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# Double-Shell Tank Maintenance and Recovery Subsystem Definition Report

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Abstract:

The description of the Double-Shell Tank (DST) Maintenance and Recovery Subsystem presented in this document was developed to establish its boundaries. The DST Maintenance and Recovery Subsystem consists of new and existing equipment and facilities used to provide tank farm operators logistic support and problem resolution for the DST System during operations. This support will include evaluating equipment status, performing preventive and corrective maintenance, developing work packages, managing spares and consumables, supplying tooling, and training maintenance and operations personnel.

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Assistant Secretary for Environmental Management

CH2MHILL
Hanford Group, Inc.
Richland, Washington
Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC06-99RL14047

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# Double-Shell Tank Maintenance and Recovery Subsystem Definition Report

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## EXECUTIVE SUMMARY

The description of the Double-Shell Tank (DST) Maintenance and Recovery Subsystem presented in this document was developed to establish the boundaries of the subsystem based on the *Tank Waste Remediation Architecture Tree*, HNF-4208, and the *Functional Analysis for Double-Shell Tank Subsystems*, HNF-5136.

The DST Maintenance and Recovery Subsystem consists of new and existing equipment and facilities used to provide tank farm operators with logistic support and problem resolution for the DST System during operations. This support will include evaluating equipment status, performing preventive and corrective maintenance, developing work packages, managing spares and consumables, supplying tooling, and training maintenance and operations personnel.

The current system for DST maintenance and recovery contains most of the equipment and facilities that will be needed to support waste feed delivery (WFD). However, some new equipment and facilities will be required to support the DST System. Facilities will be required for testing, maintaining, storing, and fabricating equipment as well as for training personnel on the equipment's use and preparing the equipment for disposal. Equipment will be required for supporting the mixer and transfer pump subsystems. Other facilities and equipment needs will be determined as the DST System is assessed and its philosophy of operation is defined further.

Appendix A contains a cursory assessment of the current DST System maintenance and recovery activities and the probability that each activity can be performed with existing systems and procedures to meet WFD needs.

A critical issue identified in preparing this definition report is the need to better manage the resources used for maintenance and recovery of the DST System. The current system is not efficient, which results in schedule delays and keeps preventive and corrective maintenance from being completed. These cumulative problems are causing equipment failures. Equipment failure will become a greater issue as the time allowed for maintenance and recovery activities becomes more critical during WFD activities.

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## TERMS

| | |
|---|---|
| DST | double-shell tank |
| M&R | Maintenance and Recovery |
| WFD | Waste Feed Delivery |

# 1.0 INTRODUCTION

## 1.1 PURPOSE

This document provides the rationale for, and description of, the Double-Shell Tank (DST) Maintenance and Recovery (M&R) Subsystem. This description establishes the bounds of the subsystem to facilitate development of the functional analysis.

## 1.2 DOCUMENT ORGANIZATION

This document is organized as follows:

- Section 2 establishes DST Maintenance and Recovery as a subsystem of the DST System.
- Section 3 describes the DST M&R Subsystem description.
- Section 4 describes the interfaces and support between the M&R Subsystem and other subsystems.
- Section 5 provides a cursory look at the functions provided by the M&R Subsystem.
- Section 6 provides the subsystem definition and conclusions.
- Section 7 lists the references cited in this document.

# 2.0 BACKGROUND

The *System Specification for the Double-Shell Tank System*, HNF-SD-WM-TRD-007, established DST System functions, system-level requirements, and interfaces applicable to the first phase (Phase 1) of the River Protection Project mission described in the *Tank Waste Remediation System Mission Analysis Report*, HNF-SD-WM-MAR. The purpose of the DST System, according to the DST System specification, is to receive, store, and treat (prepare) waste, and to transfer it to the Phase I Privatization Contractor, as shown in the DST System functional flow block diagram (Figure 1). The flow block diagram shows Support DST System as a floating function. This indicates that the Support DST System function will apply to the receive, store, prepare, and transfer waste functions.

A DST M&R architecture to accomplish the Support DST System functions was established in the *Tank Waste Remediation System Architecture Tree*, HNF-4208, and is shown in Figure 2.

Figure 1. Double-Shell Tank System Functional Flow Block Diagram. (Sheet 1 of 2)

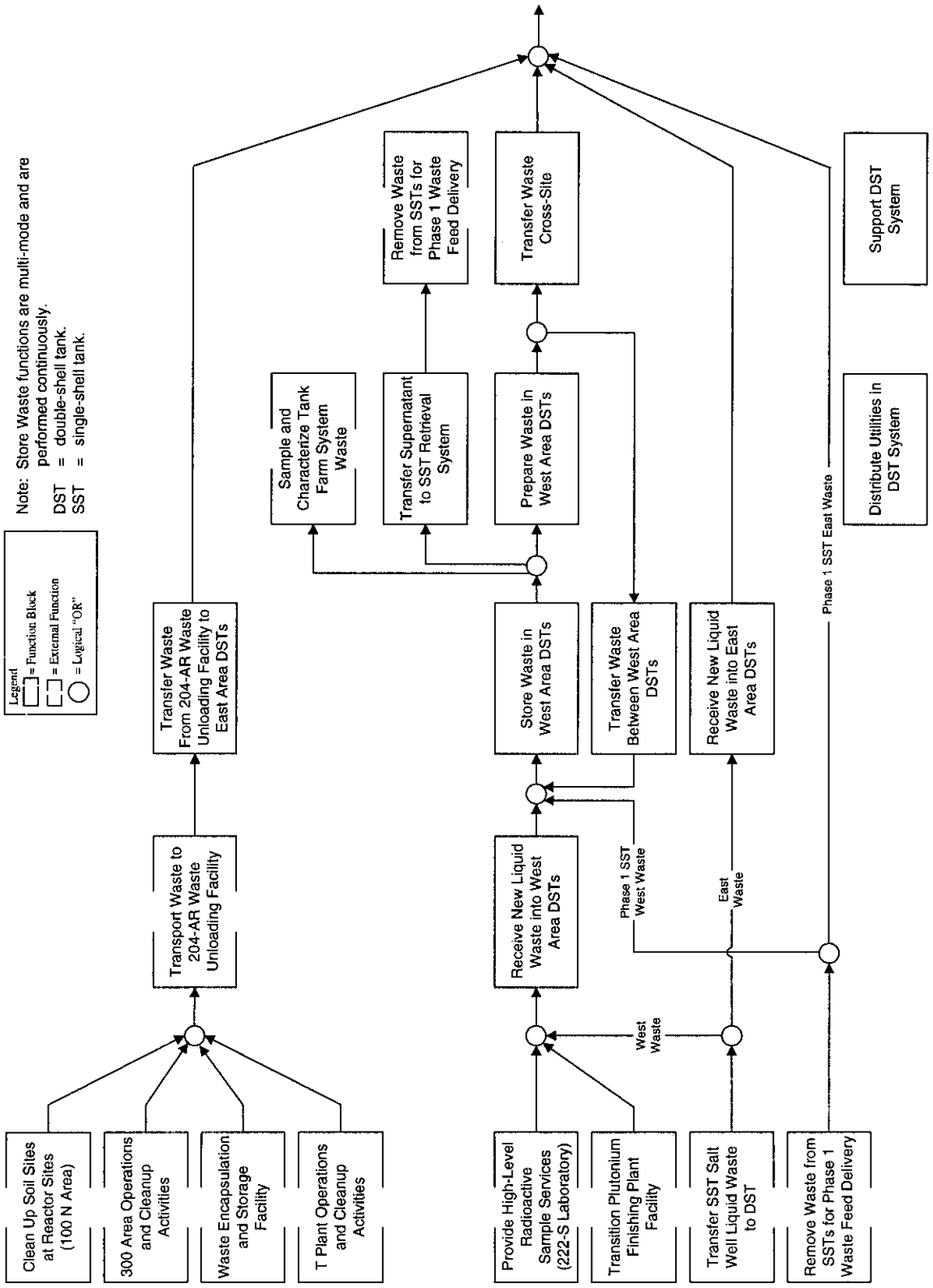


Figure 1. Double-Shell Tank System Functional Flow Block Diagram. (Sheet 2 of 2)

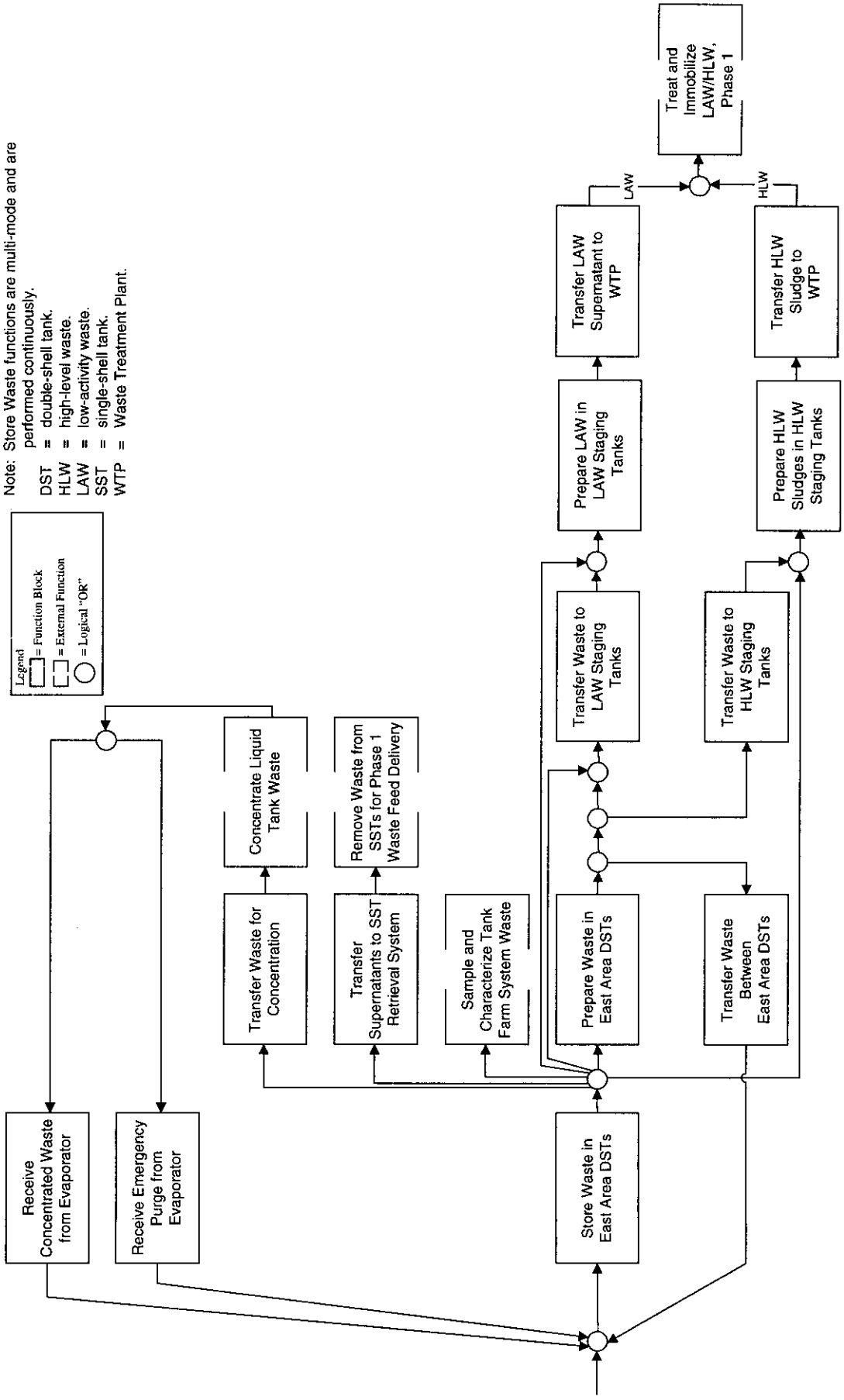
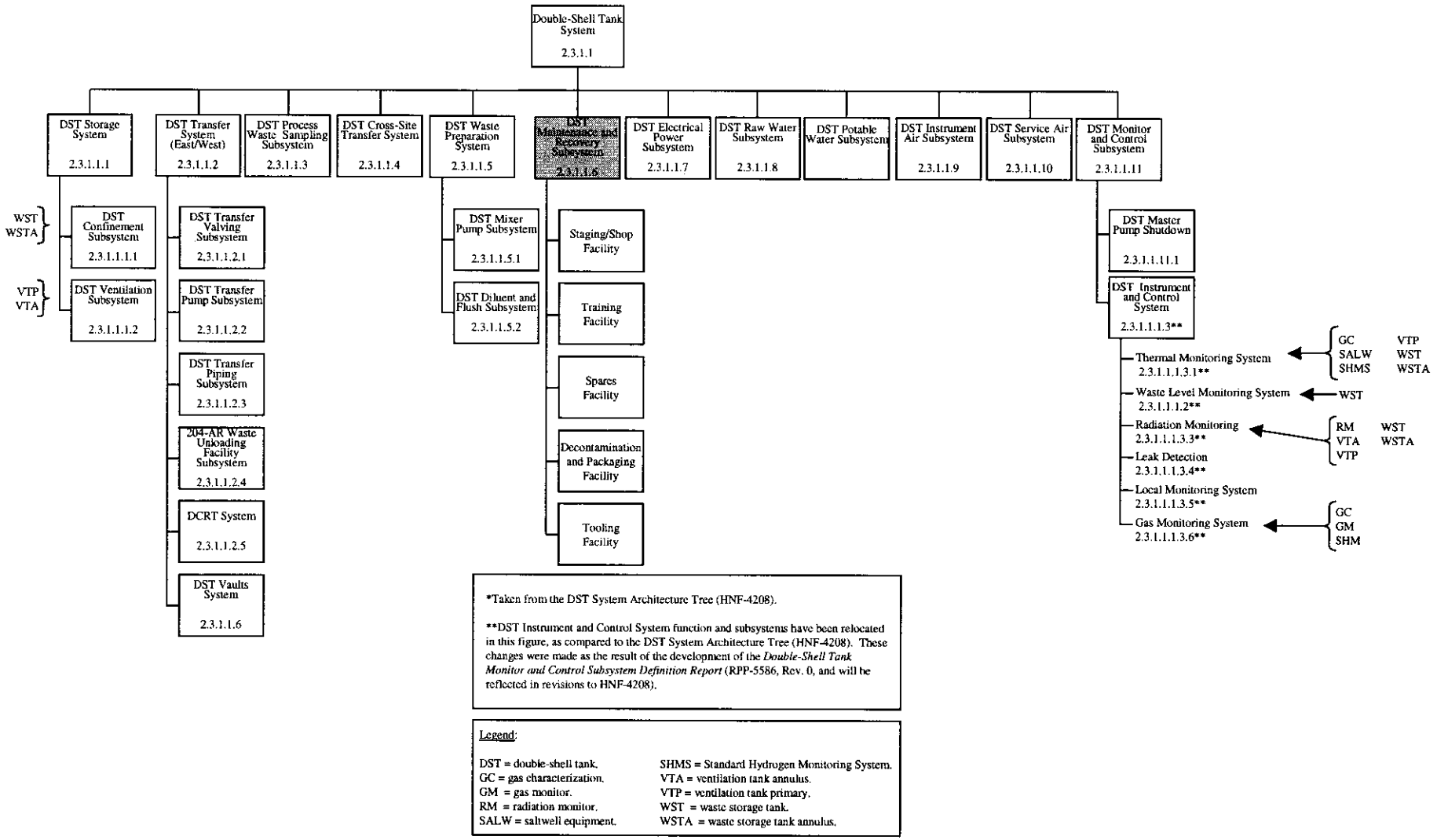


Figure 2. Double-Shell Tank System Architecture Tree.




*Taken from the DST System Architecture Tree (HNF-4208).

**DST Instrument and Control System function and subsystems have been relocated in this figure, as compared to the DST System Architecture Tree (HNF-4208). These changes were made as the result of the development of the *Double-Shell Tank Monitor and Control Subsystem Definition Report* (RPP-5586, Rev. 0, and will be reflected in revisions to HNF-4208).

Legend:

DST = double-shell tank.
GC = gas characterization.
GM = gas monitor.
RM = radiation monitor.
SALW = saltwell equipment.
SHMS = Standard Hydrogen Monitoring System.
VTA = ventilation tank annulus.
VTP = ventilation tank primary.
WST = waste storage tank.
WSTA = waste storage tank annulus.

## 3.0 DOUBLE-SHELL TANK MAINTENANCE AND RECOVERY DESCRIPTION

M&R activities for the waste feed delivery (WFD) mission are performed by the DST M&R Subsystem.

The DST System Specification describes the DST M&R Subsystem as a collection of systems that enable maintenance and recovery from failures and abnormal circumstances (e.g., plugged lines, leaking waste into secondary containment).

The existing maintenance and recovery activities associated with the store waste, transfer waste, and distribute DST utilities functions will continue during the WFD mission. Therefore, they become part of the DST M&R Subsystem. Components and the configuration of the existing system for maintenance and recovery will be modified as required to support the WFD mission.

The architecture tree shown in Figure 2 includes five subsystems under the M&R Subsystem. These subsystems are as follows:

- **Staging/Shop Facility**. The M&R staging/shop facility includes the floor space and equipment necessary to evaluate the equipment status and support the repair of failed components.

- **Training Facility**. The M&R training facility includes the floor space and training equipment needed to provide specialized training for mixer and transfer pump maintenance including replacement and valve pit maintenance.

- **Spares Facility**. The M&R spares facility includes the floor space and equipment to prepare parts as spares and to store, issue, and track the use of the spares. It also includes the floor space and equipment to store and issue consumables and track their use.

- **Decontamination and Packaging Facility**. The M&R decontamination and packaging facility provides the floor space and equipment to decontaminate equipment before maintenance and decontaminate and package failed equipment for disposal.

- **Tooling Facility**. The M&R tooling facility provides the floor space and equipment to store and issue tools.

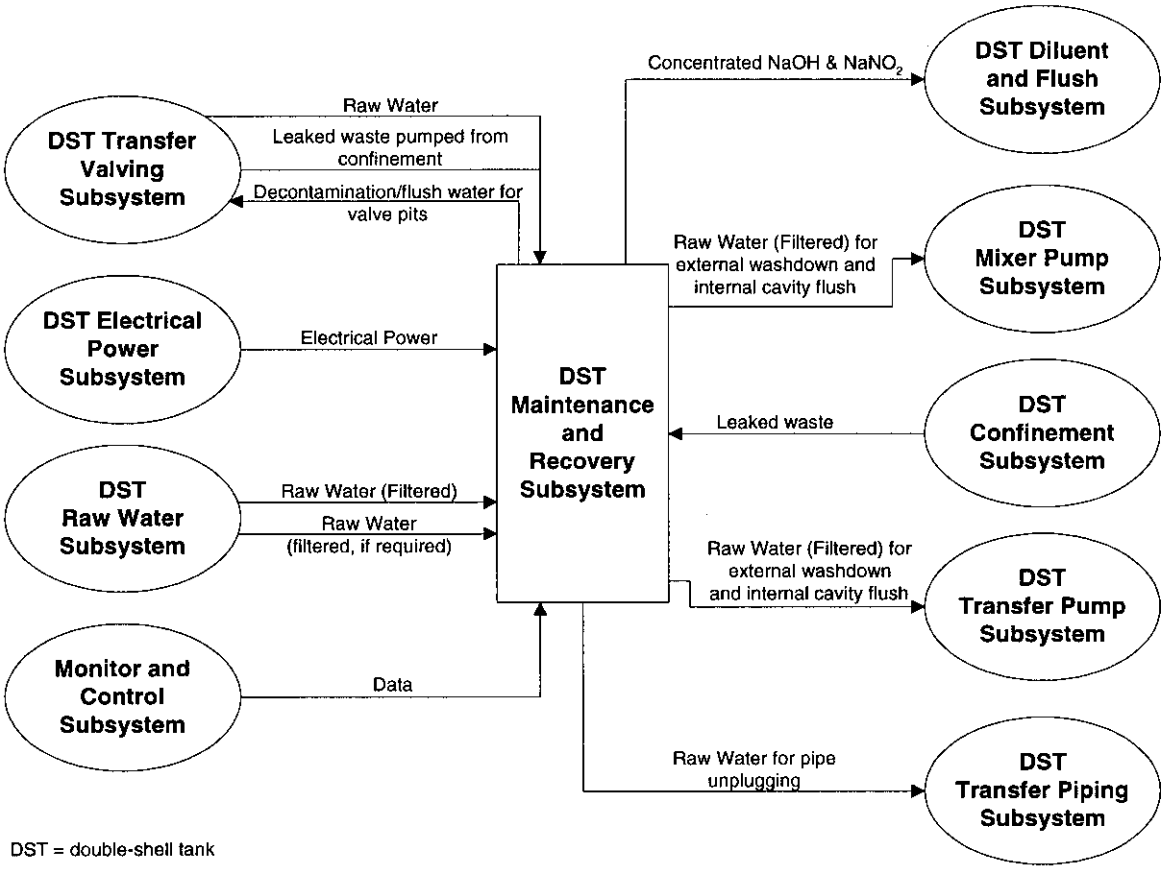
## 4.0 DOUBLE-SHELL TANK MAINTENANCE AND RECOVERY SUBSYSTEM INTERFACES/SUPPORT

Fifteen DST subsystems have been created to support the DST System architecture functions shown in Figure 2. The DST subsystems are as follows:

- Transfer Pump
- Mixer Pump
- Transfer Valving
- Transfer Piping
- Ventilation
- Diluent and Flush
- Electrical Power
- Raw Water
- Potable Water
- Instrument Air
- Service Air
- Monitor and Control
- Process Waste Sampling
- Confinement
- Maintenance and Recovery.

The DST M&R Subsystem interfaces with other DST subsystems as shown in the interface diagram (Figure 3). These interfaces include the passing of chemical and utility material between the M&R Subsystem and each of the other subsystems shown.

Figure 3. Double-Shell Tank Maintenance and Recovery Subsystem Interface Diagram.

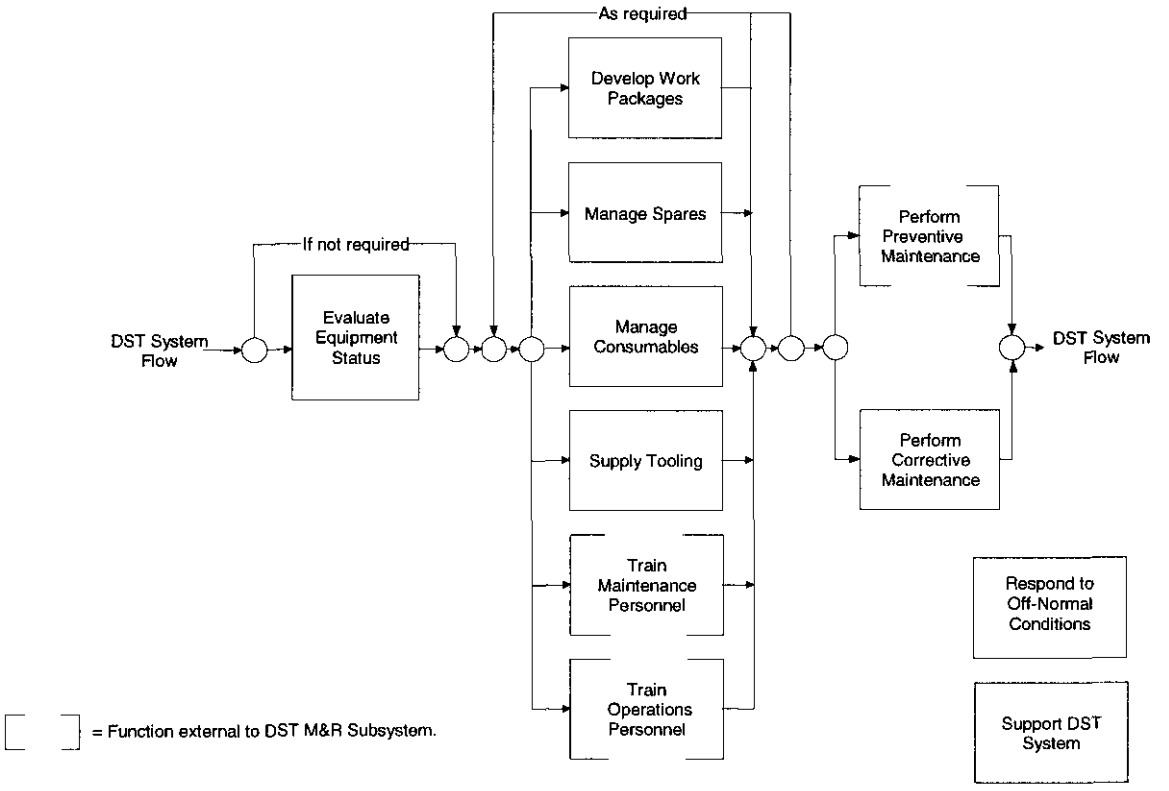



DST = double-shell tank

# 5.0 DOUBLE-SHELL TANK MAINTENANCE AND RECOVERY FUNCTIONS

The Support DST System functional flow diagram, Figure 4, is described in Section 5.1. These functions include the predictive, preventive, and corrective maintenance activities necessary to support the DST Subsystem failures and abnormal conditions.

Figure 4. Functional Flow Block Diagram for Support to the Double-Shell Tank System.




## 5.1 MAINTENANCE AND RECOVERY FUNCTIONS IN SUPPORT OF THE DOUBLE-SHELL TANK SYSTEM

The DST M&R Subsystem supports the DST System categories above by performing the functions described in Section 5.1.1 through 5.1.7. These functions will be performed in a manner that complies with safe and efficient work practices.

### 5.1.1 Evaluating Equipment Status

This predictive maintenance function begins with data provided by the DST subsystems through the Monitor and Control Subsystem or from a local data collection point. This function includes assessing equipment status by analyzing collected data for abnormal or off-normal indications and also may include performance of special inspections and tests to ascertain equipment status. Data analysis includes formatting, trending, or other analysis to determine equipment status with

a focus on detecting potential equipment failures. This function ends with a notification to maintenance engineering that a component requires maintenance. Maintenance engineering will track the status of the maintenance activity.

**5.1.1.1 Assess Equipment Status.** This function begins with data provided by the DST subsystems through the Monitor and Control Subsystem or from a local data collection point. This function includes the capability of remotely monitoring predictive maintenance instrument-generated data. This function ends with a notification to maintenance engineering that a component requires evaluation or additional data are needed. Maintenance engineering will track the status of the maintenance activity.

**5.1.1.2 Analyze Equipment Data.** This function begins with data provided from the "assess equipment status" function. This function includes the capability of analyzing predictive maintenance instrument-generated data. This function ends with a decision to replace or repair a component. The status of the maintenance activity will be tracked.

**5.1.1.3 Identify Maintenance Action.** This function begins with a conclusion to replace or repair from the "analyze equipment data" function. This function includes notifying maintenance personnel of a required maintenance action. This function ends with a notification to production control that a component requires maintenance. Maintenance engineering will track the status of the maintenance activity.

### 5.1.2 Developing Work Packages

This function begins with a notification of a required preventive or corrective maintenance action. It includes developing a tank farm work package containing items such as the applicable maintenance procedures, required spare parts, and required permits. The function ends with a completed work package.

### 5.1.3 Managing Spares

This function begins with the list of required spare equipment to support the waste feed production mission. The function includes acquiring any required spares beyond those provided by the projects; preparing, storing, and issuing spares; tracking spares use; and replacing issued spares. This function ends with the required spares available for maintenance.

**5.1.3.1 Acquire Parts as Spares.** This function begins with the list of required spare parts. The function includes spares for critical components to be determined and included as part of the onsite spare parts inventory. This function ends with the parts accepted and entered into the spares tracking system.

**5.1.3.2 Prepare New/Recycled Parts for Spares.** This function begins with the received parts. The function includes the steps necessary to prepare the parts for storage and issuance as spares including, but not limited to, repair/decontamination, packaging, testing, and equipment run-in. This function ends with the spares/recycled components ready for storage.

**5.1.3.3 Store Spares/Recycled Components.** This function begins with the prepared spares/recycled components ready for storage. The function includes the storage of spares/recycled components within the vendor's specified environments including, but not limited to, temperature, physical orientation, moisture, and shelf life. Pumps may be stored horizontally if strong backs and jigs are provided. This function ends with the spares/recycled components in storage and ready for issuance.

**5.1.3.4 Issue Spares/Recycled Components.** This function begins with the spares/recycled components in storage and ready for issuance. The function includes the issuance of spares to maintenance personnel to support preventive and corrective maintenance. This function ends with the transfer of spares/recycled components to maintenance personnel.

**5.1.3.5 Track Spares.** This function begins with the receipt of parts for spares. The function includes entry of the received parts into the system, tracking quantity, location, shelf time, and use rate. This function ends when the notification spares reorder point has been reached.

### 5.1.4 Managing Consumables

This function begins with a list of required consumables to support the waste feed production mission. The function includes acquiring any consumables beyond those already stocked; storing, issuing, and tracking consumables used; replacing issued consumables; and disposing of used consumables. This function ends with the required consumables available for maintenance.

### 5.1.5 Supplying Tooling

This function begins with a list of required tooling to support the waste feed production mission. The function provides shop and tools for fabricating special one-of-a-kind parts or equipment to support spare-part installation. This includes a jumper fabrication shop and a computer maintenance and repair shop. The function provides tools and equipment in a manner such that they do not delay the waste feed delivery schedule. The function develops specialized tools and equipment beyond that which the River Protection Project organizations already possess to repair failures. The function ensures that facility equipment is adequately maintained and accessible for maintenance activities such that area hoists, ladders, work platforms, and temporary platforms are provided as necessary to assist in the adherence to safe and efficient work practices. The function provides the facility and/or equipment necessary to test critical-path jumper hardware. This function ends with the required tools being available for maintenance.

### 5.1.6 Performing Corrective Maintenance

This function starts with identifying the equipment requiring corrective maintenance and includes obtaining the procedure, training, spare parts and/or consumables, and tooling necessary to perform the maintenance. The function includes the activities necessary to correct deficiencies of the DST subsystems, repair or replace failed components, and preemptively replace components when predictive or preventive maintenance indicates that they are reaching the end of their useful life. The function also includes transporting the necessary materials to the

field to perform the work or transporting the component needing maintenance to a maintenance facility. The function ends with the corrective maintenance on the component complete, consumables disposed of, equipment decontaminated, and the resources returned to the shop. This function starts with a down system and component in need of replacement or repair and ends with a working component and operating system.

**5.1.6.1 Perform Double-Shell Tank Mixer Pump Subsystem Corrective Maintenance.** This function begins with identification of a need for mixer pump subsystem corrective maintenance. The function includes removing/replacing the mixer pump, motor, variable-speed drive, and predictive instrumentation. This function ends with the mixer pump corrective maintenance completed.

**5.1.6.2 Perform Double-Shell Tank Transfer Pump Corrective Maintenance.** This function begins with the identification of a need for transfer pump corrective maintenance. The function includes removing/replacing the transfer pump, motor, variable-intake equipment, and predictive instrumentation. This function ends with the transfer pump corrective maintenance completed.

**5.1.6.3 Perform Double-Shell Tank Sampling Subsystem Corrective Maintenance.** This function begins with identification of a need for sampling subsystem corrective maintenance. The function includes repairing/replacing failed drill and core strings, pumped loop systems, augers, and agitated liquid samplers. The function ends with sampling subsystem corrective maintenance completed.

**5.1.6.4 Perform Double-Shell Tank Ventilation Subsystem Corrective Maintenance.** This function begins with identification of a need for ventilation subsystem corrective maintenance. The function includes replacing filtration train components, instrumentation and decontaminating filtration systems and ventilation pits. The function ends with ventilation subsystem corrective maintenance completed.

**5.1.6.5 Perform Double-Shell Tank Transfer Piping Subsystem Corrective Maintenance.** This function begins with identification of a need for piping subsystem corrective maintenance. The function includes recovering from a failed leak-detection instrument and plugged pipes. The function ends with the piping subsystem corrective maintenance completed.

**5.1.6.6 Perform Double-Shell Tank Transfer Valving Subsystem Corrective Maintenance.** This function begins with identification of a need for valving subsystem corrective maintenance. The function includes recovering from a failed nozzle, jumper, or pit leak detector, a plugged drain line, seal-loop valve in secondary containment, and other mechanical equipment and instrumentation supporting the valving subsystem and cover blocks. The function ends with valving subsystem corrective maintenance completed.

**5.1.6.7 Perform Double-Shell Tank Electrical Power Subsystem Corrective Maintenance.** This function begins with identification of a need for electrical power corrective maintenance. The function includes removing/replacing the master control console, the uninterruptible power, and/or the 480 V distribution equipment. The function ends with electrical power subsystem corrective maintenance completed.

**5.1.6.8 Perform Double-Shell Tank Monitor and Control Subsystem Corrective Maintenance.** This function begins with identification of a need for monitor and control subsystem corrective maintenance. The function includes repairing/replacing weight factor pressure differential pressure indicators/switches, in-tank cameras, and camera purge gas pressure and flow instruments. The function ends with monitor and control subsystem corrective maintenance completed.

**5.1.6.9 Perform Double-Shell Tank Diluent and Flush Subsystem Corrective Maintenance.** This function begins with identification of a need for diluent and flush subsystem corrective maintenance. The function includes corrective maintenance on pumps and other mechanical/electrical equipment and repair of pressure, temperature, flow, and level instrumentation. The function ends with diluent and flush subsystem corrective maintenance completed. The function ends with a system ready for operation.

**5.1.6.10 Back Out After Completing Maintenance.** This function begins with a completed maintenance activity. The function includes removing equipment for disposal, packaging, loading, and transporting to a decontamination/contamination-reduction facility, performing a system checkout, and removing administrative controls. The function ends with a safe and clean workspace.

**5.1.6.11 Equipment Returned to Operation.** This function begins with backing out after a maintenance activity. The function includes system tests to ensure that maintenance activities are complete and the system is ready for operation. The function ends with an operating system.

**5.1.6.12 Reduce Contamination/Decontaminate and/or Dispose of Equipment.** This function begins with a need to reduce contamination/decontaminate and/or dispose of equipment including tools used to perform maintenance and replaced components. The function includes receiving, unloading, and reducing contamination or decontaminating equipment as well as disassembling and packaging for disposal. The function ends with equipment ready to return to storage or packaged for disposal.

**5.1.6.13 Return to Shop.** This function begins with the completion of backing out after a maintenance activity. The function includes packaging for transport, transporting to a storage facility, unloading, and restocking tools. The function ends with tools restocked in the shop.

### 5.1.7 Responding to Off-Normal Conditions

This function begins with a need to respond to an off-normal condition. The function includes assessing the off-normal indication (e.g., waste temperature, transfer pump pressure) and performing the necessary operational or maintenance actions to restore the equipment operation to within normal operating parameters. The function ends with a restored system.

## 5.2 MAINTENANCE AND RECOVERY SUPPORT OF DOUBLE-SHELL TANK SUBSYTEMS

Figure 5 provides details for the preventive and corrective maintenance support to all DST subsystems. This diagram is not meant to be all inclusive but rather to give an idea of support provided by the M&R Subsystem to the other subsystems.

## 5.3 MAINTENANCE AND RECOVERY SUBSYSTEM SUPPORT OF FIRST-TIER DOUBLE-SHELL TANK SYSTEM

The discussion of HNF-5136, *Functional Analysis for Double-Shell Tank Subsystems*, organizes the first-tier DST System functions that support the Phase 1 WFD mission as follows:

- Store waste
- Transfer and receive waste
- Prepare waste
- Distribute DST utilities.

These four DST functions are supported by the M&R Subsystem preventive and corrective maintenance functions that are applied to the other DST subsystems. The M&R Subsystem will support each subsystem by supplying equipment and facilities needed to maintain the systems and recover from failures and off-normal events. Tables 5-1 through 5-4 show the general type of support provided by the M&R Subsystem to each of the other subsystems. See Appendix A for a more detailed list.

The first-tier functions and the maintenance and recovery subsystem support are described in Sections 5.3.1 through 5.3.4.

### 5.3.1 Double-Shell Tank Store Waste Function

The DST Store Waste function includes the 200 East and 200 West Area DSTs. The SY tank farm in the 200 West Area houses 3 DSTs. The AY (2 tanks), AZ (2 tanks), AN (7 tanks), AW (6 tanks), and AP (8 tanks) in the 200 East Area house 25 DSTs. The DST Storage System performs a role in accomplishing the five third-tier DST Store Waste functions as described in HNF-5136 and Table 5-1.

### 5.3.2 Double-Shell Tank Transfer Waste Function

The Transfer Waste function involves transferring waste between DST facilities or transferring waste between two facilities outside the DST System. Waste received into the DST System includes waste from singe-shell tanks; the evaporator; the privatization waste immobilization contractor; the 100K, 100N, 300, and 400 Areas; and various 200 East and 200 West Area processing facilities and laboratories.

The third-tier functions for the Transfer Waste function are provided in Table 5-2.

Figure 5. Double-Shell Tank Maintenance and Recovery Subsystem Support Diagram.

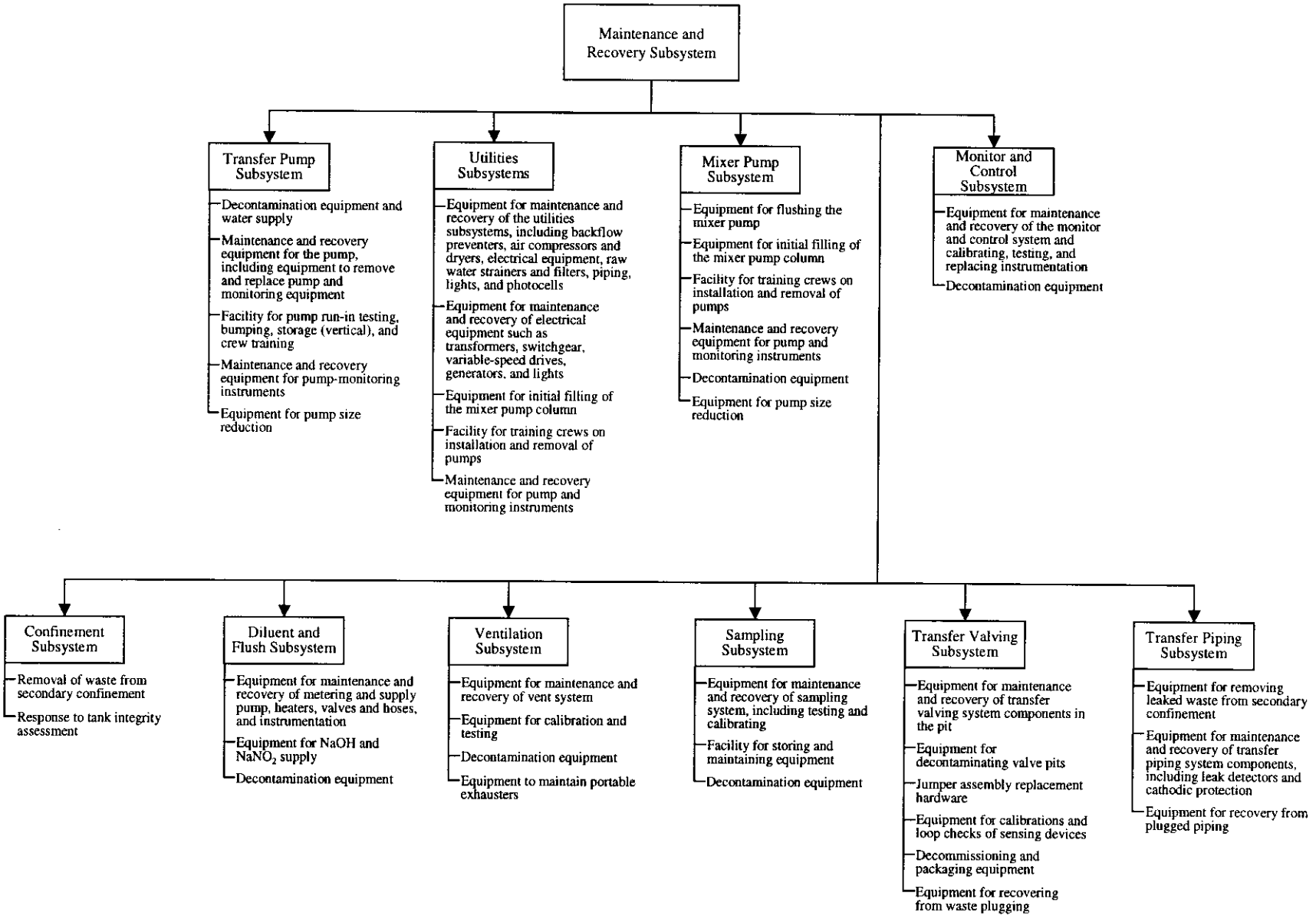


Table 5-1. Double-Shell Tank Store Waste Function.

| DST Store Waste Function | Examples of support provided by the Maintenance and Recovery Subsystem |
|---|---|
| Control DST waste composition | Maintains or replaces the DST Diluent and Flush Subsystem. This support includes pumps; electric/steam heaters; pipe; flexible hoses; connections; flow, temperature, and pressure instrumentation; pH transmitters and transducers; valves; and instrument position indicators. Support also includes decontamination and packaging of equipment at the end of its life. |
| Control DST and waste temperature | Maintains the DST Ventilation Subsystem, which includes calibrations for flow, pressure and temperature instrumentation; and the DST Monitor and Control Subsystem, which includes calibrating or functionally testing temperature instruments. The function also includes replacing fans, valves, ventilation heaters, chillers, heat exchangers, moisture separators, and demistors. |
| Control DST hydrostatic loads | Calibrates or functionally tests vapor and annulus space pressure measurement instrumentation, and tank level instrumentation. |
| Control DST primary confinement leaks | Provides equipment to pump waste from the annulus and maintain the annulus leak-detection system. |
| Control DST gaseous discharge | Maintains the DST Monitor and Control Subsystem and Ventilation Subsystem. Support includes calibrating and replacing leak detectors, continuous air monitor vacuum pumps, effluent monitoring systems, continuous air monitors, portable exhausters, high-efficiency gas adsorbers, and high-efficiency mist eliminators. |

DST = double-shell tank.

Table 5-2. Double-Shell Tank Transfer Waste Function. (2 sheets)

| DST Transfer Waste Function | Examples of Support provided by the Maintenance and Recovery Subsystem |
|---|---|
| Establish transfer route for waste transfer | Calibrates valve position indicators, flowmeters, and pressure transmitters. Periodically cycles valves and maintains and replaces valve system components, such as failed nozzles, jumpers, leak detectors, T-handles, cover blocks, pump pit structures, gear boxes, and valve motor operators. |

Table 5-2. Double-Shell Tank Transfer Waste Function. (2 sheets)

| DST Transfer Waste Function | Examples of Support provided by the Maintenance and Recovery Subsystem |
|---|---|
| Provide diluent during transfers | Calibrates flow, pressure, temperature, pH, and tank level measurement instruments; provides chemicals via supply trucks or drums; provides the piping and connections to the DST Diluent and Flush Subsystem; and maintains or replaces metering pumps, supply pumps, the electric and steam heater, valves, hoses, and instruments. |
| Convey waste | Maintains and recovers the mixer pumps, transfer pumps, and transfer piping and jumpers. Support includes off-normal flushing of the pumps; providing filtered raw water to pump seals; providing a facility for training crews on installation and removal; providing a facility for pre-installation periodic pump testing; providing a facility for vertical storage; maintaining and replacing pump monitoring and control equipment; "bumping" installed pumps periodically; and removing and replacing failed pumps and leak detectors. Recovers from a leaking or plugged pipe. |
| Confine waste along transfer route | Maintains and recovers from failures of the DST Transfer Piping Subsystem. Support includes testing and replacing leak detectors, testing and maintaining cathodic protection, and recovering from leaking pipes. |
| Confine waste leakage along transfer route | Provides the equipment to pump waste from secondary confinement and to maintain and repair leak detector systems. |
| Flush transfer system | Maintains and recovers the DST Diluent and Flush Subsystem, pumps used for flushing, and special equipment used to unplug transfer lines. |
| Drain transfer piping | Recovers from plugged piping. |
| Perform material balance for DST transfers | Maintains the DST Monitor and Control Subsystem including calibrating, testing, and replacing flow instruments, leak detectors, and level gauges. |
| Reconfigure transfer route | Maintains and recovers the DST Transfer Valving Subsystem, performs periodic cycling of the valves to ensure that they are in working order, and performs instrument checks. |

DST = double-shell tank.

### 5.3.3 Double-Shell Tank Prepare Waste Function

The Prepare Waste Function includes operations performed on the stored waste to support preparing waste for transfer to a staging tank or for transfer to the privatization contractor. The Prepare Waste functions are described in Table 5-3.

Table 5-3. Double-Shell Tank Prepare Waste Function. (2 sheets)

| DST Prepare Waste Function | Examples of Support provided by the Monitor and Control Subsystem |
|---|---|
| Prepare waste in 200 East Area DSTs | Maintains and recovers the DST Mixer Pump Subsystem, Diluent and Flush Subsystem, and Process Waste Sampling Subsystem. Support includes calibrating temperature, flow, pressure, and pH instrumentation and maintaining or replacing pumps, heaters, pipes, hoses, drill and core strings, and stuck augers. |
| Prepare waste in 200 West Area DSTs | Maintains and recovers the DST Mixer Pump Subsystem, Diluent and Flush Subsystem, and Process Waste Sampling Subsystem. Support includes calibrating temperature, flow, pressure, and pH instrumentation and maintaining or replacing pumps, heaters, pipes, hoses, drill and core strings, and stuck augers. |
| Prepare low-activity waste in low-activity waste staging tanks | Maintains and recovers the DST Mixer Pump Subsystem, Diluent and Flush Subsystem, and Process Waste Sampling Subsystem. Support includes calibrating temperature, flow, pressure, and pH instrumentation and maintaining or replacing pumps, heaters, pipes, hoses, drill and core strings, and stuck augers. |
| Prepare high-level waste sludges in high-level waste staging tanks | Maintains and recovers the DST Mixer Pump Subsystem and Diluent and Flush Subsystem. Support includes calibrating temperature, flow, pressure, and pH instrumentation and maintaining or replacing pumps, heaters, pipes, and hoses. |

DST = double-shell tank.

### 5.3.4 Double-Shell Tank Distribute Utilities Function

The DST Utilities Subsystems provide the electrical power, raw and potable water, and service and instrument air that support the systems used to maintain safe storage within the DSTs;

process, stage, and transfer LAW and HLW feed to the privatization contractor; and receive and manage routine waste receipts. The DST Utilities Subsystem functions, as provided by the system breakdown structure, are provided in Table 5-4.

Table 5-4. Double-Shell Tank Distribute Utilities Function.

| DST Distribute Utilities Function | Examples of Support provided by the Maintenance and Recovery Subsystem |
|---|---|
| Distribute DST electrical power | Maintains and recovers electrical equipment such as the transformers, switchgear, variable-speed drives, and backup power generators. |
| Distribute DST raw water | Maintains and recovers raw water system components such as the backflow preventers, strainers and filters, valves, flow totalizers, and piping. |
| Distribute DST potable water | Maintains and recovers failed backflow preventers and piping. |
| Distribute DST service air | Maintains and recovers air compressors. |
| Distribute DST instrument air | Maintains and recovers instrument air compressors and filters and dryers. |

## 6.0 CONCLUSIONS

The Maintenance and Recovery Subsystem shall provide the equipment and facilities necessary for logistic support and problem resolution of the DST System during system operations. The equipment and facilities will be used for evaluating equipment status; developing work packages; managing spares; managing consumables; supplying tooling, training maintenance personnel, and training operations personnel; performing preventive maintenance; and performing corrective maintenance.

Appendix A shows that further development will be needed on some subsystems to ensure a high probability that the maintenance and recovery of DST subsystems can occur in a timely manner to support WFD. The assessment also shows that current practices and equipment exist to handle most M&R activities but that the administrative processes for management of what is already available on the Hanford Site need development.

Specifications will need to be developed for both facilities and equipment to support the DST System. The specifications needed include but are not limited to facilities for storing spare parts, fabricating special tools or equipment, training maintenance and operations personnel, building mockups of equipment and maintenance processes, and performing corrective and preventive maintenance. In addition to facility development, specifications will be required for predictive

maintenance equipment and special tools. Other equipment and facility specification needs will be identified as the DST systems are further defined.

## 7.0 REFERENCES

HNF-4208, 1999, *Tank Waste Remediation System Architecture Tree*, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-5136, 1999, *Functional Analysis for Double-Shell Tank Subsystems*, Rev. 0, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-SD-WM-MAR, 1998, *Tank Waste Remediation System Mission Analysis Report*, Rev. 3, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-SD-WM-TRD-007, 1998, *System Specification For the Double-Shell Tank System*, Rev. 0-E, Numatec Hanford Corporation for Lockheed Martin Hanford Corporation, Richland, Washington.

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# APPENDIX A

# CURSORY ASSESSMENT OF THE DOUBLE-SHELL TANK MAINTENANCE AND RECOVERY SUBSYSTEM ACTIVITIES

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# APPENDIX A

## CURSORY ASSESSMENT OF THE DOUBLE-SHELL TANK MAINTENANCE AND RECOVERY SUBSYSTEM ACTIVITIES

Appendix A contains a cursory assessment of the current Double-Shell Tank (DST) Maintenance and Recovery Subsystem activities for the tank farms. This table provides a list of activities that will take place for each subsystem during the Waste Feed Delivery mission. The first column describes the maintenance and recovery activities for each of the DST subsystems other than the Maintenance and Recovery Subsystem. The second column describes practices and procedures related to the activity. The third column identifies the equipment that is required by the DST System to perform the activities and whether or not the equipment is currently available on the Hanford Site. The fourth column ranks the probability that each activity can be performed during future Waste Feed Delivery activities with no further system development.

The fourth column ranking is only meant to give a general idea of readiness of the current Maintenance and Recovery Subsystem. These rankings are based on consultations with maintenance engineering and operations personnel. A formal assessment in the form of an engineering study will be necessary to provide a substantive ranking.

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**Table A-1. Double-Shell Tank Mixer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Flush the mixer pump with chemically adjusted water. | Procedures are contained in work packages written for the pumps on a case-by-case basis. The current pumps are not representative of future mixer pumps. | The mixer pump systems and their support systems have not been installed. | Low |
| Provide water to the pump for various infrequent needs (e.g., provide water to pump seals and to keep a cavity around a pump opening after the pump is installed). | Procedures are contained in work packages written for the pumps on a case-by-case basis. | The equipment needed to perform this activity exists on Site. | Medium |
| Provide a facility for training crews to install and replace pumps and for periodic testing of the pumps before and after installation. | Not applicable. | No such facility currently exists.<br>Pump installation equipment exists on Site. | Low |
| Provide a facility for storing the pumps vertically. | Not applicable. | No such facility currently exists.<br>Equipment needed for moving pumps to storage facilities is available. | Low |

**Table A-1. Double-Shell Tank Mixer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Maintain the pump monitoring equipment. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Minimal equipment currently is installed to perform predictive maintenance on mixer pumps. There are no programs to support predictive maintenance. | Low |
| Routinely bump the pump. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment exists on Site. | Medium |
| Decontaminate/reduce contamination of the pumps when they are removed from the tanks. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Minimal facilities are available to perform equipment decontamination. Equipment can be rinsed as it is removed from the tanks and, if the dose rates are not too high, minor hand decontamination of equipment can be performed. The capability is not available to decontaminate pumps or other highly contaminated equipment or to take them back to a shop and perform hands-on maintenance. | Low |

**Table A-1. Double-Shell Tank Mixer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from mixer pump external leakage. | Current practice is to replace the pump if the leakage is not acceptable. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment for removal and replacement of a mixer pump is not really available on Site. Equipment was fabricated for supporting the removal and replacement of the 241-SY-101 mixer pump, but the condition and operability of many items has not been verified. Many of the high-pressure hydraulic hoses likely will need to be replaced. | Low |
| Recover from mixer pump failure caused by impeller failure. | Current practice is to remove and replace the pump. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment for removal and replacement of a mixer pump is not really available on Site. Equipment was fabricated for supporting the removal and replacement of the 241-SY-101 mixer pump, but the condition and operability of many items has not been verified. Many of the high-pressure hydraulic hoses likely will need to be replaced. | Low |

**Table A-1. Double-Shell Tank Mixer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from mixer pump failure to run caused by internal corrosion or erosion. | Current practice is to remove and replace the pump. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment for removal and replacement of a mixer pump is not really available on Site. Equipment was fabricated for supporting the removal and replacement of the 241-SY-101 mixer pump, but the condition and operability of many items has not been verified. Many of the high-pressure hydraulic hoses likely will need to be replaced. | Low |
| Recover from mixer pump failure to run caused by slurry blockage. | Current practice is to flush the pump to clear the blockage. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment required for flushing the pump is available on Site. | Medium |
| Recover from mixer pump failure to start (e.g., pump shaft will not rotate). | Current practice is to torque the shaft to help free it up. If the mixer pump cannot be started, the pump will be replaced. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment is available on Site to torque the shaft or replace the pump. | Medium |

**Table A-1. Double-Shell Tank Mixer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from mixer pump turntable failure to rotate. | Current practice is to torque the shaft to help free it up. If the mixer pump cannot be started, the pump will be replaced. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment is available on Site to torque the shaft or replace the pump. | Medium |
| Recover from failure of mixer pump support assembly. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment is available on Site to support the repair of the support assembly. | Medium |
| Recover from mixer pump speed control or variable-speed drive failure. | Current practice is to troubleshoot and replace the speed drive. We do not have the expertise to repair variable-speed drives. We currently rely on contracted assistance from off Site. | Equipment exists on Site to repair or replace the variable speed drive. | Medium |
| Install replacement pump. (Includes hardware needed for the installation.) | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment exists on Site for the replacement and installation of the mixer pump. However, the equipment has not been demonstrated adequately. | Medium |

Table A-1. Double-Shell Tank Mixer Pump Subsystem.

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from onboard instrument failures (e.g., motor-winding temperature measurement device and other devices that are located in an accessible place). | Instruments that are located above the pump pit can be replaced. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment needed to replace instruments may not be available on Site. | Medium |

**Table A-2. Double-Shell Tank Transfer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Flush the transfer pump with chemically adjusted water. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment needed for this activity exists on Site for some tank farms but needs to be expanded to cover all pump locations. | Medium |
| Provide a facility for training crews to install and replace pumps and for testing pumps before and after installation. | Not applicable. | No such facility currently exists on Site.<br>Equipment for installation activities is available on Site. | Low |
| Provide a facility for storing pumps in a vertical position. | Not applicable. | No such facility currently exists on Site.<br>Equipment needed for moving pumps to storage facilities exists on Site. | Low |
| Provide a facility for rotating shafts of stored pumps periodically. | Not applicable. | No such facility currently exists on Site. | Low |
| Maintain the pump monitoring equipment. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Minimal equipment is installed to perform predictive maintenance on mixer pumps. No program exists to support predictive maintenance. | Low |

**Table A-2. Double-Shell Tank Transfer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Bump pump motors. Recirculate back to the tank, close discharge valve, or run pump at low speed so that waste does not have energy to exit the pump column. | A procedure for bumping a pump exists but is not used because it requires about as much preparation as using the pump for a transfer and is therefore cost prohibitive. | Equipment needed to bump the pumps exists on Site. | Medium |
| Repair variable suction-level components in pump pit. | Procedures would need to be developed. | Equipment needs would be determined after a design is completed. | Medium |
| Replace failed transfer pump motor (vertical turbine type only) while pump stays in place. | Procedures would need to be developed. This was a common practice in the 1970s and 1980s. | Equipment needed exists on Site. | High |
| Remove failed pump within 48 hours of the failure (per RAM analysis recommendations [HNF-5141]). Hardware needed to remove and replace a failed pump is part of this system. (Note: 48 hours is a small window in a much longer pump removal and replacement activity.) | Procedures are contained in work packages written for the pumps on a case-by-case basis.<br>Current conduct of operations takes significantly longer than the required response time. | Some equipment for pump removal exists on Site, and other equipment needs to be developed or fabricated. | Low |

**Table A-2. Double-Shell Tank Transfer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Decontaminate the pumps when they are removed from the tanks. ("A flexible receiver" and associated high-pressure water wash system will be provided for decontamination and containment of the transfer pump as it is retracted from the tank in preparation for final waste packaging.) | Procedures are contained in work packages written for the pumps as needed. | A "flexible receiver" system exists on Site for removing and decontaminating equipment removed from a tank. The system has been designed to handle long-length equipment that has a diameter of less than 1.27 m (50 in.).<br>So far, the system has been used only on smaller risers, when pulling instrument trees, etc. Plans are in work to assemble a team that will maintain and operate the system as needed. | Medium |
| Recover from transfer pump external leakage caused by excessive seal leakage. | Current practice is to remove and replace the pump. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Some equipment for removing and replacing the pump is available on Site, while other equipment still needs to be developed and/or fabricated. | Medium |
| Recover from transfer pump external leakage caused by corrosion/erosion. | Current practice is to remove and replace the pump. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Some equipment for removing and replacing the pump is available on Site, while other equipment still needs to be developed and/or fabricated. | Medium |

**Table A-2. Double-Shell Tank Transfer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from pump failing to start because of shaft not rotating. | Current practice is to flush the pumps and torque the shaft from above the pit until the pump is freed or fails. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment for torquing the shaft is available on Site unless the pump is a submersible type and must simply be removed. | Medium |
| Recover from failed variable-speed drive. | Current practice is to replace or repair the variable speed drive. Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment for replacing the variable-speed drive is available on Site. | High |
| Contain the pump in a "flexible receiver" when it is removed from a tank for normal and emergency conditions. | Procedures for using the flexible receiver are contained in work packages written for the pumps on a case-by-case basis. | A "flexible receiver" system exists on Site for removing and decontaminating equipment removed from a tank. The system has been designed to handle long-length equipment that has a diameter of less than 1.27 m (50 in.).<br><br>So far, the system has been used only on smaller risers, when pulling instrument trees, etc. Plans are in work to assemble a team that will maintain and operate the system as needed. | Medium |

**Table A-2. Double-Shell Tank Transfer Pump Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Provide hoses to the pumps during removal for flushing. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Hoses for flushing exist on Site. | Medium |
| Provide a method for dismantling, cutting up, removing, and packaging the pump and associated hardware for burial. | Procedures are contained in work packages written for the decontamination on a case-by-case basis. | Equipment has been used to dismantle and set up pumps in the past, but with the changing radiological standards and ALARA rules, much of the previously used equipment is now obsolete or cannot be used. | Low |
| Decontaminate the valve pits. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment exists on Site for decontaminating the valve pits. | High |
| Install and reconnect replacement pump. | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment exists on Site for the installation and connection of replacement pumps. | High |
| Recover from "air-bound" pump (i.e., suction hose kinks). | Procedures are contained in work packages written for the pumps on a case-by-case basis. | Equipment exists on Site for "blowing" water through a line to prime the pump. | Medium |

**Table A-3. Double-Shell Tank Transfer Piping Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Test leak detection system. | Specific procedures are issued and used. | Equipment for testing leak detection systems exists on Site. | High |
| Test and maintain cathodic protection where required. | Procedures exist for testing cathodic protection. | Equipment needed for testing and maintaining cathodic protection is available on Site. | High |

**Table A-4. Double-Shell Tank Transfer Piping Subsystem.**

| Recovery Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Remotely repair or replace the leak detector sensors within 8 hours of failure (per RAM analysis recommendations [HNF 5141]). | Procedures are written for repairing leak detectors on a case-by-case basis. The current practice may not require the repair to be done within 8 hours of the failure. | The equipment needed to remotely repair the leak detectors on Site is available. | Medium |
| Recover from a leaking pipe. | Abandon the pipe and use an alternate route. Drain the encasement. | Alternate routes need to be determined. | Low |
| Recover from a frozen (solidified with high-salt level) pipe. | Procedures for recovering from a frozen pipe are written as part of a work package on a case-by-case basis.<br>Past practice is to pressurize the pipe or attempt to dissolve the plug with a heated caustic solution. | The equipment needed to recover from a frozen pipe is available. | Medium |
| Recover from plugged (solids buildup) pipe. (A study may be needed to examine the probability of a plug and the best methods to unplug.) | Past practice is to pressurize the pipe or attempt to dissolve the plug with a heated caustic solution. | The equipment needed to pressurize or add a heated caustic solution exists. No other equipment such as a hydrolaser system is currently available. | Low |

**Table A-4. Double-Shell Tank Transfer Piping Subsystem.**

| Recovery Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Package (including size reduction) piping and components for burial. | Procedures for packaging are written on a case-by-case basis. | The equipment needed for packaging and size reduction is available on Site. | High |
| Provide a laydown area when removing and packaging piping components. | No dedicated laydown areas currently exist, but they are provided as needed. | Laydown areas are available as needed. | High |
| Access spare parts and install. | Procedures for accessing and installing spare parts are written as part of work packages as needed. | The equipment needed to access spare parts is available on Site. | Medium |

**Table A-5. Double-Shell Tank Transfer Valving Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Perform preventive maintenance on DST Transfer Valving Subsystem components located inside the pit (e.g., testing leak detectors). | Procedures exist for preventive maintenance of DST Transfer Valving Subsystem components. | Equipment needed to perform the preventive maintenance activities exists on Site. | High |
| Operate or stroke valves periodically. | This activity is performed with work packages as needed. | Equipment necessary for this activity is available on Site. | Medium |
| Perform calibration and periodic loop checks of sensing devices (e.g., sensors for the liquid level, flow and pressure switches, densitometers). | Procedures and equipment exist in the current system. | Equipment necessary for this activity is available on Site. | High |
| Inspect and test valve stops. Verify that there is no valve damage. | No procedures exist in the current system. | This equipment currently is not available on Site. | Low |
| Decontaminate the valve pits, including removing and replacing cover blocks. | Procedures are written as part of work packages when needed. | Equipment for performing this activity exists in the current system. | High |
| Remove standing water with a portable pump within transfer-associated structures. | Procedures are written as part of work packages when needed. | Sump pumps and hoses for performing this activity exist in the current system. | High |
| Recover from excessive internal leakage of valves through the valve seat or shutoff element. | Replace the entire jumper assembly. Procedures are written as part of work packages when needed. | Equipment needed to replace jumper assemblies is available on Site. | High |

**Table A-5. Double-Shell Tank Transfer Valving Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from external leakage of valve stems. | Replace the entire jumper assembly. Procedures are written as part of work packages when needed. | Equipment needed to replace jumper assemblies is available on Site. | High |
| Replace valve in a pit. | Replace the entire jumper assembly. Procedures are written as part of work packages when needed. | Equipment needed to replace jumper assemblies is available on Site. | High |
| Replace valve seat. | Replace the entire jumper assembly. Procedures are written as part of work packages when needed. | Equipment needed to replace jumper assemblies is available on Site. | High |
| Remove valve-operating devices, manifolds, and jumpers. | Procedures are written as part of work packages when needed. | Removal equipment is available on Site. | High |
| Remotely remove and replace components internal to transfer-associated structures. | Procedures are written as part of work packages when needed. | Equipment for remote removal and replacement of components internal to transfer-associated structures may or may not exist on Site. | Medium |
| Replace motor-operated valves. | Procedures are written as part of work packages when needed. | Equipment for replacement of motor-operated valves exists on Site. | High |
| Reduce the size and package the failed components. | Procedures are written as part of work packages when needed. | Equipment exists on Site for size reduction and packaging. | High |

**Table A-5. Double-Shell Tank Transfer Valving Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Provide laydown areas for valving system components and other long-length contaminated equipment. | Procedures are written as part of work packages when needed. | Laydown areas can be developed on Site as needed. | High |
| Recover from external leakage of components (pipes, valves, valve manifolds, and the attached hard jumper assemblies). | Current practice is to abandon leaking pipes and to replace entire jumper assemblies if a valve fails. Procedures are written as part of a work package as needed. | Equipment for jumper replacement exists on Site. | High |
| Recover from blocking caused by cooling of slurry material. | Past practice is to flush piping with high pressures or caustics. If flushing fails to clear a blockage, the entire jumper assembly is replaced. | Equipment exists for flushing or replacing jumper assemblies. | Medium |
| Replace slurry distributor (jumpers would need to be removed to gain access to the slurry distributor). | Procedures are written as part of work packages when needed. | Equipment exists for removing and replacing slurry distributors on Site. | Medium |

**Table A-5. Double-Shell Tank Transfer Valving Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Decontaminate slurry distributor. | Procedures are written as part of work packages when needed. | Equipment exists for decontaminating slurry distributors. | High |
| Replace failed leak detectors. | Procedures are written as part of work packages when needed. | Equipment exists for replacing failed leak detectors. | High |
| Access and install spare parts, including valve position switches, liquid-level sensing devices, jumper assemblies, valve manifolds, valve operators, valve reach rods, and components of the pit cooling systems internal to the transfer-associated structures. | A spare parts inventory is kept, but accessing it in a timely manner has been a problem in the past. | Better management of the spare parts inventory and better methods for getting parts to the field need to be developed. | Medium |

**Table A-6. Double-Shell Tank Utilities Subsystems.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Test raw water backflow preventer annually. | Current procedures exist for testing raw water backflow preventers. | The equipment required for testing backflow preventers is available on Site. | High |
| Maintain air compressor/dryers. | Current procedures for maintaining air compressors/ dryers exist on Site. | The equipment required for maintaining air compressors is available on Site. | High |
| Maintain electrical equipment (e.g., transformers, switchgear, variable-speed drives, backup power generators). | Current procedures for maintaining electrical equipment are available on Site. | The equipment required for maintaining electrical equipment is available on Site. | High |
| Change out potable water filters. | Current procedures for changing out potable water filters are available on Site. | The equipment required for maintaining potable water filters is available on Site. | High |
| Change out raw water strainers/filters. | Current procedures for changing out raw water strainers/filters are available on Site. | The equipment required to change out raw water strainers/ filters is available on Site. | High |
| Remove and replace components internal to transfer-associated structures (leaking valves, flow totalizers, strainers). | Procedures are written as part of work packages as needed. | The equipment needed to remove and replace failed components is available on Site. | High |

**Table A-6. Double-Shell Tank Utilities Subsystems.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from a failed backflow preventer. | Procedures are written as part of work packages as needed. | The equipment needed to remove and replace a failed backflow preventer is available on Site. | High |
| Recover from leaking raw water piping. | Procedures are written as part of work packages as needed. | The equipment needed to repair or replace raw water piping is available on Site. | High |
| Recover from failed raw water filters. | Procedures are written as part of work packages as needed. | The equipment needed to recover from failed raw water filters is available on Site. | High |
| Recover from failed instrument air filters and air dryers. | Procedures are written as part of work packages as needed. | The required equipment is available. | High |
| Recover from failed air compressor. | Procedures are written as part of work packages as needed. | The required equipment is available. | High |
| Recover from failed lights/photocells in the tank farm exterior and interior lighting system or closed-circuit television system. | Procedures are written as part of work packages as needed.<br>The process is difficult if the systems are permanent installations rather than temporary. | The required equipment is available. | Medium |

**Table A-6. Double-Shell Tank Utilities Subsystems.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from failed power. | Procedures are written as part of work packages as needed. | The required equipment is available. | High |
| Recover from failed safety class instrument air used for purging. | Procedures are written as part of work packages as needed. | The required equipment is available. | High |
| Access spare parts and install (transformers, motor control centers, variable-speed drives). | Procedures are written as part of work packages as needed. | The required equipment is available. | Medium |
| Decontaminate system components. | Procedures are written as part of work packages as needed. | Limited ability exists on Site to decontaminate or reduce the size of components for disposal. Current practices are manual and are labor/exposure intensive. Often equipment is replaced that could be repaired because there is no place to sufficiently decontaminate the item to repair it. This is a major deficiency. | Low |
| Reduce component size and package for decommissioning. | Procedures are written as part of work packages as needed. | The required equipment is available. | High |

**Table A-7. Double-Shell Tank Ventilation Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Calibrate effluent monitoring systems and continuous air monitors. | Procedures are available on Site. | Equipment to perform this activity is available on Site. | High |
| Calibrate ventilation instrument and control systems. | Procedures are available on Site. | Equipment to perform this activity is available on Site. | High |
| Test and clean filters. | Procedures are available on Site. | Equipment to perform this activity is available on Site. | High |
| Functionally test filtration trains and interlocks (demisters, compressors, heaters). | Procedures are available on Site. | Equipment to perform this activity is available on Site. | High |
| Perform predictive, preventive, and corrective maintenance on fans and motor-operated valves. | Procedures are developed as part of work packages as needed. | Limited predictive maintenance currently is being performed for tank farm equipment. More instrumentation and better procedures are needed to use predictive maintenance to improve equipment reliability. | Medium |
| Maintain record sampler. | Procedures are available on Site. | Equipment to perform this activity is available on Site. | High |
| Maintain high-efficiency gas absorber. | Procedures are available on Site. | Equipment to perform this activity is available on Site. | High |

**Table A-7. Double-Shell Tank Ventilation Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Maintain portable exhausters (not currently defined as part of the DST Ventilation Subsystem). | Procedures are available on Site. | Equipment to perform this activity is available on Site. | Medium |
| Recover from failed ventilation heater within 48 hours of the failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | Medium |
| Recover from failed high-efficiency particulate air filters (e.g., plugged, excessive differential pressure, hole). | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed ventilation inlet prefilter. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed fans. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed motor-operated valves. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed chillers. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed primary ventilation system isolation valves, dampers, and other system components. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed high-efficiency gas absorber. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |

**Table A-7. Double-Shell Tank Ventilation Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from failed high-efficiency mist eliminator. | Procedures are written as part of work packages as needed, but this has never been done before. | Equipment is available on Site. | Medium |
| Decontaminate ventilation pits. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Remove, decontaminate, cut up, dismantle, and package ventilation equipment. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Replace refrigeration components. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed ventilation duct. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed valve manifolds. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed heat exchangers. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed moisture separators. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failed demister. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Access and install spare parts. | Procedures are written for accessing spare parts as part of work packages as needed. | Facilities are available on Site. | High |

**Table A-8. Double-Shell Tank Process Water Sampling Subsystem.**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Maintain the sampling equipment. | Procedures are written for maintaining equipment as part of work packages. The current sampling truck is on an extensive preventive maintenance cycle that keeps it out of service for too long. | Maintenance facilities or management of current facilities needs to allow for quicker turnaround of sampling equipment. | High |
| Provide a facility to store and maintain the sampling equipment. | Procedures for storing and maintaining the equipment exist. | If sampling equipment that is new to the Site is required, then a new facility may be required as well.<br>The tight schedules for taking samples also may require that a facility be built closer to the tanks to provide faster access to the equipment. | Medium |
| Test and calibrate sampling equipment. | Procedures for testing and calibrating current sampling equipment are available. New procedures may need to be written if new equipment is procured. | The equipment needed to test and calibrate current sampling equipment is available. If new sampling equipment is procured it may require new testing equipment as well. | High |
| Recover severed or stuck drill strings. | Procedures are written as needed as part of work packages. | Two different systems exist for recovering stuck drill strings: internal mandrel and external jack. | High |

Table A-8. Double-Shell Tank Process Water Sampling Subsystem.

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Access spares and replace within the allowed time limit. | Procedures for accessing and replacing sampling equipment are written as part of work packages as needed. | Spare parts and the facilities to house them are available on Site, but the facilities are not necessarily in locations close to the tank farms and the parts are not always available or easily located when needed. | Medium |
| Provide the facilities and laydown areas needed. | Procedures for accessing and replacing sampling equipment are written as part of work packages as needed. | Laydown areas can be provided as needed. | High |

Table A-8. Double-Shell Tank Process Water Sampling Subsystem.

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Decontaminate drill strings. | Procedures for decontaminating drill strings are written as part of work packages as needed. The current practice is to unscrew the drill string in short sections and bag it out for disposal. There is limited ability on Site to decontaminate or reduce the size of components for disposal. Current practices are manual and are labor/exposure intensive. Often equipment is replaced that could be repaired because there is no place to sufficiently decontaminate the item to repair it. This is a major deficiency. | Limited equipment is available on Site for drill string decontamination. | Low |
| Provide an improved all-weather decontamination facility for sample trucks and systems. | Current decontamination facilities are not meeting sampling needs on a timely basis. Trucks are rotated through the decontamination and maintenance facility but are often out of service and not available when needed. | Adequate facilities (or trucks) are not available. | Low |

**Table A-9. *Double-Shell Tank Monitor and Control Subsystem.***

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Maintain DST Monitor and Control Subsystem. | Various procedures exist for performing preventive maintenance calibrations and loop checks. | Equipment is available on Site. | High |
| Calibrate or functionally test instrumentation (e.g., flow instruments, leak detectors, pressure instrumentation, temperature instruments). | Procedures exist on a case-by-case basis. | Equipment is available on Site. | High |
| Decontaminate tank waste intrusive rheology instruments. | A riser adapter with spray ring and special containers are used to store instruments to prevent contamination. | Equipment is available on Site. | High |
| Replace thermocouple tree within 24 hours of failure. | Some instruments on Site could be used to remove equipment through a riser, although this has not been done in an emergency situation (e.g., a mixer pump damages a tree). | Equipment is available on Site (internal mandrel and external jack). | Medium |
| Replace continuous air monitor vacuum pump within 8 hours of pump failure. | Work package is written as needed. Replace with a spare. | Equipment is available on Site. | Medium |

Table A-9. Double-Shell Tank Monitor and Control Subsystem.

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Replace flow instruments, leak detectors, pressure instruments, and temperature instruments within 8 hours of failure. | Work package is written as needed. | Equipment is available on Site. | Medium |

**Table A-10. Double-Shell Tank Diluent and Flush Subsystem (Caustic Addition).**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Provide chemicals (19 molar NaOH and 100% $NaNO_2$) by way of a caustic supply truck or caustic supply drums and the piping and connections up to the connection from the DST Diluent and Flush Subsystem. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Maintain metering pump. | Procedures are available on Site. | Equipment is available on Site. | High |
| Maintain supply pumps. | Procedures are available on Site. | Equipment is available on Site. | High |
| Maintain electric/steam heater. | Procedures are available on Site. | Equipment is available on Site. | High |
| Maintain valves/hoses. | Procedures are available on Site. | Equipment is available on Site. | High |
| Maintain instruments (e.g., flowmeters). | Procedures are available on Site. | Equipment is available on Site. | High |
| Recover from failed metering pump within 24 hours of failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | Medium |
| Recover from failed supply pumps within 24 hours of failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | Medium |

Table A-10. Double-Shell Tank Diluent and Flush Subsystem (Caustic Addition).

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Recover from electric or steam heater failure within 24 hours of failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | Medium |
| Recover from leaking of pipes, flexible hoses, and connections within 24 hours of failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | Medium |
| Recover from failed flow control and flow instrumentation, routing, and waste transfer isolation valves. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from valve position indicator failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from pressure instrument failure. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Recover from failure of a high-cost, one-of-a-kind component that is not maintained in spares. | Procedures are written as part of work packages as needed. | Equipment for recovery efforts may be available on Site. | Medium |
| Decontaminate system components. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Package (including size reduction) piping and components for burial. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |

**Table A-10. Double-Shell Tank Diluent and Flush Subsystem (Caustic Addition).**

| Maintenance Activity | Current Practice | Equipment Needs | Probability that Existing Systems and Procedures will Meet Waste Feed Delivery Needs |
|---|---|---|---|
| Provide a laydown area for removal of failed piping and components. | Procedures are written as part of work packages as needed. | Laydown areas can be provided on Site as needed. | High |
| Recover from failed sump pump. | Procedures are written as part of work packages as needed. | Equipment is available on Site. | High |
| Access and install spare parts. | Procedures are written as part of work packages as needed. | Facilities are available on Site. | High |

HNF-5141, 2000, *Reliability, Availability, and Maintainability Recommendations for the Design of Double-Shell Tank Components*, Rev. 0, Numatec Hanford Corporation for CH2M HILL Hanford Group, Inc., Richland, Washington.

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