

Appendix B

Alternative Selection Process

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Appendix B

Alternative Selection Process

This appendix is a summary of the process used to identify the alternatives found in this EIS. Of particular importance is Section B.9. Sections B.9.1 and B.9.2 describe the process used to identify the Decision Management Team's recommended preferred alternative. Section B.9.3 describes the Decision Management Team's recommended alternative, DOE's preferred alternative, and the State of Idaho's preferred alternative.

B.1 Introduction

The U.S. Department of Energy (DOE) is preparing the Idaho High-Level Waste and Facilities Disposition Environmental Impact Statement (Idaho HLW & FD EIS), in accordance with the National Environmental Policy Act (NEPA), to support the HLW decision-making process at the Idaho National Engineering and Environmental Laboratory (INEEL) formerly called the Idaho National Engineering Laboratory or INEL. Under NEPA in 40 CFR 1502.14(a), an EIS must "rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated."

The Notice of Intent for the Idaho HLW & FD EIS (62 FR 49209; September 19, 1997) identified three initial alternatives for managing the HLW at INEEL: the Proposed Action or Separations Alternative, No Action Alternative, and Non-Separations Alternative. *Since the issuance of the Notice of Intent and in the course of public scoping and review of public comments that include Tribal issues, private sector industry, State of Idaho, and agency comments on the Draft Idaho HLW & FD EIS, DOE has added a number of alternatives or options.*

B.2 Purpose

The purpose of this appendix is to describe the selection process that DOE employed to identify a range of reasonable waste processing alternatives for the Idaho HLW & FD EIS, including the identification and application of the criteria for assessing the validity of candidate alternatives.

The Council on Environmental Quality regulations direct all Federal agencies to use the NEPA process to identify and assess the reasonable alternatives to proposed actions that would avoid or minimize adverse effects of these actions upon the quality of the human environment [40 CFR 1500.2(e)]. These regulations further state that "reasonable alternatives include those that are practical or feasible from a common sense, technical, or economic standpoint. The number of reasonable alternatives considered in detail should represent the full spectrum of alternatives meeting the agency's purpose and need; but an EIS need not discuss every unique alternative, when an unmanageable number is involved."

The primary steps of the alternative selection process are:

- Review previous HLW management studies, DOE EISs, technical literature, industry recommendations, and stakeholder comments
- Identify an initial list of candidate alternatives
- Review engineering studies and public input
- Revise initial set of candidate alternatives based on recent studies and **public** input following the Notice of Intent and scoping meetings
- Identify screening criteria to evaluate the candidate alternatives
- Describe criteria that were used to assess each alternative
- Apply the screening criteria to each candidate alternative
- Select the recommended set of candidate alternatives

B.3 Identification of Candidate Alternatives

B.3.1 ANALYSIS OF PREVIOUS INEEL AND OTHER HLW DOE STUDIES

"Historical Fuel Reprocessing and HLW Management in Idaho" (Knecht et al. 1997)

A summary of historical fuel reprocessing and waste management at the Idaho Nuclear Technology and Engineering Center (INTEC) (formerly called the Idaho Chemical Processing Plant or ICPP) appeared in Radwaste Magazine (Knecht et al. 1997). The article outlines some of the early technology development work at INTEC and includes 40 references related to waste forms produced from calcine, such as metal spray coating, grout matrix, metal matrix, glass, and ceramic. Early studies were also carried out in calcine retrieval, calcine dissolution, calcine stabilization, and transuranic element separation. In many cases, results of early technology development work were used to develop pre-conceptual design and costs. The design information supported the INEEL portion of a number of complex-wide defense waste management studies under the Atomic Energy Commission and the Energy Research and Development *Administration*, predecessors to DOE.

Alternatives for Long-Term Management of Defense High-Level Waste, Idaho Chemical Processing Plant, ERDA 77-43 (ERDA 1977)

This INTEC report evaluated and provided cost and risk estimates for three alternatives: (1) retain the waste at INTEC in retrievable storage facilities; (2) ship the waste to a geologic repository; and (3) remove (separate) the actinides, ship the actinides to a geologic repository, and store the remaining waste at INTEC. Waste form options under these alternatives included calcine pelletization, metal matrix, and sintered glass ceramic to span the range of calcine, concrete, metal, glass and ceramic waste forms.

Environmental Evaluation of Alternatives for Long-Term Management of Defense High-Level Radioactive Waste at the ICPP, IDO-10105 (DOE 1982a)

The subject evaluation considered four alternatives: (1) calcine all waste and leave calcine in place (no action); (2) retrieve, modify the calcine, and dispose of modified calcine at INEEL; (3) retrieve, separate the actinides, dispose of the actinides offsite, and dispose of the remaining waste at INEEL; (4) delay retrieval, modify the calcine, and dispose of the calcine offsite. In this study the waste form options included calcine, glass or pelletized calcine, glass or stabilized calcine, glass for actinides, and calcine for onsite disposal.

Long-Term Management of Defense High-Level Radioactive Wastes [Research and Development Program for Immobilization], Savannah River Plant, DOE/EIS-0023 (DOE 1979)

From 1970 to 1983 events outside of INEEL, such as waste-form research at DOE's Savannah River Site (SRS) influenced the INEEL HLW research and development program. As a result, DOE HLW management became focused on treating wastes first at SRS, then Hanford Site, and finally Idaho. In 1977, DOE issued *the long-term management* EIS for HLW immobilization research and development. That EIS evaluated a number of potential HLW forms, and a follow-on environmental assessment selected borosilicate glass as the preferred form (DOE 1982b).

The Defense Waste Management Plan, DOE/DP-0015 (DOE 1983)

This plan established a schedule for waste treatment and assumed that the Savannah River Site and Hanford Site would vitrify their HLW. INEEL was assumed to construct a new facility to immobilize newly generated liquid waste as well as calcined HLW with annual production of approximately 500 HLW canisters. This plan provided estimates of HLW volumes to be gen-

erated through 2015. Subsequently, the DOE-Idaho Operations Office completed the study (DOE 1983) in 1983 to evaluate reducing waste volumes by more efficient fuel processing methods.

ICPP Tank Farm System Analysis
(WINCO-1192) (WINCO 1994)

This Tank Farm study proposed 14 variations of HLW separations alternatives. These alternatives differ with respect to the start of separations and immobilization operations, the number of calcining campaigns required, and various calcine pretreatment and treatment technologies. The conclusion was that the separations variations produced significant differences in calcine processing rates, bin set storage requirements, and final waste forms. This study underscored the advantages of a separations alternative and brought out the possibility of HLW calcine vitrification as a viable non-separations option.

SBW Treatment Study,
WBP-8-95/ALO-3-95 (LITCO 1995a)

This study evaluated options for meeting the Notice of Noncompliance Consent Order to cease use of the INTEC pillar and panel tanks and the remaining tanks in the Tank Farm. The study addressed 15 separations and non-separations alternatives. The separations alternatives used an evaporation precipitation technique to reduce the sodium content of the SBW prior to calcining; the separations options also included cesium, strontium, and transuranic extraction methods for separating the high-activity fraction from the low-activity fraction. The non-separations alternatives focused on improving the calcine process by high-temperature operation or using additives such as aluminum nitrate, silica, and sugar to reduce the SBW volume. The study

also included an alternative to ship all the concentrated SBW to Hanford for interim storage and processing.

ICPP Radioactive Liquid and Calcine Waste Technologies Evaluation Technical Report and Recommendation, INEL-94/OO19
(LITCO 1995b)

The purpose of this evaluation was to support DOE in developing a strategic plan to manage INTEC radioactive liquid and calcined waste by presenting performance data for candidate alternatives. The study addressed 27 alternatives for waste treatment including both separations and non-separations techniques. These alternatives varied with respect to facilities, SBW treatment, calciner operations, and calcine treatment. Screening against six criteria led to radionuclide partitioning as one of the top options to be considered. The report recommended a two-phased implementation of a high-activity waste immobilization plant to spread the funding requirements over a longer time period.

HLW Alternatives Evaluation,
WBP-29-96 (LITCO 1996)

This study reviewed calcination and separations to determine the best path forward for INTEC HLW management. Both approaches *would* meet the Settlement Agreement/Consent Order and are technically feasible; the primary discriminator is cost. These approaches were developed into three basic options: (1) calcination of HLW until June 1998 and SBW until 2012; (2) calciner shutdown in 2001, radionuclide separation/grouting beginning in 2010, and calcine retrieval, dissolution, and separation commencing in 2015; and (3) separations and shipping of the high-activity waste offsite for immobilization and storage.

Regulatory Analysis and Proposed Path Forward for the Idaho National Engineering Laboratory High-Level Waste Program, DOE/ID-10544 (DOE 1996)

This report *is* a HLW regulatory analysis of the radionuclide constituents, identification of Resource Conservation and Recovery Act (RCRA) hazardous constituents, and plans for closure of the INTEC Tank Farm and bin sets. The report offered four major alternatives for consideration: no action, planning basis (DOE 1998), full treatment (separations), and limited vitrification.

B.3.2 CONSIDERATION OF PUBLIC COMMENTS

DOE conducted public scoping workshops on the Idaho HLW & FD EIS on October 16, 1997 in Idaho Falls, Idaho and on October 23, 1997 in Boise, Idaho. These public workshops and written scoping comments provided DOE public input about issues and potential alternatives that should be addressed in the Idaho HLW & FD EIS.

DOE also received scoping comments from the State of Idaho INEEL Oversight Program (Trevor 1997), the State of Nevada Nuclear Waste Project Office (Loux 1997), and the INEEL Citizens Advisory Board (Rice 1997). All public comments were considered in developing the candidate alternatives for the Idaho HLW & FD EIS. A summary of the major *public* concerns appears in the next section; a list of new or modified alternatives obtained from the public inputs is shown later in *this appendix*.

B.3.2.1 Overall Public Concerns

Treatment Criteria - At this time, there is considerable uncertainty regarding the proposed repository at Yucca Mountain and the final technical standards for wastes to be disposed of there. Given those uncertainties, determine what criteria DOE should use to establish that the waste form(s) produced are suitable for disposal in a geologic repository outside the State of Idaho (i.e., that a "road-ready" waste form has been achieved).

Disposal - If a geologic repository is not available, determine what other disposal options exist for HLW outside the State of Idaho.

Storage/Disposal in Idaho - Clearly examine and explain any proposal to store or dispose of treated waste over the Snake River Plain Aquifer, including performance-based or landfill closure of the Tank Farm as opposed to clean closure.

Hazardous Constituents - Develop a strategy for dealing with RCRA-regulated hazardous constituents.

Technical Viability/Privatization - Demonstrate in advance that the alternative selected will work.

Cost-risk Benefits - The alternative selected should reduce health and safety risks enough to justify the cost of treatment and any additional risk to workers posed by the treatment activities.

Funding - Cleanup of the INEEL site is important, and the Federal government should seek adequate funding to honor its commitments to do so.

Compliance Concerns - Numerous, and in some cases conflicting, compliance requirements exist for INEEL HLW management and facilities disposition activities. These conflicts should be clarified, and the compliance factors prioritized.

B.3.2.2 Public Comments Applied to Alternative Development

The following comments relate to new or modified alternatives resulting from *public* input. DOE considered these comments when preparing the list of Idaho HLW & FD EIS candidate alternatives.

- Include a true no action alternative-i.e. lock up and walk away.
- Postpone any action until waste decays to non-harmful levels, better technologies are developed, or disposal sites are identified.

- Calcine now, store *the calcine* onsite, and treat *the calcine* later when DOE disposal sites are available.
- Fully review options for disposing of INEEL HLW onsite in Idaho.
- Dispose of high-activity and low-activity waste offsite, such as in a new repository.
- **Provide long-term storage of** both high-activity and low-activity waste onsite.
- **Remove** the transuranics *from the* HLW, dispose of **TRU** at the Waste Isolation Pilot Plant, and dispose of the *high-activity fraction* at INEEL.
- Identify alternatives for bin set and Tank Farm closure including clean closure of HLW tanks.
- Consider a wide range of separations technologies.
- Vitrify all HLW before or after calcination.
- Consider technologies from other sites and countries.
- Ship HLW *elsewhere* for treatment and long-term storage such as the Nevada Test Site in Nevada.
- Explore volume reduction, filtration, and encapsulation technologies.
- Modify the No Action Alternative to include placement of calcine in closed INTEC tanks.
- Analyze treatment and disposal alternatives separately.
- Develop alternatives for facility disposition.
- Analyze all waste in all bin sets and tanks *to determine* all hazardous constituents.
- Use the same process the Hanford Site is using for waste immobilization.

- Don't let Yucca Mountain waste volume restrictions drive technology development; the Yucca Mountain repository may never open.

B.3.3 CANDIDATE ALTERNATIVES

DOE's first step in conducting the candidate alternative selection process was to review previous DOE and INTEC HLW studies as described earlier in this appendix. The *review* included five major INTEC waste treatment studies conducted between January 1994 and September 1997 and helped to ensure that DOE *considered* all reasonable and viable alternatives. Potential alternatives were then identified through a systematic, iterative process that used several sources including: (1) previous INTEC HLW studies, (2) value engineering sessions, and (3) *public* comments received during the Idaho HLW & FD EIS scoping process.

B.3.3.1 Alternatives Considered for Initial Analysis

This process resulted in an initial set of potential candidate alternatives for consideration in the Idaho HLW & FD EIS. The candidate alternatives include waste processing, interim storage, transportation, and final disposal options. It is important to note that each candidate alternative is composed of individual process stages (e.g., HLW treatment, interim storage, and/or disposal of low-activity grout) that are independent. Therefore, each candidate alternative is a combination of possible process stages that may be modified. This modular approach will allow DOE greater programmatic flexibility in implementing the HLW alternatives and coordinating programs and technologies from other DOE sites. DOE identified the following waste processing alternatives and options for initial EIS screening, analysis, and evaluation.

1. No Action Alternative (as described in the Notice of Intent)
2. Separations Alternatives
 - A. Full Separations
 - B. 2006 Plan

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- C. Transuranic Separations/Class A Grout
- D. Transuranic Separations/Class C Grout
- 3. Non-Separations Alternatives
 - A. Vitrified Waste
 - B. Hot Isostatic Pressed Waste
 - C. Cement-Ceramic Waste
 - D. Direct Cement Waste

Additional information concerning these candidate alternatives considered for initial analysis is provided in DOE (1999a).

B.3.3.2 Alternatives Not Considered for Initial Analysis

Several candidate alternatives were eliminated from initial EIS analysis. These alternatives were not considered for one or more of the following reasons: (1) did not meet the purpose and need of the EIS, (2) required significantly more development work to achieve technical maturity, (3) was very similar to or was bounded by other alternatives, or (4) was judged to be impractical or too costly for consideration.

Alternatives Rejected for Technological Reasons

- In situ vitrification
- Upgrading tanks for long-term storage
- Use of Hanford crystalline silicotitanate technology
- Storage of wastes in long-lasting concrete containers
- Homogenization and mixing of various wastes (i.e., slurry)
- Use of small solid units to fill tanks versus poured liquids

Alternatives Rejected That Do Not Support the EIS Purpose and Need

- Treatment of Argonne National Laboratory-West spent nuclear fuel at INTEC
- Burning of HLW in a reactor such as the Integral Fast Reactor
- Importing other sites' HLW to INEEL for treatment and interim storage
- Use of old INTEC facilities as a second HLW repository

B.4 Evaluation of Candidate Alternatives

The primary purpose of this preliminary EIS alternative evaluation was to evaluate the candidate alternatives identified in Section B.3 and identify a reasonable set of alternatives for the Idaho HLW & FD EIS. The secondary purpose of this alternative evaluation *was* to provide a sound, traceable, and defensible process to support the final selection of Idaho HLW & FD EIS alternatives. These alternatives provided for the treatment, storage, and disposition of HLW and SBW currently managed at the INTEC.

B.4.1 EVALUATION METHODOLOGY

The methodology for the identification of the candidate alternatives was based upon a comprehensive evaluation of all potential alternatives with respect to six essential Idaho HLW & FD EIS criteria (see next section). A DOE team of experienced personnel, who qualitatively assessed each alternative against the criteria, performed the evaluation. The DOE Team was asked to recommend reasonable candidate alternatives with high potential to meet the criteria.

Prior to the evaluation of the candidate alternatives, DOE reviewed *the studies listed in Section B.3.1*. The team focused on identifying important program considerations, *public* sensitivities, and related waste management data that would help evaluate potential alternatives with respect to each criterion.

The DOE Team then systematically applied the criteria to all candidate alternatives to assess how well each alternative met the program goals and **public** concerns. The assessment of each alternative with respect to each criterion was done on a qualitative basis. Each alternative was given one of three ratings for each criterion as shown in Table **B-1**.

After reviewing the reference materials and conducting a structured **assessment**, the DOE Team rated all candidate alternatives with respect to each of the six evaluation criteria. Then the team **determined** an overall rating for the alternatives with respect to each criterion. The team addressed each criterion in turn to ensure that all essential elements of each criterion were assessed and that the final qualitative ratings represented a team consensus.

The DOE Team completed **the** final analyses to determine which alternatives were considered

reasonable and retained as an EIS candidate alternative. The team made a diligent effort to include a **range of** reasonable alternatives with potential to satisfy DOE program requirements and public concerns.

The DOE Team also **identified** potential new alternatives that were not included in the initial set of candidate alternatives. The team accomplished this by reviewing the processes involved in selecting the initial set of candidate alternatives, then applying their knowledge of HLW management technologies. This process resulted in the identification of the following additional alternatives for evaluation: (1) a No Action Orderly Shutdown Alternative, and (2) an Early Vitrification Option under the Non-Separations Alternative. The team then evaluated these two additional alternatives against the evaluation criteria described below.

Table B-1. Candidate alternatives.

Candidate alternative	Rating					
	Mission	Cost	Technical Feasibility	ES&H	Public Concerns	Program Flexibility
1. No Action						
1A Notice of Intent	-	0	+	0	-	+
1B Orderly Shutdown	-	+	+	-	-	-
2. Separations						
2A Full Separations	+	0	+	0	0	0
2B 2006 Plan	+	-	+	-	0	0
2C Transuranic Separations/ Class A Grout	+	0	+	0	0	0
2D Transuranic Separations/ Class C Grout	+	0	+	0	+	0
3. Non-Separations						
3A Vitrified Waste	+	-	+	0	+	-
3B Hot Isostatic Pressed Waste	0	0	+	-	0	-
3C Cement-Ceramic	0	0	-	-	0	-
3D Direct Cement	0	0	+	0	0	-
3E Early Vitrification	+	-	0	0	+	-

Plus (+) = Expected to satisfy the criteria with minor deficiencies or concerns

Zero (0) = Expected to satisfy the criteria with some deficiencies or concerns

Minus (-) = Expected to satisfy the criteria with major deficiencies or concerns

B.4.2 EVALUATION CRITERIA

A major step of the evaluation methodology was to develop selection criteria. DOE developed the screening criteria to be used for selecting the set of alternatives. First, DOE determined the criteria should have the following attributes:

- Defensible, and clear to all parties
- Appropriate for waste processing alternative evaluation
- Limited to major program considerations and **public** concerns
- Easily evaluated by qualitative methods and analysis
- Inclusive of all major areas of concern and program viability

DOE then reviewed the selection criteria used in previous HLW studies and two recent DOE Environmental Impact Statements: the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement* (SNF & INEL EIS) (DOE 1995) and the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997a). **As a result, DOE developed the following criteria:**

- **Program Mission**
- **Cost Factors**
- **Technical Feasibility**
- **Environment, Safety, and Health**
- **Public Concerns**
- **Program Flexibility**

B.4.3 APPLICATION OF CRITERIA TO CANDIDATE ALTERNATIVES

B.4.3.1 Program Mission

The Program Mission criterion is essential to assessing capability of the alternatives to meet DOE complex-wide and INEEL HLW program objectives, major regulatory milestones, and legal obligations. Table B-1 presents the ratings of the candidate alternatives against this criterion.

For the Program Mission criterion, both options under the No Action Alternative were assessed minus (-) ratings. These alternatives do not meet the Settlement Agreement/Consent Order requirement to have all HLW road ready by 2035, and they do not address the long-term issue of removing all HLW from the State of Idaho, nor does the Orderly Shutdown Option meet the requirement to complete calcination of liquid SBW by 2012.

All four separations alternatives were assessed a plus (+) rating with minor deficiencies or concerns. Since the separations concept was driven by program mission requirements to reduce HLW disposal volume, the high ratings were expected. The separations options may lower the HLW volume for repository disposal to minimize transportation risk and cost, and they are consistent with DOE planning documents such as the Environmental Management Contractor Report (EMI 1997), *Accelerating Cleanup: Paths to Closure* (DOE 1998), and NEPA Records of Decision (RODs), with minor exceptions.

Under the Non-Separations Alternative, the Vitrified Waste and Early Vitrification Options were assessed a plus (+) rating because both would meet the essential requirements of the Settlement Agreement/Consent Order and produce a final waste form (borosilicate glass) that has a high probability of acceptance at a geologic repository. The other three options under the Non-Separations Alternative were assessed a zero (0) rating with some deficiencies or concerns. All three options would require a determination of equivalency by the U.S. Environmental Protection Agency (EPA).

B.4.3.2 Cost Factors

Inclusion of the Cost Factors criterion was considered essential because this EIS proposes a DOE Federal project that would be supported by **Congressional appropriations**. This cost criterion includes consideration of life-cycle costs, ten-year costs, peak funding requirements, and the results of an independent risk-based cost study. The cost estimates of the risk-based study are contained in Section 5.0 of DOE (1999a). Table B-1 presents the ratings of the candidate alternatives against this criterion.

All the candidate options, except Orderly Shutdown, 2006 Plan, Vitrified Waste, and Early Vitrification, were deemed equivalent with respect to cost and received the zero (0) rating with some deficiencies or concerns. No cost estimates were available for the Orderly Shutdown Option, but it was given a plus (+) rating because of the obvious minimal costs for an orderly shutdown of INTEC facilities. The 2006 Plan Option under the Separations Alternative was considered more expensive than the other separations options **and assigned a minus (-) rating to reflect the potential cost** due to the calcination of both HLW and SBW and the subsequent calcine dissolving, separating, and processing the waste fractions into final waste forms.

With respect to the Non-Separations Alternatives, the Vitrified Waste Option was judged to have a higher life-cycle cost due to the high cost of a vitrification facility, the greater volume of material to be vitrified, and the greater amount of vitrified HLW to be transported to a geologic repository. No cost estimates were available for the Early Vitrification Option since it was a late entry to the candidate list. However, the Early Vitrification Option was assessed as more costly and assigned a minus (-) rating to reflect the potential cost of a vitrification facility and greater volumes of HLW compared to the Separations Alternative.

B.4.3.3 Technical Feasibility

Technical Feasibility or technical risk is a primary criterion to assess the capability of an alternative to meet the planned HLW program goals and milestones. Some alternatives may be more

easily implemented due to use of proven technologies or the availability of well-developed processes. For alternatives that require new, unproven technologies, the team assessed the state of development (i.e., research and development, advanced development, or full-scale testing) and whether or not the proposed process **would** require a technical breakthrough or further testing and modification. Table B-1 presents the ratings of the candidate alternatives against this criterion.

The DOE Team concluded that both options under the No Action Alternative should receive a plus (+) rating because they rely solely on facilities and processes that are currently operational and require no major high-risk modifications. Therefore, the technical risk associated with these alternatives should be very low.

The team also noted that all four options under the Separations Alternative use the same proven dissolution, separations, vitrification, and grouting technologies. All these separations treatment technologies are well developed **and** have been successfully demonstrated throughout the DOE complex and industry. The current DOE HLW treatment at the Savannah River Site Defense Waste Processing Facility and at the West Valley Demonstration Project evidences the technical maturity of the vitrification process. **Because the Separations Alternative includes vitrification as an option, which is technically mature, it** received a plus (+) rating.

Under the Non-Separations Alternative, the Vitrified Waste, Hot Isostatic Pressed Waste, and Direct Cement Waste Options all received a plus (+) rating due to incorporation of well developed, demonstrated technologies at INEEL. The Early Vitrification Option was assessed a zero (0) rating because of the unknowns associated with the vitrification of SBW.

The Cement-Ceramic Option received a minus (-) rating due to the high-risk treatment process, (i.e., calcination of SBW/calcine slurry in the New Waste Calcining Facility). The New Waste Calcining Facility, designed to process a liquid feed, would have to undergo major modifications to process the slurry mixture. No research and development work has been done to demonstrate the feasibility of calcining this slurry feed in the New Waste Calcining Facility.

B.4.3.4 Environment, Safety, and Health

The Environment, Safety, and Health criterion focuses on the risk of radioactive and hazardous materials emissions, potential migration into the Snake River Plain Aquifer, waste volume produced, potential worker exposure during operations, and complex process hazards. Table B-1 presents the ratings of the candidate alternatives against this criterion.

Based on preliminary worker risk data (DOE 1997b), the Orderly Shutdown, 2006 Plan, Hot Isostatic Pressed Waste, and Cement-Ceramic Options were considered least acceptable due to increased worker risk as compared to the other alternatives and received a minus rating. The increased worker risk for the 2006 Plan, Hot Isostatic Pressed Waste, and Cement-Ceramic Alternatives was attributed to longer periods of hazardous activity and more complex and higher risk processes. In the case of the Orderly Shutdown Alternative, the liquid SBW in the Tank Farm and the HLW calcine in the bin sets, to be left indefinitely at the INTEC, increased worker and environmental risk. For these reasons these options were all assessed a minus (-) rating.

Based on the limited amount of definitive information (only worker risk data) available to the team, the remaining alternatives received a zero (0) rating because of minimal worker risk and insufficient information to rank the alternatives in the other sub-elements of Environment, Safety, and Health.

B.4.3.5 Public Concerns

Considerations for the **Public Concerns** criterion were obtained from comments *received by DOE* during the EIS scoping period. The sub-elements of the **Public Concerns** criterion include final HLW form, disposal sites, aquifer impacts, waste acceptance criteria at the proposed geologic repository, definition of SBW, equity with respect to other DOE sites, HLW transportation, and tribal cultural and historic resources. Table B-1 presents the ratings of the candidate alternatives against this criterion.

The DOE Team assigned a minus (-) rating to both options under the No Action Alternative because neither alternative addresses the widespread opposition to long-term storage or disposal of HLW above the Snake River Plain Aquifer. Also, the alternatives do not meet the Settlement Agreement/Consent Order requirement to have all INEEL HLW road ready by 2035.

Under the Separations Alternative, the team assigned the Full Separations, 2006 Plan, and Transuranic Separations/Class A Grout Options a zero (0) rating because of several concerns. These concerns include the long time estimated for the treatment processes, possible transportation for offsite treatment, health and safety of workers, and potential lack of a disposal facility that would accept INEEL HLW.

The Transuranic Separations/Class C Grout Option was given a plus (+) rating due to the possibility of eliminating the need for disposal of the HLW at the geologic repository. This is due to the planned classification of the high-activity fraction as transuranic waste, which would be eligible for disposal at the Waste Isolation Pilot Plant. Also, this option addresses the **public** concern of meeting the Settlement Agreement/Consent Order milestones. Both Transuranic Separations options would require an "incidental waste" determination.

Under the Non-Separations Alternative, the team gave the Vitrified Waste and Early Vitrification Options a plus (+) rating. These options respond to concerns of reducing worker risk (no separations activities) and expediting vitrification, which produces the acceptable waste form for disposal in a geologic repository.

The team gave zero (0) ratings to the Hot Isostatic Pressed Waste, Cement-Ceramic, and Direct Cement Waste Options to reflect the concerns for technical complexity of the treatment processes and their capability to meet the waste acceptance criteria at the disposal site. Moreover, these options would require additional research and development before the EPA could determine waste form equivalency to borosilicate glass.

B.4.3.6 Program Flexibility

Program Flexibility is an attribute of program management that allows critical funding decisions to be made in a logical, phased approach. Thus, critical decisions to implement costly programs could be done in a serial, time-phased manner to assess results of the initial phases or to allow time for technical maturity. The key to program flexibility is to minimize the number of irrevocable funding commitments at the early stages of a program. Table B-1 presents the results of the team's ratings of the candidate alternatives against this criterion.

The No Action Alternative *published in the Notice of Intent* was assessed a plus (+) rating with minor deficiencies because it is a short term, business-as-usual alternative with no significant changes in operations and requires no new facilities. Therefore, this option has high program flexibility with respect to cost and schedule because no processes or facilities that require early funding commitments would be needed.

All four options under the Separations Alternative were assigned a zero (0) rating with some deficiencies or concerns. These separations options require early funding commitments for the new separations facility, which reduces program flexibility in the near-term. However, the options under the Separations Alternative have high program flexibility in the long-term because the HLW is separated into high-activity and low-activity waste fractions that allow several immobilization and disposal options to be considered at later stages of the program.

The five options under the Non-Separations Alternative were considered to be relatively inflexible compared to the No Action and Separations Alternatives. These five options were assessed a minus (-) rating with major deficiencies or concerns. These concerns relate to the early program commitments to SBW calcination, SBW and calcine retrieval, HLW immobilization, HLW interim storage, and the potential need to construct a new vitrification facility at INEEL.

B.5 Evaluation Summary and Results

Based on the preliminary criteria ratings, the DOE Team completed the final analyses to determine which options *were* considered reasonable and worthy of being retained on the *Draft Idaho HLW & FD EIS* Candidate Alternative List. Options with all pluses (+) would be top candidates. Options with pluses and zeroes were also considered candidates. However, options with more zeroes than pluses triggered additional analysis to ensure the zero ratings were not indications of inherent weaknesses. Options rated with one or more minuses were re-evaluated to determine if the minus ratings were significant enough to eliminate them. If the minus ratings indicated large areas of uncertainty, the evaluators reduced the uncertainty by obtaining and reviewing additional data.

The team made a diligent effort to include a *range of* reasonable options with the potential to satisfy DOE program requirements and concerns of *the* public.

Table B-2 shows the total criteria ratings achieved by all the candidate alternatives during the alternative evaluation discussed in the previous section. As shown in the table, the Transuranic Separations/Class C Grout Option under the Separations Alternative was assessed the highest total rating of +3 and the Cement-Ceramic Option under the Non-Separations Alternative was assessed the lowest total rating of -3. Since the total rating spread (lowest to highest total rating) was only 6 points and the lowest alternative was only a -3 rating, the Evaluation Team recommended that none of the initial candidate alternatives be rejected at this time. Moreover, the team analysis confirmed that none of the minus ratings indicated areas of serious or inherent weakness.

Table B-2. Total rating of candidate alternatives.

Alternative	Program mission	Cost	Technical feasibility	ES&H	Public Concerns	Program flexibility	Total rating
1. No Action							
1A Notice of Intent	-	0	+	0 ^a	-	+	0 ^a
1B Orderly Shutdown	-	+	+	-	-	-	-2
2. Separations							
2A Full Separations	+	0	+	0	0	0	+2
2B 2006 Plan	+	-	+	-	0	0	0
2C Transuranic Separations/ Class A Grout	+	0	+	0	0	0	+2
2D Transuranic Separations/ Class C Grout.	+	0	+	0	+	0	+3
3. Non-Separations							
3A Vitrified Waste	+	-	+	0	+	-	+1
3B Hot Isostatic Pressed Waste	0	0	+	- ^a	0	-	-1 ^a
3C Cement-Ceramic	0	0	-	- ^a	0	-	-3 ^a
3D Direct Cement	0	0	+	0	0	-	0
3E Early Vitrification	+	-	0	0	+	-	0
<i>a. After the initial DOE Team evaluation and recommendation, these ratings were re-evaluated based on additional information received by the team. The re-evaluation did not change the team's recommended final ratings.</i>							

B.6 Refinement of Draft EIS Alternatives

Following the evaluation of candidate alternatives described in the previous section, several events occurred that affected the selection of alternatives for the Idaho HLW & FD EIS. These events include consideration of shipping stabilized HLW (or calcine or separated high-activity waste) to the Hanford Site for processing, use of the proposed INEEL Advanced Mixed Waste Treatment Project for processing certain HLW-related waste streams, and use of a cesium ion exchange process for treatment of liquid SBW and newly generated liquid waste. These events led DOE to further refine the Idaho HLW & FD EIS alternative selection process. **Additional information** for this refinement process are contained in DOE (1999a) and are summarized below.

B.6.1 DRAFT EIS ALTERNATIVES REFINEMENT (PHASE I)

DOE convened an Alternative Refinement Meeting on May 21, 1998 to evaluate the list of EIS alternatives considering the events described above. The following comparison factors (elimination criteria) were used by DOE personnel during the meeting:

- *Two or more alternatives share common process characteristics, but one presents:*
 - A bounding case for environment, safety, and health impacts
 - Substantially reduced cost
 - Substantially reduced waste handling risks

- Similar impacts, but with an increased chance for public and/or regulator acceptance
- *An implementation alternative presents a process that would likely result in:*
 - Lack of expected regulator/DOE approval
 - Lack of ability to construct or operate facilities in the required time period
 - Significantly higher volume of waste for disposal
 - Significantly higher worker risk
 - Unreasonably higher cost to treat a small volume of waste
 - Unreasonably higher worker risk to process a small volume of waste
 - Creation of an intermediate waste form that cannot be transformed into an acceptable final waste form for disposal

DOE identified the following alternatives in Table B-3 as "alternatives considered but not analyzed" and "alternatives identified for further DEIS analysis with use of the comparison fac-

tors," as discussed previously. The rationale for these conclusions is described below.

No Action Alternative - Orderly Shutdown Option - This option would not meet any of the Settlement Agreement/Consent Order and other requirements and does not tier off the SNF & INEL EIS decision to continue to operate the New Waste Calcining Facility (DOE 1999a). Under this option, the decision to shut down the New Waste Calcining Facility would be made in Fiscal Year 2000, and none of the INTEC HLW management facilities, including the Tank Farm, would be closed. The process vessels would be emptied of waste solutions, and some decontamination rinses would be performed. The Orderly Shutdown Option would stop the operation of the Process Equipment Waste Evaporator system and the Liquid Effluent Treatment and Disposal Facility, and would not empty or close the Tank Farm. The shutdown facilities would be left in a safe condition but would not be monitored. **DOE concluded that the No Action Orderly Shutdown Option was not an environmentally responsible alternative and would not be an effective basis of comparison of the action alternatives.** Thus, this option *was* eliminated from further consideration.

Separations Alternative - 2006 Plan Option - The 2006 Plan Option is identical to the Full Separations Option except that the SBW would not be processed (separated) directly but would

Table B-3. Summary of the Phase I Alternative Refinement Meeting.

Alternatives considered but not analyzed	Alternatives identified for further analysis
No Action Alternative	No Action Notice of Intent (per Notice of Intent)
No Action Orderly Shutdown Option	Separation Alternative
Separations Alternative	Full Separations Option
2006 Plan Option	Transuranic Separations/Class C Grout Option
Transuranic Separations/Class A Grout Option	Non-Separations Alternative
Offsite Disposal of Class C Grout Option under the Transuranic Separations Option	Hot Isostatic Pressed Waste Option
Non-Separations Alternative	Direct Cement Waste Option
Vitrified Waste Option	Early Vitrification Option
Minimum INEEL Processing Alternative	Minimum INEEL Processing Alternative
Advanced Mixed Waste Treatment Facility Option	Full Transport Option
	Full Transport with Alternate SBW Treatment Option

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be calcined in the New Waste Calcining Facility by 2012 before dissolution and separation.

Thus, the 2006 Plan Option would require three major processing facilities (i.e., New Waste Calcining Facility with high-temperature and Maximum Achievable Control Technology upgrades, Calcine Dissolution and Separations Facility, and a HLW Vitrification Facility). The proposed 2006 Plan Option waste form would require redissolution of calcine with potential higher life cycle costs and worker risks than other separation options. For these reasons and for the additional processing and storage facilities required, it is apparent that this option offers no advantages over the Full Separations Option. It was also predicted to cost considerably more than the Full Separations Option. **Therefore, it was** determined that it be eliminated from the alternative list.

Non-Separations Alternative - Vitrified Waste Option - The calcining of SBW and newly generated liquid waste is the only action that differentiates the Vitrified Waste Option from the Early Vitrification Option. This option not only creates an additional waste form (SBW calcine) to be vitrified with the HLW calcine but also would not maintain the beneficial segregation of the SBW calcine from the HLW calcine. Because of this potential co-mingling, this option could result in a larger quantity of HLW being shipped to a geologic repository for disposal with the attendant higher disposal costs and would require greater facility costs for vitrification and storage. Therefore, there are no advantages for this option over the Early Vitrification Option that otherwise contains the same treatment concepts. For these reasons, **it was** concluded that the Vitrified Waste Option should be eliminated from further EIS consideration.

Offsite Low-Activity Waste Disposal - The group determined that offsite disposal of Class A grout should be retained. Initially, Hanford was selected to be a representative offsite location for Class A grout disposal. However, disposal at Hanford has been eliminated from consideration because previous evaluations of low-activity grout disposal at Hanford have indicated that the long-term (beyond 1,000 years) impacts of low-activity grout disposal could exceed regulatory standards for groundwater protection. Also, **at**

the time, Hanford's HLW management strategy **called** for vitrifying the low-activity waste prior to onsite disposal **and it was** unlikely that Hanford would accept grouted INEEL low-activity waste for disposal. The group then recommended that the Envirocare facility in Utah be considered as a representative offsite disposal facility because it is a commercial facility that is limited only by its waste acceptance criteria.

Notice of Intent version of the No Action Alternative - **This** Option was re-aligned by the group to include the following requirements to meet the Notice of Noncompliance Consent Order:

- Run the New Waste Calcining Facility until June 2000.
- Place the New Waste Calcining Facility in standby and perform the high temperature and Maximum Achievable Control Technology upgrades.
- Run the High-Level Liquid Waste Evaporator until 2003 while the New Waste Calcining Facility is being upgraded.
- Complete the New Waste Calcining Facility permitting and upgrades by 2010.
- Run the New Waste Calcining Facility at an accelerated schedule to calcine the SBW by 2014.

Separations Alternative - Full Separations with Hanford Vitrification - This option is identical to the Full Separations Option except for the suboption to perform high-activity waste vitrification at the Hanford Site instead of at INEEL. In this option, the high-activity waste fraction would be solidified, packaged, and shipped to the Hanford Site for vitrification. The resulting HLW canisters would be returned to INEEL for interim storage awaiting shipment to a geologic repository. **DOE** concluded that the Idaho HLW & FD EIS will include "Hanford Vitrification" as an independent transportation analysis that will be covered in this EIS. The at-Hanford impacts would be discussed in a separate section of the EIS. This would allow the public to isolate the "at-INEEL" and "at-Hanford" impacts.

Separations Alternative - Transuranic Separations/Class A Grout Option - This option is similar to the Full Separations Option, except the separation process under this option would result in three waste products:

- Transuranic waste
- Fission products (primarily strontium/cesium)
- Class A grout

In the Transuranic Separations/Class A Grout Option, the liquid SBW would be sent directly to the Separations Facility for processing into high-activity and low-activity waste streams. After the SBW is processed, the HLW calcine would be retrieved from the bin sets, dissolved, and processed in the Separations Facility. Ion exchange columns would be used to remove the cesium from the waste stream. The resulting effluent would undergo the transuranic extraction process to remove the transuranic elements for eventual shipment to the Waste Isolation Pilot Plant. Then strontium would be removed from the transuranic extraction effluent stream via the strontium extraction process. The cesium and strontium would be combined to produce a high-activity waste stream that would be vitrified into borosilicate glass. This glass would be stored in an interim storage facility before shipment to a geologic repository. The Transuranic Separations waste would be dried and denitrated to produce a granular solid waste, and the low-activity waste would be denitrated and grouted to form Class A grout.

The Transuranic Separations/Class C Grout Option process would create only two waste streams: (1) solidified transuranic waste for disposal at the Waste Isolation Pilot Plant and (2) a low-activity waste stream to form Class C grout for onsite disposal. The Transuranic Separations/Class A Grout Option would involve more separations steps than the Transuranic Separations/Class C Grout Option and would require a larger Waste Separations Facility. Also, *this* option would require a separate High-Activity Waste Treatment (Vitrification) Facility and a High-Level Waste Interim Storage Facility that have an estimated cost substantially greater than the Transuranic Separations (Class C Grout) Option.

The estimated total discounted cost for the Transuranic Separations/Class A Grout Option is \$3.29 billion, which would be 80 percent greater than the estimated total discounted cost of \$1.82 billion for the Transuranic Separations (Class C Grout) Option. Thus, the Transuranic Separations/Class C Grout Option is similar, has less complex separations processing, and is more cost-effective than the Transuranic Separations/Class A Option. Moreover, the impacts of this option are expected to be bounded by the remaining two options under the Separations Alternative. For these reasons, the Transuranic Separations/Class A Option was eliminated from further consideration.

Non-Separations Alternative - Cement-Ceramic Waste Option - The Cement-Ceramic Waste Option under the Non-Separations Alternative is similar to the Direct Cement Waste Option except the liquid SBW would not be calcined directly but would be mixed with the existing calcine to form a slurry. In this option, all calcine would be retrieved and combined with the liquid SBW. The combined slurry would be recalcined in the New Waste Calcining Facility with the resulting calcine mixed into a concrete-like material. The concrete waste product would then be poured into drums, autoclaved (curing in a pressurized oven), and stored in an interim storage facility before shipment to a geologic repository. An estimated 16,000 concrete canisters would be produced. This option would require a calcine retrieval system, a major modification to the New Waste Calcining Facility to allow slurry calcination and the upgrade for compliance with the Maximum Achievable Control Technology rule, and a Grout Facility with autoclave. The final product would require an equivalency determination by EPA.

The rationale for initially considering the Cement-Ceramic Waste Option in the EIS was the potential for significant cost savings in using a greater confinement facility (such as at the Nevada Test Site) as the final repository for the resulting product. A basis for this assumption was that the cementitious waste form and the alluvial soil at the greater confinement facility were chemically compatible, and the cement waste form would be the least likely to migrate in the surrounding soil. However, the greater confinement facility for HLW disposal has not been constructed, nor has DOE approved the

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project for construction at this date. Moreover, DOE experiences at the Waste Isolation Pilot Plant and Yucca Mountain suggest that the development of a repository is a lengthy, costly, and high-risk undertaking. In addition, if INEEL were the only site disposing HLW at a greater confinement facility, INEEL would bear all costs associated with the development of the repository (e.g., site characterization and performance assessments associated with U.S. Nuclear Regulatory Commission licensing and EPA certification of compliance). Therefore, it is unlikely that significant cost savings at a greater confinement facility could be realized over a geologic repository where INEEL would pay a prorated share of the development and operational costs based on its share of the waste disposed of.

The Cement-Ceramic Waste Option is based on calcination of SBW/calcline slurry in the New Waste Calcining Facility, which is currently configured to process a liquid feed. To reconfigure the New Waste Calcining Facility to process an SBW/calcline slurry would be costly. Even if the New Waste Calcining Facility were modified to accept the slurry feed, no prior research and development work has been conducted to verify the feasibility of calcining the slurry. ***Even if the Cement-Ceramic Waste Option had a high potential to reduce life cycle costs, the fact that DOE has included the Direct Cement Waste Option, which has lower technical risk than the Cement-Ceramic Waste Option, negates the need to include the Cement-Ceramic Waste Option in the EIS analysis.***

Minimum INEEL Processing Alternative - The group concluded that an additional alternative, entitled the "Minimum INEEL Processing Alternative," should be analyzed in the Idaho HLW & FD EIS. This alternative would have two options: (1) the Full Transport Option and (2) the Full Transport with Alternate SBW

Treatment Option. Under either option in this alternative, DOE would perform only the minimum activities necessary to prepare the calcine for shipment to the Hanford Site for treatment. In the Full Transport Option, DOE would also solidify and package the SBW for transport to Hanford. In the Full Transport with Alternate SBW Processing Option, DOE would not ship the SBW to Hanford but would instead process the SBW through an ion-exchange column to remove the cesium and grout to create a contact-handled transuranic waste that DOE would ship to the Waste Isolation Pilot Plant.

B.6.2 EIS ADVISORY GROUP (EAG) REVIEW

Subsequent to the Alternatives Refinement Meeting, DOE convened the Idaho HLW & FD EIS Advisory Group Meeting on June 30 and July 1, 1998. The purpose of the EIS Advisory Group *was* to provide a forum to assess the resolution of issues related to preparation and review of this EIS. The EIS Advisory Group concluded that the alternatives resulting from the Phase I Alternatives Refinement Meeting *were* acceptable except that the No Action Alternative should be revised so it does not include *calcination* or construction of new storage tanks. DOE subsequently decided that the alternative previously entitled the No Action Alternative would be retained but would be retitled the "Continued Current Operations" Alternative.

B.6.3 ALTERNATIVE REFINEMENT (PHASE II)

A second alternative refinement meeting was held on September 16, 1998. The intent of this second meeting was to discuss the potential Hanford alternatives for treatment of INEEL HLW and SBW. The DOE Evaluation Team

concentrated on evaluating the physical characteristics of the Hanford alternatives and the timing for potential shipments of waste to Hanford for treatment. Timing of shipments is critical since it affects the treatment processes at INTEC, which would supply the waste for Hanford treatment.

The DOE Evaluation Team evaluated several options for treatment of INTEC wastes at Hanford, including (1) direct vitrification of calcine, (2) direct vitrification of separated high-activity waste, (3) calcine separations, and (4) shipping SBW/newly generated liquid waste to the Hanford Site for treatment. The DOE Evaluation Team concluded that only Option 3, "calcine separations," should be evaluated in the EIS. DOE's rationale for eliminating the other options is explained in DOE (1999a) and Section 3.3 of this EIS.

Therefore, the Minimum INEEL Processing Alternative would entail shipping calcine from INEEL to Hanford, separation of this calcine at Hanford into high-activity and low-activity streams, and vitrification of both waste streams at Hanford. The vitrified high-activity waste would be shipped back to INEEL for interim storage pending shipment to a geologic repository, while the vitrified low-activity waste would be shipped back to INEEL for disposal. The existing liquid SBW and newly generated liquid wastes would be retrieved and transported to an ion exchange facility, where it would be filtered and processed through an ion exchange column. The filtered solids would be dried and disposed of at the Waste Isolation Pilot Plant as remote-handled transuranic waste. The loaded ion exchange resin would be temporarily stored at INEEL, dried and containerized, and transported to Hanford for vitrification. After ion exchange, the liquid waste would be grouted to produce a contact-handled transuranic waste for disposal at the Waste Isolation Pilot Plant.

B.6.4 STATE OF IDAHO REVIEW

As described in Section 2.3, the State of Idaho *served* as a "Cooperating Agency" in the preparation of this EIS. In fulfilling this responsibility, the State reviewed the list of waste processing alternatives. The State's review concluded that the 2006 Plan Option comes the closest to fulfilling the Settlement Agreement/Consent Order and should be analyzed in the EIS. DOE incorporated the State's recommendation and evaluated this option in the EIS but retitled it the "Planning Basis Option."

B.7 Final List of Draft EIS Alternatives

Therefore, as a result of all the activities discussed in this Appendix, the Draft Idaho HLW & FD EIS analyzed the following waste processing alternatives and options:

1. No Action Alternative
2. Continued Current Operations Alternative
3. Separations Alternative
 - A. Full Separations Option
 - B. Planning Basis Option
 - C. Transuranic Separations Option
4. Non-Separations Alternative
 - A. Hot Isostatic Pressed Waste Option
 - B. Direct Cement Waste Option
 - C. Early Vitrification Option
5. Minimum INEEL Processing Alternative

B.8 Additional Alternatives/Options and Technologies Identified during the Public Comment Process

B.8.1 INTRODUCTION AND PURPOSE

The Notice of Availability of the Draft EIS was issued in 65 FR 3432 on January 21, 2000. Additional alternatives for the treatment and disposal of mixed transuranic waste/SBW and mixed HLW calcine were proposed by the public during the public comment period. Public comments, along with other relevant factors, such as information received after the Draft EIS was approved, had a bearing on the development of the Preferred Alternatives. This section identifies and describes the new alternatives and treatment technologies and their disposition. The new alternatives (Steam Reforming and Grout-in-Place) were identified from public comment on the Draft EIS. The additional treatment technologies described here include those identified by:

- The National Academy of Sciences (NAS 1999)
- The public comment process, and
- HLW treatment experts during the Preferred Alternative identification process

The evaluation criteria for the alternatives and technologies included environment, safety, and health impacts; treatment process effectiveness for both mixed transuranic waste/SBW and mixed HLW calcine; technical maturity of treatment technologies and risk of failure; public comment; ability to meet legal commitments for treating and preparing mixed transuranic waste/SBW and mixed HLW calcine to meet the Settlement Agreement/Consent Order and Notice of Noncompliance Consent Order requirements; agency concerns; adherence to DOE's mission and policies; uncertainties; schedule risk; project and operational costs; final waste form shipping and disposal costs; and

maximizing the potential for early disposal of the final waste form.

B.8.2 ALTERNATIVES/OPTIONS EVALUATED AFTER THE DRAFT EIS WAS ISSUED

Waste processing methods were identified and evaluated during the review of public comments on the Draft EIS, from other reports, and during DOE internal review. Most of these methods, including Steam Reforming, were variations on the waste processing alternatives presented in the Draft EIS. However, application of Steam Reforming and Grout-In-Place as proposed waste treatment alternatives was identified during public comment and considered in the Final EIS alternative identification process. These proposed alternatives are described in the following subsections.

B.8.2.1 Steam Reforming

The steam reforming process proposed for processing mixed transuranic waste/SBW involves reaction of the waste in a fluidized bed with steam and certain reductants and additives, to produce a small volume of inorganic residue essentially free of nitrates and organic materials. The mixed transuranic waste/SBW, after mixing with sucrose, would be fed to the reactor. Solid carbon would be fed separately as a reactant in the steam-reforming process. Additional additives may also be used to alter the physical and chemical properties of the final product. Water in the waste would be vaporized to superheated steam. Additional energy would be supplied to the bed by injecting oxygen to react with the carbon sources. Organic compounds in the waste would be broken down through thermal processes (pyrolysis) and through reaction with hot nitrates, steam, and oxygen.

The fine solid-waste products, including small amounts of fixed carbon and alumina fines from the bed, would be separated from the larger semi-permanent fluid-bed particles in a cyclone within the reactor. The resultant vapor stream would be passed through ceramic candle filters where the solids would be separated from the vapors. The filter candles periodically would be backpulsed with nitrogen to recover the solids,

which would then be packaged for disposal. These solids would be combined with larger particles that occasionally would be discharged from the bottom of the fluid bed reactor. Together these solids would make up the primary steam-reformed product.

The vapor stream exiting the ceramic candle filters would be processed through a quencher where acid gases would be neutralized. The vapor from the dryer would be combined with the building air exhaust before high-efficiency particulate air filtration. The water vapor from the scrubber would be condensed and cooled. The gases exiting the condenser would pass through a demister and bag house before being treated with air in a thermal converter. The vapors exiting the thermal converter would be passed through a high-efficiency particulate air filter and a cooler before being discharged to the atmosphere through a monitored vent stack.

A DOE-sponsored Tanks Focus Area sub-team evaluated the steam reforming technology for processing mixed transuranic waste/SBW (TFA 2001). The sub-team concluded that there was no strong technical incentive to pursue steam reforming but the technology may be useful as a vitrification pretreatment or offgas treatment method. The sub-team also concluded that DOE should not pursue the steam reforming technology as a means to treat the mixed transuranic waste/SBW. The recommendation was based primarily on process technical concerns and concerns about long-term storage of the resulting product (hydration and radiolysis). The steam reforming process is similar to the Continued Current Operations Alternative analyzed in this EIS, except the resultant waste produced would be shipped offsite rather than stored indefinitely in the bin sets. This is similar to NAS Option 6. Subsequently, DOE management requested an assessment of the steam reforming technology to treat the mixed transuranic waste/SBW. The assessment resulted in a Steam Reforming Option being added to the EIS in response to public and agency comments. The option includes containerizing the mixed HLW calcine and shipping it to the geologic repository. In addition, transportation of both waste streams to the respective disposal sites has been added.

B.8.2.2 Grout-In-Place

As part of the public comment process on the Draft EIS, the INEEL Citizens Advisory Board proposed a new alternative for evaluation (CAB 2000). This new alternative, Grout-in Place or Entombment, would leave the mixed transuranic waste/SBW in the tanks and the calcine in the bin sets and add grout to immobilize the waste in place. For the mixed transuranic waste/SBW, the grout/SBW mixture would be entombed directly in the tanks. The calcine would either be mixed with grout and entombed in the bin sets, or the vaults surrounding the bin sets could be filled with clean grout. This alternative was evaluated, but was eliminated from detailed analysis for the following reasons:

- Transformation of the mixed transuranic waste/SBW into a stable solid form may require removal of the waste from the tanks and addition of neutralizing and stabilizing materials that would result in a substantial volume increase. Although adding a grout mixture to the waste in the tanks may not exceed the capacity of the existing tanks (assuming a 30 percent waste loading and all 11 tanks filled to capacity), there are technical uncertainties related to the solidification in a tank to entomb the liquid mixed transuranic waste/SBW. For the calcine, there is insufficient capacity in the bin sets to grout the calcine in place. If the calcine were encased in clean grout around the bin sets, the potential long-term impacts would be similar to the Continued Current Operations and No Action Alternatives. For long-term impact analysis (Section 5.3.5.2 of this EIS), DOE assumed that any structure was vulnerable to degradation failure after 500 years in accordance with the U.S. Nuclear Regulatory Commission (NRC) position for long-term storage facilities (NRC 1994).
- Under NEPA, agencies may consider alternatives that are not consistent with applicable laws, regulations, and enforceable agreements. However, DOE does not regard disposal of the mixed transuranic waste/SBW in the tanks or calcine in the bin sets to be rea-

- New Information -

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sonable. This alternative would violate the Notice of Noncompliance Consent Order and Settlement Agreement/Consent Order, and would not meet RCRA regulatory requirements for a disposal facility for mixed waste.

B.8.3 TREATMENT TECHNOLOGIES EVALUATED AFTER THE DRAFT EIS WAS ISSUED

Following publication of the Draft EIS, new waste processing technologies and variations of previously studied treatment options were suggested by the public, the NAS, and subject matter experts. These options were evaluated and eventually eliminated from detailed analysis. This section includes a summary of the waste processing options considered and evaluated as part of the alternative review process and provides an abbreviated discussion as to why they were eliminated from detailed evaluation. The treatment technologies are grouped here by commentor, waste type, and by treatment type.

B.8.3.1 Treatment Technologies Suggested by the National Academy of Sciences

The following technologies for treating mixed transuranic waste/SBW were suggested by the NAS in *Alternative High-Level Waste Treatments at the Idaho National Engineering and Environmental Laboratory* (NAS 1999). In addition to the NAS report, the NAS team provided an extensive briefing on their findings and conclusions.

- **NAS Option 1, Two-Stage Low-Temperature Evaporation and Ship to the Waste Isolation Pilot Plant** - This option would use a first stage evaporator to heat the liquid mixed transuranic waste/SBW and produce a concentrated liquid, that would be sent to a second stage evaporator for further drying. This second stage could be a wiped film evaporator, a pot evaporator, or a rotary drier. Following the second stage evaporation, the concentrated liquid would be sent to a container filling operation

where the liquid would be allowed to solidify upon cooling. The solidified product, a relatively large volume (1,300 cubic meters), would be sent to the Waste Isolation Pilot Plant as remote-handled transuranic waste. This option was eliminated from detailed evaluation because, in general, the process scored relatively low against the criteria listed in Section B.8.1. There were significant issues on technical maturity and technology for this option, and issues regarding remote maintenance requirements and containerization of product.

- **NAS Option 2, Hydroxide Precipitation without Separation** - In this process, excess acid in the mixed transuranic waste/SBW would be destroyed in an evaporator step. The concentrate would be neutralized with sodium hydroxide to a pH of 8 to 10, precipitating most of the metals. The slurry would be evaporated and solidified for disposition as in NAS Option 1. This process would produce additional remote-handled transuranic waste because acid neutralization adds waste volume. Precipitation of the concentrated mixed transuranic waste/SBW by caustic would introduce processing difficulties due to the gel-like substances produced. This option was eliminated from further evaluation because it would generate about 30 percent more remote-handled transuranic waste than NAS Option 1 above, and it is technically enveloped by that option.
- **NAS Option 3, Hydroxide Precipitation w/Separation** - This treatment option is similar to NAS Option 2, but requires additional processing steps. Excess acid would be destroyed and the waste would be evaporated and neutralized producing gelatinous slurry. Sulfide would be added to the slurry to treat for metals. A solid/liquid separator would then be used to separate the gelatinous material. This technology is considered to be very difficult and require significant technical development with no advantage compared to NAS Option 2.

- **NAS Option 4, Modified Hydroxide Precipitation** - This treatment process is similar to NAS Option 3 except two additional solid/liquid separation steps add technical complexity. The process is based on the Hanford Enhanced Sludge Leaching Process which operates on basic waste, not acidic waste, and would require the addition of caustic materials to increase the pH. This option would reduce the amount of remote-handled transuranic waste produced but would produce over 3,000 cubic meters of remote-handled low-level waste. No advantage was discerned over NAS Option 3.
- **NAS Option 5, Lanthanum Fluoride Precipitation** - In this option, multiple lanthanum fluoride scavengers would precipitate a transuranic waste fraction as an insoluble fluoride. This technology was eliminated from detailed evaluation because it has previously been investigated for application to the INTEC mixed transuranic waste/SBW and was shown to be an unsuccessful technology (Olsen et al. 1993).
- **NAS Option 6, Calcination with Maximum Achievable Control Technology (MACT) Upgrade and Ship Process Waste to the Waste Isolation Pilot Plant** - This option would calcine the mixed transuranic waste/SBW in the New Waste Calcining Facility following a MACT upgrade. The mixed transuranic waste/SBW calcine would be placed in RCRA compliant containers and sent to the Waste Isolation Pilot Plant. This option is similar to the Continued Current Operations Alternative analyzed in this EIS, except that the resultant waste produced would be shipped offsite rather than stored indefinitely in the bin sets.

B.8.3.2 Treatment Technologies Identified from Public Comment

This section briefly discusses options or treatment technologies suggested by the public during the public comment period on the Draft EIS.

- **Savannah River and/or West Valley treatment of Idaho waste** - This option would involve shipping mixed transuranic waste/SBW and mixed HLW calcine to Savannah River or West Valley for treatment. This option was evaluated for the Draft EIS, and considered again during preparation of the Final EIS. There was no additional information that would change the outcome of the initial evaluation. For the reasons identified in Section 3.3.5 of this EIS, this option was eliminated from detailed analysis.
- **"Formed Under Elevated Temperature and Pressure (FUETAP)" technology developed at Oak Ridge** - This technology was developed at Oak Ridge and was considered during the preparation of the Draft EIS. The technology is similar to the Hot Isostatic Pressed Waste and Direct Cement Waste treatment options. Its primary disadvantages are lack of technical maturity with an increase in technical risk. It would have an application to both mixed transuranic waste/SBW and mixed HLW calcine. The FUETAP option was not evaluated further for mixed HLW calcine treatment because it would produce about the same amount of HLW (13,000 cubic meters) as the less technically demanding Direct Cement Waste Option, would at present produce an unqualified waste form for the potential geologic repository, and would require considerable technology development.

- New Information -

- **Liquid waste treatment technologies used at other DOE sites** - Treatment technologies developed or being considered at other sites were examined as part of the alternative selection process.
- **Steam reforming process** - This technology has been added to the Final EIS. See Section B.8.2.1 for description.
- **Silicon ingots** - This process is considered equivalent to vitrification, where waste and frit are added to the melter to form glass. Since it is enveloped by the Early Vitrification Option, it was not further evaluated as a stand-alone alternative.
- **Dry-pack process for mixed HLW** - This process is similar to the two-stage evaporator process evaluated (see Section B.8.3.1, NAS Option 1) and was eliminated from detailed evaluation for the same reasons.
- **Cold crucible vitrification process for treating calcine** - This process was identified during the Draft EIS public comment period by a company called COGEMA. This process is under evaluation by the HLW program and could be chosen for mixed transuranic waste/SBW and mixed HLW calcine vitrification. This technology is similar to that evaluated under the Early Vitrification Option and the Vitrification with or without Calcine Separations, therefore further evaluation of the process was not performed.
- **Advanced Vitrification System (AVS)** - The Radioactive Isolation Consortium AVS technology involves vitrification of HLW in the same canister in which it would be disposed of. This technology currently has maturity and technology development issues that DOE is studying. Depending on the results of the studies, this technology may be considered for waste treatment at the INEEL. This technology is similar to that evaluated under the Early Vitrification Option and the Vitrification with or without Calcine Separations, therefore further evaluation of the process was not performed.
- **Mixed HLW calcine encapsulation in a metal matrix** - Early research at INTEC showed that surrogate calcined HLW could be melted directly into an aluminum matrix potentially making the handling and transport of the calcined waste safer and easier. The option was dropped from further consideration because of the lack of technical maturity and it offers no advantage for disposal in a national geologic repository. Additionally, the process has no application to the treatment of mixed transuranic waste/SBW unless the liquid waste was first calcined.
- **Mixed HLW calcine entombed in situ and mixed transuranic waste/SBW solidified and entombed in tanks** - This option is discussed in Section B.8.2.2.
- **Other waste disposal options** - During public comment, several comments suggested various methods of disposing of INTEC waste. These included such ideas as disposing of waste in the Great Salt Lake Desert, Sahara Desert, outer space, other countries, etc. These alternatives were dropped from further consideration based on costs, transportation risk, environmental justice, managerial risk (political acceptability), and technology issues.

B.8.3.3 Evaluation of Treatment Technologies and Options During the Preferred Alternative Identification Process

The following treatment technologies were identified during the Preferred Alternative identification process by subject matter experts, from reference materials and other sources.

Calcine Options for Mixed Transuranic Waste/SBW Treatment - Options involving calcination of the mixed transuranic waste/SBW were generally eliminated from detailed evaluation during the Preferred Alternative identifica-

tion process because they 1) would not meet the Settlement Agreement/Consent Order requirements, 2) upgrades to the New Waste Calcining Facility would require restart after a prolonged shutdown of an old facility, 3) expected difficulty in obtaining approvals for partial upgrades from the State of Idaho and the U.S. Environmental Protection Agency, 4) calcination without offsite shipment would not close the waste disposal loop, 5) calcination involves a thermal treatment which received significant negative public comment after the Draft EIS was released, and 6) major modifications to the 20 year old New Waste Calcining Facility could be technologically difficult. For these reasons, options that required calcination of the mixed transuranic waste/SBW were evaluated and eliminated from further analysis as candidates for the preferred treatment alternative. These are listed below.

- Calcine with MACT Upgrade with calcine to Bin Sets
- Calcine without MACT Upgrade with Project XL (eXcellence and Leadership), and Shipment of the Product to the Waste Isolation Pilot Plant (similar to NAS Option 6) (See Section B.8.3.1.)
- Calcine with Partial MACT Compliance
- Risk-Based Calcination to Bin Set
- Calcine under Interim Status with RCRA Upgrades
- Calcine with Propane in place of Kerosene
- Calcination with Sugar at 500°C with MACT Upgrade and shipment to the Waste Isolation Pilot Plant
- Calcine with a Surrogate Raffinate

Calciner under Interim Status - The option of operating the calciner in its interim status configuration was not included in the detailed analysis of the Draft EIS because it was analyzed in the SNF & INEL EIS. For purposes of the Final EIS, DOE has determined that it is not a reason-

able alternative based on programmatic considerations, including those discussed above.

Evaporation Methods for Treatment of Mixed Transuranic Waste/SBW - In addition to NAS Option 1, Two-Stage Low-Temperature Evaporation (see Section B.8.3.1), two additional evaporation methods were evaluated for the treatment of mixed transuranic waste/SBW: Direct Evaporation in the Shipping Cask, and High-Temperature Evaporation with a Rotary Kiln (with MACT) and shipment of process waste to the Waste Isolation Pilot Plant. Direct Evaporation in the Shipping Cask was eliminated from detailed evaluation because of container integrity concerns and significant materials development and investigation. Treatment of mixed transuranic waste/SBW using High-Temperature Evaporation with a Rotary Kiln was eliminated because 1) it is expected to cost significantly more than calcination, 2) it has no significant technical or schedule advantages, and 3) it is a thermal process, would produce considerable air emissions, and would require MACT.

Separations Options for Treatment of Mixed Transuranic Waste/SBW - Various options involving separation of the mixed transuranic waste/SBW were evaluated during the Preferred Alternative identification process. These options, and the reasons they were eliminated from detailed evaluation, are listed below.

- **Cesium Ion Exchange with Transuranic Waste Grout Treatment** - This technology uses a sorbent in an ion exchange column to extract cesium from the mixed transuranic waste/SBW. The remaining waste product would be grouted and shipped to the Waste Isolation Pilot Plant. At the time of this evaluation, the cesium-loaded resin would be grouted and sent directly to Hanford or the Nevada Test Site for disposal as remote-handled low-level waste. This process has some technology development questions concerning cesium ion-exchange column performance that would need to be resolved to use for mixed transuranic waste/SBW. In addition, this process has development questions that would require sig-

nificant added functions and technology development in order to treat calcined waste, which would require dissolution prior to separations. This process was eliminated for further evaluation since it is not directly applicable to the treatment of mixed HLW calcine without significant further technology development. However, if calcine separations were considered it could be reconsidered.

- **Cesium Ion Exchange with Transuranic Extractions** - This option involves the use of cesium ion exchange, as described above, followed by transuranic extraction through the use of solvent technology and centrifugal contactors. The process is more complex than Cesium Ion Exchange with Transuranic Waste Grout, requiring several additional processes for the transuranic extraction cycle. The process has a low technical maturity, and would be more expensive than Cesium Ion Exchange or Transuranic Extractions alone.
- **Transuranic Extractions with Class C-Type Grout or Class A-Type Grout** - This option is similar to that described above and uses a solvent and centrifugal contactors to separate high activity and transuranic radionuclides from the mixed transuranic waste/SBW. Because cesium is not separated out of the waste stream at the front of the process, the process would produce transuranic wastes as well as remote-handled low activity waste for disposal at Hanford. The flow sheets for these options are more complex than either Universal Extractions (described below) or the Cesium Ion Exchange with Transuranic Waste Grout Treatment (described above), have low technical maturity and no perceived technical advantage over other mixed transuranic waste/SBW treatment options.
- **Universal Extractions and Modified Universal Extractions** - Universal Extractions technology uses solvents and centrifugal contactors to separate

the high-activity and transuranic radionuclides from the mixed transuranic waste/SBW. The Modified Universal Extraction Option differs in that the low-activity transuranic waste would stay with the low-activity waste stream to create 5,000 cubic meters of contact-handled transuranic grout. Both extraction technologies would produce about 400 cubic meters of remote-handled transuranic waste. In general, Universal Extractions is not as mature a technology as Cesium Ion Exchange, and has a relatively complicated flow sheet, which would require significant technology development. Currently, solvent procurement questions exist with this technology since most technology development has been performed in foreign countries. Since these alternatives have no advantage over other separation processes, they were dropped from further evaluation.

Separations by Precipitation for Mixed Transuranic Waste/SBW - In addition to the four precipitation technologies proposed by the NAS (NAS Options 2-5, Section B.8.3.1), two additional precipitation methods were evaluated: Low-Temperature Precipitation and High-Temperature Evaporation and Precipitation.

- **Low-Temperature Precipitation** - Low-Temperature Precipitation removes the heat from mixed transuranic waste/SBW by refrigeration, causing at least one component of the waste to solidify as salt crystals, which can then be separated off. The concentrated liquid contains most of the fission and transuranic elements, and the precipitate would contain approximately 60 percent of the sodium. The precipitated salt cake would be grouted. This treatment technology is complex, in particular attempting to separate crystals out of the liquid mixed transuranic waste/SBW is viewed as difficult and perhaps impossible. A large amount of technology development would be required in order to determine if this process would work. There was no perceived advantage of this technology over more mature sepa-

rations technologies and the technological risk was higher. Consequently, it was dropped from further evaluation.

- **High-Temperature Evaporation and Precipitation** - This option would evaporate mixed transuranic waste/SBW at less than 150°C to a specific gravity of 1.3, then collect the precipitate as the batch cools. The remaining liquid would be direct grouted, and the remote-handled grout would be shipped the Waste Isolation Pilot Plant. The precipitate would be low-level waste. There is no technical advantage of this technology over Low-Temperature Precipitation. It would produce more remote-handled transuranic waste and offgases compared to Low-Temperature Precipitation. There is significant technological uncertainty associated with this alternative, in particular there is a potential hazard of unplanned cool down with precipitate depositing and solidifying in process lines.

Direct Immobilization of Mixed Transuranic Waste/SBW - In addition to the waste immobilization options evaluated in the Draft EIS, three additional direct immobilization options were evaluated: Polymer Encapsulation, Direct Absorbent, and Silica Gel. Steam Reforming, also a direct immobilization alternative, was discussed in Section B.8.2.1.

- **Polymer Encapsulation** - This option would use a mix of 40 percent mixed transuranic waste/SBW and 60 percent polymer. The polymer is mixed with the mixed transuranic waste/SBW and forms a solid block directly in the can. This option was eliminated because waste volumes of remote-handled transuranic waste would be large (6,100 cubic meters), and the polymer is expensive. Although this technology has been demonstrated for low-level waste, the manufacturer does not recommend this treatment alternative for mixed transuranic waste/SBW. Consequently, it was dropped from further evaluation.
- **Direct Absorbent (similar to kitty litter)** - A clay material such as kitty litter

or Ultra Sorb would be used to absorb mixed transuranic waste/SBW and eliminate the free liquids associated with the waste. This option was eliminated from detailed evaluation because of the large quantity of remote-handled transuranic waste that would be produced by this treatment alternative (12,500 cubic meters). This quantity of waste could exceed the Waste Isolation Pilot Plant capacity for remote-handled transuranics, and there are technical uncertainties regarding the dissociation of water in the containers.

- **Silica Gel** - In this option, a clay material would be added directly to the mixed transuranic waste/SBW and eliminate free liquid. The adsorbed waste would then be sent to Hanford for vitrification. The volume of remote-handled transuranic waste could exceed the capacity of the Waste Isolation Pilot Plant, significant development work could be required to initiate this alternative, and there is no perceived advantage over the Direct Cement Waste Option (evaluated in the Draft EIS) where the process is simpler.

HLW Calcine Technologies - For calcine treatment technologies, both separations and non-separations technologies were evaluated during the Preferred Alternative identification process. Calcine separations technologies were not eliminated from detailed evaluation, rather the final decision was postponed until at least 2007 after additional technology development. The technologies listed below are essentially the same as for mixed transuranic waste/SBW with some modifications to handle the calcine. In addition to the technologies listed below, separated high-activity waste could be sent to Hanford for vitrification.

- **Polymer Encapsulation** - In addition to the non-separations options evaluated in the Draft EIS, Polymer Encapsulation of mixed HLW calcine was also evaluated. The technology is described above for mixed transuranic waste/SBW. Polymer Encapsulation was eliminated from detailed evaluation because it would produce twice as much HLW as the Hot

Isostatic Pressed Waste Option evaluated in the Draft EIS. Additionally, the vendor has indicated it is probably not applicable for calcine treatment.

- **Cesium Ion Exchange with Transuranic Grout Treatment** - This process would be the same as for mixed transuranic waste/SBW, except for an added dissolution step for the mixed HLW calcine. For the calcine, cesium represents 99 percent of the gamma radiation associated with the dissolved calcine. This option removes the cesium in a downstream operation that allows the rest of the process to operate with less shielding. This separation technology for calcine has advantages of a simple flow sheet, small waste volumes of remote-handled low-level and transuranic wastes, and it is a non-thermal treatment. Disadvantages include leaving key nuclides in the low-activity stream, some technology development questions exist concerning the operation of the cesium ion exchange column, and it would require a waste incidental to reprocessing determination for disposal at the Waste Isolation Pilot Plant. If a decision were to be made in the future to separate mixed HLW calcine and process the waste, this option could be evaluated as a part of that process.
- **Cesium Ion Exchange with Transuranic Extractions** - This alternative is similar to the mixed transuranic waste/SBW treatment alternative except it would include the retrieval and dissolution of mixed HLW calcine prior to treatment. For calcine, cesium represents 99 percent of the gamma radiation associated with the dissolved calcine. This option removes the cesium in a downstream operation that allows the rest of the process to operate with less shielding. Most of the waste could go to Hanford as low-activity waste, it is a non-thermal process, and it maintains the flexibility to send high-activity waste to Hanford for vitrification. Disadvantages include low technical maturity, and it is more complicated than either Cesium Ion

Exchange or Transuranic Extractions alone.

- **Transuranic Extractions with Class C-Type or Class A-Type Grout** - Both of these options have the advantage of non-thermal processes and were described for mixed transuranic waste/SBW processing. The same disadvantages discussed for mixed transuranic waste/SBW would apply to the processing of mixed HLW calcine and these options were dropped from further evaluation for the separations and treatment of calcine.
- **Universal Extractions and Modified Universal Extractions** - These processes are described above for mixed transuranic waste/SBW. These options are non-thermal and less complicated than Transuranic Extractions. Separations for calcine have not been eliminated, and this option could be evaluated as a backup to Cesium Ion Exchange with Transuranic Grout if needed.

B.9 Process Used to Identify the Preferred Alternatives

The purpose of this section is to provide a description of the activities undertaken by DOE and, as a cooperating agency, the State of Idaho (the State) to evaluate available data and reach consensus on recommended Preferred Alternatives for this EIS. This section summarizes the Preferred Alternatives identification process undertaken after the Draft EIS was issued in December 1999.

B.9.1 BACKGROUND

In 1995, DOE and the State entered into a Settlement Agreement/Consent Order which, in part, set enforceable milestones for the treatment of approximately 4,400 cubic meters of solid

mixed HLW calcine and 1 million gallons of liquid mixed transuranic waste/SBW stored at the INTEC. In order to meet the milestones, various waste processing alternatives needed to be evaluated and programmatic decisions made relative to identifying the best path forward. Subsequently, DOE filed a Notice of Intent in 1997 to complete an EIS in accordance with NEPA to evaluate the environmental impacts of alternatives for treating calcine and mixed transuranic waste/SBW (as well as newly generated liquid waste), and the alternatives for the disposition of related HLW management facilities at INTEC. The State agreed to participate as a cooperating agency in the development of the EIS as a means to support the Settlement Agreement/Consent Order, provide State input into the decision process, and to facilitate the EIS review process.

During the alternative selection process for the Draft EIS, DOE identified and evaluated over 100 potential treatment technologies for calcine, mixed transuranic waste/SBW and newly generated liquid waste. The potential environmental impacts of the identified alternatives were analyzed in the Draft EIS. The extensive effort to identify the alternatives for the Draft EIS was documented in the report entitled *Process for Identifying Potential Alternatives for the Idaho High-Level Waste and Facilities Disposition Draft EIS* (DOE 1999a).

In January 2000, DOE issued the Draft EIS, but did not identify a Preferred Alternative to allow consideration of all public comment on the Draft EIS as a part of the Preferred Alternative identification process. After the Draft EIS was issued, data gathering and evaluation of potential waste processing technologies began, and continued until a Preferred Alternative was identified in October 2000.

B.9.2 APPROACH

This section provides an overview of the process for identifying the preferred waste processing alternatives for treating mixed transuranic waste/SBW, newly generated liquid waste, and calcine, and the Preferred Alternative for the disposition of HLW management facilities at INTEC.

B.9.2.1 Waste Processing Alternative Evaluation

The preferred waste processing alternative identification process commenced with the development of a Decision Management Plan that defined a structured approach. Key to this approach was the establishment of a Decision Management Team assigned the responsibility for overseeing the evaluation of relevant data, reaching consensus, and recommending a Preferred Alternative to senior DOE management. The plan also defined the roles and responsibilities of the three teams supporting the Decision Management Team, and included directions for incorporating public input and independent reviews. The process for identifying the preferred facility disposition alternative is discussed in Section B.9.2.2.

Figure B-1 shows the general organization of the teams supporting the identification of the Decision Management Team Preferred Alternative. The DOE Assistant Secretary for Environmental Management provided management guidance and direction to the Decision Management Team. Senior State of Idaho management were also involved through representatives on the team. The Decision Management Team consisted of a multidisciplinary group of experienced personnel from the State of Idaho's INEEL Oversight Program and Department of Environmental Quality and within the DOE complex (DOE Headquarters, DOE Idaho Operations, DOE Carlsbad Area Office, DOE Office of River Protection, and DOE Savannah River). The Public Involvement Team, the Performance Management Team, and the Decision Support Team provided input to the Decision Management Team for their consideration in identifying a Preferred Alternative.

In January 2000, the Decision Support Team began collecting and evaluating data to support the decision process. The Decision Support Team was comprised of four subteams. Team members were identified for specific expertise needed for each subteam and represented DOE, the State, and contractor staffs. The subteams and their areas of responsibility were:

- Technology and Cost Subteam - technology and costs

- *New Information* -

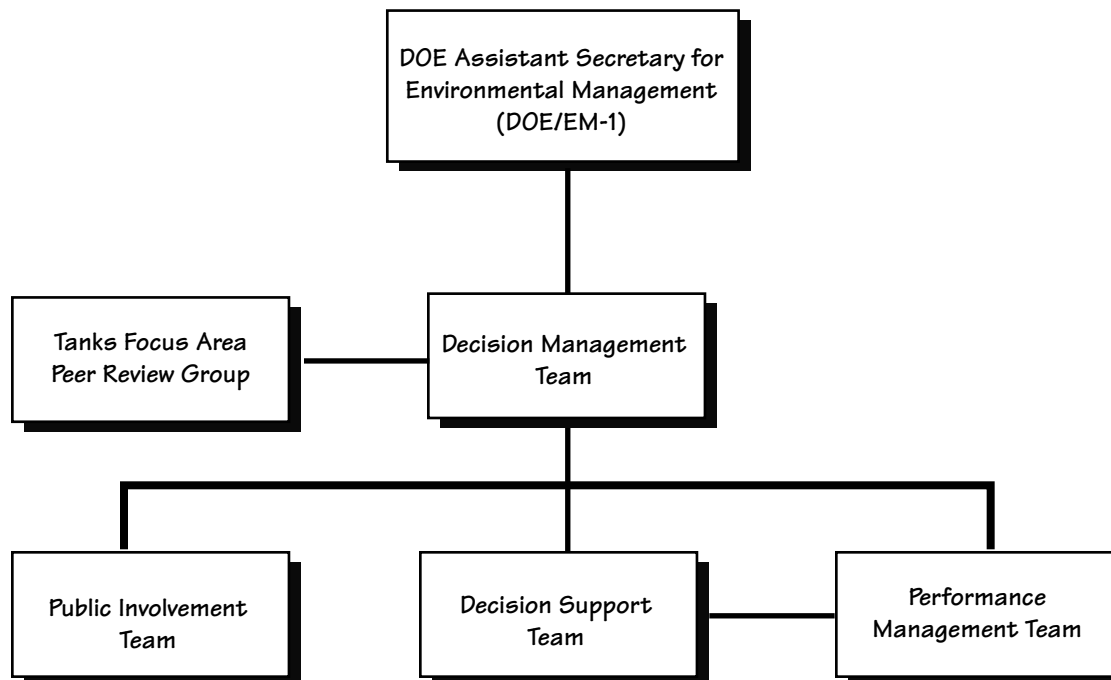


FIGURE B-1.
Organization of teams for identifying the Preferred Alternative.

- Environmental Subteam - estimated environmental impacts
- Facility Disposition Subteam - facility disposition impacts and approaches
- Combined Subteam - agency concerns, mission, policy, and uncertainties.

However, for simplicity, the individual subteams will be referred to here solely as the Decision Support Team.

Figure B-2 depicts the overall decision process. As shown in Figure B-2, the process began with a methodical search for reasonable waste processing technologies. Over sixty reference documents were evaluated, along with input from interviews, presentations, and agency and public comment. The technology identification process resource database included:

- The Draft EIS alternatives identification report (DOE 1999a) to identify technologies and alternatives warranting re-evaluation
- The NAS report, *Alternative High Level Waste Treatments at the Idaho National Engineering and Environmental Laboratory* (NAS 1999)
- A mixed transuranic waste/SBW processing analysis conducted by the management and operating contractor (Murphy et al. 2000) and detailed talks with authors
- Presentations by, and discussions with, waste processing subject matter experts
- Recommendations by the INEEL Citizens Advisory Board (CAB 2000)

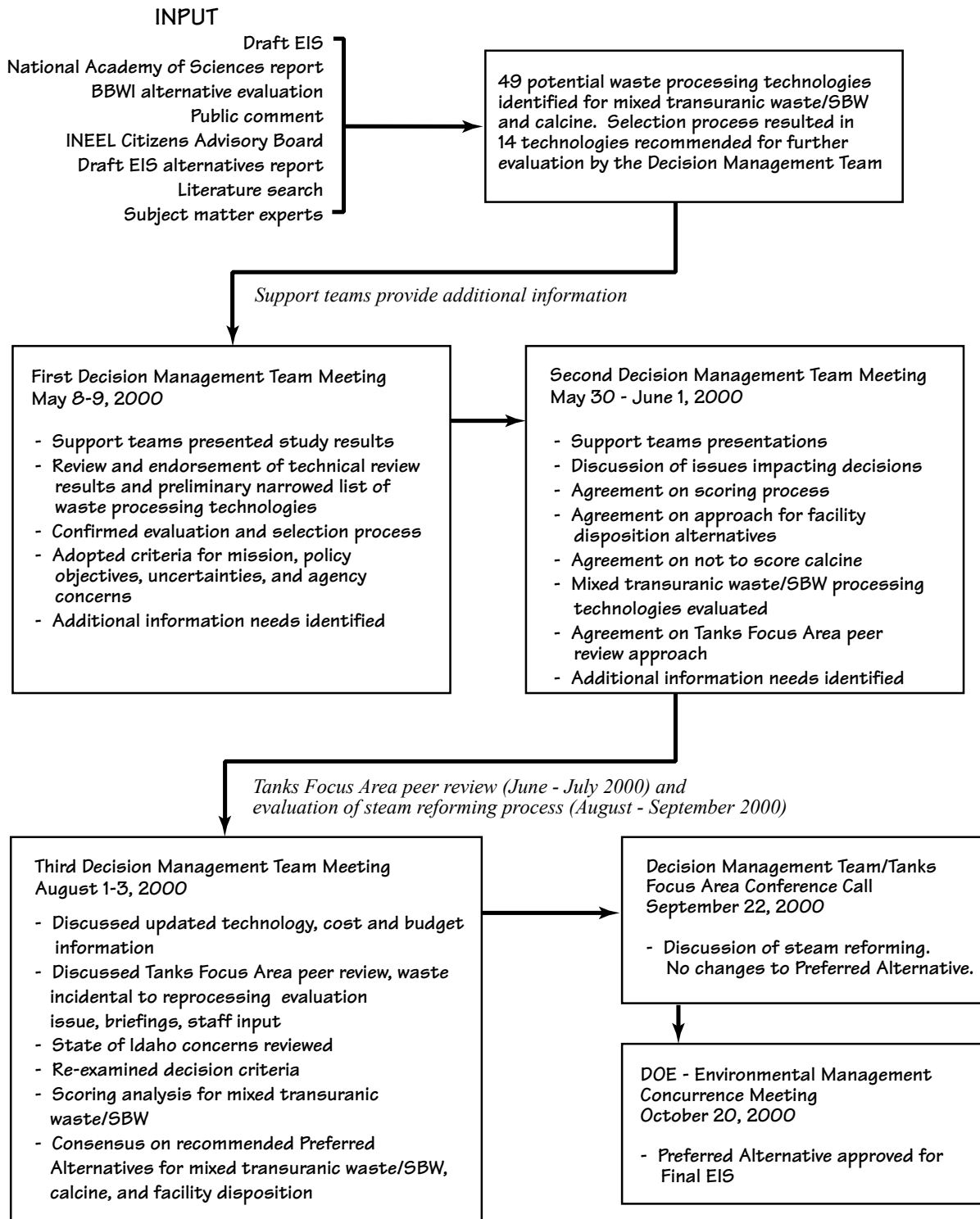


FIGURE B-2.
Overview of Decision Management Team.

- New Information -

- Input from the public from scoping activities, public involvement activities, and the Draft EIS public comment process
- Draft EIS alternative descriptions

Using this input and a structured alternatives identification process, the Decision Support Team identified 34 potential mixed transuranic waste/SBW treatment technologies and 15 potential calcine treatment technologies. The potential mixed transuranic waste/SBW treatment technologies were also applicable to newly generated liquid waste. The Decision Support Team then developed screening criteria. These criteria were eventually incorporated into one comprehensive list. Go/no-go criteria were also developed and used to screen out technologies. If a technology failed to meet this criteria, it was not scored. The go/no-go criteria were:

- Judged to be reasonable and satisfies "purpose and need" for this EIS
- Meets INTEC objectives of ultimate disposition of DOE radioactive liquid waste, calcine, and contaminated mixed debris according to regulatory requirements
- All the liquid in the 300,000 gallon underground tanks and all calcine in the bin sets is treated and made ready to leave Idaho by 2035

This process eliminated most of the technologies, leaving the most promising for further review.

The Decision Management Team was tasked with reviewing the technical data provided on various waste processing technologies, and determining if the data presented were suitable to support the identification process and if all reasonable technologies had been considered.

In addition, the Decision Management Team considered public and agency comments on the Draft EIS. The 15 key issues expressed from the comment period on the Draft EIS are listed below:

- Treatment alternatives
- Continued public involvement
- Meeting agreements/requirements versus making sound technical decisions
- Federal government obligations to States/Tribes versus funding constraints
- Scope of EIS (cost, technical viability)
- Continued calcine operations
- Treat liquids (mixed transuranic waste/SBW) first
- Protection of air and water
- Concern over the capability to fund alternatives
- DOE credibility
- Reclassification of waste
- Long-term stewardship of the land
- Issues affecting disposal
- Maintaining agreements with tribes
- Opposition to waste incineration

The Decision Management Team considered this information as it developed the goals and criteria used for evaluating, narrowing, and scoring the mixed transuranic waste/SBW technologies. For instance, the public preferences for no separations treatments and no incineration-type treatments were considered and discussed as the technologies were scored. These considerations and all other public issues identified were folded into appropriate criteria for scoring and were discussed as each technology was scored by the Decision Management Team. The Decision Management Team also periodically briefed and received guidance/direction from senior DOE/EM management on the nature of the public comments received, and the team's process for factoring the consideration of public comments into its deliberations.

The Decision Management Team also decided that an independent peer review team would be tasked with reviewing and evaluating the adequacy of the Preferred Alternative identification process and making independent recommendations. The requested independent review was conducted by the DOE Tanks Focus Area Peer Review Team. This team included experts in the field of HLW processing from Hanford, the Savannah River Site, Los Alamos National Laboratory, Oak Ridge National Laboratory, Syracuse University, and a consulting company. The Tanks Focus Area Peer Review Team issued a report in July 2000 (TFA 2000). The team concluded "DOE-ID and contractor staff have implemented a technology identification process and path forward planning approach that is very likely to succeed." (TFA 2000)

For mixed transuranic waste/SBW processing, the Tanks Focus Area Peer Review Team recommended adoption of direct vitrification as the baseline Preferred Alternative, with cesium ion exchange as a backup process. For treatment of calcine, the team recommended that DOE continue to develop direct vitrification and separations options and make final processing decisions consistent with plans to meet the 2035 "road-ready" compliance date specified by the Settlement Agreement/Consent Order. Additional recommendations include detailed technology road mapping with adequate resources made available to support evaluations and development of technologies.

The Tanks Focus Area Peer Review Team was also asked to participate in the evaluation of the steam reforming process, an alternative suggested as a result of public review of the Draft EIS. The team concluded that steam reforming of liquid mixed transuranic waste/SBW would not generate a waste form that can be directly disposed in a repository.

The Decision Management Team's goals and final screening criteria that were used to score the mixed transuranic waste/SBW processing technologies incorporated criteria from the areas of technology, costs, environmental impacts, public concerns, mission, agency concerns, uncertainties, and policy. Overall goals and individual criteria measuring the success of the goals were established by the Decision Management Team (Table B-4).

The Decision Management Team met three times and had one conference call over a period of five months to discuss and evaluate the proposed waste processing technologies. The results of the meetings are summarized in Figure B-2. The narrowed set of potential mixed transuranic waste/SBW processing technologies were scored by the Decision Management Team at the final meeting in August 2000.

The Decision Management Team also decided against scoring the calcine processing technologies because DOE lacked information regarding calcine retrievability and the potential impact of calcine characterization on the success of separations and immobilization technologies. The Decision Management Team determined that these knowledge gaps warranted further technology development as part of the overall decision process on a Preferred Alternative for calcine.

B.9.2.2 Facility Disposition Alternative Evaluation

As the list of waste processing technologies was narrowed, the Decision Support Team evaluated the various technologies and determined which facilities would need to be disposed that are currently part of the HLW program or that would be constructed to support the preferred waste processing alternative. The facility disposition alternatives evaluated were those identified in the Draft EIS, namely:

- Clean closure, with no hazardous or radiological contamination detectable above background
- Performance-based closure, with cleanup and closure conducted on a case-by-case basis based on risk to the workers and public
- Landfill closure, with cleanup conducted to meet standards for landfills

Consistent with the objectives and requirements of DOE Order 430.1A, Life Cycle Management, and DOE Manual 435.1-1, Radioactive Waste Management Manual, all newly constructed facilities implementing the preferred waste processing alternative would be designed and con-

Table B-4. Goals and associated criteria used by the Decision Management Team to score mixed transuranic waste/SBW processing technologies.

Goal and Definition	Criteria
Maximize Meeting Schedule Commitments - Meet the 2012 and 2035 Settlement Agreement/Consent Order and Notice of Noncompliance Consent Order milestones.	1. Schedule risk 2. Liquid mixed transuranic waste/SBW road-ready date
Minimize Cost - Minimize the near-term costs as well as the life-cycle costs. Disposal cost includes packaging and transportation.	3. Projects and operational costs 4. Disposal cost
Minimize Technical Risk - Minimize the potential for selection of a technically nonviable waste processing technology.	5. Technical maturity 6. Risk of technical failure
Minimize Environment, Safety, and Health Impacts -Minimize (a) impact to workers during the construction and operation of the facilities, (b) public risk from transportation doses and accidents, and (c) risk to the environment from releases to the air, soil, and water.	7. Safety and health (worker) 8. Public risk 9. Environmental risk
Maximize Utilization by Other Wastes - Get the most from the technology in terms of processing newly generated liquid waste, tank heel solids, and calcine.	10. Newly generated liquid waste mission 11. Calcine mission 12. Heel solids mission
Maximize Ability to Dispose - Make a waste that can be disposed of as quickly as possible.	13. Maximizes early disposal

structed consistent with the measures that facilitate clean closure methods.

The team reviewed the list of existing HLW Program facilities for accuracy and developed a list of new facilities anticipated for each waste processing technology. The team determined that there were three measurable parameters impacting facility disposition decisions: (a) size of the new facility, (b) complexity of facility operations, and (c) volume of the waste streams generated during facility disposition. Using the relative waste volumes, size of facility, and a judgment of process complexity, the team participated in an evaluation process that assigned a ranking score for each of the individual treatment technologies as it related to the requirements and activities associated with facility disposition.

The primary conclusion made by the Decision Management Team was that there were no facility disposition discriminators that would affect the team's decisions related to the preferred waste processing alternative. The team also con-

cluded that the total environmental impact to meet facility disposition requirements for the EIS is considerably less significant when compared with the total environmental impacts associated with waste processing activities.

B.9.3 PREFERRED ALTERNATIVES

B.9.3.1 Decision Management Team's Recommended Preferred Alternative

This section summarizes the Decision Management Team's recommended Preferred Alternative.

B.9.3.1.1 *Waste Processing*

Mixed Transuranic Waste/SBW Treatment Preferred Alternative - Direct vitrification was recommended by the Decision Management Team because it has the advantage of being a

mature technology with a lower risk of technical failure, and the final waste form (borosilicate glass) is the EPA's approved form for disposal in the HLW national geologic repository. Converting the mixed transuranic waste/SBW to glass would allow the waste to go to either the Waste Isolation Pilot Plant or the HLW geologic repository. Vitrification also has the advantage of being able to treat both mixed transuranic waste/SBW and calcine, although some modifications to the treatment process would be required for the treatment of calcined waste. Use of vitrification for both waste types enables the prorating of facility and processing costs, thereby reducing the overall cost for mixed transuranic waste/SBW processing.

The final disposal for vitrified SBW would depend on the outcome of the Waste Incidental to Reprocessing determination required by DOE Order 435.1 (DOE 1999b). The Waste Incidental to Reprocessing process is being used to determine whether the SBW at INTEC can be managed as mixed transuranic waste. The designation of the vitrified SBW as HLW would require disposal of the waste in a HLW national geologic repository (assumed to be Yucca Mountain). If the vitrified SBW were designated as transuranic waste, it would be disposed of at the Waste Isolation Pilot Plant. Disposing the vitrified SBW at the Waste Isolation Pilot Plant has the advantages of lower disposal costs, schedule compatibility with INEEL proposed processing times, a final waste form that would meet the Waste Isolation Pilot Plant waste acceptance criteria, and adequate disposal space to handle INEEL waste.

The HLW national geologic repository has not developed a final waste acceptance criteria, the schedule for opening the proposed Yucca Mountain facility (the only site currently being studied for a HLW geologic repository) is uncertain, and there are concerns on the adequacy of capacity available to accommodate DOE HLW. However, regardless of which location the final waste form is disposed of, it will be protective of human health and the environment.

Calcine Treatment Preferred Alternative - The Decision Management Team's recommended Preferred Alternative for calcine was to retrieve the calcine presently stored in the six bin sets at INTEC, vitrify it, and place it in a form to enable

compliance with the current legal and regulatory requirement to have HLW road ready by a target date of December 31, 2035. Concurrent with the program to design, construct, and operate the vitrification facility for mixed transuranic waste/SBW, DOE would initiate a program to characterize the calcine, and develop methods to construct and install the necessary equipment to retrieve calcine from the bin sets. DOE would focus technology development on the preferred calcine treatment technology of vitrification, and the feasibility and merits of performing calcine separations as well as refine cost and engineering design. Conditioned on the outcome of future technology development and resulting treatment decisions, DOE could design and construct the appropriate calcine separations capability at INEEL. For treatment of separated mixed HLW fractions, DOE would also evaluate the use of Hanford vitrification capabilities as they are developed. A final treatment decision on the specific waste processing method would be anticipated after 2007 when technology development would be completed.

Newly Generated Liquid Waste Treatment Preferred Alternative - In 2005, DOE intends to redirect all newly generated liquid waste to tanks that meet state and federal Resource Conservation and Recovery Act regulations, or treat the waste directly. Under the Decision Management Team's Preferred Alternative, the newly generated liquid waste stream would be completely segregated from the mixed HLW calcine and mixed transuranic waste/SBW streams and would contain no fraction requiring management as HLW. Newly generated liquid waste could be grouted in containers and disposed of as low-level waste or transuranic waste, depending on its characteristics.

B.9.3.1.2 Facility Disposition

Consistent with the objectives and requirements of DOE Order 430.1A, Life Cycle Management, and DOE Manual 435.1-1, Radioactive Waste Management Manual, all newly constructed facilities implementing the preferred waste processing alternative would be designed and constructed consistent with the measures that facilitate clean closure methods. For existing HLW facilities, the Decision Management Team's Preferred Alternative was to apply, on a

case-by-case basis, the most viable closure options, that would provide a systematic reduction of risks due to residual wastes and contaminants. These remaining residual wastes would be immobilized by methods such as grouting and disposed of in-place and monitored in accordance with the applicable requirements of RCRA and Idaho Hazardous Waste Management Act. Closure would be performed to levels economically, practically, and technically feasible such that satisfactory protection of the environment and the public is achieved in accordance with applicable regulations.

The Decision Management Team's Preferred Alternatives for mixed transuranic waste/SBW processing, newly generated liquid waste, calcine processing, and facility disposition were identified for recommendation to DOE/EM. Final approval of the alternatives recommended by the Decision Management Team was obtained from the DOE Assistant Secretary for Environmental Management on October 20, 2000.

After DOE and the State of Idaho identified the alternative of vitrification with or without calcine separations, it was decided to use the term "direct vitrification" in reference to the broader alternative with "vitrification without calcine separations" and "vitrification with calcine separations" to distinguish options. The new alternative referred to in this EIS as Direct Vitrification is described in Section 3.1.6.

B.9.3.2 DOE's Preferred Alternative

As discussed in the previous section, DOE and the State of Idaho identified vitrification of the mixed transuranic waste/SBW and calcine with or without separations as the Preferred Alternative in October 2000. In September 2001, DOE conducted an assessment of the alternatives and options using the following assumptions:

- Sodium bearing waste is mixed transuranic waste
- Treated SBW can be disposed of at WIPP
- Calcine is an acceptable final waste form for disposal at the geologic repository
- Steam reforming is an acceptable treatment technology for the SBW
- The liquid mixed transuranic waste/SBW can be grouted in place
- The calciner can be operated in its present interim status configuration.

With these assumptions as a basis, and also in consideration of public comment on the Draft EIS, DOE decided on a performance based rather than a technology based Preferred Alternative for waste processing. DOE's Preferred Alternative for facility disposition is the same as that identified by DOE and the State of Idaho in October 2000.

The revised Preferred Alternative for waste processing focuses on the removal and stabilization of the remaining liquids, without specifying a stabilization technology. There is a range of technologies, analyzed in the EIS that meet this performance objective.

With respect to the alternative of continued calcination of the remaining liquids, the current analysis regarding operation of the calciner with modifications to comply with environmental regulations would be maintained. Operating the calciner in its present interim status configuration was evaluated and eliminated from detailed analysis in the Final EIS based on programmatic considerations.

The alternative of disposing of the grouted liquid waste *in situ* was re-evaluated and eliminated from detailed analysis considering the complexity of the stabilization process and regulatory obstacles involved. Based on the re-evaluation it is included in the Final EIS as an alternative considered but eliminated from detailed analysis.

An additional option called Steam Reforming has been added to the Non-Separations Alternative. This option analyzes the use of a steam reforming technology to treat the mixed

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transuranic waste/SBW, and incorporates updated information received since the Tanks Focus Area report was issued that recommended steam reforming as an offgas treatment. In addition, this option includes the analysis for placing the HLW calcine in containers and sending it directly to a repository. This option is structured similar to the alternatives/options analyzed in the EIS for comparison purposes.

DOE has decided to identify a Preferred Alternative that meets performance objectives rather than a single technology. Thus, DOE's Preferred Alternative is to implement a slightly revised version of the Proposed Action presented in Chapter 1 of this EIS. The Preferred Alternative is a performance-based rather than technology-based approach to fulfilling the Department's statutory mission and responsibilities. The performance objectives could be accomplished through implementing technologies and actions representative of those analyzed in the EIS. The Proposed Action and the performance objectives of the Preferred Alternative are presented below:

- **Develop appropriate technologies and construct facilities necessary to prepare INTEC mixed transuranic waste/SBW for shipment to WIPP** - DOE would treat all mixed transuranic waste/SBW stored in the INTEC Tank Farm and ship the product waste to WIPP for disposal. A range of potential treatment technologies representative of those that could be used is analyzed in this EIS. The Department's objective is to treat the mixed transuranic waste/SBW such that this waste would be ready for shipment to WIPP by December 31, 2012.
- **Prepare the mixed HLW calcine so that it will be suitable for disposal in a repository** - DOE would place all mixed HLW calcine in a form suitable for disposal in a repository. This may include any of the treatment technologies analyzed in this EIS in addition to shipment to a repository without treatment as analyzed in this final EIS. The

Department's objective is to place the mixed HLW calcine in a form such that this waste would be ready for shipment out of Idaho by December 2035.

- **Treat and dispose of associated radioactive wastes** - DOE would treat and dispose of all wastes associated with the treatment and management of HLW and mixed transuranic waste at INTEC. This includes the treatment and disposal of newly generated liquid waste. A range of the potential treatment technologies that could be used is analyzed in this EIS.
- **Provide safe storage of HLW destined for a repository** - DOE will continue to store mixed HLW calcine in the INTEC calcine bin sets until the calcine is retrieved for treatment or placed in containers for shipment to a repository.
- **Provide for the disposition of INTEC HLW management facilities when their missions are completed** - DOE will disposition existing INTEC HLW management facilities in accordance with performance based closure standards. All newly constructed facilities necessary to implement the Proposed Action/Preferred Alternative would be designed and constructed consistent with measures that facilitate clean closure.

Selection and implementation of specific technologies would be based on a balance of optimum treatment and cost effectiveness with reduction of risk to human health and the environment. The range of potential environmental impacts and risk to human health, including cumulative impacts, under any of the currently available technologies is characterized by the analysis in this EIS. The alternatives are composed of modular options and projects that may be combined and configured as needed to implement the Proposed Action/Preferred Alternative.

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Appendix B

B.9.3.3 State of Idaho's Preferred Alternative

The State of Idaho has elected to keep the Preferred Alternative recommended by the Decision Management Team as the State of Idaho's Preferred Alternative. The State is willing to reconsider its preference if further development of other technologies or analysis of repository and transportation requirements indicates another alternative meets the following criteria:

- The alternative meets transportation and repository waste acceptance requirements to enable DOE to ship all HLW and mixed transuranic waste/SBW and any fraction thereof out of Idaho;
- The alternative has environmental impacts comparable or less than those of the State's Preferred Alternative;
- The alternative can be completed in a comparable or shorter timeframe; and
- The alternative is of comparable or lower cost.

B.9.3.3.1 Waste Processing

The State of Idaho's Preferred Alternative for waste processing is the Direct Vitrification Alternative described in Section 3.1.6. This alternative includes vitrification of mixed transuranic waste/SBW and vitrification of the HLW calcine with or without separations.

Under the option to vitrify the mixed transuranic waste/SBW and calcine without separations, the mixed transuranic waste/SBW would be retrieved from the INTEC Tank Farm and vitrified. Calcine would be retrieved from the bin sets and vitrified. In both cases, the vitrified product would be stored at INTEC pending disposal in a geologic repository.

The option to vitrify the mixed transuranic waste/SBW and vitrify the HLW fraction after calcine separations would be selected if separations were shown to be technically and economically practical. Mixed transuranic waste/SBW

would be retrieved from the INTEC Tank Farm and vitrified. Calcine would be retrieved from the bin sets and chemically separated into a HLW fraction and transuranic or low-level waste fractions, depending on the characteristics of the waste fractions. The HLW fraction would be vitrified. In both cases, the vitrified product would be stored at INTEC pending disposal in a geologic repository. The transuranic or low-level waste fractions would be disposed of at an appropriate disposal facility outside of Idaho.

In addition, under the Direct Vitrification Alternative, newly generated liquid waste could be vitrified in the same facility as the mixed transuranic waste/SBW, or DOE could construct a separate treatment facility for newly generated liquid waste.

B.9.3.3.2 Facility Disposition

The State of Idaho's Preferred Alternative for facility disposition is the same as that recommended by the Decision Management Team. DOE would disposition existing INTEC HLW management facilities in accordance with performance based closure standards. All newly constructed facilities necessary to implement the Preferred Alternative would be designed and constructed consistent with measures that facilitate clean closure.

B.10 Final List of Final EIS Alternatives

Therefore, as a result of all the activities discussed in this Appendix, the Final Idaho HLW & FD EIS analyzed the following waste processing alternatives and options:

1. No Action Alternative
2. Continued Current Operations Alternative
3. Separations Alternative
 - A. Full Separations Option

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- B. Planning Basis Option
- C. Transuranic Separations Option
- 4. Non-Separations Alternative
 - A. Hot Isostatic Pressed Waste Option
 - B. Direct Cement Waste Option
 - C. Early Vitrification Option
- D. Steam Reforming Option
- 5. Minimum INEEL Processing Alternative
- 6. Direct Vitrification Alternative
 - A. Vitrification without Calcine Separations Option
 - B. Vitrification with Calcine Separations Option

Appendix B References

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