of Nevada at Reno (UNR) except High Gradient Magnetic Separation (HGMS), which will be conducted at the Los Alamos National Laboratory
 - Plutonium and uranium contaminated soils provided by Fernald, LANL, Hanford, Idaho National Engineering Laboratory (INEL) and Mound
 - Soil sample analysis performed at the US EPA NAREL under the USEPA/DOE interagency agreement
 - Testing to begin in March 1994 and to be completed by September 30, 1994

***Technology:**

SEPOR
Campbell Centrifugal Jig
Air Sparged Hydrocyclone
Tall Column Flotation
Knelson Concentrator
Denver Flotation Cell
High Gradient Magnetic Separation

Provided by:

U.S. Naval Academy
Trans Mar, Inc.
Advanced Processing Technology
University of Nevada at Reno
University of Nevada at Reno
University of Nevada at Reno
Los Alamos National Lab. and LESAT

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End Point

- **Project Success Criteria**
 - Transfer of successful technologies to EM-40
 - Transfer technologies nationally
 - Completion of project final report
 - Facilitate technology transfer internationally
- **Technology Success Criteria**
 - Surrogate testing success criteria was 80 percent surrogate recovered in 20 percent of the original feed volume
 - Contaminated soil success criteria is intended to achieve similar levels of success

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Customer Needs Window of Opportunity

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Customer Needs Window of Opportunity

- **LEFT FIGURE (previous page)**
 - Curve indicates dollars committed from a hypothetical calculated cost for remediation of all Pu contamination problems for which a ROD has been identified
 - If the technology becomes available after a ROD has been signed, it is very difficult to get a new technology considered for use in the remediation effort under that ROD
 - The earlier a new technology comes on-line, the greater role it can play in cleanup and, therefore, the more dollars it can save
- **RIGHT FIGURE (previous page)**
 - Baseline technology for comparison is Dig-Haul-and-Dispose
 - Top curve indicates the amount of dollars committed to the cleanup of sites for which RODs have been signed
 - Lower curves indicate the 15 and 30 percent cost-savings that can be realized with the use of an enhanced capability vs baseline

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User Regulatory Interface

- **EM-30**
- **EM-40**
- **State of Nevada**
- **Department of Transportation**
- **EPA**

Ties to Other Efforts:

- **Uranium in soils integrated demonstration**
- **FUSRAP**
- **Efficient separations integrated program**
- **Buried waste integrated demonstration**

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Heavy Metal Contaminated Soil Breakdown

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Funding FY94 Function 1

TTP	Technology	\$(K)	PI	Industry/ Academic Partner
PE031001	HMCSP	1920 (FY93 CO)	Dugan Reber, MSE, Inc.	None
PE031001	HMCSP	270	Dugan Reber	None
IAG	HMCSP	165	Martin Nelson	USNA
IAG	HMCSP	120	John Griggs	EPA-NAREL
MSE Subcontract	HMCSP	1264*	Manoranjan Misra	UNR
MSE Subcontract	HMCSP	44*	Ye Yi	APT, Inc
MSE Subcontract	HMCSP	53*	Wallace Henderson	Trans Mar, Inc

*Funding distributed by MSE, Inc., from the TTP PE031001

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Program Funding Profile (\$K)

FY92	FY93	FY94	FY95
525	1920	270	0

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Major Milestones/Deliverables

- **DOE Operational Readiness Evaluation approval (2/94)**
- **Receipt, homogenization and characterization of DOE soils (3/94)**
- **Completion of seven technology demonstrations (9/94)**
- **Completion of project (9/94)**

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Cost Savings (Example for the Nevada Test Site Only)

• Cost of using conventional excavation and NTS disposal (baseline technology)	\$2100M
• Cost of using improved excavation technology and NTS disposal	\$440M
• Cost of using conventional excavation followed by physical separation of contaminants from soil and NTS disposal	\$440M
• Cost of using improved excavation followed by physical separation of contaminants from soil and NTS disposal	\$88M
• Potential savings at NTS	\$1660M - 2012M

PERFORMANCE:

- Reduced volume of contaminants requiring disposal by 80 percent
- Pollution prevention through secondary processing of waste streams

SAFETY/RISK:

- Reduced health and environmental risks at sites remediated

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Industry

- Industrial Superfund sites
- Non-Superfund sites
- Pollution prevention through secondary processing of waste streams
- New applications of existing mineral extraction technologies
- Efficient separation of long and short half-life radionuclides

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Program Issues

- **Cost benefit data to be developed**
- **No cleanup standards set to determine success criteria of technology demonstrations**
- **Soil disposition not yet finalized**
- **Technology transfer criteria yet to be developed**

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Reference/Documentation

- **FY94 Mid-Year Review Briefing**
- **Technology Needs Crosswalk Report - 1/93**
- **Heavy Metals in Soil Project TTP # PE-031001**

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Accomplishments

- Placed contract with APT, Inc., and Trans Mar, Inc., to demonstrate technologies
- Acquired permit from Nevada to process uranium-contaminated soil at UNR
- Completed Operational Readiness Review (ORE) of UNR Soil Washing Laboratory (SWL)
- Completed DOE ORE with conditional approval of UNR SWL
- Surrogate tests completed on several technologies, with results rolled into Phase II (treatability study with contaminated soil) Test Planning
- Categorical Exclusion (CX) approved
- Appropriate NEPA documentation completed
- Contract placed with the University of Nevada at Reno for physical separation testing
- Required environment, safety and health issues addressed and requisite documentation completed
- QAPP complete
- Health and safety training (including rad-safety) for operational personnel complete

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Future Program Objectives - FY94

- Receive soil samples from five DOE sites
- Complete demonstration of seven technologies, including reports
- Facilitate initiation of technology transfer and supporting information
- Return soils to respective DOE sites
- Decontaminate and decommission test equipment

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Future Program Objectives - FY95

- **Promote technology transfer and supporting information dissemination**

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Soil Washing

FY 94 Budget vs. Expenditures

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Heavy Metal Project Schedule

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Buried Waste Integrated Demonstration

PM: Jaffer Mohiuddin DOE HQ

FO PM: George Schneider DOE-Idaho

IDC: Kevin Kostelnik EG&G Idaho

Operations Offices: Idaho

Laboratory Site: Idaho National Engineering Laboratory

EM-50 Division: DT&E

**Principal Customers: EM-30, EM-40, MWIP, MWLF, USTID
Waste Retrieval and Processing**

**Application Area: EM-30, EM-40, EPA REGION X, DOD,
WGA, ID-DEQ, WHC, Argonne-East,**

**Joint Participants: GJPD, Ames Lab, ID-WINCO, LANL,
ORNL, PNL, LLNL**

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The Buried Waste Problem

- **Early disposal practices allowed the commingling of various types of waste**
- **Many of the original containers have degraded significantly, resulting in contamination of the adjacent soil**
- **Transuranic (TRU), Low-Level Radioactive Waste (LLW), hazardous waste, mixed TRU waste, and mixed LLW, and contaminated soils must be characterized, stabilized, and/or retrieved, treated, and disposed**
- **The total estimated waste/soil volume is 3.0 million cubic meters**

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Objectives

- **Address the DOE Complex problems associated with buried waste by initially focusing on the buried waste located at Idaho National Engineering Laboratory (INEL)**
- **Develop a comprehensive, synergistic system consisting of technologies for characterization, retrieval, treatment, and disposal**
- **Encourage extensive private and public sector participation**
- **Transfer of buried waste technologies to and from DOE, other federal agencies, academia and industry**

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Scope

- **Compliance with the FFA/CO agreements**
- **Development of technologies to meet complex-wide buried waste needs**
- **Advancement of the current state of technology for remediation of buried waste**

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Three Dimensions of BWID Goals

- Establish performance baseline criteria (state-of-the-art capabilities)
- Conduct laboratory and field demonstrations based on "good" science
- Ensure technology exchange between industry, universities, and DOE

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Window of Opportunity

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BWID Coordination

BWID has established formal mechanisms to coordinate its activities with:

DOE:

- EM-30 Headquarters
- EM-40 Headquarters
- Idaho Office of Environmental Restoration
- M&O Environmental Restoration

EPA:

- EPA serves on the BWID Program Planning Group

Idaho:

- Department of Environmental Quality is represented on the BWID Program Planning Group

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BWID Organization and Coordination

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BWID Coordination Activities and Interfaces

	EM-50												Other DOE	Outside DOE			
	Technology Transfer	CMST-IP	MWIP	MWLD	ISRTIP	UST-ID	ESPIP	MAWS	Robotics Program	EM-30	EM-40	Private Sector	Universities	U.S. Bureau of Mines	U.S. Geological Survey	Idaho Site EPA	User Site EPA
Characterization	•	•	•	•		•		•	•	•	•	•	•	•	•	•	•
Retrieval	•	•	•	•		•		•	•	•	•	•	•		•	•	•
Treatment/ Pretreatment	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
Containment/ Stabilization	•	•	•	•	•	•				•	•	•			•	•	•
Transportation	•	•								•	•	•			•	•	•
Disposal	•									•	•	•			•	•	•

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Buried Waste Integrated Demonstration

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BWID FY 1994 Funding

Site Characterization

TTP#	Technology Name	\$ (K)	PI	Industry/Academic/Partner (Resource Share)
ID121112	Non-Intrusive Characterization	25	W. M. Roggenthen	South Dakota School of Mines and Technology
ID121213	BWID Field Demonstrations	35	S. Johnson	TechniScan/University of Utah
ID142004	VETEM	700	M. Pfeifer	U.S. Geological Survey, UC Berkeley, U of Arizona, U of Utah, Colorado School of Mines, RUST Geotech, Inc., LBL, ORNL, and SNL (\$155K to universities, \$130K to private companies, & \$415K to national labs)
ID142017	Airborne Platforms	70	M. Pfeifer	U.S. Geological Survey (\$47K)
ID142003	Imaging Infrared Interferometer	400	G. A. Moore	Physical Science, Inc. (\$250K)
ID142018	GPR Consortium	300	G. G. Streier	Ohio State University
ID132019	Geophysics Workshop	20	G. Schneider	N/A
AL911201	Non-Intrusive Sensing of BW	840	C. Schwenk	RUST Geotech, Inc. (\$577K), U.S. Geological Survey (\$163K), and LBL (\$100K)

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BWID FY 1994 Funding

Site Characterization

TTP#	Technology Name	\$ (K)	PI	Industry/Academic/Partner (Resource Share)
ID042002	USGS VETEM	450	Dr. L. Pellerin	Same as VETEM (ID142004) (\$450K to USGS)
RL342030	High Resolution Imaging	467	Dr. D. Collins	Pacific Northwest Laboratory (\$467K)
ID132018	Electromagnetic Imaging	93	A. Anderson	A. Anderson (\$60K)
ID142011	Gravity Field Measurements	533	A. Edwards	Bell Aerospace Textron (\$350K)
ID132003	Dig-Face Characterization	1100	N. Josten	Ecology International and RUST Geotech, Inc. (no new funds for FY94)
ID142005	Virtual Environment Gen.	1100	T. Larson	TBD (\$30K to universities, and \$50K to the private sector—planned)

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BWID FY 1994 Funding

Waste Characterization

TTP#	Technology Name	\$(K)	PI	Industry/Academic/Partner (Resource Share)
ID121212	Rad. & Haz. Mat. Measuring System	716	T. Roney	Idaho State Univ. (\$100K)
ID142016	Digital Radiography	400	T. Roney	Scientific Measurement Systems, Inc. (\$400K)
ID121210	Rapid TRU Laboratory	696	C. McIsaac	Enseco
ID142002	Real-Time Monitor of TRU Dust	400	J. Fincke	N/A
ID142015	Assay of Contaminate Soil	400	T. Roney	N/A
CH121202	Electrothermal Cathode	235	S. Weeks	Iowa State Univ./Ames Lab (\$235K)
AL132012	Improved TRU Assay (CTEN)	899	K. Coop	Los Alamos National Lab (\$899K)
SF221209	NDA Char. for TRU/LLW	745	H. Martz	LLNL and UC San Francisco Bio-Imaging Research Inc. (\$100K to UCSF and \$645K to LLNL)

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BWID FY 1994 Funding

Retrieval

TTP#	Technology Name	\$(K)	PI	Industry/Academic/Partner (Resource Share)
ID142006	Waste Conveyance for BW	550	P. Rice	TBD (\$250K planned)
ID142007	Retrieval Technology End Effector	532	P. Rice	TBD (\$250K planned)
ID142008	Full-Scale Telerobotic Retrieval	900	J. Rawlins	ORNL (\$150K), Wright Laboratory (\$400K), and Caterpillar (\$0K at this time)
ID142019	Cryogenic Cutting System	395	D. Bingham	Cimetrix, CS&P Cryogenics, Hydropac, and PCI Energy Services (developing CRADAs at this time, \$125K)
ID142009	Cooperative Telerobotic Retrieval	900	K. Croft	TBD (\$650K planned)
ID142020	Machine Health Monitoring	500	R. MacDonald	Colorado School of Mines (\$50K)
ID132022	3-D Dynamic Graphic Simulation	0	Dr. R. King	Colorado School of Mines
OR142003	ORNL Remote Excavation	300	B. Burkes	ORNL (\$300K)
RL342001	Contaminated Material	200	J. Konynenbelt	Pacific Northwest Laboratory (\$200K)

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BWID FY 1994 Funding

Treatment

<u>TTP #</u>	<u>Technology Name</u>	<u>\$ (K)</u>	<u>PI</u>	<u>Industry/Academic/Partner (Resource Share)</u>
ID132011	BWID Arc Melter Vitrification	970	N. Soelberg	N/A
ID142010	Modeling of Plasma Arc Technology	350	M. Mckellar	N/A
AL142012	Offgas Treatment	240	L. Rosocha	Los Alamos National Laboratory (\$140K), Electric Power Research Institute (\$50K), and University of Illinois (\$50K)
CH242002	STRATEX for Treatment of Soils	325	R. Peters	Argonne National Laboratory (\$255K) and LVW Associates (\$100K)
RL321211	Graphite DC Arc	970	J. Surma	Pacific Northwest Laboratory (\$970K)

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BWID FY 1994 Funding

Containment/Stabilization

<u>TTP #</u>	<u>Technology Name</u>	<u>\$ (K)</u>	<u>PI</u>	<u>Industry/Academic/Partner (Resource Share)</u>
ID142012	In-Situ Encapsulation	463	J. Weidner	N/A
ID142014	Innovative Grout Demonstration	383	G. Loomis	N/A
RL421212	Monolithic Confinement	465	G. Loomis	Westinghouse Hanford Company and Brookhaven National Laboratory (\$465K, split not known at this time)

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BWID Funding Profile (\$M)

<u>90</u>	<u>91</u>	<u>92</u>	<u>93</u>	<u>94</u>	<u>95</u>
1.5	18.7	14.5	14.2	22.0	22.3

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BWID FY94 Demonstration Schedule

Bench (Lab) Testing
Pilot Scale Testing

Full Scale Testing (INEL Cold Test Pit)
Full Scale Testing (Vendor Site)

ER Implementation

Field Deployment Test
Plans Due to BWID

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BWID FY94 Demonstration Schedule (Continued)

Bench (Lab) Testing
 Pilot Scale Testing
 Full Scale Testing (INEL Cold Test Pit)
 Full Scale Testing (Vendor Site)
 ER Implementation
 Field Deployment Test Plans Due to BWID

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BWID Retrieval Technology Demonstration Logic Diagram

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BWID Thermal Treatment Technology Demonstration Logic Diagram

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BWID Containment Technology Demonstration Logic Diagram

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Major Milestones/Deliverables

BWID to INEL WAG 7 have developed an Integration Plan with specific deliverables:

1. Technical evaluation report of the innovative grout demonstration by 12/1/94
2. Technical evaluation report of the in situ encapsulation of buried waste by 12/1/94
3. Technical evaluation report of the innovative end effector testing by 12/1/94
4. Technical evaluation report of the waste conveyance demonstration by 12/1/94
5. Interim technical evaluation report of the BWID dig face characterization by 12/1/94
6. Technical evaluation report of the gravity field measurements work by 12/1/94
7. The Rapid TRU Monitoring Laboratory shall be ready for ER use by 4/1/94
8. Technical evaluation report of the remote excavation demonstration at Oak Ridge National Laboratory (ORNL) by 12/1/94
9. Technical evaluation report of the DC ARC Plasma demonstration by 12/1/94
10. Technical evaluation report of the FY94 Arc Melter vitrification testing 12/1/94

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Major Milestones/Deliverables (Continued)

11. Technical evaluation report of the remote retrieval demonstration by 2/1/95
12. Technical evaluation report of the High Resolution Imaging Testing 3/1/95
13. Technical evaluation report of the Tensor Magnetic Gradiometer demonstration by 12/1/94
14. Technical evaluation report of monolithic confinement testing by 12/1/94
15. Progress report for very early time domain testing by 12/1/94
16. Technical evaluation report of real-time monitoring of TRU dust testing by 4/1/95
17. Technical evaluation report of cryogenic cutting system testing by 12/1/94
18. Technical evaluation report of the cooperative telerobotic retrieval demonstration by 12/1/94
19. Technical evaluation report of the FY95 full-scale field demonstration by 4/1/96
20. Results of all BWID technology evaluations that support WAG-7 by 4/1/96. This is the critical time when WAG-7 must have these results.

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Benefits

General:

- Remediation of soil contaminated by releases from buried waste
- Compliance with interagency agreements
- Technology transfer between DOE, federal agencies, industry, and academia
- The program is designed to develop significantly safer, faster, more precise and accurate, and more cost-effective technologies than the current state-of-the-art

Characterization Technologies:

- Will have remote operation capabilities and will significantly reduce worker exposure
- Will accurately define the pit and trench boundaries
- Will more clearly define clean from contaminated soil
- Will identify the contents of retrieved waste containers
- Will verify a final waste form

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Benefits (Continued)

Retrieval Technologies:

- Will operate remotely and will reduce worker exposure significantly
- Will retrieve all contaminated soil with the least amount of clean soil intermixed
- Will greatly limit the spread of contamination during retrieval activities
- Will be capable of surgical retrieval of "hot spots"

Treatment Technologies:

- Will operate remotely and will significantly reduce worker exposure
- Will treat the widest range of wastes and waste types
- Will provide real-time system diagnostics for process control
- Will produce the appropriate final waste form

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Scoping Cost Savings Analysis

Summary Results:

- Cost for baseline retrieval and treatment \$14–26K per m³
- Cost for advanced technology systems \$0.7–8.5K per m³
- Potential cost savings at RWMC Minimum \$1.5B

Assumptions/Basis for Estimates:

- Volume of waste and surrounding contaminated soil at RWMC is 280,000 m³
- Robotic retrieval will increase throughput a minimum of 25 % over manned operations
- New characterization technologies will reduce amount of soil to be excavated by 20 %

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Cost/Benefits

Rapid Geophysical Surveyor (with Flux gate magnets):

- Licensing agreement signed
- Based on the surveying of Pit 9
- 1500 data points were taken with current hand-held technology
60,000 data points were taken with this new technology
- Traditional methods cost \$3 per data point
This technology costs approximately \$0.25 per data point
- The time taken to gather both sets of data was the same
- The Rapid Geophysical Surveyor can be set to gather fewer data sets at a higher speed

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The Rapid Transuranic Monitoring Laboratory

- Currently in negotiations for the commercialization of the technology
- Continuously monitors airborne transuranic concentrations
- Rapidly analyzes soil, smear, and air filter samples
 - Samples prepared and analyzed in less than one hour
 - \$30 per sample
- The following sample throughputs were demonstrated
 - Photon spectrometer: 79 per day
 - Ion chambers: 33 per 8-hour shift
- Conventional radiochemical laboratory limited to 5 samples per day
- RTML
 - Sample analyzed in less than 1 hour
 - Less than \$30 per sample
- Conventional analysis
 - Takes several days
 - \$200–\$300 per sample

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Program Issues

Issue 1:

Below Regulatory Concern (BRC) or de minimus levels for radioactive and mixed waste have not been established.

Issue 2:

The analytical capabilities of environmental laboratories do not meet DOE Idaho ER projected requirements for sampling activities.

Issue 3:

The public perception of health, life, safety, and environmental risks does not agree with the INEL technical evaluation or risk assessment.

Issue 4:

Cradle-to-grave management of buried radioactive and mixed waste requires: (a) acceptable waste handling methods, (b) accepted criteria governing disposal facilities, and (c) accepted treatment technologies.

Issue 5:

Need identification and use of a common or the same computer architecture for all computer-operated/-assisted technologies that may be used simultaneously in the field.

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Reference Documentation

- **Integration Action Plan for WAG 7 and the BWID Program (EGG-ER-11142)**
- **Fiscal Year 1994 BWID Test Goals and Objectives (EGG-WTD-11112)**
- **FY93 BWID Lessons Learned (Letter Report)**
- **BWID FY 1994 Program Book**
- **BWID FY 1995 Need Statement**
- **BWID Commercialization Action Plans**
- **BWID Stakeholder Involvement Model**
- **BWID Preliminary Systems Design Study-Assessment Report 1992 (EGG-WTD-9594) Vol. I to Vol. VII**
- **BWID Monthly Progress Reports**

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FY 92 Accomplishments

- **Complete Cryogenic Retrieval Demonstration at the INEL Cold Test Pit**
- **Completed Pad A Treatability Study Lab Scale Testing and Lab Scale Testing Report**
- **Completed Funnel Dump Testing for Contamination Control**
- **Assembled Field Deployable Rapid Monitoring Unit**
- **Completed Demonstration of Broad Band Electromagnetic Systems at INEL Cold Test Pit, Acid Pit, and Pit 9**
- **Completed Aerial Surveillance of Subsurface Disposal Area to Demonstrate Non-intrusive Characterization Techniques**
- **Completed Bench Scale Testing of Ice Electrode**
- **Initiated Testing on the First Generation DC Arc Plasma Pilot Unit**
- **Completed Pilot Scale Testing on Buried/Stored TRU Treatment Plasma Hearth Furnace**

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FY 93 Accomplishments

- Completed field deployable Rapid TRU Monitoring Unit demonstration
- Completed Rapid Geophysical Surveyor field demonstration
- Completed field deployable Contamination Control Unit demonstration
- Completed Remote Characterization System (RCS) demonstration
- Completed the contamination migration control: fixation of soil surface large-scale demonstration
- Completed Remote Excavation System (RES) and Overburden Removal demonstrations
- Engineering scale experiments on electrostatic enclosure and ventilation system for contamination control during retrieval operations
- Completed Multi-axis Crane Control demonstration
- Completed construction of the Mark II DC Plasma Arc Furnace
- Completed proof-of-concept of Dig-Face Characterization System
- Completion of test melt campaign for the Electric Arc Furnace

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Future Program Objectives - FY 1994

Technologies to be Demonstrated in FY94

- Complete bench-scale testing of the High Resolution Imaging using Holographic Impulse Radar array
- Complete the Dig-Face Characterization Demonstration
- Complete bench-scale testing of the Imaging Infrared Interferometer
- Implementation of the Rapid TRU Monitoring Unit by Environmental Restoration at INEL
- Completion of pilot-scale testing of the Real-Time Monitor for TRU dust
- Completion of Waste Conveyance and Innovative End-Effector demonstration

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Future Program Objectives - FY 1994 (Continued)

- **Completion of the full-scale Remote Retrieval demonstration**
- **Completion of pilot-scale Cryogenic Cutting System**
- **Completion of the pilot-scale Cooperative Telerobotic Retrieval**
- **Completion of the full-scale In Situ Encapsulation of Buried Waste demonstration**
- **Completion of the pilot-scale Monolithic Confinement demonstration**
- **Completion of the Innovative Grout demonstration**

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Future Program Objectives - FY 1995

- **Integrate full-scale characterization, retrieval, and treatment demonstrations**
- **Focus on field deployment and technology systems**
- **Initiate "HOT" demonstration of characterization, retrieval, and treatment technologies**
- **Advance waste containment and stabilization field demonstrations**
- **Significant return on investment from incorporating BWID-developed technologies in the RI/FS-ROD process at INEL TRU-Contaminated Waste Pits and Trenches (FY98), Hanford Site 100 (FY96), and Oak Ridge WAG 5 Draft ROD and Corrective Measures/Remedial Design in FY96**

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BWID's FY 1994 Core Program

- **Focusing on the Characterization, Retrieval, Treatment System**
- **Deploying field-ready prototypes for performance tests**
- **Resolving technical issues through "cold" testing prior to ER/WM "hot" implementation**
- **Testing supports ER/WM RI/FS process**
- **Satisfies stakeholder/regulator acceptance issues**

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BWID's Stakeholder Model is a Partnership with EPA, WGA, & State of Idaho

- **EPA Region 10, WGA, and the State of Idaho serve on BWID PPG**
- **Four BWID technologies were selected by the WGA DOIT Committee**
- **EPA, WGA, and the State of Idaho have supported BWID stakeholder/technology transfer meetings**

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Technology Commercialization/Implementation is One Objective of the BWID Mission

- **Technology-specific action plans to achieve commercialization/implementation**
- **Industry partnerships to enhance commercialization**
- **Technology implementation with DOE ER/WM**

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Three Dimensions of Technology Transfer

- **Technology Infusion** – the transfer of technology from industry, universities, other federal agencies for integration into the RDDT&E process
- **Technology Adoption** – the sharing of demonstrated technology among DOE sites (EM-30, 40, 60 and DP) and integrated demonstrations and programs for implementation in site activities
- **Technology Diffusion** – the transfer of demonstrated technology from the BWID to industry for commercialization

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BWID Partnerships

- **FY 1992**
 - 17 industry/university partnerships (\$5M)
 - 7 DOE laboratory partners (\$7.2M)
 - 53% of the total budget
- **FY 1993**
 - 16 industry/university partnerships (\$2.8M)
 - 6 DOE laboratory partners (\$2.8M)
 - 47% of the total budget
- **FY 1994**
 - 36 industry/ university partnerships (\$5.4M)
 - 9 DOE laboratory partners (\$6.1M)
 - 52% of the total budget

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BWID/WGA DOIT Technologies

- **Rapid Transuranic Monitoring Labs**
- **Dig-Face Characterization**
- **Radiological Hazardous Material Measurements System**
- **Off-Gas Treatment**

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BWID Licensing Efforts

Rapid Geophysical Surveyor

- Sage Earth Sciences, Inc.

Rapid Transuranic Monitoring Lab

Active Millimeter Wave Radiometer

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BWID CRADAs (Pending)

Cryogenic Cutting

- CS&P Cryogenics
- Cimetrix
- PCI Energy Services
- Hydro-PAC

Contaminated Material Handling

- Oceaneering
- Lampson

Off-Gas Treatment

- EPRI

NDA Characterization

- BioImaging Research

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Implemented Technologies

- Contamination Control Unit
- Rapid Geophysical Surveyor
- Centrifugal Plasma Furnace

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Implemented Technologies

Contamination Control Unit

The CCU is a mobile unit which is capable of dispensing soil fixatives and dust suppression agents, providing a water misting curtain, and has a vacuum system for the control of contamination spread during retrieval operations. Currently, the CCU is being used by the Environmental Restoration Program at Hanford for in support of a retrieval treatability study. The unit was also used by the INEL Environmental Restoration Program during a capping action at Experimental Breeder Reactor 1. Fernald has expressed interest in using the CCU in the FY 94/95 time frame for use during actual retrieval activities.

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Implemented Technologies (Continued)

Rapid Geophysical Surveyor

- A device which quickly and inexpensively characterizes buried waste sites by collecting high density, high quality magnetic data sets. A patent and licensing agreement is being sought by the inventors who are interested in marketing the unit. The RGS has been used at Pits 7 and 9 at the INEL Radioactive Waste Management Complex, at Los Alamos National Laboratory, Pendleton Marine Base, and at the EPA Region IX, Environmental Monitoring Systems Laboratory - Las Vegas, Newmark Groundwater Contamination site. The RGS is also scheduled to be used at the Drake Chemical NPL site in EPA Region III.

Centrifugal Plasma Furnace

- A plasma furnace which allows the melt container to rotate during operation to provide for a more homogenous mixture after processing. The furnace was used in the proof-of-principle phase of the INEL Pit 9 remediation procurement as part of one of the bidder's solution to the cleanup of the pit.

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Flow of Technology Transfer

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Underground Storage Tank Integrated Demonstration

Program Manager: Sherry Gibson

**Integrated Demonstration
Coordinators:** Roger Gilchrist
Dr. Marilyn Quadrel

Operations Offices: HQ, SR, RL, ID, OR

Laboratory Sites: All

EM-50 Division: DT&E

Principal Customers: EM-30, EM-40

Application Areas: Waste Characterization, Retrieval,
Processing, and Disposal

Joint Participants: PNL, WHC, ORNL, LANL, LLNL, SNL,
ANL, SRS, NRL, EM-30, INEL-WINCO,
FERMCO, DoD, EPA

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Objectives

- Adapt, improve, and demonstrate technology systems to solve the Department of Energy's underground storage tank radioactive and mixed waste problems
 - Solutions should be designed to solve problems that are borne by multiple sites
 - Solutions must be demonstrated on a schedule that will ensure the broadest possible implementation
 - Solutions must present the greatest possible improvement in schedule and environmental clean-up
 - Solutions should demonstrate the greatest possible cost-savings across the DOE complex
- Develop industrial partners capable of fabricating and using the technologies and/or systems developed by the UST-ID
- Encourage commercialization of technologies and systems developed by the UST-ID

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Scope

- **UST-ID is a national demonstration that responds to tank related needs from all tank sites**
- **The breadth of the demonstration includes waste characterization (in situ and ex situ), sensor development, deployment arm development, investigation of subsurface barriers, waste dislodging and conveyance to a transport mechanism, waste processing for final disposal, and evaluation of LLW alternatives**
- **The UST-ID collaborates with other IDs and IPs for development and transfer of technology**

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Definition of Success

- **Incorporation of UST-ID systems or technologies into existing EM baselines, thereby replacing the current approach**
- **Commercialization of demonstrated system or technology**

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Success Indicators

- Co-funding by users to demonstrate, evaluate and transfer systems into their baseline
- Active participation by industrial partners in the development and demonstration of a new product

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Window of Opportunity

	90	91	92	93	94	95	96	97	98	99	2000	2001	2002	2003
Characterization														
Retrieval														
Processing														
Disposal														

The window of opportunity is driven by the site-specific regulatory agreements, and is subject to change.

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User/Regulatory Interface

- EM-30
- EM-40
- States
- EPA
- DoD

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Ties to Other Efforts

- ESP-IP
- CMST-IP
- Robotics
- ISR-IP
- MW-IP
- VOC-Arid-ID

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Funding FY94 Characterization System

TTP	Technology	\$(k)	PI	Industry/Academic/ Partner (Cost Share)
OR132008	Acoustic Leak Detection	200	C. E. Pepper	Vista Research (\$20k)
RL421207	Raman & IR Spectroscopies	650	F. R. Reich	Florida State U. (\$150k)
RL421207	Characterization System Integration	1175	S. J. Eberlein	Naval Research Lab (\$75k) Texas Tech U. (\$60k) Science Engineering Ass. (\$35k)
RL421207	On-line Monitoring Process	100	S. J. Mech	
SF211203	Advanced Fiber Optics Spectroscopy	300	T. Vess	
SR132003	Fiber Optics Probes	270	P. O'Rourke	Ciba-Geigy (\$20k) Akzo (\$20k)
AL141005*	Raman Probe Radiation Study	150	R. Donohoe	
RL341003*	TRU & Moisture Measurement by Neutron Activation	300	R. Brodzinski	
RL341005*	Imaging Through Obscurants	175	T. Peters	
RL441001*	Cone Penetrometer	800	L. Bunes	
SF241002*	Electrical Resistance Tomography	300	W. Dally	

*TTPs funded by CMST-IP.

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Funding FY94

Light Duty Utility Arm

TTP	Technology	\$(k)	PI	Industry/Academic/ Partner (Cost Share)
AL232001	Computer Control/Sensor Interface	1680	B. Davies	National Instruments (\$40k) Misc. vendors (\$10k)
ID442001	Decontamination & End Effector Testing	200	B. Griebenwo	Vista Research (\$20k)
OR132008	Topographical Mapping System	850	W. R. Hamel	MTI (\$500k) U. of Tennessee (\$30k)
RL332011	LDUA and End Effectors	825	C. M. Smith	
RL421207	LDUA System	4475	B. A. Carteret	Spar (\$1290k)
SR132001	Surveillance & Inspection End Effector	350	F. Heckendorn	

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Funding FY94

Waste Dislodging & Conveyance System

TTP	Technology	\$(k)	PI	Industry/Academic/ Partner (Cost Share)
RL332011	Simulant Development	100	G. Golcar	BNFL (\$50k)
RL332011	WD&C Mechanics	800	J. A. Bamberger	Washington State U. (\$30k)
RL332011	Test Requirements & Evaluations	200	M. Rinker	
RL332011	Integrated Testing	500	M. Rinker	
RL343502	Low Pressure System/Mining Strategy	200	J. A. Bamberger	U. of Missouri, Rolla (\$200k)
RL343503	High Pressure Jet Scarification	300	J. A. Bamberger	Quest (\$300k)
RL421207	WD&C System	400	J. A. Yount	

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Funding FY94 Waste Processing & Disposal System

TTP	Technology	\$(k)	PI	Industry/Academic/ Partner (Cost Share)
CH232001	Generic TRUEX Model	300	G. F. Vandegrift	U. of Illinois (\$30k) Spring Harbor College (\$10k)
CH243501	Mobile Evaporator/Concentrator	600	D. Chamberlain	Licon (\$35k), Artisan (\$40k) U. of Illinois (\$5k)
ID121204	Biodegradation	300	G. Andrews	
OR132008	Nitrate Treatment (NAC Process)	1700	A. J. Mattus	Florida International U. (\$250k)
OR132008	Comprehensive Sludge/Supernatant Processing	1400	B. Z. Egan	
OR132008	Organics Destruction	100	R. D. Hunt	
OR132008	TRUEX Validation	125	L. K. Felker	
OR132008	CEA Technical Interchange	350	R. T. Jubin	
OR132008	Clean Option Support	300	D. W. Malkemus	
RL332011	Compact Processing Unit	1500	W. Richmond	Ebasco/BNFL (\$100k) Washington State U. (\$50k)
SR132002	Cesium Extraction	1700	J. Bibler	BNFL (\$100k) Clark Atlanta U. (\$100k) Purdue U. (\$75k)

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Funding FY94 Program Support

TTP	Technology	\$(k)	PI	Industry/Academic/ Partner (Cost Share)
RL332011	USTID Program Support — PNL	645	M. Quadrel	Ebasco (\$200k)
RL421207	USTID Program Support — WHC	1405	R. Gilchrist	Ebasco (\$165k)
OR132008	USTID Program Support — ORNL	800	C. P. McGinnis	

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Program Funding Profile

(in \$ Millions)

<u>FY90</u>	<u>FY91</u>	<u>FY92</u>	<u>FY93</u>	<u>FY94</u>	<u>FY95</u> (projected)
0	7.30	19.75	25.53	23.97	24.73

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Schedule

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Benefits

Cost/Savings:

- Waste processing to reduce the amount of HLW transferred to the vitrification operation can cut the number of glass logs
- Another benefit is two-thirds volume reduction of final waste form

Performance:

- Enable surveillance and monitoring that is not currently achievable
- Maximize fraction of waste that is acceptable for disposal as LLW
- Decrease in secondary waste streams generated from waste treatment
- Enable waste retrieval percentage goals mandated by the Tri-Party Agreement to be met

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Benefits (Continued)

Safety/Risk:

- Decrease health/safety risks during retrieval and waste processing operations
- Decrease long term risks due to tank structure failure through maximizing the percent of waste retrieved

Regulatory:

- Develop technologies and systems that comply with all applicable state and federal regulations

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Program Issues

- **Waste simulants provide performance data. Actual waste is difficult to acquire, multiple sample types are required and hot cell space is sparse and expensive**
- **The perceived commercial market for tank related technologies (e.g., chemical processing) is very small and industrial partners are difficult to find**
- **Scale up activities require sizable facilities and hot cell space which are scarce and expensive**
- **In-tank testing or demonstrations require extensive coordination, safety reviews, operating procedures, state permits and compliance with extensive federal regulations**
- **Budget cuts could cause the program to miss technology windows of opportunity established by regulatory deadlines requiring rapid development**
- **Continuity of funding is essential to meet schedules that support site specific regulatory milestones**

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Reference/Documentation

- **UST-ID FY93 Technology Summary**
- **UST-ID FY95 Needs Statement**
- **FY93 & FY94 Mid-year Review Briefing**
- **Strategic Plan for UST-ID**
- **Strategic Plan for Characterization and Waste Retrieval Program**
- **Strategic Plan for Waste Processing and Disposal Program**
- **Program Management Plan for UST-ID**
- **Program Management Plan for CWRP**
- **Program Management Plan for WPDP**
- **CDR LDUA**
- **CDR Compact Processing Unit**
- **F & R Subsurface Barriers**
- **Tank Waste Processing and Disposal Technology Development Data Summary**

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Accomplishments (since FY93 midyear)

Characterization:

- **Raman spectroscopy system was successfully demonstrated in the hot cell for screening of real tank waste**
- **CRADA placed with Ciba-Geigy for process monitoring testing**
- **Infrared spectroscopy system showed sensitivity to 1% change in moisture content in waste simulants**
- **Agreement reached in Acoustic Leak Detection with the Navy, EPA, Vista Research and DOE; co-funding obtained from ORNL and EPA. SERDP proposal funded**
- **Naval Research Laboratory has completed a study of radiation effects on fiber optics**

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Accomplishments (since FY93 midyear)

Characterization (Continued):

- **Texas Tech University has been contracted to develop an in situ rheology probe**
- **Test plans were completed for the Raman Spectroscopy system and testing was initiated**
- **Contract placed with Science & Engineering Associates to complete standards for fiber optics testing**
- **A national technical exchange was conducted with all EM-30 and EM-50 funded researchers performing research or development of Raman Spectroscopy**
- **On line processing needs for Hanford site were documented**

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Accomplishments (since FY93 midyear) ***(Continued)***

Light Duty Utility Arm System :

- The Conceptual Design Review for the Light Duty Utility Arm (LDUA) System was completed. The System Preliminary Design has been initiated
- Placed 1.29M contract with Spar Aerospace, Inc. to provide the LDUA system robotic arm
- Hanford's EM-30 tank farm operations have committed a full-time cognizant lead engineer; the FY 1994 EM-30 budget for the LDUA includes \$700k expense, \$1M capital
- INEL is committing funding to purchase the LDUA and deployment system for inspection and tank cleaning applications
- Completed Mechanical Technology Inc. structured light demonstration
- ORNL is investigating use of LDUA for potential gunnite tank retrieval

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Accomplishments (since FY93 midyear) ***(Continued)***

Light Duty Utility Arm System (Continued):

- Supervisory Data Acquisition System software for data transfer between VxWorks and LabViews has been developed
- A contract has been placed with Non-Destructive Cleaning (NDC) Company for CO₂ decontamination equipment
- Cooperative Research And Development Agreements (CRADAs) are being negotiated with NDC and Oceaneering Technology
- CRADA placed with Mechanical Technology, Inc. for topographical mapping
- Laser Rangefinder Hardware Evaluation Test Plan completed on schedule
- Spar Aerospace, Inc. is performing an LDUA operations feasibility study regarding tank dome loading relative to the tanks at INEL
- Final design packages completed for two overview camera systems and two end effectors

MDA-GT-016 23

Accomplishments (since FY93 midyear) ***(Continued)***

Long Reach Arm:

- The first generation Long Reach Arm was accepted by the EM-30 user at Hanford as a viable part of the first tank retrieval project (W340). The technology for this arm was transferred to the user and a procurement specification is being developed

Waste Dislodging and Conveyance End Effectors:

- WD&C accomplishments will be used by EM-30 to aid in meeting Hanford's retrieval milestone M 45-01. Previous accomplishments have already helped meet an earlier milestone
- Completed a Waste Dislodging and Conveyance Workplan which integrated all individual PI workplans and schedules
- Issued a Multi-Year Testing Strategy for Test Requirements and Evaluation
- Demonstrated high pressure scarifier apparatus at removal rates of 2 cubic feet/minute, and achieved target particle size of 0.2" diameter

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Accomplishments (since FY93 midyear) ***(Continued)***

Waste Dislodging and Conveyance End Effectors (Continued):

- UST-ID WD&C testing has revealed that tensile strength and particle size more than shear strength will be the major drivers of water jet cutters and conveyance systems. This could change industry's equipment design
- Placed a contract with University of Missouri to test medium pressure systems and lead mining strategy approach to dislodging
- Placed a contract with British Nuclear Fuels to collaborate on simulant development tests
- Installation of the Pneumatic conveyance test fixture system is near completion. Calibration testing is underway. Start-up testing is expected this spring
- Issued procurement specification for hydraulics test bed gantry. Three qualified bidders have responded. Contract award is expected in February

MDA-QT-0116 24

Accomplishments (since FY93 midyear)

(Continued)

Waste Dislodging and Conveyance End Effectors (Continued):

- Completed testing of sludge dislodging tool. Retrieval rates of 30-50 gpm were routinely achieved. An upper end of 95 gpm was demonstrated
- Three invention disclosures were prepared by WHC for two dislodging technologies and one conveyance technology

Compact Processing Units and SKID:

- The NEPA Information Bulletin/Categorical Exclusion for the CPU was approved by DOE-RL. This is essentially all the regulatory documentation required for non-radioactive demonstration
- An agreement was reached with EM-30 for co-funding and co-management of cesium extraction and the Compact Processing Unit. The EM-50 project manager was appointed to lead both activities

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Accomplishments (since FY93 midyear)

(Continued)

Compact Processing Units and SKID (Continued):

- Initiated installation of the SKID unit for testing of resin performance at a significant scale up (2 ml/min to 45,000ml/min (12.5 gal/min)). Testing to begin in the summer of 1994
- A conceptual design for the CPU enclosures system was developed and analyzed by Washington State University. This design formed the basis of the enclosure presented in the CPU conceptual design report
- The conceptual design report and cost estimate for the first CPU deployment was issued for project validation
- The CPU deployment for the treatment of Hanford Tank Waste was endorsed by the WHC TWRS Programs Office and the WHC TWRS Executive VP
- The removal of cesium from concentrated tank solutions by ion-exchange was demonstrated and shown to be technically achievable. This demonstration resulted in a major change in the planning basis for the Hanford TWRS. This change will reduce the waste generated by cesium removal processing by 20 - 50%

WDA-GT-0116 18

Accomplishments (since FY93 midyear) ***(Continued)***

Compact Processing Units and SKID (Continued):

- The radiolytic stability of the formaldehyde resorcinol resin was tested. The resin was found to be radiolytically stable at doses up to 10^6 rads
- Began resin stability and characterization testing at Clark Atlanta University
- Began development of a model of resin performance at Purdue University. This model will allow accurate prediction of resin performance and optimizing of the scale-up design
- The Commerce Business Daily Announcement for industrial support of the organics destruction CPU was prepared and is ready for release when funding issues are resolved
- The Preliminary Design Criteria for the evaporator CPU were issued for review and approval
- A project to develop an evaporator CPU was initiated at Argonne with Licon Corp. as an industrial partner

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Accomplishments (since FY93 midyear) ***(Continued)***

TRUEX Model Validation:

- Completed TRUEX solvent extraction tests using dissolved Mark 42 targets at ORNL. The results from the Mark 42 demonstrations will be compared to the predictions from the Generic TRUEX Model (GTM)
- TRUEX test data have been received from the Power Reactor and Nuclear Fuel Development Corporation of Japan and are being evaluated. The Generic TRUEX Model will be used to predict the results and then the predictions will be compared to actual Japanese data
- Completed modifications and enhancements to the Generic TRUEX Model. Version 3.0 will contain a better model for zirconium and fluoride extraction

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Accomplishments (since FY93 midyear)

(Continued)

Sludge and Supernatant Processing:

- The initial batch evaluation of resorcinol/formaldehyde resin, sodium silicotitanate, CS-100, and potassium cobalt hexacyanoferrate (II) for cesium removal from Melton Valley Storage Tank supernate (ORNL) has been completed
- Samples of Melton Valley Storage Tank sludge were leached with a series of sodium hydroxide and nitric acid solutions, and the dissolution behaviors of cesium, cobalt, and europium were determined

Mobile Evaporator/Concentrator:

- Completion of the preliminary design will be used in the proof-of-principle demonstration of mobile evaporator/concentrator for tank waste remediation, utilizing evaporator and concentrator technologies of LICON and Artisan, respectively

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Accomplishments (since FY93 midyear)

(Continued)

Calcination/Dissolution:

- The second development test of the calcination/dissolution technology was completed using the plasma-fired cupola system. Over 100 gallons of tank 101-SY simulants were successfully processed

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Accomplishments (since FY93 midyear)

(Continued)

Nitrate to Ammonia and Ceramics (NAC):

- A patent on the NAC process was granted by the United States patent office to Martin Marietta Energy Systems on November 30, 1993
- The NAC concept has been proven in the batch mode to effectively destroy nitrates and nitrites, bind metals into solids, and produce a ceramic low level waste form with very high leach indices. Continuous mode of operation is being investigated. Improvements in aluminum usage efficiency have been made, and further improvements are expected
- A NAC Pilot Plant has been designed to process nitrate at a rate of 0.2 liter/min of 3 molar sodium nitrate. The equipment has been specified and orders are being prepared
- Initiated a kinetics study on the aluminum particle in the NAC reaction at Florida International University. Investigation of applying microwave drying and sintering techniques to the NAC process has also begun

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Future Program Objectives – FY94

- Complete preliminary and detailed design reviews for LDUA System
- Conduct an LDUA end effector/data acquisition demonstration
- Complete cold demonstration of Laser Raman Spectroscopy System for identification of chemical species including nitrates/nitrites and organics
- Complete engineering-scale test of resorcinol/formaldehyde resin for cesium removal using tank waste simulants
- Demonstrate sludge partitioning and treatment of actual waste representative of Hanford tank waste
- Transfer waste dislodging and conveyance technology evaluation results in support of EM30's Tri-Party Agreement milestone M-06-00 "Develop single-shell tank retrieval technology" (New milestone M-45-01)
- Verify resorcinol/formaldehyde resin performance under repeated cycling on the SKID project
- Place contract with private industry for demonstrating new cesium-removal technologies (from ESPIP) and CPU fabrication

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Future Program Objectives – FY95

- **Complete cold testing of Light Duty Utility Arm (LDUA)**
- **Complete hot demonstration of Near Infrared Spectroscopy System for moisture determination and monitoring**
- **Initiate Nitrate-to-Ammonia-and-Ceramics (NAC) pilot plant operation at 0.2 l/min**
- **Complete TRUEX model validation**
- **Complete design of CPU deployment system**
- **Receive and initiate testing of initial CPU**

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Commercialization

Industry Partnerships:

- **Working with Spar Aerospace to develop and construct the Light Duty Utility Arm**
- **CRADA with Mechanical Technology, Inc. (MTI) to develop topographical tank mapping systems for deployment on the LDUA**
- **Working with Quest to develop high pressure abrasive water jet cutting technology for dislodging tank waste**
- **Working with the British Nuclear Fuels on an ion exchange column for cesium extraction and a SKID unit**
- **Working with Aitken on database development**
- **Working with the Westinghouse Science and Technology Center on a plasma arc calcination of tank waste**
- **Working with LICON, Inc. to develop a mobile evaporator/concentrator**
- **Technical exchange with Commissariat à l'Energie Atomique (CEA) of France to understand French waste management programs**

MD-OT-0116 36

Commercialization

Industry Partnerships (Continued):

- **Enserch (formerly Ebasco) is supplying technical, management, and regulatory support for UST-ID. Testing Raman and infrared sensors in realistic process environments with Ciba-Geigy**
- **Oceaneering Space Systems is building the Non-Destructive Examination End Effector for the LDUA**
- **Vista Research is developing an acoustic emission method for underground pipe leak detection**
- **The Naval Research Laboratory is providing studies on radiation affects to fiber optics**
- **Working with Science Engineering Association to provide radiation studies on probe components**
- **Developing a CRADA with Akzo to test the Spectroscopy instrument system**

MS-GT-016 37

Commercialization

Industry Partnerships (Continued):

- **National Instruments is providing the software and technical support for the LDUA computer interface**
- **CRADA with Non-Destructive Cleaning to develop decontamination methods for the LDUA end effectors**
- **Working with Perceptron to develop high resolution laser range finder**
- **Artisan is designing a mobile concentrator**

University Partnerships:

- **Working with University of Missouri, Rolla to research confined sluicing hydraulics for dislodging tank waste**
- **Working with Washington State University to develop a multifunction scarifier/conveyer**
- **Working with Florida State University to develop Laser Raman Spectroscopy for in-tank sensing**

MS-GT-016 38

Commercialization

University Partnerships (Continued):

- Working with Seattle University and Washington State University on the Compact Processing Unit Preconceptual Design
- Working with Florida International University to develop drying/sintering techniques using microwaves for the NAC process
- Working with Clark Atlanta University on resorcinol degradation studies
- Working with Texas Tech University on a tool to measure waste rheological properties
- Working with Purdue University on column design for cesium extraction
- The University of Tennessee is providing technical support to develop topographical tank mapping systems for deployment of the LDUA

WMA-OT-0116 39

Commercialization

University Partnerships (Continued):

- The University of Illinois is collecting extraction behavior data for the TRUEX model and is performing analysis work for the mobile evaporator concentrator
- Spring Harbor College is developing models for extraction of actinides for the TRUEX model
- Working with the University of South Carolina on testing Raman and Infrared Probes
- Working with Science Engineering Associates in developing fiber optics testing standards

WMA-OT-0116 40

UST-ID Scheduled Funding Profile

MB4-QT-0116 41

Facility Transitioning, Decommissioning, and Final Disposition
– Decontamination and Decommissioning of Facilities –

***Decontamination and Decommissioning of
Facilities Integrated Demonstration***

PM: Jerry M. Hyde

IDC: R. Keith Kibbe

Operations Offices: Oak Ridge, Savannah River

Laboratory Sites: Fernald, Hanford, Oak Ridge, Savannah River

EM-50 Division: DT&E

Principal Customers: EM-30, EM-40, EM-60

Applications Areas: Facility Transitioning, Decommissioning and Final Disposition

Joint Participants: FERMCO, MMES, WHC, WSRC

MD4-GT-0087- 1

Facility Transitioning, Decommissioning, and Final Disposition
– Decontamination and Decommissioning of Facilities –

Objective:

- To improve, adapt, and develop equipment and processes, and then demonstrate these processes to provide a total system approach to the transitioning, decommissioning and final disposition of facilities and sites across the Department of Energy complex

Scope:

- Bulk decontamination and material recycle processes
- Surface decontamination processes
- Dismantlement, robotics and automation processes
- Characterization processes

MD4-GT-0087- 2

Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

End Point:

- Adapted, improved or developed processes are being used in facility transitioning, decommissioning and final disposition
 - EM-30, EM-40, EM-60
 - EM Scrap Metal Recycling Program
 - Industry

M04-GT-0087- 3

Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Customer Needs:

- Contaminated metals recycling
- Contaminated concrete decontamination
- Fuel reprocessing facilities
- Reactor facilities
- Fuel storage pool facilities
- Gaseous diffusion plant facilities
- Hot cell facilities
- Plutonium processing facilities
- Uranium processing facilities
- Lithium processing facilities

M04-GT-0087- 4

Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Window of Opportunity Fuel Reprocessing Facilities

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Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Window of Opportunity Reactor Facilities

MO4-GT-0097- 6

Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Window of Opportunity Fuel Storage Facilities

MD4-GT-0097- 7

Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Window of Opportunity Hot Cell Facilities

MD4-GT-0097- 8

Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

- **User/regulatory interface**
 - EM-30
 - EM-40
 - EM-60
 - EH-12 (policy and standards)
 - EH-22 (Environmental Protection Agency)
 - EH-23 (Nuclear Regulatory Commission)
- **Ties to other efforts**
 - Characterization program
 - Efficient separations program
 - Innovative technologies
 - Pollution prevention
 - Robotics/automation program

ME4-GT-0087- 9

Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Work Breakdown Decontamination and Decommissioning of Facilities

Bulk Decontamination and Materials Recycle	Surface Decontamination	Dismantlement, Robotics, and Automation	Characterization
Melting Decontamination of Stainless Steel	Microwave Decontamination of Concrete	Dismantlement Tooling Delivery System with Improved Cutting Tools	Radiological Characterization of Equipment Interior Surfaces
Purification Decontamination of Nickel	Dry, Liquid or Gas Decontamination of Equipment Interior and Exterior Surfaces	Remote Disassembly and Component Handling System	Radiological Characterization of Dry and Wet Bulk Concrete
Electro-Osmotic Decontamination of Concrete	Dry or Liquid Decontamination of Dry and Wet Bulk Concrete	Operations Surveillance System	

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Funding FY94

Bulk Decontamination and Materials Recycle

TTP	Tech	\$ (K)	PI	Industry/Academic/Partner (Cost Share)
SR1-4-20-03	Stainless Steel Beneficial Reuse Demonstration	2900	Bill Boettinger	Consortium (28 percent)
OR1-4-20-05	Electro-Osmotic Concrete Decontamination	350	Ivan Morgan	Planned for FY 1995
OR1-4-20-06	Removal of Radiological Contaminants from Nickel Scrap	100	Wayne Hayden	None This FY

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Funding FY94

Surface Decontamination

TTP	Tech	\$ (K)	PI	Industry/Academic/Partner (Cost Share)
OR1-0-12-04	Microwave Concrete Decontamination System	800	Don Foster	Planning CRADA

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Facility Transitioning, Decommissioning, and Final Disposition
– Decontamination and Decommissioning of Facilities –

Funding FY94

Characterization

TTP	Tech	\$ (K)	PI	Industry/Academic/Partner (Cost Share)
SF3-4-20-01	Sampling and Tritium Measurements for SRS Steel Recycling	50	D. Kneff	None This FY

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Facility Transitioning, Decommissioning, and Final Disposition
– Decontamination and Decommissioning of Facilities –

Funding FY94

Planning and Site Support

TTP	Tech	\$ (K)	PI	Industry/Academic/Partner (Cost Share)
OR1-2-20-01	D&D Integrated Demonstration Coordination	350	Keith Kibbe	None This FY
OR1-3-20-07	PRDA Support - D&D	200	D. Neiswander	21 Industry Partners
FN1-3-20-01	PRDA Support - D&D	101	Don Herman	21 Industry Partners

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**Facility Transitioning, Decommissioning, and Final Disposition
– Decontamination and Decommissioning of Facilities –**

Program Funding Profile (in million \$)

FY90	FY91	FY92	FY93	FY94	FY95
0.8	0.2	1.1	1.7	4.9	15.9

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**Facility Transitioning, Decommissioning, and Final Disposition
– Decontamination and Decommissioning of Facilities –**

Schedule

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Major Milestones/Deliverables

Bulk Decontamination (Stainless):

- Technology Status Report (September 1994)
- Technology Status Report (September 1995)
- Technology Status Report with Consortium Test Results (September 1996)

Bulk Decontamination (Nickel):

- Technology Status Report (September 1994)

Bulk Decontamination (Electro-Osmosis):

- Technology Status Report with Field Test Results (September 1994)

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Major Milestones/Deliverables

Surface Decontamination (Microwave):

- Technology Status Report with Prototype Test Results (September 1994)
- Technology Status Report with Field Test Report (September 1995)
- System Performance Specification (January 1996)

Program Planning:

- Facility Transitioning, Decommissioning and Final Disposition Focus Area Strategic Plan, Management Plan and Implementation Plan (September 1994)

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Benefits/Cost Savings

Scrap stainless steel baseline process (sample, clean, size, transport, sample, bury) one stainless steel heat exchanger	\$320K
Scrap stainless steel improved process (sample, clean, size, melt, form, fabricate, sample, transport, use, bury slag) one stainless steel heat exchanger, (490 new waste boxes)	\$330K
Projected investment	\$16M
Projected savings (burial avoidance, waste container purchase avoidance) for stainless steel inventories	\$90M

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Benefits

Cost/Savings:

- Reduce the amount of exposure to workers (microwave)
- Reduce the amount of secondary waste requiring disposal (electro-osmosis)
- Reduce the amount of mixed waste requiring disposal (electro-osmosis)

Performance:

- Use stainless steel containers to replace carbon steel in high humidity areas (stainless)
- Minimize the amount of contaminant forced into the base material (electro-osmosis, microwave)

M94-GT-0097- 20

Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Benefits

Safety/Risk:

- **Minimize the amount of uncontaminated and virgin material required in the fabrication of waste containers (stainless)**
- **Minimize the amount of, and contain at the source, the airborne dust created (electro-osmosis)**

Regulatory:

- **Allow the use of residually contaminated material until an “unrestricted release” de minimis standard is adopted (stainless)**

Industry:

- **Create contaminated metals recycle industry using a consortium of private and government investment (stainless)**

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Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Program Issues

- **Lack of accepted release limits for recycle of materials**
 - **May significantly increase waste disposal quantities and costs**
- **Uncertainty in magnitude, diversity, scope and cost estimates**
 - **May impact planning and prioritization**

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Reference/Documentation

- **An Assessment and Evaluation for Recycle/Reuse of Contaminated Process and Metallurgical Equipment at the DOE Rocky Flats Plant Site - Building 865**
- **Decontamination and Decommissioning Technology Assessment**
- **DOE Weapons Complex Scrap Metal Inventory**
- **Technical Program Plan for Facility Transitioning, Decommissioning and Final Disposition Focus Area**

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Accomplishments

- **Issued the Stainless Steel Consortium (melt metal, form plate, and fabricate waste containers) Request for Proposals**
- **Demonstrated the surface decontamination of concrete at a rate of 40 square feet per hour using a pilot-scale microwave process mounted on a tethered vehicle in the laboratory at the Oak Ridge Site**
- **Published the Technical Program Plan for Facility Transitioning, Decommissioning and Final Disposition Focus Area**
- **Published the Assessment and Evaluation for Recycle/Reuse of Contaminated Process and Metallurgical Equipment at the DOE Rocky Flats Site - Building 865**

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Facility Transitioning, Decommissioning, and Final Disposition **– Decontamination and Decommissioning of Facilities –**

Future Program Objectives – FY 1994

- **Develop equipment for the bulk decontamination of stainless steel using a bench scale melting process**
- **Develop equipment for the surface decontamination of concrete using a pilot-scale microwave process mounted on a self-propelled, remotely operated vehicle**
- **Develop equipment for bulk decontamination of concrete using a bench-scale electro-osmotic process**

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Facility Transitioning, Decommissioning, and Final Disposition **– Decontamination and Decommissioning of Facilities –**

Future Program Objectives – FY 1995

- **Develop equipment for the bulk decontamination of stainless steel using a melting process, the conversion of the stainless steel into plates, and the fabrication of waste containers from the plates**
- **Develop equipment for the surface decontamination of concrete using a pilot-scale microwave process mounted on a self-propelled, remotely operated vehicle**

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Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Future Program Objectives – FY 1995

- **Develop equipment for the bulk decontamination and purification of nickel using either a bench-scale melting or refining process**
- **Develop equipment for the bulk decontamination of concrete using a pilot-scale electro-osmotic process**
- **Develop equipment for the in situ surface decontamination of equipment interior and exterior surfaces using either a pilot-scale dry, liquid or gas process**
- **Develop equipment for the dismantlement and handling of concrete structures using either a pilot-scale remote or a hands-on process**

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Facility Transitioning, Decommissioning, and Final Disposition

– Decontamination and Decommissioning of Facilities –

Commercialization

Industry:

- **F2 Associates (laser cleaning decontamination)**
- **Isotron Corporation (bulk concrete decontamination)**
- **Manufacturing Sciences Corporation (nickel decontamination)**
- **Membrane Technology & Research (protective clothing)**
- **Molten Metal Technology (bulk metal decontamination)**
- **Oceaneering Space Systems (worker protection system)**
- **Oceaneering Technologies (dry ice decontamination)**
- **Science & Engineering Associates (interior characterization)**
- **Scientific Ecology Group (bulk metal decontamination)**
- **Scientific Ecology Group (equipment decontamination)**
- **Textron Defense Systems (electro-hydraulic decontamination)**
- **Westinghouse Electric Corporation (bulk metal characterization)**

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Commercialization

University:

- Carnegie Mellon University (asbestos removal)
- Carnegie Mellon University (dismantlement delivery system)
- Florida International University (microwave decontamination)

Technology Transfer:

- Through Program Research and Development Announcement and Research Opportunity Announcement projects

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Facility Transitioning, Decommissioning, and Final Disposition – Decontamination and Decommissioning of Facilities –

Cost/Schedule Performance (\$M)

MD4-GT-0007- 30

Efficient Separations and Processing Integrated Program

PM:	Dr. Teresa Fryberger
IPC:	Dr. Bill Kuhn Dr. Jack Watson
Operations Offices:	HQ
Laboratory Sites:	All
EM-50 Division:	R&D
Principal Customers:	EM-30, USTID, D&D, EM-40, MWIP
Application Areas:	Waste Retrieval and Processing Soils and Groundwater

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Presentation Contents

- I. Efficient Separations IP**
 - Objectives**
 - Scope**
 - Organization/Participants**
- II. Separations for Focus Areas**
 - Needs**
 - Example Technologies**
 - Plans**
- III. Supplemental/Details**

M94-GT-0143- 2

Efficient Separations Mission

Efficient Separations and Processing:

- **EM-50 Integrated Program**
- **Started in Spring of 1991 with 2 national workshops**

Mission:

- **Provide separations technologies for DOE radioactive and hazardous wastes**
- **Coordinate separations technologies within the EM complex**
- **Transfer demonstrated technology to the private sector**

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DOE Separations Needs

- **Removal of radionuclides and other contaminants from waste to meet DOE ES&H needs by**
 - **Reducing waste volumes**
 - **Improving waste forms**
 - **Easing handling requirements**
 - **Improving decontamination/recycle**
 - **Reducing remediation and waste treatment costs**

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Incentives for Separations

Example: High Level Waste

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The Technical Challenge

- Often the toxic materials to be removed are exceedingly dilute —> *high affinity*
- Chemically similar components with widely differing concentrations must be separated —> *high selectivity*
- Radiation or pH destroys materials used in many separation processes —> *durability*
- Separation processes must be operable with little or no "hands on" control —> *simplicity*

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Efficient Separations: Strong Ties to Customers

MD4-GT-0143- 7

Efficient Separations Toolbox Approach

MD4-GT-0143- 8

Efficient Separations and Processing Integrated Program

- 26 Projects
- 60 percent of the TTPs have outside collaboration

Funding Profile

FY92	FY93	FY94	FY95
\$1.6M	\$11.4M	\$14.0M	\$16.7M

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Efficient Separations Industrial Collaborations

Industrial Collaborations

- IBC Corp.
- Bradtech
- UOP
- SAIC
- 3M
- Allied Signal
- Khlopin Radium Institute

22%
FY94
funds!

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Efficient Separations: Other Linkages

- **University collaborations**
 - Texas A&M
 - U. Cal. Berkeley
 - Northern Illinois State
 - Georgia Institute of Technology
 - Clemson
 - U. So. Carolina
 - Colorado State U.
 - MIT
 - U. of Illinois
 - U. of New Mexico
 - Tenn. Tech U.
- **International collaborations**
 - Russia
 - Japan
 - Czech Republic
 - Canada
- **Strong ties to scientific community (BES, NE, ACS, AIChE)**

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Major Focus Areas

- **High Level Waste Tanks**
- **Contaminant Plume Remediation**
- **Transitioning, Decommissioning, and final Disposition**
- **Characterization, Treatment, and Disposal of Mixed Waste**
- **Landfill Stabilization**

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Total Volume of DOE HLW

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Tank HLW

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Treatment of HLW Tanks

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Separations Issues — Tri-Party Agreement

- Can we develop adequate Cs and Sr separations to make supernate for a commercial glass plant in time to meet schedules? (FY96 technology selection)
- Will alkaline wash reduce sludge volume sufficiently to avoid cost and repository issues? (FY98 sludge wash decision)

M94-GT-0143- 16

Technical Objectives for Tank HLW

- **Develop aqueous separations technologies (acid & alkaline)**
 - Cs, Sr, Tc
 - TRU removal
 - Removal of species incompatible with glass
- **Develop treatment methods for sludges**
 - Caustic treatment
 - Acid dissolution
 - Behavior prediction
- **Develop treatment methods for calcine**
 - Pyrochemical removal of radionuclides

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ESPIP Sponsored Aqueous Separations/Processes

Cesium and Strontium Removal

- **Remove short-lived isotopes to ease handling requirements and improve waste form quality**
- **Develop treatment for supernates, washwater, dissolver liquids (acid and base side)**
- **Technologies include**
 - Titanate (SNL-UOP)
 - Pillared clays (Allied Signal-Texas A&M-PNL)
 - Cobalt dicarbollide (INEL-KRI, SRS, LANL)
 - Crown ether attachment to solids (3M-IBC-PNL)
 - Advanced solvent extraction (ANL)
- **Window of Opportunity: FY94-96**
- **Milestone: Transfer to UST-ID in FY95**

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TRU and Other Separations

- **Separate long-lived TRUs and concentrate into a small volume**
- **Current Projects:**
 - **Sequestering agents on solid based polymers (LANL)**
 - **Sequestering agents/magnetic beads (ANL/Bradtech)**
 - **Advanced solvent extraction (ANL)**
 - **Technetium Removal (LANL, ORNL)**
 - **Aqueous Biphasic Systems (ANL)**
 - **Technology Evaluation and Process Definition (WHC-PNL)**

Window of Opportunity: FY94-02

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Technical Objectives: Tank HLW

- **Sludge Treatment**
 - **Recover radionuclides from complex sludges**
 - **Reduce HLW volume**
 - **Remove troublesome chemicals for better waste form**
 - **Current projects**
 - **Comprehensive Sludge Treatment (ORNL, USTID)**
 - **Sludge washing/dissolution behavior**
 - **Colloid formation**
 - **Aluminum removal**
 - **Alkaline Sludge Treatment (PNL)**
 - **Selective leach/wash (Bradtech)**
 - **Complexation**
 - **Plasma – calcine treatment (WHC, EM-30)**
 - **Sludge Workshop (April 94)**
- **Window of Opportunity: FY94-98**

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Major Focus Areas

- High Level Waste Tanks

- Contaminant Plume Remediation
- Transitioning, Decommissioning, and final Disposition
- Characterization, Treatment, and Disposal of Mixed Waste

- Landfill Stabilization

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Soils & Groundwater

Problems are:

Varied, dilute contaminants
Host matrix complexity
Strong binding possible
Large leachate volumes
Absence of technologies (tritium)

Status:

Tritium removal/Catalytic exchange (SRS)
Tritium removal/membrane (PNL)
Separations toolbox

Future:

Ligand development for barriers
Enhanced aqueous separations toolbox
(Selective leaching for soils)

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D&D/Facilities

MS4-GT-0143- 23

Mixed Waste

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Example Technology: A DOE/Industry Partnership

Selective removal of Cs and Sr from nuclear wastes

Partnership

- 3M: Empore membrane
- IBC Advanced Technologies; Designer molecule
- PNL: Radiolytic and actual waste testing

M04-GT-0143- 25

Feasibility

- 4 ligands synthesized, specific to cesium and strontium under acidic and basic conditions
- Remove parts per billion in presence of large excess of potassium and sodium with at least 99.999 percent efficiency
- 400 fold increase in flow rates over packed columns
- Cartridges produced

M04-GT-0143- 26

Bonded Macrocyclic Sequestering Agents

MB4-GT-0143- 27

Single Use Cartridge

- 4 sq. ft. cartridge
- 88 gm superlig for cesium
- Process 360 liters
- Absorb 2.26 gm cesium
- Run at 8 liters per minute
- 45 minutes per cartridge
- Elution volume: 250 ml

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2 of 3

Plans

1. Tests

- INEL acid waste (FY94)
- ORNL supernate (FY95)
- SRS full scale (FY95)

2. Other applications

- Technetium
- Mercury

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Efficient Separations and Processing IP

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Efficient Separations FY94 Funding

TRU & Other Aqueous Separations

TTP	Title	\$ (K)	PI	Affiliation
AL121217	Solid Sequestering Agents/Removal of TRU	300	G. Jarvinen	LANL Florida State University
CH232005	Advanced Processing for Clean Option	400	P. Horwitz	ANL
CH232006	Aqueous Biphasic Systems/Radioactive Waste Pretreatment	350	D. Chalko	ANL MIT
RL321204	High Capacity, Highly Selective Sequestrants for Innovative Chemical Separation	4894	D. Wester	PNL Allied Signal, 3M/IBC Texas A&M
RL332008	Technology Evaluation and Process Development - Unit Level	710	L. Lauerhaus	PNL
RL342003	Separations of HTO Using Membranes	220	D. Nelson	PNL
RL411205	Technology Evaluation and Process Development - Global Level	200	S. Seeman	PNL

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Efficient Separations FY94 Funding (Continued)

TRU & Other Aqueous Separations (cont'd)

TTP	Title	\$ (K)	PI	Affiliation
SF132001	Removal & Recovery of Toxic Metal Ions/Aqueous Waste Streams	540	R. Fish	LBL
SF232003	Derivatives of Natural Complexing Agents for the Removal of Pu from Waste Waters	263	D. Hoffman	UC Berkeley
SR142002	Aqueous Phase Catalytic Exchange Detritiation of Waste	330	M. Lee	SRS U. South Carolina

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Efficient Separations FY94 Funding (Continued)

Sludge Treatment

TTP	Title	\$ (K)	PI	Affiliation
OR132012	Sludge Washing & Dissolution of ORNL MVST Waste	2050	P. McGinnis	MMES Tenn. Tech. U. Georgia Institute of Tech.
RL332018	Alkaline Tank Sludge Treatment	451	J. Greeting	PNL Bradtec

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Efficient Separations FY94 Funding (Continued)

Hazardous Waste Dest'n and Sep'n

TTP	Title	\$ (K)	PI	Affiliation
AL142001	Vacuum Distillation Separation of Plutonium Waste	406	E. Garcia	LANL
RL442002	Significant Volume Reduction of Tank Waste by Selective Crystallization of Sodium Nitrate as a Clean Salt	300	D. Herting	WHC
SR132005	Development & Evaluation of Electrochemical Methods of Destroying Nitrates and Nitrites in HLW and LLW	850	D. Hobbs	SRS U. South Carolina Texas A&M

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Efficient Separations FY94 Funding (Continued)

Fission Product Removal

TTP	Title	\$(K)	PI	Affiliation
AL132010	Fission Product Chemistry	1026	M. Attrep	LANL Colorado State U.
AL232004	Waste Separation and Pretreatment Using Titanate Ion Exchangers	675	N. Brown	SNL UOP
AL242002	International Separations Work	250	R. Mataluci	SNL SAIC, KRI
CH232004	Magnetically Assisted Chemical Separations	350	L. Nunez	ANL U. of Ill., No. Ill. U. Bradtec
SR132007	Carbolilide/CDCB Process Development for Radioactive Cesium-137 Decontamination	590	D. McCabe	SRS Clemson

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Efficient Separations FY94 Funding (Continued)

Calcine Treatment

TTP	Title	\$(K)	PI	Affiliation
ID421201	Pyrochemical Treatment and Immobilization of Idaho Chemical Processing Plant HLW Calcine	700	T. Todd	WINCO
RL432004	Calcine Residue Leaching	325	C. Culley	WHC

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Schedule

	FY93	FY94	FY95	FY96	FY97	FY98	FY99
Pyroprocess for HLW Calcine			1				
Develop/Implement Technology Selection/ Systems Analysis Tool							
Cesium and Strontium Removal from Supernates			2	3			
Organic/Nitrate Treatment							
Transuranic and Fission Product Removal from Aqueous Wastes							
HLW Sludge Treatment							
Identify EM-40 Needs and Establish Coordination Network							
Heavy Metal Removal							
Noble Metal Removal							
Tritium, Carbon-14, Iodine-29 Separation							
Transfer to Industry							

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Major Milestones/Deliverables

1. Issue Technology Status Report and "go/no-go" decision on integrated demonstration, testing, and evaluation phase for pyroprocessing
2. Determine feasibility of using cobalt dicarbollide or its derivatives to precipitate cesium from Savannah River Site High Level Waste streams
3. Transfer industrial cesium and/or strontium removal technology to integrated process demonstration, testing, and evaluation phase

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Benefits

Cost/Savings:

- \$30-40 billion cost reduction in high-level waste disposal
- Delay need for renegotiation of defense repository space or second repository
- Decrease costs of radioactive waste treatment

Performance:

- Improved quality of final waste forms
- Decrease in secondary waste streams generated from waste treatment

Safety/Risk:

- Decrease health/safety risks of radioactive waste treatment

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Benefits (Continued)

Regulatory:

- Compliance with Federal Facility Compliance, Interagency, and Tri-Party Agreements
- Compliance with Section 222 of the Nuclear Waste Policy Act of 1982

Industry:

- Many technologies will have general use in/benefit to industry

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Program Issues

- **Facilities, permitting, and availability of samples for testing and demonstration of new technologies on actual tank waste are limited and expensive. Testing on real wastes is crucial to the success of technologies for certain applications (e.g. sludge processing)**
- **Technology selection is frequently driven by facilities, planned, or existent. This may be due to huge times required for licensing, approval, etc. of facilities. The result can be that promising technologies are excluded from consideration by unnecessary specifications**
- **Waste acceptance criteria need to be developed to plan technology performance standards**

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Reference/Documentation

- **ESPIP FY93 Technology Catalogue**
- **ESPIP FY95 Needs Statement**
- **FY93 & FY94 Mid-year Review Briefing**
- **ESPIP Fact Sheet**
 - **“Selective Removal of Cesium and Strontium from Nuclear Wastes”**
 - **“Radioactive Waste Treatment”**
 - **“Developing Advanced Chemical Treatment for Nuclear Waste Management and Environmental Restoration”**

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Accomplishments

- Continue international dialogue and technical exchanges on separations technologies
- Initiate sludge treatment on actual waste
- Continue studies of pyrochemical processing and equipment feasibility tests; make "go/no-go" decision on whether to further pursue pyroprocessing/transfer to EM-30 if go decision
- Develop separations technologies for extraction of heavy metals and technetium from HLW and LLW

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Future Program Objectives

- Transfer an industrial cesium/strontium removal technology to customer (EM-30)
- Initiate separations needs assessment for low-level and mixed wastes
- Begin extension of new technologies developed for HLW to contaminated soil and groundwater cleanup via selective extraction and separations of TRUs and toxic metals
- Begin evaluation of separation methods developed for HLW for treating mixed wastes, soils, groundwater, and toxic wastes

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Future Program Objectives – FY95

- **Initiate/continue R&D for processing of mixed and low-level wastes. Particular emphasis on adaptation of technologies developed for HLW treatment to these needs**
- **Continue work on sludge processes and testing on actual wastes. Develop database on results for range of actual waste compositions to provide input for treatment of dissolved sludges**
- **Expand work on industrial cesium/strontium removal technologies completed in FY94 to other waste streams and radionuclides**
- **Continue development of technology selection tool for INEL and RF**
- **Continue work on advanced processing schemes, incorporating data on new technologies and sludge treatment studies developed in the program**

Office of Technology Development (EM-50)

Mixed Waste Integrated Program (MWIP)

Program Manager:

Dr. Paul W. Hart

Integrated Program Coordinator: Ms. Jeanette B. Berry

Operations Office: Headquarters

Laboratory Sites: All DOE National Laboratories

EM-50 Division: Research and Development (EM-54)

Principal Users: Industry (Commercialization)

Office of Waste Management (EM-30)

Office of Environmental Restoration (EM-40)

Office of Facility Transition and Management (EM-60)

Application Area: Mixed Waste Characterization, Treatment and Disposal

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MWIP Joint Participants – Industry (19)

Synthetica Corp. (AL 242001)

Retech, Inc. (ID 142001)

Pacific Nuclear, Inc. (RL 332009)

Delphi Research, Inc.

Vortec, Inc. (PRDA)

MSE, Inc. (ID 142001)

Pall Corp. (SR 242001)

PSI Environmental (AL 342003)

General Electric Company (OR132010)

Molten Metals Technology, Inc. (PRDA)

StirMelter Division of Glasstech, Inc. (SR 132004)

EnVitco Division of Toledo Engineering, Inc. (SR 132004)

Rust Remedial Services, Clemson Technical Center (SR 132004)

Science Applications International Corp. (ID 142001)

HPD Inc. (RL 442001)

ADA Technologies (AL 342002)

IT Corp. (AL 121219)

Aerojet General Corp. (ROA)

SEG Inc. (PRDA)

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MWIP Joint Participants - Universities (6)

**Clemson University DOE/Industry Center for Waste
Vitrification Research (SR 132004)**

**Diagnostics Instrumentation and Analysis Laboratory at
Mississippi State University (CH 242003)**

Massachusetts Institute of Technology (RL 332009)

University of Illinois (CH 242004)

University of Iowa (CH 242001)

Georgia Institute of Technology (SR 142001)

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Scope

**Identify, evaluate, develop, demonstrate, and
transfer technologies and systems to characterize,
treat, and dispose of DOE mixed low-level waste.**

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Objectives

- **Conduct three field-scale demonstrations by FY97 on technologies which will be capable of treating 75 percent of the current mixed waste inventory**
 - Accelerate technology development schedules
- **Promote public/regulatory acceptance of mixed waste characterization, treatment and disposal technologies**
 - Participate in the Western Governor's Association (WGA) Advisory Committee to Develop On-site Innovative Technologies (DOIT) Mixed Waste Working Group process (plasma hearth process demonstration)
 - Produce final waste forms which meet disposal criteria
 - Develop robust technologies that have reduced waste characterization requirements
- **Involve the private sector to increase efficiency and strengthen the U.S. industrial base**
 - Industrial involvement with TTP's, PRDA's, and ROA's
- **Develop closed-loop treatment systems**
 - No secondary waste streams released to environment
 - Capture and treat off-gas
 - Real-time monitors, controls, and diagnostics

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Definition of Success

- **Deliver technologies and treatment systems that will treat waste to comply with RCRA Land Disposal Restrictions and DOE Orders**
- **Demonstrate technologies in 1-2 years**
 - Vitrification FY94-95
 - Plasma Hearth Process FY95-96
- **Have technologies ready for field-scale implementation in 3-5 years**
- **Transfer successful technologies to:**
 - Industry
 - Other Office of Technology Development Programs
 - Office of Waste Management (EM-30)
 - Office of Environmental Restoration (EM-40)
- **Develop technologies that are permittable, and publicly acceptable**
 - Involve stakeholders and regulators

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User/Customer Needs

- **Engineering design packages for MWIP-developed technologies**
- **Permittable and publicly accepted technologies and treatment systems**
- **Versatile technology systems for the treatment of inventoried mixed low-level waste**
- **Technologies and treatment systems that will allow DOE to meet regulatory schedules and agreements**

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Window of Opportunity

- **Waste treatment schedules are set by**
 - **The Federal Facility Compliance Act of 1992 (Site Treatment Plans due October 1995)**
 - **DOE Orders (require that all waste be treated by 2019)**
 - **Site-specific Federal Facility agreements**
- **MWIP will impact DOE's response to regulatory schedules by providing**
 - **More cost- and performance-effective mixed low-level waste treatment systems**
 - **Treatability study capability**

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User/Regulatory Interface

- **Western Governors' Association**
 - **Advisory Committee to Develop On-Site Innovative Technologies (DOIT Committee)**
 - **Mixed Waste Working Group (MWWG)**
- **Environmental Protection Agency**
- **State of Idaho (Plasma Hearth Process)**
- **State of South Carolina (Vitrification System)**

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Ties to Other Efforts

- **Rocky Flats Compliance Program**
- **Buried Waste Integrated Demonstration**
- **Minimum Added Waste Stabilization**
- **Mixed Waste Landfill Integrated Demonstration**
- **Underground Storage Tanks Integrated Demonstration**
- **Robotics**
- **Efficient Separations and Processing Integrated Program Robotics**
- **Characterization, Monitoring, and Sensor Technology Integrated Program**
- **Diagnostics, Instrumentation and Analysis Laboratory**

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Ties to Other Efforts

- DOE Office of Waste Management
- DOE Office of Environmental Restoration
- DOE Office of Energy Research
- Cooperative Research and Development Announcement
- Program Research and Development Announcements
- Research Opportunity Announcements
- Small Business Innovative Research
- Strategic Environmental Research and Development Program
- National Science Foundation
- Department of Defense/DESA

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MWIP Technical Structure

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Development of Plasma Treatment System

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Development of Vitrification Treatment System

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Development of Molten Metal Treatment System

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FY94 MWIP Funding Profile (\$ x 1000)

Plasma Hearth Process	5,694
Vitrification	4,660
Offgas Technologies	2,135
Other	7,092
Total Allocated	19,581

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MWIP Funding Profile

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Plasma Hearth Process Development

	FY94	FY95	FY96	FY97
Nonradioactive Testing				
Design Pilot-Scale System	██████████			
Testing		██████████		
Bench-Scale Radioactive Testing				
Design System	██████████	██████████		
Radioactive Testing		██████████		
Field-Scale Radioactive Testing				
Design System	██████████	██████████	██████████	
Compliance Testing				██████████
Initial Waste Operations				██████████

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Vitrification Process Development

	FY94	FY95	FY96	FY97
Nonradioactive Testing at Clemson University Initial Test Phase Process Limits Support Radioactive Operations	████████████████████	████████████████████		
Bench-Scale Radioactive Testing (CRADA with SEG and StirMelter) Design System Radioactive Testing	████████████████████ ████████████████████	████████████████████		
Field-Scale Radioactive Testing (Ash Vitrification CRADA with SEG and EnVltCo) System Design Testing	████████████████████ ████████████████████	████████████████████		
Field-Scale Radioactive Testing (Modular System) System Design Testing	████████████████████ ████████████████████	████████████████████ ████████████████████	████████████████████	
Field-Scale Radioactive Testing (Solid Waste Vitrification) Design System Compliance Testing Initial Waste Operations	████████████████████ ████████████████████	████████████████████ ████████████████████	████████████████████ ████████████████████	

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Benefits

Cost Savings (Based on current MLLW inventory of 250,000m³)

- Plasma Arc Furnace¹
 - Baseline Incineration Treat and Dispose Cost = \$14–27K per m³
 - Plasma Arc Furnace Treat and Dispose Cost = \$6–12K per m³
 - Minimum Cost Savings across DOE Complex = \$400 Million
- Vitrification cost/benefit analysis in progress
 - Targeting a \$300M cost savings

Performance

- Improved final waste form quality
- Reduced volume of waste for final disposal
- Potential for reuse of metals

¹ "Life Cycle Cost Analysis for the Plasma Arc Furnace," Steven Booth, LANL, and Peter Barnes Smith, IT Corporation, Oct. 1993

Safety/Risk

- Decreased waste handling reduces worker exposure
- Environmental releases are minimized

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Benefits

Regulatory

- **Achieve compliance with two sets of regulations:**
 - **Resource Conservation and Recovery Act (RCRA)**
 - **Atomic Energy Act (AEA) and DOE Orders**
- **Optimal characterization requirements**
- **Improved process monitoring and controls**
- **Public acceptability**

Industry

- **Improved U.S. industrial competitiveness**
- **Technology transfer**
- **Medical waste capacity**
- **Commercial nuclear power waste**

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Program Issues

Regulatory Agency Participation

- **Expedited permitting for radioactive waste treatment demonstrations in FY94-95**
- **Waste acceptance criteria and characterization requirements for versatile treatment technologies**

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FY 1991-94 Accomplishments

- **Conducted bench-scale testing of the plasma hearth process, demonstrating the destruction of surrogate wastes and production of a highly durable glass/slag waste form**
- **Conducted life cycle cost analysis, and risk/preliminary hazards analysis for the plasma hearth process**
- **Conducted laboratory and bench-scale vitrification tests showing the production of an enhanced vitrified waste form**
- **Demonstrated Vortec's combustion and vitrification technology on surrogate mixed waste incinerator ash**

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FY 1991-94 Accomplishments

- **Established the DOE/Industrial Center for Vitrification Research at Clemson University for use as a technical resource for MWIP's vitrification effort**
- **Published 24 technology assessments reports**
- **Evaluated microwave vitrification and decontamination treatment technology**
- **Conducted bench-scale testing of silent discharge plasma technology for the destruction of VOCs in gas streams**

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FY 1994 Activities

Technology Demonstrations

- Vitrification (on radioactive waste)
- Steam reforming
- Mercury removal from aqueous and sludge wastes
- Particulate removal for two cleanable HEPA filter systems
- Thermoplastic encapsulated waste forms

Demonstrations of Process Monitoring and Controls

- Field-scale alpha detection in gas streams
- Real-time, continuous emission monitors for NH₃, Hg, organics

Other Activities

- Construct a field-scale mobile vitrification treatment system
- Cost/benefit and risk assessment reports for the Vitrification Treatment System
- MWIP is collaborating on plasma arc testing in Russia

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Future Activities

- Expedited Demonstrations on Radioactive Wastes
 - Plasma hearth process
 - Field-scale mobile vitrification system
- Other Activities
 - Complete development of the cleanable HEPA filter system selected in FY94
 - Initiate development of closed loop offgas systems for thermal treatment technologies
 - Establish automated materials waste handling process for plasma arc technology
- Other Activities
 - Collaborate with States/EPA/stakeholders to support decision making on mixed waste technologies
 - Accelerate development of alternatives to thermal technology
 - Initiate development of mixed waste debris treatment technologies

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Commercialization

Retech, Inc. - Plasma Arc Furnace

StirMelter Division of Glasstech, Inc. - Vitrification Melters

EnVitCo of Toledo Engineering, Inc. - Vitrification Melters

Pacific Nuclear, Inc. - Vitrification Melter

Vortec, Inc. - Combustion and Melting System

Synthetica, Corp. - Steam Reformer

Delphi Research, Inc. - Wet Oxidation Reactor

ADA Technologies - Ammonia Monitors

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The MWIP Team

PI	Affiliation
Warner Bergman	Lawrence Livermore National Laboratory
Jan Berry	Oak Ridge National Laboratory
Dennis Bickford	Savannah River
William Bostick	Oak Ridge National Laboratory
Steve Booth	Los Alamos National Laboratory
Cliff Brown	Los Alamos Technology Office
David Chaiko	Argonne National Laboratory-East
Pat Coyle	Lawrence Livermore National Laboratory
J. Cunnane	Argonne National Laboratory-East
Les Dole	Oak Ridge National Laboratory
D.E. Fain	Oak Ridge National Laboratory
Juan Ferrada	Oak Ridge National Laboratory
Eena-Mai Franz	Brookhaven National Laboratory
Nina French	Sandia National Laboratory
Randy Gibson	Oak Ridge National Laboratory
Robert Gillins	Science Applications International Corporation
Ray Geimer	Science Applications International Corporation
R.E. Gritz	Los Alamos National Laboratory
M.F. Hardwick	Sandia National Laboratory
Donnie Helton	Savannah River

PI	Affiliation
Carol Jantzen	Savannah River
Paul Kalb	Brookhaven National Laboratory
Theodore Krause	Argonne National Laboratory-East
John Mayberry	Science Applications International Corporation
John McFee	International Technology Corporation
Grant McLellan	Argonne National Laboratory-West
J. Ottesen	Sandia National Laboratory
J.J. Perona	Oak Ridge National Laboratory
Rich Peters	Pacific Northwest Laboratory
Ankur Purohit	Argonne National Laboratory-East
Richard Ragaini	Lawrence Livermore National Laboratory
Bill Scott	Idaho National Engineering Laboratory
Randy Singer	Savannah River
Dileet Singh	Argonne National Laboratory-East
Jerry Sprung	Sandia National Laboratory
Arun Wagh	Argonne National Laboratory-East
L.C. Walters	Argonne National Laboratory-West
J. Wang	Sandia National Laboratory
Clyde Ward	Savannah River
John Wong	Westinghouse Hanford Company

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Funding FY94
Materials Handling Technical Area

TTP	Title	\$ (K)	PI	Industrial/Academic/ Partners
SR142001	SR Remote Material Handling	50	Randy Singer	Georgia Tech
SR142005	Materials Handling Technical Support Group	100	Clyde Ward	

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Funding FY94
Chemical/Physical Treatment Technical Area

TTP	Title	\$ (K)	PI	Industrial/Academic/ Partners
CH242001	Biocatalytic Destruction of Nitrate and Nitrite	150	David Chaiko, Theodore Krause	U. of Iowa
RL442001	Freeze Crystallization Technology	600	John Wong	J.L. Humphries & Assoc. FTCAC HPD Inc.
OR132010	MWIP Mercury Control	580	J.J. Perona	General Electric Co.
CH221104	Destruction of Hazardous Waste Chlorocarbons via Catalytic Hydrodechlorination	192	Theodore Krause	U. of Iowa
OR132016	Chemical/Physical Treatment Technical Support Group	100	Cliff Brown	

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Funding FY94

Waste Destruction and Stabilization Technical Area

TTP	Title	\$ (K)	PI	Industrial/Academic/ Partners
AL242001	Steam Reforming of Mixed Waste	500	Jerry Sprung	Synthetica Corporation
CH242007	Plasma Hearth Process Facility Development at Argonne West	1,200	Grant McLellan	SAIC, Retech
ID032001	Plasma Hearth Process Bench-Scale Procurement	500	Robert Gillins	SAIC, Retech
ID142001	Plasma Hearth Process Engineering Development and Demonstration	3,475	Ray Geimer	SAIC, Retech
CH242005	Plasma Hearth Process Slag/Metal Product Development	400	Ankur Purohit	
ID142023	Plasma Support	119	Bill Scott	
OR142002	Waste Destruction & Stabilization Technical Support Group	100	John McFee	

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Funding FY94

Offgas Technical Area

TTP	Title	\$ (K)	PI	Industrial/Academic/ Partners
OR142001	Cleanable HEPA	100	D.E. Fain	
AL342003	Continuous Monitor Tunable Diode Laser for NH ₃ Contaminant Detection	500	J. Ottesen	PSI Environmental
AL342002	Control and Recovery of Vapor Phase Hg	295	M.F. Hardwick	ADA Technology
AL142003	Development of a Real - Time Monitor for Alpha Particles	400	R.E. Gritz	
AL221207	Offgas Technical Support Group	100	Nina French	
AL342004	Continuous Monitor for Hg in Gases and on Solids	390	J. Wang	ADA Technology
HQ042001	HEPA Filter Demonstration	750	TBD	TBD
SF242001	Demonstration Proof of Concept Cleanable Steel HEPA	100	Werner Bergman	Pall Corporation

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Funding FY94

Final Forms Technical Area

TTP	Title	\$ (K)	PI	Industrial/Academic/ Partners
CH332001	Waste Form Performance Criteria	180	Eena-Mai Franz	
SR132004	Vitrification Process Limits	2,100	Dennis Bickford	Clemson University StirMelter, Inc. EnVitCo, Inc. U. of Missouri-Rolla NY State College of Ceramics Virginia Military Institute Rust Engineering, Inc.
RL332009	Vitrification Process Limits/Treatability Studies	800	Rich Peters	Massachusetts Institute of Technology Pacific Nuclear
CH342001	Mixed Waste Treatability - Thermoplastic Final Form	600	Paul Kalb	
CH242004	Phosphate Bonded Ceramic Waste Forms	300	Arun Wagh, Dileet Singh, J. Cunnane	U. of Illinois
SR142009	Vitrification Demonstration on an Actual Mixed Waste Stream	1,400	Dennis Bickford Carol Jantzen	Clemson University Others to be determined
OR132017	Final Waste Forms Technical Support Group	100	John Mayberry	Science Applications International Corporation

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Funding FY94

General Technical Support

TTP	Title	\$ (K)	PI	Industrial/Academic/ Partners
AL121219	Cost Savings Analysis	50	Steve Booth	IT Corporation
SR132008	Vitrification Support	180	Donnie Helton	
CH242003	Process Monitoring and Control	350	L.C. Walters	Diagnostic Instrumentation and Analysis Laboratory at Mississippi State University
OR132002	Systems Analysis for MWIP	200	Juan Ferrada Randy Gibson	
OR121202	Mixed Waste Support (IPC)	750	Jan Berry	
OR132015	Waste Stream Diagnostics and Control	100	William Bostick	
SF221211	Risk Assessment for MWIP	50	Richard Ragaini	EPA, Science Applications International Corporation
OR142004	Support of FFCAct STP Emerging Technologies	410	Les Dole	
SF242002	MWIP Support	185	Pat Coyle	

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MWIP Collaborative Research

Project Title	Industrial Participant	Objective	Estimated Cost
Program Research and Development Announcements			
Research and Development of an Innovative Fossil Fuel Fired Vitrification for Soil Remediation	Vortec Corporation, 3770 Ridge Pike Collegeville, PA	Develop and deploy an innovative fossil fuel fired vitrification process for the remediation of soils containing hazardous and/or radioactive constituents. The process is an extension of an advanced, multi-fuel capable, combustion and melting system (CMS) technology being developed for commercial glass manufacturing and waste processing/recycling.	10,687K
Catalytic Extraction of Scrap Metal	Molten Metals Technology 950 Winter Street, Suite 4100 North Waltham, MA 02154	Apply its patented technology, Catalytic Extraction processing (CEP), to radioactively contaminated scrap metal. In the CEP, wastes are fed into a sealed molten iron bath operating at 2,000°K where they are broken down into their constituent elements. Through the addition of selective reactants, these elements recombine to form commercially viable products which partition into a metal phase, a ceramic phase, and a gaseous phase. The radioactive metals partition to the dense, low volume ceramic phase. The metal phase is suitable for DOE reuse.	1,255K
Decontamination of Process Equipment using Four Technologies	Scientific Ecology Group, Inc. 1560 Bear Creek Rd. Oak Ridge, TN 37830	Evaluate decontamination of compressor units from Oak Ridge K-25 facility using 1) high pressure water system, 2) dry abrasive impingement, 3) liquid abrasive system, and 4) dry ice blasting. The proposed work will involve technical and economical comparisons of these four technologies.	490K

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MWIP Collaborative Research

Advanced Technologies for Decontamination and Conversion of Radioactively Contaminated Scrap Metal to High Value Intermediate and Final Product Forms	Manufacturing Sciences Corporation 804 Kerr Rd. Oak Ridge, TN 37830	Manufacturing Sciences Corporation and the Colorado School of Mines have teamed up to develop a technology for reusing radioactively contaminated nickel. They will decontaminate the nickel, then alloy it with decontaminated steel and purchased chromium to produce stainless steel. They will use the stainless steel to make containers suitable for storing vitrified high-level nuclear waste.	3700K
Research Opportunity Agreements			
Platelet-Cooled Plasma Arc Torch	Aerojet General Corp. P.O. Box 3530 Rancho Cordova, CA 95741	Use Aerojet's proprietary platelet technology to improve the efficiency of plasma arc torches by increasing the life of the anodes of existing plasma arc torches used for the vitrification of low-level waste.	521K
Interagency Agreements			
Diagnostic Instrumentation and Analysis Lab	Mississippi State University	DIAL is supporting MWIP in the area of process monitoring and control. DIAL has developed a suite of high technology instruments which can be used to investigate and document combustion, gas phase and surface environments. DIAL will work with ANL-W to incorporate its measurement instruments and expertise in MWIP expedited demonstrations and will support MWIP's thermal technology development projects.	3500K

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Reference/Documentation

- **Office of Technology Development FY93 Program Summary (DOE/EM-0109P)**
- **MWIP FY94 Technology Summary (MWIP-24)**
- **MWIP FY95 Needs Statement**
- **Technical Area Status Reports (TASRs) in:**
 - **Final Waste Forms (MWIP-3)**
 - **Waste Destruction and Stabilization (MWIP-4)**
 - **Off-gas Technology (MWIP-5)**
 - **Chemical and Physical Treatment (MWIP-8)**
 - **Alternatives to Thermal Treatment (Draft - MWIP)**
 - **Materials Handling (Draft - MWIP-21)**

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Reference/Documentation

Other Reports and Assessments:

- **Assessment of Off-gas Treatment Technologies for Application to Thermal Treatment (MWIP-1)**
- **Interim Evaluation Report on Thermal Treatment Technologies (MWIP-2)**
- **Assessment of Mercury-Containing Mixed Waste (MWIP-9)**
- **Surrogate Formulation for Thermal Treatment of Low-Level Mixed Waste (MWIP 15-18)**
- **Preliminary Hazards Analysis - Plasma Hearth Process (MWIP-13)**

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Reference/Documentation

Other Reports and Assessments

- **Lessons Learned for Radioactive Thermal Processing Systems (MWIP-6)**
- **Case Studies: Public Involvement in Permitting DOE Incinerators (MWIP-7)**
- **Evaluation of Nitrate Destruction Methods (MWIP-10)**
- **Vitrification Development Plan for DOE Mixed Waste (MWIP-11)**
- **Vitrification Treatability Study and Process Demonstration Capabilities Assessment (MWIP-12)**

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Reference/Documentation

Other Reports and Assessments

- **Multicriteria Decision Methodology for Selecting Technical Alternatives in the MWIP (MWIP-14)**
- **Guideline for Benchmarking Thermal Treatment Systems for Low-Level Waste (MWIP-19)**
- **Treatment Technology Analysis for Mixed Waste Containers and Debris (MWIP-20)**
- **Data Quality Objectives: Evaluation of Thermal Treatment Processes (MWIP-22)**
- **MWIP Performance Systems Analysis (MWIP-23)**

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U.S. Department of Energy
Office of Environmental Management (EM-50)

Waste Management and Technologies
Analytical Database System
(WMTADS)

PM: Paul Lurk
PC: Jim Fannon
IP: Bill McCulla

Operations Office: DOE-AL
Laboratory Sites: LANL/CST Division
EM-50 Division: RDDT&E
Principal Customers: DOE, EPA, DOD, State Regulators and other stakeholders
Application Areas: Mixed Waste, Buried Waste, Waste Retrieval and Processing, RDDT&E Technologies (existing, under development or planned)

What's in WMTADS?

- **Standardized descriptions of available and developing technologies provided by the researchers**
 - **Standardized description of mixed waste streams provided by site waste managers (wastes generated by environmental restoration or D&D are not yet available)**
 - **Descriptions of existing facility capacities, planned and conceptual facilities**
-

Organization

Objectives

- Why was WMTADS developed?
 - To provide a better means of finding technology solutions for waste problems
 - To support Federal Facility Compliance Act 1992 (FFCA-92)

FFCAct-92

- **A report containing a national inventory of all such mixed wastes, regardless of the time they were generated, on a State by State basis (SEC 105 a.a.1.A)**
 - **A report containing a national inventory of mixed waste treatment capacities and technologies. (SEC 105 a.a.1.B)**
 - **A description, including the capacity, number and location of each treatment unit considered in calculating the estimate under subparagraph (A). (SEC 105 a.a.3.B)**
 - **A plan for developing treatment capacities and technologies to treat all of the facility's mixed wastes, regardless of the time they were generated, to the standards promulgated pursuant to section 3004(m). (SEC 105 a.b.1)**
 - **For mixed wastes for which no treatment technologies exist, a schedule for identifying and developing such technologies, identifying the funding requirements for the identification and development of such technologies, submitting treatability study exemption, and submitting research and development permit applications. (SEC 105 a.b.1.B.ii)**
-

Accomplishments

- **Up and Running:**
 - **Provides support to the Mixed Waste Inventory Report (MWIR)**
 - **Provides disk and Internet platforms to present data**
 - **Provides analyses capabilities for the decision making process to match hazardous/radioactive waste streams with technologies in characterization, monitoring, treatment and handling (for storage and disposal)**
-

Accomplishments (Cont.)

- **What's different about WMTADS?**
 - **WMTADS is more than a compiler or library of information**
 - **WMTADS provides users with a centralized one-stop location for both information retrieval and data analysis**
 - **WMTADS provides a variety of applications to assist in processes including complex analyses of matching waste streams to treatment technologies**

Advantages of WMTADS

- **Advanced Waste Processing Analysis**
 - **Flowsheet system analysis**
 - **Treatment module selections**
 - **System optimizations**
- **Technology Development**
 - **Information on technologies**
 - **Uniform descriptions of technologies**
 - **Correlations between technologies and wastes**
 - **Modeling of systems based on technologies**
- **Waste Processing/Technology Development Information**
 - **Standard network tools: FTP, Gopher, World Wide Web**

How to Access WMTADS

- **EM-10 will help individuals gain Internet access**
- **Access through Internet/Mosaic linked to World Wide Web (WWW)**
- **LANL has WMTADS on exhibit in the lobby**
- **WMTADS is available at Trevion II on workstations of:**
 - **Bill Schutte**
 - **Paul Lurk**
 - **Paul Hart**

Issues/Problems

- **EM-30 and EM-50 joint funding**
- **FY94 allocations are completely expended: not all tasks completed and not all milestones met**
- **Expectations for WMTADS currently exceed funding**

Major Milestones

Task #	Activity/Milestone	Start Date	End Date
1	WMTADS supports FFCA-92 on data collection/update	8/01/93	9/30/94
2	Design and establish WMTADS Internet LANL to DOE-HQ	1/03/94	2/25/94
3	Survey DOE complex sites and States, Internet capabilities	1/25/94	4/30/94
4	Determine user needs, develop help sites, bulletin boards	2/01/94	6/30/94
5	Identify data gaps, collect support user application needs	1/20/94	9/30/94
6	QA/QC data validation and control	1/17/94	9/30/94
7	LANL WMTADS database operations, training, etc.	2/08/94	9/30/94
8	Develop server-based modeling tools for cross-walk applications	1/03/94	9/30/94

Program Funding Profile

BCWP = Budgeted Cost for Work Performed

Goals

- **Address DOE in-house needs for accurate and reliable technical data that supports the EM Technology Development Program**
 - **Establish information sharing partnerships with stakeholders and regulators**
 - **Increase cost effectiveness and efficiency of treatment technology selection**
-

Goals (Cont.)

- **Provide informed database source to:**
 - **Eliminate redundant environmental technology development program/funding**
 - **Establish partnership opportunities in Federal research**
 - **Save millions in R&D dollars**
-

Demand

- **Within 48 hours of WMTADS connection to Internet/Mosaic/World Wide Web, LANL received 387 electronic inquiries for data. Inquiries continue to come in at a rate of 70/day**
 - **Inquiries are from:**
 - **Foreign countries**
 - **Universities and Medical Centers**
 - **National Laboratories**
 - **DOD/NASA/NIST/ARPA**
 - **Private industry**
-

Rocky Flats Compliance Program

PM: James R. Taylor

TPO: Sherri L. Rudolph - DOE/RFO

TPM: Jerry Petersen - EG&G/RF

Operations Offices: Rocky Flats Office

Laboratory Sites: LANL, LATO, LLNL, PNL, NIST

EM-50 Division: DT&E

Principal Sites: Rocky Flats Plant

Application Sites: Richland, Savannah River Site,
Los Alamos, Oak Ridge, Idaho

Joint Participants: Delphi Research, LCI Corporation, American Leistriz, Rust
Corporation, University of Colorado, Microdry, Ferrotech,
RF Technology, Colorado School of Mines, Waste Tech

MO4-GT-0088- 1

Objectives

- **Develop and implement technologies to treat Rocky Flats mixed waste in accordance with the Comprehensive Treatment and Management Plan**
- **Transfer demonstrated technology to the private sector**
- **Involve stakeholders in the technology development and selection process to achieve public and regulatory acceptance**

MO4-GT-0088- 2

Scope

- Inventory of untreated low-level mixed waste is over 47,000 ft³
(in addition to pondcrete, saltcrete and solar pond water)
- Five treatment systems for Rocky Flats mixed waste are under development
- The treatment systems fulfill the functional needs of:
 - Organic Destruction
Project: Incineration Alternatives
 - Organic Separation
Project: Surface Organic Removal
 - Solidification and Stabilization of RCRA Metals
Projects: Microwave Solidification
Polymer Solidification
Polymer Macroencapsulation

MS4-GT-0006- 3

Rocky Flats Plant

Low-Level Mixed Waste Inventory (Excluding Pondcrete, Saltcrete, and Solar Pond Water)

MS4-GT-0006- 4

Desired Outcomes

- Technology treatment systems will be made available for EM-30 to treat specified RFP mixed waste in a manner that will meet or exceed all user requirements and expectations, including:
 - Regulatory compliance
 - DOE-specified technical milestones and regulatory schedules
 - All provisions outlined in any agreements between DOE and external organizations
- Public opinion will ease the ability to implement technologies in the operations phase
- RFCP technology development activities will be completed at the lowest possible cost and in the least time
- Additional benefits of RFCP technology development will be realized both within EM and other governmental and commercial entities

MB4-GT-0085- 5

Rocky Flats CTMP Milestones Timeline

MB4-GT-0085- 6

Technology Applicability to RFP Treatment Needs

CTMP TREATMENT SYSTEM

TECHNOLOGY

**1A Solvent-Contaminated Waste
Thermal**

**FBU, Plasma Arc,
Controlled Air Furnace**

**1B Solvent-Contaminated Waste
Treat System Non Thermal**

**UV Oxidation, MEO,
Biodegradation Catalytic Ox,
SCWO, Chemical Ox**

2 Solidified Bypass Sludge

**Polymer Solidification,
Microwave Solidification**

3 Misc Waste Forms

Polymer Macroencapsulation

MB4-GT-0095- 7

Technology Applicability to RFP Treatment Needs (Continued)

CTMP TREATMENT SYSTEM

TECHNOLOGY

**4A Bldg 374/774
Nitrate Salts**

Polymer Solidification

**4B Bldg 374/774
Sludge Immobilization**

**Polymer Solidification
Microwave Solidification**

**5 Surface Organics Removal
Lead Gloves, Bulk Lead**

**Supercritical CO₂, Low
Temperature Thermal
Desorption**

MB4-GT-0095- 8

User/Regulatory Interface:

- **Monthly RFP program managers meeting between DOE, EPA & CDH to discuss issues and progress associated with CTMP**
- **Monthly HQ RF coordination meetings between EM-30, -40, -50 and -60 HQ program managers**
- **Weekly conference call between EM-30 & EM-50 HQ and Field**
- **Semi-annual joint program review with EM-30 and EM-50**
- **HQ Program Management Plan created with EM-30 and Field input which outlines program strategies (including objectives, responsibilities, and performance measures)**

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Ties to Other Efforts

- **Mixed Waste Focus Area**
 - **RFP surrogate waste tested in melter and plasma arc**
 - **Collaboration on polymer and microwave solidification**
 - **Potential linkage to Synthetica steam reforming demonstration**
 - **RFP surrogate waste tested using Supercritical Water Oxidation**
- **EM-30 Rocky Flats Waste Management Program**

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Ties to Other Efforts (Continued)

- **LANL Mixed Waste Treatment Program (EM-30)**
Collaboration on Delphi Research DETOX Chemical Oxidation Process
- **LLNL Mixed Waste Treatment Program (EM-30)**
 - **Collaboration on Mediated Electrolytic Oxidation Process**
- **UST Focus Area**
 - **Collaboration on Polymer Solidification Technology**

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Rocky Flats Compliance Program

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Funding FY94 Rocky Flats Compliance Program

<u>TTP</u>	<u>Technology</u>	<u>\$(K)</u>	<u>PI</u>
RF142001	Microwave Solidification	2140	G.S. Sprenger
RF142001	Altern to Incineration	1180	C.M. Brown
RF142001	Polymer Solidification	2175	A. Faucette
RF142001	Surf Organic Cntm Rmvl	1173	C.M. Brown P.L. Montez
RF142001	Expanded Public Involvmnt	100	C. Sanda
RF132004	Expedited Development	430	J. Lucerna
RF142001	Technology Transfer	100	D. Westphall
		Total	7298

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Rocky Flats Compliance Program December Variance Report

Variance Values					
Cost			Schedule		
Current	FY	Total Project	Current	FY	Total Project
(332)	(35)	(35)	(1137)	(264)	(264)
-4%	0%	0%	-22%	-17%	-17%

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Industrial/Academic Partners Rocky Flats Compliance Program

<u>Project</u>	<u>Industry/Academic Partner (Cost Share)</u>	<u>FY94 Scope</u>
Microwave	Microdry RF Technologies	Pretreatment drying & feed preparation Microwave applicator redesign
Alternatives to Incin.	Delphi Research U. CO/Boulder	Complete surrogate lab-scale testing Materials evaluation study
Polymer	Am Liestritz Pacific Nuclear	Perform surrogate testing using twin-screw extruder. Provide pretreatment dryer for Brookhaven demo.
Surface Organic	U. of Colorado NIST	Conduct lab-scale surrogate tests on nonvolatiles. Solvent trapping design

MD4-GT-0086- 15

Program Funding Profile

	<u>93</u>	<u>94</u>	<u>95</u>
EM-50	8550	7400	13000 (split TBD)
EM-30	4327	5356	
TOTAL	<u>12877</u>	<u>12756</u>	<u>13000</u>

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Schedule

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Major Milestones/Deliverables

- **Polymer Solidification:**

- Complete hot lab-scale tests on nitrate salt wastes
- Complete cold pilot demonstration at Brookhaven
- Complete treatability studies on additional waste forms
- Complete scale-up testing on polymer encapsulation of lead

- **Expedited Demonstration:**

- Complete scale-up testing on polymer encapsulation of debris waste

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Major Milestones/Deliverables (Continued)

- **Microwave Solidification:**
 - Complete chiller installation on microwave system
 - Complete bench-scale microwave testing on hot sludge
 - Complete cold testing with multimode microwave
 - Complete drum drop tests for microwave bagless posting system
 - Initiate testing of single mode microwave
 - Complete microwave system integration

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Major Milestones/Deliverables (Continued)

- **Surface Organic Contaminant Removal:**
 - Select vendor to provide low-temperature thermal desorption unit
 - Initiate pilot-scale installation and testing for low-temperature thermal desorption
 - Complete lab-scale CO₂ testing
- **Technology Transfer:**
 - Develop and implement technology transfer strategies for all RF technologies
 - Goal: Execute technology transfer agreements for at least two projects

MB4-GT-0098- 20

Benefits

Regulatory

- Compliance with the Comprehensive Treatment and Management Plan & FFCA
- Two RF technologies to be under DOIT program (Microwave and LTTD); will help expedite regulatory issues

Industry

- Cooperative development of technologies with private industry
- Transfer of technologies to industry for commercialization

Public Participation

- Increased participation by stakeholders in the clean-up decision process and in public education

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Benefits (Continued)

Cost/Savings Examples:

- Polymer Solidification
 - A cost savings of over \$10/lb for polymer solidification treatment of 16,000 ft³ of sludge can yield a minimum of \$9M in savings
- Microwave Solidification
 - Microwave may provide over \$15/lb savings when treating the sludge, for a minimum of \$13M in savings

Performance:

- Microwave and Polymer Solidification
 - Improved performance of final waste forms over cementation
 - Potential volume reduction of 50–80 percent
- Low Temperature Thermal Desorption
 - Render combustibles non-RCRA waste

M04-GT-0006- 22

Program Issues

- **Expedited Demonstration:**
 - Complete scale-up testing on polymer encapsulation of debris waste
- **EM-50 and EM-30 are currently working to define the division of funding responsibilities**
- **Technology selection decision due this year for certain solidification systems**
- **Decision to proceed/not proceed with Part B Permit for Fluidized Bed Incinerator due (EM-30 program)**

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Reference/Documentation

General:

- **Rocky Flats Compliance Program Technology Summary**
- **Review of Technical Task Plans for the Mixed Waste Program at the Rocky Flats Plant**
- **Technology Development Quality Assurance Management Plan (TD-QAMP)**
- **HQ Rocky Flats Compliance Program Management Plan**
- **Comprehensive Treatment and Management Plan**
- **RF Conceptual Site Treatment Plan**

Microwave Solidification:

- **Microwave Solidification System FY93 Summary Report**

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Reference/Documentation (Continued)

Polymer Solidification:

- **Polymer Solidification National Effort Report**
- **Polymer Solidification System FY93 Summary Report**
- **Polymer Solidification Equipment Evaluation Report**

Surface Organic Contaminant Removal:

- **Technology Status Report on Supercritical Carbon Dioxide Extraction**
- **FY93 Technology Status Report on LTTD Treatment Studies**

Incineration Alternatives:

- **Summary of FY93 Development Activities for Incineration Alternatives**
- **Technology Status Report of Volatilization Technologies**

SUPERCRITICAL WATER OXIDATION PROGRAM

Program Manager: Jaffer Mohiuddin, EM-552
Program Coordinator: John Beller, EG&G Idaho, Inc.
Operations Offices: HQ, Idaho
Laboratory Sites: INEL, PNL, ORNL, SNLL, LLNL
EM-50 Division: DT&E
Principal Customers: EM-30, EM-40, EM-60, MWIP, USTID,
D&D, RF Compliance Program
Application Areas: Waste Retrieval and Processing
Joint Participants: Department of Defense, U.S. Army ARDEC,
Aerojet GenCorp, Foster Wheeler, Modell
Development Corporation, Modar, Innotek
Corporation, Engineered Coatings, Inc.,
Pennsylvania State University,
University of Iowa, Massachusetts Institute of
Technology

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SUPERCRITICAL WATER OXIDATION PROGRAM

Problem

- DOE has stored at its sites and facilities significant inventories of mixed waste which fall under EPA's land disposal restrictions. As such, they cannot be stored indefinitely, nor can they be disposed of without prior treatment to destroy, separate, or immobilize the hazardous component.
- DOE sites and facilities will generate significant volumes of mixed waste due to decontamination and decommissioning activities and continue to generate significant quantities of mixed and hazardous waste as part of ongoing operations. Depending upon DOE's activities, as much as 60,000 cubic meters of mixed waste could be generated annually.
- Available technologies such as incineration are considered inadequate in terms of cost, environmental impact, and public acceptance for treating mixed waste.

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SUPERCritical WATER OXIDATION PROGRAM

Mission

- **Develop and demonstrate supercritical water oxidation (SCWO) as a viable technology for treating DOE hazardous and mixed wastes**
- **Coordinate SCWO RDDT&E activities with other Federal agencies, industry, and academia**

MD4-GT-0124- 3

SUPERCritical WATER OXIDATION PROGRAM

Benefits

- **A high efficiency waste treatment technology (achieves high organic destruction efficiencies of over 99.99%)**
- **Effluents from SCWO treatment process are relatively benign (primarily CO₂ and H₂O)**
- **SCWO treatment unit can be designed as a full containment process with no release to the atmosphere**
- **Presents a viable option to incineration for treating mixed wastes. High potential for public acceptance**
- **Facilitates technology transfer for the treatment of Federal and private sector wastes**
- **Preliminary assessment of cost savings are \$560M for treating existing stored mixed wastes and \$73M/year for generated mixed waste**

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SUPERCritical WATER OXIDATION PROGRAM

Technical Objectives

- **Demonstrate a SCWO hazardous waste pilot plant (HWPP)**
 - Demonstrate the technical viability and cost effectiveness of SCWO technology for treating DOE hazardous and surrogate mixed wastes
 - Provide sufficient design, operational, environmental, and safety data to evaluate the feasibility of a mixed waste pilot plant demonstration and to provide the design basis for the pilot plant
- **Demonstrate a SCWO mixed waste pilot plant (MWPP)**
 - Demonstrate the technical viability and cost effectiveness of SCWO technology for treating DOE mixed wastes
 - Provide sufficient design, operational, environmental, and safety data to evaluate the feasibility of a production scale mixed waste plant and to provide the design basis for the production scale plant
- **Conduct studies to address issues associated with SCWO pilot plant demonstration such as corrosion, salt precipitation, throughput, etc.**

MD-OT-0124- 5

SUPERCritical WATER OXIDATION PROGRAM

Scope

MD-OT-0124- 6

SUPERCritical WATER OXIDATION PROGRAM

Test Bed System for the Hazardous Waste Pilot Plant Demonstration

- Test Bed System will include the non-proprietary support system (feed pressurization, pressure let-down, etc.) into which reactors designed and fabricated by the private sector can be incorporated for testing
 - Test bed will be designed, fabricated, and operated at INEL providing DOE with rapid evaluation of alternative SCWO reactors
 - SCWO reactors will be obtained from commercial designers through CRADA's, cooperative agreements, or through direct purchase
 - Private sector reactors will be fabricated to meet the process requirements of the Test Bed system
 - WRRTF (INEL) facility; all utilities available (power, water, DI water, etc.) limited modifications required

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SUPERCritical WATER OXIDATION PROGRAM

Depiction of the Test Bed System

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SUPERCritical WATER OXIDATION PROGRAM

Candidate Mixed Wastes for SCWO Treatment

- Solvents and oils
- Scintillation fluids
- Organic laden sludges
- Spent carbon and graphite
- Combustibles and debris
- Aqueous liquids

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SUPERCritical WATER OXIDATION PROGRAM

Window of Opportunity

- By FY2000, provide data of SCWO technology performance as an alternative method to incineration for processing low-level mixed waste to support Rocky Flats Plant (RFP) FFCA milestones
- By FY1999, sufficiently demonstrate SCWO technology as an incineration alternate for consideration in the Idaho Waste Treatment Facility design at the Idaho National Engineering Laboratory (INEL)
- Other DOE sites and facilities subject to RCRA and CERCLA derived compliance agreements which may contain legally enforceable milestones.

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SUPERCRITICAL WATER OXIDATION PROGRAM

Schedule

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SUPERCRITICAL WATER OXIDATION PROGRAM

Program Management Structure

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SUPERCritical WATER OXIDATION PROGRAM

National Supercritical Water Oxidation Program

Steering Committee Charter

1. **Coordinate federally funded SCWO RDDT&E activities to provide technical prioritization and focus to the RDDT&E effort**
2. **Facilitate the technology transfer for treatment of Federal and private sector wastes**
3. **Monitor Federal agency funding of SCWO RDDT&E activities and assist in the development of appropriate plans for the best utilization of Federal resources**
4. **Advise management of Federal agencies on the technical and programmatic issues pertaining to SCWO technology development**

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SUPERCritical WATER OXIDATION PROGRAM

National Supercritical Water Oxidation Program

Steering Committee

Executive Subcommittee Members:

Clyde Frank (Chairman)	EM-50
Barry Breen	EPA
Jill Lytle	EM-30
James Marsh	DoD
Elsie Munsell	Navy
Mac Lankford	EM-55
Jaffer Mohiuddin (Secretary)	EM-552

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SUPERCRITICAL WATER OXIDATION PROGRAM

National Supercritical Water Oxidation Program Steering Committee

Technical Subcommittee Members:

Jaffer Mohiuddin (Chairman)	EM-552
John A. Bachinsky	Army Watervliet Arsenal
Larry Dubois	ARPA
Douglas Elstrodt	Indian Head Division, NSWC
Milon Essoglou	Navy
Jim Hurley	Air Force Armstrong Laboratory
Richard Kirts	NFESC
Richard O'Donnell	Army Environmental Center
Kevin Price	DOE-ID
Crane Robinson	Army ARDEC
Anthony T. Rodriguez	Carderock Division, NSWC
Gregory J. Rosasco	NIST
Peter Schmidt	ONR
Gideon M. Varga	DOE-CE

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SUPERCRITICAL WATER OXIDATION PROGRAM

Steering Committee Mechanisms for Coordination

- **Focus meetings**
- **Participation in SCWO design reviews**
- **Coordination of ancillary equipment**
- **Sharing of lessons learned from SCWO activities**
- **Participation in public forums**
- **Maintain and share information on SCWO activities and key points of contact**
- **Maintain and share information on SCWO technical documentation**
- **Participation in waste testing. Advanced Research Projects Agency (ARPA) is the first to offer waste testing on their system for other Federal Agencies's wastes**

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SUPERCRITICAL WATER OXIDATION PROGRAM

Accomplishments

- Demonstrated proof-of-concept of a SCWO waste treatment unit
- Developed an initial list of candidate wastes for SCWO treatment
- Completed surrogate waste testing
- Established National Supercritical Water Oxidation Program Steering Committee
- Completed performance specifications for the hazardous waste pilot plant demonstration
- Completed Phase I of a corrosion and neutralizers study under the CRADA with MODEC

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SUPERCRITICAL WATER OXIDATION PROGRAM

FY94 Objectives

- Complete NEPA documentation for the hazardous waste pilot plant
- Complete design of the hazardous waste pilot plant
- Complete Phase II of a corrosion and neutralizers study under the CRADA with MODEC
- Complete Joint DOE/Army SCWO bench scale platelet reactor demonstration

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SUPERCritical WATER OXIDATION PROGRAM

FY95 Objectives

- Complete fabrication of the hazardous waste pilot plant test bed
- Conduct testing of the hazardous waste pilot plant
- Complete conceptual design of the mixed waste pilot plant
- Initiate Title I design NEPA documentation, and safety analysis of the mixed waste pilot plant

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SUPERCritical WATER OXIDATION PROGRAM

Funding Profile

(\$ in Millions)

FY91	FY92	FY93	FY94	FY95
0.0	0.6	2.4	5.0	8.0

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SUPERCRITICAL WATER OXIDATION PROGRAM

FY 1994 Technical Task Plans (TTPs)

TTP	Technical Task	\$K	PI	Industry/Academic/ Partner (Resource Share)
AL342001	Design Models for SCWO corrosion studies	205	Brent Haroldsen	University of Iowa (\$70k), Massachusetts Institute of Technology (\$10k)
ID021102	HWPP Design	1100	Mike Modell	Modell Development Corporation/Walk, Haydel, and Associates (\$1100k)
ID121217	SCWO Demonstration Program (task includes HWPP, MWPP, alternative reactor concepts evaluation, corrosion testing, salt separation, diagnostics, and modeling)	2520	John Beller	Pennsylvania State University (\$330k), Engineered Coatings, Inc (\$20k), MODAR (\$383k)
OR121206	In Situ Neutralization	350	Robert Mesmer	Modell Development Corporation - CRADA
RL342004	Dual Shell Reactor Vessel	225	Bob Robertus	Innotek Corporation - CRADA
AL342005	Joint DOE/Army SCWO Bench Scale Platelet Demonstration	600	Brent Haroldsen	Aerojet GenCorp/Foster Wheeler (\$300k)

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SUPERCRITICAL WATER OXIDATION PROGRAM

FY94 Sector Participation

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SUPERCritical WATER OXIDATION PROGRAM

Cost/Schedule Performance

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SUPERCritical WATER OXIDATION PROGRAM

Issues

- Technical issues associated with corrosion, materials, and solids deposition are a concern in the demonstration of this technology
- Federal and State regulatory requirements for treating mixed waste are not well defined and will continue to evolve

M04-GT-0124- 24

SUPERCritical WATER OXIDATION PROGRAM

Program Documentation

G. Thurston, and K. Garcia, *Supercritical Water Oxidation Pump Investigation*, EGG-WTD-10674, February 1993

G. Thurston, and K. Garcia, *Supercritical Water Oxidation Demonstration Test Plan, (Bench Scale Testing)*, September 1992

B. Norby, *Supercritical Water Oxidation Benchscale Testing Metallurgical Analysis Report*, EGG-WTD-10675, February 1993

J. Beller, K. Garcia, and C. Shapiro, *Treatment of Simulated Mixed Waste with Supercritical Water Oxidation Proceedings*, Second International Mixed Waste Symposium, August 1993

J. Svoboda, *SCWO Demonstration Data Quality Plan*, DQP-11980, April 1993

R. Rohweder, *Supercritical Water Oxidation Demonstration Project Configuration Management Plan*, CMP-136, January 1993

***Quality Assurance Plan for Modell Development Corporation Supercritical Water Oxidation Technology Development*, ES-51485, January 1993**

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SUPERCritical WATER OXIDATION PROGRAM

Program Documentation (Continued)

C. Barnes, R. Marshall, R. Mizia, J. Herring, and E. Peterson, *Identification of Technical Constraints for Treatment of DOE Mixed Waste By Supercritical Water Oxidation*, EG&G-WTD-10768, August 1993

***Supercritical Water Oxidation Program Plan*, August 1993**

J. Beller, V. Berg, T. Burr, K. Garcia, T. McLaughlin, R. Rohweder, C. Shapiro, J. Svoboda, G. Thurston, and Lee Tuott, *Specification for Supercritical Water Oxidation Demonstration Project*, ES-51485, January 1993

C. Shapiro, *Supercritical Water Oxidation System Study*, EG&G-WTD-10983, September 1993

C. Barnes, *Mixed Waste Survey for the Supercritical Water Oxidation Program*, EG&G-WTD-10984, September 1993

R. Kochan and C. Oh, *Preliminary Analytical Modeling Requirements for Thermal-Hydraulic Analysis of SCWO Pilot Plant*, EG&G-WTD-10985, September 1993

K. Garcia, *Design Considerations for SCWO Pilot Plants*, EG&G-WTD-10986, September 1993

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DOE/USAF Memorandum of Understanding Program

Program Manager: Miles C. Dionisio

PC: Steven Brown

Operations Office: HQ

Laboratory Sites: All DOE sites, DoD (USAF, Army, Navy) sites

EM-50 Division: DT&E

Principal Customers: EM-30, 40, 50, 60; USAF; Industry; Academia

Application Areas: Pollution Prevention/Waste Minimization and Recycle

Joint Participants: INEL, PNL, SNL, ORNL, MSE, AS-KCP, EM-352, DP
USAF Armstrong Laboratory/Environics Directorate (AL/EQ)
USAF Wright Laboratory/Materials Directorate (WL/ML)
Custom Spray Technology (CST)
Boeing Defense and Space Group
U.S. Naval Civil Engineering Laboratory

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Objectives & Scope

Objectives:

- Utilize to the maximum extent possible, the combined resources of the DOE and USAF, to facilitate technology solutions aimed at eliminating or minimizing environmental pollutants
- Minimize duplication of effort through interagency information exchange, joint technology needs identification, and coordinated technology development strategic planning

Scope:

- Crosscutting program to focus on process modifications, material substitutions, recycling/reuse, and energy efficiency
- Technologies that minimize risks to the environment, workers, and public
- Overlaps with the Facility Transitioning, Decommissioning, and Final Disposition Focus Area
- Scope excludes non-R&D pollution prevention waste minimization activities

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End Point

- **Project partnerships with industry, universities, DoD/other government agencies**
 - **Built-in commercialization**
- **Technology development that maintains regulatory and stakeholder acceptability with no secondary legacy waste streams**
- **Transfer to, and use of successfully demonstrated technologies and information:**
 - **Facility Transitioning, Decommissioning, and Final Disposition Focus Area**
 - **Department of Defense: USAF, Army, Navy**
 - **Private Industry**
- **Life-cycle cost/savings to the taxpayer**
- **Enhanced worker health and safety**
- **Reduced Federal facility liability**

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User/Regulatory Interface

- **Facility Transitioning, Decommissioning and Final Disposition Focus Area**
- **EM-30 (production facilities e.g., Kansas City, Oak Ridge, PNL, Rocky Flats, etc.)**
- **EM-60 Facility Transition and Management (Decontamination & Decommissioning)**
- **USAF Material Command**
 - **AF Air Logistics Centers (maintenance facilities)**
 - **AF Laboratories (Armstrong, Wright, Rome, Phillips)**
- **Industry (Boeing, Viatec)**

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Ties to Other Efforts

- **Environmentally Conscious Manufacturing Integrated Demo (ECMID)**
- **Weapons Component Dismantlement Integrated Demo (WeDID)**
- **Mixed Waste Integrated Program (MWIP)**
- **Decontamination and Decommissioning Integrated Demo (D&D ID)**
- **National Defense Center for Environmental Excellence**
- **National Center for Manufacturing Sciences (NCMS)**
- **EM-352 (Waste Reduction Steering Committee)**

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Work Breakdown Structure

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Funding FY94

Recycling Technologies

TTP	Technology Title	\$(K)	PI	Industry/Academic/Partner (Cost Share)
AL243001	Contaminant Removal From Solid Wastes by SC-CO₂	120	Carol Adkins	USAF McClellan AFB, CA (Integrated demo of dry clean with PERK)
AL443001	Contaminant Removal From Solid Wastes by SC-CO₂	130	Mike Smith	USAF Hill/Brooks AFB (Integrated demo of water wash)
RL333001	Waste Acid Detoxification and Reclamation	300	Evan Jones	Tinker AFB (\$350K) Viatec Inc. Boeing Aerospace
RL343002	Chemi-Microbial Processing of Waste Tire Rubber	195	Robert Romine	Anticipate CRADA to be signed in March with the largest tire retread corporation in North America

(TTP numbers AL243001 and AL443001 are a jointly coordinated effort)

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Funding FY94

Process Modification

TTP	Technology Title	\$(K)	PI	Industry/Academic/Partner (Cost Share)
OR133001	Spray Casting	300	Jim Thompson	Custom Spray Technologies, Inc.
PE021301	Spray Casting	200	Ron Glovan	USAF (\$600K) Boeing Defense and Space
AL243012	Real Time, On-line Quantitative Monitor of Surface Cleanliness	200	Steven Martin	New Start, none yet

(TTP numbers OR133001 and PE021301 are a jointly coordinated effort)

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Funding FY94

Material Substitution

TTP	Technology Title	\$(K)	PI	Industry/Academic/Partner (Cost Share)
	Solvent Substitution Handbook	N/A	Angela Reyes	Project completed FY93

Energy Efficiency

TTP	Technology Title	\$(K)	PI	Industry/Academic/Partner (Cost Share)
None				

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Program Funding Profile (\$M)

	91	92	93	94	95	96
DOE	0	1.3	2.1	1.5	1.5	1.6
USAF	2.9	2.2	1.8	1.2	1.0	1.0
Total	2.9	3.5	3.9	2.7	2.5	2.6

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Pollution Prevention Program

Activity	1994				1995				1996			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
DOE/USAF Coordination Support <ul style="list-style-type: none"> Complete integration of EM-60 TD needs into DOE/DoD Technology Needs Matrix Hold DOE/USAF Industrial Exchange Workshop Hold IV Annual International Workshop on Solvent Substitution Provide coordination support between DOE-EM and USAF laboratories via Tyndall AFB Program Coordination Office 	Start: 10/93 End: 12/93											
Spray Casting <ul style="list-style-type: none"> Complete the fabrication of a near net shape component and submit report with go/no-go recommendation Implement pilot-scale spray casting system at Warner-Robins ALC and DOE DP facility 	Start: 10/93 End: 9/94											
Containment Removal from Solid Wastes by SC-CO₂ <ul style="list-style-type: none"> Demonstrate oil, grease, and solvent extraction from solid wastes, and submit report Design separator and demonstrate, submit final report 	Start: 10/93 End: 12/94											

△ Start ▲ End

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Pollution Prevention Program (Continued)

Activity	1994				1995				1996			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Chemi-Microbial Processing of Waste Tire Rubber <ul style="list-style-type: none"> Conduct bench-scale devulcanization studies and prepare report with go/no-go recommendation Develop bench scale bioreactor and scale-up to a commercially viable process 	Start: 10/93 End: 9/94											
Waste Acid Detoxification and Reclamation (WADR) <ul style="list-style-type: none"> Complete WADR procurement and fabrication Complete demonstration testing of DOE/Industry acids at Boeing Aerospace, and submit report Deliver system to USAF Oklahoma Air Logistics Center 	Start: 10/93 End: 6/94											
Real-Time, On-Line Quantitative Monitor of Surface Cleanliness <ul style="list-style-type: none"> Fabricate fixture, evaluate capabilities, and prepare report with go/no-go recommendation for further development Develop portable system, and perform field demonstration 	Start: 10/93 End: 9/94											

△ Start ▲ End

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Major Milestones/Deliverables

- Complete the fabrication of a near net shape component and submit report with "go/no go" recommendation for the implementation of a pilot-scale spray casting system at a DOE DP facility
- Demonstrate oil, grease, and solvent extraction from solid wastes (e.g., rags, wipes, coveralls, etc.), and submit report with "go/no go" recommendation for the design and demonstration of an efficient contaminant separator system
- Conduct bench-scale devulcanization studies on waste tire rubber samples and submit report with "go/no go" recommendation for the development of a bench-scale bioreactor
- Complete WADR demonstration testing of DOE/Industry acid samples at the Boeing Aerospace facility in Kent, WA
- Fabricate a quartz crystal microbalance fixture and evaluate performance capabilities to measure surface cleanliness. Submit report with "go/no go" recommendation for further development

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Benefits

Benefits – Cost/Savings

- Waste Acid Detoxification and Reclamation of Metals (WADR)
 - Potential cost savings across DOE Complex:
\$110M - \$230M per year
 - Potential cost savings for Private Industry:
 - \$4M - \$97M per year
- Spray Casting
 - USAF operating cost savings of >\$15M per year
 - Disposal of Cr plating waste: \$2M-\$3M per year (all saved)

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Benefits (Continued)

- **Contaminant Removal by Supercritical CO₂**
 - Potential cost savings would be near \$3M per year if this supercritical technology were applied
 - Estimated cost savings associated with the military bases and private manufacturers (such as Boeing, Lockheed, McDonnell-Douglas, etc.) could exceed \$20M per year
- **Waste Tire Rubber**
 - Potential dollar volume for this market ranges between \$300 and \$450M per year
- **Real-Time Cleaning Monitor**
 - Potential industry savings on cleaning costs of \$4M - \$40M

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Benefits

Performance:

- **WADR:** Recovers a variety of acids and chemicals in a single, lightweight, modular system
- **Waste Tire Rubber:** Increases the value of the waste tires by modifying their properties with bio-organisms
- **Contaminant Removal by Supercritical CO₂:** Minimizes the total amount of hazardous waste being buried or incinerated nationwide
- **DOE/USAF MOU Support:** The Program Coordination Office (PCO) at Tyndall AFB provides a single point-of-contact for integrating activities

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Benefits

Safety/Risk:

- **DOE Spray Casting:** Decreases the potential for worker exposure and environmental insult
- **USAF Spray Casting:** Reduced or eliminated waste streams associated with chromium electroplating of aviation parts

Regulatory:

- **WADR:** Demonstrate compliance with zero waste discharge initiatives with respect to aqueous Land Disposal Restricted (LDR) wastes

Industry:

- **Waste Tire Rubber:** Will provide a much needed solution to the nation's serious problem of refuse tire piles

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Program Issues

- **Budget restrictions to the target level would limit the number of pollution prevention technologies that could be developed through leveraging with the DoD/USAF**
- **Headquarters level support from EM-50, EM-30, and EM-60 will be critical to the successful update and utilization of the jointly developed Technology Needs Matrix**
- **Waste disposal costs are increasing; therefore, there is a greater need for eliminating the generation of pollutants at the source**
- **The end-of-pipe solutions currently being used to correct existing problems does not take a systems approach utilizing process modification or material substitution to eliminate or minimize the generation of hazardous pollutants**

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Reference/Documentation

- DOE/DoD Technology Needs Matrix
- DOE/USAF Memorandum of Understanding report number EGG-M-92717
- Strategic Plan for Joint Research and Development between the U.S. Department of Energy and U.S. Air Force as part of the DOE/USAF MOU Program report number EGG-30702-9795
- DOE/USAF MOU Program Fact Sheet
- FY93 & FY94 Midyear Review Briefing
- DOE Waste Minimization Cross Cut Plan
- Pollution Prevention EM-50 Management Plan

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Accomplishments

- Conducted the Fourth Annual International Workshop on Solvent Substitution sponsored by the DOE and USAF with representatives from industry, academia, and government
- Produced an on-line Solvent Utilization Handbook Database System containing test data for over 300 substitute solvents. The system is available for use by university, government, and industry through the Idaho National Engineering Laboratory. Call 208-356-7834
- Developed hardware to support the fabrication and spraying of special nuclear materials. Performed hardware improvements on the nozzle, gas heater, chamber, and computer integrated controls
- Completed the first DOE/DoD Pollution Prevention Technology Needs Matrix (TNM)

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Future Program Objectives – FY94

- With robotic arm manipulation, the pressure controlled atomization spray casting process will attempt to spray surrogate materials for a Uranium 6 alloy, to form a near net shape hemishell component
- Oils, greases, and solvents common to the DOE/USAF manufacturing and maintenance repair facilities will be identified and tested for their solubility in Supercritical CO₂
- Bench-scale devulcanization studies will be conducted for the matrix of selected tire samples and bio-organisms
- Simulated DOE acids will be tested via the WADR process in Richland, WA
- Quartz crystal microbalance monitor will be fabricated and tested in real-time, for contaminant removal during component cleaning processes
- Deliver to the USAF Armstrong Laboratory, the final Phase II hazardous waste Zero Discharge Plan computer system

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Future Program Objectives – FY95

- Complete a pilot-scale demonstration of the spray casting technology at the ORNL Y-12 facility, or other DOE-DP location, for the fabrication of special nuclear materials
- Design, develop, and demonstrate a separator capable of removing a maximum amount of hazardous contaminants from the Supercritical CO₂ reactor
- Develop and demonstrate a bench-scale bioreactor which is capable of processing large quantities of ground tire rubber with enhanced reactive surface area
- Develop and demonstrate a portable real-time monitor of surface cleanliness using the quartz crystal microbalance technology

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Commercialization

Industry:

- The PNL Waste Acid Detoxification and Reclamation technology has been licensed in partnership with Viatec, Inc., Hastings, Michigan

Technology Transfer:

- A Cooperative Research and Development Agreement (CRADA) is expected to be signed in March 1994 between Pacific Northwest Laboratories (PNL) and Les Schwab Tire
- All projects have had discussions with the USAF on the transfer and utilization of the technologies within the Air Force Air Logistics Center system

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Cost/Schedule Performance

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Cross Section of Inductively Heated Spray Nozzle

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Enclosed Components of Spray Forming System @ Custom Spray Technologies

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In an ideal SCCO₂ cleaning apparatus, the hazardous contaminants are dissolved in the supercritical CO₂ solvent and are carried away from the non-hazardous solid waste. These contaminants are then separated from the solvent by expansion of the supercritical fluid to a subcritical pressure where CO₂ is a gas and the dissolved materials precipitate out (usually as a liquid or solid). The gaseous CO₂ can then be recompressed to a supercritical fluid and recycled. Only the oils, greases, and solvents, now in concentrated form, would require disposal as hazardous waste.

TIRE RUBBER RECYCLING OPTIONS

CHEMI-MICROBIAL PROCESSING

In-Bath Cleaning Monitor

In-Process Cleaning Monitor

Microelectronics Research and
Development Department
Sandia National Laboratories

Process Flow Diagram WADR Acid Recovery System for TTP# RL3-4-30-01 and Oklahoma City - Air Logistics Center

Capacity: 200 gal in 16 hours

Size: 8 ft x 10 ft. x 12 ft. module

Acid Types:
Nitric, hydrochloric, and sulfuric

Solvent Utilization Handbook (SUH)

**SPRAY CASTING PROJECT
NOZZLE TUNDISH ASSEMBLY**

RDDT&E Innovation and Support

PM:	Susan Weber
IPC:	N/A
Operations Offices:	All
Laboratory Sites:	All
EM-50 Division:	R&D
Principal Customers:	All IDs and IPs
Application Areas:	All Focus Areas
Joint Participants:	Private Sector, Universities, Federal Agencies, and National Labs

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Objectives

- **Mission:**
 - **Develop technologies that show promise to address specific EM needs, but require proof-of-concept experimentation**
 - **Modify already-proven technologies in other fields that show promise of being adapted to specific EM needs**
- **Scope:**
 - **Cross cutting Integrated Program**
 - **Serves needs of other IPs and/or IDs**
 - **Scope excludes retrieval, transportation, and regulation**
 - **Two program elements:**
 - **RDDT&E New Initiatives (RD01)**
 - **Interagency Agreements (RD02)**

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End Point

- Transfer of successful technologies to:
 - Other IPs and IDs
 - Private sector for commercialization
 - Other Federal Agencies (DoD)

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Program Linkages

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RDDT&E Innovation and Support Organizational Structure

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Innovative Technology Development

Robert C. Bedick
Morgantown Energy Technology Center

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METC EWM Mission

**Development of Innovative
Technologies Through Industrial Partnerships**

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METC EWM Achievements

- **44 Development Programs Established**
- **Active Procurements**
 - Sent out > 1025 ROA packages
 - Reviewed 103 proposals
 - Selected 9 for award
 - 4 contracts being negotiated

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RD01: RDDT&E New Initiatives

Number of Projects

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RD02: Interagency Agreements

Number of Projects

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User Interface by Focus Area

Number of Projects

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Funding Distribution

(\$M)

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Funding Profile

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Major Milestones

RDDT&E New Initiatives

- Completed proof-of-principle experimentation of seven Idaho PRDA innovative technologies
- Evaluated progress of 14 private sector and five university groundwater and soils technologies awarded under first METC PRDA
- Awarded 19 decontamination and decommissioning technology contracts to the private sector and universities under the second METC PRDA, transferred technical oversight for three contracts to Oak Ridge
- Awarded six innovative R&D technology contracts to private sector and one innovative technology contract to university technology developers under first METC ROA
- Received R&D 100 Award for the hydrocarbon aerobic biofilter (CRADA) and transferred technology to private sector for commercialization

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Major Milestones (Continued)

IAGs:

- Completed three HSRC projects and received 40 new proposals for co-funding with EPA
- Completed four SITE Emerging Technologies projects, accepted five new projects into the program in FY93, and received 20 new proposals for co-funding with EPA for FY94
- Signed three new IAGs with USGS, one new IAG with EPA, and one master IAG with the U.S. Air Force (nine individual tasks)
- Continued supporting the Western Governors Association

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Accomplishments

- **RDDT&E New Initiatives**
 - Demonstrated industrial sorbents on simulated waste for selective separation of radionuclides. Transferred technology to ESPIP for further development and demonstration
 - Completed hydrocarbon aerobic biofilter demonstration and commercialized technology in the private sector
 - Completed development of 2D Bar Coding waste tracking system. Distributed technology to over 35 federal facility and industrial sites
 - Tested cleanable HEPA filter technology at Oak Ridge's Y-12 plant
 - Transferred six METC PRDA1 technologies to appropriate IPs

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Accomplishments

IAGs

- **Demonstrated Pneumatic Fracturing Technology at Tinker Air Force Base**
- **Completed UV Photolysis of PCB Contaminated Soils**
- **Issued Final Report on Fluid Extraction Biological Treatment Technology**
- **Demonstrated Removal of Heavy Metals with a Centrifugal Jig**
- **Completed Integrated Chemical and Biological Treatment System**
- **Demonstrated In Situ Bioremediation technology at AF Plant-44, Tucson**
- **Completed Phase 1 of Electrochemical Sensor Technology for In Situ Real Time Detection of Heavy Metals**

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Benefits RDDT&E New Initiatives

Technology Transfer Product

- **Cleanable HEPA Filter:** Stainless steel HEPA filter developed as a replacement for currently disposable used glass fiber HEPA filters
- **General Benefit:** Stainless steel HEPA filters can be cleaned and reused thereby saving disposal costs and reducing safety risks
- **Cost Savings:** Potential life-cycle savings of a single large filter system (RFP), employing 100 filters per year for 15 years is in excess of \$10M. Typical life cycle ratios for cleanable filter systems is 0.3 to 0.5 for LLW, and 0.1 to 0.3 for TRU and HLW
- **Industry:** Technology will have general use in commercial toxic or radioactive waste incinerators and other thermal processing units employing HEPA filters to comply with Clean Air Act emissions standards

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Benefits RDDT&E New Initiatives

Commercial Product: ROTRON-Biofilter

- **Bio-processing technology** designed to remove and degrade organic constituents in a gas or vapor system to harmless components
- **General Benefit:** Portable technology that is cost-effective, requires little maintenance and does not generate a secondary waste stream
- **COST SAVINGS:** Per pound of organic contaminant removed, biofilter is a **FACTOR 2-5** more cost-effective than conventional thermal and catalytic oxidation processes, and a **FACTOR 5-20** more cost-effective than granular activated carbon, if regenerated off-site or disposed of
- **Industry:** Technology has general use in/benefit to remediation of toxic organic vapors that are extracted from subsurface soils or emanate from manufacturing operations

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Benefits IAGs

Federal Agency Product: Pneumatic Fracturing

- **Well stimulation technology** that enhances the recovery and treatment of contaminants trapped in tightly packed formations by creating a network of fractures in the soil
- **General Benefit:** Technology will reduce cleanup time by allowing conventional technologies (such as vapor extraction, bioremediation) to be used more effectively
- **COST SAVINGS:** Based on the Tinker Air Force demonstration, pneumatic fracturing can decrease remediation cost of VOC contaminated sites **BY 74 PERCENT (\$4.3M)** for a dense clay substrate, and **BY 24 PERCENT (\$0.3M)** for a tight siltstone formation where the alternatives are excavation/incineration and vapor extraction with or without pneumatic fracturing, respectively
- **Industry:** Technology has general use in in situ remediation of difficult to access contaminants (e.g. DNAPLs), and has benefit to the oil and gas industry to enhance the recovery of crude oil from tight siltstone formations

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3 of 3

FY 95 Future Objectives RDDT&E New Initiatives

- Evaluate progress of projects awarded to private sector and university technology developers under first and second METC PRDA, and first METC ROA
- Continue providing financial assistance to DIAL, State of Idaho and University of Idaho for selected projects
- Evaluate small business innovative research (SBIR) proposals and award contracts in one or more topic areas
- Complete demonstration of innovative technologies and transfer technologies to other EM programs and to the private sector for commercialization
- Transfer continuous metals emission monitor to Mixed Waste or CMST-IP

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FY 95 Future Objectives IAGs

- Continue multi-year IAGs. Initiate new IAGs as needed with other Federal Agencies
- Continue participation in NSF's Industry-University Cooperative Research Centers
- Transfer successfully demonstrated technologies to EM IPs and IDs and other Federal Agencies
- Continue supporting the Western Governors Association

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Program Issues

RDDT&E New Initiatives

- Identification and prioritization of technology gaps
- Technology transfer within Windows of Opportunity
- Continued significant funding for PRDAs and ROAs
- IAGs
 - Joint Agency technology development planning
 - Streamlining transfer of funds between agencies

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Technology Transfer

Commercialization

- ROTRON Biofilter
- IPs and IDs
 - Directional and Position Specific Sampling
 - Portable Analyzer for Chlorinated Compounds
 - Road Transportable Analytical Laboratory
 - Field Deployable Raman Spectrograph
 - High Resolution Subsurface Imaging
 - Geophysical Data Fusion
 - High Capacity Sequestering Agents
 - 2D Bar Coding Waste Tracking System
- Other Federal Agencies
 - Pneumatic Fracturing Technology
 - In Situ Bioremediation Technology

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Reference/Documentation

- **RDDT&E Innovation and Support FY93 Technology Catalogue**
- **RDDT&E Innovation and Support Technology Summary Book**
- **FY93 Program Summary, Office of Technology Development**

Robotics Technology Development Program

PM: Dr. Linton W. Yarbrough

Operations Offices: HQ

Laboratory Sites: SNL, ORNL, PNL, INEL, LANL, SRTC, LLNL

EM-50 DIVISION: DT&E

Principal Customers: EM-30, EM-40, Other OTD Programs

Joint Participants: Above Plus Universities and Private Companies

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RTDP Approach/Philosophy

- **Teams**—best expertise from across complex = multi-lab teams
- **Broad Applicability**—focussed projects to solve complex-wide problems
- **Needs Driven**—direct contact with sites and within OTD
- **OTD Interfaces**—directly mapped onto OTD ID/IPs
- **Integrated Program**—common solutions within RTDP and ID/IPs
- **National Program**—direct HQ management, national perspective

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Robotics Technology Areas

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Program Objective

Replace humans with robotic systems, where justified by safety, cost, and/or efficiency arguments

Technical Area Objectives

- **Robotics Tank Waste Retrieval (TWR):** Demonstrate robotic retrieval/characterization systems applicable to storage tanks
- **Robotics Contaminant Analysis Automation (CAA):** Demonstrate systems to automate analytical chemistry procedures
- **Robotics Mixed Waste Operations (MWO):** Demonstrate robotic systems to automate the handling/processing of mixed waste
- **Robotics Decontamination & Dismantlement (D&D):** Demonstrate robotic systems to secure retired facilities
- **Robotics Crosscutting & Advanced Technology (CC&AT):** Demonstrate advanced systems applicable across the entire program

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Scope

- **Robotics Tank Waste Retrieval (TWR)**: Develop and integrate a full-scale, fully functional long-reach manipulator demonstration system for retrieval/characterization of high-level storage tank waste
- **Robotics Contaminant Analysis Automation (CAA)**: Develop and integrate standardized modules into a sample-preparation to sample-analysis to data-interpretation system
- **Robotics Mixed Waste Operations (MWO)**: Develop and integrate robotic systems to front-end handle mixed waste containers/contents and back-end handle post-treatment waste forms
- **Robotics Decontamination & Dismantlement (D&D)**: Develop and integrate robotic systems for surveillance, characterization, cleanup, and decommissioning of retired facilities
- **Robotics Crosscutting & Advanced Technology (CC&AT)**: Develop and integrate hardware and software into advanced systems for control, analysis, simulation, sensors, and communication

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End Point

- The RTDP will have achieved its purpose when:
 - all significant technical, regulatory, and systematic choke-points have been eliminated by the demonstration of integrated systems

AND

- the ultimate user can acquire such systems (substantially improved) from a commercial supplier

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Customer Needs

- Needs data gathered from visiting five key DOE sites in early CY90
 - Current RTDP Five-Year Plan is based on these data
 - Defined current organization and scope of RTDP

- Needs data re-gathered from visits to ten DOE sites recently
 - Used to rewrite an updated RTDP Five-Year Plan
 - Data formatted in uniform matrices
 - Data analyzed by quantitative algorithm

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Needs Data

Data used to quantitatively address 3 issues/questions:

1. **Work on significant problems: Which is more important, Problem A at Site B or Problem X at Site Y?**
(Relative Importance)

2. **Work on broadly applicable problems: Which has the greater commonality accross the complex, Problem A at Site B or Problem X at Site Y?**
(Common Threads)

3. **Perform reality checks against ground truth: Are the current RTDP projects still valid?**
(Self Assessment)

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Relative Importance Algorithm

Problem's Value = (F₁) (Priority) + (F₂) (Schedule) + (F₃) (Risk)

Priority = H,M,L = 3,2,1

Schedule = S,M,L = 3,2,1

Risk = (F₄) (Quantity) + (F₅) (Level) + (F₆) (Exposure)

Quantity = H,M,L = 3,2,1

Level = H,M,L = 3,2,1

Exposure = H,M,L = 3,2,1

Issues we're working on:

- 1) Relative values of F_x terms**
- 2) Apples vs. Oranges – quantity units**
- 3) Defensible exposure interpretation**

Preliminary Results:

Statistically significant spread

Realistic/meaningful differences

No blatant site differences

No apparently skewed scores

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Algorithm & Preliminary Analysis (Continued)

Common Threads Algorithm

Just starting to look at several approaches

How Are the RTAs Doing (HARD) Algorithm

Preliminary Results:

- Earlier needs data were valid and accurate**
- AND we're meeting those needs fairly well**
- BUT there are some big holes to be filled**

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Program Funding Profile (\$M)

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Budget Matrix

Site	TWR	CAA	MWO	D&D	CCAT	
SNL	X	X	X	X	X	
ORNL	X	X	X	X	X	
PNL	X	X		X	X	
INEL		X	X	X		
LANL		X			X	
SRTC			X	X		
METC	X					
LLNL			X			
FEMC				X		
						TOTALS
RTDP	4.9	3.6	4.0	3.6	6.0	22.1
UNIV R&D	X	X	X	X	X	3.5
OTHER		X				2.5
TOTAL	5.6	6.9	4.8	4.5	6.3	28.1

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Universities, Industries & CRADAs

- Through FY93: 40 percent of budget to industries
10 percent to universities
- In FY93: 87 separate industry interactions
22 university R&D projects
- FY94 projected: \$8.7M to industry and \$6.0M to universities

CRADAs		
<u>Status</u>	<u>Number</u>	<u>Industrial Matching Funds</u>
Completed/ongoing	7	\$2.7M
In approval process	6	\$1.4M
Projected	7	\$3.8M

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Major Thrusts/Major Milestones

Robotics Tank Waste Retrieval (PNL, ORNL, SNL, METC) \$4.9M, (\$3.3M OP/\$1.6M CE)

- 1) Robotics Development Test Facility-full-scale, realistic DT&E facility
 - Functional requirements complete 1Q
 - Long Reach Manipulator contract placed 3Q
 - FY95: LRM delivered, other systems procured
 - FY96: Test facility operational
- 2) Robotics Technology Development- develop and evaluate systems in test facility
 - Modeling & analysis of ingress/egress 2Q
 - Mapping/viewing evaluation complete 2Q
 - Demo flexure control and waste retrieval system 4Q
 - FY95: Demo advanced flexure control in LRM and mast
 - FY96: Demo advanced control algorithms in test facility

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Major Thrusts/Major Milestones

Robotics Contaminant Analysis Automation (LANL, SNL, INEL, ORNL, PNL) \$3.6M Total (\$3.0M OP/\$0.6M CE)

- 1) **Develop Priority SLMs** - design/procure/fabricate prototypical SLMs for heavily used EPA & DOE methods
 - Prototypes for radiochemistry, metals and organics 4Q
 - FY95 & FY96: Continue for additional SLMs
- 2) **Proof Current SLMs** - test & modify SLMs for EPA validation process
 - Proof SLMs for EPA 3000 & 3500 series
 - FY95 & FY96: Continue for additional SLMs

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Major Thrusts/Major Milestones

Robotics Contaminant Analysis Automation (Continued)

- 3) **SLM Phase II Validation** - run real-world samples and verify results by EPA & DOE performance rating methods
 - Finish validation of 3540/3550 SAM
 - FY95 & FY96: Continue for additional SAMs
- 4) **SAM System Integration** - hardware & software integration of SLMs into plug-and-play system
 - Demonstrate EPA 3540/3550 SAM system
 - FY95 & FY96: Beta test EPA 3540/3550 and 3051 SAMs

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Major Thrusts/Major Milestones

Robotics Mixed Waste Operations (SRTC, LLNL, SNL, ORNL, INEL, FEMP) \$4.0M Total (\$3.34M OP/\$0.66M CE)

- 1) **AC Swing-Free Crane Control**-commercialize operator in the loop swing-free crane control
 - Transfer technology to industry 4Q
- 2) **Remote Inspection & Survey of Drums**-develop autonomous mobile robot to provide radiation survey map
 - Demonstrate SWAM I 1Q
 - Develop mobile robot GISC with industry 4Q
 - FY95 & FY96: Test SWAMI II at Fernald and commercialize system
- 3) **Singulation**-teleoperator and autonomous singulation of objects
 - Demo singulation from waste drum and pile 1Q
 - FY95 & FY96: Finish autonomous singulation and demo on high payload manipulator

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Major Thrusts/Major Milestones

Robotics Mixed Waste Operations (Continued)

- 4) **Autonomous Workcell Model Updating** - structured light system for 3-D real-time modeling
- 5) **Item Characterization and Sorting** - develop characterization (rad., chem., phys.) and sorting criteria
- 6) **Container Opening and Transporting** - automated systems
 - Demo drum opening and cryogenic bin opening 4Q
 - FY95 & FY96: Develop and test materials handling for MWIP
- 7) **Waste Processing Operations**-system for handling/treating mixed waste debris

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Major Thrusts/Major Milestones

Robotics Decontamination and Dismantlement (ORNL, SNL, INEL, SRTC, PNL) \$3.6M Total (\$2.4M OP/\$1.2M CE)

- 1) **Surveillance and Maintenance (S&M) Risk/Cost Reduction** -
cost/benefit trade-offs of automated systems
 - Finish S&M assessment methodologies and examples 4Q
 - FY95 & FY96: Continue refinement
- 2) **Mapping, Characterization, and Inspection (MC&I) System**-mobile
MC&I system
 - Prototype subsystems and demonstrate complete
system on small area 4Q
 - FY95 & FY96: Demonstrate large floor capability and extend to walls
and equipment surfaces

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Major Thrusts/Major Milestones

Robotics Decontamination and Dismantlement (Continued)

- 3) **Selective Equipment Removal System** - mobile teleroptic system
incorporating the dual arm module
 - Finish major systems integration 3Q
 - Demonstrate teleoperation capability 4Q
 - FY95 & FY96: Integrate subsystems, test, and continue refinement
- 4) **Small Pipe Characterization System** - systems to characterize
small-diameter (1-3") pipes
 - Fabricate and demonstrate system for upper-end sizes 4Q
 - FY95: Demonstrate subsystem for lower-end sizes
- 5) **Internal Duct Characterization** - develop and commercialize in FY96

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Major Thrusts/Major Milestones

Robotics Crosscutting & Advanced Technology

(SNL, ORNL, PNL, LANL)

\$6.0M Total (\$5.5M OP/\$0.4M CE)

- 1) **Sensing Systems** - application/integration of control and characterization sensor systems
 - FY95 & FY96: Commercialize Minilab; refine whole arm sensing and integrate with path planning
- 2) **Controls** - algorithms, computer architecture, and interfaces for robot system control
 - Advanced GISC library modules available 4Q
 - FY95 & FY96: Refine GISC and multilink damping, commercialize GISC
- 3) **Systems Analysis** - generalized cost/benefit method for use across robotics program

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Major Thrusts/Major Milestones

Robotics Crosscutting & Advanced Technology

(Continued)

- 4) **University Research Program** - software safety, reliability; operator interfaces, sensor integration, and environmental hardening
- 5) **Cooperating Multi-Arm Manipulator** - develop generic control system for multi-arm system
- 6) **Modeling and Simulation** - computer simulation for design, analysis, and evaluation
- 7) **Technology Transfer** - aggressive TT plan for use across robotics program to commercialize robotics technology

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Reference/Documentation

- **RTDP Five-Year Plan – Update 5/94**
- **Needs Assessment**
- **EM-50 Technical Summary Book**
- **Proceedings of 1993 RTDP DOE/University/Industry Robotics Forum**

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Accomplishments

- **TWR**: Completed technology transfer through CRADAs for:
 - In-tank mapping system
 - Improved dynamic performance of telescoping tube masts
- **CAA**: Developed the Standard Analysis Method, a fully integrated system, for Soxhlet Extraction (EPA 3540) and Sonication Extraction (EPA 3550) methods
- **MWO**: Demonstration of containerized waste processing
 - AC swing-free crane
 - SWAMI in simulated warehouse
 - Automated treatment process
 - Remote drum and liner opening
 - Item characterization and sorting
 - Whole drum characterization

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Accomplishments (Continued)

- **D&D**

- **Initiated major industry procurements:**

- **Floor characterization system mobile platform**
 - **Dual-arm work module base**
 - **Internal duct characterization system**

- **Conceptual design of reconfigurable dual-arm work module**

- **CC&AT:** **Developed control technologies that support the rapid integration of advanced robotics technologies as they become available**

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Cost/Schedule Performance

- **FY 94 Allocation & Cumulative BCWS agree within 1%**

- **Underspending projection in PTS due to step-function in University program**

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Notes

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