INNOVATIVE TECHNOLOGY
Summary Report

TRUEX/SREX

Demonstration

OST Reference #347

Tanks Focus Area

MASTER

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Demonstrated at
Idaho National Energy and Environmental Laboratory
Idaho Falls, Idaho

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Innovative Technology
Summary Report

Purpose of this document

Innovative Technology Summary Reports are designed to provide potential users with the information they need to quickly determine if a technology would apply to a particular environmental management problem. They are also designed for readers who may recommend that a technology be considered by prospective users.

Each report describes a technology, system, or process that has been developed and tested with funding from DOE's Office of Science and Technology (OST). A report presents the full range of problems that a technology, system, or process will address and its advantages to the DOE cleanup in terms of system performance, cost, and cleanup effectiveness. Most reports include comparisons to baseline technologies as well as other competing technologies. Information about commercial availability and technology readiness for implementation is also included. Innovative Technology Summary Reports are intended to provide summary information. References for more detailed information are provided in an appendix.

Efforts have been made to provide key data describing the performance, cost, and regulatory acceptance of the technology. If this information was not available at the time of publication, the omission is noted.

All published Innovative Technology Summary Reports are available on the OST Web site at http://OST.em.doe.gov under "Publications."

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SECTION 1

SUMMARY

Technology Summary

The Idaho Chemical Processing Plant (ICPP) contains 11 tanks with a total of 5.6 million liters of liquid radioactive waste and 4 million liters of calcine that need to be processed. As part of a 1995 agreement between the State of Idaho, the Department of Energy, and the Department of the Navy, the tank waste at the Idaho National Engineering and Environmental Laboratory (INEEL) must be removed from the tanks by 2012. Transuranic Extraction (TRUEX) and Strontium Extraction (SREX) are the preferred processes for treating INEEL tank waste.

TRUEX and SREX efficiently separate small quantities of transuranic (TRU) elements (with TRUEX) and strontium (Sr) (with SREX) from aqueous nitrate or chloride solutions. The two processes were developed by the U.S. Department of Energy (DOE) to treat acidic wastes generated by reprocessing plant operations or *during plutonium production and purification operations.*

Figure 1 shows a sample process diagram. Waste is mixed with extractants and process solvents using centrifugal contactors under continuous, countercurrent conditions. Typically, multiple contactors are required to extract the TRU, technetium, uranium, and Sr. Additional contactors are used to remove the extractant and process solvent from the aqueous phase. When combined with a cesium separation process, the resulting solutions have sufficiently low concentrations of radionuclides to permit immobilization (the grouting process) and disposal as a non-TRU, low-level waste (LLW). The radionuclide-containing waste is vitrified and disposed off site as high-level waste (HLW).

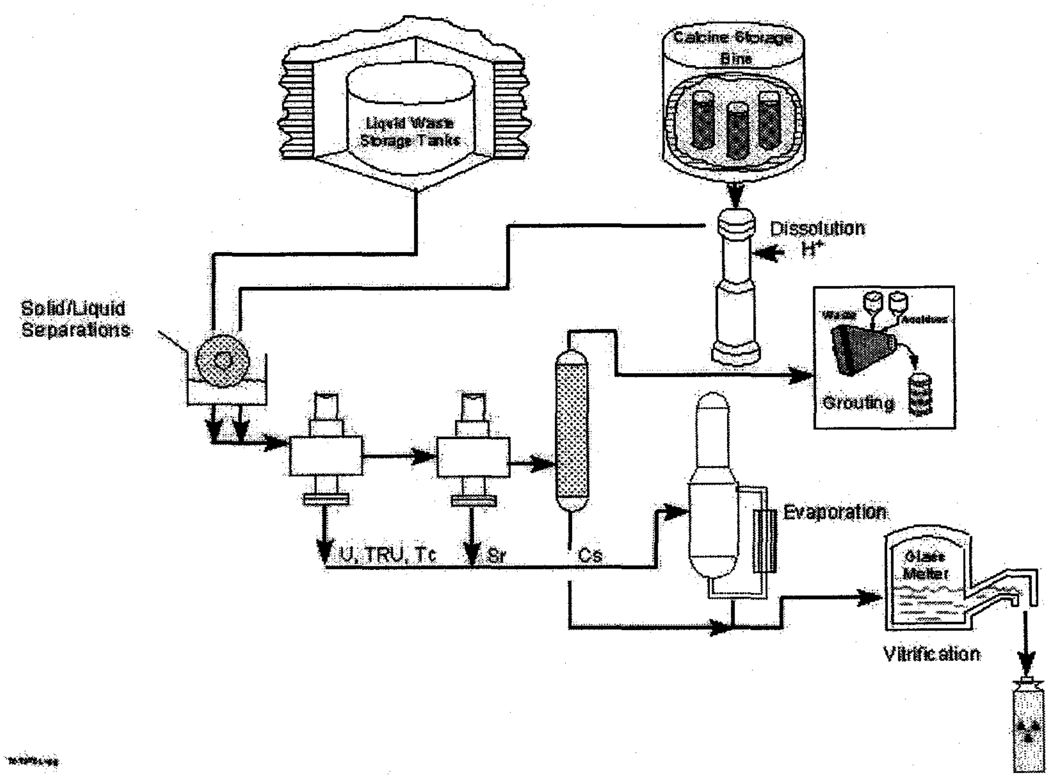

Figure 1. Schematic of the full TRUEX/SREX process.

The TRUEX and SREX processes are available for treating highly radioactive wastes at Idaho and other sites (see Table 1). Highly radioactive waste stored at Idaho is acidic liquid in stainless steel tanks. Hanford, Savannah River Site (SRS), and Oak Ridge store alkaline wastes in carbon steel tanks. Their wastes, acidic when first generated, are neutralized with chemicals to inhibit corrosion in the carbon steel tanks. Alkaline-side solvent extraction processes would use similar process equipment, but the solvents would be different. TRUEX and SREX are potential technologies for treating liquid waste following sludge dissolution, if an acid process is used.

Table 1. Tank waste summary for Hanford, INEEL, Oak Ridge, and SRS

Tank characteristics	Sites			
	Hanford	INEEL	Oak Ridge	SRS
Number of tanks	177	11 (tanks) 7 (calcine vaults)	34	51
Waste volume, megaliters	208	5.6 (tanks) 4 (calcine vaults)	1.9 (legacy) 1.5 (active/year)	126
Activity, megacuries	198	2 (tanks) 50 (calcine vaults)	0.05 (legacy) 0.013 (active)	534

At INEEL, radionuclides will be removed from high-activity liquid waste to below Nuclear Regulatory Commission (NRC) Class A LLW criteria. Without radionuclide separation, approximately 12,000 m^3 of vitrified HLW glass would be produced compared to 500 m^3 with radionuclide separation. This is more than a 95% reduction in the overall HLW volume. Other competing technologies are available (e.g., ion exchange, precipitation, other solvent extraction processes, etc.). However, they are unable to achieve the same separation efficiencies and therefore the same HLW volume reductions.

The TRUEX and SREX processes are nearly ready for large-scale application treating actual waste. Prior to the design of a facility utilizing the TRUEX and SREX processes, they must be demonstrated at the bench-scale using real waste. Hence, the DOE and personnel at the ICPP carried out hot-cell demonstrations in FY96 and FY97.

Demonstration Summary

The demonstrations for both the TRUEX and SREX processes were carried out separately in the ICPP Remote Analytical Laboratory (RAL) shielded hot cell. A 24-stage bank of 2-cm diameter, centrifugal contactors was fabricated by Argonne National Laboratory. The contactors were modified at the ICPP for remote installation and operation in the RAL hot cell. An overall removal efficiency of 99.79% was obtained for the actinides using TRUEX. An overall removal efficiency of 94% was obtained for the actinides using SREX.

The TRUEX and SREX processes will undergo further testing before full-scale processes are built. The experimental results are based on short-term testing (2-3 h). Longer testing times are needed. This technology is one of the alternatives in the HLW Environmental Impact Statement (EIS). Additionally, other sites are considering this technology through the Environmental Management Integration Effort.

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Other

All published Innovative Technology Summary Reports are available at http://em-50.em.doe.gov. The Technology Management System, also available through the EM-50 Web site, provides information about Office of Science and Technology (OST) programs, technologies, and problems. The OST Reference number for TRUEX/SREX is 347.

SECTION 2

TECHNOLOGY DESCRIPTION

Overall Process Definition

The TRUEX and SREX processes use centrifugal contactors to mix radioactive tank waste with a solvent containing an extractant. In the TRUEX process, an extractant [octyl(phenyl)-N, N-diisobutylcarbamoylmethylphosphine oxide (CMPO)] is dissolved in organic solvent. The transuranic elements are extracted into the organic phase, and the other waste components remain in the aqueous phase. The transuranic elements are subsequently stripped from the organic phase, which can then be recycled and reused in the process. Similarly, the SREX process uses a crown ether [4',4'(5')-di-(tertbutyldicyclohexo)-18-crown-6 (DtBuCH18C6)] in an organic solvent to remove strontium from a tank waste solution.

DOE demonstrated the overall operability of centrifugal contactors with the TRUEX and SREX flowsheets using actual ICPP waste. For the demonstrations, 2-cm centrifugal contactors were installed in the ICPP RAL shielded hot cell (see Figure 2). The configuration consisted of 24 stages (later reduced to 20 for TRUEX). Solution was fed to the contactors using valveless metering pumps. Surge lines, consisting of 4-in sections of 1-in stainless steel tubing, were placed on the outlet of the pumps to dampen the surging flow. Teflon or Teflon-lined Tygon tubing was used for inlet and outlet connections to the feed and receiving vessels. The feed lines were 1/8-in (outside diameter) tubing and the product lines were 3/8-in (outside diameter) tubing. An air purging system was connected to the contactor bearing housings. ICPP waste was obtained from Tank WM-183 as feed for the tests.

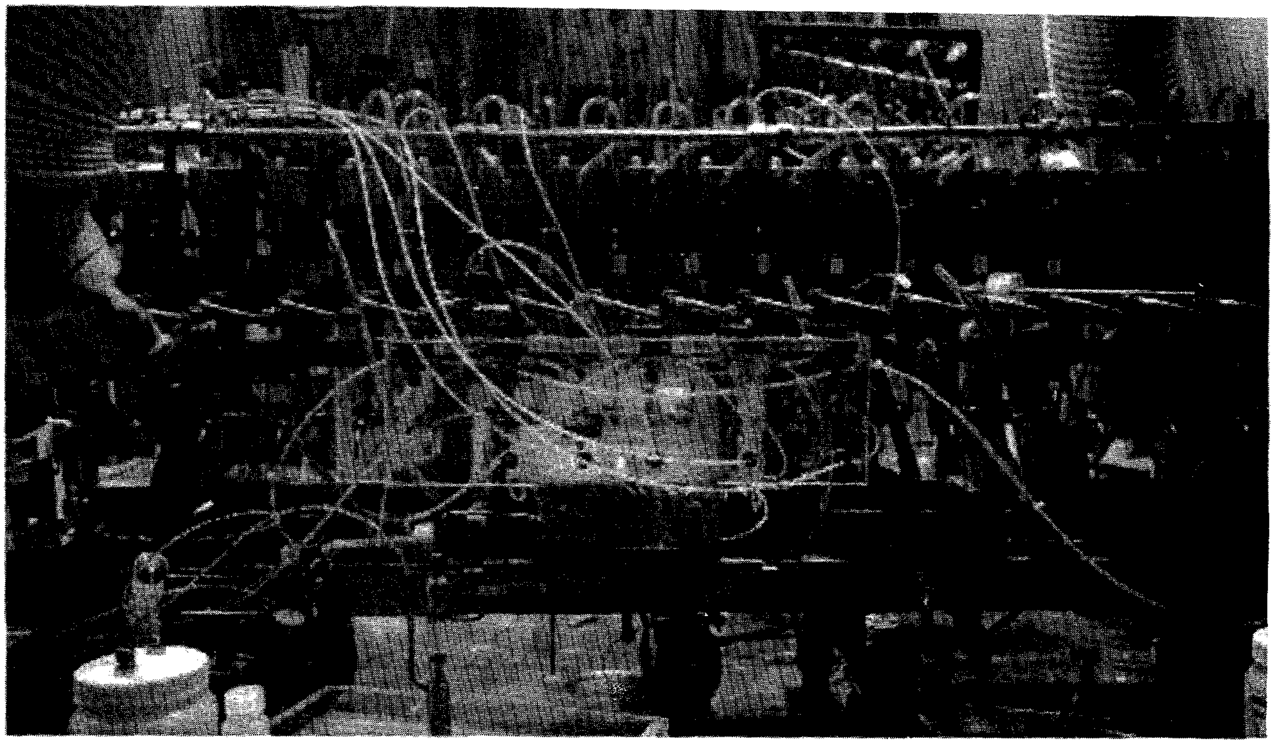

Figure 2. The 2-cm-diameter centrifugal contactors installed in the RAL shielded cell.

The TRUEX flow sheet (Figure 3) consisted of six extraction stages, four HNO_3 scrubbing stages, six stages of 0.01 M 1 hydroxyethane 1,1-diphosphonic acid (HEDPA) with HNO_3, two Na_2CO_3 wash stages, and two HNO_3 rinses. There is no benefit for the fractionation of individual actinides (i.e., Am from Pu) since all the actinides will be disposed of in the high-activity waste glass. Therefore, a gross actinide stripping agent (HEDPA) was used. The concentration of HEDPA was reduced from 0.04 M to 0.01 M for the second test to reduce the quantity of phosphorous in the HLW strip product. The presence of phosphorous in the HLW fraction will increase the quantity of HLW glass product.

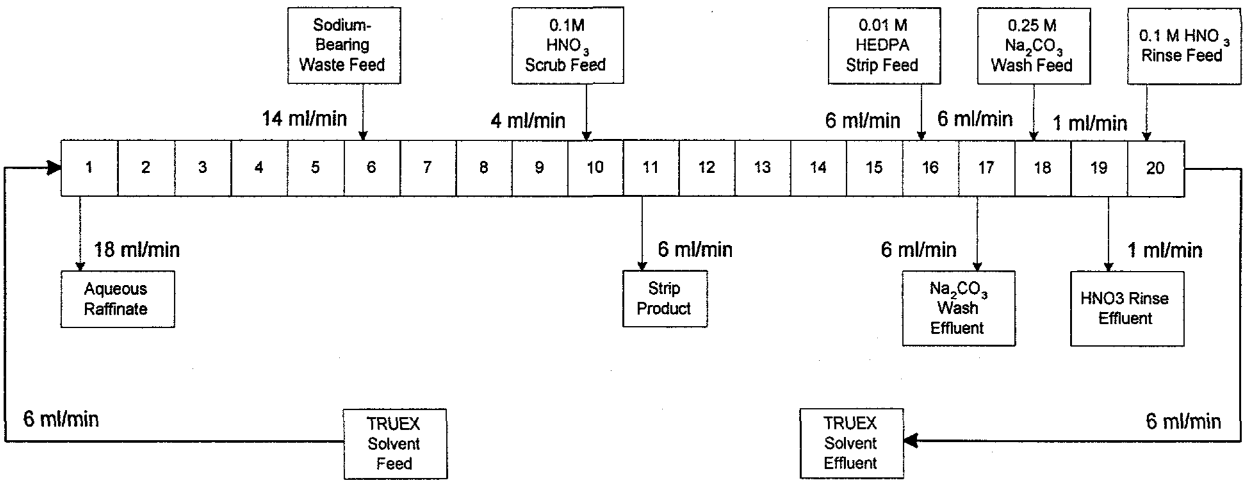

Figure 3. Flow sheet for the TRUEX process.

The SREX flow sheet (Figure 4) consisted of an extraction section (0.15 *M* DtBuCH18C6 and 1.5 *M* tributylphosphate (TBP) in Isopar-L), a 2.0 *M* HNO_3 scrub section to remove extracted K from the SREX solvent, a 0.05 *M* HNO_3 strip section for the removal of Sr from the SREX solvent, a 0.1 *M* ammonium citrate strip section for the removal of Pb from the SREX solvent, and a 3.0 *M* HNO_3 equilibration section. TBP was added to the solvent as a phase modifier to prevent third-phase formation and a paraffinic hydrocarbon was used as a diluent.

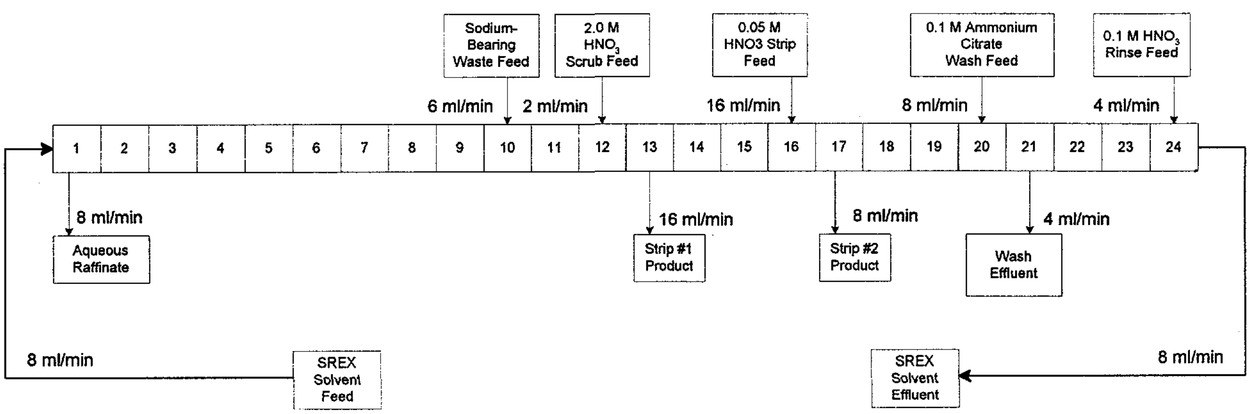

Figure 4. Flow sheet for the SREX process.

System Operation

Table 2 below summarizes the system operation requirements for performing the processes depicted in the TRUEX and SREX flow sheets.

Table 2. System operations requirements for the TRUEX/SREX processes

Special operational parameters	Due to the highly radioactive nature of the tank waste, all treatment by TRUEX/SREX was performed remotely in a hot cell. Production facilities will require shielding.
Materials, energy, other expendable items	Centrifugal contactors: The 2-cm centrifugal contactors used in these demonstrations were designed specifically for testing with the TRUEX process. Full-scale technology would require contactors between 10-15 cm in diameter. These are commercially available and would provide higher removal efficiency.
	Chemical reagents: See schematics of TRUEX/SREX. The reagents required are all available commercially.
Personnel required	The personnel operating the TRUEX/SREX processes need to have knowledge of the technology and remote handling skills.
Secondary waste stream	The process generates aqueous raffinate, strip product, wash effluent, and solvent effluent.
Potential operational concerns and risks	Remote handling is required due to the radioactive components in the tank waste and calcine.
	Tributylphosphate presents a potential explosion hazard when extended contact with highly acidic solution occurs.

SECTION 3

PERFORMANCE

Demonstration Plan

The ICPP, located at the INEEL, formerly reprocessed spent nuclear fuel to recover fissionable uranium. During the course of reprocessing, a sodium-bearing waste (SBW) stream was generated primarily from equipment decontamination between campaigns and solvent wash activities. This SBW cannot be directly calcined, thus leaving 5.6 million liters of liquid SBW temporarily stored at the ICPP in large underground storage tanks. The recommended method for treating this acidic waste is to separate the radionuclides from the waste using TRUEX and SREX. This enables the majority of the waste volume, mostly inert materials, to be disposed of as LLW. Only a small volume of extracted radionuclides requires vitrification and management as HLW.

INEEL is designing production facilities. Demonstrations with actual equipment using real waste provide the basis for the designing separation facilities to treat ICPP waste. The requirement for separations has been to achieve the NRC Class A LLW limits for liquid wastes, consisting of

- less than 10 nCi/g of alpha-emitting transuranic elements with half-lives greater than 5 years,
- less than 0.04 Ci/m^3 of ^{90}Sr, and
- less than 1.0 Ci/m^3 of ^{137}Cs.

TRUEX and SREX demonstrations conducted in FY96 and FY97 were also designed to meet the following performance objectives:

- Determine the concentrations and distribution coefficients of the actinides and the nonradioactive components at steady-state conditions for the TRUEX flow sheet.
- Determine the removal efficiencies and distribution coefficients of ^{90}Sr, the actinides, and the nonradioactive components for the SREX flow sheet.
- Determine if any precipitate or third-phase formation exist with the TRUEX/SREX flow sheets.
- Evaluate the effectiveness of the TRUEX process with the concentration of HEDPA reduced to 0.01 *M* in the strip feed.
- Evaluate the effectiveness of the SREX flow sheet in selectively stripping lead (Pb) from the SREX solvent.
- Determine the operational time required for the mass transfer in the contactors to reach steady state for the TRUEX/SREX flow sheets.

System Performance

During TRUEX flow sheet testing, 900 mL of waste from tank WM-183 was treated. The flow rate was 6 mL/min for 150 min. The SREX demonstration treated 1400 mL (14 mL/min for 100 min) of waste from tank WM-183. Both processes achieved steady state for the radionuclides being removed. Distribution coefficients were determined for most stages. Key results and observations from the demonstrations are summarized in Tables 3 and 4.

Table 3. Summary of TRUEX and SREX demonstrations from actual ICPP tank waste using centrifugal contactors in a shielded cell

Technology	Date	Radionuclide removal efficiency	Results	Other observations
TRUEX	1996	99.97% was obtained for the actinides	Reduced the actinide activity from 457 nCi/g to 0.12 nCi/g	One of the centrifugal contactors motors did not work on the scrub stage. Nitric acid and iron were not scrubbed from the solvent
TRUEX	1997	99.97% was obtained for the actinides	Reduced the actinide activity from 540 nCi/g to 0.90 nCi/g (Class A LLW criteria of 10 nCi/g)	Total number of contactor stages reduced from 24 to 20.
				Reduced concentration of HEDPA in the stripping solution from 0.04 M to 0.01 M.
				Iron and nitric acid efficiently scrubbed from the solvent.
				A precipitate formed in the strip section. Further studies should be performed to determine if a small adjustment in the concentration of HEDPA or flow rate of strip section prevents precipitate formation.
				The TRUEX solvent extracted Mercury (Hg).
SREX	1997	94% was obtained for the actinides	Reduced activity of ^{90}Sr to 0.0089 Ci/m^3 (Class A LLW limit of 0.04 Ci/m^3 for ^{90}Sr)	Flooding, precipitation, and/or third-phase formation were not observed during testing.
				Further removal of ^{90}Sr would have been observed, but centrifugal contactor contained residual contamination.
				Both Pb and Hg were extracted, but Hg could not be stripped from the solvent.

Table 4. Observed removal efficiencies from TRUEX/SREX flow sheet testing

Process	Component	Removal efficiency percentage
TRUEX	Total alpha	99.79
	^{241}Am	99.84
	^{238}Pu	99.97
	^{239}Pu	99.97
	^{235}U	99.85
	^{238}U	99.76
	K	0.06
	Na	0.07
	Fe	0.7
	Hg	74
SREX	^{90}Sr	99.995
	Pb	>95
	Pu	99.94
	U	99.6
	^{241}Am	1.9
	K	37.2
	Hg	89
	Na	0.5
	Zr	81.6
	Ba	64
	Al, B, Cd, Ca, Cr, Cs, Fe, Mn, and Ni are inextractable	

Estimates show that the waste and by-products generated by the treatment of 5.6 million liters of liquid waste and 4 million liters of calcine will include

- 500 m^3 of vitrified waste glass (HLW),
- 20,000 - 25,000 m^3 grout (LLW), and
- 1,000 gal of solvent to be incinerated.

Without radionuclide separation, approximately 12,000 m^3 of vitrified HLW glass would be produced. This is a 95% reduction in the overall HLW volume.

SECTION 4

TECHNOLOGY APPLICABILITY AND ALTERNATIVES

Competing Technologies

Currently, INEEL plans to use TRUEX and SREX processes to treat ICPP wastes. Other competing technologies are available or are undergoing development.bThe advantages of the TRUEX/SREX process over competing technologies are provided in the Table 5.

Table 5. Summary of alternatives to the TRUEX/SREX processes

Competing technologies and advantages of TRUEX and SREX:	
Ion exchange	This technology is not as effective as TRUEX/SREX because the final high level waste volume resulting from its use is much greater than the high level waste volume produced by TRUEX and SREX. Also, this technology is not as effective as TRUEX and SREX for actinide and Sr-90 removal.
Precipitation	This technology neutralizes the waste but does not completely separate the high level waste from the low level waste. The net result is an increase in the amount of waste requiring storage. This technology is also not as effective as TRUEX and SREX.
Freeze crystallization	This technology separates sodium from sodium-bearing waste. Liquid waste is calcined and then vitrified. The low activity waste is then made into grout. This technology requires calcination followed by other treatment processes and is not as cost-effective as TRUEX and SREX.
Competing solvent extraction technologies and advantages of TRUEX/CMPO:	
CMP	Carbomoyl methyl phosphonate (CMP) is no longer commercially available. The solvent is also not as strong as CMPO, so the CMP extraction process is not as efficient as the TRUEX-CMPO process.
Diphenyl-CMPO	This extractant is stronger than the CMPO used in the TRUEX process, however it is not as soluble. Diphenyl-CMPO requires a polar solvent such as nitrobenzene. TBP and Isopar are much less hazardous than nitrobenzene.

Technology Applicability

There is a potential application using the TRUEX process to additionally remove mercury from wastes. Mercury is extracted from the TRUEX solvent as $HgCl_2$. The extraction of mercury from the liquid waste is dependent upon the Cl/Hg ratio in the waste solution. The lower the Cl/Hg ratio, the less mercury will be extracted. The average ICPP waste composition has a Cl/Hg ratio of 25.5 (WM-183 feed is 4.8). Previous testing with a surrogate of composition similar to that of the average ICPP waste resulted in 97% of the mercury extracted from the waste.

A potential application of the SREX process could be to extract lead from wastes. During the SREX flow sheet demonstration, >95% of the lead was removed with the ^{90}Sr. If this process were used to extract lead, it would also be necessary to separate the lead from the ^{90}Sr. The demonstration used nitric acid to strip the Sr-90 and ammonium citrate to selectively strip lead.

Factors to consider in the scale-up of the TRUEX/SREX processes are discussed below. Future technology selection considerations will involve decisions regarding the cost of the process as compared with other competing technologies. One consideration with these technologies is that the majority of the cost is invested in the initial capital equipment.

- *Feed Stream:* The feed must be an acidic waste stream. The processes do not require an extremely detailed characterization of the feed stream. Any solids in the feed waste must be filtered out before treatment can occur.

- *Solvent:* Impurities in the TRUEX CMPO resulting from acid hydrolysis, radiolytic degradation, or residual manufacturing impurities may hinder the ability to strip the actinides from the TRUEX solvent.

- *Process Equipment:* The centrifugal contactors used in the TRUEX/SREX demonstrations were 2 cm in diameter. Larger contactors (~10-15 cm diameter) would be needed for a full-scale process. Larger centrifugal contactors are commercially available and would supply higher removal efficiency during the extraction process than mixer settlers or pulse columns. Other equipment and chemical reagents are commercially available in larger sizes and greater quantities.

- *Additional Testing:* Additional testing would be required before commencing scale-up. Previous testing has operated the process for only 2-3 h.The larger contactors would need to be tested before incorporation into a full-scale deployment.

- *Removal Efficiency:* Highest removal efficiencies are realized when both processes are used. The SREX process removed only 1.9% of the ^{241}Am. Depending on waste composition, removal of radionuclide activity to achieve Class A limits for LLW requires implementing both TRUEX and SREX.

- *Downtime:* There is no downtime affiliated with the TRUEX and SREX processes; however, if the process were to undergo any downtime for maintenance or repair, steady state would be reached less than 60 min after restarting the processes.

Patents/Commercialization/Sponsors

The primary user of this technology is DOE's Waste Management (EM-30) facilities. All equipment and chemicals used in this technology are commercially available; however, users must prepare the design specifications and assemble the equipment. The potential to commercialize the design and manufacture of full-scale, remotely operated technology will be further evaluated. Because of the uniqueness of this process and the limited customer base, commercial involvement is anticipated to be limited.

There are two patents for part of the TRUEX process which are held by Phil Horwitz et al. of Argonne National Laboratory. There are no foreign patents, and the generic TRUEX model could become copyrighted. No other patents are planned at this time.

SECTION 5

COST

Introduction

A rigorous systems analysis study at the INEEL was completed. It determined that partitioning radionuclides from acidic tank waste and calcine was the most cost effective option available for treating this waste (Murphy 1994). Although the analysis was conducted for TRUEX, the costs for SREX are assumed to be the same.

Cost Analysis

Table 6 below is a breakdown of the costs for alternative treatment methods for INEEL HLW. To determine the potential cost savings from TRUEX and SREX, four alternatives were selected. Only alternatives that included delaying the Phase II immobilization plant were considered.

Table 6. Comparison of TRUEX and SREX to other alternatives (in thousands of dollars)

	TRUEX/SREX	Precipitation and directly immobilized	Freeze crystallization and directly immobilized	No sodium separation and direct immobilized
Development	100	100	100	50
Phase I development & construction costs	500	500	500	200
Phase II development & construction costs	300	1,600	1,600	1,800
Operating costs	900	1,000	1,000	1,000
LLW disposal	200	150	150	50
HLW disposal	200	900	1,100	1,400
D&D of facilities	50	150	150	150
Total estimated cost	2,350	4,400	4,600	4,700
Potential cost savings	N/A	2,050	2,250	2,400

Cost Savings Versus Alternative Technologies

Treatment of stored waste by the TRUEX and SREX process will significantly lower the cost of final disposal. Compared to other options, by removing the radionuclides from the ICPP waste and treating the bulk as LLW, lifetime cost saving of $2 billion can be realized at INEEL alone if TRUEX and SREX are used.

SECTION 6

REGULATORY AND POLICY ISSUES

Regulatory Considerations

In 1992, the U.S. Environmental Protection Agency (EPA) and the Idaho Department of Health and Welfare filed a Notice of Noncompliance, contending the underground storage tanks at INEEL do not meet secondary containment requirements as set forth in Title 40, Part 265.13 of the Code of Federal Regulations. A recent court order based on an agreement between the State of Idaho, DOE, and the U.S. Navy committed INEEL to ceasing use of the liquid storage tanks by 2012 and removing all calcine from INEEL (in an immobilized form) by 2035. It is anticipated that TRUEX and SREX development efforts will satisfy the agreements with the State of Idaho, the Navy, and EPA. Regulatory considerations are as follows:

- *Regulatory/Permitting Issues:* Start-up regulatory/permitting requirements for TRUEX/SREX are comparable to other technologies such as ion exchange and precipitation. An exemption from a permit to construct was obtained for the demonstration to meet the State of Idaho air quality permit requirements. Tests were performed as treatability studies, and notification was made to the state at least 45 days prior to the start of testing. A National Environmental Policy Act (NEPA) categorical exclusion was obtained to conduct TRUEX and SREX testing.

- *Secondary Waste Streams:* TRUEX and SREX technologies generate minimal amounts of secondary waste. The largest secondary waste streams are spent solvents and liquid effluents.

- *CERCLA/RCRA Considerations:* These technologies are currently being considered for wastes regulated by the Resource Conservation and Recovery Act (RCRA). Treatment of wastes regulated by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) may be considered at a later date.

- *Compliance with ARARs:* The TRUEX and SREX technologies demonstrate that applicable or relevant and appropriate requirements (ARARs) can be met.

- *Reduction of Volume:* The HLW fractions produced from the TRUEX and SREX processes are of a much smaller volume and are more stable than if no treatment had been conducted. LLW volume increases; however, LLW is easier to stabilize into a form that can be disposed more safely while reducing long-term risks to human health and the environment.

- *Reduction in Mobility/Toxicity:* Although more LLW is generated from the TRUEX and SREX pretreatment activities than without it, the amount of activity in the LLW is much lower. Therefore, reduction of toxicity, mobility, and volume of HLW is more effective compared to doing no pretreatment or an alternative type of treatment.

- *Human Health and Environment:* Compared to alternative technologies, the overall protection of human health and the environment is relatively high primarily because of the minimal amount of HLW resulting from treatment and the remote handling required during treatment. Both of these factors reduce potential risks from pathways of concern such as dermal contact and inhalation.

- *Implementability:* Full-scale implementation of the TRUEX and SREX technologies is not complex. The remote handling designs and procedures already exist, all equipment and reagents are commercially available, there are people currently trained in this process, and regulatory permits can easily be obtained compared to other technologies.

- *Costs:* Costs to build and operate the TRUEX and SREX technologies are lower than alternative types of treatment considered at INEEL (see Section 5). Also pretreatment is cost-effective compared to no pretreatment. Money can be saved by not sending as much waste to the geologic repository.

- *State Acceptance:* The State of Idaho recognizes TRUEX and SREX as viable technologies that result in cheaper and safer solutions compared to other alternatives or not having pretreatment. The state also acknowledges that these technologies meet applicable regulatory guidelines. Therefore, state acceptance and continued compliance should not be an obstacle.

- *Community Acceptance:* Community acceptance of TRUEX/SREX is difficult to determine at this time. Solvent extraction is not well known by the public at large. However, the public is well-informed and tends to agree that pretreatment of HLW is a better solution than no treatment at all. Open houses have been provided to the public on solvent extraction technology at the Argonne National Laboratory and at several locations in Idaho. Positive public reaction to the technologies was noted.

- *Worker Safety:* TRUEX/SREX does not directly expose workers to hazardous or radioactive materials. The feeds are contained in a shielded or glovebox environment.

Safety, Risks, Benefits, and Community Reaction

- *Community Safety:* There is no history of accidents with these technologies. Full-scale processes would be required to comply with DOE safety policies and guidelines. It is expected that these processes will be covered by an amendment to an existing Safety Assessment Report.

- *Potential Environmental Impacts:* There is no routine release of contaminants caused by this technology. There are also no potential impacts from transportation of equipment, samples, waste, or other materials associated with this technology.

- *Other:* Additional risks, safety concerns, and socioeconomic impacts pertaining to this technology are currently being addressed in an HLW EIS.

SECTION 7

LESSONS LEARNED

Implementation Considerations

Prior to full-scale up of these technologies, longer-term testing is recommended. The longest nonstop demonstration of this technology lasted 2-3 h. A minimum of 48 h would provide data as to how the technologies would perform for actual treatment of larger volumes of waste.

Technology Limitations and Need for Future Development

Production facilities require shielding and must be remotely operated. Any solids in the feed waste must be filtered out before treatment can occur. Treatment of alkaline wastes will require additional demonstrations and the use of different solvents.

Operability problems are not anticipated. During a TRUEX demonstration in 1996, one of the centrifugal contactors was not working, causing the scrub feed to overflow with the solvent into the strip section and effectively eliminating the scrub section. This event prevented the scrubbing of nitric acid and iron from the solvent. Although a contactor did not operate, it did not greatly affect the volume or stability of the waste. Therefore, if a centrifugal contractor does not operate, it will be a minimal concern. Also, the risk of a centrifugal contactor not operating is greatly reduced at full-scale operation. Full-scale contactors are larger, more robust, and more reliable than smaller-scale contactors.

Although not part of the objectives for past demonstrations, the TRUEX/SREX technologies demonstrated that they are effective in removing mercury and lead from HLW streams. However, before TRUEX and SREX become viable lead and mercury treatment options, the following must be considered:

- When treating mercury with TRUEX, the chemistry of solution is important. Some chloride in the waste stream is important. Mercury complexes with the chloride and will extract in process as a chloride.
- The waste must also be acidic. Therefore some amount of nitric acid may be necessary to extract lead and mercury effectively.

APPENDIX A

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APPENDIX B

LIST OF ACRONYMS

ARAR	applicable or relevant appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMPO	octyl-(phenyl-N,N-diisobutyl carbamoyl) methyl phosphine oxide
DOE	Department of Energy
EIS	Environmental Impact Statement
EM	Environmental Management
EPA	Environmental Protection Agency
HEDPA	1 hydroxyethane 1,1-diphosphonic acid
HLW	high level waste
ICCP	Idaho Chemical Processing Plant
INEEL	Idaho National Engineering and Environmental Laboratory
LLW	low level waste
NEPA	National Environmental Policy Act
NRC	National Regulatory Commission
OST	Office of Science and Technology
RAL	Remote Analytical Laboratory
RCRA	Resource Conservation and Recovery Act
SBW	sodium-bearing waste
SREX	Strontium Extraction
SRS	Savannah River Site
TBP	Tributylphosphate
TRU	Transuranic
TRUEX	Transuranic Extraction