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Waste Separations and Pretreatment Workshop Report

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Waste Separations and Pretreatment Workshop Report

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WASTE SEPARATIONS AND PRETREATMENT WORKSHOP REPORT

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ABSTRACT

This document provides the minutes from the Waste Separations and Pretreatment Workshop sponsored by the Underground Storage Tank-Integrated Demonstration in Salt Lake City, Utah, February 3-5, 1993. The Efficient Separations and Processing-Integrated Program and the Hanford Site Tank Waste Remediation System were joint participants. This document provides the detailed minutes, including responses to questions asked, an attendance list, reproductions of the workshop presentations, and a revised chart showing technology development activities.

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EXECUTIVE SUMMARY

The primary purpose of the workshop was to explore opportunities for collaboration and teaming between the three participating programs: Underground Storage Tank-Integrated Demonstration (UST-ID), Efficient Separations and Processing-Integrated Program (ESP-IP), and Tank Waste Remediation System (TWRS). All three are currently conducting technology development projects in the area of waste separations and pretreatment. A number of workshop participants noted this was the first meeting they had seen in which the EM-30 (TWRS) and EM-50 (UST-ID and ESP-IP) programs were so well represented, and it was an encouraging beginning in this kind of interaction.

The workshop began with summaries of the three programs presented by the contractor program managers. This was followed by individual presentations by UST-ID principal investigators and selected principal investigators representing ESP-IP. The workshop was then divided into four breakout sessions: (1) Program Coordination (R.A. Harrington, Facilitator), (2) Supernate/Salt Cake Processing (W.G. Richmond, Chairman), (3) Sludge Processing (J.E. Helt, Chairman), and (4) Comprehensive Processing and Systems Analysis (C.P. McGinnis, Chairman).

The Program Coordination session was a valuable interaction between the program management representatives of the three programs. Discussion focused on three perceived major challenges: (1) communication, (2) "how do we manage jointly?", and (3) managing uncertainty. No clear solutions to these challenges were established in the session; however, the group agreed to pursue several action items toward improving communication and collaboration. The actions were as follows: (1) G. Mellinger, develop a distribution list for documents and other items to improve awareness, (2) T. Fryberger, evaluate the benefit of periodic meetings in this technical area (similar to this workshop, but with more EM-30 principal investigators), and (3) J.C. Peschong, evaluate establishing a pretreatment council to assist in overall integration of this work.

The technical breakout sessions (Supernate/Salt Cake Processing, Sludge Processing, and Comprehensive Processing and Systems Analysis) were also productive, facilitating open interaction and opportunities for teaming and collaboration. Each session chairman summarized the results of the session to the combined group during the final wrap-up session of the workshop. In each case, opportunities were noted for future collaboration in work efforts.

The wrap-up session of the workshop included closing remarks by the session chairmen, program managers, and representatives from the U.S. Department of Energy, Headquarters and Richland Operations Office. Most noted the meeting was beneficial and a good first step in jointly managing and integrating the three programs. Further, the attendees decided that more of these kinds of meetings were needed and would be pursued.

ACKNOWLEDGEMENTS

The Underground Storage Tank-Integrated Demonstration (UST-ID) would like to thank all those who participated in this successful workshop. A special thanks goes to the U.S. Department of Energy (DOE)-Headquarters participants (S.M. Gibson, T. Fryberger, and G. Mellinger) and the DOE Richland Operations Office participants (J.C. Peschong and C.S. Louie [attending for D. Trader]). The UST-ID is funded by the DOE, Office of Technology Development (EM-50), through its operating operations offices and contractors. Hanford is the host site for the program, with Westinghouse Hanford Company as the integrating contractor, under the direction of the DOE Richland Operations Office.

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LIST OF TERMS

BNL	Brookhaven National Laboratory
CPU	compact processing unit
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy-Headquarters
ESP-IP	Efficient Separations and Processing-Integrated Program
HLW	high-level waste
IPM	initial pretreatment module
LANL	Los Alamos National Laboratory
LLW	low-level waste
NAC	ammonia and ceramic
ORNL	Oakridge National Laboratory
PNL	Pacific Northwest Laboratory
ProTech	Prospective technology
PTS	Progress Tracking System
RL	Richland Operations Office
SNL	Sandia National Laboratory
SRS	Savannah River Site
TWRS	Tank Waste Remediation System
UST-ID	Underground Storage Tank-Integrated Demonstration
WHC	Westinghouse Hanford Company
WINCO	Westinghouse Idaho Nuclear Company, Inc.

WASTE SEPARATIONS AND PRETREATMENT WORKSHOP REPORT

1.0 AGENDA

The agenda for the workshop is provided in Table 1-1 that follows. It is important to note that significant changes were made as late as 15 minutes before the start of the workshop. The original intent of the workshop was to begin the "breakout sessions" much earlier in the sequence and allow people more time to interact.

Table 1-1. Workshop Agenda.

Time	Item/Subject	Presenter
7:00 p.m. 2/3/93	PRINCIPAL INVESTIGATOR MEETING Weekly Highlights PTS Monthly Report and Content ProTech Information System	 J. M. Cruse J. M. Cruse M. J. Quadrel
8:00 a.m. 2/4/93	Introductions	J. M. Cruse R. A. Harrington
8:15	SUMMARIES OF FY 1993 TECHNOLOGY DEVELOPMENT PROGRAMS UST-ID ESP-IP TWRS/WHC TWRS/PNL TWRS/LANL	 R. L. Gilchrist J. R. Morrey J. N. Appel L. K. Holton K. Thomas
10:00	TECHNOLOGY PRESENTATIONS Cesium Extraction CPU Resin Development Biological Nitrate Destruction NAC Process Sodium Titanate Ion Exchangers Electrochemical Destruction of Organics/Nitrates	 W. G. Richmond J. P. Bibler G. F. Andrews A. Mattus N. Brown D. Hobbs
12:00 p.m.	LUNCH	
1:00	TECHNOLOGY PRESENTATIONS (Cont'd) TRUEX Model Development TRUEX Model Validation Technical Exchange with CEA (France) Status of Sludge Technology Sludge Washing and Dissolution Calcination/Dissolution Unit Process Definition and Evaluation Global Evaluation of Separations Processes Tank Waste Processing Analysis	 G. F. Vandegrift C. P. McGinnis R. T. Jubin J. E. Helt B. Z. Egan S. A. Colby W. H. Kuhn S. E. Seemen E. G. Baker
2:00	BREAK FOR DINNER	

Table 1-1. Workshop Agenda.

Time	Item/Subject	Presenter
7:00	BREAKOUT SESSIONS Supernate/Salt Cake Processing Sludge Processing Comprehensive/Systems Analysis Program Coordination	
9:00	END FIRST DAY	
8:00 a.m. 2/5/93	BREAKOUT SESSIONS (Cont'd)	
10:30	RETURN TO COMBINED SESSION AND BREAKOUT SESSION SUMMARIES Supernate/Salt Cake Processing Sludge Processing Comprehensive/Systems Analysis Program Coordination	 W. G. Richmond J. E. Helt C. P. McGinnis J. C. Peschong
11:30	SUMMARY AND WRAP-UP RL/EM-30 Comments DOE-HQ/ESP-IP Comments DOE-HQ/EM-30 Comments DOE-HQ/UST-ID Comments Roundtable	 J. C. Peschong J. R. Morrey for T. Fryberger G. B. Mellinger R. L. Gilchrist for S. M. Gibson R. A. Harrington
12:30 p.m.	END MEETING	

CEA = Commissariat à l'Energie Atomique
CPU = central processing unit
DOE-HQ = U.S. Department of Energy-Headquarters
RL = U.S. Department of Energy-Richland Operations Office
ESP-IP = Efficient Separations and Processing-Integrated Program
FY = fiscal year
LANL = Los Alamos National Laboratory
NAC = nitrate to ammonia and ceramic
PNL = Battelle, Pacific Northwest Laboratory
ProTech = Prospective technology
PTS = Progress Tracking System
TRUEX = transuranic extraction
TWRS = Tank Waste Remediation System
UST-ID = Underground Storage Tank-Integrated Demonstration
WHC = Westinghouse Hanford Company

2.0 DETAILED MINUTES

The following sections provide the detailed minutes for the workshop. Where notable questions were asked, they were recorded. Following the workshop, these questions were forwarded to the presenters for a written reply. The questions and replies are included herein with any other discussion of the presentation.

2.1 PRINCIPAL INVESTIGATOR MEETING

The Underground Storage Tank-Integrated Demonstration (UST-ID) principal investigators met with program office staff and the U.S. Department of Energy-Headquarters (DOE-HQ) program manager (S.M. Gibson) in the evening before the workshop. The following subsections summarize the discussion for each of the agenda items. Table 2-1 shows the attendance of this session by the individuals' affiliations.

Table 2-1. Underground Storage Tank-Integrated Demonstration Principal Investigator Meeting Attendance.

Topic	Principal Investigator
Cs Extraction CPU	W.G. Richmond/J.P. Bibbler
Calcination/Dissolution	S.A. Colby
NAC Process	A.J. Mattus
TRUEX Model Development	G.F. Vandegrift
TRUEX Model Validation	C.P. McGinnis
Technical Exchange	R.T. Jubin
Sludge Washing and Dissolution	B.Z. Egan
Biological Nitrate Destruction	G.F. Andrews, A.J. Tien, G. Matthern
Tank Waste Processing Analysis	E.G. Baker
UST-ID Program Office	R.L. Gilchrist, L.K. Holton, M.J. Quadrel, R.A. Harrington
DOE-Headquarters	S.M. Gibson

CPU = compact processing unit
Cs = cesium
NAC = nitrate to ammonia and ceramic
TRUEX = transuranic extraction

2.1.1 Weekly Highlights

Weekly highlight submittals for the separations and low-level waste (LLW) portion of the UST-ID have been sparse. More highlights are needed. The highlights are a "win/win" for the author and the program. They keep U.S. Department of Energy (DOE) operations offices and Headquarters people informed and aware that good things are happening in the program. Based on success in the characterization and retrieval area, the following basic sequence will be implemented for highlights for separations and LLW: (1) principal investigators submit input to the UST-ID Program Office (J.M. Cruse), (2) Program Office compilation review, (3) highlights submitted to the DOE Richland Operations Office (RL) and DOE-HQ, and (4) highlights distributed to all principal investigators. In this way the principal investigators will see what was submitted and the modifications made so that future submittals can be tailored.

2.1.2 Progress Tracking System Monthly Reports

The Progress Tracking System (PTS) is EM-50's system for monthly reporting. The reports submitted in the past have been very general and many times not consistent with the guidance and direction as established by the approved TTPs. The UST-ID would like for the principal investigators to focus some quality time to the reports each month. The situation is similar to the weekly highlights; i.e., it is in the best interest of the principal investigators to submit excellent reports. To that end, the UST-ID would like the principal investigators to consider some details to discuss within the existing PTS report structure. Table 2-2 that follows provides the PTS structure. The bracketed items are the details to consider as the report is prepared.

Table 2-2. Progress Tracking System Information Outline for Underground Storage Tank-Integrated Demonstration Principal Investigators.

1. Significant problems and issues
2. Corrective actions
3. Summary assessment (brief statement of cost, schedule, and technical status)
4. Cost status
5. Schedule status
   [Principal investigators provide milestone status]
6. Technical status
   [Use the following categories as a checklist; if you have something to report in a category, identify it by using the appropriate subheading in your report:
   - *Technical milestones*
   - *Technical reports issued*
   - *Technical exchanges and reviews (EM-50, EM-30, professional, university, industry)*
   - *Technical planning products and results of meetings or workshops*
   - *Procurement status]*
7. Major accomplishments
   [Report and elaborate on milestones achieved or other significant task events and breakthroughs from the above list]

Several principal investigators noted a concern with providing information in the PTS system that has not been cleared for public release. The clearance process requires significant lead time, preventing the timely report of significant events and breakthroughs if the information and data needs to be cleared. The UST-ID took an action item to investigate this more fully and report back to the principal investigators.

2.1.3 Prospective Technology Information System

Prospective technology (ProTech) profiles are needed from each principal investigator as noted in the program guidance (i.e., February 28, 1993, deadline). The completed profiles will then be reviewed by a peer review team that is appointed by the program managers. Also, principal investigators will be interviewed with any questions that arise from the review process. The goal is to complete the peer reviews and provide finished products by March 31, 1993.

2.1.4 Roundtable Discussion

S.M. Gibson expressed a desire to meet "one-on-one" with each of the principal investigators at some point during the workshop. (The need for this was fulfilled by the technology presentations included in the February 4, 1993, day's agenda.)

J.P. Bibbler and W.G. Richmond noted a technical concern with the performance of the resorcinol resin being developed by the Savannah River Site (SRS) for the compact processing unit (CPU). The potassium content in the waste of Hanford Site tank 241-AW-101 has a significant impact on the resin performance. This tank is currently targeted for demonstrating the CPU.

2.2 OPENING REMARKS AND INTRODUCTIONS

The UST-ID (J.M. Cruse) welcomed everyone and thanked all for their attendance. The attendance at this meeting and at the Efficient Separations and Processing-Integrated Program (ESP-IP) meeting was larger than expected. At this meeting, about 55 persons were expected and almost 80 showed up. The agenda was changed based on the morning's direction from the customer. The basic sequence of the meeting was the programmatic summaries per the original agenda, followed by individual presentations by UST-ID principal investigators and selected ESP-IP principal investigators. The breakout sessions followed at a later time.

A chart was developed as a first attempt to show the technology development activities in all of the programs. It was a first draft; the group looked at it and provided input and comments. (See Appendix A for input, comments, and resolutions.)

The facilitator for the workshop, Mr. R.A. Harrington, took the floor with some opening remarks using flipcharts. The content of the flipcharts is provided in Table 2-3 and summarizes the discussion.

Table 2-3. Flipchart Presentation.

<u>PRINCIPAL OBJECTIVE</u>
• Explore opportunities for teaming and collaboration in TWRS, UST-ID, and ESP-IP technology development projects.
• Technology breakout session and chairperson expectations - Chair and facilitate - Record minutes - Obtain consensus (build team) - Report status (Friday session)
• Program coordination breakout session expectations - Make it happen - Address impacts to programmatic coordination and integration - Support action plan(s) for followup
<u>REMEMBER</u>
How we do business today is fine--"key is, can we do it better"
<u>GENERAL GUIDELINES AND EXPECTATIONS</u>
• Active listening - Let the person finish before questioning - Question for clarity <u>not</u> criticism
• Identify facts vs. perceptions
• Be succinct--make point
• Exchange information
• Create synergy and build teams - Seek to understand, then to be understood
• Agreed-to changes require approval--develop plan for proposals
• Expect frustration--stay with it
• Open sessions, except program coordination

TWRS = Tank Waste Remediation System

2.3 PROGRAM SUMMARIES

Contractor program managers summarized the programs represented at the workshop as noted in the following sections.

2.3.1 Underground Storage Tank-Integrated Demonstration

Mr. R.L. Gilchrist summarized the currently funded activities in the UST-ID, separations, and LLW technical area. Appendix B, Figure B-1 provides a "hard copy" of the presentation.

2.3.2 Efficient Separations and Processing Integrated Program

Mr. J.R. Morrey presented a summary of currently funded ESP-IP activities. Appendix B, Figure B-2 provides a hard copy of the presentation.

2.3.3 Los Alamos National Laboratory, EM-30 and Tank Waste Remediation System

Ms. K.W. Thomas presented a summary of the currently funded activities at Los Alamos National Laboratory (LANL) that are funded by DOE-HQ/EM-30. Appendix B, Figure B-3 provides a hard copy of the presentation.

2.3.4 Westinghouse Hanford Company, Tank Waste Remediation System and Pretreatment Development

Mr. J.N. Appel summarized the current Westinghouse Hanford Company (WHC) activities in pretreatment technology development. Appendix B, Figure B-4 provides a hard copy of the presentation.

2.3.5 Pacific Northwest Laboratory, Tank Waste Remediation System and Pretreatment Development

Mr. L.K. Holton summarized the current efforts with Battelle, Pacific Northwest Laboratory (PNL) supporting the Hanford Site and the Tank Waste Remediation System (TWRS). Appendix B, Figure B-5 provides a hard copy of the presentation.

2.4 TECHNOLOGY PRESENTATIONS

The UST-ID principal investigators and selected principal investigators from the ESP-IP Program presented their currently funded projects. The following subsections indicate the presenter and figure reference for the hard copy presentation. In cases where questions were asked, the questions and subsequent reply are included.

2.4.1 Compact Processing Units

Presenter: W.G. Richmond; see Appendix B, Figure B-6.

Question: Is there a need for a process vent system to handle offgas for emergency entry into the CPU?

Response: Emergency entry to the processing area of the CPU will not be possible after the CPU begins radioactive operations due to the high dose rates that will exist in this area. Therefore, a ventilation system to support entry to this area is not required.

Access to the low-radiation area of the CPU (emergency or planned) will be supported by attaching a portable exhauster to the CPU enclosure. This exhauster will provide sufficient ventilation system capacity to allow opening of the CPU low-radiation area access hatch(es) while maintaining appropriate ventilation flow rates to ensure radioactive material confinement. The enclosure design will provide points of attachment for this exhauster such that it can be attached before opening the CPU.

2.4.2 Cesium Extraction Testing

Presenter: J.P. Bibbler; see Appendix B, Figure B-7.

2.4.3 Biological Destruction of Tank Wastes

Presenter: G.F. Andrews; see Appendix B, Figure B-8.

Questions:

1. Are any biological processes active in the Hanford Site tanks?

2. Could carbon dioxide (CO_2) be used to adjust pH rather than sulfuric acid (H_2SO_4), phosphoric acid (H_3PO_4), or hydrochloric acid (HCl), which may all cause problems downstream? Bicarbonate (HCO_3^-) is much less of a problem. Also, CO_2 could come from ashing of biomass. (G.F. Vandegrift)

3. Has a nitrogen balance been performed on the system at lab scale? Is there any ammonia (NH_3) produced? Is there any ammonium nitrate (NH_4NO_3) produced? What other nitrogen products, in addition to nitrogen gas (N_2), are gas phase products of the reaction?

Responses:

1. We don't know and are proposing a task to find out. Given the high tolerance of some bacteria for radiation (some of our coworkers found microorganisms in the containment vessel at Three Mile Island) and high salinity, it is not unreasonable to expect to find some in tanks that are at a moderate temperature and contain significant amounts of organics (e.g., citric acid) that can act as substrates.

2. In the overall anion balance of the process, most of the nitrate (NO_3^-) is degraded already by HCO_3^- generated from the CO_2 produced by bacterial metabolism. Adding extra CO_2 to replace the rest is a definite process option that depends on the level of radionuclides in the particular tank and the effectiveness of biosorption (currently being measured). If the radionuclide level and biosorption effectiveness are low, then the "biomass sludge" process effluent (in which all the activity is concentrated) will be a low-level waste that can be disposed of in a grout form. Some level of phosphate (PO_4^{3-}) and sulphate (SO_4^{2-}) will then be

acceptable, and pH control can best be achieved by addition of the corresponding acid. However, if activity levels and biosorption effectiveness are high, the biomass sludge effluent may be classified as a high-level waste requiring vitrification. H_3PO_4 and H_2SO_4 must then be eliminated, and various schemes are possible for increased neutralization with CO_2. The CO_2 and N_2 gas mixture generated in the bioreactor will be sparged through the waste on the biosorption tank. CO_2 recovery from the ashing step is possible, but may not be cost-effective compared to buying bulk CO_2. The simplest solution, currently under investigation, may be to replace acetic acid with an acid like succinic. The extra neutralization capacity of these acids may eliminate the need for adding any mineral acid.

3. N_2 is the normal end-product of microbial denitrification. The amount produced is monitored during our continuous experiments and has been found to be close to the approximate stoichiometric value of 11.2 (1-y/5) L/mol of NO_3^- reduced. Y(?) is the cell yield in carbon-equivalents of biomass per mole of nitrate and accounts for the NO_3^- nitrogen incorporated into the biomass. There is no biochemical basis for believing NO_3^- would be reduced as far as NH_3, and none has been detected during the routine gas chromatograph analysis of the headspace of the laboratory reactors. Products of incomplete reduction, particularly nitrous oxide (N_2O), may be formed and have been detected in parts per million quantities in the headspace gas when insufficient acetic acid (the reductant) is added. Adding just sufficient reductant is one of the process control problems being addressed during process development.

2.4.4 Nitrate to Ammonia and Ceramic Process

Presenter: A.J. Mattus; see Appendix B, Figure B-9.

Questions:

1. What happens if you cannot add water to the system? Is there any potential hazard? Is there any fission product catalysis of these reactions? Is there any NH_4NO_3 formed and vaporized?

2. Two-thirds of the mass of supernate is water. You have ignored it in your presentation, but you cannot [ignore it] in total waste volume and energy balances.

Responses:

1.a As an example, when using a 4<u>M</u> sodium nitrate solution, nearly all the water is consumed in the reaction by supplying oxygen to aluminum. The hydrogen from the water goes to form NH_3 from the nitrogen in NO_3^-. Normally, in the continuous mode, solids are constantly removed from the reactor, and the filtrate recycled. Just enough excess water is necessary to facilitate heat transfer to cooling coils and to aid in mixing.

1.b There is no known hazard associated with minimizing the amount of water added except to ensure that heat can be removed as desired so as to operate in the 50 to 60 °C range.

1.c There is no reason to think that any fission products can act to catalyze the reduction reaction.

1.d Since the reaction is carried out at pH 12 and above, the ammonium cation is not stable, losing its proton to become gaseous NH_3. This gas is not very soluble in hot, saline solution, and very quickly leaves the solution. Additionally, nitrate is not vaporized at the low temperature of this process and could only leave as an entrained solid.

2. We have not ignored the water component in either the volume reduction or energy balances, the water is consumed in the reaction and is an important reactant. We do form a rather pure distillate that is used with incoming nitrate as a reactant or to facilitate heat transfer. Closed balances are presented in the report on our fiscal year 1992 work.

2.4.5 Crystalline Silico-Titanate Ion Exchangers

Presenter: N. Brown; see Appendix B, Figure B-10.

2.4.6 Electrochemical Treatment of Liquid Radioactive Wastes

Presenter: D. Hobbs; see Appendix B, Figure B-11.

2.4.7 Transuranic Extraction Model Development

Presenter: G.F. Vandegrift; see Appendix B, Figure B-12.

2.4.8 Transuranic Extraction Model Validation

Presenter: C.P. McGinnis; see Appendix B, Figure B-13.

2.4.9 Technical Interchange with Commissariat à l'Energie Atomique (France)

Presenter: R.T. Jubin; see Appendix B, Figure B-14.

2.4.10 Sludge Technology Assessment

Presenter: J.E. Helt; see Appendix B, Figure B-15.

2.4.11 Sludge Treatment

Presenter: B.Z. Egan; see Appendix B, Figure B-16.

2.4.12 Calcination and Dissolution

Presenter: S.A. Colby; see Appendix B, Figure B-17.

Question: In caustic fusion using nickel crucibles, the rate of corrosion is "acceptable" for the short time involved. However, these crucibles have a finite life. If you have sulfates and a reducing atmosphere, high nickel alloys will be questionable unless the "coldwall" approach is reliable.

Response: A corrosion study has been started to quantify corrosion of several construction materials (e.g., high nickel alloys) as a function of temperature during caustic fusion. It is anticipated that corrosion will be unacceptable at the extreme operating temperature of 850 °C. The "coldwall" approach cools the outer skin of the equipment typically with water. As a result, calcine material solidifies onto the inner wall, which serves to inhibit corrosion. Coldwall technology is readily used in industry where corrosion is a problem. The corrosion study plans to simulate the coldwall in the laboratory to determine if this approach is applicable to calcination of high sodium wastes.

2.4.13 Technology Evaluation and Process Definition

Presenters: S.E. Seeman and W.L. Kuhn; see Appendix B, Figure B-18.

Questions:

1. What does the peer review focus on and who does it?
   a) Peer review of the <u>model</u>.
   b) Peer review of developer's estimates of parameters.

2. How does the model deal with uncertainty in parameters
   a) Of the <u>technology</u> in question (will it perform as proposed)?
   b) Of the model--what if facilities aren't built, retrieval can't provide expected feed, etc.?

3. How will data be used? Are you interested in <u>absolute</u> performance or <u>relative</u> performance for some decisions. What's the decision?

Responses:

1. There are two reviews. The first is a developer's review in which we (the analysts) go over the input assumptions and results of the analysis with the people that are considered to be the advocates or developers of the process technology. Its purpose is to ensure that we have accurately and fairly represented the process from their point of view. Attendees will be the developers, advocates, and analysts. The second review is the peer review. Its purpose is to have peers look at the results or models before the report is finalized. Attendees will be EM-50 (ESP-IP, T. Fryberger and/or her representative), developers and advocates, other recognized experts in the process field (national lab experts and/or university experts), and analysts. The purpose is to come to a consensus on how the work was performed and the results. After the peer review, the analysts will make necessary changes to the models and finalize the report.

2. Normally, the uncertainties in technology parameters are dealt with through the peer review. If it is felt by the reviewers that there is considerable uncertainty in a parameter, the parameter is varied in the model to determine the sensitivity to the overall results. Uncertainties in the overall model such as unavailability, facilities, or improper feed are called out as issues in the report. These should also be determined during the reviews. It is also possible to determine the effect of these uncertainties by sensitivity analyses.

3. The results of the analyses are provided in report form to EM-50 (ESP-IP) and developers. It is expected that this information, along with other information, will be used by EM-50 in their decision-making process. Although the results are stated in absolute form only, the relative performance results have true meaning. For example, an absolute cost of $XX for cleanup of a site is not as important to this process as the result that process A results in a 20% lower overall cost than process B (along with other comparisons of health effects, amounts of waste, etc.). We expect that this information will be used in making decisions about which process developments to fund, how much to fund them, and as guidance to the developer as to what parts of the process to focus on.

2.4.14 Tank Waste Processing Analysis

Presenter: E.G. Baker; see Appendix B, Figure B-19.

2.5 PROGRAM COORDINATION BREAKOUT SESSION

Attendance in this breakout session included the following persons:

DOE-HQ

T. Fryberger
S.M. Gibson
G. Mellinger
J. Burnett

RL

C.S. Louie
J.C. Peschong

WHC

J.N. Appel
W.B. Barton
D.R. Bratzel
J.M. Cruse
R.L. Gilchrist
P.S. Schaus
J.C. Womack

Westinghouse Idaho Nuclear Company, Inc. (WINCO)

L. McClure

PNL

L.K. Holton
B.M. Johnson
J.R. Morrey
J.L. Straalsund
M.J. Quadrel

LANL

K.W. Thomas

University of Kansas

D.E. Bush

R.A. Harrington facilitated this session. The discussion focused on three elements: (1) What is working well?, (2) What are our challenges?, (3) How do we jointly manage?, (4) communication, and (5) top issues and action items. The following subsections highlight these discussions.

2.5.1 What is Working Well?

One at a time, each person offered input that was written on flip charts. Table 2-4 is a reproduction of these charts and captures the important points.

2.5.2 What Are Our Challenges?

As in the "working well" discussion, one at a time each person offered input that was written on flip charts. Table 2-5 is a reproduction of these charts and captures the important points.

2.5.3 How Do We Jointly Manage?

Group discussion led to a conclusion that two actions need to be taken to improve DOE's joint EM-30 and EM-50 management of the pretreatment development work:

- Establish a "Pretreatment Management Council"
- Negotiate an agreed-upon predictable decision "schedule."

2.5.4 Communication

The discussion led to identifying a number of items for improving communication. Table 2-6 identifies these items.

2.5.5 Top Issues and Action Plan

The group discussion identified three top issues: (1) communication, (2) "How do we jointly manage?", and (3) managing uncertainty. The following actions (Table 2-7) were identified to effect some near-term actions to deal with some of the issues and concerns identified.

2.6 SUPERNATE AND SALT CAKE TECHNOLOGIES BREAKOUT SESSION

The following individuals (shown by technology) were in attendance in this breakout session:

Cesium Extraction CPU--W.G. Richmond/J.P. Bibbler
Biological Nitrate Destruction--G.F. Andrews
NAC Process--A.J. Mattus
Sodium Titanate Ion Exchangers--N. Brown
Development and Testing of Solid Sequestering Agents--D.W. Wester
Electrochemical Destruction of Organics and Nitrates--D. Hobbs

Biphasic Systems for Radionuclide Extraction--D. Chaiko
W.L. Kuhn
Major M.C. Thompson

Table 2-4. What Is Working Well--Flip Chart Summary.

WHAT IS WORKING WELL
People are attempting to communicate, •, •, •,
Evolutionary process is working--driving focus, •
ESP-IP is working well by cross cutting via funding
Great education--well planned
Starting to embrace systems analysis
Interaction (EM-30/50) is very good
People are really trying! Dedicated
Encouraged by the progress and integration of TRUEX
Three programs have focus
Recognizing the national effort required
The focus is Hanford
EM-50 is needs driven, •, •,
Increased credibility of DOE nation wide
EM-30 communicating needs, •
Program's abilities to attract good people
Support from DOE-HQ (level of effort)
Dedicated people
Integration of programs is improving and has great potential
Progress and teaming

Mr. W.G. Richmond chaired the session. Detailed minutes are provided in the following subsections.

Table 2-5. What Are Our Challenges--Flip Chart Summary.

CHALLENGES
1. Ability to make decisions
2. Clear definition of responsibilities (interface control)
3. Managing uncertainties
4. Focused research vs. ingenuity
5. Common stable vision •, •, •
6. Speed of decision making
7. Overcoming "not invented here" (NIH) "think win-win"
8. Technology transfer (EM-50 to EM-30)
9. How to jointly manage
10. Streamline management system and lines of communication
11. Operational interface
12. Mechanics for selection of technology
13. Technology windows
14. Communication, •
15. Trust, •
16. Accepting research innovation
17. Slow bureaucracy, i.e., procurement
18. Accomplishments

2.6.1 Compact Processing Philosophy and Waste Blending

A compact processing philosophy for waste processing precludes large-scale blending of the waste.

2.6.1.1 Implications. The lack of ability to blend wastes results in an increased need for process flexibility and robustness with respect to changes in waste composition. This means that processes that are relatively insensitive to waste composition have a significant advantage over those that are sensitive to waste composition.

Table 2-6. Ideas for Improving Communication.

<u>COMMUNICATION</u>
Monthly video conference.
Planning of meetings and joint events (e.g., interface control point of contact).
Organize meetings by functional requisition, <u>not</u> funding source (do not include funding as scope).
Develop an EM-30/50 distribution list, with responsibility to distribute.
Commitment to close the loop with principal investigators.
Assign staff to Hanford Site from national lab staff by term, i.e., 1 year, etc.
Assign Hanford Site point person to each national team.
Have field managers spend time periodically at DOE-HQ and vice versa.
Evaluate "value added" of all procedures.
Full use of electronic and video media.

Table 2-7. Action Plan.

What	Who/When	
1. Develop EM-30/50 distribution list with responsibility for distribution. Issue draft (including E Mail)	G. Mellinger	3/5/93
2. Conduct pretreatment monthly teleconference meeting (as a start). Develop plan and execute first meeting.	T. Fryberger	3/5/93
3. Develop pretreatment coordination council for coordination and integration. - Issue proposal - Take challenges and ideas from Salt Lake meeting and proceed with appropriate action.	J.C. Peschong	2/12/93

The principal investigators present felt that an understanding of the extremes of waste compositions was key to successful development and testing of waste treatment processes. In fact, there was a general consensus that if a range of compositions over which a process was required to perform could be defined, it could become a key early selection criteria for determining process applicability.

2.6.1.2 Recommended Action. The UST-ID needs to define the extremes of waste composition as well as the average or mean if processes are to be evaluated in light of a compact processing philosophy for waste treatment.

2.6.2 Systems Study

There was a general concern expressed that the systems study did not address many of the processes being pursued by the UST-ID. In addition, the principal investigators noted that they did not know how to get their process considered in the systems study.

It was also noted that the systems study currently did not address the distributed processing concept for waste treatment.**Recommended Action:**

Recommended Action:

The UST-ID should communicate these concerns to the respective ESP-IP principal investigators responsible for the systems study. The UST-ID principal investigators suggested that a systematic process for inclusion in this study be documented. This process would include the following elements: (1) identification of required information, (2) identification of a method of information transmittal to the systems study, (3) communication of systems study results to the principal investigator.

The systems study should be modified or expanded to include appropriate consideration of distributed processing.

2.6.3 Selection of Technologies for Demonstration

There was considerable discussion regarding the selection of technologies for field demonstration with actual tank waste. The principle concern of the principal investigators in this area was a lack of understanding of the radioactive demonstration process selection criteria. The principal investigators felt that if this criteria were more clearly understood, they could better focus their TTPs on developing the information required for this decision. One of the principle questions discussed was, "At what stage in the process development (e.g., lab scale, bench scale, pilot scale) is a process selected for field demonstration?"

Recommended Action:

The UST-ID and ESP-IP should identify the criteria for process selection and the information needed for the process selection decision, and communicate this information to the principal investigators.

2.6.4 General Comments

The UST-ID and ESP-IP do not appear to address the development of treatment technologies for the liquids generated from sludge treatment, e.g., dissolved sludges. The development of these treatment technologies appears to be required to implement some of EM-30's plans for waste treatment.

The principal investigators would like to see a table of all ESP-IP and UST-ID funded TTPs and their targeted contaminant application. This table could enhance linkages between the principal investigators and assist in identifying areas where further work is required.

The principal investigators expressed an interest in understanding the EM-30 (waste treatment) baseline at all of the DOE sites (e.g., Oakridge National Laboratory [ORNL], SRS, etc.). This understanding could assist in developing or identifying technologies that are applicable at more than one site.

2.6.5 Identification of Linkages Between Technologies, Programs, and Projects

The following potential linkages were identified:

- Silico-titanates could be linked with the CPU concept for deployment.
- Silico-titanates could be linked to the nitrate to ammonia and ceramic (NAC) or biphasic processes to provide treatment of the liquid streams generated.
- Silico-titanates could be linked with pillared clays to improve selectivity.
- The electrochemical destruction processes should be conducted on a stream that has already had the cesium removed to improve membrane life expectancy.
- The ProTech profiles submitted in February could form the basis for W.B. Barton's (WHC EM-30) process selection study. These profiles should be made available to WHC for this purpose.
- The ESP-IP should use the ProTech system.
- The silico-titanate testing should be expanded to address higher potassium concentrations, higher caustic concentrations, and regeneration processes to enable consideration for application in the cesium CPU.
- The radiation testing plan developed for the resorcinol-formaldehyde should be transmitted to Sandia National Laboratory for consideration and as a basis for similar testing of the silico-titanates.

2.6.6 Demonstration Schedule

The time each process currently under development will be ready for demonstration was estimated by the responsible principal investigators and is summarized below:

- Silico-titanates: 3 years
- NAC: 1 year
- Resorcinol-formaldehyde resin: 1 year
- Biodenitrification: 2 years until applicability of process is known and approximately 4 years until ready for demonstration
- Electrochemical destruction: 3 years.

2.7 SLUDGE PROCESSING TECHNOLOGIES BREAKOUT SESSION

The following individuals (shown by technology) were in attendance in this breakout session:

TRUEX Model Development--G.F. Vandegrift
TRUEX Model Validation--J.T. Bell
Technical Exchange--R.T. Jubin
Sequestering Agents for Transuranics--G. Jarvinen
Status of Sludge Technology--J.E. Helt
ACT-DE-CON Leaching of Hanford Sludge--D.E. Kurath
Sludge Washing and Dissolution--B.Z. Egan
Sequestering Agent-Coated Magnetic Beads--L. Nunez
Advanced Solvent Extraction for the Clean Option--P. Horwitz
Naturally Occurring Sequestering Agents--D. Hoffman

Mr. J.E. Helt chaired the session noting the following major points.

- There is a common need to develop options for DOE; the UST-ID needs to define and expand its envelope of operations.
- The common goal is to produce better final waste and less volume for high-level waste (HLW) in repository.

  NOTE: ORNL will have actual sludge waste to work with in testing.
- Sequential modeling of dissolution is needed.
- Thermodynamic models probably do not do any good.
- Polymers or colloids cause problems.

- Mutual need by all--better envelope of sludge and dissolution of that material:

  - pH
  - Colloids.

- Common waste simulants should be developed and used by all projects to ensure common basis for evaluation.

- A single contact for "sludge" material is needed.

- Better interaction is needed with those conducting characterization development projects.

- J.L. Straalsund (PNL) can provide characterization data from "clean option" study.

- Two steps are needed in sludge treatment:
  1. Leach or dissolve
  2. Treat dissolved solution.

  Questions:
  1. Gap between these two steps?
  2. Interface problem?
  3. In tank treatment?

- Eliminate sludges, if possible; note Rocky Flats work.

- "Clean Option" report gives guidelines for Hanford Site glass? All should get copies. Work on common basis.

- Duplication of work among principal investigators not apparent now. This is only for EM-50 ESP-IP. Not at all clear how other work funded by EM-30 (PNL, LANL) is doing.

- Better interactions with sites that have similar problems with EM-30 funding are needed.

- Better linkage with "customers" in EM-30 and EM-40 is needed.

- Much more communication, interaction, coordination by principal investigators is needed, including these areas:

  - Characterization
  - Retrieval
  - Systems studies.

- Most of the work in sludge processing is in the area of treatment of "dissolved solutions." It is not clear that there is enough and/or appropriate work in getting sludge in tank to that "dissolved solution."

2.8 COMPREHENSIVE TECHNOLOGIES AND SYSTEMS ANALYSIS BREAKOUT SESSION

The following individuals (shown by technology) were in attendance in this breakout session:

Sludge/Supernate Processing--C.P. McGinnis
Calcination/Dissolution--S.A. Colby
Unit Process Definition and Evaluation--W.L. Kuhn
Global Evaluation of Separations Processes--S.E. Seeman
Leaching of Calcined HLW--R.G. Cowen
Pyrochemical Forms for Idaho National Engineering Laboratory Calcine Waste--T. Todd
Tank Waste Processing Analysis--E.G. Baker

Mr. C.P. McGinnis chaired the session. Detailed minutes are provided in the following subsections.

2.8.1 Objective

The group discussion identified the following objective for the session:

"Demonstrate value of ESP-IP and UST-ID from a system prospective with near-term focus on IPM and CPU."

2.8.2 Initial Pretreatment Module Constraints, Criteria, and Issues

The discussion focused on the initial pretreatment module (IPM). Major points were recorded on flipcharts and are presented in Table 2-8.

Table 2-8. Initial Pretreatment Module Constraints, Criterias, and Issues.

<u>IPM Constraints</u>

1. IPM technology help from ESP-IP and UST-ID must <u>now</u> be in development.
2. Solution to IPM <u>must</u> be complementary to TWRS objective.
3. IPM must be done <u>before</u> full-scale TWRS plant to be meaningful.

<u>Functional Design Criteria</u>

1. Undefined
2. Assumed:
    - IPM low-level product goes to final disposal (not storage).
    - IPM HLW solids can be safely stored.

Table 2-8. Initial Pretreatment Module Constraints, Criterias, and Issues. (cont.)

IPM Issues
Safety
1. Organic and ferrocyanide destruction.
2. Cesium removal and strontium removal.
Disposal
1. LLW form.
2. Nitrate question.

2.8.3 Issue Resolution

As above, Table 2-9 presents the major items of discussion.

Table 2-9. Issue Resolution.

Organic Destruction
1. Calcination and dissolution
2. NAC
3. Electrochemical destruction
Ferrocyanide
Calcination and dissolution
Cesium and Strontium Removal
1. Resorcinol resin
2. Silico-titanate
3. Pillared clays Cesium and strontium specific ligands Coated magnetic beads

Table 2-9. Issue Resolution. (cont.)

Low-Level Waste Form
1. NAC (waste form producer)
2. Calcination and dissolution
3. Polyethylene
Nitrates
1. NAC
2. Calcination and dissolution
3. Electrochemical destruction
4. Biodenitrification

2.8.4 Conclusions

Table 2-10. Conclusions.

1.	ESP-IP and UST-ID in overall framework supports TWRS.
2.	NAC, calcination and dissolution, resorcinol, and titanate are of value to IPM in the near term.
3.	Characterization needs to be stressed within EM-50: W.R.T. Class A waste W.R.T. Safety issues in solid W.R.T. Process integration
4.	Systems analysis (modeling, etc.) should specifically address how above processes meet the various low-level waste form requirements (not now established).
5.	Development of LLW forms is, and will continue to be, a critical issue to evaluate performance of TWRS processes.

2.9 SUMMARY AND WRAP-UP SESSION

2.9.1 Supernate and Salt Cake Processing Breakout Summary

Mr. W.G. Richmond summarized the breakout session with the following major points:

- An issue was raised regarding the impact of blending waste on the CPU approach. This will be investigated.
- Definition, use, and acceptability of simulants continues to be an issue; a comprehensive simulant document is needed to address this.
- Liquid waste streams resulting from treatment of sludges will present an issue with overall system impact and an impact on CPU processing.
- Hydrothermal processing ranked high in the group of technologies that should be pursued.
- Knowledge of "customer" (i.e. EM-30, EM-40) needs is limited and needs to improve.
- The discussion led to a number of areas where collaboration could occur, including: silico-titanate development work (common test plans, testing shared results), electrochemical destruction with cesium removal, and electrochemical destruction with biphasic systems.
- The silico-titanate was considered a candidate for near-term deployment with a possible linkage with the biphasic extraction technology.

2.9.2 Sludge Processing Breakout Summary

Mr. J.E. Helt summarized this session with the following:

- Many questions were asked regarding the impact of characterization and retrieval operations on the waste with the interest being their affect on the input stream to the processes in question.
- Some projects were assuming dissolved input streams from the retrieval operation.
- Additional characterization is needed for sludges to address input stream questions.
- More awareness of sites' needs will be crucial as work progresses.

2.9.3 Comprehensive Processing and Systems Analysis Breakout Summary

Messrs. C.P. McGinnis and S.E. Seeman summarized this session with the following:

- The group worked well as a team in this session.

- IPM and CPU interface issues were: safety and disposal. For safety, organics and ferrocyanide destruction is needed. For disposal, cesium and strontium removal is needed. Organic destruction could be achieved by calcination and dissolution followed by NAC and ammonia destruction.

- Conclusions: (1) ESP-IP and UST-ID programs should support TWRS in the near term but retain focus on long-range solutions, (2) calcination and dissolution, NAC, resorcinol resin, and silico-titanate technologies are of highest value to IPM.

2.9.4 Program Coordination Breakout Summary

Mr. J.C. Peschong provided a summary of this session with the following:

- The group focused on discussing "What is going well?" and "What are our challenges?".

  - Going well--the right people are involved and beginning to communicate. This meeting was a good start in that direction and more of this needs to happen.

  - Major challenges--(1) communication, (2) how do we manage jointly, and (3) managing uncertainty.

- Some actions to address these challenges were taken: (1) G. Mellinger volunteered to develop a distribution list for documents and other items to improve awareness, (2) T. Fryberger volunteered to evaluate the benefit of periodic meetings in this technical area (similar to this workshop, but with more EM-30 principal investigators), and (3) J.C. Peschong volunteered to evaluate establishing a pretreatment council to assist in overall integration of this work.

2.9.5 Richland Operations Office Perspective of Workshop

Mr. J.C. Peschong provided the following comments:

- The Hanford Site and TWRS are spending $2 million per day on this problem; the goal is to pretreat the waste and close the plant.

- Logic diagrams are being developed in 1-, 5-, and 20-year windows. The diagrams are how we will be making decisions. We will send them to anyone who wants them for input.

- Technologies should not be abandoned from development if the only reason is the schedule will not support IPM.
- The program is not "in cement."
- This meeting was encouraging, glad I came; I will be coming to the next ones.

Mr. Peschong called upon Mr. J.N. Appel and Ms. C.S. Louie for additional input:

- Mr. Appel--development activities need to be provided with reference waste compositions and simulants.
- Ms. Louie--no input.

2.9.6 U.S. Department of Energy-Headquarters and Efficient Separations and Processing-Integrated Program Perspective

Mr. J.R. Morrey provided this discussion for T. Fryberger:

- The workshop had its good points and its rough spots.
- The ESP-IP meeting on Wednesday had many "drop-ins;" however, it was beneficial.
- The programs need to proceed with a "win/win" philosophy.
- The concern with overlap between programs needs to be worked.
- Achieving deliverables needs more attention.
- Mr. Morrey asked the group if they thought the workshop was worthwhile with a show of hands (most raised their hands).
- Mr. Morrey asked all principal investigators in the group if they thought there were any redundant work efforts going on across the programs with a show of hands (none were raised).
- For the most part, the benefit of this workshop was accomplished.
- Mr. Morrey encouraged the group to follow through with the outcome of the meeting and to respond to Mr. Peschong's offer (logic diagrams).

2.9.7 U.S. Department of Energy-Headquarters and EM-30 Perspective

Mr. G. Mellinger provided the following comments:

- The programs are dealing with a huge problem that is comparable to the original challenge of the Manhattan Project.

- Seeing all of the technology options was beneficial.
- "We're in this together." This meeting was a first step in overall integration and we need to do more.
- Jointly managing a program of this size is new ground.

2.9.8 U.S. Department of Energy-Headquarters and Underground Storage Tank-Integrated Demonstration Program Perspective

Mr. R.L. Gilchrist provided the following comments for S.M. Gibson:

- This is the first of many meetings needed in this area; we have a bright future in working together.
- We need to produce deliverables and enhance communication to ensure success.
- Mr. Gilchrist then thanked the principal investigators; J.C. Peschong; the breakout session leaders; J.R. Morrey, S.M. Gibson, T. Fryberger, R.A. Harrington, and J.M. Cruse for setting up the workshop; and to all others who participated.

2.9.9 Closing Remarks

Mr. R.A. Harrington opened the floor for closing remarks, as follows:

- S.E. Seeman noted the need to continue to work the systems analysis approach to solving this problem.
- W.B. Barton--IPM is an important part of the TWRS mission, but it is only a first step. The programs should focus on getting the right technologies developed.
- A.J. Mattus discussed the rebaselining work that was currently underway at the Hanford Site with the Leadership Council. The options range from no pretreatment to extended pretreatment (no glass). The TWRS direction is to submit a rough proposal in March 1993 with milestone definition in September 1993. The IPM project was unchanged, new tanks were unchanged, and technology development will be affected.
- J.C. Peschong noted that there is no sure solution and no sure reference case at this time, but we are working toward it.
- R.L. Gilchrist noted that the UST-ID, while Hanford is the host site, is evaluating the needs of the DOE complex as a whole. When the baseline is established, the impact will be assessed and balanced with the other drivers, the broad picture, and DOE-HQ direction.

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APPENDIX A

TECHNOLOGY DEVELOPMENT ACTIVITIES CHART

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APPENDIX A

TECHNOLOGY DEVELOPMENT ACTIVITIES CHART

An earlier version of the chart included at the end of this appendix was presented at the workshop. A number of comments were received at the workshop and in subsequent reviews. The comments received and their resolutions are presented below; the chart reflects the resolutions as incorporated.

C-1 Comments (L. Bustard)

The following comments were transmitted at the workshop in a meeting (L. Bustard, Sandia National Laboratory [SNL], with J. M. Cruse, Westinghouse Hanford Company [WHC], dated February 4, 1993).

- Steam reforming (EM-36) funding should be added to the Organic/Nitrate Destruction function.
- Crystalline silico-titanates should be added to the following functions:

  - Basic side Cs removal
  - Basic side Sr removal
  - Basic side TRU removal
  - Acid side Cs removal
  - Acid side Sr removal
  - Acid side TRU removal

Response:

The comment(s) were reviewed and incorporated in the current version as applicable.

C-2 Comments (P.D. Kalb)

The following comments were transmitted via telephone conversation (P.D. Kalb, Brookhaven National Laboratory [BNL], with J.M. Cruse, WHC, dated February 17, 1993).

- In the LLW Disposal function, change "Grout" to read "Baseline--Grout."
- The NAC and polyethylene encapsulation may fit in other functional needs.
- In the Hazardous Materials Removal function, NAC and biological destruction would be redundant technologies.

Response:

The comment(s) were reviewed and incorporated in the current version as applicable.

C-3 Comments (M.C. Thompson)

The following comments were transmitted via fax dated February 24, 1993.

I have reviewed the Tank Waste Separations and Disposal Technology Development Activities Chart and find it very informative, and yet I'm not sure that it is complete in terms of work supported by UST-ID. Unless the UST-ID box under Organic/FeCN Destruction is intended to represent any one of several activities funded this year, steam reforming work at SNL is not represented.

The box for Hazardous Materials Destruction seems to be aimed at destruction primarily of nitrate, but does not include a number of the technologies which destroy organics and FeCN, such as hydrothermal processes, steam reforming, and calcination, which are being considered by UST-ID because the technologies destroy all three species.

The box for Chemical Recycle does not have any processes shown being funded. However, several of the processes for destruction of organics and nitrate can also be used for recycle of chemicals. At present, I believe the Clean Option is assuming calcination to recover NaOH for recycle to earlier portions of the process. Likewise, the NO_x produced from these high temperature processes or electrochemical nitrate destruction can be scrubbed to recover HNO_3 for recycle to the acid part of the flowsheet. Why aren't these technologies listed in the box? Are you only listing technologies that aren't listed elsewhere? Perhaps this box can be combined with the Hazardous Materials Destruction box because most of the same technologies are applicable.

I think this is a good idea. The chart should be made available to principal investigators during the request for proposals if possible. There needs to be a mechanism for regular revision of the chart to include new technologies being funded by ESP-IP and UST-ID and for removal of technologies which are no longer funded because they don't work or are not practical for whatever reason. My concern is that new technologies funded by ESP-IP need to be included so that DOE-RL is aware of where they fit in especially if technologies must be on the chart to be considered by DOE-RL for funding and application at Hanford.

Thanks for the opportunity to comment. I would appreciate a copy of the chart after all revisions have been incorporated.

Response:

The comment(s) were reviewed and incorporated in the current version as applicable.

C-4 Comments (G. Jensen)

The following comment was transmitted via telephone conversation (G. Jensen, WHC, with J. M. Cruse, WHC, dated February 26, 1993).

Tom Woods should be shown as the principal investigator for the EM-30 systems analysis task.

Response:

The comment(s) were reviewed and incorporated in the current version as applicable.

C-5 Comments (N. Brown)

The following comments were transmitted via telephone conversation (N. Brown, SNL, with J. M. Cruse, WHC, dated March 2, 1993).

- Add steam reforming to the Organic/FeCN Destruction function.
- Add crystalline silico-titanates to the Sr Removal and Cs Removal (acidic) functions.
- Add steam reforming to the Nitrate Destruction/Recycle function.
- Add calcination and steam reforming to the NO_3 Destruction/Recycle function.
- This is a very worthwhile effort; please send the final version to me.
- Add Sr and I to the Tank Waste Retrieval function.
- Add biphasic systems to the Tc/I Removal function (discuss this with [D.] Chaiko at ANL [Argonne National Laboratory]).

Response:

The comment(s) were reviewed and incorporated in the current version as applicable.

C-6 Comments (W.L. Kuhn)

The following comments were transmitted via electronic mail May 7, 1993.

- Add to "Sludge Dissolution" block--

  Alkaline Tank Sludge Treatment
  EM-50, ESP-IP
  PNL Lumetta/Colton

- Move "Advanced Solvent Extraction" [Horowitz] from "Selective Leach block" to "TRU Removal" block and also add to "Sr Removal" block and to "Tc Removal" block.
- Add "Selective Solid-Based Sequestering Agents" to "Removal of Other Radionuclides" block.
- Change work location for "Natural Sequestering Agents" from LLNL to LBL. The principal investigator is [D.] Hoffman. The TTP for this work focuses on removal of Pu from waste water, and hence is not a

selective leach technology. Suggest moving to "TRU Removal" or "Removal of Other Radionuclides" [alkaline] block.

- Add "Electrochemical Dest." [D. Hobbs] also to "Nitrate/Organic Destruction" block. Also, note principal investigator is [D.] Hobbs in the "Hazardous Materials Removal" block.

- Add to "Cs Removal [Acidic]" block--

  Cobalt Dicarbolide Support
  EM-50, ESP-IP
  Geotech Carlson

- Add to "Systems Analysis/Crosscut" block--

  Innovative Chemical Separation
  EM-50, ESP-IP
  PNL, tbd Morrey

- Add to "Alkaline-Side Cs Removal" block--

  Dicarbolide for Cs Decontamination
  EM-50, ESP-IP
  SRL King

- Add to "Other Radionuclides Removal" block--

  Actinides Separations for Adv. Processing
  EM-50, ESP-IP
  LANL Smith

Response:

The comment(s) were reviewed and incorporated in the current version as applicable.

Figure A-1. Technology Development Activities Chart.

The following pages can be laid out in the following manner to create the overall flow of activities.

Sheet 1	Sheet 3	Sheet 5
Sheet 2	Sheet 4	Sheet 6

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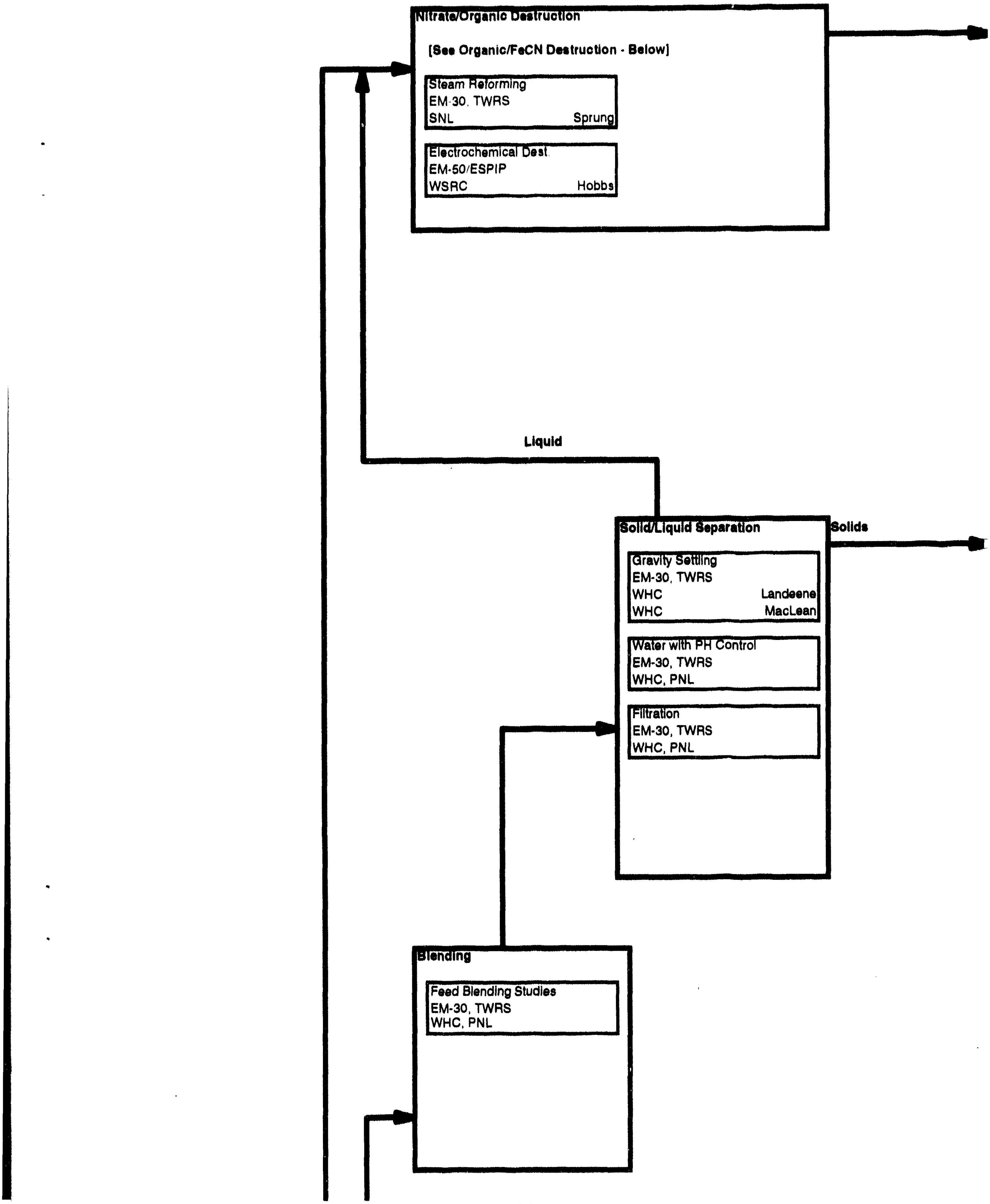


Nitrate/Organic Destruction
[See Organic/FeCN Destruction - Below]
Steam Reforming
EM-30, TWRS
SNL Sprung
Electrochemical Dest.
EM-50/ESPIP
WSRC Hobbs
Liquid
Solid/Liquid Separation
Solids
Gravity Settling
EM-30, TWRS
WHC Landeene
WHC MacLean
Water with PH Control
EM-30, TWRS
WHC, PNL
Filtration
EM-30, TWRS
WHC, PNL
Blending
Feed Blending Studies
EM-30, TWRS
WHC, PNL

Figure A-1. Technology Development Activities Chart. (sheet 1 of 6)

Alkaline-Side Cs Removal

- CS-100 / EM-30, TWRS / PNL, WHC
- SRS Resorcinol Resin IX / EM-30, TWRS / PNL, WHC
- Crystalline Titantes / EM-30, TWRS / WHC, PNL / Stephens
- Fission Product Separation Technology Development / EM-30, TWRS / PNL / Bray
- Selective Solid-Based Sequestering Agents / EM-50, ESPIP / PNL / Industry
- CPU Development / EM-50, UST-ID / PNL / Richmond
- Cs Extraction Testing / EM-50, UST-ID / WSRC / Bibbler
- Crystalline Silico-titantes / EM-30, TWRS / SNL / Brown
- Crystalline Silico-titanate IX / EM-50, ESPIP / SNL / Brown
- Biphasic Systems for Rx Extr. / EM-50, ESPIP / ANL / Chaiko
- Dicarbolide for Cs Decon. / EM-50, ESPIP / SRL / King

Cs

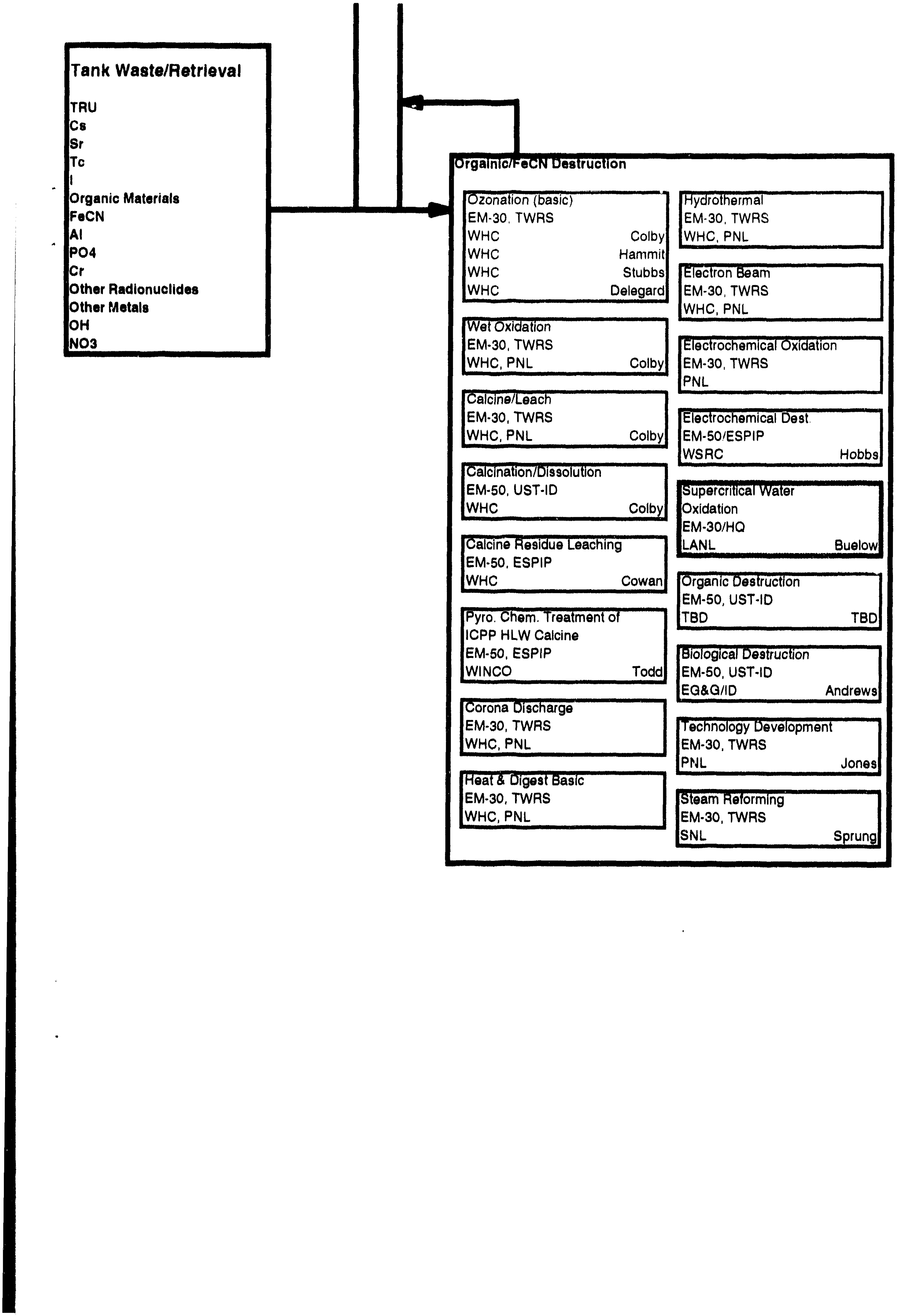
Liquid

Sludge Washing

Solids

- Chem. Dissolution (Aqueous) / EM-30, TWRS / WHC, PNL
- Electrochemical Dissolution / EM-30, TWRS / WHC, PNL
- Fusion / EM-30, TWRS / WHC, PNL
- In-Tank Washing Lab. Tests Sludge Washing Studies / EM-30, TWRS / PNL / Lumetta
- Sludge Dissolution Lab Studies / EM-30, TWRS / PNL / Lumetta
- Solvent Extration Lab Studies / EM-30, TWRS / PNL / Lumetta
- Sludge Washing & Dissolution / EM-50, UST-ID / MMES/OR / Egan

Solids


Tank Waste/Retrieval
TRU
Cs
Sr
Tc
I
Organic Materials
FeCN
Al
PO4
Cr
Other Radionuclides
Other Metals
OH
NO3
Orgainic/FeCN Destruction
Ozonation (basic)
EM-30, TWRS
WHC Colby
WHC Hammit
WHC Stubbs
WHC Delegard
Wet Oxidation
EM-30, TWRS
WHC, PNL Colby
Calcine/Leach
EM-30, TWRS
WHC, PNL Colby
Calcination/Dissolution
EM-50, UST-ID
WHC Colby
Calcine Residue Leaching
EM-50, ESPIP
WHC Cowan
Pyro. Chem. Treatment of
ICPP HLW Calcine
EM-50, ESPIP
WINCO Todd
Corona Discharge
EM-30, TWRS
WHC, PNL
Heat & Digest Basic
EM-30, TWRS
WHC, PNL
Hydrothermal
EM-30, TWRS
WHC, PNL
Electron Beam
EM-30, TWRS
WHC, PNL
Electrochemical Oxidation
EM-30, TWRS
PNL
Electrochemical Dest.
EM-50/ESPIP
WSRC Hobbs
Supercritical Water
Oxidation
EM-30/HQ
LANL Buelow
Organic Destruction
EM-50, UST-ID
TBD TBD
Biological Destruction
EM-50, UST-ID
EG&G/ID Andrews
Technology Development
EM-30, TWRS
PNL Jones
Steam Reforming
EM-30, TWRS
SNL Sprung

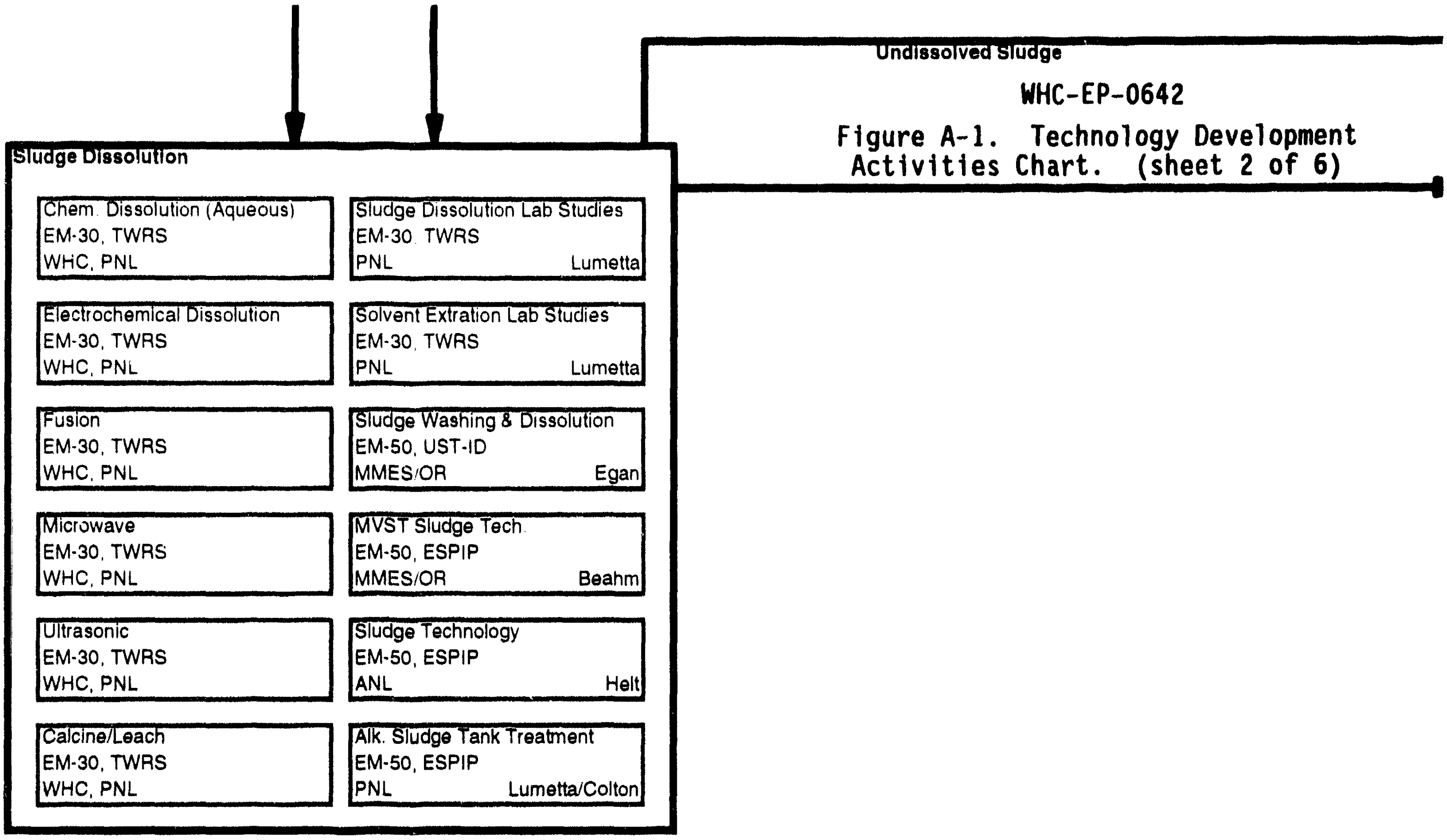
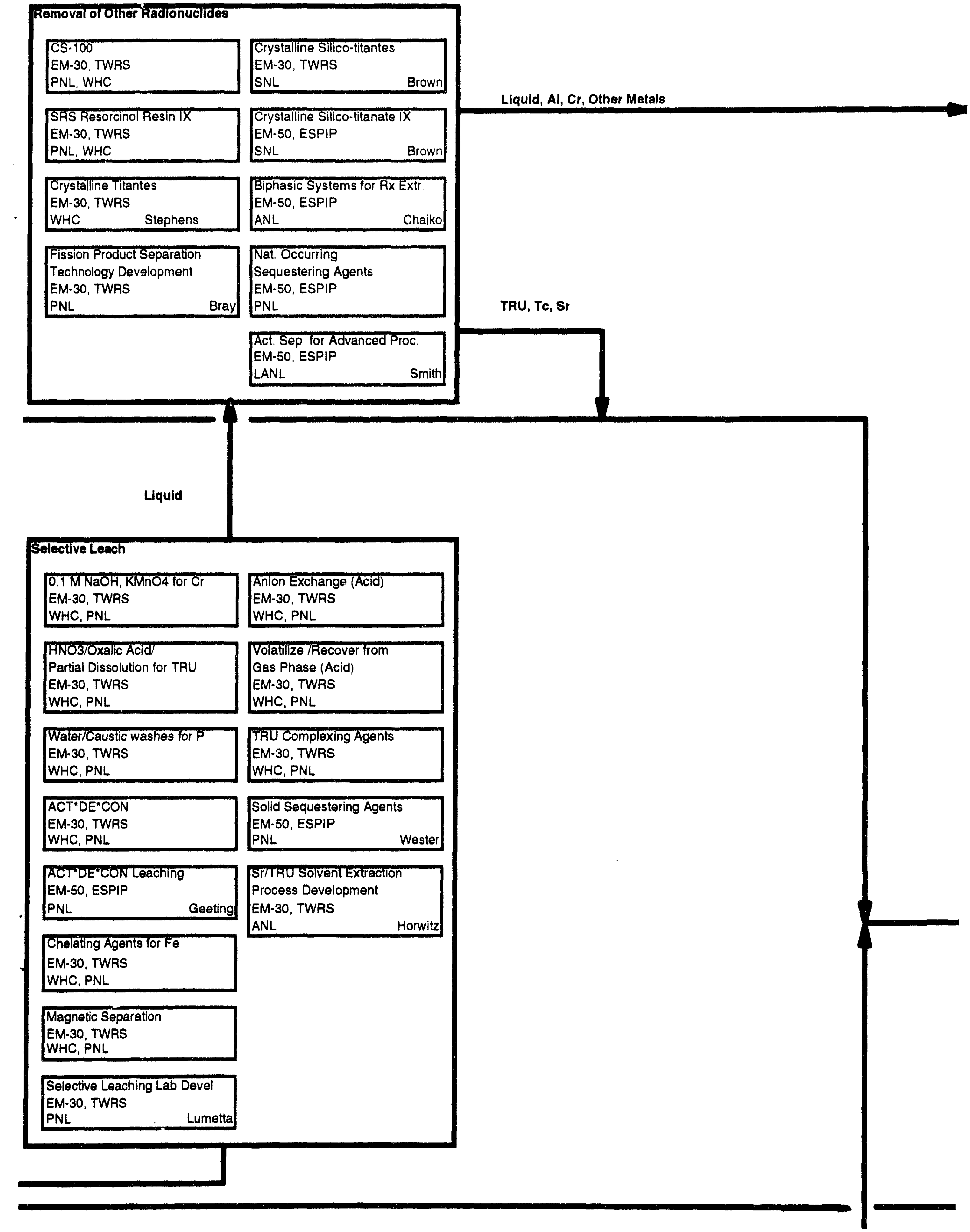


Figure A-1. Technology Development Activities Chart. (sheet 2 of 6)



Removal of Other Radionuclides
CS-100
EM-30, TWRS
PNL, WHC
Crystalline Silico-titantes
EM-30, TWRS
SNL Brown
SRS Resorcinol Resin IX
EM-30, TWRS
PNL, WHC
Crystalline Silico-titanate IX
EM-50, ESPIP
SNL Brown
Crystalline Titantes
EM-30, TWRS
WHC Stephens
Biphasic Systems for Rx Extr.
EM-50, ESPIP
ANL Chaiko
Fission Product Separation
Technology Development
EM-30, TWRS
PNL Bray
Nat. Occurring
Sequestering Agents
EM-50, ESPIP
PNL
Act. Sep for Advanced Proc.
EM-50, ESPIP
LANL Smith
Liquid, Al, Cr, Other Metals
TRU, Tc, Sr
Liquid
Selective Leach
0.1 M NaOH, KMnO4 for Cr
EM-30, TWRS
WHC, PNL
Anion Exchange (Acid)
EM-30, TWRS
WHC, PNL
HNO3/Oxalic Acid/
Partial Dissolution for TRU
EM-30, TWRS
WHC, PNL
Volatilize /Recover from
Gas Phase (Acid)
EM-30, TWRS
WHC, PNL
Water/Caustic washes for P
EM-30, TWRS
WHC, PNL
TRU Complexing Agents
EM-30, TWRS
WHC, PNL
ACT*DE*CON
EM-30, TWRS
WHC, PNL
Solid Sequestering Agents
EM-50, ESPIP
PNL Wester
ACT*DE*CON Leaching
EM-50, ESPIP
PNL Geeting
Sr/TRU Solvent Extraction
Process Development
EM-30, TWRS
ANL Horwitz
Chelating Agents for Fe
EM-30, TWRS
WHC, PNL
Magnetic Separation
EM-30, TWRS
WHC, PNL
Selective Leaching Lab Devel
EM-30, TWRS
PNL Lumetta

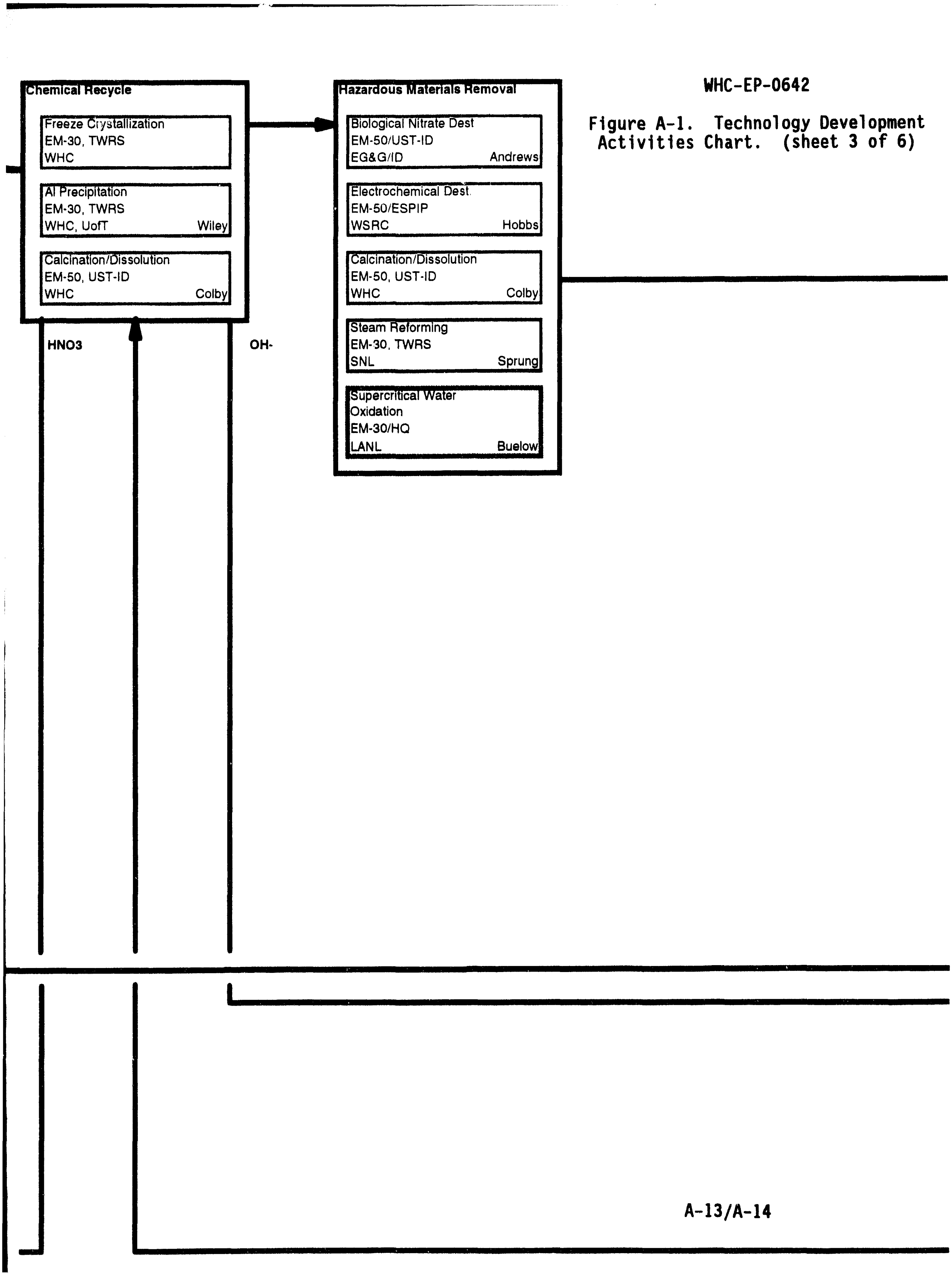


Figure A-1. Technology Development Activities Chart. (sheet 3 of 6)

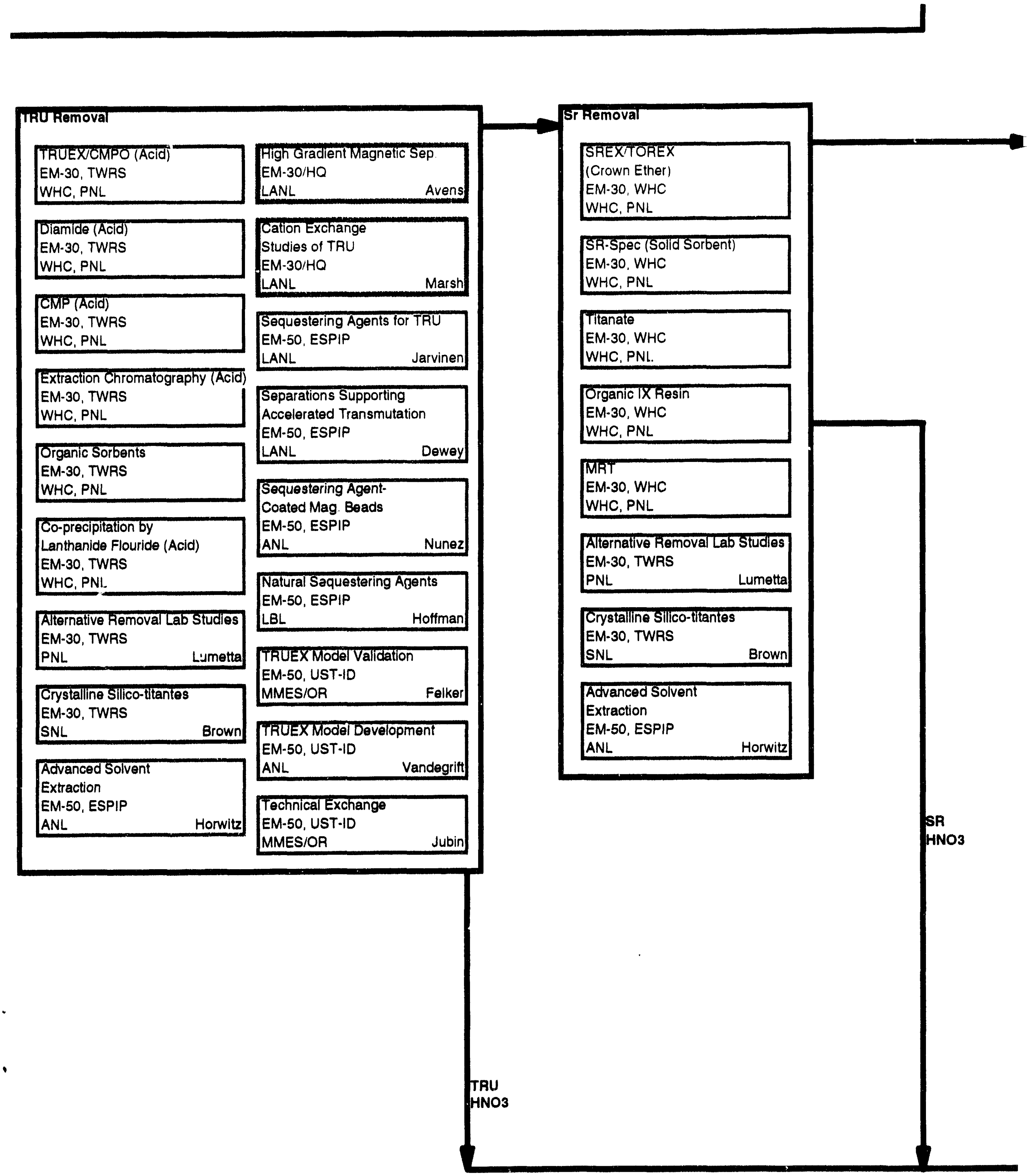
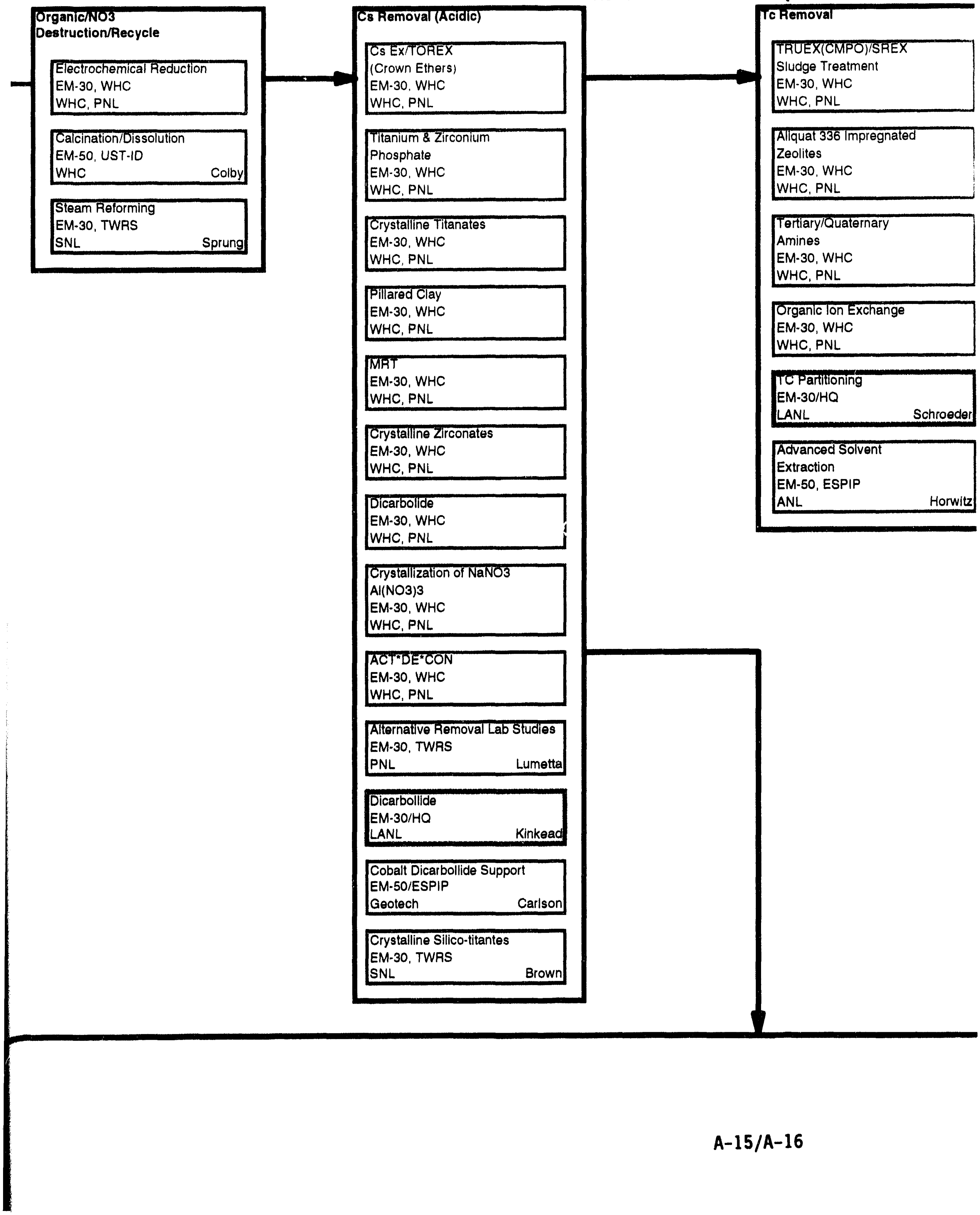

TRU Removal
TRUEX/CMPO (Acid)
EM-30, TWRS
WHC, PNL
Diamide (Acid)
EM-30, TWRS
WHC, PNL
CMP (Acid)
EM-30, TWRS
WHC, PNL
Extraction Chromatography (Acid)
EM-30, TWRS
WHC, PNL
Organic Sorbents
EM-30, TWRS
WHC, PNL
Co-precipitation by
Lanthanide Flouride (Acid)
EM-30, TWRS
WHC, PNL
Alternative Removal Lab Studies
EM-30, TWRS
PNL Lumetta
Crystalline Silico-titantes
EM-30, TWRS
SNL Brown
Advanced Solvent
Extraction
EM-50, ESPIP
ANL Horwitz
High Gradient Magnetic Sep.
EM-30/HQ
LANL Avens
Cation Exchange
Studies of TRU
EM-30/HQ
LANL Marsh
Sequestering Agents for TRU
EM-50, ESPIP
LANL Jarvinen
Separations Supporting
Accelerated Transmutation
EM-50, ESPIP
LANL Dewey
Sequestering Agent-
Coated Mag. Beads
EM-50, ESPIP
ANL Nunez
Natural Sequestering Agents
EM-50, ESPIP
LBL Hoffman
TRUEX Model Validation
EM-50, UST-ID
MMES/OR Felker
TRUEX Model Development
EM-50, UST-ID
ANL Vandegrift
Technical Exchange
EM-50, UST-ID
MMES/OR Jubin
Sr Removal
SREX/TOREX
(Crown Ether)
EM-30, WHC
WHC, PNL
SR-Spec (Solid Sorbent)
EM-30, WHC
WHC, PNL
Titanate
EM-30, WHC
WHC, PNL
Organic IX Resin
EM-30, WHC
WHC, PNL
MRT
EM-30, WHC
WHC, PNL
Alternative Removal Lab Studies
EM-30, TWRS
PNL Lumetta
Crystalline Silico-titantes
EM-30, TWRS
SNL Brown
Advanced Solvent
Extraction
EM-50, ESPIP
ANL Horwitz
SR
HNO3
TRU
HNO3

Figure A-1. Technology Development Activities Chart. (sheet 4 of 6)



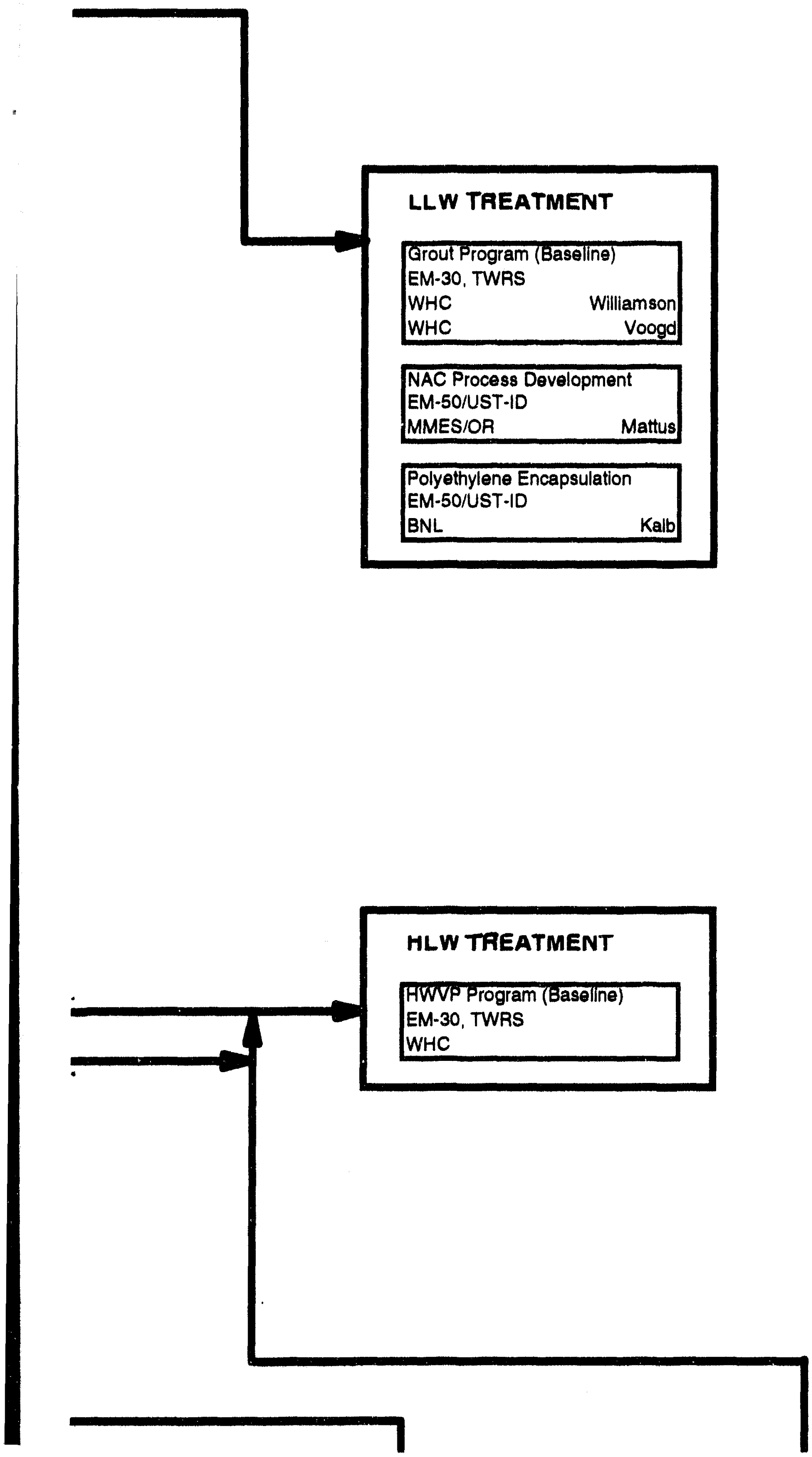

LLW TREATMENT
Grout Program (Baseline)
EM-30, TWRS
WHC Williamson
WHC Voogd
NAC Process Development
EM-50/UST-ID
MMES/OR Mattus
Polyethylene Encapsulation
EM-50/UST-ID
BNL Kalb
HLW TREATMENT
HWVP Program (Baseline)
EM-30, TWRS
WHC

Figure A-1. Technology Development Activities Chart. (sheet 5 of 6)

Systems Analysis/Crosscut

Systems Engineering
EM-30, TWRS
WHC Woods

TWRS Options Analysis
EM-30, TWRS
WHC Boomer

Waste Simulants
EM-30, TWRS
WHC Hohl

Early Treatment of DSSF
EM-30, TWRS
WHC Bratzel

Systems Analysis
EM-30/HQ
LANL Farish

PFP Flowsheet Devel.
EM-30/HQ
LANL Yarbro

Analytical Chemistry
EM-30/HQ
LANL Villarreal

Clean Option Process Development
EM-50, UST-ID
PNL Straalsund

Alternative Process Eval.
EM-30, TWRS
WHC Barton

Water Re-Use Study
EM-30, TWRS
WHC Barton

Process Engineering & Evaluation
EM-30, TWRS
PNL Kurath

Materials Evaluations
EM-30, TWRS
PNL Bunnell

Clean Option Support
EM-50, UST-ID
MMES/OR Watson

Tank Waste Processing Analysis
EM-50, UST-ID
PNL Baker

Unit Process Definition & Evaluation
EM-50, ESPIP
PNL Kuhn

Global Evaluation of Separations Processes
EM-50, ESPIP
WHC Seeman

Innovative Chemical Separation
EM-50, ESPIP
PNL, tbd Morrey

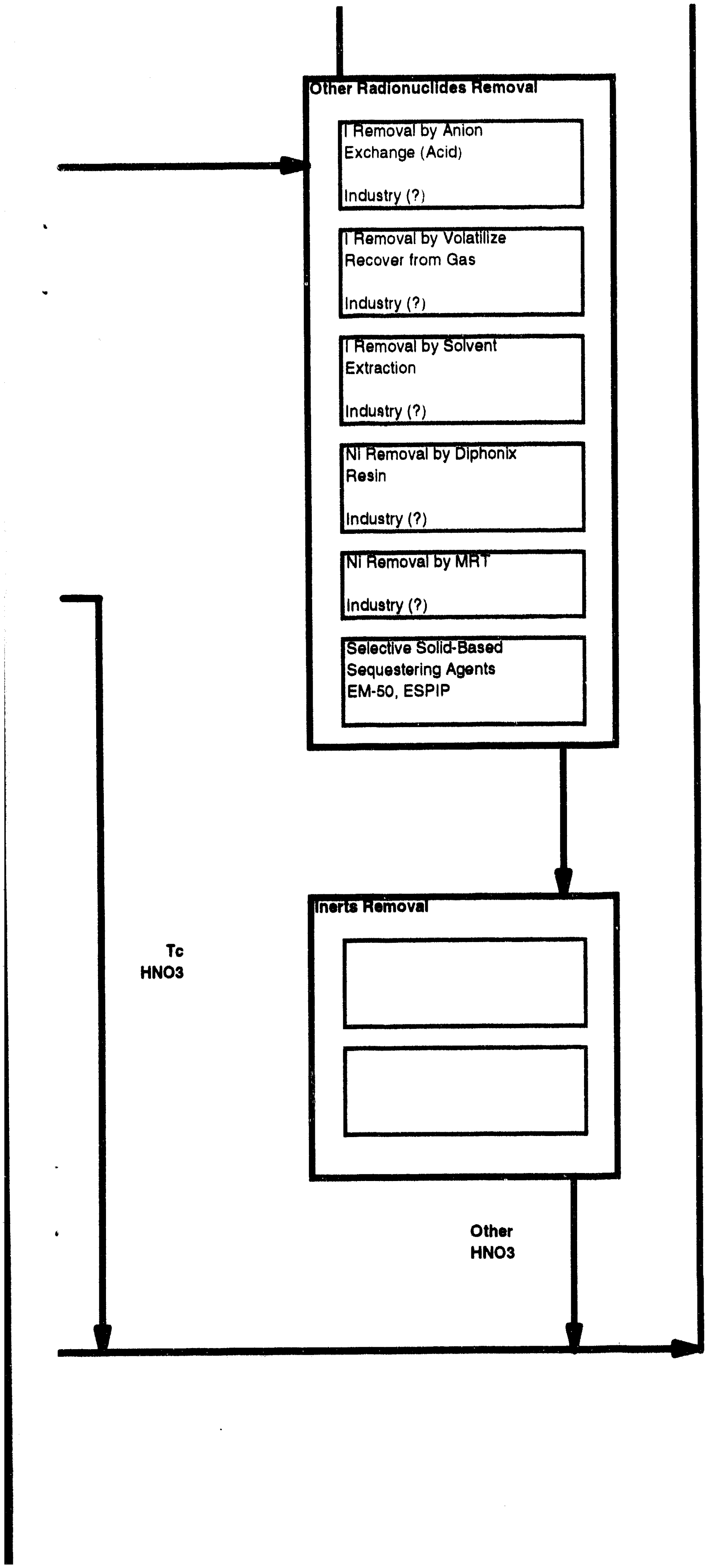

Other Radionuclides Removal
I Removal by Anion Exchange (Acid)
Industry (?)
I Removal by Volatilize Recover from Gas
Industry (?)
I Removal by Solvent Extraction
Industry (?)
Ni Removal by Diphonix Resin
Industry (?)
Ni Removal by MRT
Industry (?)
Selective Solid-Based Sequestering Agents EM-50, ESPIP
Inerts Removal
Tc
HNO3
Other
HNO3

Figure A-1. Technology Development Activities Chart. (sheet 6 of 6)

Key

Title [DOE/Field Program Element Contractor PI	EM-30/TWRS/LANL Funded Activities
EM-30, TWRS Funded Activities	EM-30/TWRS/SNL Funded Activities
EM-50/UST-ID Funded Activities	
EM-50, ESPIP Funded Activities	

TWRS, UST-ID, ESPIP

Technology Development Activities arranged by TWRS Functional Flow for Extensive Separations Approach

April 15, 1993
(Interim Draft)

Ref: DOE/RL-92-61Draft, Fig. 3.5.3-2

APPENDIX B

PRESENTATION VIEWGRAPHS

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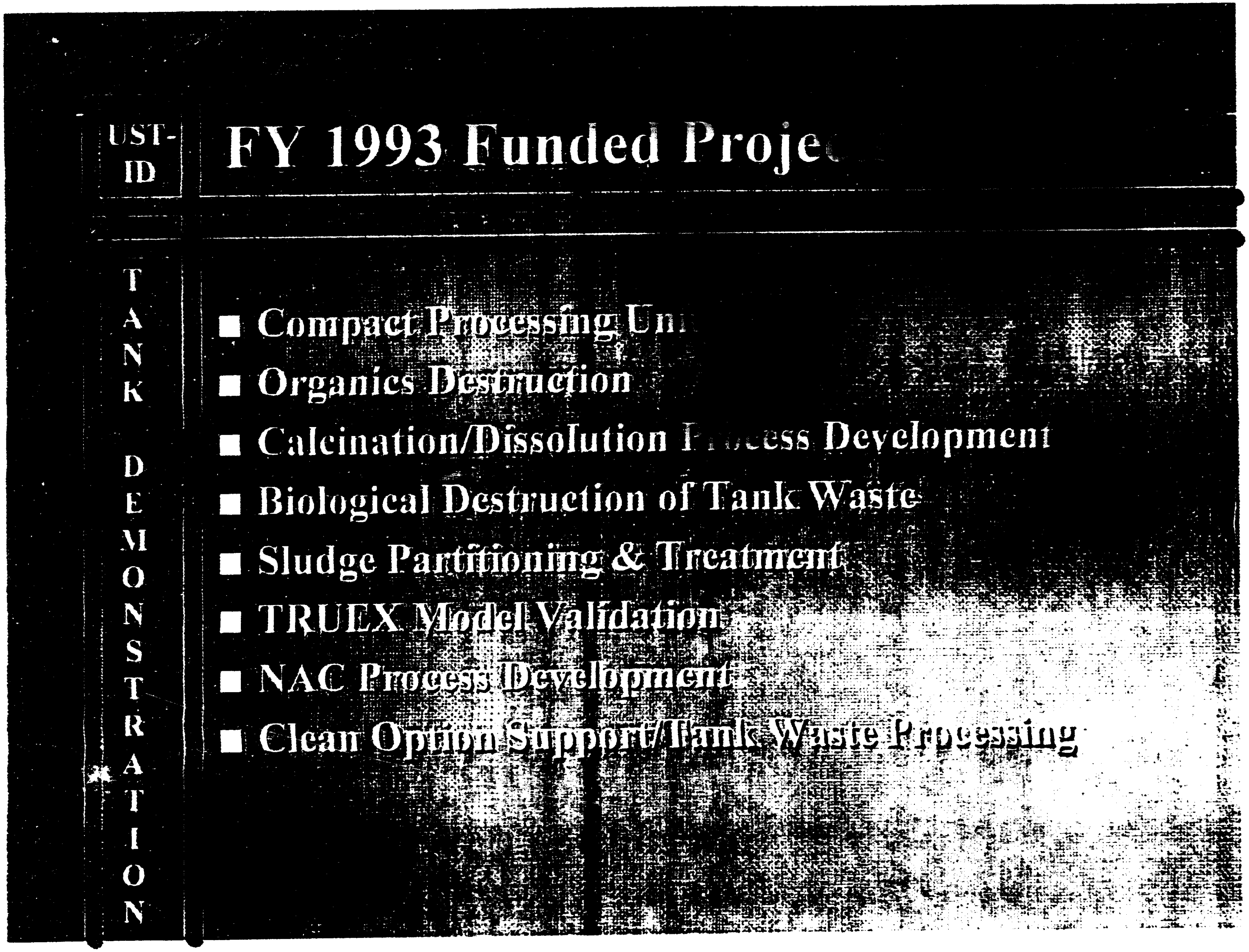

Figure B-1. (1 of 1)

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FY93 ESPIP PROJECTS

P.I.	LAB	SCOPE
Indust.	PNL	Develop high capacity, highly selective solid-based sequestering agents for Cs and Sr
Wester	PNL	Identify, develop, and test new options to separate Cs, Sr, and Trus from HLW
Jarvinen	LANL	Develop polymer-supported ion-specific extractants for TRUs & other toxic ions
Brown	SNL	Develop crystalline silicotitanate ion exchanger to selectively remove Cs & Sr from HLW
Cowan	WHC	Evaluate/develop calcine & leach process for treating Hanford HLW
Geeting	PNL	Evaluate Bradtech ACT*DE*CON™ process to recover radionuclides from waste sludge
Beam	ORNL	Develop technology to handle ORNL Mehon Valley Storage Tank waste (MVST)
Todd	WINCO	Establish feasibility of pyrochemically treating ICPP HLW calcine

Figure B-2. (1 of 2)

FY93 ESPIP PROJECTS

P.I.	LAB	SCOPE
Seeman	WHC	Define/evaluate prospective separations processes for total remediation systems
Kuhn	PNL	Define/evaluate prospective unit separations processes & provide data for total systems
Hobbs	SRL	Develop/evaluate electrochemical destruction of nitrates, nitrites, and organics .
Horwitz	ANL	Develop advanced solvent-extraction separations in support of the "Clean Option"
Chaiko	ANL	Develop biphasic systems for extraction of radionuclides
Dewey	LANL	Develop separations in support of Accelerated Transmutation of Waste
Helt	ANL	Survey status of sludge technology and recommend elements of sludge separation program
Hoffman	LLNL	Develop natural sequestering agents for separating TRUs from radioactive waste
Nunez	ANL	Develop/evaluate magnetic beads as carriers for sequestering agents

Figure B-2. (2 of 2)

Figure B-3. (1 of 3)

LOS ALAMOS

TANK WASTE REMEDIATION SYSTEM
TWRS

Technology Applications

Kimberly W. Thomas, Program Manager
Isotope and Nuclear Chemistry Division
Los Alamos National Laboratory

Figure B-3. (2 of 3)

LOS ALAMOS TWRS

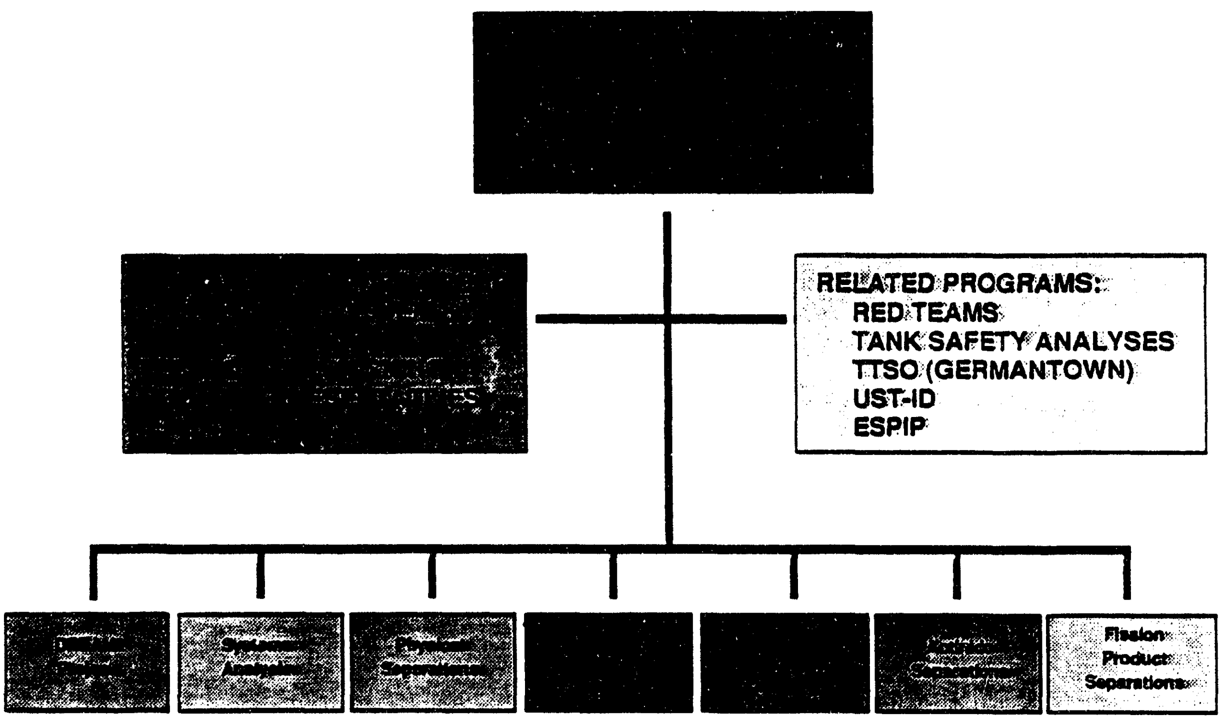


Figure B-3. (3 of 3)

LOS ALAMOS HQTS FUNDED FY 93 ACTIVITIES

1) DREAM Project **PI: Steve Agnew**	$1100k
2) Systems Analysis **PI: Tom Farish**	400k
3) High Gradient Magnetic Sepn **PI: Larry Avens**	250k
4) Analytical Chemistry **PI: Roberto Villarreal**	1430k
5) PFP Flowsheet Development **PI: Steve Yarbro**	1500k
6) Cation Exchange Studies of TRU/fp **PI: Fred Marsh**	300k
7) Cs/Sr dicarbollide (advisory to EM-50) **PI: Scott Kinkead**	20k
8) Tc Partitioning **PI: Norm Schroeder**	300k
9) Hydrothermal Processing/radnuclide behavior **PI: Steve Buelow**	3200k
10) Sample Transportation **PI: TBD**	100k
11) "Red Oil" Investigations **PI: John Watkin**	180k
12) Program Management/external contracts **Program Manager: Kim Thomas**	420k
TOTAL	$9200k

Figure B-4. (1 of 2)

ACTIVITY	MAJOR WORK	INVESTIGATOR/ORG.	FUNDING ($K)
Organic/FeCN Destruction by Wet Oxidation	Bench-Scale Tests with Synthetic Waste Using Piston Reactor	Colby/WHC	70
Organic/FeCN Destruction by Ozonation	Laboratory Screening Tests with Synthetic and Actual Wastes	Stubbs & Delegard/WHC	216
Organic/FeCN Destruction by Ozonation	Grout Tests with Actual Wastes	Hammitt/WHC	62
Organic/FeCN Destruction by Ozonation	Design Cold Ozone Pilot Plant	Colby/WHC	328
Organic/FeCN Destruction	Document and Prepare Waste Simulants	Hohl/WHC	43
Alkaline-Side Cs Removal Using Crystalline Titanates	Produce Pilot-Scale Quantities of Crystalline Titanates	Stephens/WHC	825
Controlled Precipitation of Aluminum	Laboratory Study of Controlled CO_2 Addition to Synthetic Waste	Wiley/University of Texas - Permian Basin	65
Early Treatment of DSSF	DSSF Pretreatment Plan	Bratzel/WHC	115
Dissolve Sludge by Calcination and Leaching	Laboratory Study Using Synthetic and Actual Waste	Colby/WHC	280
Sludge Washing and Gravity Settling	Develop In-Tank Settling Process and Analytical Instrumentation Including: - DNAAS - TRU Monitor - Suspended Solids Monitor	Landeene & MacLean/WHC	416
Sludge Washing and Gravity Settling	Perform Computer Simulation of In-Tank Washing	Sathya/WHC & Numerical Application Inc., Richland, WA	116

Figure B-4. (2 of 2)

ACTIVITY	MAJOR WORK	INVESTIGATOR/ORG.	FUNDING ($K)
Sr/TRU Solvent Extraction Process Development	Develop a New Nonphosphate Stripping Agent (TUCS Class B) That Selectively Removes Actinides Without Removing Uranium and a Solvent For Combined Sr/TRU Removal Processes	Horwitz/ANL	400
Alternative Pretreatment Process Evaluations	Identify Alternative Processes Applicable to the Pretreatment of Hanford Tank Wastes	Barton/WHC /NUMATEC/ BNFL	1038
TWRS Water Re-Use Study	Evaluate Opportunities and Benefits Associated with Recycling Water in the Tank Waste Disposal Operations	Barton/WHC	123

Figure B-5. (1 of 11)

PACIFIC NORTHWEST LABORATORY FY93 TWRS PRETREATMENT TECHNOLOGY DEVELOPMENT PROJECT

FEBRUARY 4, 1993

LANGDON K. HOLTON

Presented to EM-50/EM-30 Workshop on Pretreatment
Salt Lake City, Utah, February 4, 1993

Figure B-5. (2 of 11)

PNL TWRS Pretreatment Technology Development Project

PRIMARY GOAL

- PROVIDE TECHNOLOGY SUPPORT TO THE REFERENCE TWRS PRETREATMENT SYSTEM
  - Tank Safety Resolution
  - Tank Waste Disposal

GENERAL ACTIVITIES

- TECHNOLOGY DEVELOPMENT TO SUPPORT THE INITIAL PRETREATMENT MODULE
  - Cs Ion Exchange and Organic Destruction
- SLUDGE WASHING TECHNOLOGY TO SUPPORT IN-TANK WASHING
- LONG-TERM PRETREATMENT TECHNOLOGY
  - Sludge dissolution, extraction of chemical/radiochemical contaminants
- EVALUATION OF PRETREATMENT MATERIALS OF CONSTRUCTION

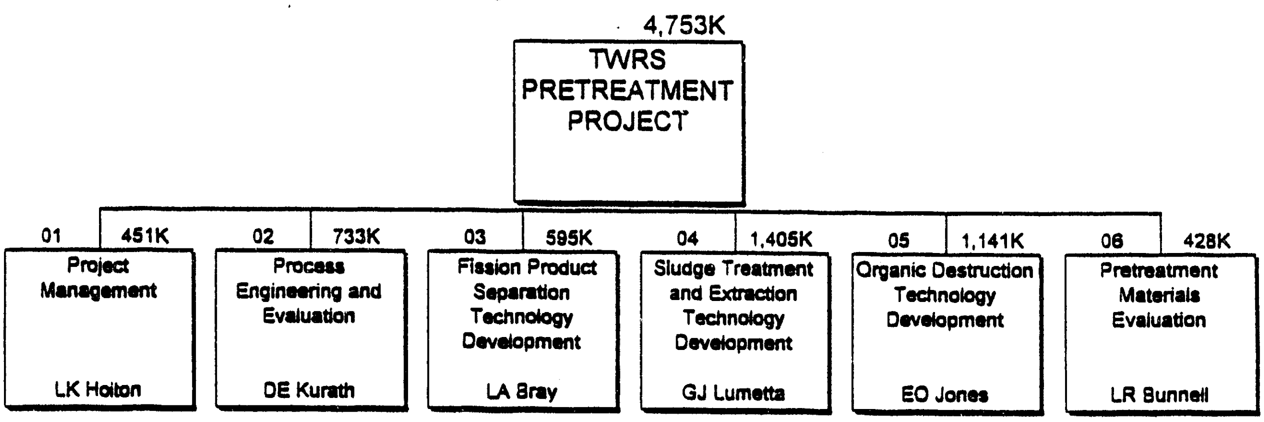
Figure B-5. (3 of 11)

PNL TWRS Pretreatment Technology Development Project

SCOPE OF WORK

- LITERATURE REVIEWS OF TECHNOLOGY ALTERNATIVES
- CONCEPTUAL ENGINEERING ASSESSMENTS
- LABORATORY-SCALE RADIOACTIVE AND NONRADIOACTIVE TESTING
- PILOT- /BENCH-SCALE NONRADIOACTIVE/RADIOACTIVE TESTING (FUTURE)
- SUPPORT TO WHC CONDUCTED ENGINEERING-SCALE TESTS
- INDUSTRIAL VENDOR TESTS

Figure B-5. (4 of 11)



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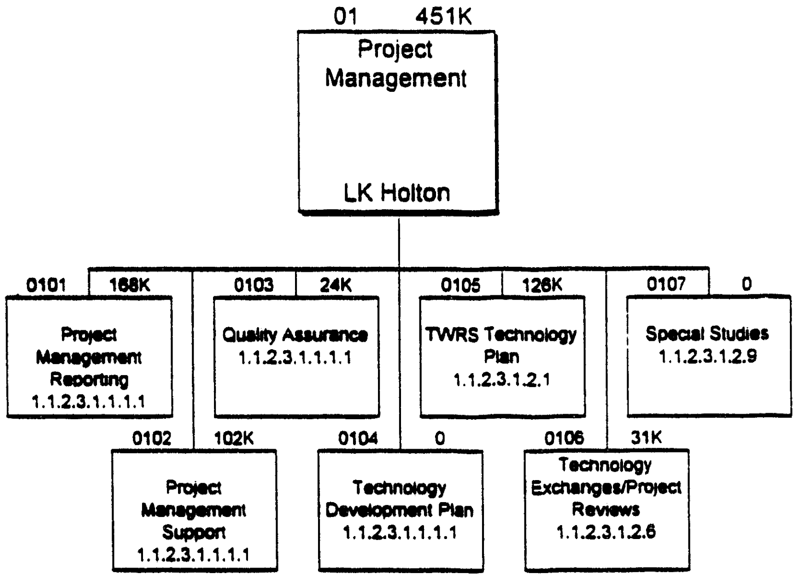
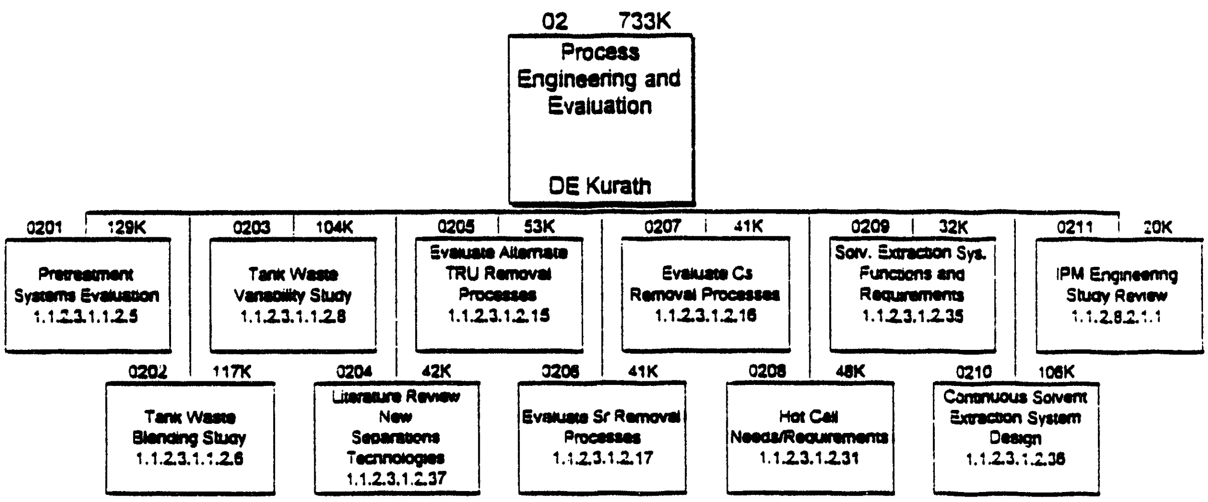


Rev. 2

Figure B-5. (6 of 11)



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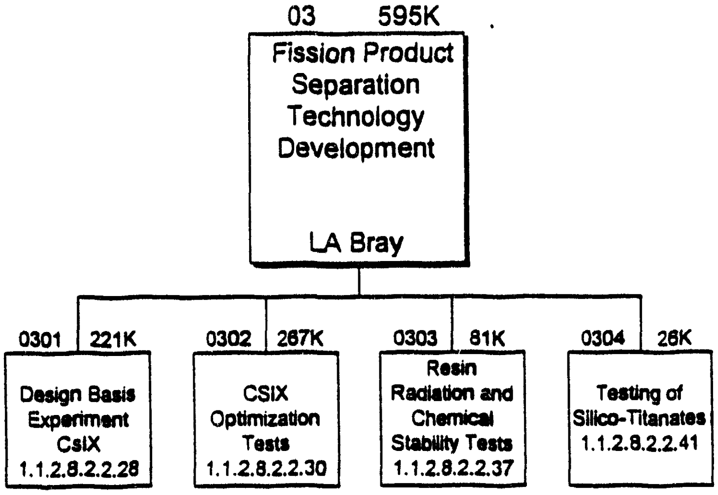
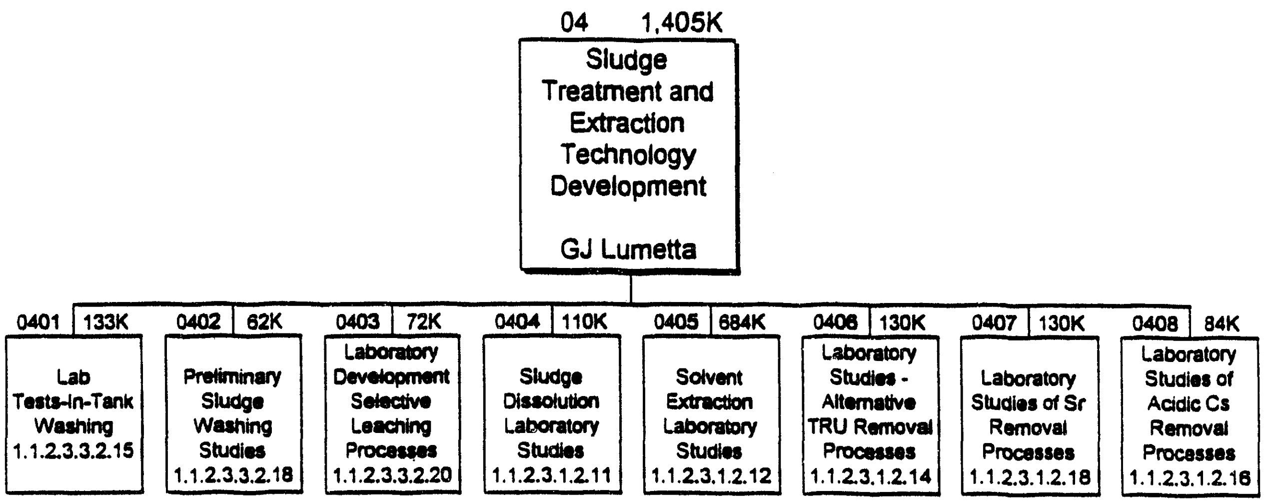


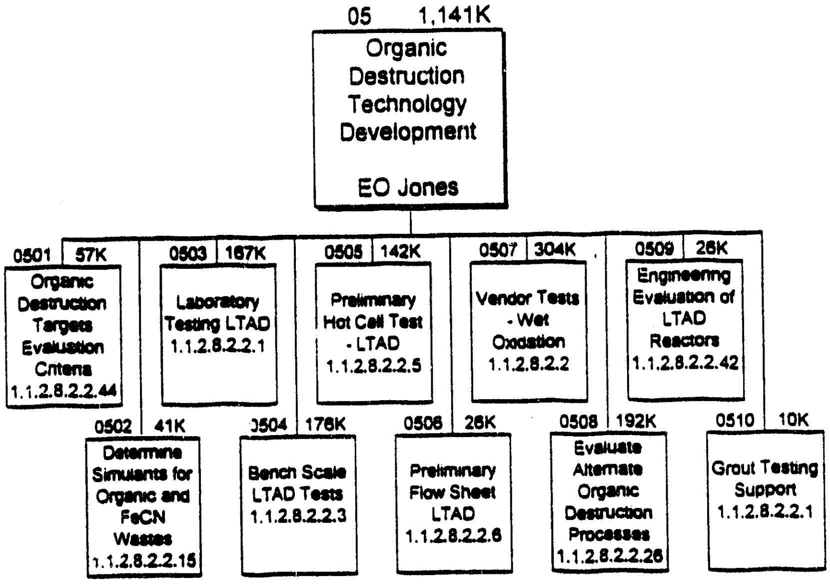
Rev. 2

Figure B-5. (8 of 11)



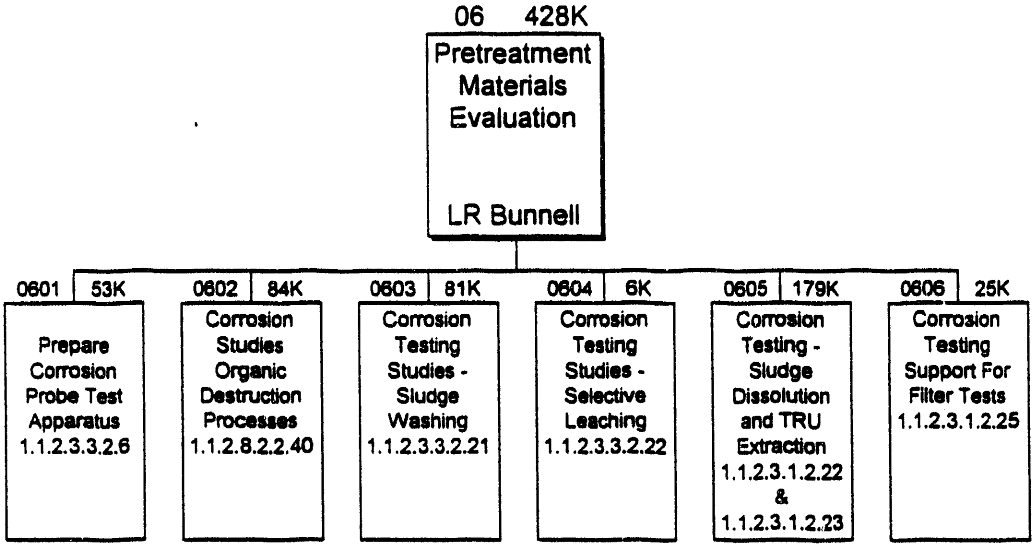
Rev. 2

Figure B-5. (9 of 11)



Rev. 2

Figure B-5. (10 of 11)



Rev. 2

Figure B-5. (11 of 11)

PNL TWRS Pretreatment Technology Development Project

SUMMARY

- PNL TWRS PRETREATMENT TECHNOLOGY PROJECT PROVIDES A BROAD SPECTRUM OF TECHNOLOGY NEEDS FOR TWRS DECISION MAKING AND PRETREATMENT PROJECTS.
- TECHNICAL LINKAGES WITH EM-50 AND LANL EM-30 PRETREATEMENT PROGRAMS ARE JUST BEGINNING. STØRONGER LINKAGES ARE DESIRED IN THE FUTURE.
  - Sludge Dissolution and Extraction Technologies
  - Sludge Leaching Technologies
  - Materials Evaluation

Figure B-6. (1 of 30)

U.S. Department of Energy

Pacific Northwest Laboratory

Figure B-6. (2 of 30)

Waste Technology Center

Compact Processing Units

W. G. Richmond

Pacific Northwest Laboratory

Figure B-6. (3 of 30)

Waste Technology Center

Agenda

- CPU Concept
- Why Consider CPU?
- CPU Project Status
- CPU Process Flowsheet
- CPU Schedule
- CPU Funding Profiles
- CPU Open Issues

Pacific Northwest Laboratory

Figure B-6. (4 of 30)

Waste Technology Center

Compact Processing Unit Concept

- Treat waste with small distributed units
- Early start for waste pretreatment
- Provide pilot plant facilities for IPM

Pacific Northwest Laboratory

Figure B-6. (5 of 30)

Waste Technology Center

CPU Design Concept

- Provide stand alone field deployable process unit for tank waste processing
- Unit meets all RCRA/DOE/NRC requirements for containment and accident mitigation
- Unit capable of refit/upgrade
- Minimize in-process inventory to maximize safety

Pacific Northwest Laboratory

Figure B-6. (6 of 30)

Waste Technology Center

Insert CPU Design Figure Here

Pacific Northwest Laboratory

Figure B-6. (7 of 30)

Waste Technology Center

Why Consider CPUs?

- Economics of waste pretreatment are dominated by process deployment cost
- Centralized canyon type facilities cost approximately $1 Billion dollars and are 7+ years from start-up
- Facility construction and engineering costs are approximately 55% of total project cost

Pacific Northwest Laboratory

Figure B-6. (8 of 30)

Waste Technology Center

Why Consider CPUs?

COST -- CPU funding requirements are significantly different than for a centralized facility

SCHEDULE -- Waste treatment could start sooner

TECHNICAL UNCERTAINTY -- Modular facility allows for continuous process improvement

RISK -- Modularity allows for lower risk deployment of new processes

Pacific Northwest Laboratory

Figure B-6. (9 of 30)

Waste Technology Center

CPU Project Status

- Process Flowsheet Selected
- Functional and Operation Requirements Document Completed
- Project CPU Concepts Developed
- Baseline project schedule developed
- Project acceleration scenarios under investigation

Pacific Northwest Laboratory

Figure B-6. (10 of 30)

Waste Technology Center

PROCESS SELECTION

Option	Decision	Reasoning
Resin	Formaldehyde Resorcinol	High Capacity; Selectivity
Elute versus Once-Through	Elute Column	Minimize Waste
Number of Columns	3 in Series / 1 Eluting	Attain High DF / Continuous Operation
Recycle or Recover HNO_3	Recycle Low [Cs] Eluant	Minimize Waste

Pacific Northwest Laboratory

Figure B-6. (11 of 30)

Waste Technology Center

Option	Decision	Reasoning
Upward versus Downward Elution	Upward Elution	Higher Efficiency & DF
Dilution	None	Minimize Waste
Elute and Reload Onto Zeolite	Do not Reload onto Zeolite	Too much added Complexity; WFQ, Transport Issues

Pacific Northwest Laboratory

Figure B-6. (12 of 30)

Waste Technology Center

CPU FLOWSHEET CALCULATIONS

	Feed	LLW	High Cs^+
$[Na^+]$	11.	11.	0.25
$[K^+]$	1.0	1.0	0.01
$[Al^{3+}]$	1.0	1.0	--
$[OH^-]$	5.0	5.0	0.10
$[NO_3^-]$	3.5	3.5	0.05
Cs^+, Ci/L	0.5	< 0.001	4.0
Sr^{2+}, Ci/L	0.001	0.001	--
Volume (gal)	$1.0x10^6$	$1.08x10^6$	$8.7x10^4$

Pacific Northwest Laboratory

Figure B-6. (13 of 30)

Waste Technology Center

Process Capability

- Current Design Basis is DSSF (Tk 101-AW)
- Process Capable of Handling any pumpable liquid requiring Cesium removal

Pacific Northwest Laboratory

Figure B-6. (14 of 30)

Waste Technology Center

CPU Demonstration Objectives

- Transportable
- Process 1×10^6 gal/year, Cs DF $\geq 1 \times 10^4$
- Design life 1 year, minimum
- Comply with federal, state, DOE regulations

Pacific Northwest Laboratory

Figure B-6. (15 of 30)

Waste Technology Center

CPU Four Major Subsystems

- Ion-exchange Process (Design FY93)
- Process Control System (Design FY93)
- Containment System (Design FY93-FY 94)
- Tank Farm Interface (Design FY94)

Pacific Northwest Laboratory

Figure B-6. (16 of 30)

Waste Technology Center

Ion-exchange Process Functions

- Resides in enclosure
- Separates incoming DST supernatant
  - low-level Cs stream
  - concentrated Cs stream
- Adjusts streams to meet tank farm regulations
- Returns streams to tank farm

Status: Process flow diagram in development

Pacific Northwest Laboratory

Figure B-6. (17 of 30)

Waste Technology Center

Process Control System Functions

- Remotely controls process operations
- Provides surveillance
- Acquires and analyzes data
- Interfaces to tank farm monitoring system

Status: Requirements being identified for FDC

Pacific Northwest Laboratory

Figure B-6. (18 of 30)

Waste Technology Center

Enclosure/Containment System Functions

- Encloses IX process
- Confines radioactive/hazardous materials
- Shields public/personnel from radiation
- Interfaces to loading/transportation equipment
- Provides HVAC and fire protection

Status: Enclosure concepts under development

Pacific Northwest Laboratory

Figure B-6. (19 of 30)

Waste Technology Center

MORE CPU CONCEPT FIGURE AND DEPLOYMENT FIGURES SHOWN HERE

Pacific Northwest Laboratory

Figure B-6. (20 of 30)

Waste Technology Center

Tank Farm Interface Functions

- Provides suitable site for deployment
- Interfaces utilities and waste transfer systems to IX process
- Provides a nonradioactive chemical supply system

Pacific Northwest Laboratory

Figure B-6. (21 of 30)

Waste Technology Center

Project Baseline Schedule

- Design Completed 1993
- Test system procured 1994
- Non-Radioactive Demonstration 1995
- Radioactive Demonstration 1998

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Figure B-6. (22 of 30)

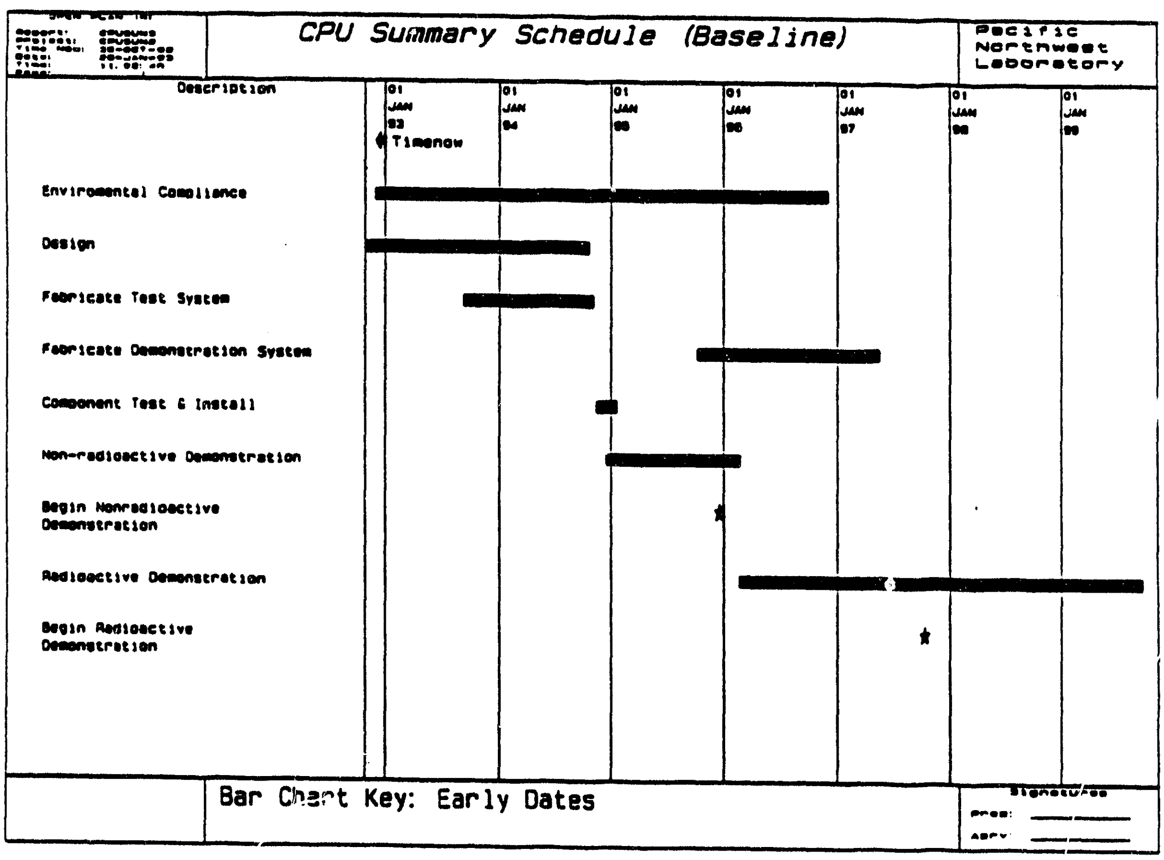

Figure B-6. (23 of 30)

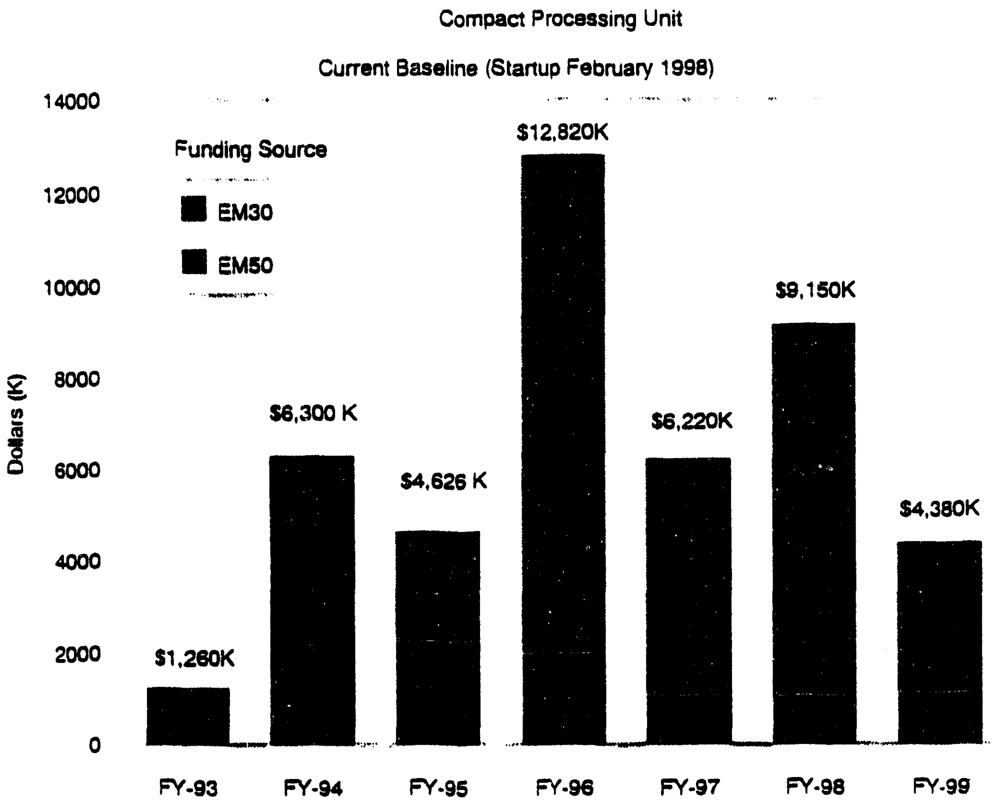

Figure B-6. (24 of 30)

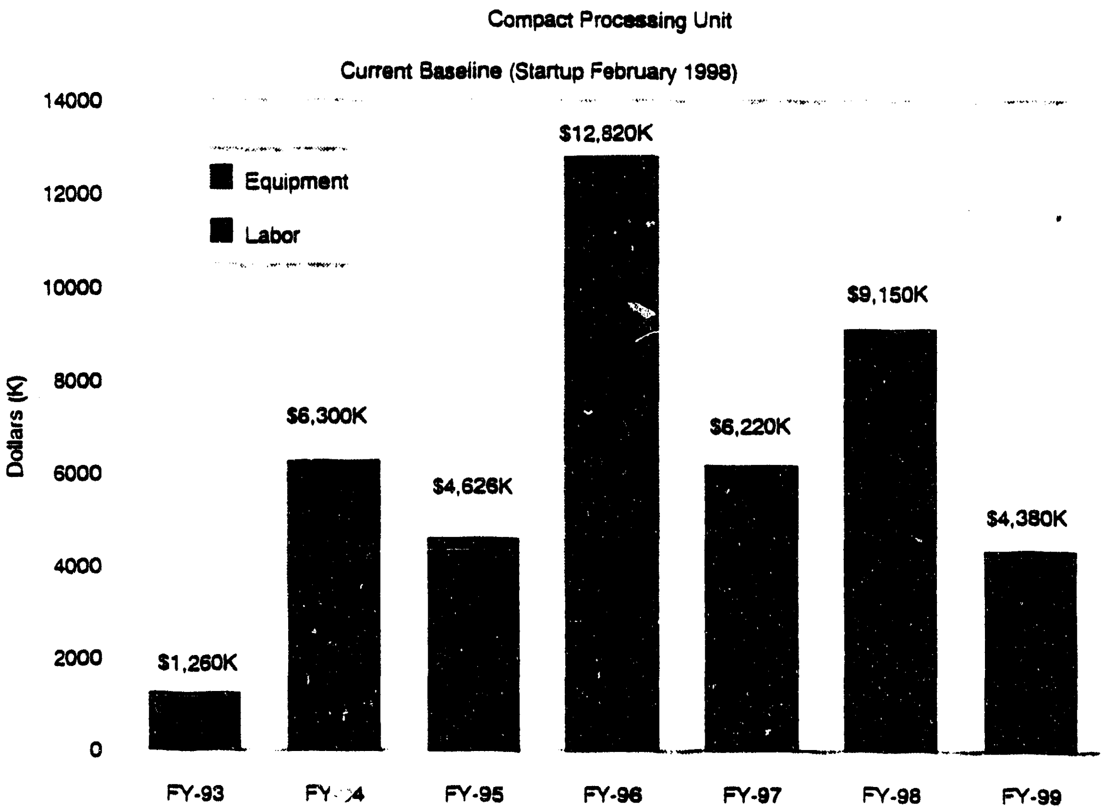

Figure B-6. (25 of 30)

Compact Processing Unit

Current Baseline (Startup Startup February 1998)

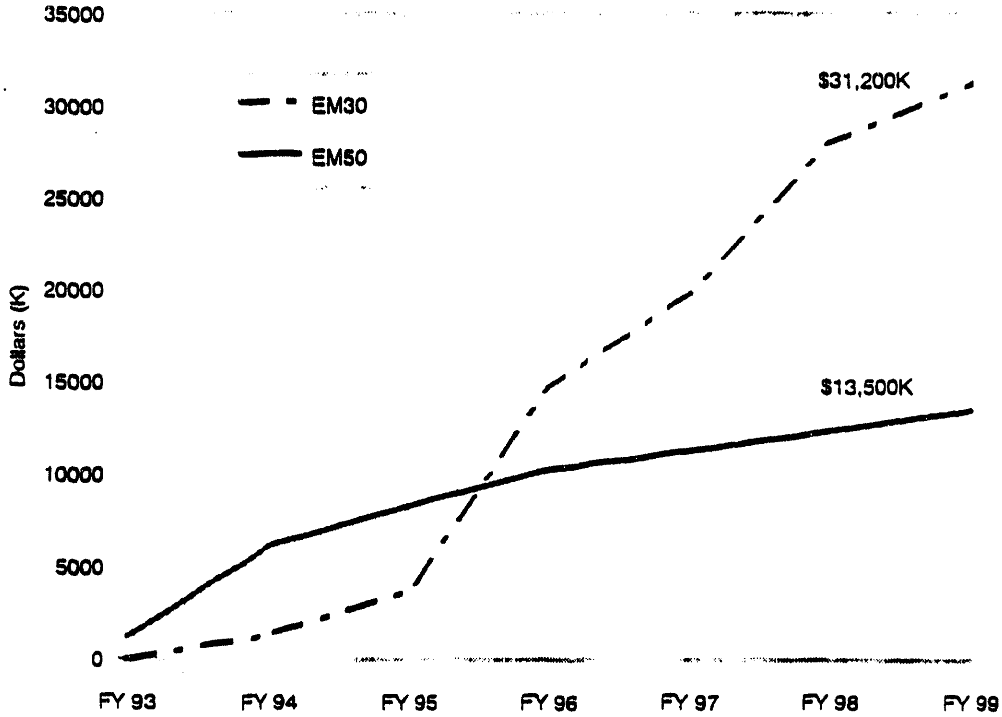

Figure B-6. (26 of 30)

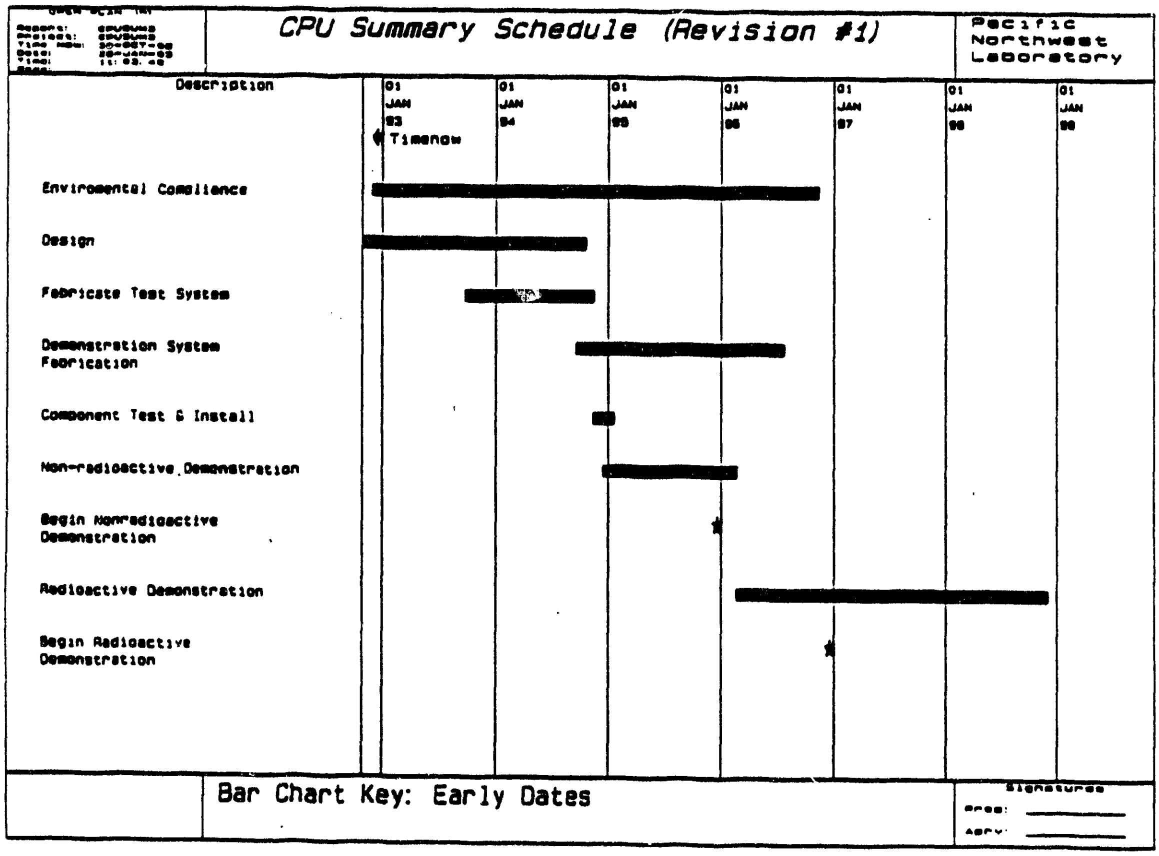

Figure B-6. (27 of 30)

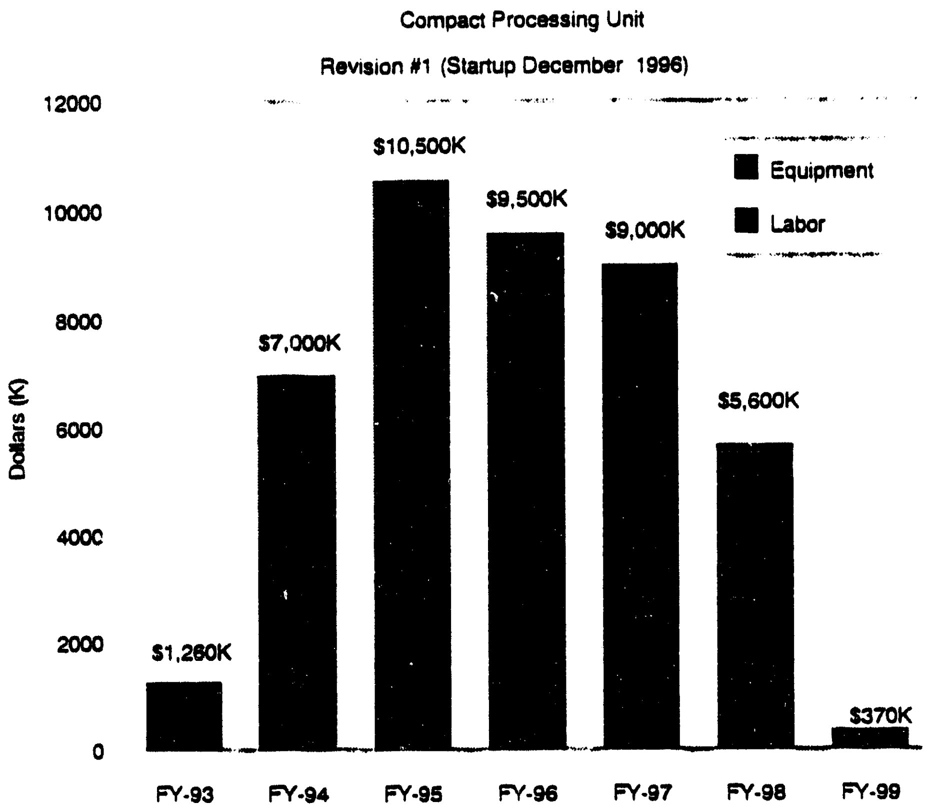

Figure B-6. (28 of 30)

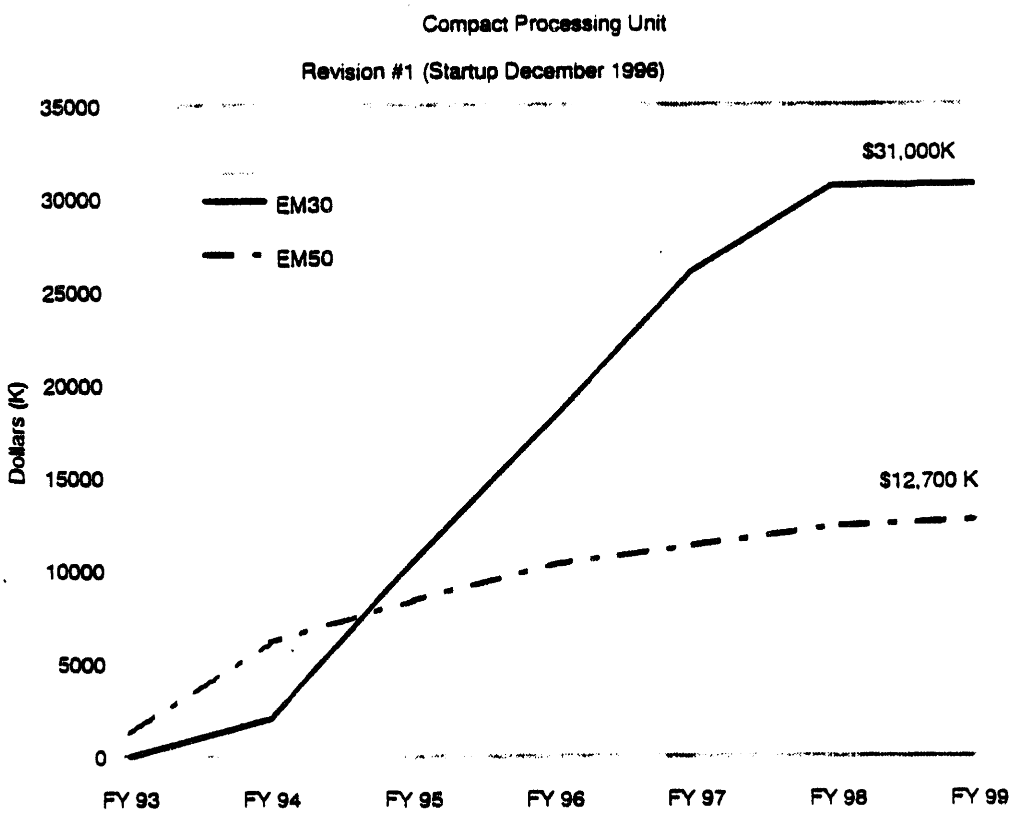

Figure B-6. (29 of 30)

Compact Processing Unit

Funding Profile Comparison

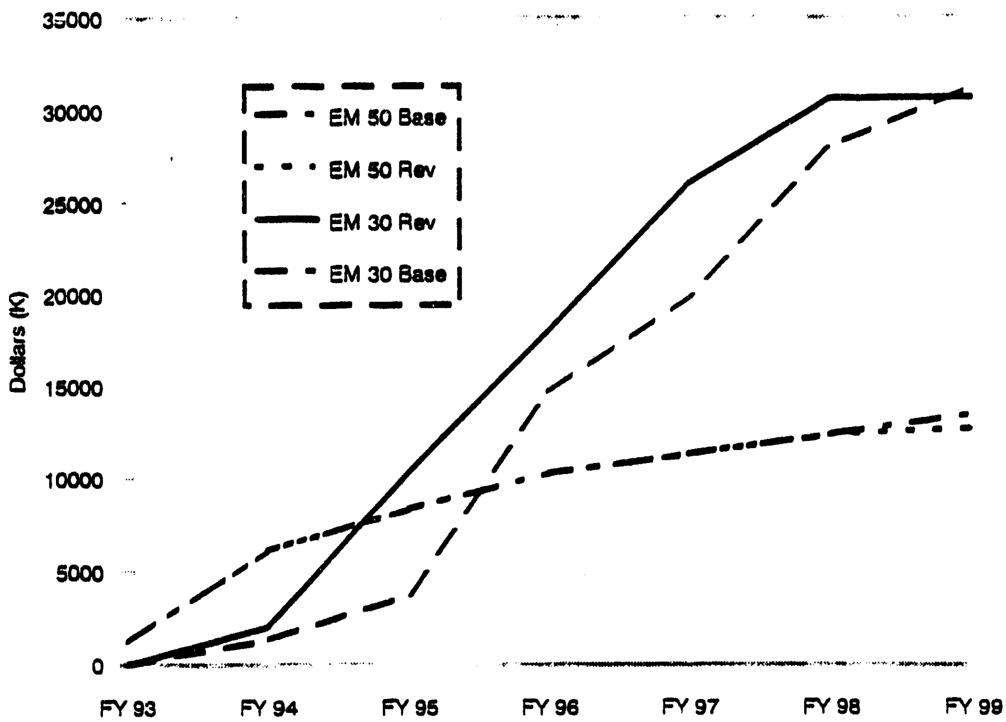

Figure B-6. (30 of 30)

Waste Technology Center

CPU Open Issues

- DOE Order Compliance
  - KEH being funded to do analysis
- Demonstration Site
- Interface with IPM Plans
- EM-30 Funding Support
- CPU project schedule acceleration

Pacific Northwest Laboratory

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Figure B-7. (1 of 10)

UST: Cesium Extraction Testing Project

DOE/DT&E TTP No. SR-1320-20

Jane P. Bibler
SRTC/WSRC
William G. Richmond
PNL

Figure B-7. (2 of 10)

TECHNICAL TASKS

RESORCINOL/FORMALDEHYDE RESIN BEHAVIOR

- Flow Rate Dependence for H-101-AW
- Effect of Temperature Elevation
- Elution Scheme

RADIOLYSIS STUDIES

- Dose Rate Dependence of Capacity
- Radiolytic Products

Figure B-7. (3 of 10)

HANFORD 241-101-AW COMPOSITION

CHEMICAL	MOLARITY
Sodium Hydroxide	5.1
Aluminum Nitrate	0.5
Sodium Nitrate	2.4
Sodium Carbonate	0.21
Sodium Sulfate	0.01
Potassium Hydroxide	1.1(0.8)
Cesium Nitrate	4.4E-5
Sodium Nitrite	2.2
Cs-137	1.3E-11

Figure B-7. (4 of 10)

Breakthrough Curves with SRS Simulant

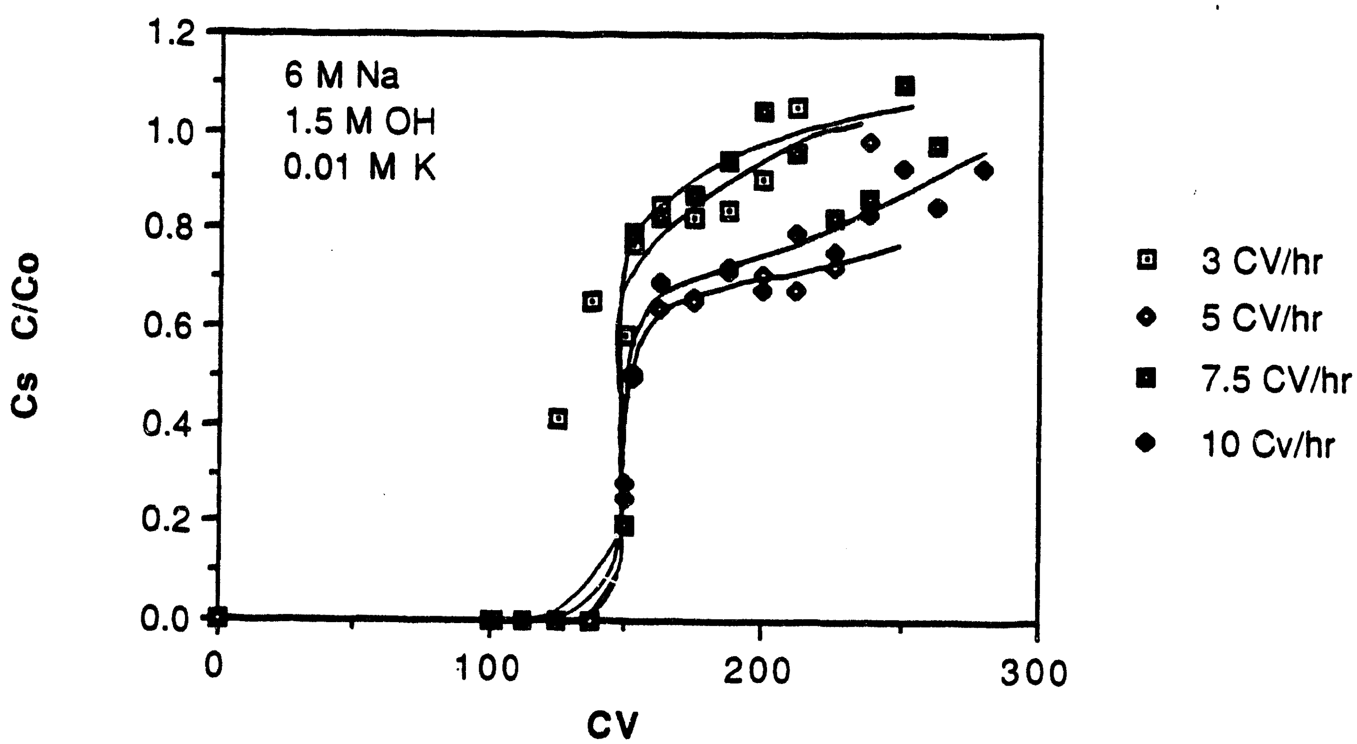

Figure B-7. (5 of 10)

FOUR FLOW RATES FOR UNDILUTED 101-AW

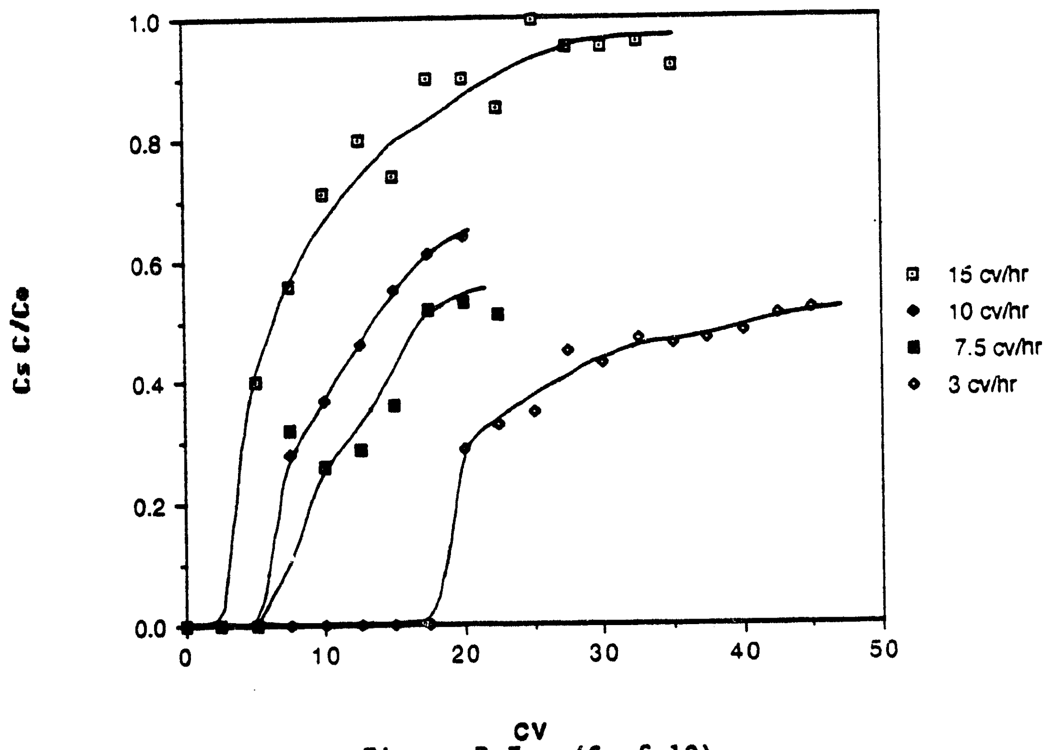

Figure B-7. (6 of 10)

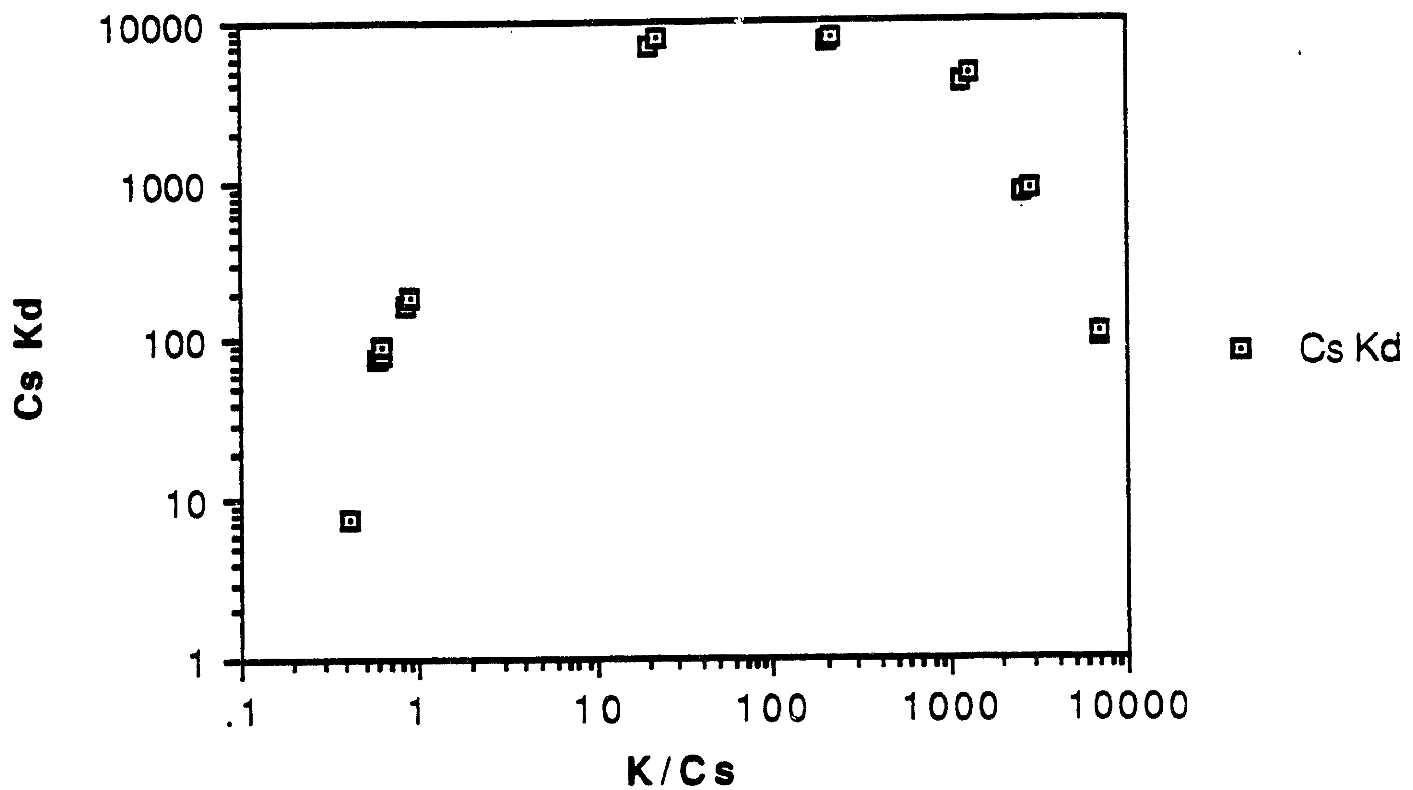

Figure B-7. (7 of 10)

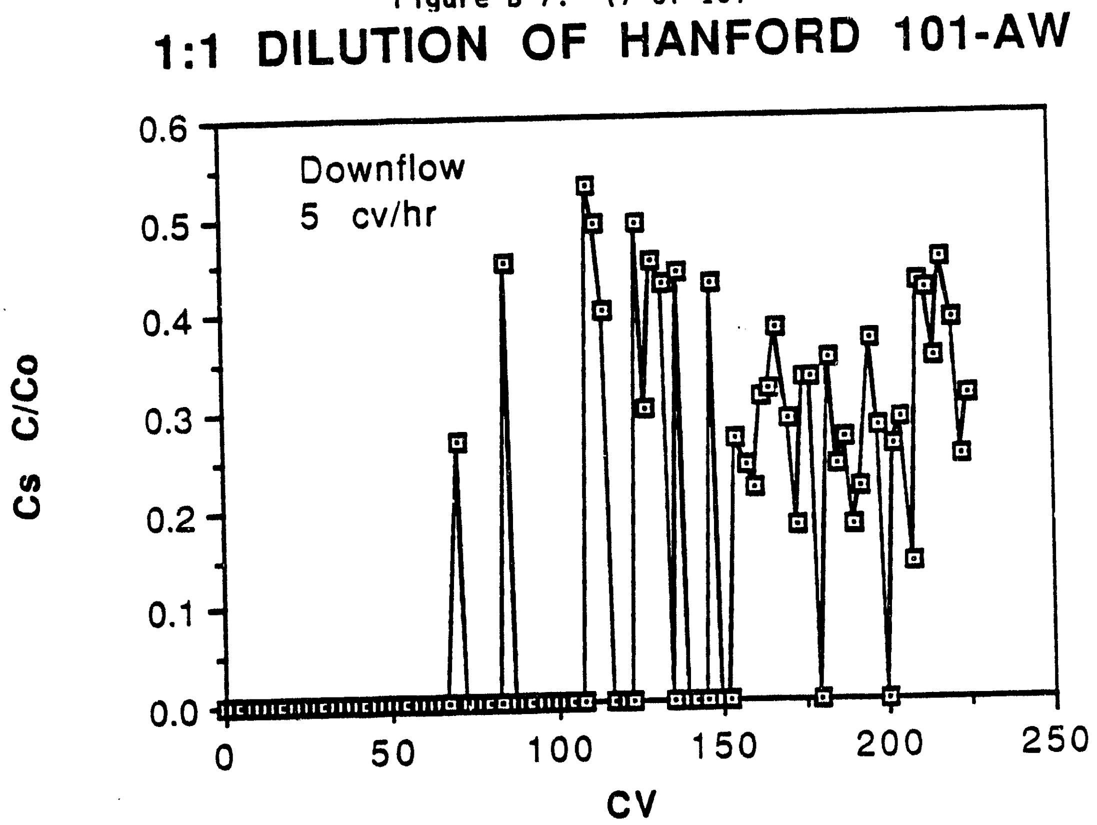

Figure B-7. (8 of 10)

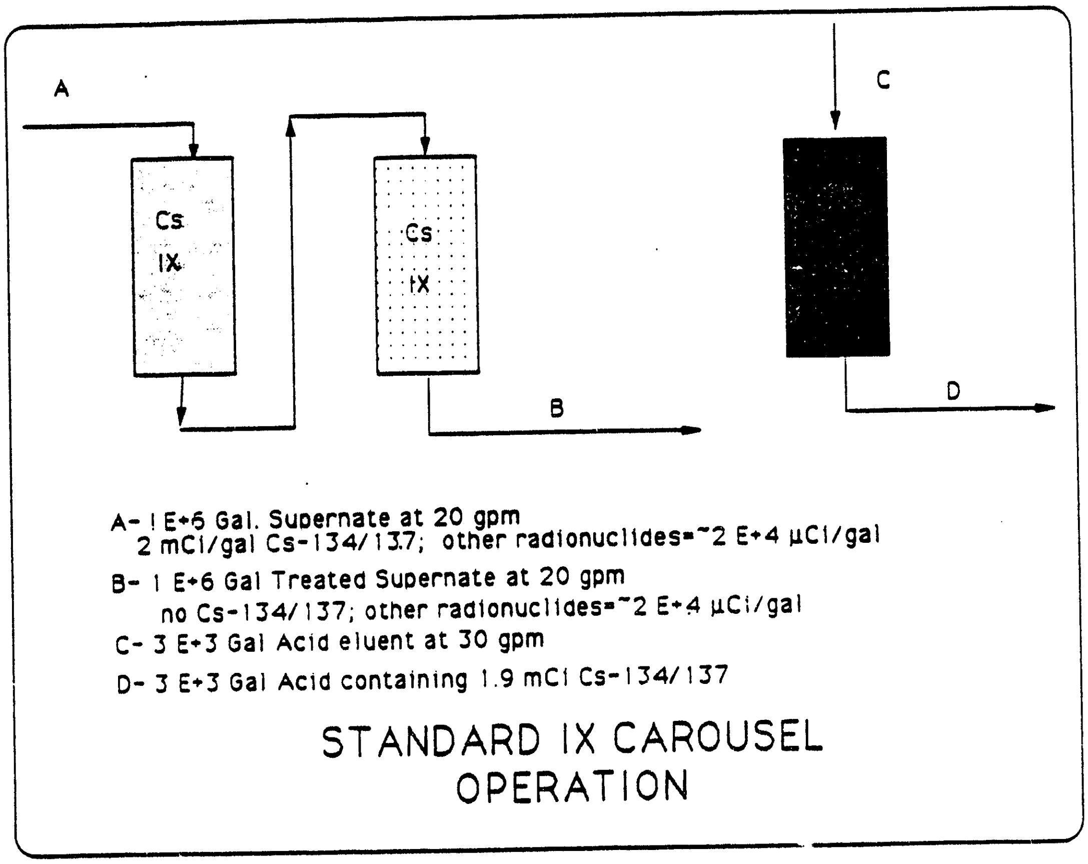

Figure B-7. (9 of 10)

SCHEDULE

- FLOW RATE TESTS - Complete 4/30/93
  Mid-Year Report due 4/30/93
- RADIATION STABILITY TESTS - Complete 11/15/93
  Mid-Year Report due 4/30/93
- ELUTION STUDIES - Begin 5/1/93
  Complete 11/15/93
- FINAL REPORT - Due 11/15/93

Figure B-7. (10 of 10)

FUNDING REQUIREMENTS

- Available--$290K for FY '93
  OE EW4020
- Monthly Spendout to Date--
  $48 K($24K/Mo Average)
- "Bulge" Expected for Radiolysis Studies--$60K($12K/Mo for 3/93-7/93)
- 10/93-11/93 Lower to Accomodate "Bulge"

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Figure B-8. (1 of 9)

UNDERGROUND STORAGE TANK INTEGRATED DEMONSTRATION
Biological Destruction of Tank Wastes

TTP # ID 1212 04

Principal Investigator: Graham Andrews (208) 526-0174
Program Manager: Don Maiers (208) 526-6991

OBJECTIVE

To demonstrate a microbial process that will remediate wastes from the Hanford tanks by:

- **reduction of nitrate to N2 and replacement with desired anions**
- **separation of radionuclides by biosorption**
- **oxidation of organics?**

Halophilic bacteria are used to minimize the amount of water that must be added to the process

Figure B-8. (2 of 9)

BIOTECHNOLOGY IN HAZARDOUS WASTE MANAGEMENT

- **Will carry out one or more of the following:**

  Biodegradation of hazardous organic wastes (e.g., xylenes, chlorinated solvents, polychlorinated biphenyls) to innocuous end products (CO_2, Cl^-, etc.)

  Denitrification: reducing nitrate in nuclear waste streams, agricultural run-off or groundwater to N_2

  Biosorption of heavy metals and transuranides from dilute aqueous solution

- **Bacteria function as self-replication catalysts at ambient temperature and pressure, thus reducing costs**

Figure B-8. (3 of 9)

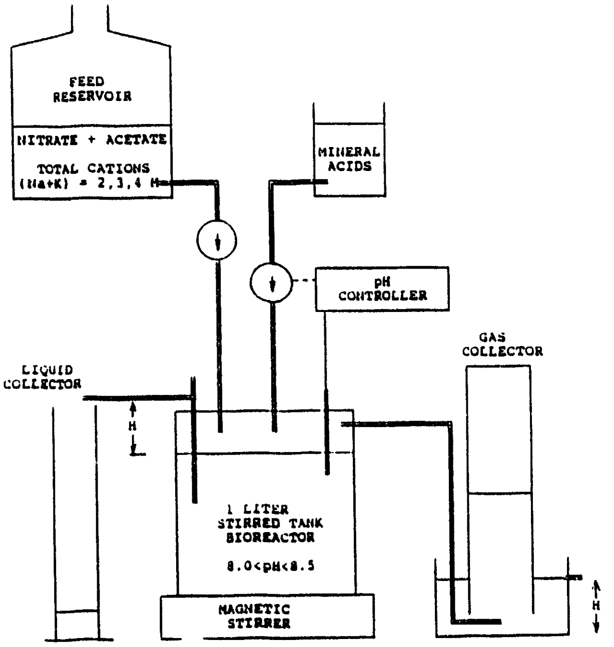
FY-92 Accomplishments under Buried Waste Integrated Demonstration (INEL: Pad A Waste)

- **Collection of halophilic denitrifying bacteria established; both previously studied strains and our own isolates from the Great Salt Lake and Death Valley regions**
- **Microbial growth and denitrification demonstrated on synthetic waste, water, acetic and phosphoric acids at salinity of 4M (Na+K)**
- **Start-up of three 1 liter chemostats using mixed culture:**
    - **Start-up procedure developed**
    - **> 99% nitrate reduction at steady-state**
    - **No NOx formed**
- **Preliminary process flowsheet developed using counter-current contacting to maximize biosorption**

Figure B-8. (4 of 9)

Strain	Source	Morphology and Color	Doubling time (hr)	N_2/Acetate
Haloferax mediterranei	ATCC	pleomorphic, tan	12	0.032
Haloarcula marismortui	ATCC	pleomorphic, orange	21	0.054
HASL7o	North arm GSL, UT	rod-shaped, orange	5.4	0.279
HASL7t	North arm GSL, UT	long thin rods, tan	7.5	0.784
HADV2	Death Valley, CA	pleomorphic, tan	8.3	0.753
HAPV	Panamint Valley, CA	pleomorphic, off white	6.4	0.337

Figure B-8. (5 of 9)



- BIOREACTOR ACTS AS A SELECTION CULTURE; FASTEST GROWING STRAINS WILL DOMINATE THE POPULATION
- MAINTAINING A POSITIVE PRESSURE ,H, PREVENTS INFLOW OF INHIBITORY OXYGEN. HEADSPACE ANALYSIS SHOWS N_2, CO_2 BUT NO NO_x.

Figure B-8. (6 of 9)

11/92 - 3/93 Accomplishments under USTID Pretreatment/Separations Task

- **Prepare project management/test plan and technology status report (drafts circulated)**
- **Identify target tank waste, and switch lab chemostats to appropriate surrogate waste composition**
- **Find best fit of microbial process in overall USTID flowsheets (feed concentration, pretreatment, effect of anion composition on disposal, etc.)**
- **First design study for Compact Processing Unit for SST "drainable liquor" based on conservative estimates of process variables shows**
  - **need for experiments at salinity > 4M**
  - **use of biosorption as polishing step for radionuclide separation**
  - **danger of reaching "biomass paste" limit**

Figure B-8. (7 of 9)

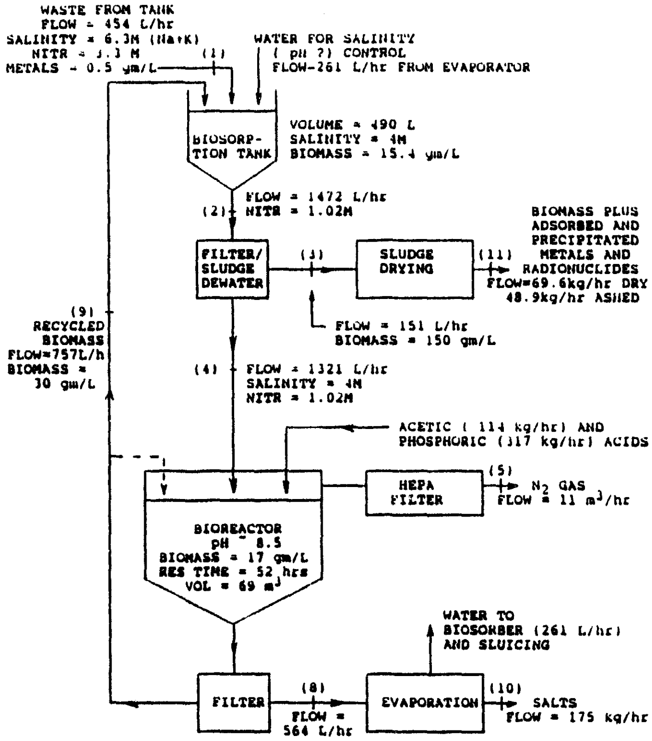


FIG 1 PRELIMINARY DESIGN OF COMPACT PROCESSING UNIT

Figure B-8. (8 of 9)

Milestones for FY-93 ($300K)

3/93 -->: Run lab chemostats at decreasing residence times (10 days --> 1 day) on surrogate tank waste to:

- **optimize culture by natural adaption and selection**
- **provide biomass for other experiments**
- **provide parameter values for yield and rate**

3/93 - 7/93: Study effects of potential inhibitors (ALO2, EDTA, F) and potential nutrients (citrate) in batch culture. Add to chemostat feed if possible

5/93 - 11/94: Measure capacity and affinity of cells for biosorption of heavy metals and radionuclides (U, Cr, Cs, Sr, Zr)

Figure B-8. (9 of 9)

Milestones for FY-94 ($420K) and Beyond

--> 9/94: Continue operation of lab chemostats to:

- explore limits of process performance (salinity, residence time)
- provide biomass for start-up at next scale

12/94 - 5/94: Design and build a large-laboratory scale (5 gal/day) process

6/94 - 11/94: Demonstration/testing of large-lab scale process on surrogate waste. Test biomass separation steps and simultaneous denitrification/ biosorption concept

12/94 - 2/95: Evaluation and Analysis of Test Data.

Issue technology status report.

Update and freeze design of Compact Processing Unit.

Provide cost estimates for transportable CPU

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Figure B-9. (1 of 6)

OR-1120-03

The Nitrate to Ammonia and Ceramic Process

Importance of NAC to UST-ID

- New Process to Decompose Nitrate at Low Temperature (50°C)
- Process is NaOH Free
- Co-Production of Waste Form Which is Low Volume (less than third of equivalent grout volume), Durable, and Regulatory Acceptable (binds most RCRA and radioactive metals)
- D&D ID is Proposing Al Recycle to NAC Process for Waste Minimization and Cost Effectiveness for NAC

Figure B-9. (2 of 6)

OR-1120-03

The Nitrate to Ammonia and Ceramic Process

Key Deliverables

Process Chemistry Proven FY-92

FY-93 Activities
- Optimization of A1 Usage vs. Nitrate Destruction
- Ceramic Waste-Form Development and Verification
- Use of Actual LLW from MVST as Experimental Fuel
- Acquisition of Scale-Up Data for Pilot Plant

FY-93 Supplemental Request
- Pilot Plant Equipment Specification and Layout

FY-94 Activities
- Operate Pilot Plant
- Confirm Waste Form Acceptability on Pilot Plant Product

Figure B-9. (3 of 6)

ORNL DWG 91A-349R2

RELATIVE VOLUME REDUCTION EFFICIENCIES: A COMPARISON OF GROUTING WITH THE NAC PROCESS

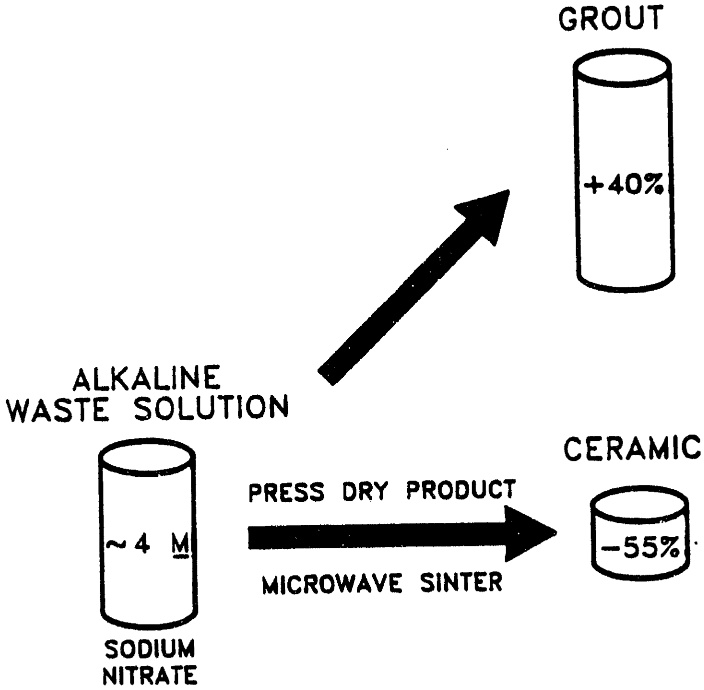

Figure B-9. (4 of 6)

GENERAL FLOW SHEET FOR THE NITRATE TO AMMONIA AND CERAMIC (NAC) PROCESS

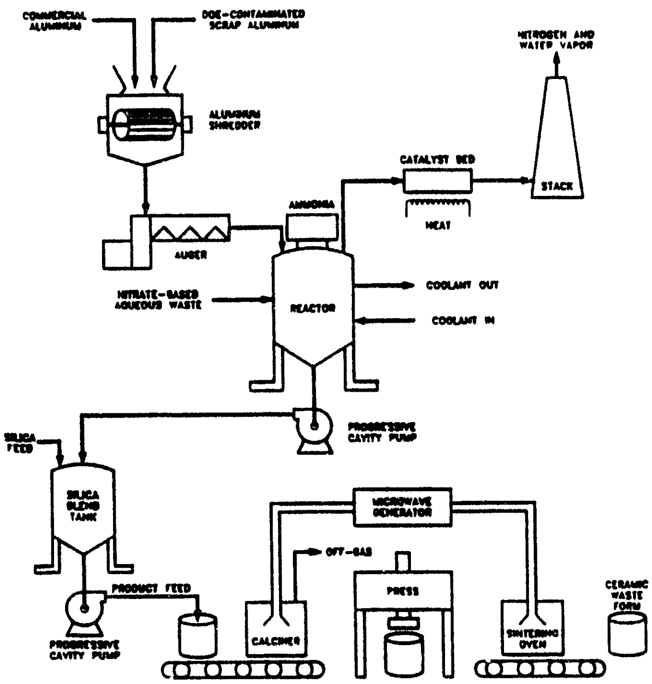

Figure B-9. (5 of 6)

Proposed Pilot Facility for the Testing of the NAC Process in [illegible]

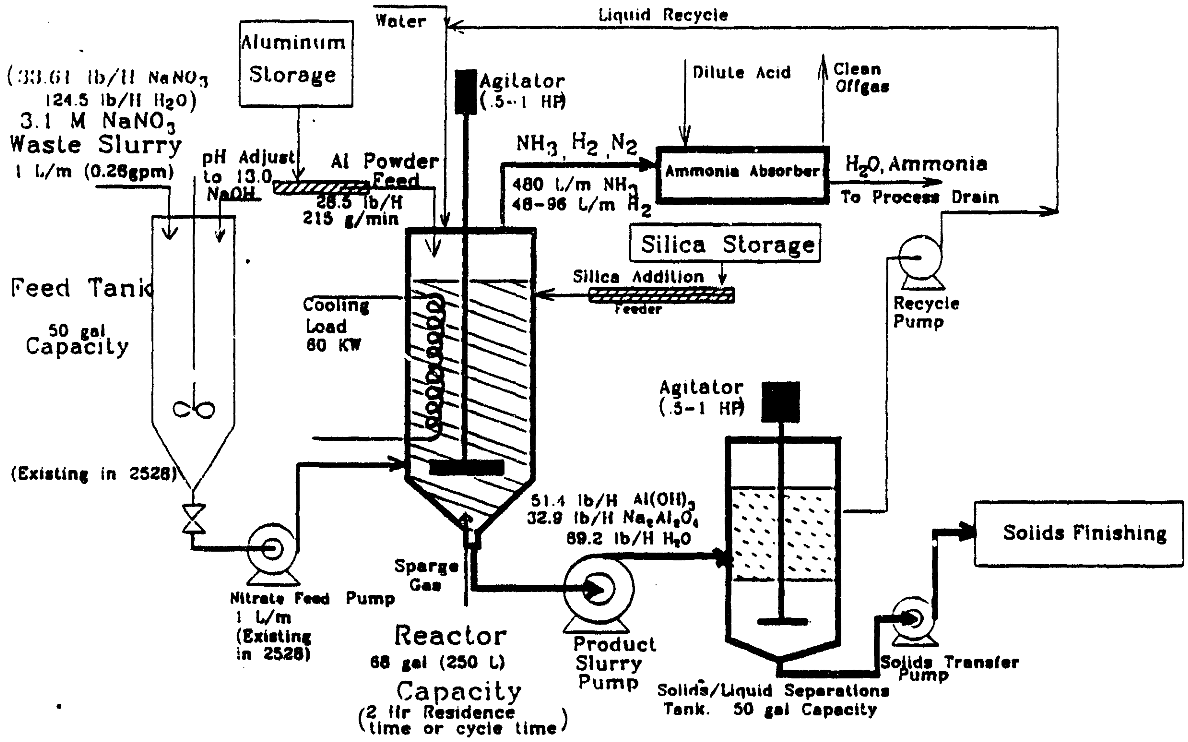

Figure B-9. (6 of 6)

NAC CONCEPT APPLIED AT HANFORD

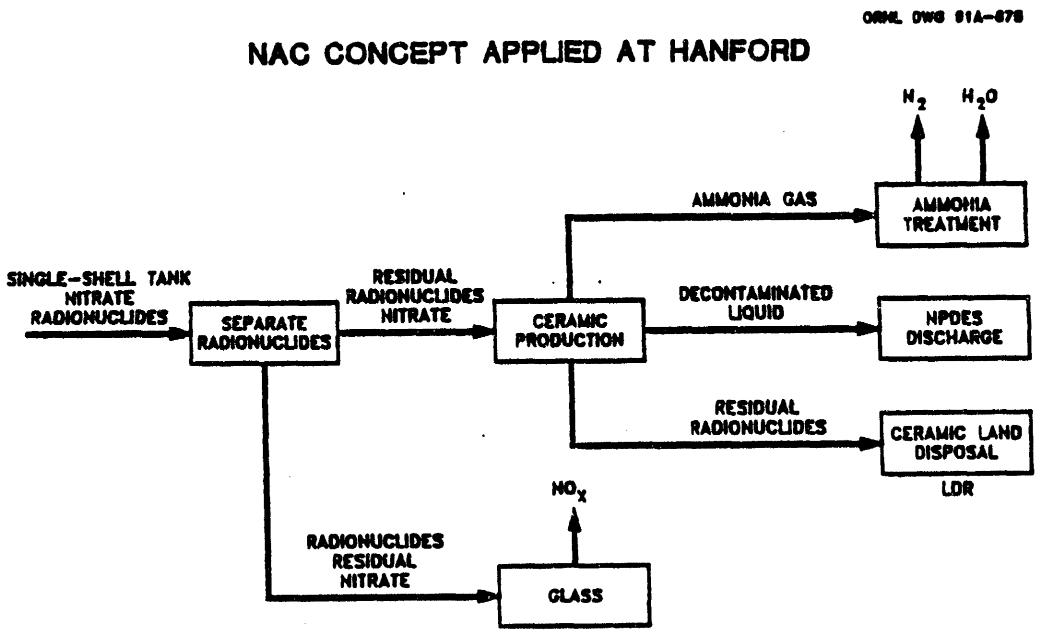

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Figure B-10. (1 of 18)

CRYSTALLINE SILICOTITANATE ION EXCHANGERS

UST-ID/ESPIP Meeting
February 3, 1993
Salt Lake City, Utah

N. E. Brown, H. P. Stephens, R. G. Dosch, L. D. Bustard
Sandia National Laboratories
Albuquerque, New Mexico

R. G. Anthony
Texas A&M University
College Station, Texas

Figure B-10. (2 of 18)

PRESENTATION OUTLINE

- **Background on titanates at Sandia National Labs**
- **Patent status on crystalline silicotitanates (CST)**
- **Preparation and characterization of CST**
- **LDRD, ESPIP, DOE-RL activities**
- **DSSF process description**
- **Scale-up and commercialization of CST**
- **Funding requirements**

Figure B-10. (3 of 18)

TITANATE ION EXCHANGER DEVELOPMENT AT SANDIA

- 1969 ELECTROACTIVE CERAMICS VIA TITANATES
- 1975 TITANATE ION EXCHANGERS FOR HIGH LEVEL REPROCESSING WASTES - CERAMIC WASTE FROM PRODUCED
- 1979-1981 TITANATE ION EXCHANGERS FOR HANFORD DEFENSE WASTES
- 1980 AUSTRALIANS ADOPT SANDIA TITANATE ION EXCHANGER ROUTE FOR PREPARATION OF SYNROC
- 1981-PRES TITANATE CATALYST DEVELOPMENT PROGRAMS FOR DOE/FE

SANDIA NATIONAL LABORATORIES/HOWARD STEPHENS/PROCESS RESEARCH DEPARTMENT 6212/(505)844-9178

Figure B-10. (4 of 18)

TITANATE ION EXCHANGER DEVELOPMENT AT SANDIA

- 1984 SAVANNAH RIVER LAB ADOPTS TITANATES FOR IN-TANK PRECIPITATION OF SR AND PU
- 1990 PROGRAM INITIATED TO EXPLORE CRYSTALLINE SILICOTITANATES AS CATALYSTS
- 1992 DISCOVERY OF CS SELECTIVE CRYSTALLINE SILICOTITANATES

SANDIA NATIONAL LABORATORIES/HOWARD STEPHENS/PROCESS RESEARCH DEPARTMENT 6212/(505)844-9178

Figure B-10. (5 of 18)

PATENT STATUS

- CST's are a new class of compounds with wide potential applications as catalysts and ion exchangers
- Patent application to be filed by mid February 1993
- Commerce Business Daily announcement is in draft
- Non-disclosure, non-analysis agreement is being written
- Limited information on composition and synthesis conditions will be openly released

Figure B-10. (6 of 18)

SYNTHESIS OF CST's

CST formed by reaction of

Tetraalkyl titanate

Tetraalkyl silicate

Sodium hydroxide

Hydrothermal treatment similar to zeolite synthesis

Wash, dry, isolate

Formation of engineered form

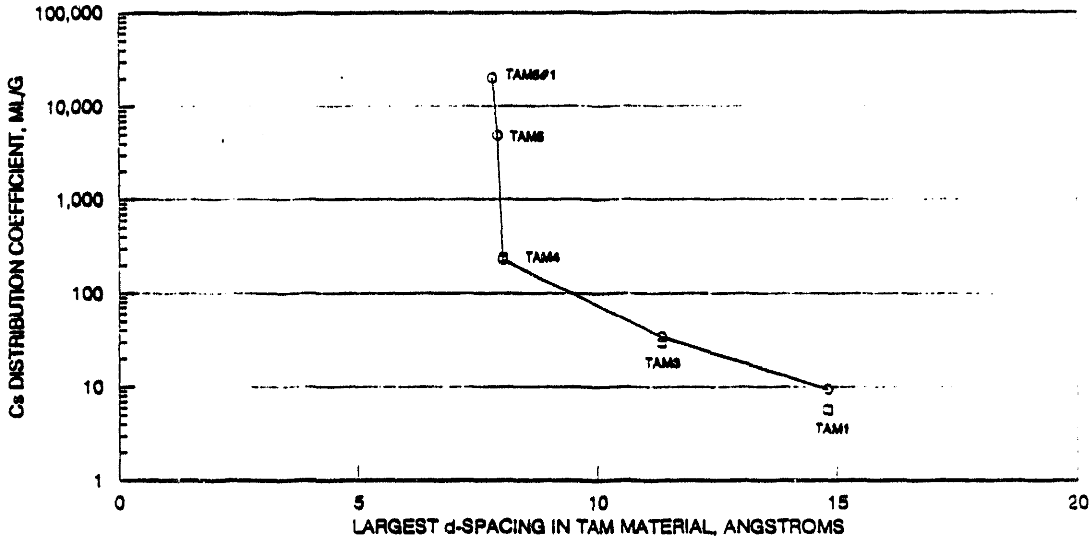
Ion exchange reactions in Cs removal process

$$NaCST + Cs^{+} (aq) \longrightarrow CsCST + Na^{+} (aq)$$

Figure B-10. (7 of 18)

Cs ADSORPTION ON CRYSTALLINE SILICO-TITANATES DEPENDS ON STRUCTURE AND SYNTHESIS METHOD

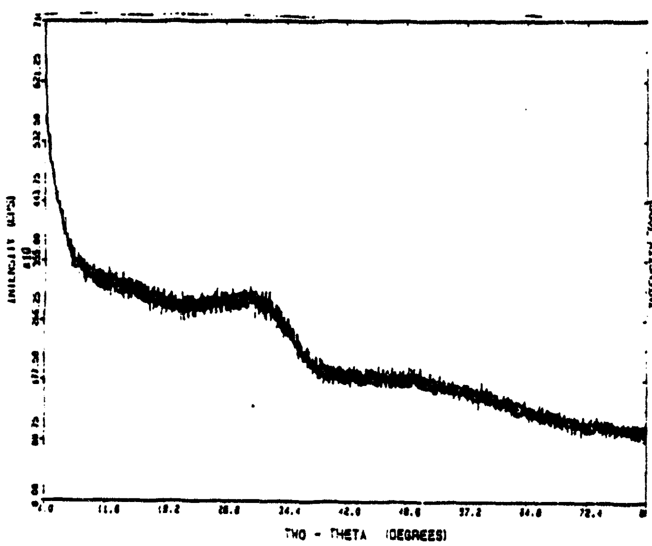
3M NaNO3 - 100 PPM Cs



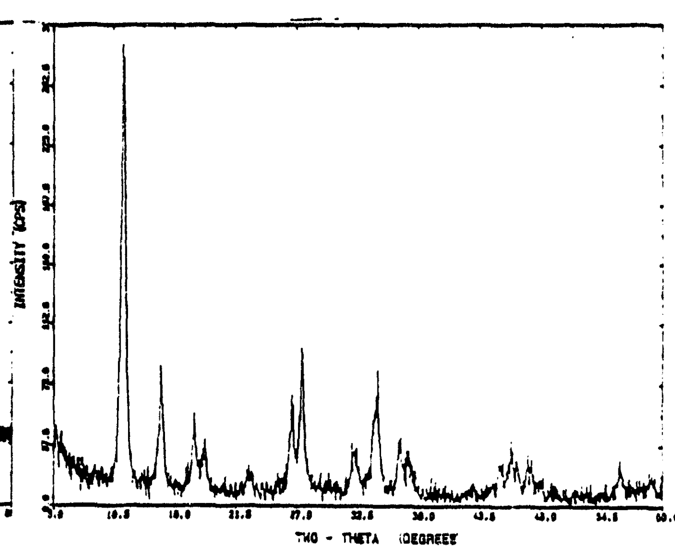
0.1 GRAM OF TAM IN 10 ML OF SOLUTION
24 HOUR EQUILIBRATION TIME

Figure B-10. (8 of 18)

DIFFERENT MOLECULAR STRUCTURES IN CRYSTALLINE (VS. AMORPHOUS) TITANATES RESULT IN HIGH CESIUM SELECTIVITY



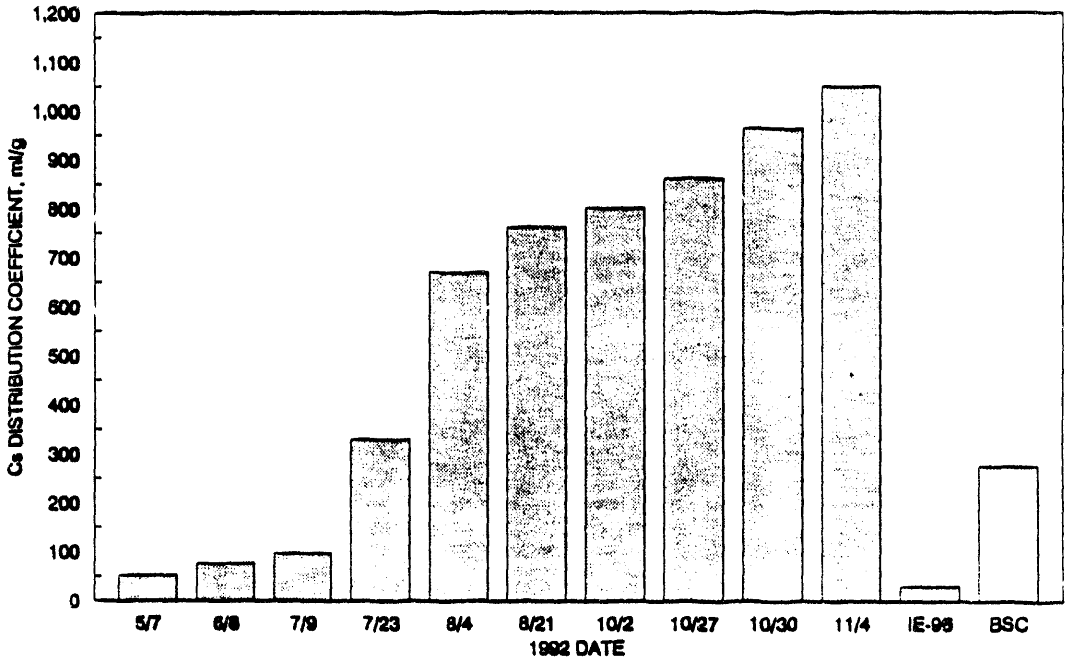
X-RAY DIFFRACTION PATTERN OF TITANATE SHOWING NO LONG-RANGE ORDERING WHICH IS TYPICAL OF AN AMORPHOUS MATERIAL



X-RAY DIFFRACTION PATTERN OF SILICO -TITANATE SHOWING ORDERING TYPICAL OF OF CRYSTALLINE MATERIALS

Figure B-10. (9 of 18)

CHRONOLOGY OF THE DEVELOPMENT OF Cs SELECTIVITY IN TAM5 SILICO-TITANATES IN CAUSTIC SOLUTIONS

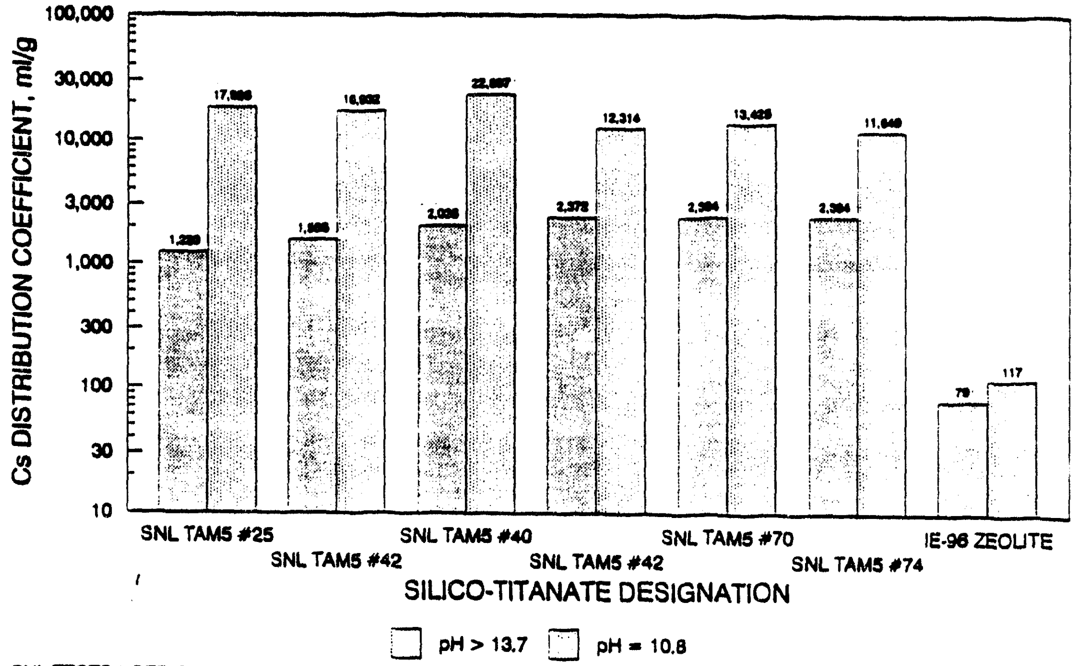


ALL SOLUTIONS CONTAINED 5.7M Na - 0.6M OH
WITH INITIAL Cs CONCENTRATIONS OF 100 PPM

Sandia National Laboratories Dosch File "CsKd102"

Figure B-10. (10 of 18)

Cs DISTRIBUTION COEFFICIENT RESULTS FROM THE LAST GROUP OF SAMPLES SENT TO PNL FOR EVALUATION

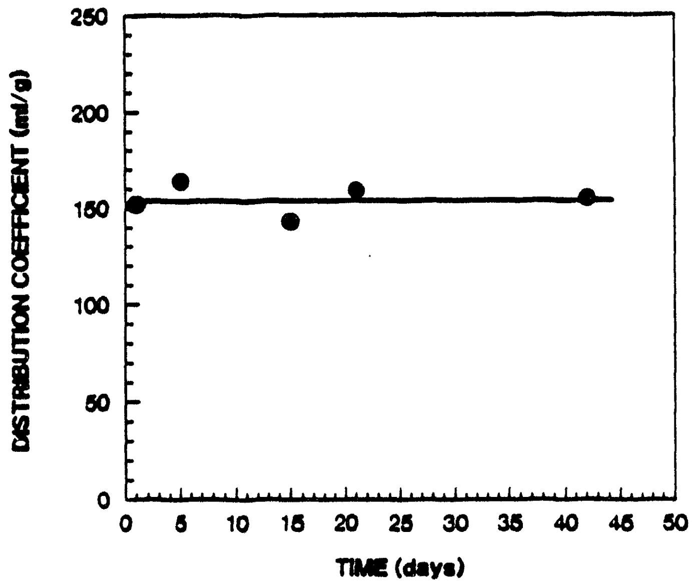


PNL TESTS USED SYNTHETIC DSSF
TESTS RUN FOR 16 HOURS AT 25C

Sandia National Laboratories Dosch "CSKD100"

Figure B-10. (11 of 18)

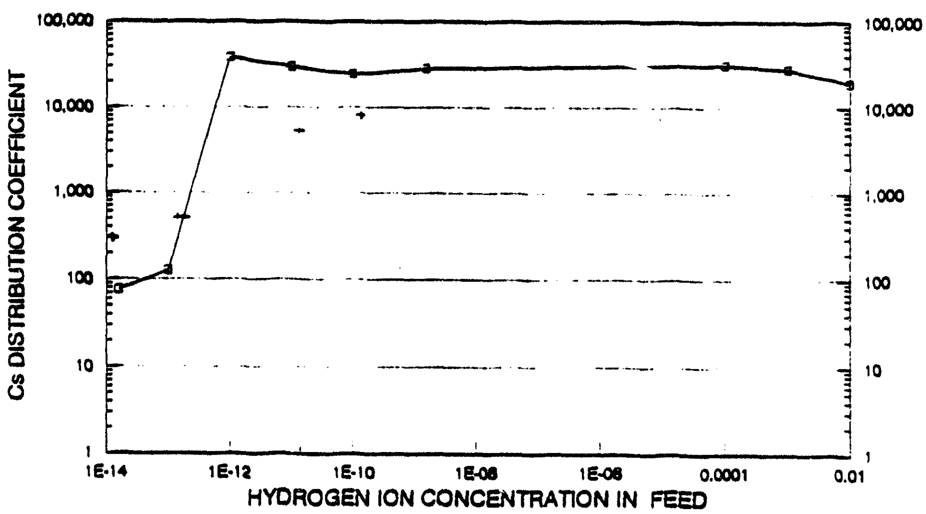
THE STABILITY OF SILICOTITANATES IN HIGHLY ALKALINE SOLUTIONS HAS BEEN DEMONSTRATED



Measurements performed by Lane Bray, PNL   Simulated DSSF waste solutions

Figure B-10. (12 of 18)

CESIUM SELECTIVITY OF SILICO-TITANATES IN 5.7M Na SOLUTION DECREASES AT HIGH pH



AAS AND ICP-MS USED FOR Cs ANALYSES
INITIAL Cs CONCENTRATION WAS 100 PPM IN 5.7N Na+

Sandia National Laboratories Dosch FL "CSKD13"

Figure B-10. (13 of 18)

SPECIFIC PROJECT ACTIVITIES

LDRD-Sandia Laboratory Directed Research & Development
Initial synthesis, characterization and composition studies to evaluate promise of CST for various applications

ESPIP- Generic Materials Properties Characterization

Provide samples for testing at PNL	**2/28/93**
Assess radiation stability	**6/30/93**
Preliminary study of regeneration	**6/30/93**
Measure Cs Kd vs pH from 0 to 14	**9/30/93**

DOE-RL-Synthesis/Characterization for Specific Processes
Application of CST to DSSF Cs removal, IPM use, ...
Production scaleup/Commercial partner development
Development of engineered form
Acid-side screening assessment

Figure B-10. (14 of 18)

DSSF PROCESS DESCRIPTION

WHC baseline concept-Once through, self shielded column

5'diameter x 10' long -- 4,000 Kg inorganic exchanger

70 gpm

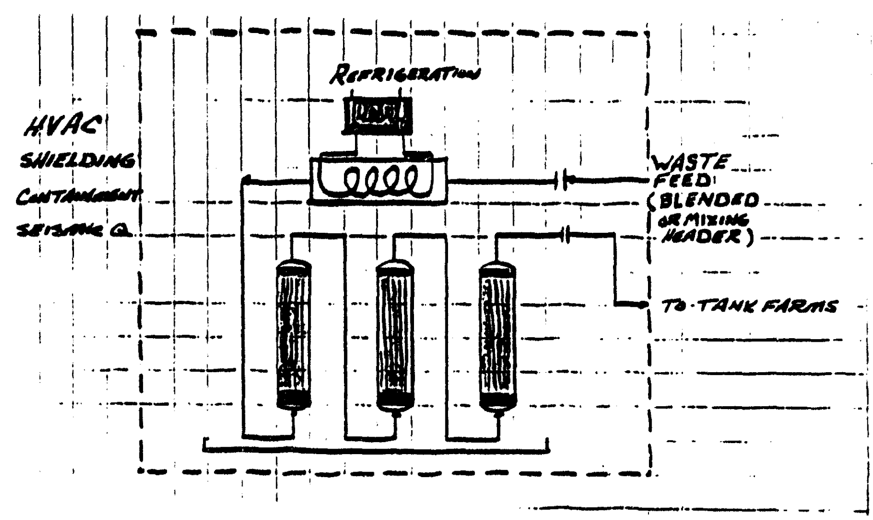


Figure B-10. (15 of 18)

SCALE-UP AND COMMERCIALIZATION

- Lab scale preparation-2 grams in 20 mL vessel

  Vary compositions and reaction conditions

- Synthesize 200⁺ g in 3.8 L autoclave

  All runs have yielded the desired materials

  Kd approaches that obtained in small reactors

- 5 gallon autoclave at Texas A&M
- Select industrial partner and transfer technology

  Conditions similar to those used for zeolites

Figure B-10. (16 of 18)

FUNDING REQUIREMENTS

	FY93 9 months	FY94 (est.)	FY95 (est.)
ESPIP			
Operating	$300K	$800K	$1,000K
Capital	0	$100K	$50K
DOE-RL			
Operating	$825K	$1,800K	$2,000K
Capital	0	$300K	$150K

Figure B-10. (17 of 18)

POTENTIAL APPLICATIONS FOR CRYSTALLINE SILICOTITANATES

Solution decontamination-Column or in-tank
- B Plant cleanup, minimize waste volume to Tank Farm
- WESF water recirculation system
- On-site process for D&D
- Savannah River-Cs removal
- Civilian reactor water treatment

Advanced chemical separations
- Sr removal
- Cation/anion resin for several species
- IPM, CPU

Soil decontamination
- Cs, U removal-INEL

Barrier technology
- Retard waste migration outside tanks
- Repository backfill

Catalyst Development

Figure B-10. (18 of 18)

SUMMARY

- CST's have a wide variety of potential applications for radwaste processing
- Rapid progress in optimizing CST composition and Cs Kd
- CST properties are well suited to DSSF column Cs removal
- Baseline samples will be provided to PNL for "hot testing"
- Radiation stability and regeneration data available this FY
- Scale-up and industrial partner selection are key issues

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Figure B-11. (1 of 11)

Westinghouse Savannah River Company

Electrochemical Treatment of Liquid Radioactive Wastes

Efficient Separations and Processing Integrated Program

Salt Lake City, UT
February 4, 1993

David T. Hobbs
Waste Management and Environmental Technology

Savannah River Technology Center

Figure B-11. (2 of 11)

Westinghouse Savannah River Company

Why Electrochemical Technology ?

- Destruction of Hazardous Species
- Radionuclide Decontamination
- Removal of Heavy Metals
- Recovery of Chemicals/Materials for Recycle
- Reduce Volume of Waste Requiring Disposal

Savannah River Technology Center

Figure B-11. (3 of 11)

Westinghouse Savannah River Company

Decontaminated Supernate

Volume:	9.6 MM gal/yr	
Hazardous Species(s):	Nitrate	1.9M
	Nitrite	0.75M
	Hydroxide	1.5M
	Chromium	150 ppm
	Mercury	350 ppm
	Benzene	500 ppm
Corrosive Species:	Sulfate	0.14M
	Chloride	0.022M
	Fluoride	0.016M
Radionuclides:	Cs-134	Cs-137
	Sr-90	Ru-106
	Tc-99	Sb-125

Savannah River Technology Center

Figure B-11. (4 of 11)

Westinghouse Savannah River Company

Electrolysis

Possible Reactions

$$NO_3^- + H_2O + 2e^- = NO_2^- + 2OH^-$$

$$2NO_2^- + H_2O + 4e^- = N_2O + 2OH^-$$

$$2NO_2^- + 4H_2O + 6e^- = N_2 + 8OH^-$$

$$NO_2^- + 4H_2O + 4e^- = NH_2OH + 5OH^-$$

$$NO_2^- + 5H_2O + 6e^- = NH_3 + 7OH^-$$

$$RuO_4^{2-} + 2H_2O + 2e^- = RuO_2 + 4OH^-$$

$$TcO_4^- + 2H_2O + 3e^- = TcO_2 + 4OH^-$$

$$2H_2O + 2e^- = H_2 + 2OH^-$$

$$4OH^- = O_2 + 2H_2O + 4e^-$$

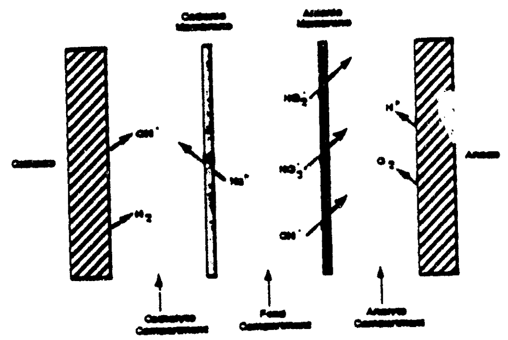
Savannah River Technology Center

Figure B-11. (5 of 11)

Westinghouse Savannah River Company

Electrodialysis

3 - Compartment Cell
Center Feed



Savannah River Technology Center

Figure B-11. (6 of 11)

Westinghouse Savannah River Company

Technology Assessment

- **Electrodialysis**
  - **attractive for alkaline nitrate solutions**
  - **not attractive for SRS alkaline wastes because of high aluminate and silicate content**
- **Electrolytic Reduction**
  - **successfully treated simulants and actual waste**

	% Removed/Destroyed	
Species	Simulants	Actual Waste
Nitrate/Nitrite	>99	79-91
Technetium-99	>99.9	56-58
Ruthenium-106	>98	31-74

Savannah River Technology Center

Figure B-11. (7 of 11)

Westinghouse Savannah River Company

Electrolytic Denitration Technology Development

Key Findings (planar electrode cell)

- Divided cell inproves current efficiency
- Lead is the cathode material of choice
- Operate up to 1000+ hours at 500 ma/sq cm and 70°C
- Off-gas composition dependent on electrode material and solution composition
- Anodes are slowly attacked when acidic anolyte employed
- Can recover and purify caustic product
- Product solution is compatible with cement formulation
- Electrocatalysts identified which enhance peak current

Savannah River Technology Center

Figure B-11. (8 of 11)

Westinghouse Savannah River Company

Costs/Savings

Annual Production Volume	9 million gal	1 million gal
Process Rate	17 gpm	2 gpm
Electrode Surface Area	430 m^2	50 m^2
Cell Cost ($10,000/$m^2$)	$4.3 million	$0.50 million
Annual Caustic Production (50% solution)	15 million lb.	1.7 million lb.
Caustic Value ($300/ton)	$2.2 million	$0.26 million
Annual AN Production	5.1 million lb.	0.60 million lb.
AN Value ($128/ton)	$0.32 million	$0.038 million
Maximum Saltstone Volume Reduction	78%	10%
Annual Saltstone Cost Savings	$21 million	$2.7 million
Total Annual Cost Savings	$24 million	$3.0 million

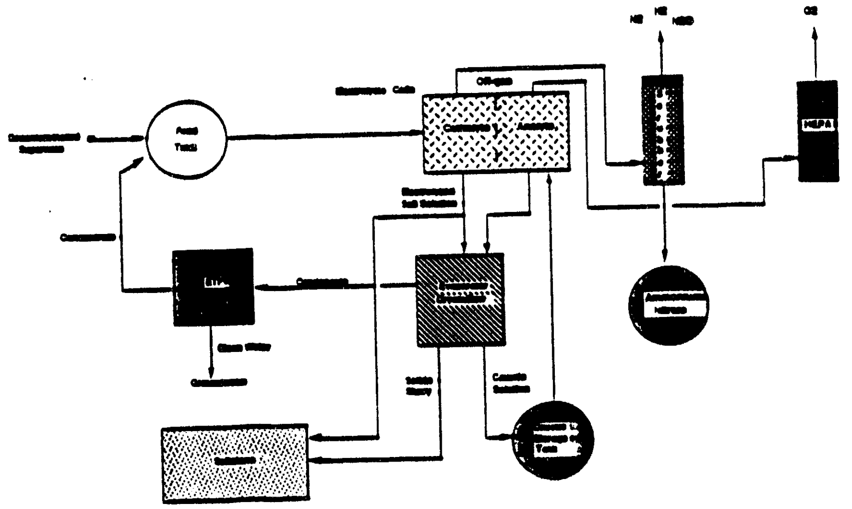
Savannah River Technology Center

Figure B-11. (9 of 11)

Westinghouse Savannah River Company

Electrolytic Process Flowsheet

Divided Cell - Caustic Anolyte



Savannah River Technology Center

Figure B-11. (10 of 11)

Westinghouse Savannah River Company

Proposed Technology Development Program

TASK	Scheduled Completion
• Design	
- identify/characterize candidate waste streams	9/93
- develop conceptual flowsheets	12/93
- develop engineering models	3/94
- identify data needs for models	4/94
• Demonstration/Testing	
- conduct lab tests for engineering models	4/95
- conduct radioactive tests with actual waste	9/96
- modify flowsheets	9/96
- evaluate materials	9/96
• Evaluation/Analysis	
- conduct preliminary cost analyses	6/95
- issue technical evaluation of lab-scale tests	6/93 (annual)
- complete conceptual design of process flowsheet	4/95
- complete pilot plant design	6/95
• Prototype/Test Equipment	
- complete installation of pilot plant equipment	9/95
- conduct pilot plant testing	9/96
- issue final report on pilot plant testing	12/96

Savannah River Technology Center

Figure B-11. (11 of 11)

Westinghouse Savannah River Company

Program Funding

	93	94	95	96
Design	100K	50K	50K	-
Demonstration/Testing	175K	650K	200K	-
Analysis/Evaluation	25K	150K	100K	-
Prototype/Test Equipment	-	-	625K	100K
Totals	300K	850K	975K	100K

Savannah River Technology Center

Figure B-12. (1 of 18)

TRUEX Model Validation

CH-232001

George F. Vandegrift, ANL

Separations & Waste Pretreatment Review

Salt Lake City, UT

February 3-5, 1993

Figure B-12. (2 of 18)

Outline

Background/Status

Process Description and Capability

Development Approach

Schedule

Funding Requirements

Figure B-12. (3 of 18)

Background /Status

The TRUEX Process Status

- Assurance that most, if not all, Hanford wastes can be treated.
- Generic TRUEX Model (GTM) can be used to design flowsheets for most feeds.
- PNL/RHO have batch tested TRUEX on some actual sludge samples and CC wastes.
- Complete TRUEX process flowsheets have been demonstrated on TRU wastes at Hanford and ANL.
- The mini-centrifugal contactor has been designed for demonstrating TRUEX flowsheets in glove boxes or shielded cells.

Figure B-12. (4 of 18)

Background /Status

TRUEX Process Needs

- Insufficient data to accurately predict/model the extraction behavior of Th, Bi, Cr, and Zr.
- Effects of process temperature is not yet included in the GTM.
- Solvent loadings
  - ≤25% are adequately modeled by the GTM
  - but modeling of higher loadings need improvements to the loading module
  - especially for metals extractable by TBP (e.g., Pu, U).
- Stage-wise extraction efficiency must be added to the GTM.
- GTM does not allow more than solvent feed.
- Complete TRUEX-process flowsheet has not been demonstrated on actual high level waste in the United States.

Figure B-12. (5 of 18)

Process Description and Capability

The TRUEX process is a solvent extraction procedure

- Capable ofhigh efficiency separation of Np, Pu, Am, and Cm from aqueous nitrate or chloride solutions typical of Pu production and purification wastes
- Removing TRU to <100 nCi/g
- Concentrating them in one or more product streams
- Removing troublesome metals from the glass feed

Figure B-12. (6 of 18)

Process Description and Capability

The Generic TRUEX Model is computer software for

- Predicting extraction behavior of waste components
- Designing process flowsheets
- Performing flowsheet sensitivity analyses
  - flow rate variations
  - compositional variations
  - stage loss
  - effects of other-phase carryover
  - effects of equipment type
- Predicting solvent damage vs. temperature due to
  - hydrolysis
  - radiolysis
- Estimating cost and space requirements for installing a solvent extraction processes
- SREX/TRUEX flowsheet predictions

Figure B-12. (7 of 18)

Process Description and Capability

The Generic TRUEX Model

- User-friendly for both Macintosh and IBM PCs
  - use front end, or
  - perform multiple runs
- Distribution Ratio calculations are
  - based on copious experimental data
  - mechanistically correct
  - based on thermodynamic activities of important aqueous-phase species
  - therefore, accurate for all nitrate solutions (whether high acid, high salt, or low ionic strength)
- Calculates process flowsheets for centrifugal contactors, mixer settlers, and pulsed columns

Figure B-12. (8 of 18)

Process Description and Capability

The Generic TRUEX Model
-- Flowsheet Calculations

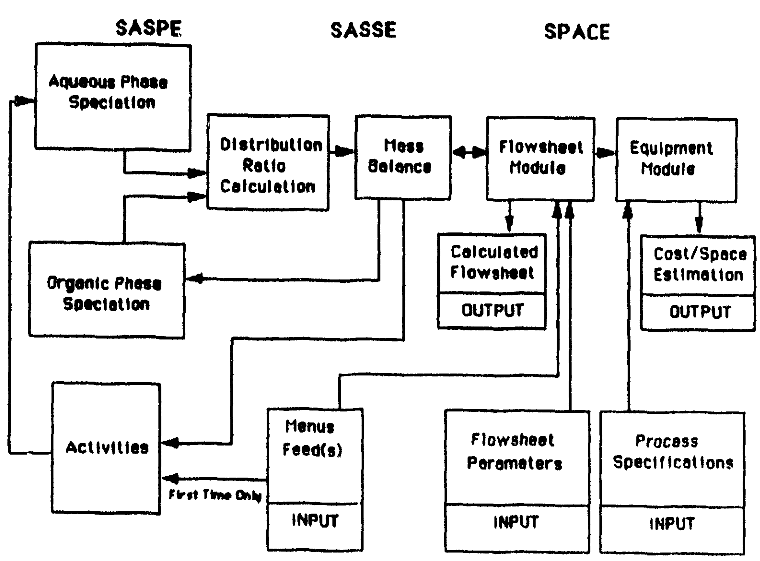


Figure B-12. (9 of 18)

Process Description and Capability

The Generic TRUEX Model

-- Option Menu

User Options (choose option from menu bar)

1 calculate complete Generic TRUEX Model for a specific feed solution
2 calculate the following:
- charge balance check of complex aqueous solution
- density of complex aqueous solution
- ionic strength of complex aqueous solution
- activities of H + , NO3 - , and water

3 calculate oxalic-acid additions to fission-product-containing waste
4 calculate D values for user-specified aqueous phase (org. phase assumed equilibrated)
5 calculate D values for equilibration of user-specified aqueous and organic phases
6 flowsheet analysis with user-specified distribution ratios
7 generate a TRUEX flowsheet for a user-specified feed
8 estimate space and costs for user-specified flowsheet
9 estimate solvent degradation for specific TRUEX process
10 generate reports from existing TRUEX flowsheets or space and cost calculations.

Figure B-12. (10 of 18)

Process Description and Capability

The Generic TRUEX Model

-- Feed Card

Extraction

Non-Fission-Product Cations
H (+) 1
Fe (3+)
Cr (3+)
Bi (3+)
Al (3+)
Na (+)

Ca (2+)
Cu (2+)
Mg (2+)

Fission-Product Rare Earths
La (3+)
Ce (3+)
Pr (3+)
Nd (3+)
Pm (3+)
Sm (3+)
Eu (3+)
Gd (3+)

Fission Products
Zr (4+)
Rb (+)
Cd (2+)
Cs (+)
Sr (2+)
Y (3+)
Ba (2+)
Rh (3+)
Pd (2+)
Ag (+)
RuNO (3+)

Actinides
Th (4+)
UO2 (2+)
Np (4+)
NpO2 (+)
Am (3+)
Pu (3+)
Pu (4+)
Cm (3+)

Anions
NO3 (-) 1
F (-)
SO4 (2-)
C2O4 (2-)
PO4 (3-)
TcO4 (-)

Neutral Species
B(OH)3

Enter all concentrations in molar units.

Figure B-12. (11 of 18)

Process Description and Capability

The Generic TRUEX Model

-- Main Input Card for Option 1

Please enter the following information:

User-specified file name:
Directory (folder) name:
Number of sections:
Year for cost estimate:
Feed rate to extraction section in L/h:

Type of TRUEX solvent ("TCE", "NPH", or "SREX") :
Recycle organic ("Yes" or "No"):
Solvent extraction unit type
("Contactor", "Pulsed Column", "Mixer Settler"):
Solvent extraction unit location
("Canyon", "Cell", "Glove box"):

Figure B-12. (12 of 18)

Process Description and Capability

The Generic TRUEX Model

-- Stage Profile Result Chart

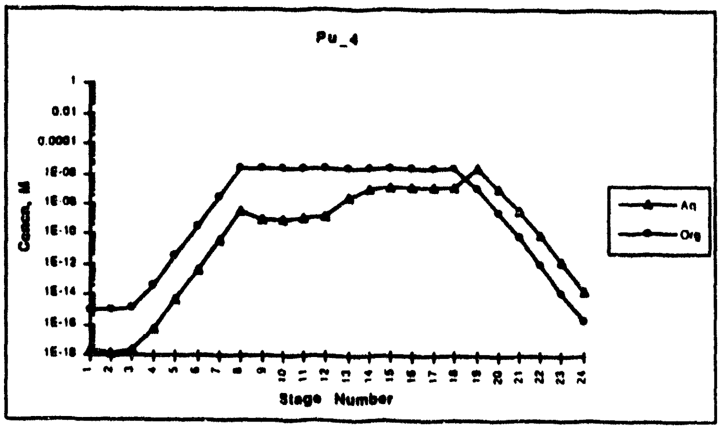


Figure B-12. (13 of 18)

Development Approach and Schedule

FY 1993 Activities

- Provide technical support for researchers at ORNL and PNL.
- Validate the GTM based on data collected at ORNL and PNL.
- Meet specific tasks of Program Management Plan.

Figure B-12. (14 of 18)

Development Approach and Schedule

ORNL Melton Valley Waste Treatment

- Review ORNL procedures for sludge dissolution and TRUEX shake tests.
- Act as a consultant to ORNL on TRUEX processing of Melton Valley waste.
- Evaluate GTM predictions and ORNL experimental data and suggest changes in
  - dissolution procedures and/or model
  - to resolve any discrepancies.

Figure B-12. (15 of 18)
ORNL Mark 42 Target Processing

- Design a TRUEX process flowsheet
  - to recover Pu, Am, and Cm from Mark 42 targets
  - make compatible with the overall recovery-and-purification flowsheet
  - using already in-place equipment.
- Devise a solvent clean-up process to allow solvent recycle.
- Consult on running the process at ORNL
- Complete the additions to GTM
  - extraction efficiency
  - multiple solvent feed
  - enhanced loading module (?)
- Use results of target processing to validate the GTM.

Figure B-12. (16 of 18)
PNL Experiments Using Dissolved Sludge

- Consult on and review
  - draft specifications for function and requirements guide
  - design concept for selecting continuous, bench-scale solvent extraction equipment for demonstrating the TRUEX process at Hanford.
- Take part in three quarterly reviews and the annual technical review of the EM-30 solvent extraction activities at Hanford.
- Collect limited laboratory batch data under controlled conditions at ANL on Th, Cr, Zr, and Bi to help clarify extraction behavior of these species in actual waste tests at PNL.
- Evaluate GTM predictions and PNL experimental data and suggest changes in
  - dissolution procedures and/or model
  - to resolve any discrepancies.

Figure B-12. (17 of 18)

Development Approach and Schedule

Milestones

	Start Date	End Date
Complete Project Management Plan for approval by DOE-HQ Program Manager		1/15/93
Provide TRUEX process flowsheet to ORNL for processing Mark 42 targets	12/17/92	4/30/93
Provide technical support to ORNL	12/17/92	9/30/93
Provide technical support to PNL	12/8/92	9/30/93
Draft ANL topical report documenting GTM validation using ORNL and PNL data		9/30/93

Figure B-12. (18 of 18)

Development Approach and Schedule

Funding

FY 1993

- A funding level of $300K has been set
- Additional funding has been requested for demonstrating the TRUEX process on actual high-level waste at Chalk River Laboratories.
- Request additional $100K for
- enhanced loading module
- validating GTM with Japanese data

Future Funding Requirements

- Continue technical support activities
- Add improvements to GTM
    - accuracy improvement from validation studies
    - models for new stripping agents (Horwitz and PNL data)
    - temperature effects on distributions ratios
    - improved TRUEX/SREX/PUREX models
    - ICPP waste components

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Figure B-13. (1 of 8)

TRUEX VALIDATION DATA COLLECTION

L. Kevin Felker and Dennis E. Benker
Chemical Technology Division
Oak Ridge National Laboratory

UST-ID and ESPIP Program Review
Salt Lake City, UT
February 3-5, 1993

Presented by C. P. (Phil) McGinnis

Figure B-13. (2 of 8)

BACKGROUND:

- Transuranium (TRU) elements are present in many waste storage tanks at DOE sites.
- TRU element removal and concentration will simplify subsequent handling and disposal.
- TRUEX was developed by Argonne National Laboratory to remove TRU elements from waste solutions.
- The Generalized Truex Model was developed by Argonne National Laboratory to predict the operation of the process at varying conditions and with different waste solutions.

Figure B-13. (3 of 8)

OBJECTIVE:

- Test TRUEX process on larger scale with very high activity levels.
- Collect and analyze data for validation of the Generalized Truex Model.
- TRUEX process may have application in processing irradiated fuel/targets.

Figure B-13. (4 of 8)

RADIOCHEMICAL ENGINEERING DEVELOPMENT CENTER:

- Radiochemical Engineering Development Center (REDC) at ORNL is a multipurpose radiochemical processing facility.
- REDC processes irradiated fuel elements and targets for DOE-DP and DOE-ER programs.
- Solvent Extraction Test Facility (SETF) at the REDC was an experimental facility for testing kg quantities of LWR/FBR fuel reprocessing.
- This equipment may be adapted to testing TRUEX with solutions currently being processed at the REDC.

Figure B-13. (5 of 8)

SOLVENT EXTRACTION TEST FACILITY:

- Contained in shielded hot cell facility for use with high levels of radioactivity.
- Uses three banks of 16-stage continuous mixer/settler contactors.
- Constructed to handle kg quantities of irradiated fuels in nitric acid solutions.
- Idle since 1986, operational readiness unknown. Equipment may need significant repairs/refurbishments to make operational.

Figure B-13. (6 of 8)

TRUEX PROCESS TEST:

- TRUEX will be tested in SETF equipment using irradiated SRP assemblies as feed.
- The feed will contain Pu, Am, Cm and associated fission products.

  Nominal Concentrations:

Pu:	10 g/L
Am/Cm:	5 g/L
FP:	40 g/L

- REDC needs high DF's (>1000) for both Pu product and Am/Cm product.
- TRUEX flowsheet will be design by Argonne personnel based on REDC feed and SETF equipment.

Figure B-13. (7 of 8)

TASK SUMMARY

• Evaluate SETF equipment for operability and initiate repairs/ refurbishments.	03/31/93
• Complete flowsheet design for SETF test.	04/30/93
• Restore operability of SETF equipment.	06/30/93
• Complete TRUEX test run, collect samples for analysis, and summarize data.	07/31/93-09/30/93
• Apply data to GTM to validate model or identify areas for changes or further evaluation.	12/31/93

Figure B-13. (8 of 8)

FUNDING:

- Provides necessary support to Analytical Chemistry Division and REDC to collect and analyze data.

  FY93: 500K

- Provides support for reporting of results and application of data to GTM in collaborative effort with ANL.

  FY94: 225K

- This add-on project greatly benefits from the substantial programs funded by DOE-DP and DOE-ER at the REDC.

Figure B-14. (1 of 8)

COMPREHENSIVE SLUDGE/SUPERNATE DT&E

SUBTASK B: TECHNICAL INTERCHANGE WITH CEA (FRANCE)

Principal Investigator: C. P. McGinnis
Responsible Engineer: R. T. Jubin

Presented at the UST-ID & ESPIP Workshop

Salt Lake City, Utah

February 3-5, 1993

Figure B-14. (2 of 8)

BACKGROUND/STATUS

- Numerous countries (including France, Japan, and the United Kingdom) are developing new technologies for the separation of specific fission products and actinides from the waste streams.
- It is in the national interest to establish/expand our collaborative agreements with the major international organizations.
- The French CEA initiated, under 1991 legislation, an R&D program to be conducted over the next 15 years which focuses on the broad area of radioactive waste management.

Figure B-14. (3 of 8)

THE CEA PROGRAM IS DIVIDED INTO THREE MAJOR SUB-PROGRAMS

- The study of storage options in deep geologic formations.
- The development of methods for separating and transmuting the long-lived radionuclides in the waste.
- A study into the packaging and storage processes for long term engineered surface storage of waste to either eliminate the need for disposal or at least decrease the radioactivity and thus reduce the disposal costs.

Figure B-14. (4 of 8)

PARTITIONING AND TRANSMUTATION EFFORTS ARE INCLUDED IN THE R&D PROJECT CALLED SPIN

- PURETEX - focused on improving plutonium separation and neptunium management within existing reprocessing plants
  - Implementation of results within the next 10 years.
- ACTINEX - aimed at defining processes for the separation of the long-lived radionuclides and on the incineration or transmutation of the plutonium isotopes as well as the minor actinides.
  - Implementation of results in 2010 to 2030.

Figure B-14. (5 of 8)

APPROACH

- Assignment of technical staff member representing USDOE to one of the CEA sites for approximately one year.
- The tasking for the assignee will be twofold.
  - Work with a CEA development team in the R&D activities.
  - Develop a broad understanding into the French waste management programs.
- Explore possibilities of technical collaborations in mutually beneficial areas.
- Provide regular progress reports detailing
  - technical progress
  - requests for technical input from the US
  - insights into the French waste management programs
- A team of technical experts in the US review this information and provide the technical support and feedback to the assignee.

Figure B-14. (6 of 8)

SOLICITATION FOR INPUT

- Requests for information concerning the French programs is desired from all workshop attendees.

Figure B-14. (7 of 8)

SCHEDULE FOR ASSIGNMENT

- 12/92 - 2/93 Obtain approvals and prepare for relocation.
- 3/93 - 4/93 Relocation to France complete.
- 4/93 - 4/94 Provide monthly feedback to program personnel on activities related to program.

  Respond to specific requests for information, if possible.
- 4/94 - 6/94 Return to ORNL and submit report.

Figure B-14. (8 of 8)

FUNDING REQUIREMENTS

All funds are EM-50 UST-ID

	FY 1993	FY 1994
Capital		
Operating	350K	250K
Total	350K	250K

Figure B-15. (1 of 6)

SLUDGE TECHNOLOGY ASSESSMENT

TTP No:	**CH-2320-03**
Principal Investigator:	**James E. Helt**
Program:	**Efficient Separations and Processing Integrated Program**
Funding for FY 93:	**$50K**

Argonne Office of Waste Management Programs

Figure B-15. (2 of 6)

SLUDGE TECHNOLOGY ASSESSMENT

OBJECTIVES

1. **To assess the state of radioactive sludge problems and treatment capabilities within the DOE complex**

2. **To identify potential treatment capabilities and specialists in industry and academia**

3. **To identify areas where R&D is needed**

Argonne Office of Waste Management Programs

Figure B-15. (3 of 6)

SLUDGE TECHNOLOGY ASSESSMENT

MILESTONES

Assess sludge problems, technologies, and plans at ORNL, SRL, and RL	**3/31/93**
Assess sludge capabilities in industry, academia, and remaining national laboratories	**6/1/93**
Compile bibliography of existing literature, data, databases, etc.	**6/1/93**

Argonne Office of Waste Management Programs

Figure B-15. (4 of 6)

SLUDGE TECHNOLOGY ASSESSMENT

- **Define sludge problems, volume, and chemical composition (if known) at various DOE facilities**
- **Define processes under consideration for treatment and disposal of sludge**
- **Evaluate status of technologies and technology gaps**

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Figure B-15. (5 of 6)

DOE FACILITIES OF INTEREST

- **Hanford**
- **Savannah River**
- **Oak Ridge**
- **Rocky Flats**
- **Others (Los Alamos, West Valley)**

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Figure B-15. (6 of 6)

INFORMATION ON PROCESSES

- **Fully integrated treatment processes -- systems approach**
- **Potential for success, overall contribution to treatment and disposal process requirements**
- **State of development**

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Figure B-16. (1 of 11)

TREATMENT OF MVST WASTE

MAJOR OBJECTIVES

- Separation of Solids from Solution
- Washing of Solids
- Acid Dissolution of Solids
- Partitioning of TRU Components

Figure B-16. (2 of 11)

PROCESS STEPS

- Retrieval of Sludge and Transfer to Hot Cell
- Solid-Liquid Separation at Waste pH
- Wash Solids at Supernatant pH
- Treatment of Supernatant
- Acid Dissolution of Sludge
- Partitioning and Separation of Actinides and Other Radionuclides
    - TRUEX
    - SREX
- TRU Solidification
- Treatment of LLLW

Figure B-16. (3 of 11)

WORK DIAGRAM FOR INITIAL SLUDGE TREATMENT STUDIES

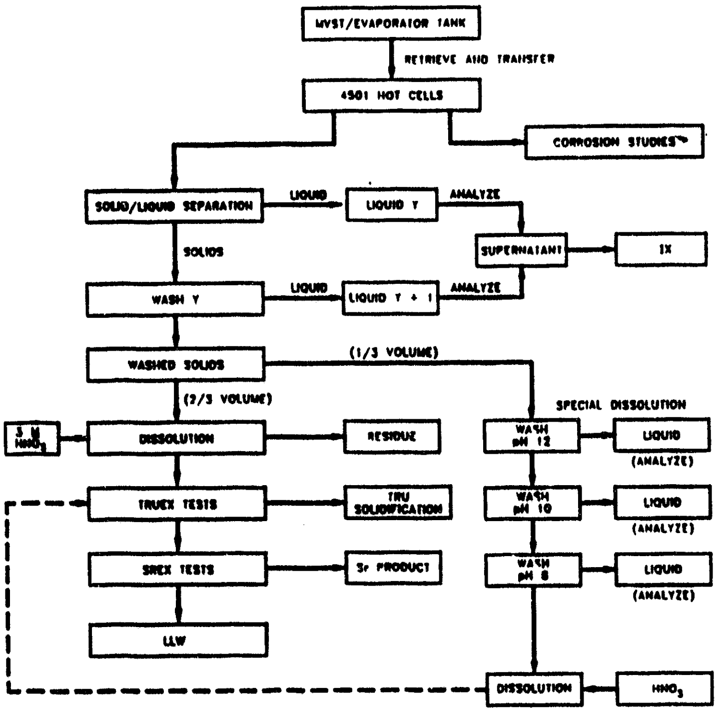


Figure B-16. (4 of 11)

TASK: PREPARE EXPERIMENTAL PLAN

- **Approvals and procedures for transfer and handling of waste**
- **Preparation of documentation (safety summaries, QA, etc.)**
- **Identify and select liquid/solid separation methodology**
  - **Filtration**
  - **Centrifugation**
  - **Other**
- **Surrogate (non-radioactive) waste composition**
- **Identify analysis requirements and procedures**
- **Specify and procure equipment and instrumentation**
- **Preparation and evaluation of experimental procedures**
  - **Solid/liquid separation**
  - **Acid dissolution**
  - **TRUEX**
  - **SREX**
- **Waste disposal**

Figure B-16. (5 of 11)

TASK: EQUIPMENT ASSEMBLY AND COLD TESTING

- **Assembly and testing of solid/liquid separation equipment**
  - **Surrogate waste preparation**
  - **Evaluate efficiency and throughput**
- **Batch solvent extraction tests**
  - **Verify TRU distribution**
  - **Measure distribution of other metallic components**
- **Transfer of equipment to hot cell**

Figure B-16. (6 of 11)

TASK: WASTE RECOVERY, TRANSFER, AND SOLID/LIQUID SEPARATION

- **Selection and removal of sludge sample from MVST**
- **Transfer of sludge sample to 4501 hot cells**
- **Installation of filtration equipment in the hot cell**
- **Separation of solid/liquid of sludge by filtration**
- **Storage of filtrate (supernatant)**
- **Storage of 1/3 of solids for special dissolution tests**

Figure B-16. (7 of 11)

TASK: WASH TREATMENT AND ACID DISSOLUTION

- Wash solids twice with NaOH and combine filtrates
- Store and analyze filtrates
- Dissolution of solids in 3 M nitric acid
- Measurement and analysis of residue
- Analysis of nitric acid dissolution solution

Figure B-16. (8 of 11)

TASK: TRUEX BENCH SCALE TESTS

- Single-stage TRUEX solvent extraction tests
- Distribution of TRU elements
- Distribution of non-TRU elements
- Optimization of parameters for TRU separation
  - Extraction parameters
  - Strip parameters
  - Optimum TRU - nonTRU separation

Figure B-16. (9 of 11)

TASK: SREX TESTS

- Removal of Sr from TRUEX raffinate
- Sr extraction by SREX
- Alternatives
  - IX Resins
  - Sodium Titanate precipitation

Figure B-16. (10 of 11)

TASK: TRU SOLIDIFICATION

- Conversion of TRUEX strip product to a solid
  - IX
  - Calcination
- Evaluate final waste forms
  - Vitrification
  - Other

Figure B-16. (11 of 11)

TASK: CELL CLEAN-UP AND REPORTING

- **Equipment decontamination**
- **Waste disposal**
- **Reports**
  - **OTD Monthly reports**
  - **Initial flowsheet and procedures**
  - **Test results**
  - **Mass balances, operating conditions**
  - **Estimates of secondary wastes**
  - **Recommendations and conclusions**
  - **Flowsheet for pilot plant**

Figure B-17. (1 of 9)

CALCINATION/DISSOLUTION PROCESS DEVELOPMENT

February 3 - 5, 1993

UST-ID WASTE PRETREATMENT
Principal Investigator: Scott A. Colby
Westinghouse Hanford Company

Figure B-17. (2 of 9)

AGENDA

- Background/Status
- Process Description
- Development Approach and Schedule
- Funding Requirements

Figure B-17. (3 of 9)

Waste Calcination Process

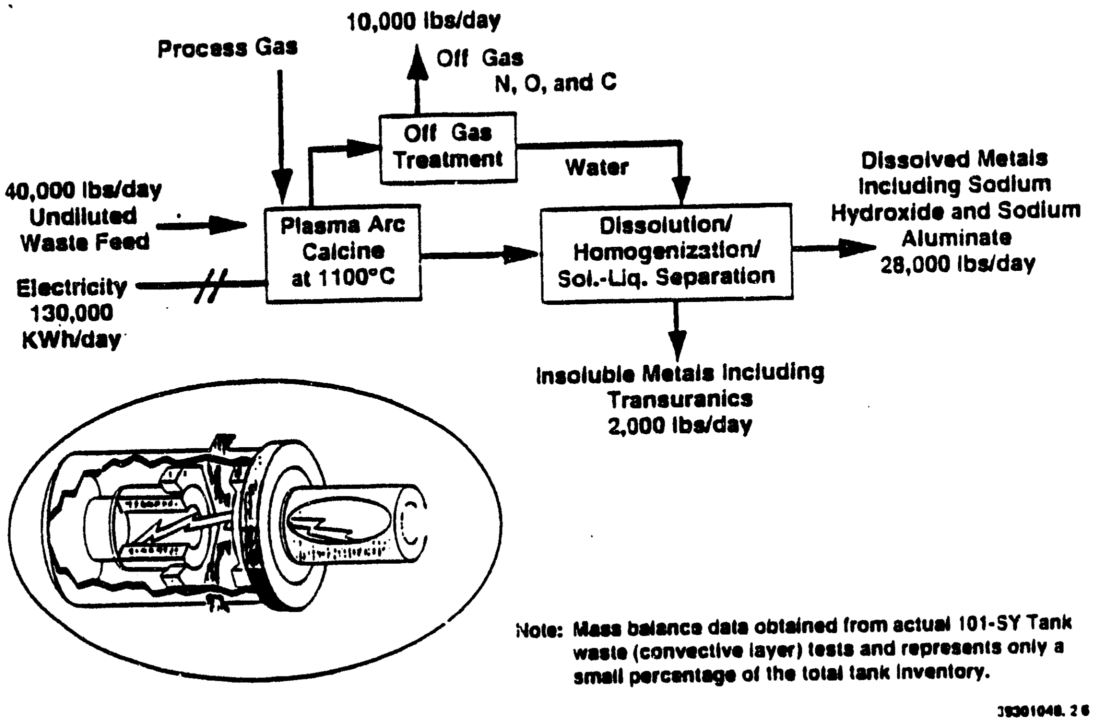


Figure B-17. (4 of 9)

CHEMICAL INVENTORY OF HLW
(before calcination)

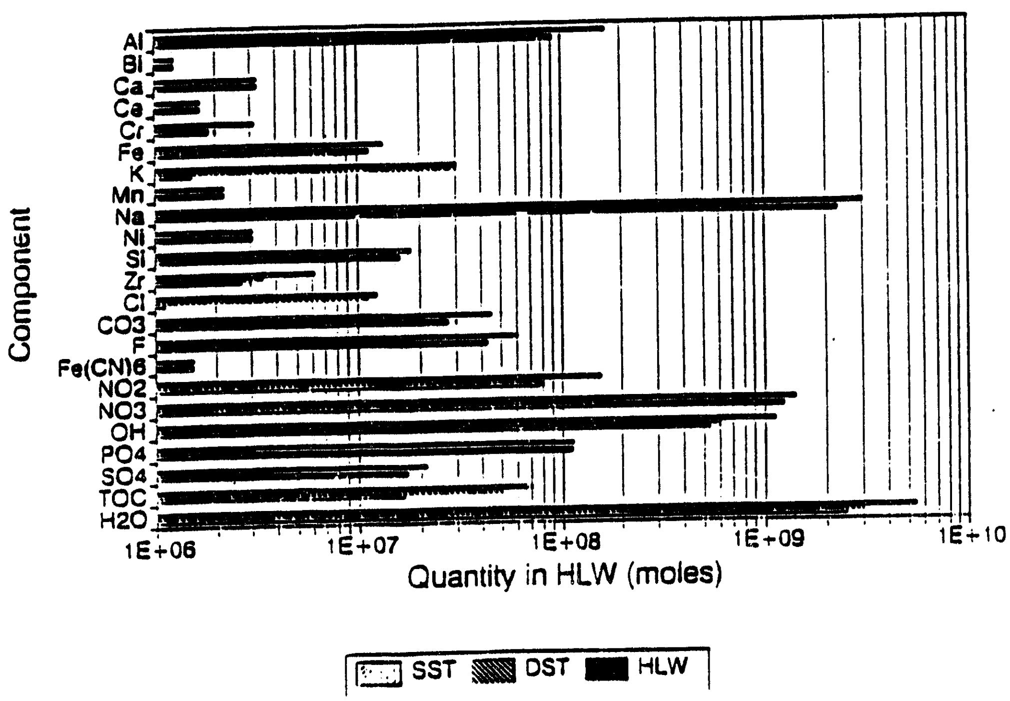


Figure B-17. (5 of 9)

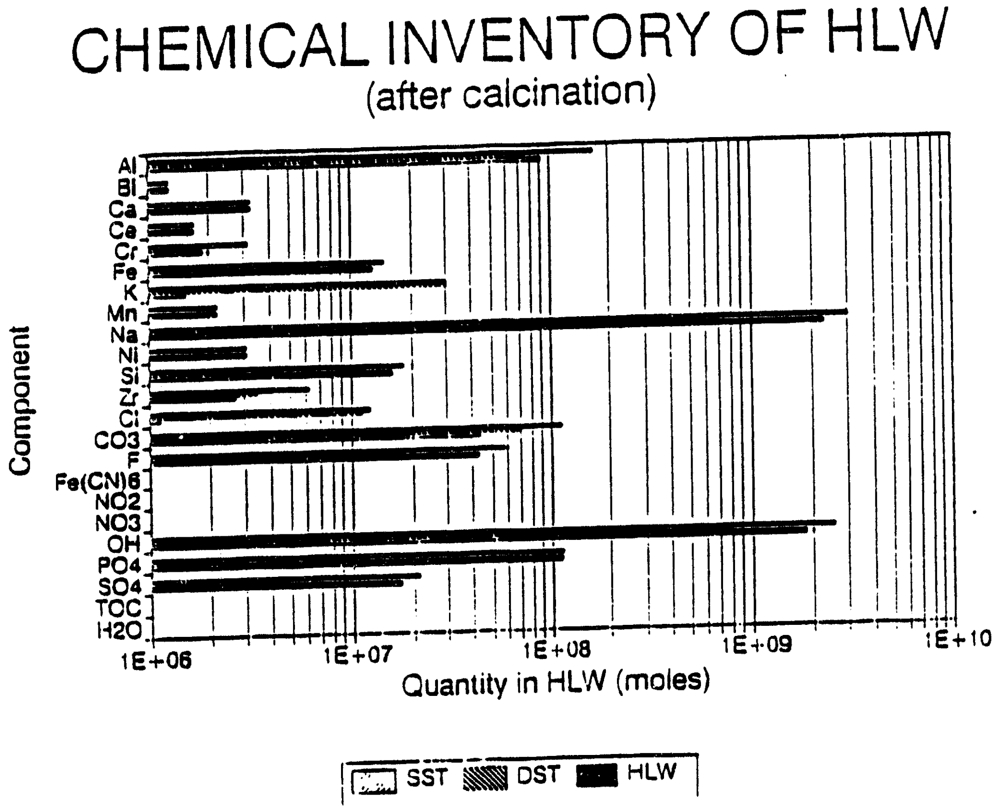


Figure B-17. (6 of 9)

STATUS

Completed Initial Plasma Arc Calcination

Received Proposal and Cost Estimate from WEC

Completed Project Management Plan

- Integrates EM 50 and EM 30 needs

Future Testing On Schedule

Figure B-17. (7 of 9)

EQUIPMENT DEVELOPMENT APPROACH AND SCHEDULE

Perform one demonstration on 101-SY simulated tank waste by 7/93

Increased demonstration times to better define steady state

Feed system re-build (i.e., tanks, mixers, pumps)

Re-line cupola refractory

Additional chemical analysis needs

Figure B-17. (8 of 9)

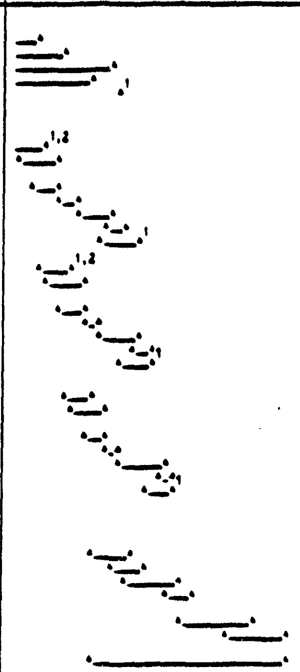
INTEGRATED DEVELOPMENT APPROACH AND SCHEDULE

Plasma Arc Equipment Development (UST-ID, $300K)	
Complete initial testing using existing equipment geometry.	Completed 10/30/92
Complete second test using increased test demonstration time.	07/01/93
Calcination/Dissolution Chemistry Development (EM-30, $300K)	
Complete literature review.	07/01/93
Complete laboratory calcination and dissolution tests.	09/30/93
Physical Chemistry of leached residues (ESPIP, $250k)	
Determine insoluble mineral forms in plasma calcine simulant.	03/31/93
Select and report reference process.	06/30/93
Complete leaching of five waste types.	08/31/93
Integration With EM 30 Development Needs (TWRS, Unfunded - ~$1,100K)	
Provide conceptual design for process technical review based on treating tank 101-SY and a 20 gpm flow rate.	05/15/93
Identify primary organic destruction technology.	10/1/93

Figure B-17. (9 of 9)

INTEGRATION WITH EM 30 DEVELOPMENT NEEDS COST SCHEDULE

Cost $	Task	Months After Start of Program 1 2 3 4 5 6 7 8 9 10
	1. Thermodynamic Analysis	
[illegible]	1.1 Expand CET Array Diagnostics	
[illegible]	1.2 Database Extension	
[illegible]	1.3 Simulation Calculations	
27121	1.4 Heat and Material Balances	
[illegible]	1.5 Reporting	
	2. Testing	
	2.1 Test 1	
7900	2.1.1 Prepare Test Plan	
[illegible]	2.1.2 Prepare Materials: Prepare Simulant	
[illegible]	2.1.3 Prepare the Cupola	
[illegible]	2.1.4 Perform Test	
[illegible]	2.1.5 Analyze Test Data	
8776	2.1.6 Disposal of Waste	
[illegible]	2.1.7 Prepare Report	
	2.2 Test Plan 2	
7900	2.2.1 Prepare Test Plan	
[illegible]	2.2.2 Prepare Materials: Prepare Simulant	
[illegible]	2.2.3 Prepare the Cupola	
[illegible]	2.2.4 Perform Test	
[illegible]	2.2.5 Analyze Test Data	
8776	2.2.6 Disposal of Waste	
[illegible]	2.2.7 Prepare Report	
	2.3 Test Plan 3	
7900	2.3.1 Prepare Test Plan	
[illegible]	2.3.2 Prepare Materials: Prepare Simulant	
[illegible]	2.3.3 Prepare the Cupola	
[illegible]	2.3.4 Perform Test	
[illegible]	2.3.5 Analyze Test Data	
8776	2.3.6 Disposal of Waste	
[illegible]	2.3.7 Prepare Report	
	3. Design and Fabricate Plasma Arc [illegible]	
16122	3.1 Prepare Functional Spec	
[illegible]	3.2 Prepare Design Spec	
[illegible]	3.3 Prepare Design	
21578	3.4 Design Review	
n/a	3.5 Fabrication	
n/a	3.5.1 Procurement	
	3.5.2 Assembly	
n/a	4. System Integration	



[1] Deliverable Due
[2] Decision Point

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Figure B-18. (1 of 22)

TECHNOLOGY EVALUATION AND PROCESS DEFINITION (WHC/PNL)

WHC: GLOBAL LEVEL (RL-411205) $250K
PI: STEVE E. SEEMAN
PNL: UNIT LEVEL (RL-321215) $250K
PI: WILLIAM L. KUHN

PURPOSE:

- ANALYTICALLY DETERMINE HOW WELL SPECIFIC SEPARATION TECHNOLOGIES PERFORM IN ACTUAL CLEANUP SCENARIOS

DELIVERABLES:

- LETTER REPORTS DOCUMENTING RESULTS OF TECHNOLOGY EVALUATIONS: TRUEX, Cs/Sr REMOVAL, CLEAN OPTION

BENEFIT:

- WILL PROVIDE SUFFICIENT INFORMATION TO ALLOW EM-50 TO DECIDE WHICH SEPARATION TECHNOLOGIES SHOULD BE FUNDED FOR FURTHER DEVELOPMENT

Figure B-18. (2 of 22)

STEPS IN ANALYSIS PROCESS

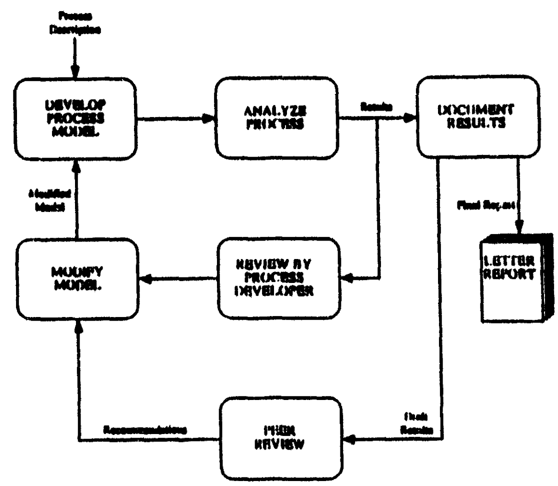


Figure B-18. (3 of 22)

COMPUTER MODELS DEVELOPED:

- TOTAL WASTE TREATMENT SYSTEM: RETRIEVAL / TRANSFER / TREATMENT / FINAL DISPOSITION
- VARIOUS SEPARATION TECHNOLOGIES

PERFORMANCE MEASURES:

- WASTE PRODUCTS PRODUCED (GLASS, GROUT)
- SECONDARY PROCESS WASTE PRODUCED
- RELATIVE LONG-TERM HEALTH RISK (TC/I)

<u>TO BE ADDED THIS YEAR:</u>

- COST
- SHORT TERM (Cs/Sr) WORKER EXPOSURE RISK
- SHORT TERM (Cs/Sr) GENERAL POPULAT. RISK
- LONG TERM (Pu) ONSITE INTRUSION RISK

Figure B-18. (4 of 22)

SEPARATION TECHNOLOGIES EVALUATED TO DATE:

- SLUDGE WASH C (USED AS BASE CASE)
- TRUEX-A
- CALCINATION/DISSOLUTION
- CLEAN SALT/SALT SPLIT
- PLASMA/CENTRIFUGE

COMPARISON BASIS:

PROCESSING OF HANFORD SINGLE SHELL TANK (SST) WASTE

Figure B-18. (5 of 22)

EVALUATION STEPS:

1.) DESCRIPTION OF SEPARATION PROCESS

2.) FLOWSHEET IS DEVELOPED

3.) FLOWSHEET IS INTEGRATED INTO GLOBAL SYSTEM MODEL

4.) CHEMICAL SPECIES LIST IS DETERMINED

5.) FLOWSHEET MODEL CONSTRUCTED (ASPEN+)

6.) MASS BALANCE RESULTS (PERFORMANCE MEASURES CALCULATED)

Figure B-18. (6 of 22)

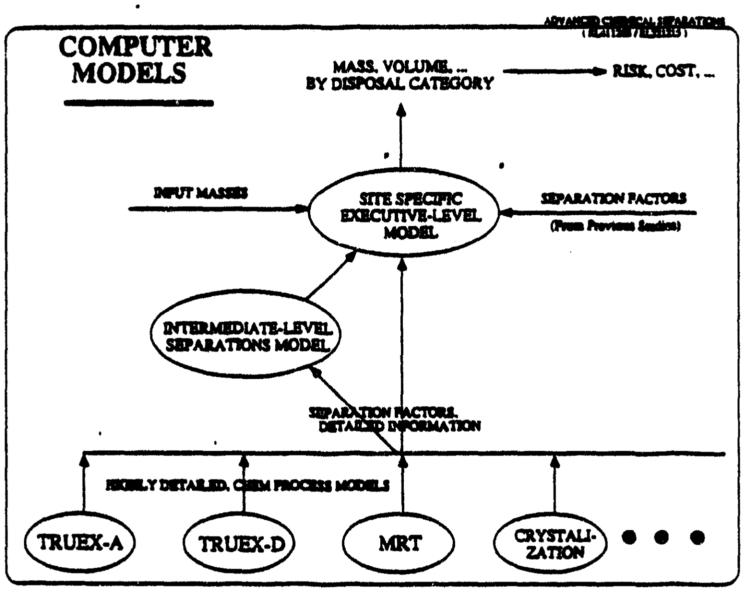


Figure B-18. (7 of 22)

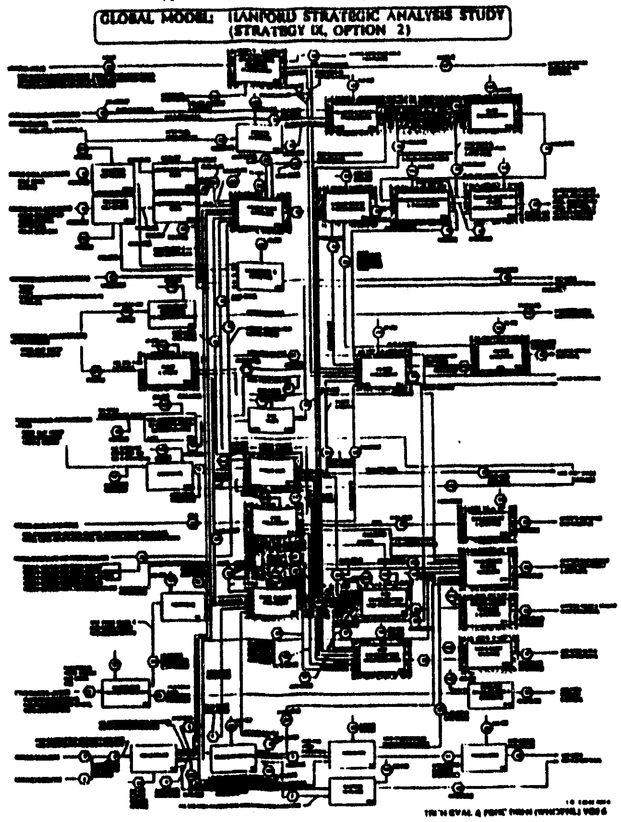


Figure B-18. (8 of 22)

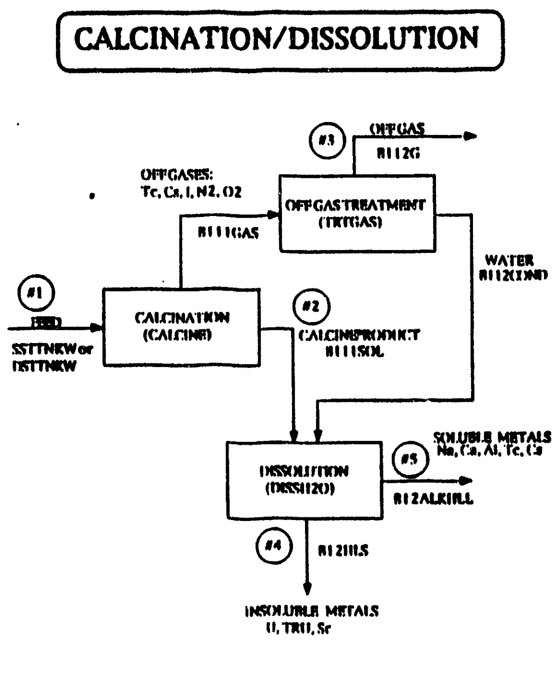
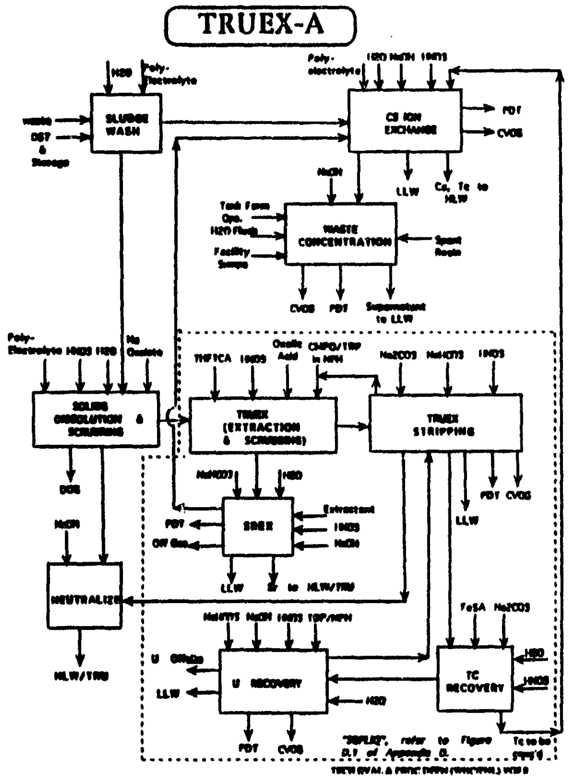


Figure B-18. (9 of 22)



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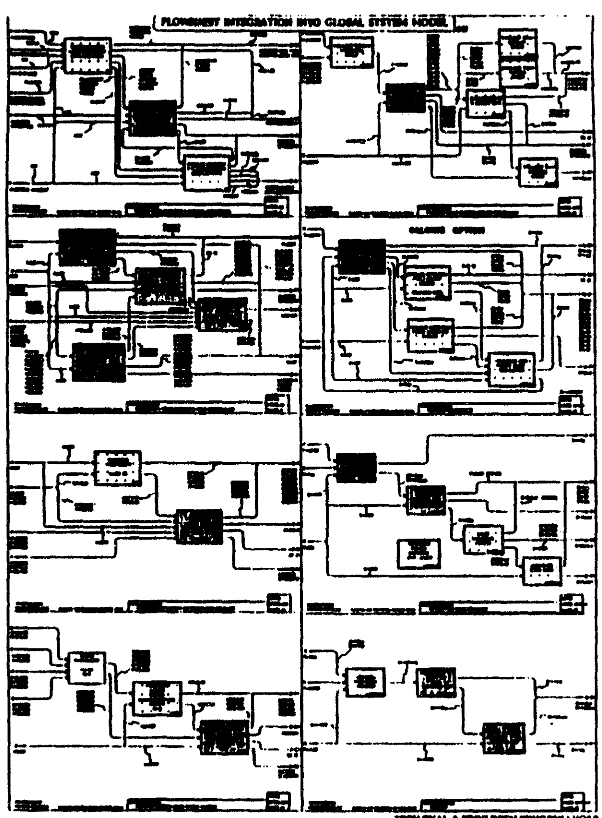

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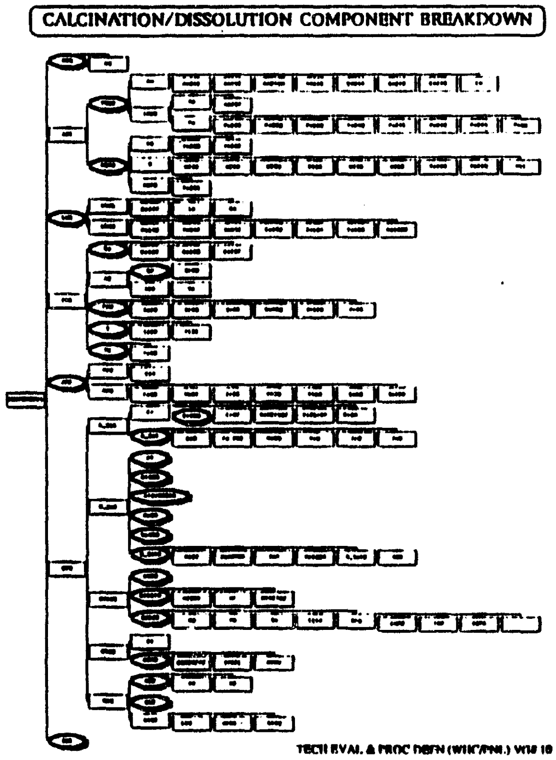

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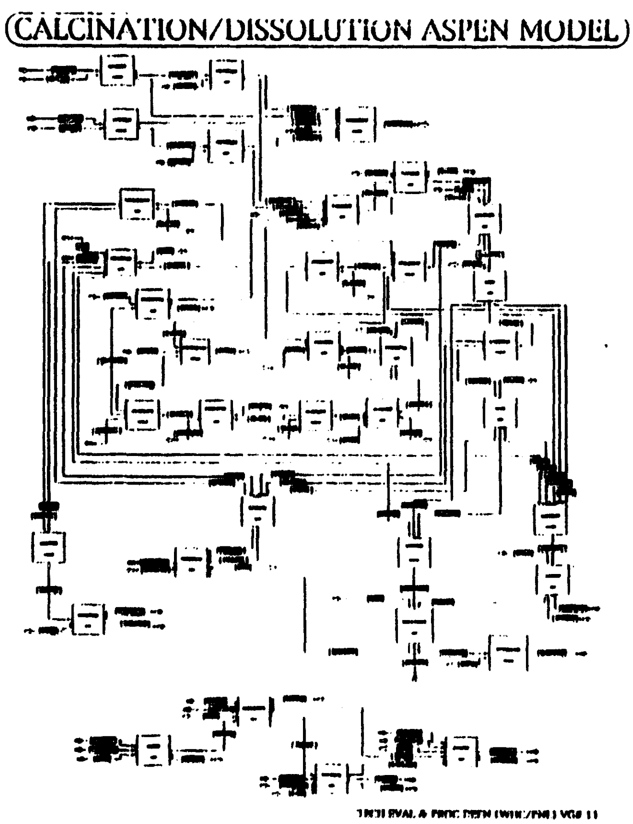
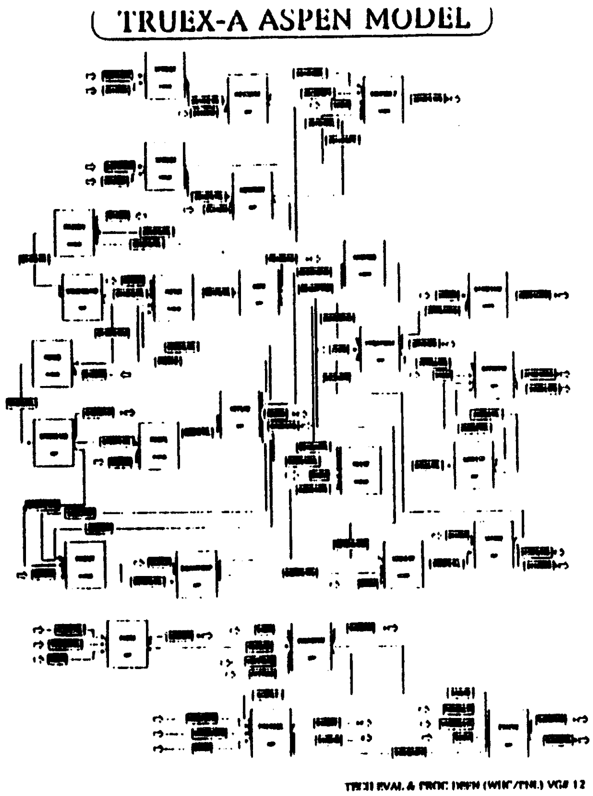


Figure B-18. (13 of 22)



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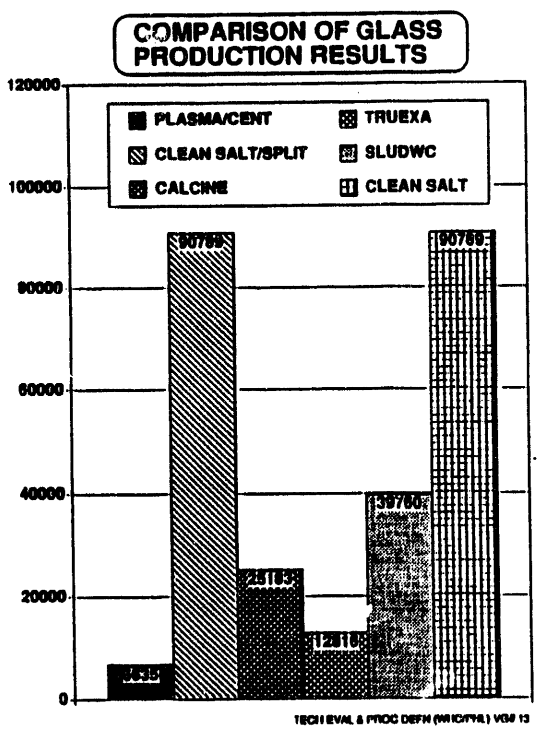

Figure B-18. (15 of 22)

GLASS CANISTERS PRODUCED BY COMPONENT

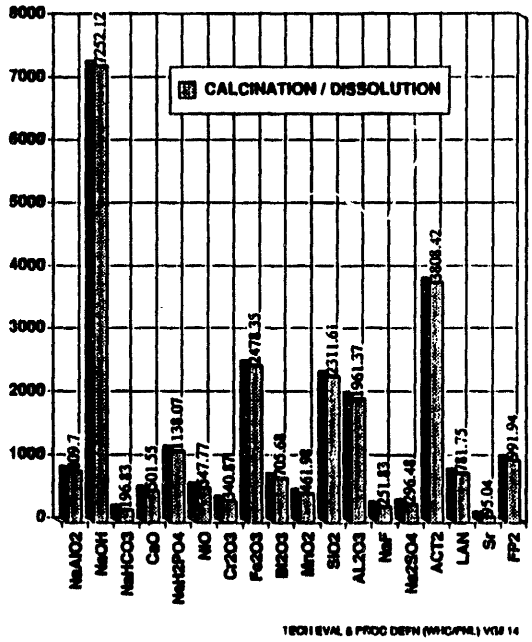

Figure B-18. (16 of 22)

COMPARISON OF GROUT PRODUCTION RESULTS (EXCLUDES SEC. PROC. WASTE)

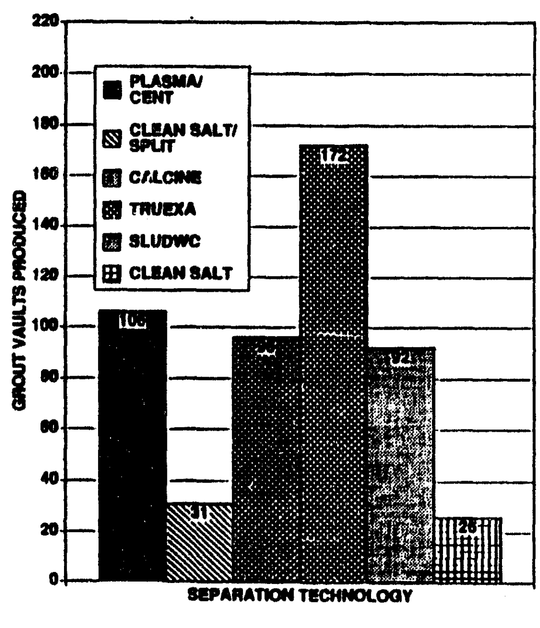

Figure B-18. (17 of 22)

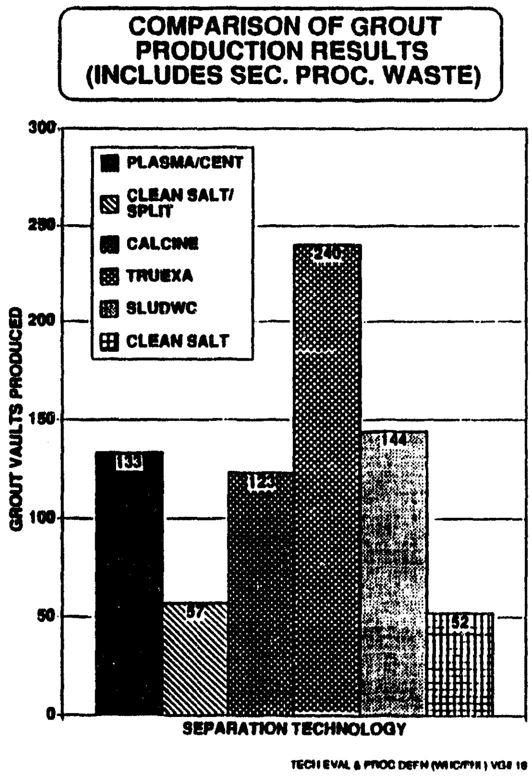

Figure B-18. (18 of 22)

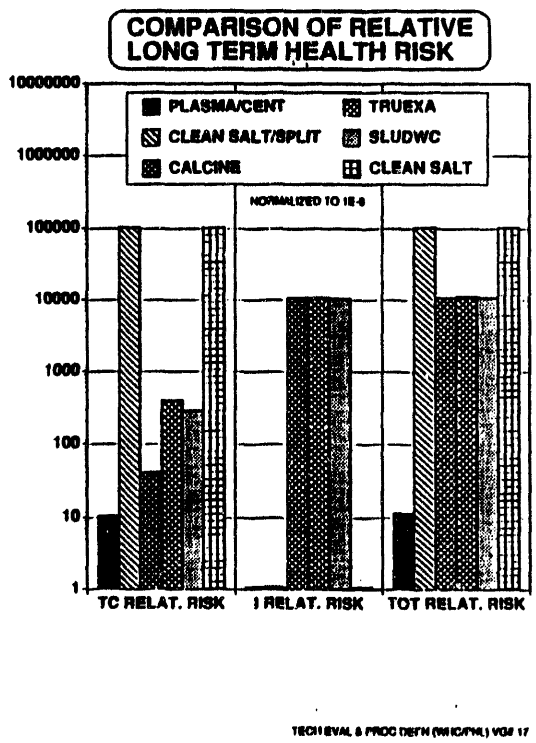

Figure B-18. (19 of 22)

FY93 ACS WORK PLAN

TECHNOLOGY EVALUATIONS:

- TRUEX REVISITED
  (INCLUDE WATER/CAUSTIC RECYCLE)
- VARIOUS Cs/Sr REMOVAL PROCESSES
- CLEAN OPTION (PNL) FLOWSHEET

PREFORMANCE MEASURE ADDITIONS:

- ADD NEW HEALTH RISK MODELS:
  - WORKER EXPOSURE (SEC. WASTE VOL. FROM PROCESS) (Cs/Sr)
  - GENERAL POPULATION EXPOSURE, SHORT TERM (Cs/Sr)
  - LONG TERM ONSITE INTRUSION HEALTH RISK (Pu)
- DEVELOP COST MODEL

Figure B-18. (20 of 22)

SCHEDULE FOR RL-411205 & RL-321215 WORK

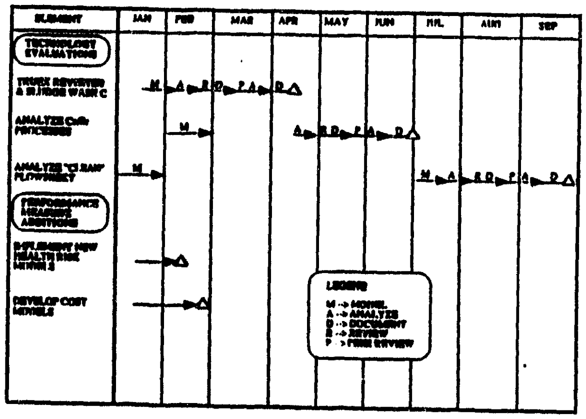

Figure B-18. (21 of 22)

Technology Evaluation and Process Definition -- Global Level

MILESTONE SUMMARY:

- REEVALUATE TRUEX STRAGEGY COMPARED TO SLUDGE WASH WITH ION EXCHANGE. COMPLETE LETTER REPORT. -- 4/15/93
- EVALUATE VARIOUS Cs/Sr TECHNOLOGIES. COMPLETE LETTER REPORT. -- 6/30/93
- EVALUATE "CLEAN" FLOWSHEET. COMPLETE LETTER REPORT. -- 9/30/93

Figure B-18. (22 of 22)

Technology Evaluation and Process Definition -- Global Level

BUDGET REQUEST SUMMARY

	92 ACT	92 CO	93	94	95	96	97
OP	233	3	250	300	300	?	?
EQ	0						
GPP	0						
LI	0						
TOTAL	233	3	250	300	300	?	?

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Figure B-19. (1 of 10)

Pacific Northwest Laboratory

Tank Waste Processing Analysis

EG Baker
NG Colton
RJ Orth

Pacific Northwest Laboratory

EA Aitken
Aitken Engineering, Inc.

Presented at the
UST-ID and ESP-IP Waste Pretreatment and
Separations Technical Review Meeting

February 3-5, 1993

Salt Lake City, UT

Tank Waste Processing Analysis *February 4, 1993*

Figure B-19. (2 of 10)

Pacific Northwest Laboratory

Objective

- Complete by FY95 an in-depth assesment of Distributed Processing to define the role of CPUs in Hanford Tank Waste Remediation
  - Define Processing Requirements for Each Tank
    - Unit operations
    - Separation or Decontamination Factors (DFs)
  - Develop Time-Phased Deployment Schedule for implementation of CPUs
- Sub-objectives
  - focus CPU technology development
  - better understand sensitivity of processing decisions to chemical characterization data

Tank Waste Processing Analysis *February 4, 1993*

Figure B-19. (3 of 10)

Pacific Northwest Laboratory

Generic Process Operations

- organic destruction
- radionuclide separation from LLW
  - Cs, Sr, TRU, Tc, I, others
- nitrate/nitrite destruction
- leaching of non-rad components from HLW

Tank Waste Processing Analysis — February 4, 1993

Figure B-19. (4 of 10)

Pacific Northwest Laboratory

Evaluation Criteria

- "Base Case"
  - approximately 12,000 canisters of HLW
  - LLW will meet NRC Class C limits for radionuclides
- "Clean Option"
  - approximately 1,000 canisters of HLW glass
  - LLW will meet NRC Class A limits for radionuclides

Tank Waste Processing Analysis — February 4, 1993

Figure B-19. (5 of 10)

Pacific Northwest Laboratory

Convert Criteria to Component Specific Concentration Limits in HLW and LLW

- NRC limits set radionuclide concentration in LLW
  - stricter limits were used for long-lived radionuclides TC99 and I129 based health effects criteria
- The number of canisters and the HWVP feed specifications set limits for many bulk components in HWVP
  - canisters must not exceed heat limit, may impact Sr and Cs loading

Tank Waste Processing Analysis — *February 4, 1990*

Figure B-19. (6 of 10)

Pacific Northwest Laboratory

Criteria (continued)

- Organic Destruction Criteria are less clear
  - safety concerns
  - grout limits
- Nitrate Destruction Criteria are very tenuous
  - concern regarding toxicity and impact on grout performance

Tank Waste Processing Analysis — *February 4, 1990*

Figure B-19. (7 of 10)

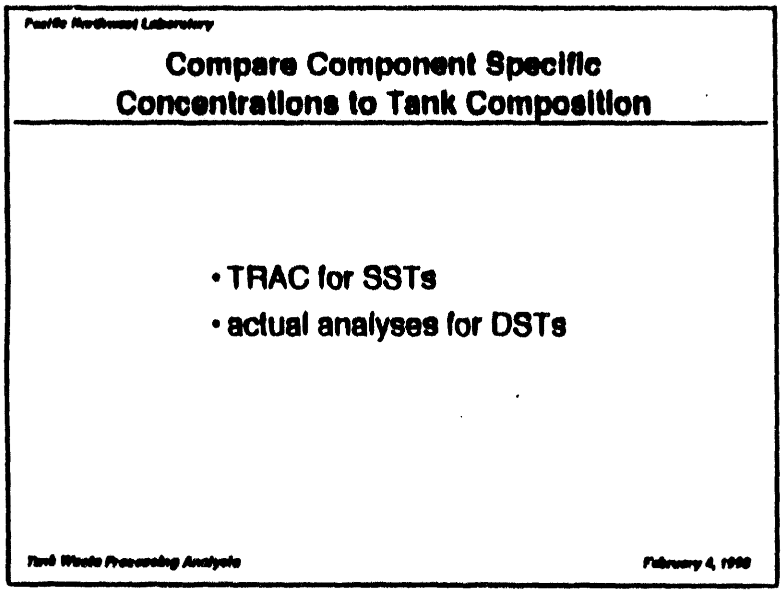

Figure B-19. (8 of 10)

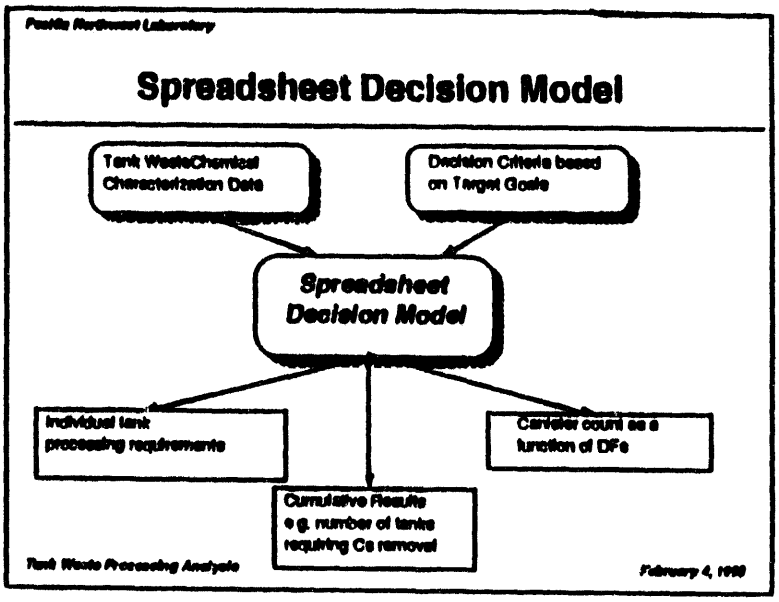

Figure B-19. (9 of 10)

Pacific Northwest Laboratory

Approach and Schedule

- FY 93
  - Define processing requirements and DFs for supernatant wastes
  - Develop preliminary time-phased schedule for implementation
- FY 94 (same as FY 93 except focused on salt cake wastes)
- FY 95 (same as FY 93 except focused on sludge wastes)
- Results of this task will help decide the ultimate role of CPUs in Hanford Tank Waste Remediation

Tank Waste Processing Analysis *February 4, 199[illegible]*

Figure B-19. (10 of 10)

Pacific Northwest Laboratory

Funding

- $300 K per year for FY 93-95 from EM-50
- Transfer to TWRS as a planning tool after FY 95 if compact processing proceeds

Tank Waste Processing Analysis *February 4, 199[illegible]*

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APPENDIX C

ATTENDANCE LIST

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NAME	INIT	PROG.	OPS	COMPANY/ORG	MAIL	ADDRESS	CITY	ST	ZIP	PHONE	FAX
Andrews	G.F.	UST-ID	ID	EG&G/Idaho		1955 Freemont Ave	Idaho Falls	ID	83415	208-526-0174	208-526-0828
Appel	J. N.	TWRS	RL	Westinghouse Hanford Co.	S4-58	2355 Stevens Dr.	Richland	WA	99352	509-372-0355	509-372-0065
Attrep	M.	UST-ID	AL	Los Alamos National Lab	J5-14	Warehouse SM-30, Bikini Road	Los Alamos	NM	87545	505-667-0088	505-665-4955
Baker	E.G.	UST-ID	RL	Battelle, PNL	P8-38	902 Battelle Blvd.	Richland	WA	99352	509-376-1494	509-372-0682
Barton	W.B.	TWRS	RL	Westinghouse Hanford Co.	L4-75	2355 Stevens Dr.	Richland	WA	99352	509-376-5118	509-376-1079
Bell	J.T.	UST-ID	OR	Martin Marietta Energy Systems		Bethel Valley Road	Oak Ridge	TN	37831-	615-574-4934	505-665-6870
Bibbler	J.P.	UST-ID	SR	Westinghouse Savannah River Co.		Bldg. 773-A	Aiken	SC	29808	803-725-5276	803-725-4704
Bratzel	D.R.	WHC/EA	RL	Westinghouse Hanford Co.	L5-31	2355 Stevens Dr.	Richland	WA	99352	509-372-3570	509-376-4450
Brown	N.	ESPIP	AL	Sandia National Lab		Dept. 6612	Alburqurque	NM	87185	505-845-8180	510-422-2105
Burnett	J.	ER-142	HQ	Department of Energy - HQ	G-335	1000 Independence Ave. SW	Wash.	DC	20585	301-903-5804	301-903-6067
Bush	D.E.	ESPIP		University of Kansas		Dept. of Chemistry	Lawrence	KS	66045	913-749-5888	913-749-7393
Chaiko	D.	ESPIP	ID	Argonne National Lab		9700 S. Cass Ave.	Argonne	IL	60439	708-252-7335	708-252-5912
Chopin	G.	ESPIP		Florida State University		Dept. of Chemistry	Talahasee	FL	32306	904-644-3810	904-644-8281
Colby	S.A.	UST-ID	RL	Westinghouse Hanford Co.	L5-31	2355 Stevens Dr.	Richland	WA	99352	509-376-8676	509-376-4450
Cowen	R.G.	ESPIP	RL	Westinghouse Hanford Co.	L5-31	2355 Stevens Dr.	Richland	WA	99352	509-373-4062	509-376-4450
Cruse	J.M.	UST-ID	RL	Westinghouse Hanford Co.	L5-63	2355 Stevens Dr.	Richland	WA	99352	509-372-1024	509-376-4661
Egan	B.Z.	UST-ID	OR	Martin Marietta Energy Systems		Bethel Valley Road	Oak Ridge	TN	37831-	615-574-6868	615-574-6870
Farish	T.	TWRS/LANL	AL	Los Alamos National Lab		Warehouse SM-30, Bikini Road	Los Alamos	NM	87545	505-665-5170	505-665-5283
Felker	K.	UST-ID	OR	Martin Marietta Energy Systems		Bethel Valley Road	Oak Ridge	TN	37831-	615-574-7071	615-576-6312
Fryberger	T.	EM-50/HQ	HQ	Department of Energy - HQ		12800 Middlebrook	Germantown	MD	20874	301-903-7688	301-903-7457
Gibson	S.M.	EM-50/HQ	HQ	Department of Energy - HQ		12800 Middlebrook	Germantown	MD	20874	301-903-7258	903-301-7236
Gilchrist	R.L.	UST-ID	RL	Westinghouse Hanford Co.	L5-63	2355 Stevens Dr.	Richland	WA	99352	509-376-5310	509-376-4661
Hanstrote	G.	TWRS	RL	Westinghouse Hanford Co.	G6-12	2355 Stevens Dr.	Richland	WA	99352	509-376-4059	509-376-2410
Harrington	R.A.	UST-ID	RL	Kaiser Engineers Hanford	E6-66	801 First Street, Bldg 1264	Richland	WA	99352	509-376-2331	509-376-6698
Helt	J.E.	ESPIP	CH	Argonne National Lab		9700 S. Cass Ave	Argonne	IL	60439-	708-252-7335	708-252-5912
Hobbs	D.	ESPIP	SR	Westinghouse Savannah River Co.		Bldg. 773-A, B-117	Aiken	SC	29802	803-725-2838	803-725-4704
Hoffman	D.	ESPIP	SF	LLNL/Glenn Seaborg Institute	L-396	7000 East Ave.	Livermore	CA	94550	510-423-5031	510-422-2105
Holton	L.K.	UST-ID	RL	Battelle, PNL	P7-43	902 Battelle Blvd.	Richland	WA	99352	509-376-5954	509-376-1867
Horwitz	P.	ESPIP	ID	Argonne National Lab		9700 S. Cass Ave	Argonne	IL	60439	708-252-3653	708-252-7501
Jansen	G.	TWRS	RL	Westinghouse Hanford Co.	L0-14	2355 Stevens Dr.	Richland	WA	99352	509-376-9343	509-376-2573
Jarvinen	G.	ESPIP	AL	Los Alamos National Lab	E-501	Warehouse SM-30, Bikini Road	Los Alamos	NM	87545	505-665-0822	505-665-1780
Jenson	R.	ESPIP	AL	Los Alamos National Lab	A-102	Warehouse SM-30, Bikini Road	Los Alamos	NM	87545	505-667-5061	505-667-1139
Johnson	B.M.	PNL	RL	Battelle, PNL	K1-78	902 Battelle Blvd.	Richland	WA	99352	509-375-2006	509-375-5900
Jubin	R.T.	UST-ID	OR	Martin Marietta Energy Systems		Bethel Valley Road	Oak Ridge	TN	37831-	615-574-6566	615-574-4624
Kalb	P.D.	UST-ID	CH	Brookhaven National Lab		Bldg. 703	Upton	NY	11973	516-282-7644	516-282-4486
Kitchen	B.	ESPIP	SR	Westinghouse Savannah River Co.		US Highway 19	Aiken	SC	29802	803-725-5331	803-725-2978
Kuhn	W.L.	ESPIP	RL	Battelle, PNL	P8-38	902 Battelle Blvd.	Richland	WA	99352	509-376-0458	509-372-0682
Kurath	D.E.	ESPIP	RL	Battelle, PNL	D7-43	902 Battelle Blvd.	Richland	WA	99352	509-376-6752	509-376-1876
Louie	C.S.	EM-30/RL	RL	MacTec	A5-16	825 Jadwin Ave	Richland	WA	99352	509-376-5995	509-376-8547
Matthern	G.	UST-ID	ID	EG&G/Idaho		1955 Freemont Ave	Idaho Falls	ID	83415	208-526-8747	208-526-0828
Mattus	A.J.	UST-ID	OR	Martin Marietta Energy Systems		Bethel Valley Road	Oak Ridge	TN	37831-	615-576-1795	615-576-7865
McClure	L.	ESPIP	ID	Westinghouse Idaho Nuclear Co.		2151 N. Blvd.	Idaho Falls	ID	83415-	208-526-1170	208-526-1390
McGinnis	C.P.	UST-ID	OR	Martin Marietta Energy Systems		Bethel Valley Road	Oak Ridge	TN	37831-	615-576-6845	615-574-7229
Mellinger	G.	EM-36	HQ	Department of Energy - HQ		Trevion II	Wash.	DC	20585-	301-903-7165	301-903-7604
Morrey	J.R.	ESPIP	RL	Battelle, PNL	P7-19	902 Battelle Blvd.	Richland	WA	99352	509-376-1982	509-376-0166
Nunez	L.	ESPIP	ID	Argonne National Lab		9700 S. Cass Ave	Argonne	IL	60439	708-252-3069	708-252-5246

NAME	INIT	PROG	OPS	COMPANY/ORG	MAIL	ADDRESS	CITY	ST	ZIP	PHONE	FAX
Olson	A.L.	UST-ID	ID	Westinghouse Idaho Nuclear Co.		2151 N. Blvd.	Idaho Falls	ID	83415	208-526-3852	208-526-5937
Orth	D.	ESPIP	NA	Home address-retired		124 Vivion Drive	Aiken	SC	29803	803-648-5747	None
Peschong	J.C.	EM-30/RL	RL	Department of Energy - RL	A5-16	825 Jadwin Ave	Richland	WA	99352	509-376-6687	509-376-1350
Quadrel	M.J.	UST-ID	RL	Westinghouse Hanford Co.	K6-30	2355 Stevens Dr.	Richland	WA	99352	509-376-4484	509-372-1266
Richmond	W.G.	UST-ID	RL	Battelle, PNL	P7-41	902 Battelle Blvd.	Richland	WA	99352	509-376-8195	509-376-1867
Schaus	P.S.	TWRS	RL	Westinghouse Hanford Co.	B1-59	2355 Stevens Dr.	Richland	WA	99352	509-372-2053	509-372-1533
Seeman	S.E.	ESPIP	RL	Westinghouse Hanford Co.	L0-06	2355 Stevens Dr.	Richland	WA	99352	509-376-1178	509-376-2573
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