ECE-HANFORD-21-00002
Revision 1

Environmental Cost Estimate for the Fast Flux Test Facility (FFTF) Complex

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract 89303320DEM000030

CPCCo
Central Plateau
Cleanup Company

P.O. Box 1464
Richland, Washington 99352

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C. M. Ocampo
Central Plateau Cleanup Company LLC (CPCCo)

Date Published
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P.O. Box 1464
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APPROVED
By Sarah Harrison at 1:35 pm, Oct 31, 2023

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CPCCO ENVIRONMENTAL COST ESTIMATE COVER PAGE

Part 1: To be completed by the ER&QA Lead Cost Estimator

Project: Engineering Evaluation/Cost Analysis for the Fast Flux Test Facility (FFTF) Complex	**Date:** 9/13/2023

Calculation Title & Description: Environmental Cost Estimate (ECE) for the FFTF Complex, prepared to support the response alternatives provided in DOE/RL-2020-52, Engineering Evaluation/Cost Analysis for the Fast flux Test Facility (FFTF) Complex.

James Horton **Project Cost Estimator(s)**	**Basis of Qualification:** 20 years expereince in preparing certified cost estimates for Department of Energy, USACE, CHPRC, Betchel, Jacobs, CPCCo, and various subcontractors and certified by AACE as a Certified Cost Professional.
Bob Cathel **Cost Estimate Checker**	**Basis of Qualification:** Environmental Manager with B.S. Engineering and 25+ years experience in nuclear waste cleanup projects.
Craig Arola **ER & QA Lead Cost Estimator**	**Basis of Qualification:** Lead CPCCo environmnetal cost estimator with over 15 years of environmnetal cost estimating experience.

Part 2: To be completed by Project Cost Estimator

Calculation No.: ECE-HANFORD-21-00002 **Revision No.:** 1

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Revision No.	Description	Date	Affected Pages
0	Initial Release	3/20/2023	All
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Part 3: Document Review & Approval

	NAME/POSITION / SIGNATURE	DATE
Project Cost Estimator:	James Horton james Horton Digitally signed by james Horton Date: 2023.09.13 14:31:49 -07'00'	
Cost Estimate Checker:	Bob cathel Cathel, Robert L Digitally signed by Cathel, Robert L Date: 2023.09.13 15:16:03 -07'00'	
ER & QA Lead Cost Estimator:	Craig Arola CRAIG AROLA (Affiliate) Digitally signed by CRAIG AROLA (Affiliate) Date: 2023.09.15 04:17:13 -07'00'	
Project Manager:	Randy May Randall May Digitally signed by Randall May Date: 2023.09.18 09:03:09 -07'00'	
Responsible Manager:	Randy May Randall May Digitally signed by Randall May Date: 2023.09.18 09:02:19 -07'00'	

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SIGNATURE	DATE

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Terms

CPCCo	Central Plateau Cleanup Company
DOE	U.S. Department of Energy
ECE	environmental cost estimate
EE/CA	engineering evaluation/cost analysis
ERDF	Environmental Restoration Disposal Facility
FFTF	Fast Flux Test Facility
FSF	Fuel Storage Facility
FY	fiscal year
G&A	general and administrative
HTS	heat transport system
IC	institutional control
MDBI	mobilization/demobilization/bonding/insurance
O&M	operations and maintenance
OH&P	overhead and profit
RCB	Reactor Containment Building
S&M	surveillance and maintenance
TRACE V4	Tool for Response Action Cost Estimating, Version 4
TSS	technical support services

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1 Introduction

This environmental cost estimate (ECE) was prepared to support the evaluation of removal action alternatives as documented in DOE/RL-2020-52, *Engineering Evaluation/Cost Analysis for the Fast Flux Test Facility (FFTF) Complex* (hereinafter called the Fast Flux Test Facility [FFTF] Engineering Evaluation/Cost Analysis [EE/CA]).

Cost estimates for each building and structure summarized in this ECE have been prepared to support the selection of the removal action alternative. Input parameters and related calculations used in the development of this ECE were found in historical photographs and engineering documents. The cost estimates reflect specific removal action alternative approaches, scope, assumptions, and exclusions as well as cost estimating methodologies. The removal action alternative cost estimates have expected ranges of accuracy described in Chapter 11.

2 Purpose of Estimate

This ECE provides costs needed to support the FFTF EE/CA (DOE/RL-2020-52) and an overview of removal action specific cost inputs, methodology, and results. The purpose of this ECE is to accomplish the following objectives:

- Describe the methodology applied in performing the cost estimates
- Describe the general and specific removal action assumptions and inputs applied to the subject cost estimates
- Summarize the removal action alternative cost estimates

This ECE also documents the references that provide scope and information used to prepare these estimates.

This ECE has been prepared from the information available at the time of the estimate. The final cost of the project will depend on final design, selected scope of work, actual labor and material costs, competitive market conditions, implementation schedule, and other factors. As a result, final project costs are expected to vary from the estimate presented in this document. The cost estimate was generated using the most recent version of the Tool for Response Action Cost Estimating (TRACE) Version 4 (V4) workbook (Rev. 4) in Microsoft® Excel®.

3 General Project Description

The FFTF EE/CA (DOE/RL-2020-52) identifies removal action alternatives and evaluates them against the following criteria: removal action objectives, effectiveness, implementability, and estimated cost.

The Washington State Department of Ecology is the lead regulatory agency for this removal action. The U.S. Department of Energy (DOE) is voluntarily seeking the Washington State Department of Ecology review and concurrence of the removal action to help ensure consistency with ongoing or subsequent related remedial actions.

The FFTF Complex was built in 1978 and reactor operation was initiated in April 1982. During its operation, the FFTF Complex successfully tested advanced nuclear fuels, materials, components,

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operating protocols, and reactor safety designs. It also produced a wide variety of medical isotopes, made tritium for the U.S. Fusion Research Program, and provided international nuclear testing support.

The FFTF Complex was originally designed and operated as a science test bed for U.S. liquid metal fast reactor programs. These programs, canceled in 1993, were key elements both in closed fuel cycle and actinide waste disposition technology development. In December 1993, DOE decided not to operate the FFTF Complex because of a lack of economically viable missions. In accordance with the *National Environmental Policy Act of 1969*, DOE published an environmental assessment and Finding of No Significant Impact for the shutdown and deactivation of the FFTF Complex in May 1995. The environmental assessment evaluated the environmental impacts of actions necessary to place the FFTF Complex in a radiologically and industrially safe shutdown condition.

From 1994 through 1996, deactivation activities were conducted that included offloading fuel to interim dry storage casks, construction of the 402 Sodium Storage Facility, and preparation to drain sodium. In January 1997, DOE ordered the FFTF Complex to return to a standby condition while an evaluation was conducted of any future role the facility might have in DOE's tritium-production strategy. Evaluations of other new missions for the FFTF Complex to determine if the facility could be used to support DOE's nuclear infrastructure were also performed. In December 2001, DOE indicated the facility was not needed and directed that the FFTF Complex continue with permanent deactivation. However, in November 2002, sodium draining and other deactivation activities were again placed on hold due to a court injunction prohibiting any irreversible deactivation activities based on potential legal action by Benton County. On April 4, 2003, DOE directed that the FFTF Complex will proceed with permanent deactivation.

Deactivation was completed in 2008 and the complex has been under surveillance and maintenance (S&M) since that time. S&M activities are being performed in accordance with the current S&M plan (DOE/RL-2009-26, *Surveillance and Maintenance Plan for the Fast Flux Test Facility (FFTF)* [hereinafter referred to as the FFTF S&M plan]). S&M activities will continue as part of this removal action and details will be included in the associated removal action work plan. All structures evaluated under the FFTF EE/CA (DOE/RL-2020-52), and therefore this ECE, are listed in Table 1 and shown in Figure 1.

Table 1. FFTF Complex Evaluated Structures

Structure Identification	Building/Structure Name
Alternative 2	
403	Fuel Storage Facility
408A	Main Heat Dump, East
408B	Main Heat Dump, South
408C	Main Heat Dump, West
491E	HTS Service Building, East
491S	HTS Service Building, South
491W	HTS Service Building, West
4717	Reactor Service Building
Alternative 3	
Structures listed in Alternative 2 plus:	

Table 1. FFTF Complex Evaluated Structures

Structure Identification	Building/Structure Name
405	Reactor Containment Building

HTS = heat transport system

Figure 1. FFTF Complex Buildings/Structures in the Scope of this Removal Action

4 Scope of Work

This ECE for the FFTF EE/CA (DOE/RL-2020-52) was developed in accordance with OSWER 9355.0-75, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study,* and Central Plateau Cleanup Company (CPCCo) procedures.

4.1 Removal Action Alternatives

Removal action alternatives were developed for all buildings and structures evaluated within the FFTF Complex EE/CA (DOE/RL-2020-52).

The FFTF Complex consists of the following:

- 403 Fuel Storage Facility (FSF)

- 405 Reactor Containment Building (RCB)
- 408A Main Heat Dump, East
- 408B Main Heat Dump, South
- 408C Main Heat Dump, West
- 491E Heat Transport System (HTS) Service Building, East
- 491S HTS Service Building, South
- 491W HTS Service Building, West
- 4717 Reactor Service Building

The alternatives developed include specific actions to occur within each structure. Each successive alternative includes all of the structure-specific actions involved in the previous alternative, with the addition of new actions for various structures as outlined in each of the alternative sections.

Each alternative, with the exception of Alternative 1, includes S&M and hazard abatement. Waste generated from these actions will be treated and disposed of properly. These action activities are described in the following sections.

4.1.1 Surveillance and Maintenance

S&M activities will be performed according to the most current FFTF S&M plan (DOE/RL-2009-26). Activities conducted during the S&M phase are established to monitor containment of contaminants left in place, provide physical safety and security controls, and maintain the facility in a manner that will minimize risk to human health and the environment. S&M activities may be conducted on a routine or nonroutine basis. Routine activities ensure that the structural and passive confinement integrity is maintained and may include periodic monitoring for potential radiological contamination, maintenance, identification and minor repair of friable asbestos, general visual inspections, and annual roof inspections. Nonroutine activities include major responses to hazardous conditions (e.g., a leak in one area spreading radiological contamination to another area). Surveillance must satisfy the inspection requirements identified in Table 7-1 of the FFTF S&M plan. The FFTF S&M plan will be revised to reflect the current facility conditions and identify appropriate surveillance requirements, as needed.

4.1.2 Hazard Abatement

Hazard abatement differs from S&M in that it allows for a proactive response to mitigate or reduce risk before a major response would be required. Hazard abatement may range from stabilization to complete removal of equipment and waste, as needed, to mitigate hazards. Identification of areas that will receive hazard abatement will be based on S&M activities and observations.

4.2 Alternative 1 – No Action

The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* requires the "No Action" alternative as a baseline for comparison with other removal action alternatives. Under the No Action alternative, it is assumed that no legal restrictions, institutional controls (ICs), or active measures are applied to the buildings and structures in this alternative; therefore, the alternative has no associated costs.

S&M activities would be discontinued, no additional facility stabilization would be performed, and degradation would continue. Initial risks to human health and the environment of the No Action alternative would be minimal, and barring an unusual event, contaminants are assumed to remain confined within the structures. Risks over time are expected to increase as deterioration progresses and structural integrity is compromised. The possibility of a chemical and radiological contamination spread would increase due to a lack of monitoring and controls. Physical hazards associated with structural collapse would also be anticipated.

Although Alternative 1 would not have an associated implementation cost under this analysis, it is understood that taking No Action would ultimately result in a substantial cost in the future due to addressing degradation of the facility. Alternative 1 is not consistent with DOE obligations under federal law to protect human health and the environment; therefore, this alternative was not considered viable in the FFTF EE/CA (DOE/RL-2020-52). This alternative is used as a baseline for comparison only.

4.3 Alternative 2 – Continued Surveillance and Maintenance/Hazard Abatement of Tier 2 Structures

The primary elements of Alternative 2 are as follows:

- Continued S&M of the FFTF Complex
- Hazard abatement of eight Tier 2 structures (403, 408A, 408B, 408C, 491E, 491S, 491W, and 4717)

Figure 2 provides a general overview of the removal activities that would be implemented under Alternative 2.

Under Alternative 2, S&M activities would continue for the entire FFTF Complex. Hazard abatement would take place in the eight Tier 2 structures. The scope of each removal activity is described in the following sections.

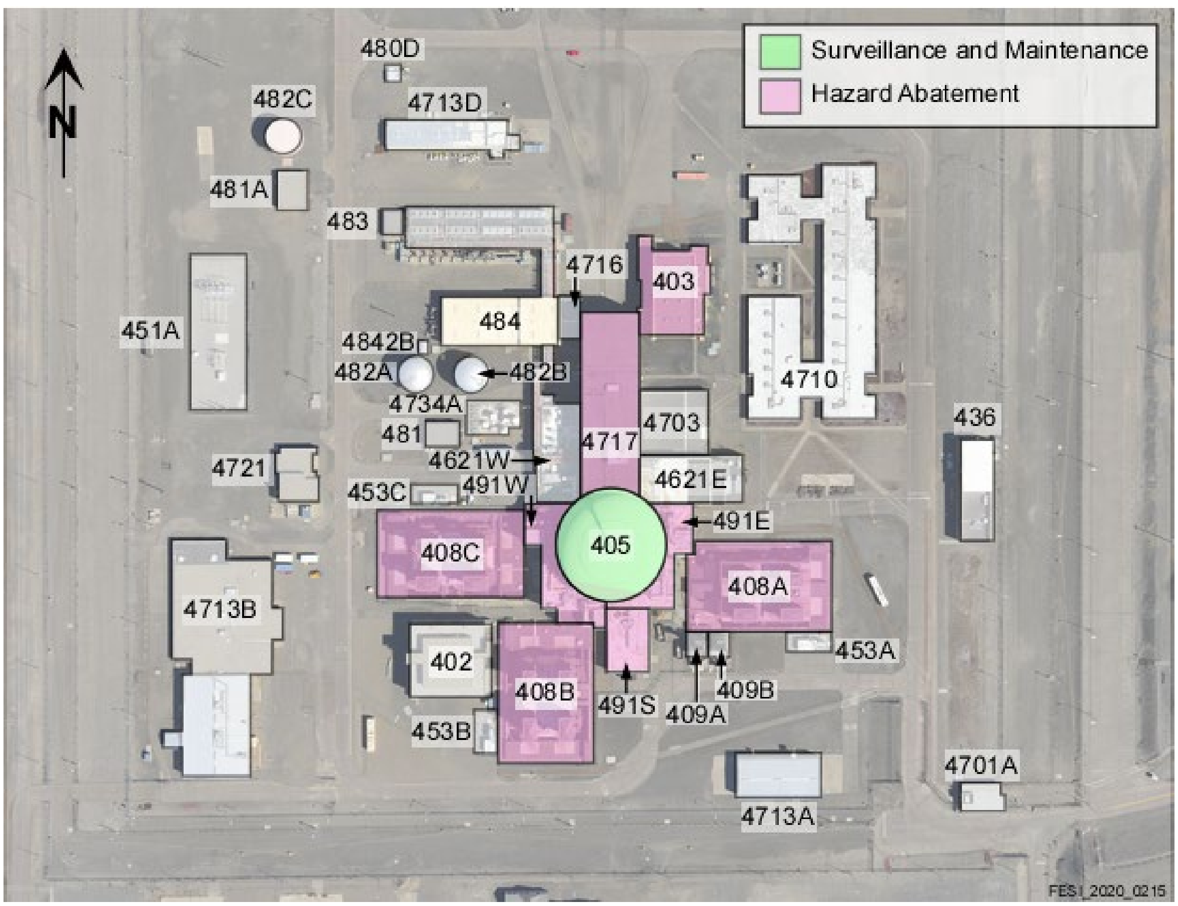


Figure 2. Alternative 2 Proposed Actions

4.3.1 Surveillance and Maintenance

Under Alternative 2, S&M activities for the FFTF Complex, including the 405 RCB and the eight Tier 2 structures, would be performed for 10 years. S&M is anticipated to continue past the 10-year duration of the non-time-critical removal action but is not included in the cost estimate. The General Decommissioning structures within the 400 Area Implementation Area would also be part of the S&M activities. S&M efforts are expected to increase over time in areas where no additional removal actions will take place due to continued aging of structures and components. No facility lifecycle upgrades will be performed.

4.3.2 Hazard Abatement

The eight Tier 2 structures (403, 408A, 408B, 408C, 491E, 491S, 491W, and 4717) contain pipes, tanks, and equipment that are chemically and radiologically contaminated. Alternative 2 proposes proactive mitigation of risks that pose a threat to human health and the environment. Hazard abatement in the eight Tier 2 structures includes stabilization or, if possible, complete decontamination and removal of the sources of contamination. Hazard abatement also includes removal of some piping and equipment, as necessary. If cleanout is not possible in the structures, contamination would be stabilized in place. Removal and treatment of bulk sodium is outside the scope of the removal action. Removal and treatment of sodium residuals located in the eight Tier 2 structures may be performed if needed.

4.4 Alternative 3 – Continued Surveillance and Maintenance/Hazard Abatement of the 405 Reactor Containment Building and Tier 2 Structures

Alternative 3 includes all activities in Alternative 2 with the addition of hazard abatement of the 405 RCB:

- Continued S&M of the FFTF Complex (Alternative 2)
- Hazard abatement of eight Tier 2 structures (403, 408A, 408B, 408C, 491E, 491S, 491W, and 4717) (Alternative 2)
- Hazard abatement of the 405 RCB

Removal and treatment of bulk sodium in the 405 RCB is outside the scope of the removal action. Removal and treatment of sodium residuals located in the 405 RCB may be performed if needed.

Figure 3 provides a general overview of the removal activities for Alternative 3.

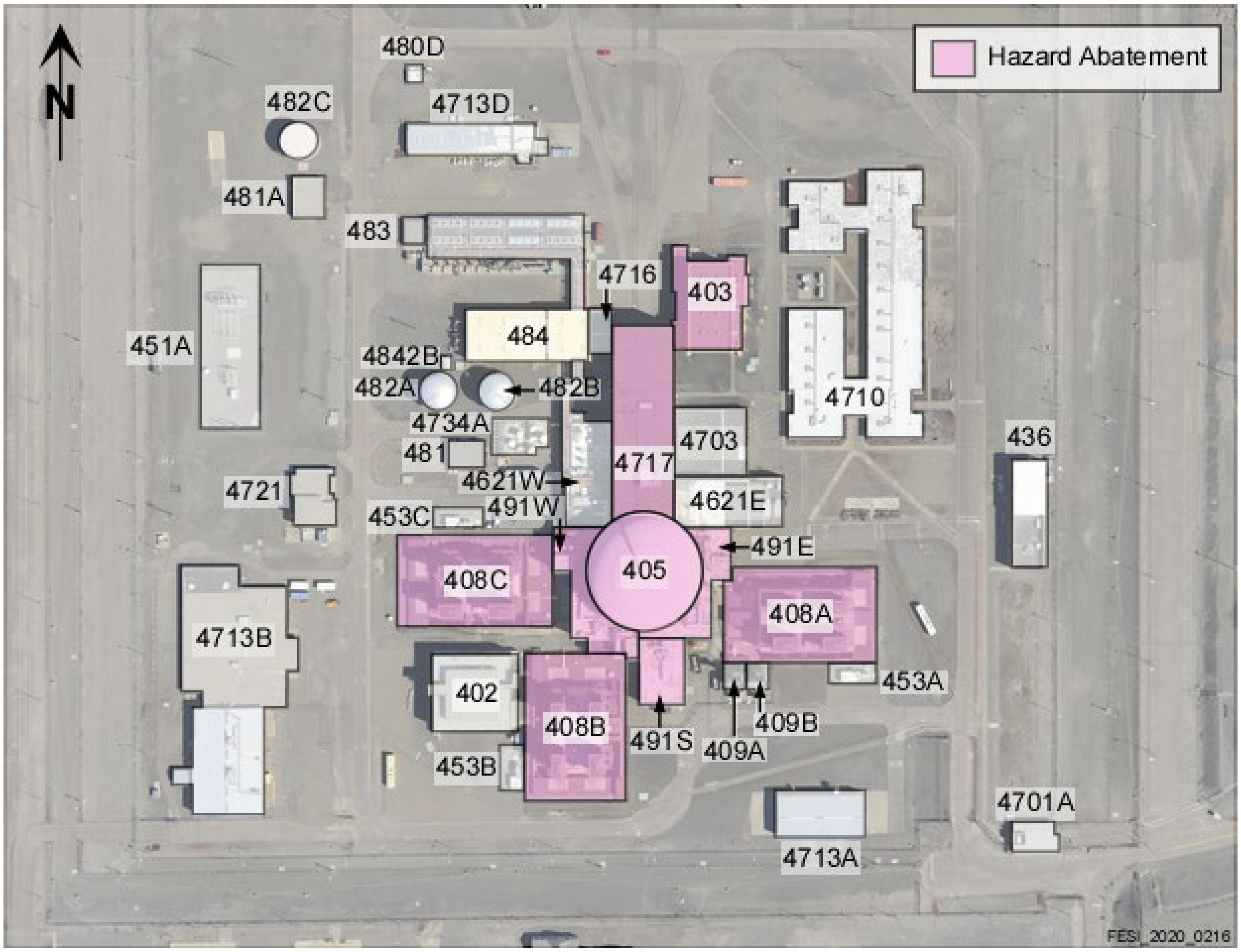


Figure 3. Alternative 3 Proposed Actions

5 Major Assumptions

The assumptions used in the estimate include general and specific cost assumptions.

5.1 General Assumptions and Inputs

General assumptions include the following direct cost factors, indirect cost factors, and other general pricing assumptions:

- Markups are included for mobilization/demobilization/bonding/insurance (MDBI), overhead and profit (OH&P), taxes, contingency, and general and administrative (G&A) (see Chapter 7).
- Markups for project management, removal action design costs, and construction management are included (see Chapter 9).
- Project will have a duration of 10 years.

5.2 Specific Assumptions

Specific assumptions are broken out by the following categories: Site Preparation, Labor, Waste Disposal, Waste Treatment, Waste Transportation, Sampling and Analysis, Operations and Maintenance (O&M) Costs, and Other.

5.2.1 Site Preparation

Site preparation will be conducted prior to removal action activities, with the following assumptions:

- Modifications to existing life safety documentation (fire hazards analysis and documented safety analysis) are required prior to initiating removal action activities following completion of facility updates.
- Removal and treatment of bulk sodium will not occur.
- Removal and treatment of sodium residuals may be performed, if needed.
- Removal of equipment will be limited to allow access to systems and components.
- Argon system will be kept operational.
- Existing office space will be used for temporary office, restroom, lunchroom, and conference rooms.
- Electrical and mechanical systems will be isolated before hazard removal.
- Temporary power will be used to support the argon system.
- Period of performance will be from fiscal year (FY) 2025 to FY 2035.
- Removal of hazardous waste will be performed in year 10.
- The Environmental Restoration Disposal Facility (ERDF) cost will be used for treatment and stabilization of waste, assuming 10% of total waste requires treatment.
- Equipment removal rate of 30 tons/day average is assumed.

5.2.2 Labor

Labor costs and duration include the following assumptions:

- Cost and time are necessary for mockups. A mockup is a simulation exercise for workers to practice a hazardous activity in a controlled environment prior to attempting the actual activity. Mockup costs include labor, equipment, and materials.
- Average of 19 workdays per month is assumed.
- Current radiological controls practices will continue for the duration of the project.

The TRACE V4 workbook provides the duration of each labor activity for all alternatives and a breakdown on worker types and hours.

5.2.3 Waste Disposal

Calculations for equipment volumes and weight for disposal are discussed in the TRACE V4 workbook of this ECE. Waste disposal includes the following assumptions:

- Hazard abatement activities will remove 10% of equipment from designated areas.
- All contaminated wastes meeting acceptance criteria are to be disposed of at ERDF as low-level waste/mixed low-level waste.
- Average load to ERDF is 13 tons.
- Sorting of waste prior to disposal will not be necessary.

5.2.4 Waste Treatment

The waste treatment cost breakdown is described in the TRACE V4 workbook and contains the following assumptions:

- ERDF containers hold 13 tons of debris.
- Treatment for each ERDF container requires 4 hours to complete.
- 10% of waste will require treatment prior to ERDF disposal.

5.2.5 Waste Transportation

Transportation of waste contains the following assumptions:

- Total drive time from the FFTF Complex to ERDF is 0.91 hours (51.5 km [32 mi] ÷ 56.3 km/hr [35 mi/hr] = 0.91 hr).
  - Distance to ERDF (×2 for return trip) is 51.5 km (32 mi).
  - Average speed is 56.3 km/hr (35 mi/hr).
- Two teamsters are required for transportation of waste to ERDF.
- Average wait time is 0.5 hour.

5.2.6 Sampling and Analysis

Sampling and analysis include the following assumptions:

- An allowance for sampling waste before transport to ERDF is included for all waste disposal activities.
- Confirmatory sampling following removal action activities will not be taken until initiation of the final remedial action.

5.2.7 Other Specific Assumptions

The following other specific assumptions are included:

- Air monitoring is assumed to occur during each removal action activity. The duration of air monitoring will be matched to the duration of labor activities for each removal action.
- At the conclusion of the 10-year project duration, a final On-Scene Coordinator Report will be completed to summarize the activities completed.

- Costs for treatment of sodium residuals are based on 2005 estimate as presented in Appendix B. Costs are broken out by alternatives based on distribution of residual sodium as identified in Table 2. The 2005 costs are escalated to 2020 dollars as shown in Table 3. The sodium residual costs are added to the present value results identified in Chapter 17.
- The total amount of residual sodium that must be reacted is 3,7854.1 L (10,000 gal) (note that this is approximately three times the "quantifiable" residual volume published in shutdown planning documents and is believed to be an upper estimate of the volume actually remaining in the systems and components following drain activities).
- Sodium residuals will generally be reacted using a superheated steam – nitrogen process followed by three cycles of water rinse.
- In general, all small bore piping (less than 8 in. diameter), valves, and other components will be removed and processed in a stationary cleaning station located in the FSF.
- Large-diameter piping and components will be cleaned in situ (except primary HTS pumps, intermediate heat exchanger tube bundles, dump heat exchanger tube bundles, and Instrument Trees).
- Three cleaning systems will be utilized:
  - A stationary system (located in the FSF) for cleaning the small piping and components.
  - A portable system to be moved to various locations for cleaning most large piping and components.
  - The large-diameter cleaning vessel located in the Maintenance and Storage Facility for cleaning large components following removal (e.g., primary pumps, intermediate heat exchanger, and Instrument Trees).
- All heat exchanger tube bundles, which contain multiple parallel flow paths, must be dismantled to assure effective cleaning.
- The "Special Components" (primary cold trap, cesium trap, and two continuous duty primary vapor traps) will be removed from the plant and stored on the Hanford Site in containers suitable for future offsite shipment. All other cold traps (three secondaries; two from the FSF and one from the Interim Decay Storage) will be removed and cleaned onsite.
- The core component pots from the Interim Decay Storage and the fuel storage tubes from the FSF will be removed and cleaned in the stationary cleaning system.
- The dump heat exchanger tube bundles will be removed from the secondary loops, cut up, and cleaned in the stationary cleaning system.
- All piping and components removed from the plant for residuals cleaning will be disposed of as low-level radioactive waste in the 200 Area after appropriate size reduction.

Table 2. Remaining Sodium in the FFTF Complex

System	Building	Component	Frozen Bulk Sodium (gal)	Sodium Residuals (gal)
Primary HTS	405	Primary Cold Trap (N-5)	675	
		Reactor Vessel and Contents (includes outside core basket, pockets periphery of core support, instrument trees and in-vessel handling machine, reflector assemblies, other core assemblies, bottom of vessel, and horizontal surfaces)		492
		T-42 Reactor Sodium Overflow Tank		20
		T-43 Primary Sodium Storage Vessel		20
		Main Coolant Pumps		10
		IHXs		5
		T-88 and T-89 (EM Pump Drain Tanks)		4
		Big Main HTS Valves		7
		PTIs		3
		Overflow Weir (drain for excess sodium from Reactor Vessel to T-42)		3
		HTS-S/P-52		10
		T-99 (N-5 NaK cooling system storage tank[a])		3
		E-137		1
		Multipurpose Samplers		3
		Piping and Valves		215
		Primary Main HTS Valves (9)[b]		690
	491S	Cesium Trap (N-3)	60	
Secondary HTS	405	IHXs (3)		10
	408A 408B 408C	DHX Module Tubes and Headers		1,805
	491E	Loop 1 Cold Trap (N-7)	300	
	491W	Loop 2 Cold Trap (N-40)	300	
		Loop 3 Cold Trap (N-41)	300	
		T-44 Secondary Sodium Storage Vessel		30

Table 2. Remaining Sodium in the FFTF Complex

System	Building	Component	Frozen Bulk Sodium (gal)	Sodium Residuals (gal)
	491E 491S 491W	Multipurpose Samplers		3
		Main Coolant Pumps		10
		PTIs		3
		Venturi Flowmeters		36
	Multiple	Piping and Valves		221
IDS	405	IDS Cold Trap (N-46)	300	
		IDS Vessel (T-62)		40
		E-79		1
		P-40 and P-41		5
		T-98 (IDS NaK cooling system storage tanka)		2
		PTI		3
		E-133		3
		E-134		1
FSF	403	Permanent Cold Trap (N-932)	140	
		Vessel (Tubes and Horizontal Surfaces)		660
		core component pots in 2 boxes (DWMU)		400
		EM Pump		2
		Piping, Valves, and In-Line Heater		10
	405	Temporary Cold Trap (E-314; relocated to 405 RCB)	300	
Other	402	SSF Sodium Storage Tanks (4)	243,000	
	4718	ISA DWMU Miscellaneous Containers (19)		N/A
Totals			**245,375**	**4,731**

Sources: FFTF-32943, *Fast Flux Test Facility Sodium Volume Reconciliation*, Chapters 5.0 and 6.0.
FFTF-36419, *Documented Safety Analysis for the Fast Flux Test Facility*, Section B.3.2.
a. Formerly contained NaK but was flushed with sodium.
b. Planned drainage was cancelled in latter stages of deactivation (FFTF-36419).

DHX = dump heat exchanger
DWMU = dangerous waste management unit
EM = electromagnetic
FSF = Fuel Storage Facility

Table 2. Remaining Sodium in the FFTF Complex

System	Building	Component	Frozen Bulk Sodium (gal)	Sodium Residuals (gal)

HTS = Heat Transport System
IDS = Interim Decay Storage
IHX = Intermediate Heat Exchange
ISA = Interim Storage Area
N/A = not available
NaK = sodium-potassium
PTI = Plugging Temperature Indicator
RCB = Reactor Containment Building
SSF = Sodium Storage Facility

Table 3. Costs for Treatment of Sodium Residuals

Alternative*	Structure ID	Sodium Residuals (gal)	Sodium Residuals (%)	Sodium Treatment Costs	Sodium Treatment Costs per Alternative
N/A	Tier 1 (405)	1,551	33%	$76,154,000	---
1	N/A	0	0	0	0
2	Tier 2 (403, 408A, 408B, 408C, 491E, 491S, 491W, 4717)	3,180	67%	$154,617,000	$154,617,000
3	All Structures (Tier 1 + Tier 2)	4,731	100%	$230,771,000	$230,771,000

*These costs are presented in 2020 dollars by escalating the FY 2005 costs using a 1.92309 multiplier. Appendix B provides additional detail for these costs.

FY = fiscal year
ID = identification
N/A = not available

6 Exclusions

This chapter identifies costs that have not been included in the estimate. The following items have been excluded from the estimate:

- Escalation – Separate escalation has not been included in these calculations.
- ICs – Costs for the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* programmatic ICs are not included in this estimate.

- Significant amounts of contaminants and contaminated materials not previously identified are excluded.
- Waste material size reduction beyond the minimum needed to handle and transport to ERDF is not included.
- Costs associated with any future removal actions or final remedial decision are excluded.

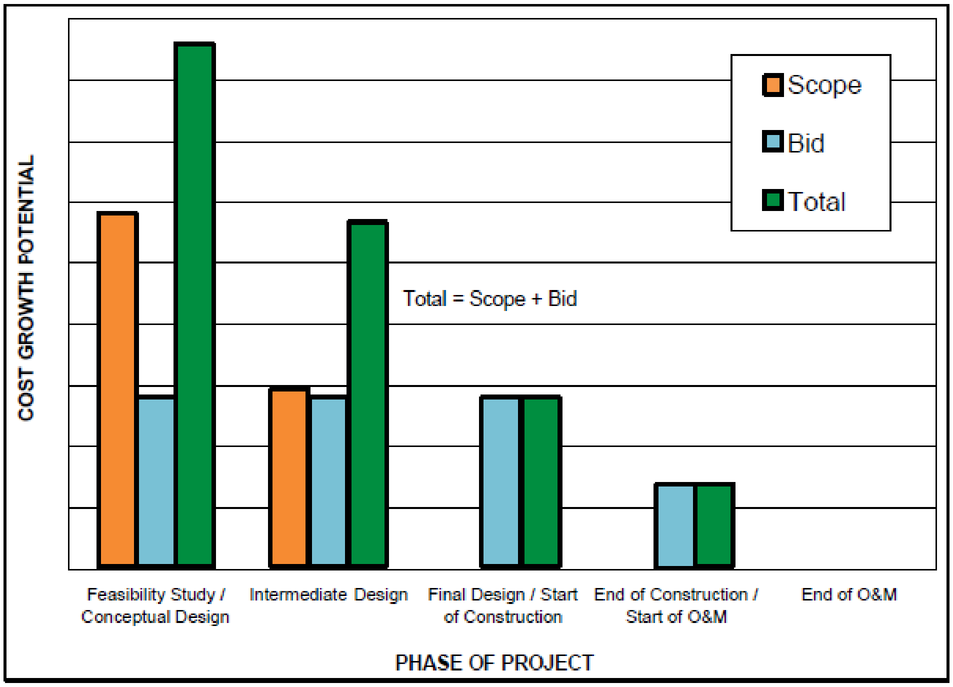
7 Markups

The following markups were utilized in the cost estimate and applied in the following order:

1. MDBI – 10% markup is applied to capital cost subtotal costs to cover contractor mobilization, demobilization, bonding, and insurance.
2. OH&P – 15% markup is applied to the capital cost subtotal with taxes for contractor overhead, and a 10% markup is applied to the capital cost subtotal for contractor profit.
3. Taxes – 8.6% Washington State sales tax is applied to travel expenses, equipment, materials, other direct costs, and subcontractors (with the exception of laboratory services and quoted costs from subcontractors). Sales tax is assumed included in costs based on previous systems and components used in this estimate.
4. Contingency – 25% overall capital cost contingency was applied (15% capital scope contingency plus 10% capital bid contingency). Additional information on contingencies is found in Chapter 8.
5. CPCCo G&A fee – 17.36% G&A markup is applied to the subtotal capital costs including contingencies.
6. The project management, remedial design, and construction management percentages are based upon the total cost of the capital for each alternative (Chapter 9); therefore, the percentages change per alternative. The percentages are as follows:
   - Project management of 5%, remedial design of 8% (Alternative 2), or 6% (Alternative 3).
   - Construction management of 6% for capital costs.

8 Contingencies

Contingency is factored into a cost estimate to cover unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the available data at the time the estimate is prepared. It is used to reduce the risk of possible cost overruns. The two main types of contingency are scope and bid. Scope contingency covers unknown costs due to scope changes that may occur during design. Bid contingency covers unknown costs associated with constructing and implementing a given project scope. Figure 4 shows how the bid and scope contingencies typically change as a project progresses through typical stages of design and implementation. Figure 4 also shows the relationship between scope, bid, and total contingencies.



Source: OSWER 9355.0-75, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, Exhibit 5-5.

Figure 4. Relationship of Scope, Bid, and Total Capital Cost Contingency

8.1 Scope Contingency

Scope contingency represents project risks associated with an incomplete design. This type of contingency represents costs, unforeseeable at the time of estimate preparation, which are likely to become known as the remedial design proceeds (Figure 4). For this reason, scope contingency is sometimes referred to as design contingency, which is the term commonly used by the U.S. Army Corps of Engineers. In general, scope contingency should decrease as design progresses and should be 0% at the 100% design stage.

At the early stages of remedial design (e.g., feasibility study, which represents 0% through 10% design completion), concepts are not typically developed enough to identify all project components or quantities. Contributing factors include limited experience with certain technologies, potential requirements due to regulatory or policy changes, and inaccuracies in defining quantities or characteristics. Scope contingency would be expected to be higher for newer or emerging remedial technologies than for more well documented systems. For these reasons, scope contingency may vary between alternatives. A low percentage for scope contingency indicates an opinion that the project scope will undergo minimal change during design. A high percentage indicates an opinion that the project scope may change considerably between the feasibility study and final design.

The scope contingency for this estimate has been set at 15% for all of the alternatives.

8.2 Bid Contingency

Bid contingency represents costs, unforeseeable at the time of estimate preparation, which are likely to become known as the remedial action construction or O&M proceeds (Figure 4). For this reason, bid contingency is sometimes referred to as construction contingency, which is the term commonly used by the U.S. Army Corps of Engineers.

Bid contingency accounts for changes that occur after the construction contract is awarded. This contingency represents a reserve for quantity overruns, modifications, change orders, and claims during construction. Considerations include the technological, geotechnical, and other unknowns applicable to the construction phase. Examples include changes due to adverse weather, material or supply shortages, or new regulations.

The range for bid contingency is typically from 10% to 20%. The bid contingency for this estimate has been set at 10% for all of the alternatives.

9 Project Management, Removal Design, Construction Management, and Technical Support Services

Project management, removal design, and construction management capital costs are estimated using factors based on OSWER 9355.0-75. These factors are provided in Table 4.

Table 4. Percentages for Professional/Technical Services Capital Costs

Capital Cost Element	<$100K (%)	$100K-$500K (%)	$500K-$2M (%)	$2M-$10M (%)	>$10M (%)
Project management	10	8	6	5	5
Remedial design	20	15	12	8	6
Construction management	15	10	8	6	6

Source: EPA 540 R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study,* Exhibit 5-8.

Since Alternative 2 has an estimated cost of $2 million to $10 million, the following percentages were used:

- Project management: 5%
- Remedial design: 8%
- Construction management: 6%

Since Alternative 3 has an estimated cost of less than $10 million, the following percentages were used:

- Project management: 5%
- Remedial design: 6%
- Construction management: 6%

Technical support services (TSS) include project management, technical coordination, and onsite logistics. TSS markup is applied to individual annual and periodic O&M cost line items with the TSS percentage varying based on the line item subtotal cost, as shown in Table 5. The line item subtotal costs corresponding to the Table 5 cost ranges include MDBI, OH&P, and Washington State sales tax.

Table 5. Percentages for Technical Support Services for O&M Costs

Operations and Maintenance Cost Element	<100K (%)	$100K-$500K (%)	$500K-$2M (%)	$2M-$10M (%)	>$10M (%)
Technical Services Support	45	33	26	19	17

Note: Percentages are the sum of the project management, remedial design, and construction management values in Table 3.

Since the individual annual O&M line item subtotals in the alternatives are in the $500,000 to $2 million range, TSS markup percentages for the annual line items in the alternatives are 26%. There are no periodic O&M line items.

10 Present Worth

The estimate includes present worth calculations for work performed in out years based on OSWER 9355.0-75.

Costs are presented as present worth values. The present worth value method establishes a common baseline for evaluating costs that occur during different time periods, thus allowing for direct cost comparisons between different alternatives. The present worth value represents the dollars that would need to be set aside today, at the defined real discount rate, to ensure that funds would be available in the future as they are needed to perform the response action alternative.

Present worth costs were estimated using the real discount rate published in Appendix C of OMB Circular No. A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." Based on this guidance and durations of 10 years for all alternatives, a real discount rate of 0.9967% was used in the cost estimate present value calculations for these alternatives.

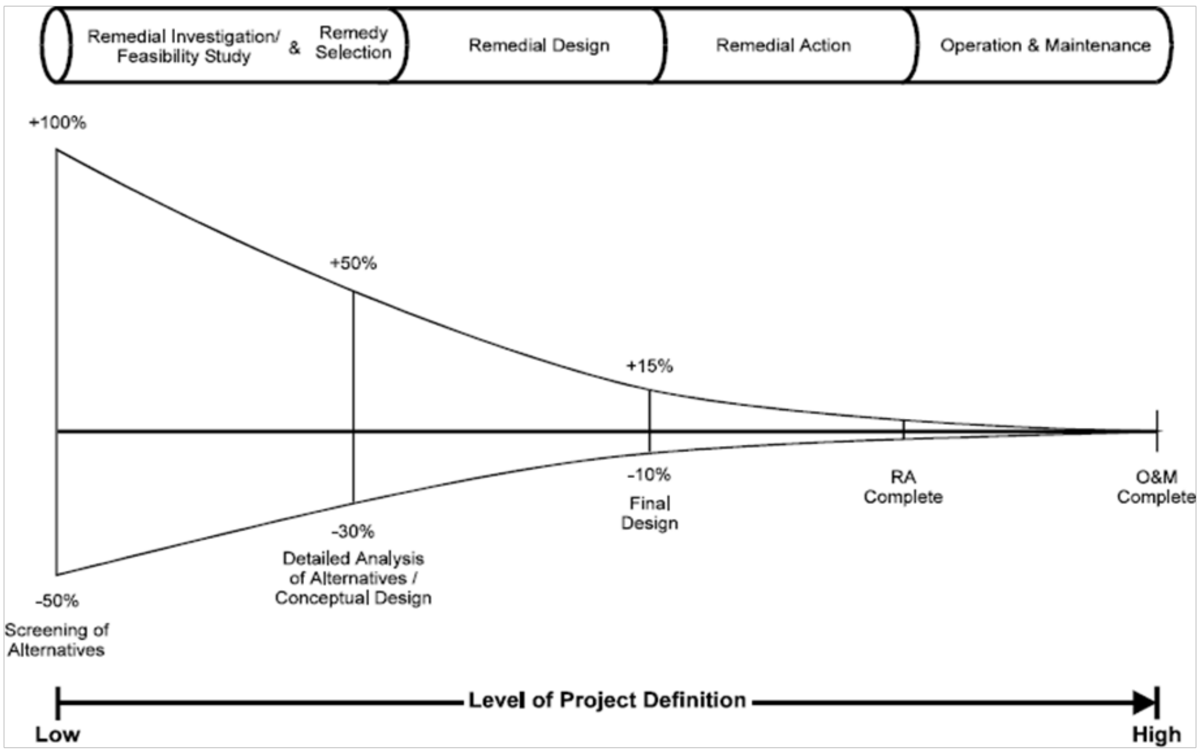
11 Estimate Classification

The expected accuracy range of the cost estimate at this stage is approximately plus 50% minus 30%. This accuracy range is consistent with OSWER 9355.0-75 for the level of project definition available at this time.

The expected accuracy range is an indication of the degree to which the final cost outcome for a given project could vary from the estimated cost. Accuracy is traditionally expressed as a +/- percentage range around the point estimate after application of contingency, with a stated level of confidence that the actual cost outcome would fall within this range (+/- measures are a useful simplification, given that actual cost outcomes have different frequency distributions for different types of projects). Typically, this results in a 90% confidence that the actual cost will fall within the bounds of the low and high ranges.

The accuracy range of an estimate is dependent upon a number of characteristics of the estimate input information and estimating process. The extent and maturity of the input information, as measured by percentage completion (and related to level of project definition), are important determinants of accuracy. However, there are factors besides the available input information that also greatly affect estimate accuracy measures. Primary among these are the state of technology in the project and the quality of reference cost estimating data.

The accuracy of any given estimate is not fixed or determined by its classification category. Significant variations in accuracy from estimate to estimate are possible if any of the determinants of accuracy, such as maturity of technology selected, quality of reference cost data, quality of the estimating process, and skill and knowledge of the estimator vary. Accuracy is also not necessarily determined by the estimating methodology used or the effort expended. Estimate accuracy must be evaluated on an estimate-by-estimate basis, usually in conjunction with some form of risk analysis process. Figure 5 shows an example of the expected level of accuracy for a remedial action, which is similar to the removal actions this cost estimate supports.



Source: OSWER 9355.0-75, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, Exhibit 2-3.

Figure 5. Expected Cost Estimate Accuracy

12 Cost Resources

The following list of various resources was used in the development of the cost estimate. The TRACE V4 workbook presents unit costs and associated sources for items included in the cost estimate). Sources listed in the Appendix A tables include historical and other. Historical costs include actual costs or estimated costs from past Hanford Site projects. Other costs are sourced from CPCCo project management, rate information gathered from subject matter experts, and estimator buildup utilizing information gathered from historical or other sources.

Labor unit prices reflect a burden rate including worker’s compensation, unemployment taxes, fringe benefits, and medical insurance.

13 Estimate Methodology

The cost estimate for the FFTF EE/CA (DOE/RL-2020-52) was developed in accordance with OSWER 9355.0-75 and contractor cost estimating procedures. The TRACE V4 workbook cost estimating workbook, in conjunction with historical cost data and estimated allowances, was used to develop the cost estimate for each of the removal action alternatives. Assumed project scope items were itemized, and unit costs were applied as shown in the TRACE V4 workbook. Where available, costs for major systems were based on existing systems costs at the Hanford Site. Percentage allowances and lump sums were applied for some of the cost items, based on Hanford Site and environmental project experience.

This cost estimate has been prepared for guidance in project evaluation from the information available at the time of the estimate. The final cost of the project will depend on final design, selected scope of work, actual labor and material costs, competitive market conditions, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimate presented in this document. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding.

14 Sensitivity Analysis

Sensitivity analysis for this cost estimate was not performed. The following factors might cause the estimate to change significantly:

- Levels of contamination
- Newly discovered hazardous conditions
- Availability of workers
- Change in worker safety protection due to field conditions or new monitoring requirements

Because of these factors, the removal action selection process must consider differences in response action cost uncertainties and risks in addition to response action specific cost estimates and ranges. Funding needs must be carefully reviewed before making specific financial decisions or establishing final budgets.

15 Labor Costs

CPCCo labor rates for management, engineering, safety oversight, and technical support are based on the CPCCo-approved planning rates for FY 2020.

For this estimate, labor needs were developed through discussions with CPCCo project management. In-depth work planning and crew development was not conducted. Labor needs were grouped into three work crew categories: hazard abatement, characterization/sampling, and equipment removal.

Following the development of these three work crew categories, past estimates, and actual costs from Hanford Site projects were studied.

The average monthly cost and labor breakdown for a single full-time crew were calculated and are provided in the TRACE V4 workbook.

16 Sales Tax

Washington State sales tax has been applied to all materials and equipment purchases at 8.6% and is included in the markups discussed in Chapter 7.

Future cost escalation is not calculated in this estimate. All costs are presented in 2020 dollars.

17 Cost Summary

Table 6 presents overall capital, annual, periodic, total nondiscounted, and total discounted (present value) costs for the FFTF Complex from the TRACE V4 workbook.

Table 6. Summary of TRACE V4 Costs

		Alternative 1	Alternative 2	Alternative 3
Total Capital Cost		$0	$242.57 M	$244.72 M
Total Annual O&M Cost		$0	$16.80 M	$16.80 M
Total Periodic O&M Cost		$0	$0	$0
Total Nondiscounted Cost		$0	$259.37 M	$261.52 M
Total Present Value Cost (Discounted)		$0	$258.13 M	$260.18 M
Total Present Value Cost Range	-30%	$0	$180.69 M	$182.13 M
	+50%	$0	$387.20 M	$390.27 M

Notes: Total Capital Cost includes Sodium Residuals Treatment Cost ($230.77 M).

Cost totals may differ slightly from the displayed values due to rounding.

Cost estimates are order-of-magnitude with an expected accuracy range of+50% to -30%.

O&M = operations and maintenance

Cost estimate summary tables and associated quantity tables from the TRACE V4 workbook are presented in Appendix A. Total costs for the FFTF Complex alternatives, including treatment of sodium residuals, are presented in 2020 dollars in Table 7.

Table 7. Summary of Alternative Costs

	Alternative 1	Alternative 2	Alternative 3
Present Value Cost	$0	$27.36 M	$29.41 M
Sodium Residuals Treatment Cost[a]	$0	$230.77 M	$230.77 M
Total Present Value Cost (2020)[b]	**$0**	**$258.13 M**	**$260.18 M**

a. Sodium Residuals Treatment Cost from Table 3.

b. Summation of Present Value and Sodium Residuals Treatment Costs.

18 References

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Appendix A

Capital and Operations and Maintenance Cost Estimate

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Table A-1. Comparison of Total Cost of Remedial Action Alternatives

Location: 400 Area		**Base Year:**	2030
Phase: EE/CA		**Date:**	10/1/2020

	Alternative 01	Alternative 02	Alternative 03
	Alternative 1 - No Action	Alternative 2 - S&M of FFTF Complex and Hazard Abatement of Tier 2 Structures	Alternative 3 - S&M of FFTF Complex and Hazard Abatement of 405 and Tier 2 Structures
Total Project Duration (Years)	0	10	10
Capital Cost	$0	$242,600,000	$244,700,000
Lifecycle O&M Cost	$0	$16,800,000	$16,800,000
Periodic O&M Cost	$0	$0	$0
Total Non-Discounted Cost	$0	$259,400,000	$261,500,000
Total Present Value of Alternative	$0	$258,100,000	$260,200,000
Expected Accuracy Range for Total Present Value is -30% to +50%			
-30%	$0	$180,700,000	$182,100,000
50%	$0	$387,200,000	$390,300,000

Note: The cost of the Sodium Reaction Facility ($230,770,000) was added to each alternative non-discounted cost and total present value figures.

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial action objectives. Changes in the cost elements may occur as a result of new information and data collected during the engineering design of the remedial alternatives. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.

Table A-2. Comparison of Total Cost Of Remedial Action Alternatives (By Site)

Location:	400 Area		**Base Year:**	2030
Phase:	EE/CA		**Date:**	10/1/2020
			Alternative 02	**Alternative 03**
			Alternative 2 - S&M of FFTF Complex and Hazard Abatement of Tier 2 Structures	Alternative 3 - S&M of FFTF Complex and Hazard Abatement of 405 and Tier 2 Structures
Site	**Site Name**	**Total Project Duration (Years)**	10	10
1	**402**			
		Capital Cost	$0	$0
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$0	$0
		Total Present Value of Alternative	$0	$0
2	**403**			
		Capital Cost	$967,912	$951,644
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$967,912	$951,644
		Total Present Value of Alternative	$919,574	$904,119
3	**408A**			
		Capital Cost	$2,118,569	$2,082,963
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$2,118,569	$2,082,963
		Total Present Value of Alternative	$2,012,767	$1,978,939
4	**408B**			

Table A-2. Comparison of Total Cost Of Remedial Action Alternatives (By Site)

Location:	400 Area		**Base Year:**	2030
Phase:	EE/CA		**Date:**	10/1/2020
			Alternative 02	**Alternative 03**
			Alternative 2 - S&M of FFTF Complex and Hazard Abatement of Tier 2 Structures	Alternative 3 - S&M of FFTF Complex and Hazard Abatement of 405 and Tier 2 Structures
Site	**Site Name**	**Total Project Duration (Years)**	10	10
		Capital Cost	$980,853	$964,368
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$980,853	$964,368
		Total Present Value of Alternative	$931,869	$916,207
5	**408C**			
		Capital Cost	$967,310	$951,053
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$967,310	$951,053
		Total Present Value of Alternative	$919,002	$903,557
6	**4717**			
		Capital Cost	$3,304,379	$3,248,843
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$3,304,379	$3,248,843
		Total Present Value of Alternative	$3,139,356	$3,086,594
7	**4718**			
		Capital Cost	$0	$0

Table A-2. Comparison of Total Cost Of Remedial Action Alternatives (By Site)

Location:	400 Area		**Base Year:**	2030
Phase:	EE/CA		**Date:**	10/1/2020
			Alternative 02	**Alternative 03**
			Alternative 2 - S&M of FFTF Complex and Hazard Abatement of Tier 2 Structures	Alternative 3 - S&M of FFTF Complex and Hazard Abatement of 405 and Tier 2 Structures
Site	**Site Name**	**Total Project Duration (Years)**	10	10
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$0	$0
		Total Present Value of Alternative	$0	$0
8	**491E**			
		Capital Cost	$1,358,191	$1,335,364
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$1,358,191	$1,335,364
		Total Present Value of Alternative	$1,290,362	$1,268,675
9	**491S**			
		Capital Cost	$733,548	$721,219
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$733,548	$721,219
		Total Present Value of Alternative	$696,914	$685,201
10	**491W**			
		Capital Cost	$1,365,512	$1,342,562
		Annual O&M Cost	$0	$0

Table A-2. Comparison of Total Cost Of Remedial Action Alternatives (By Site)

Location:	400 Area		**Base Year:**	2030
Phase:	EE/CA		**Date:**	10/1/2020
			Alternative 02	**Alternative 03**
			Alternative 2 - S&M of FFTF Complex and Hazard Abatement of Tier 2 Structures	Alternative 3 - S&M of FFTF Complex and Hazard Abatement of 405 and Tier 2 Structures
Site	**Site Name**	**Total Project Duration (Years)**	10	10
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$1,365,512	$1,342,562
		Total Present Value of Alternative	$1,297,317	$1,275,513
11	**405**			
		Capital Cost	$0	$2,356,800
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$0	$2,356,800
		Total Present Value of Alternative	$0	$2,239,100
12	**400 Area**			
		Capital Cost	$0	$0
		Lifecycle O&M Cost	$16,795,654	$16,795,654
		Periodic O&M Cost	$0	$0
		Total Non-Discounted Cost	$16,795,654	$16,795,654
		Total Present Value of Alternative	$16,152,146	$16,152,146
			Alternative 02	**Alternative 03**
		Capital Cost	$11,796,274	$13,954,817
		Annual O&M Cost	$0	$0
		Periodic O&M Cost	$0	$0

Table A-2. Comparison of Total Cost Of Remedial Action Alternatives (By Site)

Location:	400 Area		**Base Year:**	2030
Phase:	EE/CA		**Date:**	10/1/2020
			Alternative 02	**Alternative 03**
			Alternative 2 - S&M of FFTF Complex and Hazard Abatement of Tier 2 Structures	Alternative 3 - S&M of FFTF Complex and Hazard Abatement of 405 and Tier 2 Structures
Site	**Site Name**	**Total Project Duration (Years)**	10	10
		Total Non-Discounted Cost	$11,796,274	$13,954,817
		Total Present Value of Alternative	$27,359,306	$29,410,050

Note: the values for Total Capital Cost, Total Non-Discounted Cost, and Total Present Value do not include the $230,770,000 for the Sodium Reaction Facility. The $230,770,000 has been added into the final values identified in the Alternative Cost Comparison.

Table A-3. Alternative 2

Location:	400 Area	**Base Year:**	2030
Phase:	EE/CA	**Date:**	10/1/2020
Description:	Continued S&M of all FFTF Complex structures. • Hazard Abatement of 10 Tier 2 structures.		

CAPITAL COSTS

SITE	SITE NAME	WBS Top Tier	Second Tier	Third Tier	DESCRIPTION	QTY	UNIT	UNIT COST	SUBTOTAL	SOURCE	START YEAR	END YEAR	INTERVAL	NOTES
									$0					
2	403	Hazard Abatement	01	01	850 403-Steel metal frame insulated metal siding, roof	1	LS	$344,191	$344,191	OTHER	10	10	1	
1	402	Hazard Abatement	01	01	851 402-Sodium Storage Facility	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Hazard Abatement	01	01	852 408A-Main heat dump east - radiological	1	LS	$726,417	$726,417	OTHER	10	10	1	
4	408B	Hazard Abatement	01	01	853 408B-Main heat dump south - radiological	1	LS	$336,262	$336,262	OTHER	10	10	1	
5	408C	Hazard Abatement	01	01	854 408C-Main heat dump west - radiological	1	LS	$331,728	$331,728	OTHER	10	10	1	
6	4717	Hazard Abatement	01	01	855 4717-Steel frame, roof, sides, service bld, (pipe rack in front)	1	LS	$1,219,325	$1,219,325	OTHER	10	10	1	
8	491E	Hazard Abatement	01	01	856 491E-Steel and concrete walls, radiological hazard	1	LS	$496,551	$496,551	OTHER	10	10	1	
9	491S	Hazard Abatement	01	01	857 491S-Steel and concrete walls, radiological hazard	1	LS	$268,172	$268,172	OTHER	10	10	1	
10	491W	Hazard Abatement	01	01	858 491W-Steel and concrete walls, radiological hazard	1	LS	$499,029	$499,029	OTHER	10	10	1	
7	4718	Hazard Abatement	01	01	859 4718-Fenced storage area	1	LS	$0	$0	OTHER	10	10	1	
2	403	Hazard Abatement	01	01	861 403-Equipment Removal	1	LS	$25,838	$25,838	OTHER	10	10	1	
1	402	Hazard Abatement	01	01	862 402-Equipment Removal	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Hazard Abatement	01	01	863 408A-Equipment Removal	1	LS	$82,239	$82,239	OTHER	10	10	1	
4	408B	Hazard Abatement	01	01	864 408B-Equipment Removal	1	LS	$38,126	$38,126	OTHER	10	10	1	
5	408C	Hazard Abatement	01	01	865 408C-Equipment Removal	1	LS	$37,496	$37,496	OTHER	10	10	1	
6	4717	Hazard Abatement	01	01	866 4717-Equipment Removal	1	LS	$46,004	$46,004	OTHER	10	10	1	
8	491E	Hazard Abatement	01	01	867 491E-Equipment Removal	1	LS	$23,317	$23,317	OTHER	10	10	1	
9	491S	Hazard Abatement	01	01	868 491S-Equipment Removal	1	LS	$12,604	$12,604	OTHER	10	10	1	
10	491W	Hazard Abatement	01	01	869 491W-Equipment Removal	1	LS	$23,632	$23,632	OTHER	10	10	1	
2	403	Transportation Cost	01	01	870 403-Transportation Cost	1	LS	$1,180	$1,180	OTHER	10	10	1	
1	402	Transportation Cost	01	01	871 402-Transportation Cost	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Transportation Cost	01	01	872 408A-Transportation Cost	1	LS	$3,755	$3,755	OTHER	10	10	1	
4	408B	Transportation Cost	01	01	873 408B-Transportation Cost	1	LS	$1,741	$1,741	OTHER	10	10	1	
5	408C	Transportation Cost	01	01	874 408C-Transportation Cost	1	LS	$1,712	$1,712	OTHER	10	10	1	
6	4717	Transportation Cost	01	01	875 4717-Transportation Cost	1	LS	$2,100	$2,100	OTHER	10	10	1	
8	491E	Transportation Cost	01	01	876 491E-Transportation Cost	1	LS	$1,065	$1,065	OTHER	10	10	1	
9	491S	Transportation Cost	01	01	877 491S-Transportation Cost	1	LS	$575	$575	OTHER	10	10	1	
10	491W	Transportation Cost	01	01	878 491W-Transportation Cost	1	LS	$1,079	$1,079	OTHER	10	10	1	
2	403	Treatmant Cost	01	01	800 403-Treatment Cost	1	LS	$93	$93	OTHER	10	10	1	
1	402	Treatmant Cost	01	01	801 402-Treatment Cost	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Treatmant Cost	01	01	802 408A-Treatment Cost	1	LS	$294	$294	OTHER	10	10	1	
4	408B	Treatmant Cost	01	01	803 408B-Treatment Cost	1	LS	$136	$136	OTHER	10	10	1	
5	408C	Treatmant Cost	01	01	804 408C-Treatment Cost	1	LS	$134	$134	OTHER	10	10	1	
6	4717	Treatmant Cost	01	01	805 4717-Treatment Cost	1	LS	$165	$165	OTHER	10	10	1	
8	491E	Treatmant Cost	01	01	806 491E-Treatment Cost	1	LS	$83	$83	OTHER	10	10	1	
9	491S	Treatmant Cost	01	01	807 491S-Treatment Cost	1	LS	$45	$45	OTHER	10	10	1	
10	491W	Treatmant Cost	01	01	808 491W-Treatment Cost	1	LS	$85	$85	OTHER	10	10	1	
									$0					

CAPITAL MARKUPS

MDBI 10%	SUBTOTAL	Overhead 15%	Profit 10%	SUBTOTAL	WA States Sales Tax 8.6%	SUBTOTAL	Scope Contingency 15%	Bid Contingency 10%	SUBTOTAL	Project Management Percent	Project Management 5%	Remedial Design Percent	Remedial Design 8%	Construction Management Percent	Construction Management 6%	SUBTOTAL	CHPRC G&A 17.36%	COST PER YEAR
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**
$34,419	$378,610	$56,792	$37,861	**$473,263**	$40,701	**$513,964**	$77,095	$51,396	**$642,454**		$32,123		$51,396		$38,547	**$764,521**	$132,721	**$897,242**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**
$72,642	$799,058	$119,859	$79,906	**$998,823**	$85,899	**$1,084,722**	$162,708	$108,472	**$1,355,902**		$67,795		$108,472		$81,354	**$1,613,523**	$280,108	**$1,893,631**
$33,626	$369,888	$55,483	$36,989	**$462,361**	$39,763	**$502,124**	$75,319	$50,212	**$627,655**		$31,383		$50,212		$37,659	**$746,909**	$129,663	**$876,572**
$33,173	$364,901	$54,735	$36,490	**$456,126**	$39,227	**$495,353**	$74,303	$49,535	**$619,191**		$30,960		$49,535		$37,151	**$736,837**	$127,915	**$864,752**
$121,933	$1,341,258	$201,189	$134,126	**$1,676,572**	$144,185	**$1,820,758**	$273,114	$182,076	**$2,275,947**		$113,797		$182,076		$136,557	**$2,708,377**	$470,174	**$3,178,551**
$49,655	$546,206	$81,931	$54,621	**$682,758**	$58,717	**$741,475**	$111,221	$74,147	**$926,844**		$46,342		$74,147		$55,611	**$1,102,944**	$191,471	**$1,294,415**
$26,817	$294,990	$44,248	$29,499	**$368,737**	$31,711	**$400,448**	$60,067	$40,045	**$500,560**		$25,028		$40,045		$30,034	**$595,667**	$103,408	**$699,075**
$49,903	$548,932	$82,340	$54,893	**$686,165**	$59,010	**$745,175**	$111,776	$74,517	**$931,469**		$46,573		$74,517		$55,888	**$1,108,448**	$192,427	**$1,300,874**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**
$2,584	$28,421	$4,263	$2,842	**$35,527**	$3,055	**$38,582**	$5,787	$3,858	**$48,228**		$2,411		$3,858		$2,894	**$57,391**	$9,963	**$67,354**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**
$8,224	$90,463	$13,569	$9,046	**$113,079**	$9,725	**$122,804**	$18,421	$12,280	**$153,505**		$7,675		$12,280		$9,210	**$182,671**	$31,712	**$214,382**
$3,813	$41,939	$6,291	$4,194	**$52,424**	$4,508	**$56,932**	$8,540	$5,693	**$71,165**		$3,558		$5,693		$4,270	**$84,686**	$14,702	**$99,388**
$3,750	$41,246	$6,187	$4,125	**$51,557**	$4,434	**$55,991**	$8,399	$5,599	**$69,989**		$3,499		$5,599		$4,199	**$83,287**	$14,459	**$97,745**
$4,600	$50,604	$7,591	$5,060	**$63,255**	$5,440	**$68,695**	$10,304	$6,869	**$85,869**		$4,293		$6,869		$5,152	**$102,184**	$17,739	**$119,923**
$2,332	$25,649	$3,847	$2,565	**$32,061**	$2,757	**$34,818**	$5,223	$3,482	**$43,522**		$2,176		$3,482		$2,611	**$51,792**	$8,991	**$60,783**
$1,260	$13,864	$2,080	$1,386	**$17,330**	$1,490	**$18,821**	$2,823	$1,882	**$23,526**		$1,176		$1,882		$1,412	**$27,996**	$4,860	**$32,856**
$2,363	$25,995	$3,899	$2,600	**$32,494**	$2,794	**$35,288**	$5,293	$3,529	**$44,111**		$2,206		$3,529		$2,647	**$52,492**	$9,113	**$61,604**
$118	$1,298	$195	$130	**$1,622**	$139	**$1,762**	$264	$176	**$2,202**		$110		$176		$132	**$2,620**	$455	**$3,075**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**
$375	$4,130	$620	$413	**$5,163**	$444	**$5,607**	$841	$561	**$7,009**		$350		$561		$421	**$8,340**	$1,448	**$9,788**
$174	$1,915	$287	$191	**$2,394**	$206	**$2,599**	$390	$260	**$3,249**		$162		$260		$195	**$3,867**	$671	**$4,538**
$171	$1,883	$282	$188	**$2,354**	$202	**$2,556**	$383	$256	**$3,196**		$160		$256		$192	**$3,803**	$660	**$4,463**
$210	$2,310	$347	$231	**$2,888**	$248	**$3,136**	$470	$314	**$3,921**		$196		$314		$235	**$4,666**	$810	**$5,475**
$106	$1,171	$176	$117	**$1,464**	$126	**$1,590**	$238	$159	**$1,987**		$99		$159		$119	**$2,365**	$411	**$2,775**
$58	$633	$95	$63	**$791**	$68	**$859**	$129	$86	**$1,074**		$54		$86		$64	**$1,278**	$222	**$1,500**
$108	$1,187	$178	$119	**$1,484**	$128	**$1,611**	$242	$161	**$2,014**		$101		$161		$121	**$2,397**	$416	**$2,813**
$9	$102	$15	$10	**$127**	$11	**$138**	$21	$14	**$173**		$9		$14		$10	**$205**	$36	**$241**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**
$29	$324	$49	$32	**$405**	$35	**$440**	$66	$44	**$550**		$27		$44		$33	**$654**	$114	**$767**
$14	$150	$22	$15	**$187**	$16	**$203**	$31	$20	**$254**		$13		$20		$15	**$303**	$53	**$355**
$13	$148	$22	$15	**$185**	$16	**$200**	$30	$20	**$251**		$13		$20		$15	**$298**	$52	**$350**
$16	$181	$27	$18	**$226**	$19	**$246**	$37	$25	**$307**		$15		$25		$18	**$366**	$64	**$429**
$8	$92	$14	$9	**$115**	$10	**$125**	$19	$12	**$156**		$8		$12		$9	**$185**	$32	**$218**
$5	$50	$7	$5	**$62**	$5	**$67**	$10	$7	**$84**		$4		$7		$5	**$100**	$17	**$118**
$8	$93	$14	$9	**$116**	$10	**$126**	$19	$13	**$158**		$8		$13		$9	**$188**	$33	**$221**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**		$0		$0		$0	**$0**	$0	**$0**

ANNUAL O&M COST

SITE	SITE NAME	WBS Top Tier	Second Tier	Third Tier	DESCRIPTION	QTY	UNIT	UNIT COST	SUBTOTAL	SOURCE	START YEAR	END YEAR	INTERVAL	NOTES
12	400 Area	Surveillance	01	01	800 S&M of FFTF Facilities FY 2019-Actuals	1	LS	$669,355	$669,355	HISTORICAL	1	10		
									$0					

ANNUAL O&M MARKUPS

MDBI 0%	SUBTOTAL	Overhead 15%	Profit 10%	SUBTOTAL	WA State Sales Tax 8.6%	SUBTOTAL	Scope Contingency 15%	Bid Contingency 10%	SUBTOTAL	Technical Support Services Percent	Technical Support Services Subtotal	SUBTOTAL	CHPRC G&A 17.36%	COST PER YEAR
$0	$669,355	$100,403	$66,935	**$836,694**	$71,956	**$908,649**	$136,297	$90,865	**$1,135,812**	26%	$295,311	**$1,431,123**	$248,443	**$1,679,565**
$0	$0	$0	$0	**$0**	$0	**$0**	$0	$0	**$0**	45%	$0	**$0**	$0	**$0**

Table A-4. Alternative 3

Location:	400 Area	**Base Year:**	2030
Phase:	EE/CA	**Date:**	10/1/2020
Description:	Alternative 2 actions plus Hazard Abatement of 405 facility.		

CAPITAL COSTS

SITE	SITE NAME	WBS Top Tier	WBS Second Tier	WBS Third Tier	DESCRIPTION	QTY	UNIT	UNIT COST	SUBTOTAL	SOURCE	START YEAR	END YEAR	INTERVAL	NOTES
11	405	Hazard Abatement	01	01	860 405-FFTF containment building-nuclear op 10 years	1	LS	$880,536	$880,536	OTHER	10	10	1	
2	403	Hazard Abatement	01	01	850 403-Steel metal frame insulated metal siding, roof	1	LS	$344,191	$344,191	OTHER	10	10	1	
1	402	Hazard Abatement	01	01	851 402-Sodium Storage Facility	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Hazard Abatement	01	01	852 408A-Main heat dump east - radiological	1	LS	$726,417	$726,417	OTHER	10	10	1	
4	408B	Hazard Abatement	01	01	853 408B-Main heat dump south - radiological	1	LS	$336,262	$336,262	OTHER	10	10	1	
5	408C	Hazard Abatement	01	01	854 408C-Main heat dump west - radiological	1	LS	$331,728	$331,728	OTHER	10	10	1	
6	4717	Hazard Abatement	01	01	855 4717-Steel frame, roof, sides, service bld, (pipe rack in front)	1	LS	$1,219,325	$1,219,325	OTHER	10	10	1	
8	491E	Hazard Abatement	01	01	856 491E-Steel and concrete walls, radiological hazard	1	LS	$496,551	$496,551	OTHER	10	10	1	
9	491S	Hazard Abatement	01	01	857 491S-Steel and concrete walls, radiological hazard	1	LS	$268,172	$268,172	OTHER	10	10	1	
10	491W	Hazard Abatement	01	01	858 491W-Steel and concrete walls, radiological hazard	1	LS	$499,029	$499,029	OTHER	10	10	1	
7	4718	Hazard Abatement	01	01	859 4718-Fenced storage area	1	LS	$0	$0	OTHER	10	10	1	
2	403	Hazard Abatement	01	01	861 403-Equipment Removal	1	LS	$25,838	$25,838	OTHER	10	10	1	
1	402	Hazard Abatement	01	01	862 402-Equipment Removal	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Hazard Abatement	01	01	863 408A-Equipment Removal	1	LS	$82,239	$82,239	OTHER	10	10	1	
4	408B	Hazard Abatement	01	01	864 408B-Equipment Removal	1	LS	$38,126	$38,126	OTHER	10	10	1	
5	408C	Hazard Abatement	01	01	865 408C-Equipment Removal	1	LS	$37,496	$37,496	OTHER	10	10	1	
6	4717	Hazard Abatement	01	01	866 4717-Equipment Removal	1	LS	$46,004	$46,004	OTHER	10	10	1	
8	491E	Hazard Abatement	01	01	867 491E-Equipment Removal	1	LS	$23,317	$23,317	OTHER	10	10	1	
9	491S	Hazard Abatement	01	01	868 491S-Equipment Removal	1	LS	$12,604	$12,604	OTHER	10	10	1	
10	491W	Hazard Abatement	01	01	869 491W-Equipment Removal	1	LS	$23,632	$23,632	OTHER	10	10	1	
2	403	Transportation Cost	01	01	870 403-Transportation Cost	1	LS	$1,180	$1,180	OTHER	10	10	1	
1	402	Transportation Cost	01	01	871 402-Transportation Cost	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Transportation Cost	01	01	872 408A-Transportation Cost	1	LS	$3,755	$3,755	OTHER	10	10	1	
4	408B	Transportation Cost	01	01	873 408B-Transportation Cost	1	LS	$1,741	$1,741	OTHER	10	10	1	
5	408C	Transportation Cost	01	01	874 408C-Transportation Cost	1	LS	$1,712	$1,712	OTHER	10	10	1	
6	4717	Transportation Cost	01	01	875 4717-Transportation Cost	1	LS	$2,100	$2,100	OTHER	10	10	1	
8	491E	Transportation Cost	01	01	876 491E-Transportation Cost	1	LS	$1,065	$1,065	OTHER	10	10	1	
9	491S	Transportation Cost	01	01	877 491S-Transportation Cost	1	LS	$575	$575	OTHER	10	10	1	
10	491W	Transportation Cost	01	01	878 491W-Transportation Cost	1	LS	$1,079	$1,079	OTHER	10	10	1	
2	403	Treatmant Cost	01	01	800 403-Treatment Cost	1	LS	$93	$93	OTHER	10	10	1	
1	402	Treatmant Cost	01	01	801 402-Treatment Cost	1	LS	$0	$0	OTHER	10	10	1	
3	408A	Treatmant Cost	01	01	802 408A-Treatment Cost	1	LS	$294	$294	OTHER	10	10	1	
4	408B	Treatmant Cost	01	01	803 408B-Treatment Cost	1	LS	$136	$136	OTHER	10	10	1	
5	408C	Treatmant Cost	01	01	804 408C-Treatment Cost	1	LS	$134	$134	OTHER	10	10	1	
6	4717	Treatmant Cost	01	01	805 4717-Treatment Cost	1	LS	$165	$165	OTHER	10	10	1	
8	491E	Treatmant Cost	01	01	806 491E-Treatment Cost	1	LS	$83	$83	OTHER	10	10	1	
9	491S	Treatmant Cost	01	01	807 491S-Treatment Cost	1	LS	$45	$45	OTHER	10	10	1	
10	491W	Treatmant Cost	01	01	808 491W-Treatment Cost	1	LS	$85	$85	OTHER	10	10	1	
11	405	Hazard Abatement	01	01	879 405-Equipment Removal	1	LS	$37,181	$37,181	OTHER	10	10	1	
11	405	Transportation Cost	01	01	880 405-Transportation Cost	1	LS	$1,698	$1,698	OTHER	10	10	1	
11	405	Treatmant Cost	01	01	809 405-Treatment Cost	1	LS	$133	$133	OTHER	10	10	1	
									$0					

CAPITAL MARKUPS

MDBI 10%	SUBTOTAL	Overhead 15%	Profit 10%	SUBTOTAL	WA States Sales Tax 8.6%	SUBTOTAL	Scope Contingency 15%	Bid Contingency 10%	SUBTOTAL	Project Management Percent	Project Management 5%	Remedial Design Percent	Remedial Design 6%	Construction Management Percent	Construction Management 6%	SUBTOTAL	CHPRC G&A 17.36%	COST PER YEAR
$88,054	$968,589	$145,288	$96,859	$1,210,737	$104,123	$1,314,860	$197,229	$131,486	$1,643,575		$82,179		$98,615		$98,615	$1,922,983	$333,830	$2,256,813
$34,419	$378,610	$56,792	$37,861	$473,263	$40,701	$513,964	$77,095	$51,396	$642,454		$32,123		$38,547		$38,547	$751,672	$130,490	$882,162
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0		$0		$0	$0	$0	$0
$72,642	$799,058	$119,859	$79,906	$998,823	$85,899	$1,084,722	$162,708	$108,472	$1,355,902		$67,795		$81,354		$81,354	$1,586,405	$275,400	$1,861,805
$33,626	$369,888	$55,483	$36,989	$462,361	$39,763	$502,124	$75,319	$50,212	$627,655		$31,383		$37,659		$37,659	$734,356	$127,484	$861,840
$33,173	$364,901	$54,735	$36,490	$456,126	$39,227	$495,353	$74,303	$49,535	$619,191		$30,960		$37,151		$37,151	$724,453	$125,765	$850,218
$121,933	$1,341,258	$201,189	$134,126	$1,676,572	$144,185	$1,820,758	$273,114	$182,076	$2,275,947		$113,797		$136,557		$136,557	$2,662,858	$462,272	$3,125,130
$49,655	$546,206	$81,931	$54,621	$682,758	$58,717	$741,475	$111,221	$74,147	$926,844		$46,342		$55,611		$55,611	$1,084,407	$188,253	$1,272,660
$26,817	$294,990	$44,248	$29,499	$368,737	$31,711	$400,448	$60,067	$40,045	$500,560		$25,028		$30,034		$30,034	$585,656	$101,670	$687,325
$49,903	$548,932	$82,340	$54,893	$686,165	$59,010	$745,175	$111,776	$74,517	$931,469		$46,573		$55,888		$55,888	$1,089,818	$189,192	$1,279,011
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0		$0		$0	$0	$0	$0
$2,584	$28,421	$4,263	$2,842	$35,527	$3,055	$38,582	$5,787	$3,858	$48,228		$2,411		$2,894		$2,894	$56,426	$9,796	$66,222
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0		$0		$0	$0	$0	$0
$8,224	$90,463	$13,569	$9,046	$113,079	$9,725	$122,804	$18,421	$12,280	$153,505		$7,675		$9,210		$9,210	$179,601	$31,179	$210,779
$3,813	$41,939	$6,291	$4,194	$52,424	$4,508	$56,932	$8,540	$5,693	$71,165		$3,558		$4,270		$4,270	$83,263	$14,454	$97,718
$3,750	$41,246	$6,187	$4,125	$51,557	$4,434	$55,991	$8,399	$5,599	$69,989		$3,499		$4,199		$4,199	$81,887	$14,216	$96,103
$4,600	$50,604	$7,591	$5,060	$63,255	$5,440	$68,695	$10,304	$6,869	$85,869		$4,293		$5,152		$5,152	$100,466	$17,441	$117,907
$2,332	$25,649	$3,847	$2,565	$32,061	$2,757	$34,818	$5,223	$3,482	$43,522		$2,176		$2,611		$2,611	$50,921	$8,840	$59,761
$1,260	$13,864	$2,080	$1,386	$17,330	$1,490	$18,821	$2,823	$1,882	$23,526		$1,176		$1,412		$1,412	$27,525	$4,778	$32,303
$2,363	$25,995	$3,899	$2,600	$32,494	$2,794	$35,288	$5,293	$3,529	$44,111		$2,206		$2,647		$2,647	$51,609	$8,959	$60,569
$118	$1,298	$195	$130	$1,622	$139	$1,762	$264	$176	$2,202		$110		$132		$132	$2,576	$447	$3,024
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0		$0		$0	$0	$0	$0
$375	$4,130	$620	$413	$5,163	$444	$5,607	$841	$561	$7,009		$350		$421		$421	$8,200	$1,424	$9,624
$174	$1,915	$287	$191	$2,394	$206	$2,599	$390	$260	$3,249		$162		$195		$195	$3,802	$660	$4,462
$171	$1,883	$282	$188	$2,354	$202	$2,556	$383	$256	$3,196		$160		$192		$192	$3,739	$649	$4,388
$210	$2,310	$347	$231	$2,888	$248	$3,136	$470	$314	$3,921		$196		$235		$235	$4,587	$796	$5,383
$106	$1,171	$176	$117	$1,464	$126	$1,590	$238	$159	$1,987		$99		$119		$119	$2,325	$404	$2,729
$58	$633	$95	$63	$791	$68	$859	$129	$86	$1,074		$54		$64		$64	$1,257	$218	$1,475
$108	$1,187	$178	$119	$1,484	$128	$1,611	$242	$161	$2,014		$101		$121		$121	$2,356	$409	$2,765
$9	$102	$15	$10	$127	$11	$138	$21	$14	$173		$9		$10		$10	$202	$35	$237
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0		$0		$0	$0	$0	$0
$29	$324	$49	$32	$405	$35	$440	$66	$44	$550		$27		$33		$33	$643	$112	$755
$14	$150	$22	$15	$187	$16	$203	$31	$20	$254		$13		$15		$15	$297	$52	$349
$13	$148	$22	$15	$185	$16	$200	$30	$20	$251		$13		$15		$15	$293	$51	$344
$16	$181	$27	$18	$226	$19	$246	$37	$25	$307		$15		$18		$18	$360	$62	$422
$8	$92	$14	$9	$115	$10	$125	$19	$12	$156		$8		$9		$9	$182	$32	$214
$5	$50	$7	$5	$62	$5	$67	$10	$7	$84		$4		$5		$5	$99	$17	$116
$8	$93	$14	$9	$116	$10	$126	$19	$13	$158		$8		$9		$9	$185	$32	$217
$3,718	$40,899	$6,135	$4,090	$51,124	$4,397	$55,521	$8,328	$5,552	$69,401		$3,470		$4,164		$4,164	$81,199	$14,096	$95,295
$170	$1,867	$280	$187	$2,334	$201	$2,535	$380	$253	$3,169		$158		$190		$190	$3,707	$644	$4,351
$13	$146	$22	$15	$183	$16	$199	$30	$20	$248		$12		$15		$15	$291	$50	$341
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		$0		$0		$0	$0	$0	$0

ANNUAL O&M COST

SITE	SITE NAME	WBS Top Tier	WBS Second Tier	WBS Third Tier	DESCRIPTION	QTY	UNIT	UNIT COST	SUBTOTAL	SOURCE	START YEAR	END YEAR	INTERVAL	NOTES
12	400 Area	Surveillance	01	01	800 S&M of FFTF Facilities FY 2019-Actuals	1	LS	$669,355	$669,355	HISTORICAL	1	10		
									$0					

ANNUAL O&M MARKUPS

MDBI 0%	SUBTOTAL	Overhead 15%	Profit 10%	SUBTOTAL	WA States Sales Tax 8.6%	SUBTOTAL	Scope Contingency 15%	Bid Contingency 10%	SUBTOTAL	Technical Support Services Percent	Technical Support Services Subtotal	SUBTOTAL	CHPRC G&A 17.36%	COST PER YEAR
$0	$669,355	$100,403	$66,935	$836,694	$71,956	$908,649	$136,297	$90,865	$1,135,812	26%	$295,311	$1,431,123	$248,443	$1,679,565
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	45%	$0	$0	$0	$0

Table A-5. Capital Unit Cost Summary

Location:	400 Area
Phase:	EE/CA
Base Year:	2030
Date:	10/1/2020

	Item	Qty	Unit Cost	Units	Total	Source	Institutional Control?	Add OH and Profit?	Labor Only?	% of non-labor item to be taxed	Notes/References
	DECONTAMINATION: #800 - 849										
800	403-Treatment Cost	2.00	$93	LS	$ 185	OTHER	NO	YES	NO	100%	
802	408A-Treatment Cost	2.00	$294	LS	$ 589	OTHER	NO	YES	NO	100%	
803	408B-Treatment Cost	2.00	$136	LS	$ 272	OTHER	NO	YES	NO	100%	
804	408C-Treatment Cost	2.00	$134	LS	$ 268	OTHER	NO	YES	NO	100%	
805	4717-Treatment Cost	2.00	$165	LS	$ 329	OTHER	NO	YES	NO	100%	
806	491E-Treatment Cost	2.00	$83	LS	$ 167	OTHER	NO	YES	NO	100%	
807	491S-Treatment Cost	2.00	$45	LS	$ 90	OTHER	NO	YES	NO	100%	
808	491W-Treatment Cost	2.00	$85	LS	$ 169	OTHER	NO	YES	NO	100%	
809	405-Treatment Cost	1.00	$133	LS	$ 133	OTHER	NO	YES	NO	100%	
	DEMOLITION AND REMOVAL: #850 - 899										
850	403-Steel metal frame insulated metal siding, roof	2.00	$ 344,191	LS	$ 688,382	OTHER	NO	YES	NO	100%	
852	408A-Main heat dump east - radiological	2.00	$ 726,417	LS	$ 1,452,833	OTHER	NO	YES	NO	100%	
853	408B-Main heat dump south - radiological	2.00	$ 336,262	LS	$ 672,525	OTHER	NO	YES	NO	100%	
854	408C-Main heat dump west - radiological	2.00	$ 331,728	LS	$ 663,456	OTHER	NO	YES	NO	100%	
855	4717-Steel frame, roof, sides, service bld, (pipe rack in front)	2.00	$ 1,219,325	LS	$ 2,438,651	OTHER	NO	YES	NO	100%	
856	491E-Steel and concrete walls, radiological hazard	2.00	$ 496,551	LS	$ 993,102	OTHER	NO	YES	NO	100%	
857	491S-Steel and concrete walls, radiological hazard	2.00	$ 268,172	LS	$ 536,345	OTHER	NO	YES	NO	100%	
858	491W-Steel and concrete walls, radiological hazard	2.00	$ 499,029	LS	$ 998,058	OTHER	NO	YES	NO	100%	
860	405-FFTF containment building-nuclear op 10 years	1.00	$ 880,536	LS	$ 880,536	OTHER	NO	YES	NO	100%	
861	403-Equipment Removal	2.00	$ 25,838	LS	$ 51,675	OTHER	NO	YES	NO	100%	
863	408A-Equipment Removal	2.00	$ 82,239	LS	$ 164,479	OTHER	NO	YES	NO	100%	
864	408B-Equipment Removal	2.00	$ 38,126	LS	$ 76,253	OTHER	NO	YES	NO	100%	
865	408C-Equipment Removal	2.00	$ 37,496	LS	$ 74,992	OTHER	NO	YES	NO	100%	
866	4717-Equipment Removal	2.00	$ 46,004	LS	$ 92,007	OTHER	NO	YES	NO	100%	
867	491E-Equipment Removal	2.00	$ 23,317	LS	$ 46,634	OTHER	NO	YES	NO	100%	
868	491S-Equipment Removal	2.00	$ 12,604	LS	$ 25,207	OTHER	NO	YES	NO	100%	
869	491W-Equipment Removal	2.00	$ 23,632	LS	$ 47,264	OTHER	NO	YES	NO	100%	
870	403-Transportation Cost	2.00	$ 1,180	LS	$ 2,359	OTHER	NO	YES	NO	100%	
872	408A-Transportation Cost	2.00	$ 3,755	LS	$ 7,510	OTHER	NO	YES	NO	100%	
873	408B-Transportation Cost	2.00	$ 1,741	LS	$ 3,482	OTHER	NO	YES	NO	100%	
874	408C-Transportation Cost	2.00	$ 1,712	LS	$ 3,424	OTHER	NO	YES	NO	100%	
875	4717-Transportation Cost	2.00	$ 2,100	LS	$ 4,201	OTHER	NO	YES	NO	100%	
876	491E-Transportation Cost	2.00	$ 1,065	LS	$ 2,129	OTHER	NO	YES	NO	100%	
877	491S-Transportation Cost	2.00	$ 575	LS	$ 1,151	OTHER	NO	YES	NO	100%	
878	491W-Transportation Cost	2.00	$ 1,079	LS	$ 2,158	OTHER	NO	YES	NO	100%	
879	405-Equipment Removal	1.00	$ 37,181	LS	$ 37,181	OTHER	NO	YES	NO	100%	
880	405-Transportation Cost	1.00	$ 1,698	LS	$ 1,698	OTHER	NO	YES	NO	100%	

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Appendix B

Sodium Removal Contract Briefing and Cost/Schedule Estimate

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CONTRACT TRANSITION BRIEFING
SODIUM DISPOSITION

T. M. BURKE

(Updated 10/5/05; original attached to e-mail from McGee in OUTLOOK mailbox transition folder)

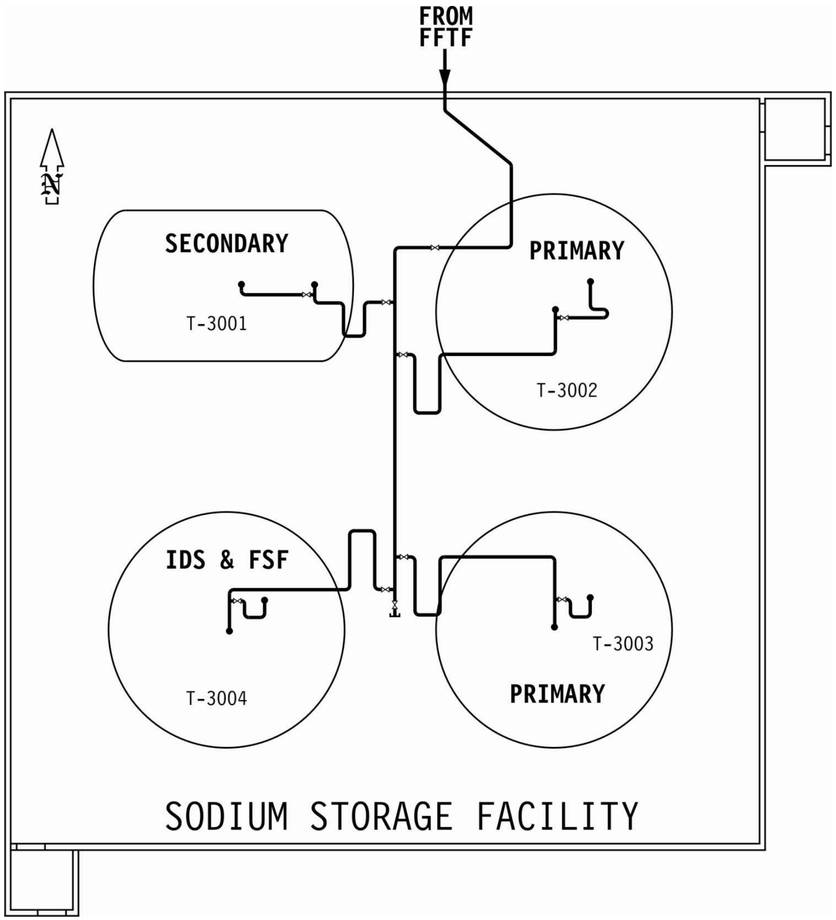
Disposition of FFTF Sodium/NaK Systems

Major Elements

- Drain and store bulk Sodium/NaK for future disposition
- Maintain drained systems (with residuals) for future cleaning
- Clean residuals
  - Small piping/components
  - Large piping/components
  - “Special components” (highly radioactive)
- Disposition bulk sodium

Sodium Storage Facility

- Will hold all FFTF sodium pending ultimate disposition
- Construction complete 1996
- Designed/constructed to RCRA requirements but "procedurally closed" since sodium designated as product
- Sodium segregated by source (activity level)



Disposition of FFTF Sodium/NaK Systems (cont)

Drain and Store

- Secondary loops
  - Non-radioactive (except for low levels of tritium)
  - ~66,000 gallons (total in three loops)
  - Sodium stored (frozen) in one tank in Sodium Storage Facility (SSF)
  - Main residuals: Cold traps, pumps, IHXs, venturi flow meters, drain tank, small bore piping
  - Residuals frozen/under argon blanket

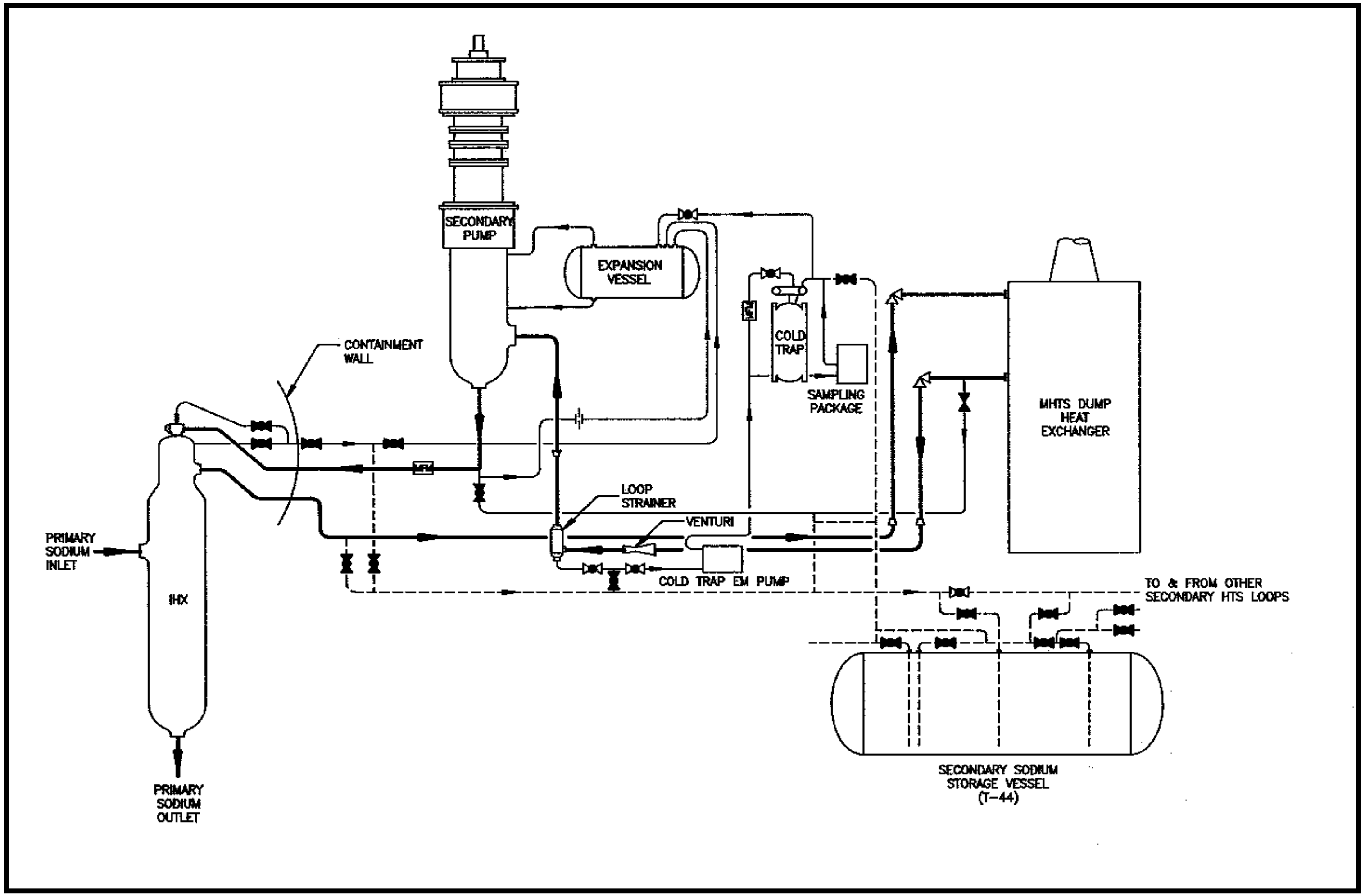
- Fuel Storage Facility (FSF) NaK loop
  - Non radioactive
  - ~360 gallons drained, transferred into sodium in FSF vessel
  - <30 gallons residual:
    - ~20 gal in storage tank; <10 gal in in-vessel cooler
    - Maintained under argon blanket
    - Cleaning of residuals in progress

Disposition of FFTF Sodium/NaK Systems (cont)

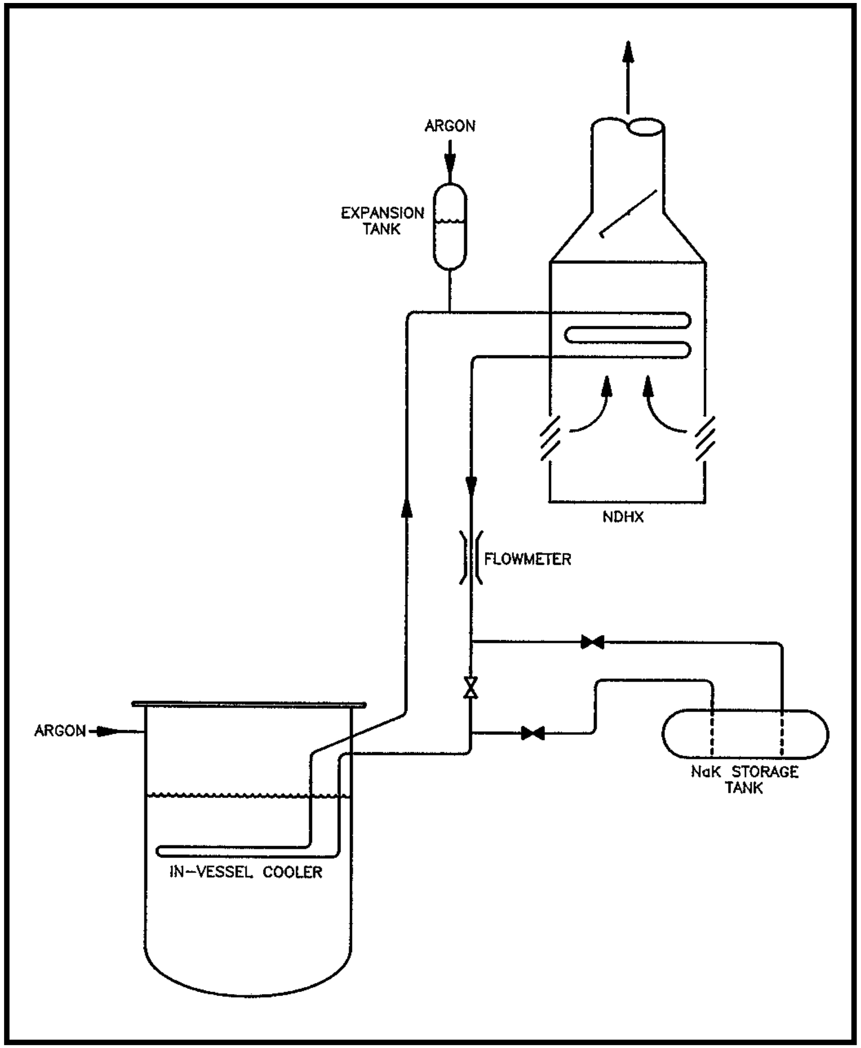
Drain and Store

- In-Containment NaK Loops (Primary cold trap and IDS cooling systems)
  - Non radioactive
  - ~500 gallons in two loops flushed into primary sodium system in July 2004
  - Residuals (mainly frozen sodium) maintained under argon blanket
    - Very small quantities of NaK may remain in cover gas piping

FFTF Secondary Loop Schematic



FSF NaK Loop Schematic



Disposition of FFTF Sodium/NaK Systems (cont)

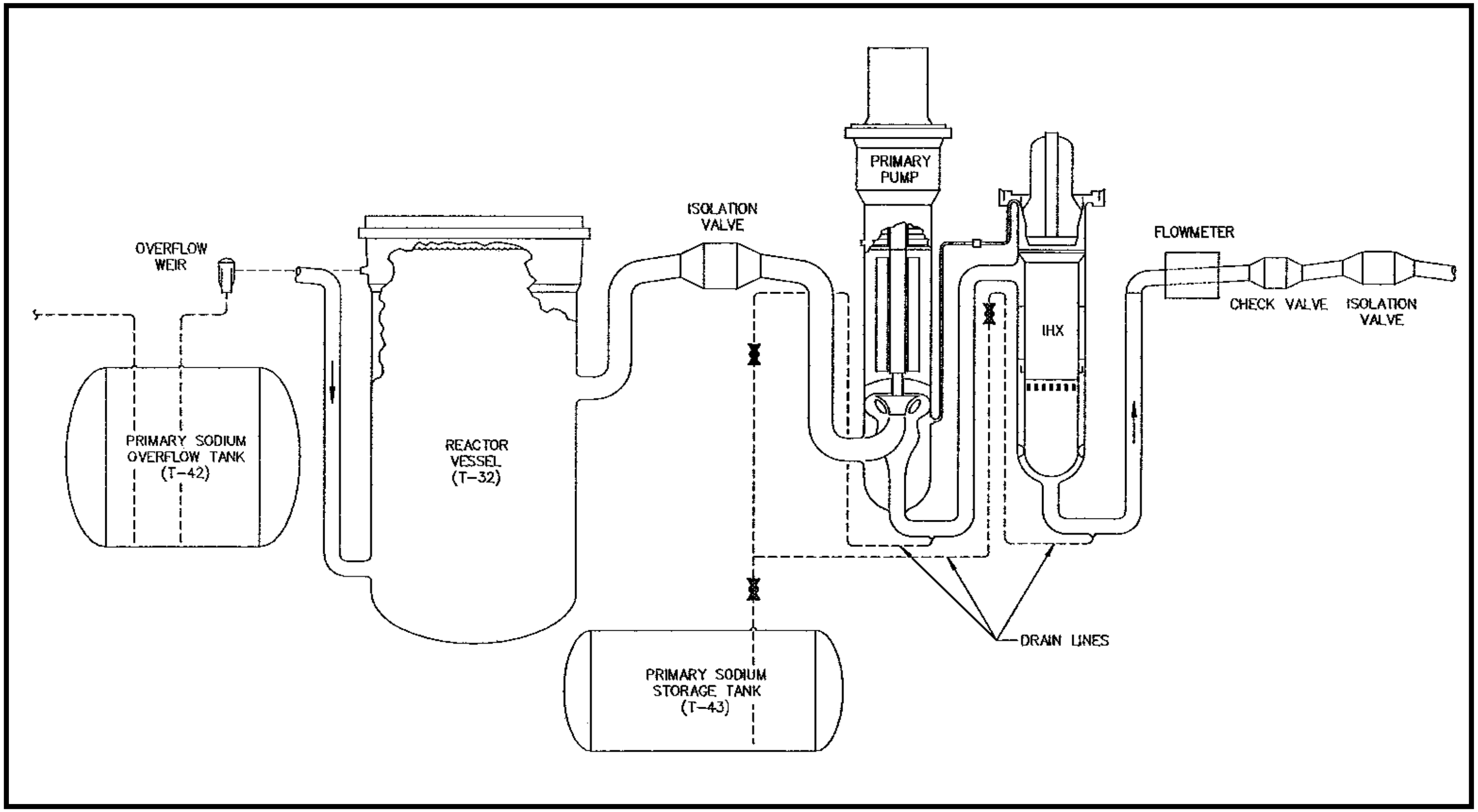
Drain and Store (cont)

- Primary System
  - Moderately Radioactive (mostly Cs-137, Na-22)
  - ~140,000 gallons in three loops, reactor vessel and auxiliary systems
  - Drain performed in three phases

B-8

Δ Phase 1 (Reduce reactor vessel level and drain loops)
  - ~75,000 gallons drained in August 2004
  - Reactor vessel sodium level reduced by ~16 feet
  - Sodium stored in one tank in SSF
  - Main residuals: Isolation / check valves, pumps, IHXs

FFTF Primary System Schematic



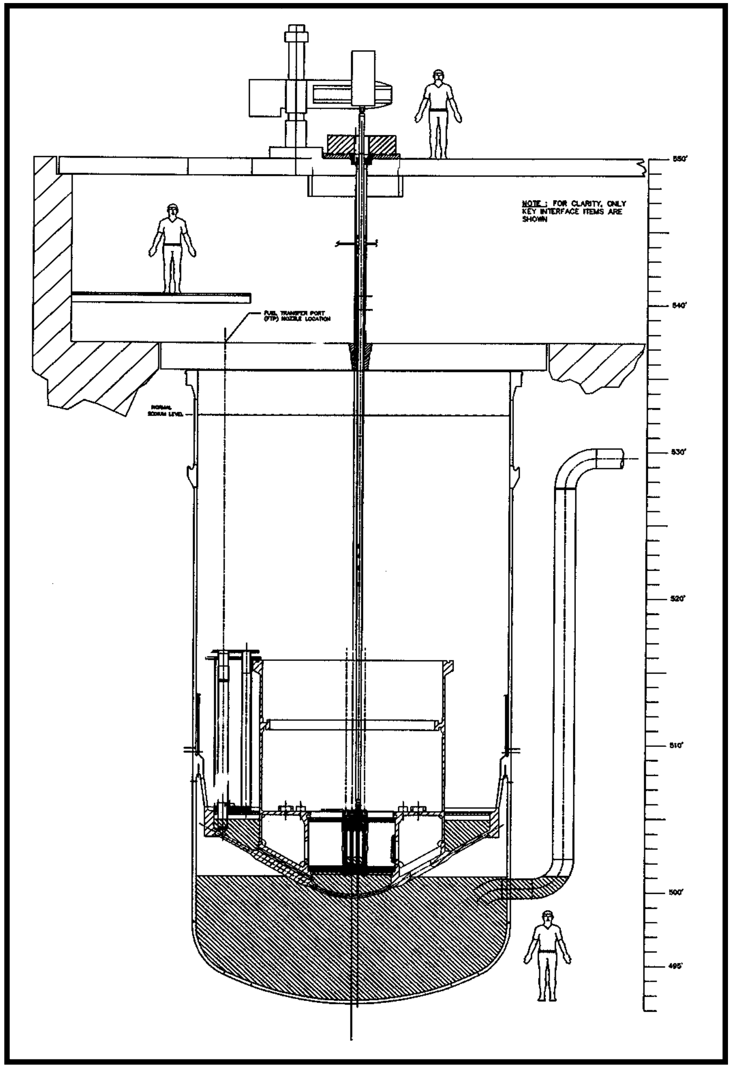
Disposition of FFTF Sodium/NaK Systems (cont)

Drain and Store (cont)

- Δ Phase 2 (Drain auxiliary systems: processing, sampling, reactor overflow)
  - ~21,000 gallons
  - Drained in October/November 2004
  - Main residuals: cold trap, overflow tank and small bore piping

- Δ Phase 3 (Drain remainder of reactor vessel)
  - ~42,000 gallons; temperature maintained by immersion heaters (backup by Nitrogen Blower-Heater Unit)
  - Drain required reaming/drilling hole through reactor internals and installing dip tube/pump
  - Reaming/drilling process developed via extensive program culminating in full scale prototypic demonstration

Reactor Vessel Residual Sodium



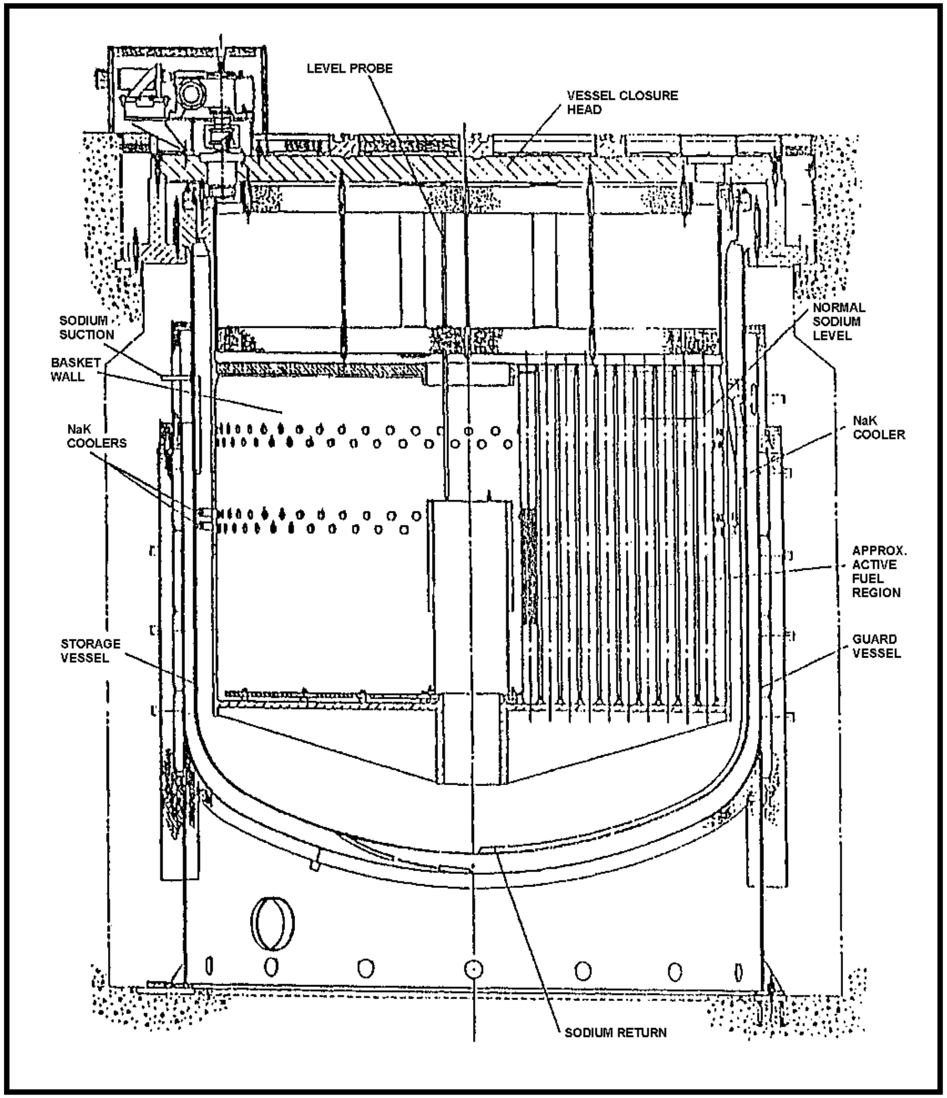
Disposition of FFTF Sodium/NaK Systems (cont)

Drain and Store (cont)

- Δ Phase 3 (Drain remainder of reactor vessel) (cont)
  - "Fluidic Pump" used (~ 60 foot long assembly)
  - Completed June 2005 (TPA Milestone)
  - All sodium from Phases 2 and 3 in one SSF tank
  - Main residuals: bottom of vessel, core support structure, thermal baffles

- Fuel Storage Facility
  - Slightly radioactive (sodium from Hallam reactor, additional contamination from fuel)
  - ~31,000 gallons (including process loop)
  - No installed drain system; used ~100 vacuum/pressure transfers through intermediate tank
  - Completed September 2005 (last SSF tank ~ ½ full)

FSF Schematic

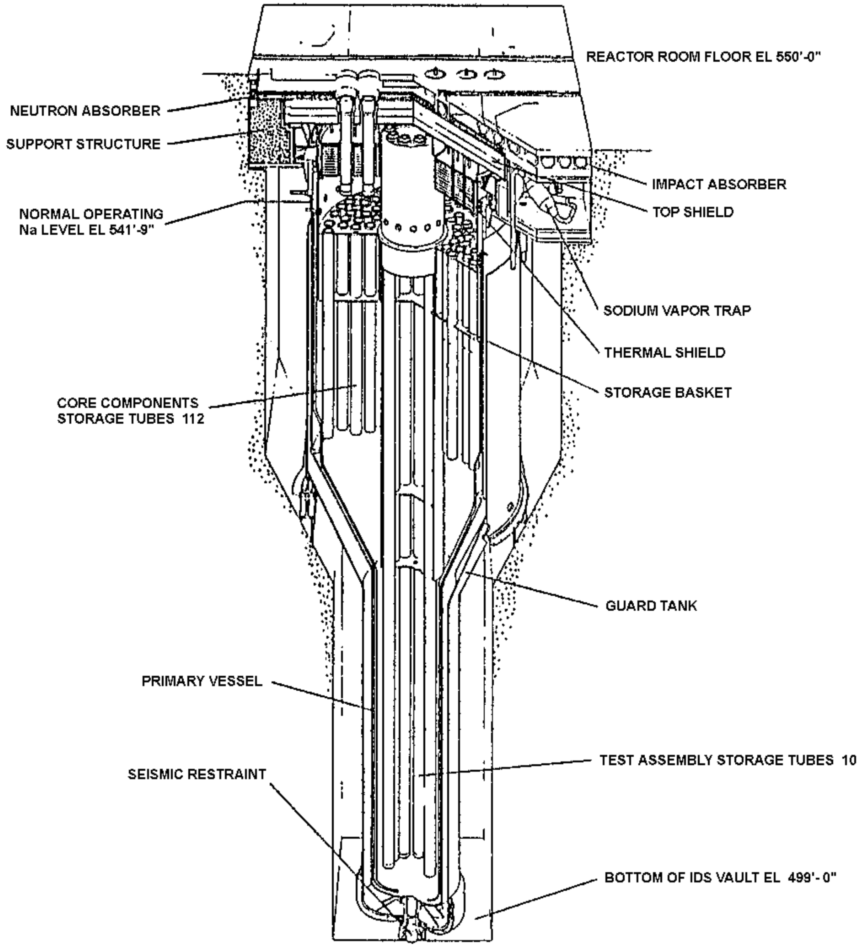


Disposition of FFTF Sodium/NaK Systems (cont)

Drain and Store (cont)

- Interim Decay Storage Vessel
  - Slightly radioactive (contamination from fuel & primary sodium)
  - Original volume ~23,000 gallons (including process/cooling loop)
  - Drain capability provided
  - Vessel sodium level reduced in 2004 to "protect" refueling equipment. Current inventory ~17,000 gallons
  - Must develop equipment for "plunging" sodium from 112 Core Component Pots and removing pots for cleaning
  - Evaluating need for immersion heater due to failure of trace heat on bottom of vessel
  - Sodium will be stored in last SSF tank (with FSF sodium)
  - Fuel scheduled to be removed ~ March 2006

IDS Schematic



Sodium/NaK Residuals

- Systems will be drained to maximum extent practical
  - ~3,600 gallons “quantifable” residual
  - ~70% of quantifiable residual sodium contained in seven cold traps
  - Very small quantity of NaK residual
  - Residuals maintained under inert gas blanket

- Current Plan:
  - Clean residuals using superheated steam in nitrogen
  - Remove small components/piping for cleaning in external facility (in FSF)
  - Clean most large components/piping in place
    - Except primary pumps, IHXs, Instrument Trees in MASF
  - Remove “special components” for interim storage/ultimate disposition
    - **Special components = highly radioactive (cesium trap, primary cold trap, two primary vapor traps)**
    - **Possible ultimate disposition at planned Remote Treatment Project at INL**

- Cleaning of residuals not included in original deactivation plan
  - Added recently
  - Cost/schedule are rough order of magnitude (~$120M/8 years)
  - Supplemental EA in preparation

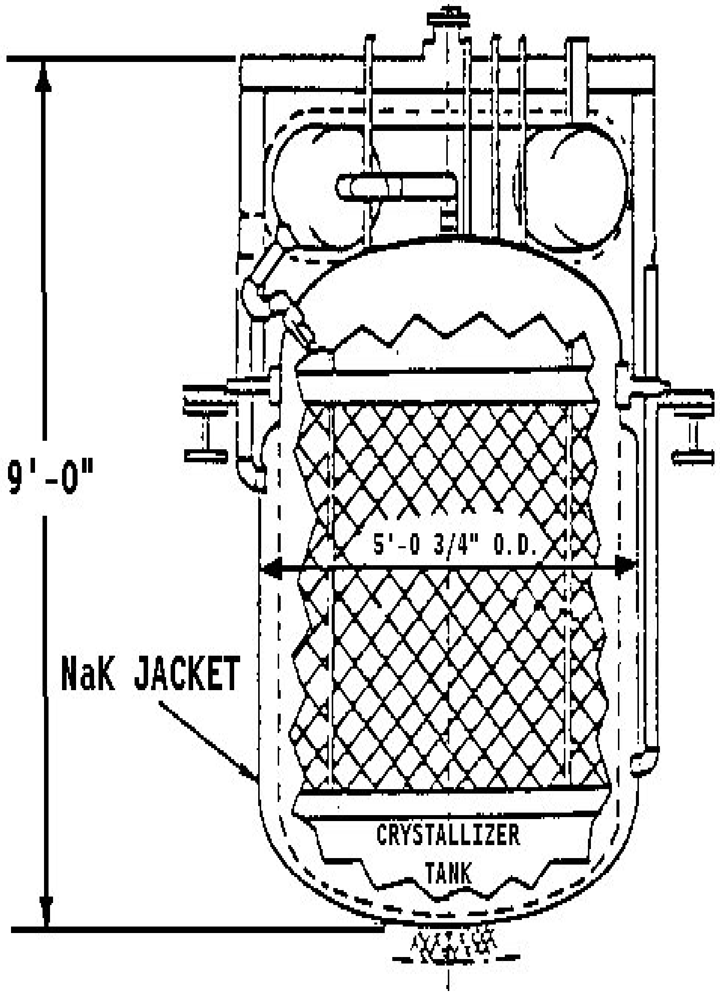
Estimated Plant Residual Sodium Volumes

LOCATION	ESTIMATED VOLUME (gallons)
Reactor Vessel	200
Primary Pump/Discharge Piping [(1)]	15
IHX Primary Side/Discharge Piping [(1)]	15
Primary Hot Leg Isolation Valve [(1)]	375
Primary Cold Leg Isolation Valve [(1)]	210
Reactor Overflow Weir	20
Reactor Overflow Tank (T-42)	15
Primary Sodium Storage Tank (T-43)	20
Primary Cold Trap (N-5) [(2)]	710
Primary Cesium Trap	80
Interim Decay Storage Vessel	100
Interim Decay Storage Cold Trap (N-46)	300
Fuel Storage Facility Vessel	100
Fuel Storage Facility Cold Trap	200
IXH Secondary Side [(1)]	30
Secondary Loop Venturi Flowmeter [(1)]	120
Secondary Sodium Storage Tank (T-44)	30
Secondary Loop Cold Trap [(1)]	900
Other Small Overflow and Drain Tanks	20
Primary Cold Trap & IDS NaK Cooling Loops	15
Total Estimated Volume	3580

[(1)] Residual sodium volume given is for three loops

[(2)] Includes residual sodium in the NaK cooling jacket.

Primary Cold Trap



Sodium Residuals "Issue"

- 3,600 gallon estimate was "quantifiable" volume only
- Volume has increased by ~900 gallons due to current planning related to IDS CCPs and FSF storage tubes
- Additional volume anticipated in complex small piping systems/components
- Additional volume very difficult to quantify but could be ~2,000 gallons
- DOE feels commitment made to EPA/Ecology that residual quantity would be ~3,600 gallons (by 9/30/09)
- Possible solution: Remove or drain all cold traps by 9/30/09

Bulk Sodium Disposition

- SSF will hold all FFTF sodium pending ultimate disposition
- Current plan converts sodium to 50% hydroxide solution for use in pre-treatment of high level waste prior to vitrification or waste tank chemistry control
- Will include disposition of Hallam and SRE sodium currently stored in 200 Area (Waste Management currently responsible)
  - Hallam: 34,000 gallons in 5 tanks
  - SRE: 7,000 gallons in 158 drums
- Trade-off study evaluated conversion at new Hanford facility versus existing SPF at INL:
  - Transport to INL judged more cost effective than constructing new facility at Hanford
  - No significant technical or regulatory issues with transport
- Growing schedule disparity between FFTF and WTP makes use of INL SPF more problematic
- Evaluation of hydroxide production/storage options in progress

SODIUM RESIDUALS REMOVAL

Cost and Schedule Estimate

September 2005

(DOE Presentation – 9/15/05)

Previous Estimate (current RLS)

- Developed primarily by Bill Brehm in 2002
- Based on use of Water Vapor-Nitrogen (WVN)
- Assumed all large components/piping cleaned in-situ (vessels, tanks, pumps, IHXs, DHXs)
- Assumed use of MASF (LDCV) for cleaning small bore piping/components after removal
- Appears to be missing cost of in-situ cleaning system(s)
- Did not include removal of residuals from refueling equipment, IEMC, etc. (covered elsewhere)

Previous Estimate (Cont.)

- Did not include "facility support services" (electrical, inert gas, lighting, HVAC, etc.)
- Did not include management, training etc.
- Estimates for many items appear to be low (e.g., casks for "Special Components")
- Included shipment & processing of "Special Components" at ANL (~$25M)
- Total cost (including $25M to ANL) ~$43M over 6-8 years (initial estimate considerably higher but reduced during management review)

Key Assumptions for New Estimate

- Use superheated steam process
- Use three separate cleaning systems:
  - portable system (in-situ cleaning of large components)
  - stationary system (in FSF for small piping/components)
  - MASF LDCV (converted to steam for large removable components)
- Primary pumps, IHXs & Instrument Trees removed and cleaned in MASF
- DHX tube bundles cut up and cleaned as small bore piping

Key Assumptions for New Estimate (Cont.)

- All small heat exchangers & valves cut up to assure effective cleaning
- Core Component Pots/storage tubes removed from IDS/FSF and cleaned as small bore pipe
- Special Components removed and stored at Hanford
- All systems/components rinsed with water (adequate from regulatory standpoint)

Key Assumptions for New Estimate (Cont.)

- All hydroxide solutions disposed of at ETF as waste at no cost to FFTF (except for treatment, sampling/analysis & transportation)
- All material removed from plant disposed of as low level rad waste at ERDF
- Includes removal of residuals from refueling equipment, IEMC, etc.
- "Facility Support Services" not included except:
  - Electrical (for steam generation only)
  - Nitrogen
  - Other consumables (e.g., PPE)

How are Management Systems & Administrative Resources Covered?

- Project Management: One full time project manager
- Engineering:
  - For every 100 hrs Engineer:
    10 hrs Engineering Manager
  - 2 hrs Chief Engineer
- Operations:
  - For every 100 hrs Operator:
  - 20 hrs SOM
  - 5 hrs Operations Manager

Management Resources and Administrative Resources (Cont.)

- Maintenance:

  For every 100 hrs Craft:
  - 10 hrs Supervisor
  - 2 hrs Maintenance Manager
  - 10 hrs Work Control
  - 5 hrs Scheduler
- Others (e.g., Rad Con, Safety)
  - Include 1 hr "management" for every 10 hrs "worker"
- Include manpower to cover training, staff meetings, etc.

Procure Cleaning Stations

- Key Parameters/Assumptions/Issues
  - Three stations required (one includes reaction vessel)
  - Competitive bid contract to design/fabricate stations and provide consultation during use
  - Reaction vessel size ~ 15' x 8'; sodium limit: 25 gal.
  - Cost/schedule include preparation of specification/RFP and contract management
- Cost/Schedule:
  - $2.9M ($2.0M equipment)
  - First two stations delivered ~ 6/1/06, third ~ 10/1/06

Regulatory Compliance & Waste Disposal Activities

- Key Parameters/Assumptions/Issues
  - liquid rad waste to ETF: Procure two road tankers
  - Procure neutralization & chemical analysis equipment
  - Solid Waste to ERDF: Includes equipment/material plus labor/transportation plus $31.92/ton disposal
  - CERCLA ROD (6/1/06) plus Removal Action Work Plan (10/1/06) required before starting field work
- Cost/Schedule
  - $5.4M (start 10/1/05)

Pull FSF Storage Tubes

- Key Parameters/Assumptions/Issues
  - 466 tubes w/ ~1 gallon frozen sodium each
  - Special grapple required (break shear pin)
  - Store tubes for later cleaning
- Cost/Schedule
  - $830K over 10 months

Clean FSF Vessel

- Key Parameters/Assumptions/Issues
  - After removal of storage tubes

    Requires penetrations through vessel wall
  - Need large expansion volume (CRBRP tank?)
  - Includes equipment setup (for vessel and small bore piping)
- Cost/Schedule
  - $1.7M over 1 year

Remove All Small Bore Piping & Components

- Key Parameters/Assumptions/Issues
  Total piping length ~13,500 feet
  - Includes NaK capillaries
  - Includes all cell opening work
  - Trace heat/insulation removed first (some asbestos)
  - Pipe cut into ~12' lengths (maximum)
  Cutting/removal requires 2.2 people 2 hours per foot (w/ factors applied for difficulty)
- Cost/Schedule
  - $12.5M over several years

Remove/Cut Up DHX Tube Bundles

- Key Parameters/Assumptions/Issues
  - Clean up bird waste
  - Remove stack to remove tube bundle
  - Total tubing length = ~109,000 ft: >10,000 cuts
  - Perform cutting in MASF
- Cost/Schedule
  - $3M over 2 years

Clean All Small Bore Piping/CCPs/Etc.

- Key Parameters/Assumptions/Issues
  - Total piping length ~ 122,500 feet
  - Cleaning station in FSF
  - 5%-25% of pipe volume filled w/ sodium (depending on pipe diameter)
- Cost/Schedule
  - $4.5M over several years

Clean All Tanks

- Key Parameters/Assumptions/Issues
  - Includes T-42, T-43, T-44, T-7, T-8, T-9, T-88, T-89, T-98, T-99, four SSF tanks, five Hallam tanks and 158 SRE drums
  - All FFTF tanks cleaned in-situ
  - Tanks require 5-12 penetrations (several new)
- Cost/Schedule
  - $11M over several years

Clean Secondary MHTS Loops

- Key Parameters/Assumptions/Issues
  - 16" pipe cut/capped outside containment
  - MHTS pumps cleaned in-situ
  - In-containment portion cleaned after IHX tube bundle removed (included as part of primary)
- Cost/Schedule
  - $6.55M

Remove & Clean Cold Traps

- Key Parameters/Assumptions/Issues
  - Three secondary, two FSF and one IDS traps (excludes primary and Cs traps)
  - Sodium drained to drums for disposition with bulk
  - All work performed "hands-on" (drained/cleaned in FSF)
- Cost/Schedule
  - $2M

Remove/Clean Primary HTS Pumps, IHX Tube Bundles & Instrument Trees

- Key Parameters/Assumptions/Issues
  - Pumps & IHXs removed via bagging operations
  - IT removal requires removal of triskelion (after cleaning reactor vessel) and use of SMC
  - Moved to MASF and cleaned in LDCV
  - Includes startup of LDCV
- Cost/Schedule
  - $ 7.2M

Remove/Store Special Components

- Key Parameters/Assumptions/Issues
  - Includes primary cold trap, cesium trap and two continuous duty primary vapor traps
  - Requires development of shielding and remote tooling (contact dose rates up to tens of R/hr)
  - Access to vapor traps especially difficult – potential dose reduction activities will be investigated
  - Requires procurement of special shipping/storage casks (capable of future off-site transport)

Remove/Store Special Components (Cont.)

- Cost/Schedule
  - Total: $24.7M over ~5 years: includes:
    - Cost of casks $11.5M per Waste Management
    - Cost of modified or new storage site $.75M per Waste Management

Clean Primary HTS Loops

- Key Parameters/Assumptions/Issues
  - After removal of MHTS pumps/IHX tube bundles
  - Piping to reactor cut/capped inside HTS cells
  - Requires 16 injection/vent points per loop
- Cost/Schedule
  - $3.1M

Clean IDS Vessel

- Key Parameters/Assumptions/Issues
  - After removal of CCPs and long components
    Requires penetrations through vessel wall
  - Need large expansion volume (T-42?)
- Cost/Schedule
  - $1.9M

Clean Reactor Vessel

- Key Parameters/Assumptions/Issues
  - IVHMs & ITs left in place (ITs removed later)
  - Immersion Heaters & instrument assembly removed and cleaned in FSF
  - Multiple head penetrations to access crush tubes and thermal baffles
  - 18 injection and 3 vent points
- Cost/Schedule

  $8.3M

Miscellaneous Support Activities and Consumables

- Key Activities/Assumptions/Issues
  - Convert from argon to nitrogen cover gas
  - Emergency preparedness, FHA, HASP, etc.
  - Downgrade systems/simplify work processes (e.g., eliminate ASME code stamps/requirements)
  - Nitrogen, electricity for steam, PPE, laundry
- Cost/Schedule
  - $5.7M

Clean Refueling Equipment/Cells

- Key Paramenters/Assumptions/Issues
  - Includes disposition of long assemblies from TACS
  - CLEM Core Component Grapple washed in SRS
  - BLTC grapple and filter washed in cleaning station in FSF
  - CLEM & BLTC casks cleaned "in-situ" using steam
  - CGCF, FVs, FVAs, MGB, PHF cleaned "hands on"
  - TACS, CCCS, SPSS cleaned "hands on
  - Most IEMC equipment dismantled and cleaned in station in FSF
- Cost/Schedule
  - $6M

Management, Training, Etc.

- Key Activities/Assumptions/Issues
  - Includes management as listed in Key Assumptions
  - Includes manpower to cover training, meetings, etc.
- Cost/Schedule
  - $12.7M over life of project

Summary

- New assessment for removing sodium residuals:
  - $120M over 8-10 years (detailed logic/schedule still being developed)
- Does not include "facility support services" except inert gas and electricity for steam
- Uncertainties are high (estimates are ROM)
- Does not include contingency or overtime
- Potential exists for reductions through identification/application of innovative approaches