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<td>R R Bafus</td>
<td>R3-73</td>
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<td>D P Fassett</td>
<td>R3-73</td>
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<td>C E Graves</td>
<td>G3-14</td>
<td>X</td>
<td></td>
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<td>C E Grenard</td>
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<td>X</td>
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<td>X</td>
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<td>T J Conrads</td>
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<td>X</td>
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<td>X</td>
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<td>C P Shaw</td>
<td>R3-74</td>
<td>X</td>
<td></td>
<td></td>
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<td>R2-12</td>
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<td>T G Goetz</td>
<td>R1-49</td>
<td>X</td>
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<td>R2-12</td>
<td>X</td>
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Functional Analysis for Double-Shell Tank Subsystems

Abstract
This analysis identifies the DST Subsystem functions for storing, transferring, receiving, and preparing waste in support of the Waste Feed Delivery mission.

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Functional Analysis for Double-Shell Tank Subsystems

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

LOCKHEED MARTIN
Richland, Washington

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC06 99RL14047

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## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td>1.1</td>
<td>BACKGROUND</td>
<td>1-1</td>
</tr>
<tr>
<td>1.2</td>
<td>PURPOSE AND SCOPE</td>
<td>1-2</td>
</tr>
<tr>
<td>1.3</td>
<td>DOCUMENT ORGANIZATION</td>
<td>1-2</td>
</tr>
<tr>
<td>2.0</td>
<td>FUNCTIONAL ANALYSIS</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1</td>
<td>STORE WASTE FUNCTIONAL DECOMPOSITION</td>
<td>2-6</td>
</tr>
<tr>
<td>2.1.1</td>
<td>Third-Tier Store Waste Flows</td>
<td>2-6</td>
</tr>
<tr>
<td>2.1.2</td>
<td>Double-Shell Tank Store Waste Function Hierarchy</td>
<td>2-7</td>
</tr>
<tr>
<td>2.1.3</td>
<td>Third-Tier Function Definitions</td>
<td>2-7</td>
</tr>
<tr>
<td>2.1.4</td>
<td>Fourth-Tier Function Definitions</td>
<td>2-9</td>
</tr>
<tr>
<td>2.2</td>
<td>TRANSFER WASTE FUNCTIONAL DECOMPOSITION</td>
<td>2-23</td>
</tr>
<tr>
<td>2.2.1</td>
<td>Third-Tier Transfer Waste Flows</td>
<td>2-24</td>
</tr>
<tr>
<td>2.2.2</td>
<td>Double-Shell Tank Transfer Waste Function Hierarchy</td>
<td>2-24</td>
</tr>
<tr>
<td>2.2.3</td>
<td>Third-Tier Function Definitions</td>
<td>2-25</td>
</tr>
<tr>
<td>2.2.4</td>
<td>Fourth-Tier Function Definitions</td>
<td>2-28</td>
</tr>
<tr>
<td>2.3</td>
<td>PREPARE WASTE FUNCTIONAL DECOMPOSITION</td>
<td>2-42</td>
</tr>
<tr>
<td>2.3.1</td>
<td>Third- and Fourth-Tier Prepare Double-Shell Tank Waste Flows</td>
<td>2-42</td>
</tr>
<tr>
<td>2.3.2</td>
<td>Double-Shell Tank Prepare Waste Functional Hierarchy</td>
<td>2-43</td>
</tr>
<tr>
<td>2.3.3</td>
<td>Third- and Fourth-Tier Function Definitions</td>
<td>2-43</td>
</tr>
<tr>
<td>2.4</td>
<td>DISTRIBUTE DST UTILITIES FUNCTIONAL DECOMPOSITION</td>
<td>2-62</td>
</tr>
<tr>
<td>2.4.1</td>
<td>Distribute Utilities Function Flows</td>
<td>2-62</td>
</tr>
<tr>
<td>2.4.2</td>
<td>Double-Shell Tank Distribute Utilities Function Hierarchy</td>
<td>2-62</td>
</tr>
<tr>
<td>2.4.3</td>
<td>Definitions for Distribute Utilities Within the Double-Shell Tank System</td>
<td>2-62</td>
</tr>
<tr>
<td>3.0</td>
<td>ALLOCATION OF FUNCTIONS TO DOUBLE-SHELL TANK COMPONENTS</td>
<td>3-1</td>
</tr>
<tr>
<td>4.0</td>
<td>REFERENCES</td>
<td>4-1</td>
</tr>
<tr>
<td>Figure Reference</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2-0</td>
<td>Double-Shell Tank System Functional Flow Block Diagram</td>
<td>2-4</td>
</tr>
<tr>
<td>2-11</td>
<td>Double-Shell Tank Third-Tier Functional Flows for Store Waste</td>
<td>2-16</td>
</tr>
<tr>
<td>2-1-2</td>
<td>Double-Shell Tank Flow, Control Double-Shell Tank Chemical Composition for Store Waste</td>
<td>2-17</td>
</tr>
<tr>
<td>2-1-3</td>
<td>Double-Shell Tank Functional Flow, Control Double-Shell Tank and Waste Temperature for Store Waste</td>
<td>2-18</td>
</tr>
<tr>
<td>2-1-4</td>
<td>Double-Shell Tank Functional Flow, Control Double-Shell Tank Hydrostatic Loads</td>
<td>2-19</td>
</tr>
<tr>
<td>2-1-5</td>
<td>Double-Shell Tank Functional Flow Control Double-Shell Tank Primary Confinement Leaks</td>
<td>2-20</td>
</tr>
<tr>
<td>2-1-6</td>
<td>Double-Shell Tank Functional Flow, Control Double-Shell Tank Gaseous Discharge</td>
<td>2-21</td>
</tr>
<tr>
<td>2-12-1</td>
<td>Double-Shell Tank System Function Hierarchy for Store Waste</td>
<td>2-22</td>
</tr>
<tr>
<td>2-2-1-1</td>
<td>Double-Shell Tank Third-Tier Functional Flows for Waste Transfer</td>
<td>2-33</td>
</tr>
<tr>
<td>2-2-1-2</td>
<td>Double-Shell Tank Functional Flow Establish Transfer Route for Waste Transfer</td>
<td>2-34</td>
</tr>
<tr>
<td>2-2-1-3</td>
<td>Double-Shell Tank Functional Flow, Provide Diluent During Transfers</td>
<td>2-35</td>
</tr>
<tr>
<td>2-2-1-4</td>
<td>Double-Shell Tank Functional Flow, Convey Waste</td>
<td>2-36</td>
</tr>
<tr>
<td>2-2-1-5</td>
<td>Double-Shell Tank Functional Flow, Confining Waste Along Transfer Route</td>
<td>2-37</td>
</tr>
<tr>
<td>2-2-1-6</td>
<td>Double-Shell Tank Functional Flow, Confine Waste Leakage Along Transfer Route</td>
<td>2-38</td>
</tr>
<tr>
<td>2-2-1-7</td>
<td>Double-Shell Tank Functional Flow, Flush Transfer System</td>
<td>2-39</td>
</tr>
<tr>
<td>2-2-1-8</td>
<td>Double-Shell Tank Functional Flow, Reconfigure Transfer Route</td>
<td>2-40</td>
</tr>
<tr>
<td>2-2-2-1</td>
<td>Double-Shell Tank System Function Hierarchy for Waste Transfer</td>
<td>2-41</td>
</tr>
<tr>
<td>2-3-1-1</td>
<td>Prepare Waste in East Area Double-Shell Tanks Functional Flow</td>
<td>2-50</td>
</tr>
<tr>
<td>2-3-1-2</td>
<td>Mobilize and Suspend Insoluble Waste Within East Area Double-Shell Tanks Functional Flow</td>
<td>2-51</td>
</tr>
<tr>
<td>Figure 2 3 1-3</td>
<td>Add Diluent to High-Level Waste Source Tank Functional Flow</td>
<td>2-52</td>
</tr>
<tr>
<td>Figure 2 3 1-4</td>
<td>Dissolve Soluble Waste in East Area Double-Shell Tanks Functional Flow</td>
<td>2-53</td>
</tr>
<tr>
<td>Figure 2 3 1-5</td>
<td>Soften Crust Layer in Low-Activity Waste Source Tanks Functional Flow</td>
<td>2-54</td>
</tr>
<tr>
<td>Figure 2 3 1-6</td>
<td>Dissolve Salts in Low-Activity Waste Source Tanks Functional Flow</td>
<td>2-55</td>
</tr>
<tr>
<td>Figure 2 3 1-7</td>
<td>Prepare Low-Activity Waste in Low-Activity Waste Staging Tanks Functional Flow</td>
<td>2-56</td>
</tr>
<tr>
<td>Figure 2 3 1-8</td>
<td>Soften Crust Layer in Low-Activity Staging Tanks Functional Flow</td>
<td>2-57</td>
</tr>
<tr>
<td>Figure 2 3 1-9</td>
<td>Add Diluent to Low-Activity Waste Staging Tank Functional Flow</td>
<td>2-58</td>
</tr>
<tr>
<td>Figure 2 3 1-10</td>
<td>Dissolve Salts in Low-Activity Staging Tanks Functional Flow</td>
<td>2-59</td>
</tr>
<tr>
<td>Figure 2 3 1-11</td>
<td>Prepare High-Level Waste Sludges in High-Level Waste Staging Tanks Functional Flow</td>
<td>2-60</td>
</tr>
<tr>
<td>Figure 2 3 2-1</td>
<td>Double-Shell Tank System Function Hierarchy for Prepare Waste</td>
<td>2-61</td>
</tr>
<tr>
<td>Figure 2 4 2-1</td>
<td>Double-Shell Tank System Function Hierarchy for Distribute Utilities</td>
<td>2-65</td>
</tr>
<tr>
<td>Figure 3 0-1</td>
<td>Store Waste Functions Applicable to Double-Shell Tank Components</td>
<td>3-2</td>
</tr>
<tr>
<td>Figure 3 0-2</td>
<td>Transfer Waste Functions Applicable to Double-Shell Tank Components</td>
<td>3-3</td>
</tr>
<tr>
<td>Figure 3 0-3</td>
<td>Prepare Waste Functions Applicable to Double-Shell Tank Components</td>
<td>3-4</td>
</tr>
<tr>
<td>Figure 3 0-4</td>
<td>Distribute Utilities Functions Applicable to Double-Shell Tank Components</td>
<td>3-5</td>
</tr>
</tbody>
</table>
### ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
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</tr>
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<td>HLW</td>
<td>high-level waste</td>
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<td>LAW</td>
<td>low-activity waste</td>
</tr>
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<td>LFL</td>
<td>lower flammability limit</td>
</tr>
<tr>
<td>OSD</td>
<td>Operating Specification Documents</td>
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<td>PFP</td>
<td>Plutonium Finishing Plant</td>
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<td>single-shell tank</td>
</tr>
<tr>
<td>WFD</td>
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</tbody>
</table>
10 INTRODUCTION

This functional analysis identifies the hierarchy and describes the subsystem functions that support the Double-Shell Tank (DST) System described in HNF-SD-WM-TRD-007, System Specification for the Double-Shell Tank System. Catch tanks are not addressed in this document, and may need to be repaired or replaced to support the Waste Feed Delivery (WFD) mission. The next version of this document will address the functions related to that equipment as applicable. The functions identified herein are applicable to the Phase 1 WFD mission only.

11 BACKGROUND

HNF-SD-WM-TRD-007 provides the following first-tier DST System functions that support the Phase 1 WFD mission:

- Maintain Safe and Compliant Waste Within the DST System (tsd 1 2 5 1 1)
- Remove Waste from DSTs Phase 1 (tsd 2 2 6 1 1)
- Prepare High-Level Waste (HLW) Feed for Phase 1 Treatment (tsd 2 2 6 1 3)
- Prepare Low-Activity Waste (LAW) Feed for Phase 1 Treatment (tsd 2 2 6 1 2)

This document is a functional analysis of the second-tier functions defined in HNF-SD-WM-TRD-007. It includes the functions for storing, transferring, receiving, and preparing waste in support of the WFD mission. The following documentation was used to describe planned or expected waste preparation and transfer operations:

- HNF-SD-WM-SP-012 Tank Waste Remediation System Operation and Utilization Plan
- HNF-SD-WM-TRD-007, System Specification for the Double-Shell Tank System
- HNF-1939, Rev 0c, Vol II Addendum 3, “Waste Feed Delivery Flowsheet for Tank 241-AN-104”

---

1 Note: tsd = treat, store, and dispose. This prefix is on all Hanford Site Technical Database (HSTD) function numbers, as instituted by Site Systems Engineering.
1.2 PURPOSE AND SCOPE

This functional analysis describes the behavior of DST subsystems and their contribution to the Phase 1 WFD mission. This is the first step in quantifying DST subsystem performance, and the results of this functional analysis will be used to construct the following DST subsystem specifications:

1. DST Transfer Pump System
2. DST Mixer Pump System
3. DST Ventilation System
4. DST Caustic and Diluent Addition System
5. DST Transfer Valving System
6. DST Transfer Piping System
7. DST Utility System

This functional analysis was performed to the level of detail needed to derive functions that are uniquely allocable to the above DST subsystems. Functional flows and functional descriptions capture the planned WFD processes and the resulting DST System behavior.

1.3 DOCUMENT ORGANIZATION

The remainder of this document is organized in two major sections as follows:

- Section 2.0 explains the methodology, rationale, and results of the functional analysis. More detail is presented in the subsections: Store Waste (Section 2.1), Transfer Waste (Section 2.2), Prepare Waste (Section 2.3), and Distribute Utilities (Section 2.4).
- Section 3.0 identifies the allocation of the functions derived in Section 2.0, to the seven DST subsystems identified in Section 1.2.
20 FUNCTIONAL ANALYSIS

This section describes the functional decomposition of storing, receiving, transferring, and preparing waste and distributing utilities (The receive functions are addressed with the Transfer Waste functional decomposition [Section 2.2]).

This functional analysis was performed in accordance with the guidelines provided by HNF-IP-0842, Tank Waste Remediation System Administration Manual, Vol IV, Section 3.2, "Functions and Requirements Analysis Allocation and Development of Level 1 and Level 2 Specifications." This functional analysis was limited to decomposing the DST System functions down to the level at which the derived functions could be allocated to one of the seven subsystems identified in Section 1.0 thus supporting development of the Level 2 specifications for each of these subsystems.

The DST System functions identified in HNF-SD-WM-TRD-007, Figure 3-2, with the exceptions noted below were used as the starting point for this functional analysis. These DST system-level functions are identified in Figure 2.0 of this document. The top-tier functions were decomposed into second-, third-, fourth-, and lower-tier functions. A function definition is provided along with the reference that establishes the need (basis) for the function. This provides traceability for the function set derived herein. Functional relationships were established through both functional hierarchy and functional flow block diagrams. Lastly, the functional hierarchy is annotated to identify the allocation of functions to one of the seven DST subsystems.

During the W-314 Project preconceptual design activities (FY 1996), it was determined that the "store waste" functional decomposition can be characterized as a series of "control" tank/waste parameters. The definitions for "control" of a tank/waste parameter while storing tank waste were derived from brainstorming sessions with representatives from Plant Engineering and Tank Farm Operations. The same philosophy for "control" of tank/waste parameters was used herein for defining the Store East/West Area DST Waste functions. In summary, "control" was determined to include the following elements:

- "monitor" means obtain, transmit, receive, record, and display data.
- "compare" means compare data received from the monitor to a set point and initiate the appropriate action.
- "maintain" means to maintain parameter within operating/design limits.
- "respond to off-normal" means to take actions to correct situations where a parameter has exceeded its operating/design limits.
Changes to functionality shown in Figure 2.0 are planned for inclusion in the next revision of the DST System Specification and are summarized as follows:

- **Deleted function**: Receive Pretreated Waste from LAW/HLW Plant. This function was removed per HNF-SD-WM-SP-012, Rev 1, *Tank Waste Remediation System Operation and Utilization Plan*, Executive Summary, which states that for scenario Case 3, BNFL Inc. provides new tanks such that no feed or solids are returned.

- **Name Change**: Transfer LAW Supernatant to LAW/HLW Plant. The name was changed to identify the LAW/HLW Plant as receiving the LAW, rather than “Vendor Feed Storage.”

- **Name Change**: Prepare LAW in LAW Staging Tanks. The name was changed to identify waste preparation functions, which are broader than “Blend.”

- **Name Change**: Prepare HLW Sludges in HLW Staging Tanks. The name was changed to identify functions for preparing waste within staging tanks so that the delineation is clear.

- **New function**: Transfer Waste to HLW Staging Tanks. This function was added to capture functionality for transferring waste to HLW staging tanks as opposed to transferring waste between DSTs, which are not identified as staging tanks.

- **Deleted function**: Receive Waste Products from LAW/HLW Plant. This function was removed per HNF-SD-WM-SP-012, Executive Summary which states that for scenario Case 3, BNFL Inc. provides new tanks such that no feed or solids are returned.

- **New function**: Transfer Supernatants to Single-Shell Tank (SST) Retrieval System. This function was added to capture functionality for transferring supernatant from a DST to the SST Retrieval System in support of SST Retrieval. Previously, this function was allocated to the SST System (open block) but should be shown as allocated to the DST System per HNF-3339 Rev 0, *Interface Control Between the Double-Shell Tank System and the Single-Shell Tank System*.

- **Deleted function**: Remove K Basin Sludge. This function was deleted. The DST System does not support receiving K Basin Sludge per HNF-4500, Rev 0, *Tank Farm System Interface Summary*.

- **Deleted function**: 400 Area Cleanup Activities. This function was deleted. The DST System does not support receiving waste from 400 Area Cleanup per HNF-4500, Rev 0.

- **Name Change**: Provide High-Level Radioactive Sample Services (222-S Laboratory). The function name was changed to clarify receiving waste from the lab rather than S Plant.

- **Added Connector**: Added a direct connector from the Store Waste in East Area DSTs function to the Prepare LAW in LAW Staging Tanks function. This addition was made to reflect the logical connection between the functions noted to circumvent prepare and transfer functions for LAW stored in East Area DST designated as LAW Staging Tanks.
• Added Connector  Added a direct connector between the Store Waste in East Area DSTs function and the Transfer LAW to LAW Staging Tanks function. This addition was made to reflect the planned decanting process from LAW Source to LAW Staging Tanks circumventing the prepare function. LAW supernatant stored in East Area DSTs will be pumped (decanted) directly to LAW Staging Tanks without preparation, as established in the "Interim Guidance on LAW Retrieval Strategy.”

• Added Connector  Added a direct connector between Prepare Waste in East Area DSTs and Transfer Waste to HLW Staging Tanks. This addition was made to reflect the logical connection between the Prepare Waste in East Area DSTs function and the newly added Transfer Waste to HLW Staging Tank function.
Figure 2.0 Double-Shell Tank System Functional Flow Block Diagram
(Sheet 1 of 2)

Note 1) Store Waste functions are minimal mode and are performed continuously.

Provide HL Radioactive Sample Services (222-S Lab)

Transition PFP Facility

Transfer SST Salt Water Liquid Waste to DST

Remove Waste from SSTs for Phase 1 WFD

Cleanup Soil Sites at Reactor Sites (100 N Area)

300 Area Operations and Cleanup Activities

WESF

T Plant Operations and Cleanup Activities

Transport Waste to 204-AR Waste Unloading Facility

Transfer Waste From 204-AR Waste Unloading Station to East Area DST

Sample and Characterize Tank Farm System Waste

Transfer Supernatents to SST Retrieval System

Remove Waste from SSTs for Phase 1 WFD

Store Waste in West Area DSTs

Prepare Waste in West Area DSTs

Transfer Waste Between West Area DSTs

Receive New Liquid Waste into West Area DSTs

Transfer Waste Cross Site

Phase 1 SST East Waste

Distribute Utilizes in DST System

Support DST System

Phase 1 SST West Waste

East Waste

West
Figure 2.0 Double-Shell Tank System Functional Flow Block Diagram
(Sheet 2 of 2)

DST = double shell tank
HLW = high level waste
LAW = low activity waste
PFP = Plutonium Finishing Plant
SST = single shell tank
WESF = Waste Encapsulation and Storage Facility
WFD = Waste Feed Delivery

Note 1) Store Waste Functions are multi-mode and are performed continuously.
2.1 STORE WASTE FUNCTIONAL DECOMPOSITION

Store waste functions shown in Figure 2.0 represent those functions required to store both existing waste and that waste received from external sources (i.e., 222-S Laboratory, Plutonium Finishing Plant [PFP], T-Plant). Store waste supports storing waste in a safe and compliant manner and maintaining the tank structural integrity. The DST System-Level Store functions shown in Figure 2.0 referred to herein as "second-tier" functions, are as follows:

- Store Waste in West Area DSTs
- Store Waste in East Area DSTs

Note that the Store Waste functions are "multi-mode" and are performed continuously throughout the WFD process. For example, the Store Waste functions are performed while waste transfers are taking place. The functional decomposition presented herein accounts for the multi-moded nature of the Store Waste function.

2.1.1 Third-Tier Store Waste Flows

The function flow shown in Figure 2.1.1-1 represents the decomposition of the second-tier Store DST Waste functions. These "third-tier" functions were derived mainly from the Tank Waste Remediation System Technical Safety Requirements (HNF-SD-WM-TSR-006) and Operating Specification Documents (OSDs). Justification (i.e., basis) for each function is provided with the function definitions in Section 2.1.2. The basis documents listed for each function are not intended to be an exhaustive list of bases for the function identified. For example, environmental regulations cited in the DST System Specification (e.g., WAC 173-303-640) or other source documents listed in Section 1.1 are also identified; however, to ensure a complete set of functions have been identified herein, reviews by Technical Operations and Engineering and Retrieval Engineering have been conducted. Further quantification of these functions (i.e., via requirements development) will entail canvassing these and other sources for applicable requirements and constraints on the system design.

Third-tier functions for DST waste storage, as shown in Figure 2.1.1-1, include the following functions, which are further decomposed as shown in Figures 2.1.1-2 through 2.1.1-6:

- Control DST Chemical Composition (Figure 2.1.1-2)
- Control DST Tank and Waste Temperature (Figure 2.1.1-3)
- Control DST Hydrostatic Loads (Figure 2.1.1-4)
- Control DST Primary Confinement Leaks (Figure 2.1.1-5)

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1 Note: The functional flow diagrams identify AND and OR relationships between functions. The AND is used to indicate that all parallel functions leading into the circle must be accomplished before proceeding into the next function or that all paths emerging from the AND must be accomplished after the preceding function. The OR indicates alternative paths.
• Control DST Gaseous Discharge (Figure 2 1 1-6)
• Direct Waste Additions Within Double-Shell Tanks

2 1 2 Double-Shell Tank Store Waste
Function Hierarchy

The hierarchy of functions representing a decomposition of the second-tier DST Store Waste functions is shown in Figure 2 1 2-1. This figure arranges the store waste functions derived in the flows of Figures 2 1 1-1 through 2 1 1-6 in a hierarchical fashion.

2 1 3 Third-Tier Function Definitions

Function definitions for the third-tier function set of Store Waste (see Figure 2 1 2-1). Function definition bases are also provided.

2 1 3 1 Direct Waste Additions Within Double-Shell Tanks

Direct waste additions within the DST by providing confinement between the transfer-associated structure and the desired location within the DST (i.e., distribute waste within the tank).

Basis Basis for directing waste additions within the destination DST was not found.

2 1 3 2 Control Double-Shell Tank Chemical Composition

Control the DST waste chemical composition to inhibit uniform corrosion and stress corrosion cracking in the DST steel liner. This function includes sampling, comparing, maintaining, and responding to off-normal chemical compositions.

Basis Per HNF-SD-WM-TRD-007 Section 3 3 6 2 1 corrosion prevention and control features shall be in accordance with WAC 173-303-640(3) Containers.

Per HNF-SD-WM-TSR-006 Tank Waste Remediation System Technical Safety Requirements Section 5 12 2 C chemical compatibility (i.e., pH) prior to transfer is ensured.

Per OSD-T-151-0007 Operating Specifications for the 241-AN AP, AW, AY, AZ & SY Tank Farms Section 7 2 1 nitrate, nitrite, and hydroxide concentrations are controlled.

Per OSD-T-151-00017 Operating Specifications for Aging Waste Operations in 241-AY and 241-AZ Section 17 4 1 1 3 maximum hydroxide concentrations are controlled.

Per OSD-T-151-00017 Section 17 4 1 1 4 maximum nitrite and nitrate concentrations are controlled.

Note Decomposition of this function is not addressed herein.

2-7
2 1 3 3 Control Double-Shell Tank and Waste Temperature

Control the DST tank and waste temperature to prevent structural damage to the DST and to maintain waste temperature limits established by accident analysis. This function includes monitoring, comparing temperature levels to limits, maintaining tank and waste temperature, and responding to off-normal temperatures.

**Basis**  
Per HNF-SD-WM-TRD-007 Section 3 3 6 2 2 waste and tank temperature limits are specified

Per HNF-SD-WM-TSR-006 Section 3 3 2 waste temperature limits are specified

Per OSD-T-151-0007 Sections 7 2 6 a 7 2 6 b and 7 2 6 c maximum temperature limits, temperature changes over time, and temperature gradients are applied to waste temperatures for AN, AP, AW, AY, AZ, and SY Tanks to protect the tank structure.

Per OSD-T-151-0007 Sections 7 2 7 a and 7 2 7 b maximum temperature limits and temperature gradients are applied to the DST concrete to protect the tank structure.

Per OSD-T-I51-00017 Sections 17 2 6 a and 17 2 6 b the maximum dome concrete temperature and temperature gradient allowed are specified.

2 1 3 4 Control Double-Shell Tank Hydrostatic Loads

Control the hydrostatic loads due to DST vapor space pressures and liquid waste levels to prevent structural damage to the DST.

**Basis**  
Per HNF-SD-WM-TRD-007 Section 3 3 6 2 3 DST pressure limits are controlled

Per HNF-SD-WM-TRD-007 (DST System Specification for the DST System Rev 0-E) Section 3 3 6 2 5 hydrostatic loads for various fluid levels are specified

Per OSD-T-151-0007 Section 7 2 3 the minimum hydrostatic head requirements for AY and AZ are stated for preventing damage to the DSTs due to uplifting the bottom of the tank by counter-balancing the vacuum within the tank with the weight of fluid in the tank. Hydrostatic head is defined as the sum of primary tank pressure and liquid level.

Per OSD-T-151-00017 Section 17 2 3 the minimum and maximum hydrostatic head at the DST primary tank walls are controlled.

2 1 3 5 Control Double-Shell Tank Primary Confinement Leaks

Control the DST primary confinement leaks. This function includes monitoring within the DST annulus for indication of leaks from the primary confinement space and responding to a detected leak.

**Basis**  
Per HNF-SD-WM-TRD-007 Section 3 3 6 3 1 the DST System is required to incorporate leak detection features in accordance with WAC-173-303 640.
Per HNF-SD-WM-TSR-006 Section 3.2.6 both a continuity probe (liquid leak) and continuous air monitoring (CAM) for primary tank leak detection are identified.

2 1 3 6 Control Double-Shell Tank Gaseous Discharge

Control the DST vapor space and annulus space to restrict emissions to the environment. This function includes monitoring the DST vapor space for flammable gas concentration.

**Basis** Per HNF-SD-WM-TRD-007 Sections 3.3.6.3.3 and 3.3.6.3.4 design constraints that limit nonradioactive and radioactive airborne emissions are specified.

Per HNF-SD-WM-TSR-006 Section 3.2.1.A.3 the primary tank flammable gas levels are monitored to ensure concentrations are less than 25 percent of the lower flammability limit (LFL) with the ventilation system off.

Per OSD-T-151-00017 Section 17.4.7 the 241-AY and 241-AZ primary tank active ventilation prevents tank vapors escaping the tanks and therefore releasing radionuclides to the atmosphere in excess of limits. Vapor releases may be caused by radiolytic heat converting water to steam by displacement of air due to natural breathing of the tank with changes in atmospheric pressure by displacement of air due to waste transfers, etc.

Per OSD-T-151-00017 Section 7.3.1.E gaseous discharge limits for annual, weekly, and instantaneous concentrations allowed for release at primary and annulus stacks are specified.

Per OSD-T-151-00017 Section 17.4.7 the averaged 4-hour and instantaneous radionuclide release requirements are specified.

2 1 4 Fourth-Tier Function Definitions

Function definitions for the fourth-tier function set of Store Waste (see Figures 2.11.2 through 2.11.6) are given in this section following the applicable third-tier function.

2 1 4 1 Direct Waste Additions Within Double-Shell Tanks

2 1 4 1.1 Reserved

2 1 4 2 Control Double-Shell Tank Chemical Composition

2 1 4 2.1 Sample Double-Shell Tank Chemical Composition Sample DST waste chemical composition to determine if operational limits are being exceeded. This function includes obtaining samples and transporting those samples to the 222-S Laboratory for analysis.

**Basis** Per OSD-T-151-00017 Operating Specifications for Aging Waste Operations in 241-AY and 241-AZ Section 17.4.1.1.3 maximum hydroxide concentrations are controlled.

Per OSD-T-151-00017 Section 17.4.1.1.4 maximum nitrite and nitrate concentrations are controlled.
21422 Compare Double-Shell Tank Chemical Composition  Compare DST waste chemical composition data received from the Monitor Double-Shell Tank Chemical Composition function to operating limits. This function analyzes data and initiates systems for appropriate action.

**Basis**  See basis for Control Double-Shell Tank Chemical Composition Section 2132

21423 Respond to Off-Normal Chemical Composition  Respond to DST waste chemical composition exceeding operating limits. This function includes providing signals to equipment and personnel and taking action to restore the chemical composition to within operating limits.

**Basis**  See basis for Control Double-Shell Tank Chemical Composition Section 2132

21424 Maintain Double-Shell Tank Chemical Composition  Maintain DST waste chemical composition to within nominal operating limits via chemical additions, if necessary.

**Basis**  See basis for Control Double-Shell Tank Chemical Composition Section 2132

214241 Add Caustic to Adjust Chemical Composition  Add bulk chemical to DST to adjust the DST waste chemical composition.

**Basis**  Per OSD-T-151-007 Section 721 the nitrate, nitrite, and hydroxide concentrations are limited to inhibit uniform corrosion rates and stress corrosion cracking.

2143 Control Double-Shell Tank and Waste Temperatures

21431 Monitor Double-Shell Tank Temperature  Monitor DST waste and tank temperatures to determine if operating limits are being exceeded. Monitoring includes obtaining transmitting, receiving, recording, and displaying the temperature data.

**Basis**  See basis for Control Double-Shell Tank and Waste Temperatures Section 2133

21432 Compare Double-Shell Tank Temperature  Compare DST waste temperature and tank temperature data received from the Monitor Double-Shell Tank Temperature function to operating limits. This function analyzes data and initiates systems for appropriate action.

**Basis**  See basis for Control Double-Shell Tank and Waste Temperatures Section 2133

21433 Respond to Off-Normal Double-Shell Tank Temperature  Respond to DST waste and/or tank temperatures exceeding operating limits. This function includes providing signals to equipment and personnel and taking action to restore the waste and tank temperatures to within operating limits.

**Basis**  See basis for Control Double-Shell Tank and Waste Temperatures Section 2133

2-10
21434 Maintain Double-Shell Tank Temperature  Maintain the DST tank and waste temperatures within nominal operating limits. This function may include mixing the waste, ventilating the primary and annulus spaces, and circulating air through the waste as needed.

*Basis*  See basis for Control Double-Shell Tank and Waste Temperatures Section 2133

214341 Ventilate Double-Shell Tank Primary Confinement System to Remove Heat  Ventilate the DST primary tank to remove heat during interim storage of waste.

*Basis*  Per HNF-1939 Rev 0a Vol II Section 314 the waste is cooled using primary ventilation

Per OSD-T-151-0007 Section 73 the primary ventilation is used to cool the primary tank

214342 Ventilate Double-Shell Tank Annulus to Remove Heat  Ventilate the DST annulus to remove heat from the stored waste.

*Basis*  Per OSD-T-151-007 Section 73 the annulus ventilation is used to cool the waste

214343 Mix Waste to Remove Heat  Stir the settled sludge layer to prevent overheating of the sludge during interim storage.

*Basis*  Per HNF-1939 Rev 0a Vol II Sections 20 and 314 the mixer pumps may be used to stir the sludge periodically during interim storage

214344 Circulate Air Through Waste to Remove Heat  Circulate air through the waste during interim storage to prevent the sludge from overheating.

*Basis*  Per HNF-1939 Rev 0a Vol II Section 314 air lift circulators may be used to impede the heating rate of the sludge

2144 Control Double-Shell Tank Hydrostatic Loads

21441 Monitor Double-Shell Tank Waste Level  Monitor the DST liquid waste levels to obtain data to determine if authorization basis limits are exceeded. Monitoring includes obtaining, transmitting, receiving, recording and displaying waste level data.

*Basis*  See basis for Control Double-Shell Tank Hydrostatic Loads 2134

21442 Monitor Double-Shell Tank Vapor Space Pressure  Monitor the DST vapor space pressure to obtain data to determine if authorization basis limits are exceeded. Monitoring includes obtaining, transmitting, receiving, recording and displaying the vapor space pressure data.

*Basis*  See basis for Control Double-Shell Tank Hydrostatic Loads 2134
2 1 4 4 3 Monitor Double-Shell Tank Annulus Pressure  Monitor the DST annulus pressure to determine if operating limits are exceeded. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the annulus pressure data.

*Basis* See basis for Control Double-Shell Tank Hydrostatic Loads Section 2 1 3 4

2 1 4 4 4 Compare Double-Shell Tank Hydrostatic Loads  Compare DST vapor space pressure data and DST waste level data received from the Monitor DST Vapor Space and Monitor DST Waste Level functions to operating limits. This function analyzes data and initiates systems for appropriate action.

*Basis* See basis for Control Double-Shell Tank Hydrostatic Loads 2 1 3 4

2 1 4 4 5 Respond to Off-Normal Double-Shell Tank Hydrostatic Loads  Respond to DST hydrostatic loads exceeding operating limits. This function includes providing signals to equipment and personnel and taking action to restore the hydrostatic loads to within operating limits.

*Basis* See basis for Control Double-Shell Tank Hydrostatic Loads 2 1 3 4

2 1 4 4 6 Maintain Double-Shell Tank Vapor Space Pressure  Maintain the DST vapor space pressure within nominal operating limits by ventilating the primary DST vapor space.

*Basis* Per HNF-SD-WM-TRD-007 Section 3 3 6 2 3, DST pressure limits are specified to protect the system from damage.

2 1 4 5 Control Double-Shell Tank Primary Confinement Leaks

2 1 4 5 1 Monitor Double-Shell Tank Annulus for Primary Leaks  Monitor the DST annulus to obtain data to determine if a liquid leak occurs in the primary tank. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the annulus liquid leak data.

*Basis* See basis for Control Double-Shell Tank Primary Confinement Leaks Section 2 1 3 5

2 1 4 5 2 Monitor Double-Shell Tank Annulus Air for Leaks  Monitor the DST annulus air to obtain data to determine if a liquid leak occurs. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the annulus liquid leak data.

*Basis* See basis for Control Double-Shell Tank Primary Confinement Leaks Section 2 1 3 5

2 1 4 5 3 Respond to Double-Shell Tank Leak in Primary Tank  Respond to the detection of a DST primary leak. This function includes providing signals to equipment and personnel and taking action to contain and control the leakage and to restore the DST to a safe state.

*Basis* See basis for Control Double-Shell Tank Primary Confinement Leaks Section 2 1 3 5
2146 Control Double-Shell Tank Gaseous Discharge

21461 Monitor Double-Shell Tank Gaseous Discharge
Monitor the DST primary and annulus exhaust to obtain data to determine if the gaseous discharge exceeds operating limits for allowable radioactive releases. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the gaseous discharge data.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136

21462 Compare Double-Shell Tank Gaseous Discharge to Operating Limits
Compare DST gaseous discharge data received from the Monitor Double-Shell Tank Gaseous Discharge function to operating limits. This function analyzes data and initiates systems for appropriate action.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136

21463 Maintain Double-Shell Tank Gaseous Discharge Within Limits
Maintain DST gaseous discharges from the exhaust to within operating limits by filtering the exhaust of the primary vapor space and the annulus.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136

214631 Monitor Double-Shell Tank Annulus Pressure
Monitor the DST annulus to obtain air pressure data. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the annulus air pressure data.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136

214632 Compare Double-Shell Tank Annulus Pressure
Compare the DST annulus air pressure data received from the Monitor DST Annulus Pressure function to operating limits. This function analyzes data and initiates systems for appropriate action.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136

214633 Maintain Double-Shell Tank Annulus Pressure
Maintain DST annulus space air pressure within nominal operating limits by ventilating the DST annulus.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136

214634 Respond to Abnormal Double-Shell Tank Annulus Pressure
Respond to DST annulus pressures exceeding operating limits. This function includes providing signals to equipment and personnel and taking action to restore the air pressure to within operating limits.

Basis: See basis for Control Double-Shell Tank Gaseous Discharge, Section 2136
2 1 4 6 3 5 Monitor Double-Shell Tank Vapor Space Pressure  Monitor the DST vapor space to obtain air pressure data. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the vapor space air pressure data.

*Basis* See basis for Control Double-Shell Tank Gaseous Discharge Section 2 1 3 6

2 1 4 6 3 6 Compare Double-Shell Tank Vapor Space Pressure  Compare the DST vapor space air pressure data received from the Monitor Double-Shell Tank Vapor Space Pressure function to operating limits. This function analyzes data and initiates systems for appropriate action.

*Basis* See basis for Control Double-Shell Tank Gaseous Discharge Section 2 1 3 6

2 1 4 6 3 7 Maintain Double-Shell Tank Vapor Space Pressure  Maintain DST vapor space air pressure within nominal operating limits by ventilating the DST vapor space.

*Basis* Per OSD-T-151-007 Section 7 3 ventilation of the primary tank serves to minimize radioactive vapor releases from the primary tank to the atmosphere by keeping a vacuum on the tank.

2 1 4 6 3 8 Respond to Abnormal Double-Shell Tank Vapor Space Pressure  Respond to DST vapor space pressures exceeding operating limits. This function includes providing signals to equipment and personnel and taking action to restore the air pressure to within operating limits.

*Basis* See basis for Control Double-Shell Tank Gaseous Discharge Section 2 1 3 6

2 1 4 6 4 Monitor Double-Shell Tank Flammable Gas Concentration  Monitor the DST flammable gas concentrations to obtain data to determine if operating limits are exceeded. Monitoring includes obtaining, transmitting, receiving, recording, and displaying the flammable gas concentration data.

*Basis* Per HNF-SD-WM-TSR-006 Section 3 2 1 A 3 the primary tank flammable gas levels are monitored to ensure concentrations are no greater than 25 percent of the lower flammability level (LFL).

2 1 4 6 5 Compare Double-Shell Tank Flammable Gas Concentration to Operating Limits  Compare DST flammable gas data received from the Monitor Double-Shell Tank Flammable Gas Concentration function. This function analyzes data and to support the "Respond to Off-Normal Double-Shell Tank Flammable Gas" function.

*Basis* Per HNF-SD-WM-TSR-006 Section 3 2 1 A 3 the system must compare flammable gas levels to 25 percent of the lower flammability limit (LFL).
2 1 4 6 6 Respond to Off-Normal Double-Shell Tank Flammable Gas Concentration
Respond to the detection of off-normal DST flammable gas concentrations. This function includes providing signals to equipment and personnel and taking action to restore the DST flammable gas concentration to within operating limits.

Basis  See basis for Control Double-Shell Tank Gaseous Discharge  Section 2 1 3 6
Figure 211-1  Double-Shell Tank Third-Tier Functional Flows for Store Waste
Figure 2.1.1-2  Double-Shell Tank Flow, Control Double-Shell Tank Chemical Composition for Store Waste

Control DST Chemical Composition

- Direct Waste Additions Within DSTs
- Sample DST Chemical Composition
- Analyze Sample
- Compare DST Chemical Composition to Operating Limits
- Prepare Waste in East Area DSTs

- Maintain DST Chemical Composition
- Respond to Off Normal Chemical Composition

- Control DST and Waste Temperature
- Control DST Hydrostatic Loads
- Control DST Primary Confinement Leaks
- Control DST Gaseous Discharge

Legend:
- Function Block
- External Function
- Repeated Function
- Logical OR
- Logical AND

DST = double-shell tank
Figure 211.3 Double-Shell Tank Functional Flow, Control Double-Shell Tank and Waste Temperature for Store Waste

Legend:
- Function Block
- External Function
- = Repeated Function
- Logical OR
& = Logical AND
DST = double shell tank
Figure 21.1-4 Double-Shell Tank Functional Flow, Control Double-Shell Tank Hydrostatic Loads

Control DST Hydrostatic Loads

1. Monitor DST Waste Level
2. Compare DST Hydrostatic Loads to Operating Limits
3. Maintain DST Annulus Pressure
4. Maintain DST Vapor Space Pressure
5. Respond to Off Normal DST Hydrostatic Loads
6. Control DST and Waste Temperature
7. Control DST Chemical Composition
8. Control DST Primary Confinement Leaks
9. Control DST Gaseous Discharge

Legend
- = Function Block
□ = External Function
= Repeated Function
〇 = Logical OR
〇 = Logical AND
DST = double-shell tank
Figure 2.11-5 Double-Shell Tank Functional Flow Control Double-Shell Tank Primary Confinement Leaks

Control DST Primary Confinement Leaks

Legend

- Repeated Function

O = Logical OR

@ = Logical AND

DST = double shell tank
Figure 2.1.6 Double-Shelf Tank Functional Flow, Control Double-Shelf Tank Gaseous Discharge
2.2 TRANSFER WASTE FUNCTIONAL DECOMPOSITION

The transfer and receive functions shown in Figure 2.0 describe the waste being transferred between DST facilities or waste being transferred between the DST System and facilities external to the DST System. Waste received from the Evaporator and new waste received by DSTs is included in this set of functions. The second-tier transfer functions shown in Figure 2.0 are as follows:

- Transfer Waste from 204-AR Waste Unloading Station to East Area DSTs (tsd 1 2 5 1 1 5)
- Receive New Liquid Waste into West Area DSTs (tsd 1 2 5 1 1)
- Transfer Supernatant to SST Retrieval System
- Transfer Waste Between West Area DSTs (tsd 2 2 6 1 1 2)
- Transfer Waste Cross-Site (tsd 2 2 6 1 1 3)
- Receive New Liquid Waste into East Area DSTs (tsd 1 2 5 1 3)
- Transfer Waste for Concentration (tsd 1 2 5 1 1 10)
- Receive Concentrated Waste from Evaporator (tsd 1 2 5 1 7)
- Receive Emergency Purge from Evaporator (tsd 1 2 5 1 6)
- Transfer Waste Between East Area DSTs (tsd 2 2 6 1 1 5)
- Transfer Waste to LAW Staging Tanks (tsd 2 2 6 1 1 6)
- Transfer Waste to HLW Staging Tanks
- Transfer HLW Sludge to LAW/HLW Plant (tsd 2 2 6 1 3 2)
- Transfer LAW Supernatant to LAW/HLW Plant (tsd 2 2 6 1 2 2)

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1 Functions do not pertain to Phase 1 WFD. They are not decomposed herein. Assumption: Existing systems will suffice for performing these functions.

2 New function to be added in the next revision to the System Specification for the Double Shell Tank System.

3 Cross site transfer functions are not decomposed herein. Assumption: An assumption was made that the new cross site transfer system installed by Project W 058 will meet Phase 1 WFD needs.
The Transfer Waste to LAW Staging Tanks function was decomposed for transfer of the following two waste types identified in HNF-1939 Vol II Addendum 1, Rev 0c

- Transfer LAW Supernatant to Staging Tanks—Remove existing clarified supernatant without disturbing the underlying settled solids (initial decant)
- Transfer LAW Salt Solution to Staging Tanks—Following dissolution of soluble salts via addition of water and mixing, remove supernatant

2.2.1 Third-Tier Transfer Waste Flows

The function flow shown in Figure 2.2.1-1 represents the decomposition of the second-tier DST waste transfer functions of Figure 2.0. Figure 2.2.1-1 represents the functional flow for waste transfers in general (i.e., for each of the second-tier functions) Justification (i.e., basis) for each function is provided with the function definitions.

Figure 2.2.1-1 functions (third tier) for DST waste transfer include the following:

1. Establish Transfer Route for Waste Transfer (Figure 2.2.1-2)
2. Provide Diluent During Transfers (Figure 2.2.1-3)
3. Convey Waste (Figure 2.2.1-4)
4. Confinement Waste Along Transfer Route (Figure 2.2.1-5)
5. Confinement Waste Leakage Along Transfer Route (Figure 2.2.1-6)
6. Flush Transfer System (Figure 2.2.1-7)
7. Drain Transfer Piping
8. Perform Material Balance for Double-Shell Tank Transfers
9. Reconfigure Transfer Route (Figure 2.2.1-8)

These functions are further decomposed, as shown in the noted Figures. No decompositions were deemed necessary for the Perform Material Balance for Double-Shell Tank Transfers or the Drain Transfer Piping functions.

2.2.2 Double-Shell Tank Transfer Waste Function Hierarchy

The hierarchy of transfer functions representing the decomposition of the second-tier DST waste transfer functions is shown in Figure 2.2.2-1 along with the third- and fourth-tier functions. Included in this hierarchy is the suite of waste transfer functions that represents the functions shown in Figures 2.2.1-1 through 2.2.1-8.

Function definitions for the third-tier and fourth-tier functions are provided in Sections 2.2.3 and 2.2.4, respectively.
223 Third-Tier Function Definitions

Function definitions for the third-tier function set of Transfer Waste (see Figure 2 2 1-1) are given below. Function definition bases are also provided.

223.1 Establish Transfer Route for Waste Transfer

Establish the transfer route between the source and destination tanks by positioning valves and verifying valve positions prior to initiation of waste transfers.

**Basis** Per HNF-SD-WM-TSR-006 Section 5 12.2 isolate waste transfer paths where valves exist and this is feasible. Independently verify waste transfer route and valve status before transfer.

223.2 Provide Diluent During Transfers

Provide heated diluent water at a prescribed temperature, flow rate, and chemical composition to the transfer pump suction intake to support preconditioning of the transfer route, initiation of waste transfers, and dilution of waste during the transfer. This function also directs the output of the transfer pump from a recirculation loop to the source DST to the transfer route if a recirculation loop were part of the initial valve setup.

**Basis** Per HNF-1939 Vol II Rev 0c Addendum 3-32 Section 3.1.5 the following process steps for waste transfer are described for LAW feed staging (i.e., transfer LAW supernatant to staging tanks). Initially heated diluent water is provided at a prescribed flow rate and routed to the transfer pump suction intake. The transfer pump is then engaged and maintains the pump discharge flow rate at the prescribed flow rate for several minutes (This transfer of heated diluent for several minutes prior to the transfer of waste was interpreted as a preconditioning of the transfer line.) The diluent water flow rate from the diluent source is then lowered and the transfer pump makes up the flow rate loss from the diluent source with tank waste (i.e., supernatant).

Per HNF-1939 Vol II Rev 0c Addendum 3 Section 2.0 diluent for 241-AN-104 is heated water (no chemical adjustment required). The heated diluent lowers viscosity and helps to prevent in-line precipitation.

Per HNF-1939 Vol II Rev 0c Addendum 3 Section 3.1.13 decanting of diluted sludge liquors (sludge dissolvent) may be suitable for transfer without in-line dilution; however, the transfer is initiated as per a diluted liquid transfer and in-line dilution is available to adjust the temperature and density.

Per HNF-1939 Vol II Rev 0a Addendum 1 Section 2 dilution of the waste for transfer is not identified. Only mixer pump seal leakage of service water is accounted for in the transfer volume. Section 3.1.2 identifies a stuck transfer pump and a slurry viscosity suitable for pumping without dilution.
2 2 3 3 Convey Waste

Provide motive force to convey liquid waste or diluent water or a combination of liquid waste and diluent water from the source tank to the destination tank. This function includes positioning of the transfer pump suction intake at various levels within the DST and confining waste within the transfer route.

*Basis* Per HNF-SD-WM-SP-012 Section 3 4 3 1 the process for transfer of LAW from liquid and salt sludge tanks (e.g., waste feed preparation) involves transfer pumps with adjustable suctions to transfer the liquid layer following salt dissolution. The adjustable suction is dropped to the top of the residual solids to transfer dissolved salts.

Per HNF-1939 Vol II Rev 0a Addendum 1-37 Section 3 1 2 the transfer pump is installed at a specific location above the bottom of the tank for all transfers.

Per HNF-1939 Vol II Rev 0a Addendum 3-36 Section 3 1 13 the transfer pump intake is positioned to decant diluted sludge liquors.

2 2 3 4 Confine Waste Along Transfer Route

Confine waste along the transfer route between the source and destination DST (for intermediate feeds to DST staging tanks) or between the source DST and the Privatization Contractor (BNFL Inc.) LAW/HLW interface.

*Basis* HNF-SD-WM-SP-012 identifies the scenarios for routing feed staging and the subsequent HLW and LAW feed routing to BNFL Inc. from the staging tanks. Per HNF-SD-WM-SP-012 Section 3 4 3 1 LAW feed routing includes lines, pump pits, and valve pits.

2 2 3 5 Confine Waste Leakage Along Transfer Route

Confine waste leakage along the transfer route between the source and destination DST (for intermediate feeds to DST staging tanks) or between the source DST and the BNFL Inc. LAW/HLW interface.

*Basis* Per HNF-SD-WM-TRD-007 Section 3 3 6 3 1 which specifies secondary containment and leak-detection constraints.

2 2 3 6 Flush Transfer System

Following completion of a waste transfer, deliver and route flush water through the transfer route from the source to the destination tank. Allow addition of flush water to the transfer pump discharge or the transfer pump suction inlet.

*Basis* Per HNF-1939 Vol II Rev 0a Addendum 1 Section 3 1 3 the flush solution point of delivery (i.e., at the pump suction or at the pump discharge) is pending.
Per HNF-1939 Vol II Rev 0c Addendum 3 Section 3.15 for termination of the waste transfer, the diluent water input is chemically adjusted (i.e., adjust diluent water NaOH and NaNO₂ molality) and the diluent flow rate increased to the prescribed flow rate to flush the transfer line. The heated water lowers the viscosity of the transferred liquid and helps to prevent in-line precipitation. The chemical adjustment at the end of the transfer provides protections against corrosion of the piping system.

Per HNF-1939 Vol II Rev 0c Addendum 3 Section 2.0 flush water for 241-AN-104 is temperature-adjusted water composition-adjusted (NaOH and NaNO₂).

### 2.2.3.7 Drain Transfer Piping

Allow liquid that remains in the transfer route following termination of motive forces on the liquid to drain to the source tank and/or the destination tank.

**Basis** Per HNF-1939 Vol II Rev 0c Addendum 3 Section 3.15 following the line flushing described by Provide Diluent Flow During Transfers for LAW feed staging (i.e., transfer LAW supernatant to staging tanks) the transfer pump is turned off after pumping chemically adjusted diluent water and the transfer line is allowed to drain back into the source tank.

Per HNF-1939 Vol II Rev 0c Addendum 3 Section 3.16 following transfer to 241-AP-106 a flush is initiated half of the flush volume drains to 241-AP-106 and half to 241-AP-104.

HNF-1939 Vol II Rev 0a Addendum 1 Section 3.13 describes the process for staging HLW that involves line flushing and identifies the flush volume allowed to drain back to the source tank.

### 2.2.3.8 Perform Material Balance for Double-Shell Tank Transfers

Perform material balance periodically during the waste conveyance to determine that the amount of waste being delivered to the destination agrees with the amount of waste being removed from the source tank.

**Basis** Per HNF-SD-WM-TSR-006 Section 5.12.2 a material balance calculation is required during each waste transfer.

Per HNF-1939 Vol II Rev 0a Addendum 1 Section 11.4 the material balance includes mixer pump seal water leakage and flush water.

### 2.2.3.9 Reconfigure Transfer Route

Reconfigure the transfer route valves and jumpers to terminate the waste transfer.

**Basis** Per HNF-SD-WM-TSR-006 Section 5.12.2 transfer system configuration management would isolate waste transfer paths connected to active waste transfer pumps.
22310 Perform Material Balance Post Double-Shell Tank Transfer

Perform material balance following completion of waste transfer to determine that the amount of waste delivered to the destination agrees with the amount of waste removed from the source tank.

Basis Per HNF-SD-WM-TSR-006 Section 5 12 2 b a material balance calculation is required during each waste transfer.

Per HNF-SP-1224 Rev 1 Interface Control Document Between the DOE and BNFL Inc Phase 1 Privatization High-Level Waste Feed Section 4 1 3 after receiving the HLW feed batch and the pipeline is flushed differences between the volume of waste received and the waste transferred will be reconciled.

Per HNF-SP-1223 Rev 1 Interface Control Document Between the DOE and BNFL Inc Phase 1 Privatization Low-Activity Waste Feed Section 4 1 3 after receiving the LAW feed batch and the pipeline is flushed differences between the volume of waste received and the waste transferred will be reconciled.

224 Fourth-Tier Function Definitions

Function definitions for the fourth-tier set of Transfer Waste Functions (see Figures 2 2 1-2 through 2 2 1-8) are given in this section following the applicable third-tier function.

2241 Establish Transfer Route for Waste Transfer

22411 Position Valves for Transfer Position transfer valves as required to enable the routing of diluent to the transfer pump suction intake and to enable or disable the routing of diluent, waste, or diluent/waste combination across the waste transfer route between the source DST and the destination. This function includes positioning the source DST recirculation valve (1) to enable waste transfer between the source DST and the destination or (2) to enable a recirculation path between the transfer pump intake, through the pump and transfer-associated structure, and back to the DST.

Basis See basis for Establish Transfer Route for Waste Transfer Section 2 2 3 1.

22412 Monitor Valve Position Provide positive local and remote indication of valve position to establish and provide confirmation of the transfer route.

Basis Per HNF-4553 Operations and Maintenance Philosophy Sections 2 1 2 and 3 2, describe local and remote monitoring of valve position.
2 2 4 2 Provide Diluent During Transfers

2 2 4 2 1 Carry Diluent/Flush Water to Transfer Pump Suction Provide routing of diluent and/or flush water through the transfer pump to the transfer pump suction intake to support initiation of waste transfer, dilution of waste during the transfer, and subsequent termination of the waste transfer by flushing of the transfer route.

**Basis** Per HNF-1939 Rev 0c Vol II Addendum 3 Sections 3 1 5 3 1 8 and 3 1 9 identify diluent and/or flush water provided to the transfer pump.

2 2 4 2 2 Deliver Caustic or Diluent to Transfer-Associated Structures Provide temperature-adjusted diluent at an adjustable flow rate to the transfer-associated structure to support initiation of waste transfer, dilution of waste during the transfer, and subsequent termination of the waste transfer. The initiation of waste transfer includes providing diluent at an increased flow rate, which serves to reduce or deny waste intake at the transfer pump suction intake to support transfer pump startup and preconditioning of the waste transfer route. The dilution of waste during the transfer includes providing diluent with flow rate and temperature adjusted to the levels required to support mobilization of the DST waste and to preclude precipitation of waste solids within the transfer route. The termination of the waste transfer includes providing diluent with flow rate increased to the transfer pump suction intake to reduce or deny waste intake at the transfer pump suction intake just prior to delivery of the flush water.

**Basis** See basis for Provide Diluent During Transfers Section 2 2 3 2

2 2 4 2 3 Confine Caustic and Diluent Within Valve Manifolds and Jumpers Confine caustic and diluent within the valve manifolds and jumpers to provide primary containment boundary for caustic or diluent routed through the pump and valve pits. Jumpers provide containment of caustic and diluent routed through diversion boxes.

**Basis** See basis for Provide Diluent During Transfers Section 2 2 3 2

2 2 4 2 4 Confine Diluent/Flush Water Within Double-Shell Tank Transfer Piping Confine diluent and/or flush water to provide primary containment boundary for diluent or flush water routed through DST transfer piping.

**Basis** See basis for Provide Diluent During Transfers Section 2 2 3 2

2 2 4 2 5 Position Recirculation Valve Position the source DST recirculation valve to enable or disable waste transfer between the source DST and the destination. If the waste transfer is disabled, the waste transfer path between the source DST and the destination is blocked and a recirculation path is established for waste and/or diluent to be pumped in a closed loop between the transfer pump suction intake, through the transfer pump within the source DST transfer-associated structure and back into the source DST. Otherwise, the waste transfer path is established between the source DST and the transfer destination for the diluent, waste, or diluent/waste combination.

**Basis** No basis was found to support recirculating supernatant however the preliminary process control strategy for LAW describes this process.

2-29
2 2 4 3 Convey Waste

2 2 4 3 1 Position Transfer Pump Suction Intake  Position the transfer pump suction intake at the required height to support transfer of liquid waste at various levels within the DST

Basis  See basis for Convey Waste  Section 2 2 3 3

2 2 4 3 2 Pump Waste/Diluent  Provide the motive force to move liquid present at the source DST transfer pump suction intake, through the transfer pump, and along a specified waste transfer route to a transfer destination. The motive force will be adjustable to maintain the flow rate of the liquid through the transfer route.

Basis  See basis for Convey Waste  Section 2 2 3 3

2 2 4 3 3 Confine Waste in Transfer Pump  Confine waste within the transfer pump casing and associated nozzles flanges and other pressure boundary connections

Basis  See basis for Convey Waste  Section 2 2 3 3

2 2 4 3 4 Monitor Position of Transfer Pump Suction Intake  Provide positive indication of the vertical position of the transfer pump suction intake within the DST

Basis  See basis for Convey Waste  Section 2 2 3 3

2 2 4 3 5 Monitor Process Parameters for Waste Transfers  Monitor process parameters as identified in the process control strategies. These monitors include measuring total water/diluent additions, flow rate of water/diluent additions, transfer stream flow rate, transfer stream density, pressure in the transfer lines, transfer stream temperature, and waste levels in the source and destination tanks where applicable

Basis  No basis was found however the process control strategy will describe this process

2 2 4 3 6 Monitor Transfer Pump Operation  Provide indication of the transfer pump operational parameters. At a minimum, these parameters include measurements of rotational speed and motor power draw

Basis  Per WHC-SD-WM-DGS-006 Rev 0 Section 4 2 2 all pumps should be instrumented to provide a remote readout of pump motor amperage and pump shaft rotational speed

2 2 4 4 Confine Waste Along Transfer Route

2 2 4 4 1 Confine Waste Within Valve Manifolds and Jumpers  Confine waste within the valve manifolds and jumpers to provide a primary containment boundary for waste routed through the pump and valve pits. Jumpers provide containment of waste routed through diversion boxes

Basis  See basis for Confine Waste Along Transfer Route  Section 2 2 3 4
2.4.4.2 Confine Waste Within Double-Shell Tank Transfer Piping

Provide primary containment boundary for waste routed through the DST transfer piping.

*Basis*  See *basis for Confine Waste Along Transfer Route Section 2.2.3.4*

2.4.5 Confine Waste Leakage Along Transfer Route

2.4.5.1 Confine Waste Leakage Within Transfer-Associated Structures

Confine waste leakage occurring within the transfer-associated structures (e.g., valve pits, pump pits, clean out boxes, and diversion boxes) and waste leaked while in route to the associated DST.

*Basis*  See *basis for Confine Waste Leakage Along Transfer Route Section 2.2.3.5*

2.4.5.2 Confine Waste Leakage Within Secondary Containment Piping

Confine waste leaked from the transfer piping primary containment within the transfer piping secondary containment.

*Basis*  See *basis for Confine Waste Leakage Along Transfer Route Section 2.2.3.5*

2.4.5.3 Monitor for Leaks in Transfer-Associated Structures

Monitor to detect leaks within the transfer-associated structures.

*Basis*  See *basis for Confine Waste Leakage Along Transfer Route Section 2.2.3.5*

2.4.5.4 Monitor for Double-Shell Tank Transfer Piping Leakage

Monitor to detect leaks from the transfer piping primary containment boundary.

*Basis*  See *basis for Confine Waste Leakage Along Transfer Route Section 2.2.3.5*

2.4.6 Flush Transfer System

2.4.6.1 Confine Flush Water Within Valve Manifolds and Jumpers

Confine flush water within the valve manifolds and jumpers to provide primary containment boundary for the flush solution routed through the pump and valve pits. Jumpers provide containment of flush water routed through diversion boxes.

*Basis*  Per *HNF-SD-WM-TRD-007 Section 3.3.6.3.1 which specifies confinement*

2.4.6.2 Deliver Flush Water to Transfer-Associated Structures

Provide temperature-adjusted and chemically adjusted water at an adjustable flow rate to the transfer-associated structure to support termination of the waste transfer and corrosion protection of the transfer route. This function supports termination of the waste transfer by providing flush water with flow rate increased to the transfer pump suction intake to reduce or deny waste intake at the transfer pump suction intake, thus allowing the flush water to dilute and remove liquid waste from the transfer path between the source DST and the transfer destination.

*Basis*  See *basis for Flush Transfer System Section 2.2.3.6*
2 2 4 6 3  **Confine Diluent/Flush Water Within Double-Shell Tank Transfer Piping**  
Confine diluent and/or flush water to provide primary containment boundary for diluent or flush water routed through DST transfer piping

*Basis*  See *basis for Provide Diluent During Transfers  Section 2 2 3 2*

2 2 4 6 4  **Carry Diluent/Flush Water to Transfer Pump Suction**  
Provide routing of diluent and/or flush water through the transfer pump to the transfer pump suction intake to support initiation of waste transfer dilution of waste during the transfer, and subsequent termination of the waste transfer by flushing of the transfer route

*Basis*  Per HNF-1939 Rev 0c Vol II Addendum 3 Sections 3 1 5 3 1 8 and 3 1 9 identify diluent and/or flush water provided to the transfer pump

2 2 4 7  **Reconfigure Transfer Route**

2 2 4 7 1  **Position Valves for Offline Service**  
Position transfer valves as required to disable the route for diluent to the transfer pump suction intake and to disable the route for diluent, waste, or diluent/waste combination across the waste transfer route between the source DST and the previous transfer destination. This function includes positioning the source DST recirculation valve to disable waste transfer between the source DST and the destination

*Basis*  See *basis for Reconfigure Transfer Route  Section 2 2 3 9*
Figure 2.2.1.1  Double-Shell Tank Third-Tier Functional Flows for Waste Transfer

Legend:
- Function Block
- External Function
- Repeated Function
= Logical AND
DST = double shell tank

1. Prepare Waste in East Area DSTs
2. Establish Transfer Route for Waste Transfer
3. Provide Diluent During Transfers
4. Flush Transfer System
5. Convey Waste
6. Confinement Waste Along Transfer Route
7. Confinement Waste Leakage Along Transfer Route
8. Perform Material Balance for DST Transfers
9. Drain Transfer Piping
10. Reconfigure Transfer Route
11. Perform Material Balance Post DST Transfer
12. Store Waste in East Area DSTs
Figure 2.21-2  Double-Shell Tank Functional Flow, Establish Transfer Route for Waste Transfer

Legend:
- Function Block
- External Function
- Repeated Function
- Logical OR
- Logical AND
DST = double-shell tank

Prepare Waste in East Area DSTs

Establish Transfer Route for Waste Transfer

Position Valves for Transfer

Monitor Valve Position

Direct Waste Additions Within DSTs

Provide Diluent During Transfers

Convey Waste
Figure 2.2.1-3 Double Shell Tank Functional Flow Provide Diluent During Transfers

Provide Diluent During Transfers

- Establish Transfer Route for Waste Transfer
- Deliver Caustic or Diluent to Transfer Associated Structures
- Confine Caustic and Diluent Within Valve Manifolds and Jumpers
- Confine Diluent/Flush Water Within DST Transfer Piping
- Carry Diluent/Flush Water to Transfer Pump Suction
- Position Recirculation Valve
- Convey Waste
- Flush Transfer System

Legend:
- = Function Block
= External Function
= Repeated Function
OR = Logical 'OR'
AND = Logical 'AND'
DST = double-shell tank
Figure 2.2.1-5  Double-Shell Tank Functional Flow, Confine Waste Along Transfer Route

Legend:
- Function Block
- External Function
- Repeated Function
  - Logical 'OR'
  - Logical 'AND'
DST = double shell tank
Figure 2.2.1-6  Double Shell Tank Functional Flow, Confining Waste Leakage Along Transfer Route

Legend
- Function Block
- External Function
- Repeated Function
O = Logical OR
and = Logical AND
DST = double shell tank

[Diagram showing flow of processes including: Provide Diluent During Transfers, Convey Waste, Establish Transfer Route for Waste Transfer, Confine Waste Leakage Within Secondary Containment Piping, Confine Waste Leakage Within Transfer Associated Structures, Monitor for Leaks in Transfer Associated Structures, Monitor for DST Transfer Pipe Leakage, Confining Waste Along Transfer Route, and Drain Transfer Piping.]
Figure 2.1.7  Double-Shell Tank Functional Flow, Flush Transfer System
Figure 2.21-8  Double-Shell Tank Functional Flow  Reconfigure Transfer Route

Reconfigure Transfer Route

Position Valves for Offline Service

Monitor Valve Position

Perform Material Balance

Store Waste in East Area DSTs

Legend
- □ = Function Block
- □ = External Function
- □ = Repeated Function
- □ = Logical AND
DST = double shell tank
Figure 2.2.2-1 Double-Shell Tank System Function Hierarchy for Waste Transfer
2.3 PREPARE WASTE FUNCTIONAL DECOMPOSITION

The Prepare Waste functions shown in Figure 2.0 represent those functions that capture operations performed on the stored waste needed to support preparing waste for transfer to a staging tank or for transfer to the privatization contractor. The Prepare Waste functions at this level (second tier) consist of the following:

- Prepare Waste in East Area Double-Shell Tanks
- Prepare Waste in West Area Double-Shell Tanks
- Prepare Low-Activity Waste in Low-Activity Waste Staging Tanks
- Prepare High-Level Waste Sludges in High-Level Waste Staging Tanks

2.3.1 Third- and Fourth-Tier Prepare Double-Shell Tank Waste Flows

The functions described in Sections 2.3.1, 2.3.2, and 2.3.3 represent the decomposition of the second-tier Prepare Double Shell Tank Waste functions. These "third-tier" and "lower-tier" functions were derived from a review of HNF-1939 and HNF-SD-WM-SP-012.

The functional flows for the third-tier and lower-tier functions are provided for each of the second-tier functions as follows:

- Prepare Waste in East Area Double-Shell Tanks (See Footnote 1) (Figure 2.3.1-1)
  - Mobilize and Suspend Insoluble Waste Within East Area Double-Shell Tanks (Figure 2.3.1-2)
  - Add Diluent to High-Level Waste Source Tank (Figure 2.3.1-3)
  - Dissolve Soluble Waste in East Area Double-Shell Tanks (Figure 2.3.1-4)
    - Soften Crust Layer in Low-Activity Waste Source Tanks (Figure 2.3.1-5)
    - Dissolve Salts in Low-Activity Waste Source Tanks (Figure 2.3.1-6)

- Prepare Low-Activity Waste in Low-Activity Waste Staging Tanks (Figure 2.3.1-7)
  - Soften Crust Layer in Low-Activity Waste Staging Tanks (Figure 2.3.1-8)
  - Add Diluent to Low-Activity Waste Staging Tanks (Figure 2.3.1-9)
  - Dissolve Salts in Low-Activity Waste Staging Tanks (Figure 2.3.1-10)

- Prepare High-Level Waste Sludges in High-Level Waste Staging Tanks (Figure 2.3.1-11)

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1 Functions under Prepare Waste in West Area DSTs were assumed to be the same as those shown for Prepare Waste in East Area DSTs.
2.3.2 Double-Shell Tank Prepare Waste
Functional Hierarchy

The hierarchy of Prepare Waste functions representing a decomposition of the second-tier Prepare Waste functions is shown in Figure 2.3.2-1. This figure arranges the Prepare Waste functions derived in the flows of Section 2.3.1 in a hierarchical fashion.

2.3.3 Third- and Fourth-Tier Function Definitions

The following function definitions apply to the third-tier and fourth-tier function set for preparing waste.

2.3.3.1 Prepare Waste in East Area Double-Shell Tanks

Prepare Waste in East Area DSTs for transfer to another East Area DST. Preparation includes both the mobilization and suspension of insoluble waste (HLW) and the dissolution of soluble waste (LAW) in an East Area DST before transfer to another East Area DST or intermediate waste feed staging tank.

2.3.3.1.1 Mobilize and Suspend Insoluble Waste Within East Area Double-Shell Tanks

Mobilize and put into suspension settled HLW solids in East Area DSTs.

*Basis* Per HNF-SD-WM-SP-012 Rev 1 Section 3.2.1.3 criteria are described for blending or pre-staging feed batches for Case 3.

2.3.3.1.1 Mix/Blend High-Level Waste in Source Tank. Combine waste in the HLW source such that a homogenous batch of waste is created for transfer. Mixing of waste within the tank is performed simultaneously with the addition of waste and diluent.

*Basis* See basis for Mix/Blend High-Level Waste in Staging Tank Section 2.3.3.1.

2.3.3.1.2 Mobilize High-Level Waste in Source Tank

Resuspend existing source tank waste solids/sludge from the bottom of the tank to prepare the waste for transfer to other East Area DSTs.

*Basis* See basis for Mobilize High-Level Waste in Staging Tank Section 2.3.3.2.

2.3.3.1.3 Suspend High-Level Waste in Source Tank

Put source tank waste solids into a uniform suspension subsequent to mobilization, so that the waste transferred to other East Area DSTs contains the desired HLW solids.

*Basis* See basis for Suspend HLW in Staging Tank Section 2.3.3.3.
233114 Monitor Mixer Pump Operation. Provide indication of the mixer pump operational parameters. At a minimum, these parameters include measurements of rotational speed, motor power draw, and nozzle orientation.

*Basis* Per WHC-SD-WM-DGS-006 Rev 0 Section 4.2.2 mixer pumps should be instrumented to provide a remote readout of pump motor amperage, pump shaft rotational speed, and nozzle orientation.

233115 Add Diluent to High-Level Waste Source Tank. Adjust tank waste composition by adding diluent (heated water and/or heated inhibited water) to the HLW in the source tank to prepare the waste for transfer to other East Area DSTs. Adding diluent to the HLW source tank consists of delivering the diluent to the appropriate transfer-associated structure and confining and routing the diluent to the HLW staging tank.

*Basis* See basis for Mobilize High-Level Waste in Staging Tank, Section 2.3.3.4.

233115.1 Deliver Caustic or Diluent to Transfer-Associated Structures. Provide temperature-adjusted diluent at an adjustable flow rate to the transfer-associated structure to support initiation of waste transfer, dilution of waste during the transfer, and subsequent termination of the waste transfer. The initiation of waste transfer includes providing diluent at an increased flow rate, which serves to reduce or deny waste intake at the transfer pump suction intake to support transfer pump startup and preconditioning of the waste transfer route. The dilution of waste during the transfer includes providing diluent with flow rate and temperature adjusted to the levels required to support mobilization of the DST waste and to preclude precipitation of waste solids within the transfer route. The termination of the waste transfer includes providing diluent with flow rate increased to the transfer pump suction intake to reduce or deny waste intake at the transfer pump suction intake just prior to delivery of the flush water.

*Basis* See basis for Provide Diluent During Transfers, Section 2.2.3.2.

233115.2 Confine Caustic and Diluent Within Valve Manifolds and Jumpers. Confine caustic and diluent within the valve manifolds and jumpers to provide primary containment boundary for caustic or diluent routed through the pump and valve pits. Jumpers provide containment of caustic and diluent routed through diversion boxes.

*Basis* See basis for Provide Diluent During Transfers, Section 2.2.3.2.

233115.3 Confine Diluent/Flush Water Within Double-Shell Tank Transfer Piping. Confine diluent and/or flush water to provide primary containment boundary for diluent or flush water routed through DST transfer piping.

*Basis* See basis for Provide Diluent During Transfers, Section 2.2.3.2.

233116 Sample Source Tank High-Level Waste. Collect samples of HLW present in the staging tank in sufficient quantities to support analysis.

*Basis* See basis for Sample Staging Tank High-Level Waste, Section 2.3.3.5.
**23312 Dissolve Soluble Waste in East Area Double-Shell Tanks** Dissolve soluble waste in East Area DSTs for transfer to the LAW/HLW Plant, Phase 1. Dissolution includes the softening/dissolution of existing crust layers, as necessary, dissolving the soluble salts in the non-convective layers of waste, settling out the undissolved solids, and sampling the prepared LAW for analysis.

*Basis* Per HNF-SD-WM-SP-012 Rev 1 Section 3.4.1.2 salt sludges are dissolved.

**23312.1 Soften Crust Layer in Low-Activity Waste Source Tanks** Soften and partially dissolve the floating solids layer within the tank by adding diluent or by recirculating diluted supernatant from the convective layer in the tank to the top of the waste.

*Basis* Per HNF-1939 Rev 0c Vol II Section 2 the crust and salt sludge are dissolved with a bulk addition of diluent augmented by mixer pump agitation.

No basis was found to support recirculating supernatant however the preliminary process control strategy for LAW describes this process.

**23312.1.1 Add Diluent to Low-Activity Waste Source Tanks** Add diluent water (bulk addition) to adjust the waste composition and support dissolution of salt within the tank.

*Basis* Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3.1.9 tank 241-AN-104 processes include dissolve crust and salt sludge with a bulk addition of diluent (heated water).

*Per HNF-SD-WM-SP-012 Rev 1 Section 3.4.1.2 following decanting of the liquid within the LAW feed tanks salt sludge is dissolved in place with a bulk addition of water.*

**23312.1.2 Recirculate Diluent in Low-Activity Waste Source Tanks** Recirculate diluted supernatant in the tank using the transfer pump.

*Basis* No basis was found however the process control strategy for LAW will describe this process.

**23312.2 Dissolve Salts in Low-Activity Waste Source Tanks** Dissolve settled undissolved salts in the tank's non-convective layer via dilution, waste mobilization, and mixing.

*Basis* See basis for Dissolve Salts in Low-Activity Waste Staging Tanks Section 2.3.3.2.4

**23312.2.1 Add Diluent to Low-Activity Waste Source Tanks** Add diluent water (bulk addition) to adjust the waste composition and support dissolution of salt within the tank.

*Basis* Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3.1.9 tank 241-AN-104 processes include dissolve crust and salt sludge with a bulk addition of diluent (heated water).

*Per HNF-SD-WM-SP-012 Rev 1 Section 3.4.1.2 following decanting of the liquid within the LAW feed tanks salt sludge is dissolved in place with a bulk addition of water.*

2-45
2 3 3 1 2 2 2 Mobilize Solids in Low-Activity Waste Source Tanks  Operate mixer pumps to facilitate dissolution

*Basis*  Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3 1 10 mixer pumps are operated subsequent to the addition of diluent water to dissolve salt sludge

2 3 3 1 2 3 Settle Undissolved Solids  Stop mixer pump, transfer pump, and other LAW feed activities to allow undissolved solids to settle after the waste is dissolved to prepare for sampling and LAW transfer

*Basis*  See basis for Settle Undissolved Solids Section 2 3 3 2 3

2 3 3 1 2 4 Sample Prepared Low-Activity Waste  Collect samples to verify that the waste meets waste compatibility requirements and to qualify waste being transferred directly to BNFL Inc

*Basis*  See basis for Sample Staging Tank Low-Activity Waste Section 2 3 3 2 5

2 3 3 2 Prepare Low-Activity Waste in Low-Activity Waste Staging Tanks

Prepare LAW in LAW staging tanks for transfer to the LAW/HLW Plant, Phase 1  Preparation includes the initial dissolution of existing soluble staging tank waste, the mixing/blending of waste from various source tanks (including staging tank heel), the settling of undissolved solids and sampling the prepared LAW for analysis

2 3 3 2 1 Homogenize Waste Batches  Combine existing waste in the LAW staging tanks with waste being transferred to the LAW staging tank such that a homogenous batch of LAW is created for LAW feed  Mixing of waste within the staging tank is performed simultaneously with the addition of waste from source tanks

*Basis*  Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3 1 6 a single mixer pump is operated for a short duration for liquid phase homogenization for tank 241-AP-102

Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3 1 14 a mixer pump is operated for a short duration for liquid phase homogenization for tank 241-AP-104

2 3 3 2 2 Soften Crust Layer in Low-Activity Waste Staging Tanks  Soften and partially dissolve the floating solids layer within the tank by adding diluent or by recirculating diluted supernatant from the convective layer of waste in the tank to the top of the waste

*Basis*  See basis for Soften Crust Layer in Low-Activity Waste Source Tanks Section 2 3 3 1

2 3 3 2 2 1 Add Diluent to Low-Activity Waste Staging Tanks  Add diluent water (bulk addition) to adjust the waste composition and support dissolution of salt within the tank

*Basis*  Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3 1 9 tank 241-AN-104 processes include dissolve crust and salt sludge with a bulk addition of diluent (heated water)
Per HNF-SD-WM-SP-012 Rev 1 Section 3.4.1.2 following decanting of the liquid within the LAW feed tanks, salt sludge is dissolved in place with a bulk addition of water.

2.3.3.2.2 Recirculate Diluent in Low-Activity Waste Staging Tanks
Recirculate diluted supernatant in the tank using the transfer pump.

*Basis* No basis was found; however, the process control strategy for LAW will describe this process.

2.3.3.2.3 Settle Undissolved Solids
Stop mixer pump, transfer pump, and other LAW feed activities to allow undissolved solids to settle after the waste is dissolved to prepare for sampling and LAW transfer.

*Basis* Per HNF-1939-Vol II Addendum 3 Rev 0c Section 2 and 3.1.3 small amounts of insoluble solids that are mobilized during dissolution are allowed to settle out in Tank 241-AN-104.

2.3.3.2.4 Dissolve Salts in Low-Activity Waste Staging Tanks
Dissolve settled undissolved salts in the tanks non-convective layer via dilution and waste mobilization.

*Basis* Per HNF-1939 Rev 0c Vol II Addendum 3 Section 2.0 and Section 3.1.10 Tank 241-AN-104 preparation involves processes which include dissolving crust and salt sludge with a bulk addition of diluent (heated water) augmented by mixer pump agitation.

Per the Interim Guidance on LAW Retrieval Strategy Section 1.0 following removal of supernatant in tanks AN-103, AN-104, AN-105, and AW-101, water is added and mixer pumps are used to mix the contents to dissolve the soluble salts.

2.3.3.2.4.1 Mobilize Solids in Low-Activity Waste Staging Tanks
Operate mixer pumps to facilitate dissolution.

*Basis* Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3.1.10 mixer pumps are operated subsequent to the addition of diluent water to dissolve salt sludge.

2.3.3.2.5 Sample Staging Tank Low-Activity Waste
Collect samples of LAW to monitor solids settling, salt dissolution, crust softening, or blending in the staging tank.

*Basis* Per HNF-1939 Rev 0c Vol II Addendum 3 Section 3.1.11 process control samples are taken to track the status of the salt dissolution process step for tank 241-AN-104.
2333 Prepare High-Level Waste Sludges in High-Level Waste Staging Tanks

Prepare HLW Sludges in HLW staging tanks for transfer to the LAW/HLW Plant, Phase 1. Preparation includes the initial mobilization of existing staging tank waste, the mixing/blending of waste from various source tanks (including staging tank heel), sampling the mixed waste for analysis and resuspending the staging tank waste as necessary prior to transferring the staging tank waste to the LAW/HLW Plant, Phase 1.

**Basis** Per HNF-SD-WM-SP-012 Rev 1 Section 3.2.1.3, reference is made to transfers needed to blend or pre-stage certain feed batches.

2333.1 Mix/Blend High-Level Waste in Staging Tank. Combine existing waste in the high level waste (HLW) staging tank with that being transferred to the HLW staging tank such that a homogenous batch of waste is created for HLW feed. Mixing of waste within the staging tank is performed simultaneously with the addition of waste from other sources tanks.

**Basis** Per HNF-SD-WM-SP-012 Vol 1 Section 2.4 HLW Feed Staging waste from tanks 241-AW-105 and 241-C-102 are both split then blended to make batches 8 and 9. Per Section 3.2 HLW Feed Staging life-cycle cost is reduced by blending HLW source tanks which increases waste oxide loading in glass and decreases the total amount of immobilized HLW canisters produced. Per Vol 11 Appendix A Section 8.6 Phase 1 HLW Sludge Blending waste from Tanks 241-C-104 and 241-C-106/241-AI-102 will be blended to increase waste oxide loading in the HLW glass.

2333.2 Mobilize High-Level Waste in Staging Tank. Resuspend existing settled staging tank waste solids/sludge to prepare the first feed batches for transfer to the LAW/HLW Plant, Phase 1.

**Basis** Per HNF-1939 Rev 0a Vol 11 Addendum 1 Section 3.11 Staging HLW Feed from Tank 241-AZ-101 is a matter of mobilizing the contents.

2333.3 Suspend High-Level Waste in Staging Tank. Put staging tank waste solids into a uniform suspension within the liquid phase of the waste subsequent to the initial mobilization or mix/blend step so that the waste transferred to the LAW/HLW Plant, Phase 1 contains the desired HLW solids.

**Basis** Per HNF-SD-WM-SP-012 Rev 1 Sections 3.2.1.3 and 3.4.1.1 feed preparation includes blending and mobilizing sludges.

2333.4 Add Diluent to High-Level Waste Staging Tank. Adjust the staging tank waste composition by adding diluent (heated water and/or heated inhibited water) to the HLW in the staging tank to prepare the feed batch for transfer to the LAW/HLW Plant, Phase 1. Adding diluent to the HLW staging tank consists of delivering the diluent to the appropriate transfer-associated structure and confining and routing the diluent to the HLW staging tank.

**Basis** Per HNF-1939 Rev 0a Vol 11 Section 3.0 Process Description feed preparation includes maintaining the aqueous Na concentration to comply with the LAW feed specification 2M to 5M Na. Water is added periodically to flush mixer pumps.
233.5 Sample Staging Tank High-Level Waste  Collect samples of HLW present in the staging tank in sufficient quantities to support feed certification

**Basis**  Per HNF-SD-WM-SP-012 Rev 1 Section 2.4 HLW Staging  HLW retrieved from selected source tanks will be transferred to staging tanks and certified before delivery to BNFL Inc’s feed receipt tanks
Figure 2.3.1-1 Prepare Waste in East Area Double-Shell Tanks Functional Flow

Prepare Waste in East Area DSTs

- Store Waste in East Area DSTs
- Dissolve Soluble Wastes in East Area DSTs
- Mobilize and Suspend Insoluble Waste within East Area DSTs
- Transfer Waste to HLW Staging Tanks
- Transfer Waste Between East Area DSTs
- Transfer Waste to LAW Staging Tanks

Legend

= Function Block
= External Function
= Repeated Function
= Logical OR
DST = double shell tank
Figure 2.3-12 Mobilize and Suspend Insoluble Waste within East Area Double-Shell Tanks Functional Flow
Figure 2.3.1-3 Add Diluent to High-Level Waste Source Tank Functional Flow

Add Diluent to HLW Source Tank

1. Analyze Sample
2. Deliver Caustic or Diluent to Transfer Associated Structures
3. Mix/Blend HLW in Staging Tank
4. Confinement: Caustic and Diluent Within Valve Manifolds and Jumpers
5. Confinement: Diluent/Flush Water Within DST Transfer Piping

Legend:
- □ = Function Block
- □ = External Function
- □ = Repeated Function
- ⊕ = Logical AND
- DST = double shell tank
- HLW = high level waste
Figure 2.3.1-4 Dissolve Soluble Waste in East Area Double-Shell Tanks Functional Flow
Figure 231-5  Soften Crust Layer in Low-Activity Waste Source Tanks Functional Flow

Legend
- = Function Block
□ = External Function
○ = Repeated Function
☑ = Logical OR
☒ = Logical AND
DST = double shell tank
LAW = low activity waste
Figure 2 3 1-6  Dissolve Salts in Low Activity Waste Source Tanks Functional Flow

Legend
- Function Block
- External Function
- Repeated Function
O = Logical OR
@ = Logical AND
DST = double shell tank
LAW = low activity waste
Figure 2.3.1-7 Prepare Low Activity Waste in Low-Activity Waste Staging Tanks Functional Flow

Legend:
- □ = Function Block
- □ = External Function
- = Repeated Function
- ◯ = Logical OR
- ⊙ = Logical AND
- DST = double shell tank
- LAW = low activity waste
Figure 231-8 Soften Crust Layer in Low-Activity Staging Tanks Functional Flow

Legend:
- = Function Block
- = External Function
= Repeated Function
O = Logical OR
= Logical AND
DST = double shell tank
LAW = low activity waste
Figure 231-9  Add Diluent to Low-Activity Waste Staging Tank Functional Flow
Figure 231-10  Dissolve Salts in Low-Activity Staging Tanks Functional Flow

**Legend**
- = Function Block
- = External Function
- = Repeated Function
- = Logical OR
- = Logical AND
DST = double shell tank
LAW = low activity waste
Figure 231-11  Prepare High-Level Waste Sludges in High-Level Waste Staging Tanks Functional Flow
Figure 2.3.2-1 Double-Shell Tank System Function Hierarchy for Prepare Waste

Second Tier Functions
- Prepare Waste in West Area DSTs
- Prepare Waste in East Area DSTs

Third and Lower Tier Functions
- Mobilize & Suspend Insoluble Waste Within East Area DSTs
- Mobilize HLW in Source Tank
  - Deliver Caustic or Diluent to Transfer Associated Structures
    - Confinement Caustic and Diluent Within Valve Manifolds and Jumppers
    - Confinement Diluent/Flush Water Within DST Transfer Piping
  - Add Diluent to HLW Source Tank
  - Suspend HLW in Source Tank
    - Mix/Blend HLW in Source Tank
    - Sample Source Tank HLW
      - Dissolve Soluble Waste in East Area DSTs
      - Soften Crust Layer in LAW Source Tanks
      - Dissolve Solids in LAW Source Tanks
    - Settle Undissolved Solids
    - Sampling Prepared LAW

Prepare LAW in LAW Staging Tanks
- Homogenize Waste Batches
  - Add Diluent to LAW Staging Tank
    - Recirculate Diluent in LAW Staging Tanks
    - Settle Undissolved Solids
    - Dissolve Solids in LAW Staging Tanks
  - Sample Staging Tank LAW

Prepare HLW Staging in HLW Staging Tank
- Mix/Blend HLW in Staging Tank
- Mobilize HLW in Staging Tank
- Suspend HLW in Staging Tank
- Add Diluent to HLW Staging Tank
  - Mobilize Solids in LAW Staging Tank
  - Sample Staging Tank HLW

*Functions for Prepare Waste in West Area DSTs have third and lower tier functions similar to Prepare Waste in East Area DSTs (i.e., replace East with West)

Same lower level functions as shown under Add Diluent to High Level Waste Source Tank Functional Flow (Figure 2.3.1.3) and should be noted as repeated functions from those with the same name in Figure 2.2.2.1

DST = double shell tank
HLW = high level waste
LAW = low activity waste
2.4 DISTRIBUT UTILITY FUNCTIONAL DECOMPOSITION

The Distribute Utilities in the DST System function is identified in Figure 24. This function contains the system behavior regarding distribution of electricity, water (both raw and potable), service air and instrument air to support the operation and maintenance of the DST System.

2.4.1 Distribute Utilities Function Flows

The function flows for distribution of utilities are not provided in this version.

2.4.2 Double-Shell Tank Distribute Utilities

Function Hierarchy

The hierarchy of Distribute Utilities functions representing a decomposition of the Distribute Utilities in DST System is shown in Figure 24.2-1.

2.4.3 Definitions for Distribute Utilities Within the Double-Shell Tank System

Function definitions for the Distribute Utilities function set are given below.

2.4.3.1 Distribute Double-Shell Tank Electrical Power

Transform control, protect, and distribute electrical power to support the operations and maintenance electrical loads of the DST System.

*Basis* HNF-SD-WM-TRD-007 Section 3.2.15 a Distribute Utilities in Double-Shell Tank System and Section 3.2.3.8 Central Plateau Electrical System

- Distribute 480/277 Vac Electrical Power—Transform, control protect, and distribute 480/277 Vac electrical power to DST System components
  
  *Basis* None

- Distribute 277 Vac Electrical Power—Control protect, and distribute 277 Vac electrical power to DST System components
  
  *Basis* None

- Light Double-Shell Tank System—Light exterior portions of the DST System to facilitate back shift operations and maintenance
  
  *Basis* None

2-62
Basis  DOE 6430 1A  General Design Criteria  Section 1650-1  External Lighting—General

- Distribute 240/120 Vac and/or 208/120 Vac Electrical Power—Transform, control, protect, and distribute 240/120 and/or 208/120 Vac electrical power to DST System components

Basis  None

- Provide Back-up Electrical Power for the Double-Shell Tank System—Generate, control protect, and distribute back up electrical power for DST System components requiring electrical power in the event of normal power loss

Basis  DOE 6430 1a  Section 1660 1  Special Systems—General

- Provide Uninterruptible Electrical Power for the Double-Shell Tank System—Generate control, protect, and distribute uninterruptible power for DST System components requiring continuous electrical power in the event of a normal power loss

Basis  DOE 6430 1a  Section 1660 1  Special Systems—General

2.4.3.2 Distribute Water Within the Double-Shell Tank System

Strain control, filter and distribute raw and potable water within the DST System to support operations including water needed for industrial safety and fire protection

Basis  HNF-SD-SM-TRD-007  Section 3.2.1.5.c  Distribute Utilities in Double-Shell Tank System

- Distribute Strained Raw Water Within the Double-Shell Tank System—Strain, control, and distribute raw water to DST System components

Basis  HNF-2938  Evaluation of 241-AN Tank Farm Supporting Phase I Waste Feed Delivery Appendix F 1.4  Calculation of Solids Deposition Velocity

- Distribute Filtered Raw Water Within the Double-Shell Tank System—Filter control, and distribute raw water to the DST Mixer Pump System

Basis  None

- Distribute Potable Water Within the Double-Shell Tank System—Filter, control and distribute potable water to the DST Caustic and Diluent Addition Systems’ shower and eyewash station

Basis  DOE 6430 1A  Section 1540 15  Safety Devices
2 4 3 3 Distribute Service Air Within the Double-Shell Tank System

*Basis* HNF-SD-SM-TRD-007 Section 3 2 1 5 c Distribute Utilities in Double-Shell Tank System

Condition and distribute Service Air to DST System Components including the DST Instrument Air System

*Basis* None

2 4 3 4 Distribute Instrument Air Within the Double-Shell Tank System

*Basis* HNF-SD-SM-TRD-007 Section 3 2 1 5 c Distribute Utilities in Double-Shell Tank System

Condition and distribute Instrument Air to the DST Monitor and Control System

*Basis* None
Figure 2.4.2-1  Double-Shell Tank System Function Hierarchy for Distribute Utilities

Second Tier Functions

Third Tier Functions

Fourth Tier Functions

Distribute Utilities within DST System

Distribute Water Within the DST System

Distribute Service Air Within the DST System

Distribute Instrument Air Within the DST System

Distribute 480/277 Vac Electric Power

Distribute 277 Vac Electric Power

Distribute Water Within the DST System

Distribute Strained Raw Water Within the DST System

Distribute Filtered Raw Water Within the DST System

Distribute Potable Water Within the DST System

Light DST System

Provide Backup Electrical Power for the DST System

Distribute 240/120 Vac and/or 208/120 Vac Electric Power

DST = double-shell tank
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3.0 ALLOCATION OF FUNCTIONS TO DOUBLE-SHELL TANK COMPONENTS

The traceability between DST System functions and DST components is provided for the following components:

- DST Transfer Pump System
- DST Mixer Pump System
- DST Ventilation System
- DST Caustic and Diluent Addition System
- DST Transfer Valving System
- DST Transfer Piping System
- DST Utility System

Traceability between these components and the Store Waste, Transfer Waste, Prepare Waste, and Distribute Utilities functions are provided as follows:

- Store Waste Functions (see Figure 3.0-1)
- Transfer Waste Functions (see Figure 3.0-2)
- Prepare Waste Functions (see Figure 3.0-3)
- Distribute Utilities Functions (see Figure 3.0-4)
Figure 3 0-1 Store Waste Functions Applicable to Double-Shell Tank Components

DST Component References
(1) DST Transfer Piping System
(2) DST M or P mg System
(3) DST Ventilat System
(4) DST Compa and D event Addt System
(5) DST Val g System
(6) DST Trans F P g System
(7) DST Utts System

These functions should be considered pending as further research is required to identify the associated basis.

DST do not include tank.
Figure 3.0-2  Transfer Waste Functions Applicable to Double-Shell Tank Components

DST Component References
(1) DST Transfer Pump System
(2) DST Mixer Pump System
(3) DST Ventilation System
(4) DST Caustic and Dihuent Addition System
(5) DST Valving System
(6) DST Transfer Piping System
(7) DST Utility System
Figure 30-3  Prepare Waste Functions Applicable to Double-Shell Tank Components

Functions for Prepare Waste in West Area DSTs have third and lower tier functions similar to Prepare Waste in East Area DSTs (i.e., replace East with West)

**Same lower level functions as shown under Add Diluent to High Level Waste Source Tank Functional Flow (Figure 2313) and should be noted as repeated functions from those with the same name in Figure 2221**

DST = double shell tank
HLW = high level waste
LAW = low activity waste
Figure 3-0-4 Distribute Utilities Functions Applicable to Double-Shell Tank Components

Distribute Electric Power
(7)

Distribute 480/277 Vac Electric Power

Distribute 277 Vac Electric Power

Light DST System

Distribute 240/120 Vac and/or 208/120 Vac Electric Power

Provide Back up Electrical Power for the DST System

Provide Uninterruptible Electrical Power for the DST System

Distribute Water Within the DST System
(7)

Distribute Strained Raw Water Within the DST System

Distribute Filtered Raw Water Within the DST System

Distribute Potable Water Within the DST System

DST Component References
(1) DST Transfer Pump System
(2) DST Mixer Pump System
(3) DST Ventilation System
(4) DST Caustic and Diluent Addition System
(5) DST Valving System
(6) DST Transfer Piping System
(7) DST Utility System

DST = double shell tank
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40 REFERENCES


OSD-T-151-00007 Operating Specifications for the 241-AN AP AW AY AZ & SY Tank Farms, 9/23/98, Rev H-21

