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Revision 2

Double-Shell Tank Integrity Program Plan

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EXECUTIVE SUMMARY

The mission of the River Protection Project is to store, retrieve, treat, and dispose of the highly radioactive waste stored in the Hanford Site tanks; in an environmentally sound, safe, and cost-effective manner. The waste is contained in 149 single-shell tanks (SST) and 28 double-shell tanks (DST). These tanks are supported by ancillary systems and equipment (e.g., transfer piping, valve pits, and one miscellaneous tank 241-AZ-301), which allow the movement of the waste into, within, and out of the tank system. The 242-A Waste Evaporator facility, for concentration of waste, is also a part of the Hanford Tank Farm waste processing and storage facility.

The SSTs, located in 12 farms, were built between 1943 and 1964. In 1980, the U.S. Department of Energy (DOE) stopped adding new waste to the SSTs. A program for interim stabilization of the waste in SSTs was completed. This program pumped the maximum amount of drainable liquid from the SSTs to the DSTs. The 28 DSTs, located in six tank farms, were constructed from 1967 to 1986 and they provide greatly improved protection from leakage and better accessibility for inspection. However, since the DSTs and ancillary equipment are expected to exceed their design life before the DST waste is removed and sent to the Waste Treatment and Immobilization Plant (WTP), the DST Integrity Project (DSTIP) must ensure that the DST system can meet the RPP mission goals.

The DSTIP implements controls and inspections that ensure DST System integrity is maintained throughout the River Protection Project mission. In fiscal year (FY) 2006, the DSTIP completed the field work and documented the integrity assessment of the DSTs and ancillary equipment as *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) Milestone 48-14.[1] An Independent Qualified Registered Professional Engineer (IQRPE) certified this assessment and provided recommendations for future integrity work RPP-28538, *Double-Shell Tank Integrity Assessment Report HFFACO M-48-14*.

This program plan identifies all the DST Integrity Project activities. The work scope covered under this DSTIP Plan includes the following principal elements:

- DST integrity assessments (e.g., ultrasonic and video examinations) and documentation of results for use in periodic re-inspections.
- DST waste chemistry sampling and adjustments for corrosion mitigation, to ensure compliance with the Technical Safety Requirement 5.16, “Corrosion Mitigation Controls.”[2]
- DST waste chemistry corrosion optimization studies to quantify the best waste chemistry parameters to minimize DST corrosion.

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[1] *Hanford Federal Facility Agreement and Consent Order*, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

[2] HNF-SD-WM-TSR-006, 2006, *Tank Farm Technical Safety Requirements*, Rev. 5, CH2M HILL Hanford Group, Inc, Richland, Washington.

- Development and installation of in-tank corrosion probes for DSTs with new or revised corrosion control limits.
- DST structural analysis and studies for thermal, operating, and seismic loads.
- Periodic testing, evaluation, and certification of DST support equipment such as waste transfer lines, valve pits, etc.,
- Periodic testing and certification of the 242-A Evaporator Facility.

The DSTIP is a comprehensive program to ensure the continued viability of the DSTs to support the Hanford mission. Additionally, in this regard, the DSTIP activities also include facilitating Expert Panel workshops on all aspects of DST use and life extension, providing for modeling of DST waste and operational characteristics, and ensuring continued programmatic steering and advice from an Expert Panel Oversight Committee.

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TERMS

AC	administrative control
ALARA	as low as reasonably achievable
BNL	Brookhaven National Laboratory
CFR	*Code of Federal Regulations*
CHAMPS	Computerized History and Maintenance Planning System
CH2M HILL	CH2M HILL Hanford Group, Inc.
DOE	U.S. Department of Energy
DST	double-shell tank
DSTIP	Double-Shell Tank Integrity Project
Ecology	Washington State Department of Ecology
EN	electrochemical noise
EPOC	Expert Panel Oversight Committee
ER	electrochemical resistance
ESH&Q	environmental, safety, health, and quality assurance
FY	fiscal year
HAZ	heat-affected zone
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
IQRPE	Independent Qualified Registered Professional Engineer
JCO	Justification for Continued Operation
LAI	liquid-air interface
LPR	linear polarization resistance
NDE	nondestructive examination
OCP	open circuit potential
ORP	U.S. Department of Energy, Office of River Protection
OSD	operating specification document
RCRA	*Resource Conservation and Recovery Act of 1976*
RPP	River Protection Project
SCC	stress corrosion cracking
SST	single-shell tank
T-SAFT	tandem-synthetic aperture focusing technique
TSIP	Tank Structural Integrity Panel
TSR	Technical Safety Requirements
UT	ultrasonic testing
VSC	vapor space corrosion
WAC	*Washington Administrative Code*
WBS	work breakdown structure
WFO	Waste Feed Operations
WTP	Waste Treatment and Immobilization Plant

1.0 INTRODUCTION AND BACKGROUND

The mission of the River Protection Project (RPP) is to store, retrieve, treat, and dispose of the highly radioactive waste in Hanford Site tanks in an environmentally sound, safe, and cost-effective manner (BCR RPP-06-003, *Alignment of TFC Lifecycle Baseline for PBS ORP-0014 and PBS HQ-HLW-0014X*). Accomplishing the RPP mission requires providing and maintaining adequate tank capacity for waste storage and waste feed delivery. Thus, functional waste storage and transfer facilities are key assets for the RPP.

1.1 INTRODUCTION

To implement the Double-Shell Tank (DST) Integrity Project (DSTIP), CH2M HILL Hanford Group, Inc. (CH2M HILL) has used applicable regulations, U.S. Department of Energy (DOE) Orders and technical standards, and guidelines developed by expert panels for DOE. The regulations addressing the operation of Hazardous Waste tanks system under the *Resource Conservation and Recovery Act of 1976* (RCRA) are found in 40 CFR, *Protection of Environment*, which the State of Washington has been authorized to regulate through the Washington Administrative Code (WAC) for *Dangerous Waste Regulation* 173-303. The management of tank systems under DOE Orders is found within DOE O 435.1-1 Chg1, *Radioactive Waste Management*. DOE O 435.1 references the Brookhaven National Laboratory (BNL) expert panel work that was used for developing the guidelines for radioactive waste tank integrity programs and seismic analysis, as described below.

Concerns related to aging of radioactive waste storage facilities throughout the DOE complex led to BNL developing guidelines for structural integrity programs for tank systems (BNL-52527, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*). The committee of experts who developed these guidelines is commonly known as the Tank Structural Integrity Panel (TSIP). The DOE has subsequently adopted these guidelines, and requires site operators to have a program consistent with them (DOE M 435.1, *Radioactive Waste Management Manual*).

Structural integrity is defined in the TSIP guidelines as including leak tightness (barriers to release of waste) and structural adequacy (strength against collapse or failure from normal and abnormal loads). The TSIP guidelines advocate a systematic ongoing approach to assessing structural integrity as a basis for identifying necessary management options to ensure leak tightness and structural adequacy over the life of the mission.

The TSIP followed previous work at BNL, which dealt with seismic analysis of the DOE's high-level waste (HLW) tanks (BNL-52361, *Seismic Design and Evaluation Guidelines for the Department of Energy High-Level Waste Tanks and Appurtenances*). The DOE incorporated these guidelines into DOE STD-1020, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*, and the supporting technical documents for this standard. Hanford developed site-specific guidelines based on this work in WHC-SD-WM-DGS-003, *Structural Acceptance Criteria for the Evaluation of Existing Double-Shell Waste Storage Tanks (DSTs) Located at Hanford Site Richland Washington*.

1.2 BACKGROUND

The Hanford radioactive waste is contained in 149 single-shell tanks (SSTs) and 28 DSTs. These tanks are supported by ancillary equipment (e.g., transfer piping, valve pits, and one catch tank), which allow the movement of the waste into, within, and out of the tank system. The SSTs were built in 12 farms between 1943 and 1964 and were designed to hold between 50,000 and 1 million gallons of waste. The construction of the DSTs began in 1968 with the sixth farm being completed in 1986. All of the DSTs have a nominal million-gallon waste capacity.

Stress corrosion cracking (SCC) of the SSTs carbon-steel liners was the main factor causing the leakage of waste from the SSTs to the surrounding soil. This leakage led to a decision by the U.S. Atomic Energy Commission (predecessor to the U.S. Energy Research and Development Administration and subsequently the DOE) in the 1960s to initiate construction of DSTs with improved design, materials, and construction. The free liquids from SSTs have been transferred to DSTs as part of the SST interim stabilization program, which was completed in fiscal year (FY) 2005. Eventually, the remaining solids (i.e., sludge and salt cake) and interstitial liquid in the SSTs will also be retrieved and transferred to DSTs for subsequent processing and disposal; after that, the disposition of the SSTs will be take place per the applicable requirements.

The decision to remove waste from the SSTs and transfer the waste to DSTs is an example of a management option, as the term is used in the TSIP guidelines that could be warranted by tank conditions. At this point, the structural integrity program for SSTs is limited to ensuring that structural adequacy is maintained throughout SST waste retrieval and closure and as such, the SST integrity is not covered as part of the DSTIP.

1.3 DESCRIPTION OF THE DOUBLE-SHELL TANK SYSTEM

In addition to the 28 DSTs, the DST System includes the 242-A Evaporator, numerous valve and pump pits to allow transfer line connections, and 89 process lines, with an additional 39 lines required for tank farm operations, for a total of 128 credited lines. There is also one miscellaneous tank, 241-AZ-301, required for tank farm operations.

1.3.1 Double-Shell Tanks

The DSTs consist of a primary steel tank inside of a secondary steel liner, which is surrounded by a reinforced concrete shell. Between the primary tank and secondary liner is eight inches of refractory concrete. Both the primary tank and secondary liner are built of the same specification carbon steel. The primary tank of all DSTs was post-weld heat treated to minimize the possibility of any SCC failures.

1.3.2 Background History

The DSTs were constructed over a period of roughly 18 years (from 1968 to 1986), with a presumed design life of 20 to 50 years. Table 1-1 covers the construction dates, year of initial service, and the expected service life at time of construction. The DSTs were constructed to replace the single-shell tanks, some which had leaked or were suspected of leaking. The single-shell tanks had been constructed with only a projected 20-year life span. The DSTs were designed such that any potential leaks could be detected, the leaking waste would be held in the secondary containment, and corrective action taken long before there could be any release of waste to the environment. To date, none of the 28 of the DSTs has experienced waste leaks, and all the DSTs have been certified by the IQRPE as fit for service. Work continues to transfer all waste out of the SSTs into the DSTs.

Table 1-1. Double-Shell Tank Construction and Age.

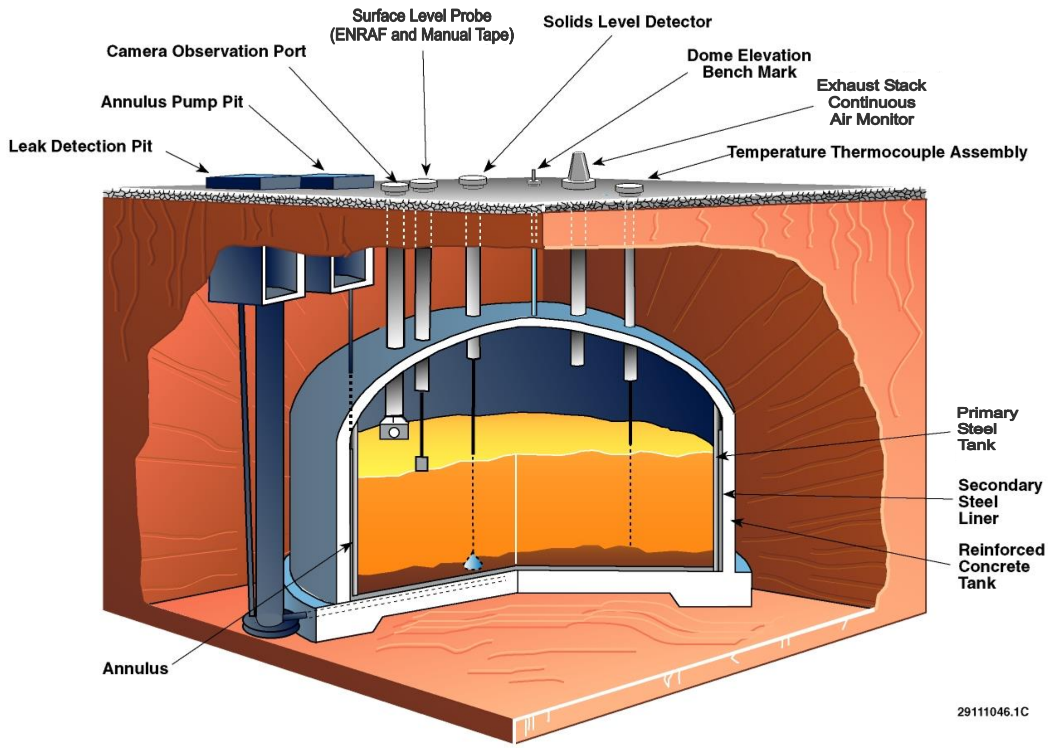
Tank Farm	Number of Tanks	Construction Period	Construction Project	Initial Operation	Service Life	Current Age
241-AY	2	1968 – 1970	IAP-614	1971	40	36
241-AZ	2	1970 – 1974	HAP-647	1976	20	31
241-SY	3	1974 – 1976	B-101	1977	50	30
241-AW	6	1976 – 1979	B-120	1980	50	27
241-AN	7	1977 – 1980	B-130, B-170	1981	50	26
241-AP	8	1982 – 1986	B-340	1986	50	21
Total	28					

1.3.3 Construction

Each DST consists of a primary steel tank inside of a secondary steel liner, which is surrounded by a reinforced-concrete shell. The primary steel tank rests atop an eight inch insulating concrete slab, separating it from the secondary steel liner, and providing for air circulation/leak detection channels under the primary tank bottom plate. An annular space of 2.5 feet exists in between the secondary liners and primary tanks, allowing for visual examination of the tank wall and secondary liner annular surfaces. The annular space also allows for ultrasonic volumetric inspections of the primary tank walls and secondary liners.

Each of the DSTs has between 59 and 126 risers penetrating the dome, providing access for video cameras, ultrasonic inspection devices, waste sampling devices, mixer pumps, and other equipment which requires access to either the primary tank interior or annular space. Above each DST (extending from grade to vary depths) are between three to five pits, which house valves and pumps. This equipment allows transfer of waste fluids and sludge from SSTs to DSTs, from DSTs to other DSTs, or from DSTs to other facilities (e.g., WTP).

Figure 1-1. Double-Shell Tank Construction.



1.3.3.1 Primary Tank

The primary tank of a DST is 75-foot in diameter, and measures approximately 46 feet and 9 inches in height at the dome center. The bottom of the primary tank consists of a 1-inch-thick steel plate, 4 feet in diameter in the center of the tank. The bottom plate thins to 0.375 inches at the interfacing weld and extends to a curved, formed section of a 0.875-inch-thick plate (or for 241-AP farm 0.938-inch), commonly referred to as the "bottom knuckle," consisting of a horizontal plate, curved section, and vertical plate known as the "bottom transition plate," also 0.875 inches in thickness. The primary tank vertical wall consists of either three or four vertical plates (courses), the courses are either 0.500-inch thick or for the bottom course in AP farm 0.750 inches thick. In the 241-AY, 241 –AZ, and 241-SY farms and, there are three plates that are approximately 10 feet in height; followed by a "top transition plate" that is approximately 3 feet in height. In the remainder of the farms, there are four plates that are approximately 8 feet in height. Finally, an inwardly curved section referred to as either the "top knuckle" or "haunch" joins the vertical wall with the roof section of the tank.

The entire primary shell rests atop an 8-inch-thick insulating concrete slab that separates it from the secondary shell. A radial pattern of air distribution and drain slots is formed into the concrete, to allow air circulation to cool the bottom of the tank and for any leakage from the primary tank to be directed into the annular space, where leak detection instrumentation is installed.

1.3.3.2 Secondary Liner

The secondary liner of a DST is 80 feet in diameter, and measures approximately 40 feet high. The tank bottom consists of 0.25-inch-thick steel plates, and connects to a bottom knuckle, also 0.25-inch thick. The bottom knuckle of the secondary tank also includes a small vertical plate, which connects to the vertical wall plates of the secondary liner. Four vertical plates form the wall of the secondary liner of the DST, between 0.25- and 0.375-inch thickness, which is topped by an inwardly curved secondary top haunch. The secondary haunch approaches the haunch of the primary tank at 460 inches. A small gap, from 0.5 inch to 1 inch in 241-AY tank farm and from zero to 1 inch in width in all of the other tank farms, exists between the two liners, which is overlapped by a series of 14-inches-wide, 18-gauge flashing strips. These strips are tack welded to the primary tank and extend approximately 4 inches past the secondary liner gap.

1.3.3.3 Concrete Liner

The concrete foundation of the DSTs is either 88 feet and 6 inches (for AY farm) or 89 feet 6 inches (for the remaining farms) in diameter, and is designed to uniformly distribute all loads. For the farms other than 241-AP, the center portion of the foundation is 2 feet thick and 3 feet in diameter. From the center, the bottom side of the foundation tapers to about a thickness of 1 foot, which then returns to 2-feet thick at the outer edge. The AP farm has no taper and the entire foundation is 2-feet thick. The foundations contain slots and drain lines to collect any leakage from the secondary tank. Any leakage from the bottom of the secondary liner is directed to a leak-detection well.

The outside of the concrete shell is 83 feet in diameter, and 1.5-feet thick, and rests on steel plates supported by the tank foundation. The dome of the concrete is 1.25-feet thick and is reinforced with steel rebar. Anchor bolts are threaded into studs welded to the secondary steel liner wall and the primary tank dome, after which the concrete is cast around the rebar and anchor bolts.

1.3.4 Risers, Pump Pits, Valve Pits

All DSTs are buried underground, the top of the concrete dome being located approximately 7 to 8 feet below the surface of the ground. The amount of ground cover increases out to the edge of the dome to more than 15 feet.

Steel riser pipes penetrate the concrete dome and the top of the primary tank and secondary liner. The risers provide access to the primary tank and the annulus space for waste transfer operations, equipment installation, and monitoring. The risers are located in covered pits or are located at grade level at specific locations above the pits.

Concrete valve pits located above the concrete dome provide access to the many cross-site pipes leading into and out of the tank farms that are used for transferring liquid waste between tanks. The pits are also used for structural support, allowing the use of large pumps and other equipment. The largest risers in the tanks lead to these pump pits. These pits are normally kept covered with large concrete blocks to prevent personnel exposure to radioactive materials.

1.3.5 242-A Evaporator

The 242-A Evaporator was built in 1976. It was based on the 242-S Evaporator and incorporated lessons learned from the earlier facility to improve design and operation of the facility. The evaporator is located north of the 241-AW tank farm. The 242-A Evaporator receives feed from DST 241-AW-102 for reducing the water content of the waste and then transfers concentrated waste to a number of receiving DSTs.

1.3.6 Waste Transfer System

The waste transfer system consists of a number of double-encased pipelines, pump and valve pits, pumps, jumpers, and valves.

1.4 RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) APPLICATION TO THE DOUBLE-SHELL TANK SYSTEM

The DSTs and ancillary equipment are considered active facilities under regulations stemming from the 1976 designations of the RCRA requirements. This law led to promulgation of regulations to specify the configuration and operation of hazardous waste treatment, storage, and disposal facilities under Title 40, *Code of Federal Regulations* (CFR), Part 265, Subpart J, "Tank Systems." The State of Washington is authorized to regulate such facilities. As such, the DST system must comply with Washington's "Dangerous Waste Regulations," *Washington Administrative Code* (WAC) 173-303-640. These regulatory requirements have similar objectives as the structural integrity program advocated in the TSIP guidelines. Thus, a tank structural integrity program consistent with the TSIP guidelines supports compliance with the regulatory requirements for the DSTs and ancillary equipment. The TSIP guidelines and comparison to the Hanford DSTIP are shown in Appendix A and environmental requirements are documented in RPP-16922, *Environmental Specifications Requirements*.

These regulations require integrity assessments of tank systems that store dangerous waste and determination by an Independent Qualified Registered Professional Engineer (IQRPE) as to whether the tank system is fit for use. Completion of the IQRPE integrity assessments (see Table 1-2) for the DST System is considered by the DOE and the Washington State Department of Ecology (Ecology) to have satisfied the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) Milestone M-48-00 ("Complete Identified Dangerous Waste Tank Corrective Actions, March 31, 2006").

In January 2001, CH2M HILL submitted a report to the U.S. Department of Energy, Office of River Protection (ORP) describing the elements of the RPP's tank structural integrity program, with recommendations for program implementation and control (external letter CHG-0000273, "Contract Number De-AC06-99RL14047; Strategy and Implementation of the River Protection Project Waste Tank Structural Integrity Program to Meet Performance Incentive ORP2.1.1 – Section 3, Standard X and Section 4, Standard X"). This report described the three major drivers for the tank structural integrity program (nuclear safety, environmental regulatory requirements, and programmatic mission needs). It also provided recommendations on how the tank structural integrity program elements supporting each of these drivers should be managed. The ORP concurred with these recommendations (CHG-5980, *River Protection Project Authorization Agreement Between the U.S. Department of Energy, Office of River Protection, and CH2M HILL Hanford Group, Inc.*).

Specifically, it recommended the following:

- Live loads on tanks continue to be controlled under Technical Safety Requirement (TSR) Administrative Control (AC) 5.14, "Dome Loading Controls" (HNF-SD-WM-TSR-006, *Tank Farm Technical Safety Requirements*).

- Waste chemistry to limit corrosion of DSTs be controlled under TSR AC 5.16 "Corrosion Mitigation Controls" (HNF-SD-WM-TSR-006).

- Environmental regulatory compliance elements be controlled under the environmental operating specification document (OSD-T-151-00031, *Operating Specifications for Tank Farm Leak Detection and Single Shell Tank Intrusion Detection*).

- Selected DST and SST operating parameters (e.g., waste height limits, differential pressure limits, etc.) continue to be managed or controlled under existing operating specification document (OSD-T-151-00007, *Operating Specifications* for *Double-Shell Storage Tanks*).

- Activities supporting decisions on DST replacement continue to be controlled under the RPP technical, cost, and schedule baseline management process.

In December 2001 the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) (Ecology et al. 1989) M-48 series of milestones was created from the Administrative Orders 00NWPKW-1250 and 00NWPKW-1251. The HFFACO M-48 Series was approved in January 2002 and is used by Ecology and ORP to establish and track completion of various tank integrity assessment activities for Hanford's DST system. To support the DST Integrity Assessment, the IQRPE prepared a planning document RPP-17266, *Plan for Development of the DST Integrity Assessment Report*, which identified how all of the elements of the M-48 series milestones would be completed.

The assessment of the DST system was completed in March 2006 (RPP-28538, *Double-Shell Tank Integrity Assessment Report, HFFAC0 M-48-14*). In conducting this evaluation, the IQRPE reviewed the DSTIP documentation pertaining to DST integrity and prepared several supplemental reports to document this evaluation. Table 1-2 shows the other supplemental reports prepared by the IQRPE to support the RPP-28538 DST System integrity assessment.

Table 1-2. Supplemental Reports Prepared by the Independent Qualified Registered Engineer.

RPP-27591	*Double-Shell Tank System Pipeline Integrity Assessment*	Contains design and condition assessment of the transfer lines.
RPP-27097	*Double-Shell Tank Waste Transfer Line Encasement Integrity Assessment Technology Study*	Contains a study of the feasible methods of assessing buried transfer lines for the purposes of future assessments.
RPP-25299	*IQRPE Assessment of the Cathodic Protection for Post-2005 DST Pipelines*	Assesses the cathodic protection systems in the tank farms.
RPP-25153	*Double Shell Tank Waste Compatibility Assessment*	Assesses the compatibility of material in contact – or potentially in contact – with the tank farm dangerous wastes.
RPP-22604	*IQRPE Evaluation and Documentation of DST Secondary Liner Issues*	Provides documentation of issues raised early in the assessment regarding the design of the secondary liners of the DSTs.
RPP-20556	*IQRPE Assessment of the Dome Load Program for Double Shell Tanks*	Documents the assessment of the tank farm dome load management program.

2.0 PROJECT STRATEGY

During DST design and construction, steps taken to prevent SCC included material selection, tank wall thickness, and post-weld heat treatment. Hanford personnel selected higher strength steels to build the DSTs as compared to that used for SST construction. The thicknesses of the primary tank walls were increased over the steel plate used in previous construction, to minimize operational stresses. Finally, to reduce residual weld stresses from construction [e.g., stresses in the heat-affected zone (HAZ)], the tanks were post-weld heat treated up to 1100 °F.

The DSTIP controls the chemistry of the waste in the DSTs to limit the propensity for corrosion to occur. In addition to this chemistry control program, the DSTIP conducts nondestructive examination (NDE) of the primary tanks and the secondary liners to detect any corrosion that may be occurring. Together these two programs provide a robust system for ensuring the continued leak and structural integrity of the DSTs.

In addition to this baseline set of programs, the DSTIP has initiated chemistry optimization testing, along with corrosion monitoring, to fully understand and improve corrosion mitigation in the DSTs. The chemistry optimization studies have built on the years of testing at Savannah River and Hanford to further identify the chemical composition ranges that minimize the propensity for localized corrosion. The in-tank corrosion monitoring looks for indications of incipient corrosion from in-tank sensors and provides for data correlation between laboratory testing parameters and actual tank chemistry environments.

The DOE provides requirements for tank integrity in Chapter II, “High Level Waste Requirements” of the Implementation Guide for use with DOE M 435.1-1 (DOE G 435.1-1). From page II-166, this guide requires that existing tanks have the following:

> *II. Q. (2) Structural Integrity Program.*
>
> *(a) Leak-Tight Tanks In-Service. A structural integrity program shall be developed for each high-level waste storage tank site to verify the structural integrity and service life of each tank to meet operational requirements for storage capacity. The program shall be capable of:*
>
> 1. *Verifying the current leak-tightness and structural strength of each tank in service;*
> 2. *Identifying corrosion, fatigue and other critical degradation modes;*
> 3. *Adjusting the chemistry of tank waste, calibrating cathodic protection systems, wherever employed, and implementing other necessary corrosion protective measures;*
> 4. *Providing credible projections as to when structural integrity of each tank can no longer be assured; and*

5. *Identifying the additional controls necessary to maintain an acceptable operating envelope.*

(b) *In-Service Tanks that Have Leaked or Are Suspect.* [These requirements don't apply to the DST System because there are no known or suspected leaks.]

(c) *Other Storage Components. The structural integrity of other storage components shall be verified to assure leak tightness and structural strength.*

DOE G 435.1-1 states that the BNL TSIP document provides the basis for an acceptable program:

> *BNL-UC-406, **Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks**, (referred to subsequently as "Guidelines") provides an acceptable process for establishing a structural integrity program. This set of Guidelines was finalized in January 1997 to promote the structural integrity of high-level waste storage tanks and transfer lines at facilities of the Department. In summary, the document lays out the essential elements of a structural integrity program. The procedures contained in the Guidelines provide an acceptable methodology to assess the structural integrity of existing tanks and to estimate the end of service life.*

These BNL guidelines, recommended by DOE, provide the basis for the CH2M HILL program. Appendix C contains a matrix that compares CH2M HILL's NDE program to the guidelines found in BNL-52527.

2.1 APPROACH FOR STRUCTURAL INTEGRITY VERIFICATION

Structural integrity verification is a two-step process consisting of data collection and data evaluation. The data required for verification of the structural integrity of a tank or piping system includes loading, geometry, and material properties (BNL-52527, Sections 2.2 and 7.2).

It is important to be able to extrapolate how far into the future tanks can be relied on to perform their waste storage function. To assess structural integrity for some point in the future, estimates of changes in postulated loading conditions (e.g., waste specific gravity), geometry (e.g., wall thinning caused by corrosion), and material properties (e.g., as affected by aging and degradation) are required. Therefore, evaluating structural integrity over the component mission life requires understanding of the historical data, past operating conditions, potential aging mechanisms, and degradation rates. Additional elements of a comprehensive tank system structural integrity program that are needed to ensure structural integrity over time include the following (BNL-52527, Sections 2.3 and 7.3):

- Identifying aging mechanisms
- Quantifying the degree of degradation
- Evaluating the effect of degradation on tank system integrity

- Verifying structural adequacy
- Considering management options.

2.2 LOADING CONDITIONS AND STRUCTURAL ANALYSIS FOR THE DOUBLE-SHELL TANKS

The DSTs were designed and constructed to maintain structural stability under a variety of load conditions. These loads include dead weight, hydrostatic pressure, soil pressure, soil overburden, equipment loads, thermal loads, positive and negative differential pressure loads, live loads, and earthquake loads. These calculations were originally done in support of the design and construction of the DSTs, but DOE considered it prudent to update the seismic guidelines for existing tanks, to ensure compliance with current requirements. As noted previously, the DOE employed BNL to develop methodology of performing structural analysis of existing tanks, which was documented in BNL-52361. These guidelines provided recommendations on structural analysis methodology, which were used in the Hanford site-specific criteria that specifies the loads required for verification of structural adequacy of tanks.

The site-specific design criteria are found in WHC-SD-WM-DGS-003, *Structural Acceptance Criteria for the Evaluation of Existing Double-Shell Waste Storage Tanks Located at the Hanford Site Richland Washington*, and specify many load combinations, and the allowable stresses for each load combination that must be considered. Finite Element Analysis models (ANSYS and Dytran) are being used to represent structural features and to calculate stresses at representative locations. These models include soil-structure interactions, concrete degradation and creep, and simulated worst-case operational cycling, to provide the DSTIP with ability to verify structural adequacy either for purposes of controlling loads on tanks or to estimate tank life expectancy as affected by degraded geometry or material properties. The DST structural analysis of record for the thermal and operating loads and seismic loads is documented in RPP-RPT-28968, which included updated seismic data derived from the latest WTP seismic analyses.

2.3 EXPERT ADVICE

Over the course of the DSTIP, advice and direction has been sought from numerous panels of outside experts (see Table 2-1), brought in to review the various aspects of DST integrity and operations. These panels date back to the BNL panel on seismic analysis for HLW tanks.

Table 2-1. Listing of Tank Integrity Expert Panels.

Expert Panel	Reference
Tank Structural Analysis	BNL-52361, *Seismic Design and Evaluation Guidelines for the Department of Energy High-Level Waste Tanks and Appurtenances*.
Tank Structural Integrity	BNL-52527, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*.
Double-Shell Tank Life Extension	PNNL-13571, *Expert Panel Recommendations for Hanford Double-Shell Tank Life Extension*
Electrochemical Noise	RPP-8416, *Final Report Technical Review Panel for EN Based Corrosion Monitoring of Hanford Double Shell Tanks*.
Double-Shell Tank Level Rise	RPP-19438, *Report of Expert Panel Workshop for Hanford Double-Shell Tank Waste Level Increase.*
Chemistry Optimization	RPP-RPT-22126, *Expert Panel Workshop for Hanford Site Double-Shell Tank Chemistry Optimization.*
Vapor Space Corrosion	RPP-RPT-31129, *Expert Panel Workshop on Double-Shell Tank Vapor Space Corrosion Testing*

3.0 DOUBLE-SHELL TANKS

The DSTs, each with a nominal capacity of 1 million gallons, are the major asset of the DST System. Though the other elements of the system are required for operation of the system, the loss of even a single DST would have a significant effect on the ability to meet mission requirements.

3.1 LEAK TIGHTNESS

For "non-enterable" underground waste tanks, the WAC 173-303-640 (2)(c) requires "a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects." For "other than non-enterable" underground tanks, this regulation requires either a leak test or other means of integrity examination as an alternative to a leak test "that is certified by an IQRPE, in accordance with WAC 173-303-810 (13)(a), "General Permit Conditions," that addresses cracks, leaks, corrosion, and erosion."

The DST liquid levels in the primary tank are monitored daily. Leak detection probes in the DST annuli are routinely monitored and continuous air monitoring of annulus ventilation exhaust is performed when ventilation systems are operating (OSD-T-151-00031). No other supplemental leak monitoring is needed for DST leak integrity determinations.

3.2 IDENTIFICATION OF AGING MECHANISMS

Numerous methods of degradation can reduce the integrity of carbon steel and concrete structures. For the primary tank and secondary liners, the three primary types of degradation that can occur are the following:

- Thinning of the walls by general corrosion that could lead to structural failure.
- Pitting of the walls that could lead to through-wall leaks.
- Stress corrosion cracking that could lead to through-wall leaks.
- Liquid-air interface (LAI) corrosion that could lead to accelerated thinning and pitting of the tank wall at an existing or previous waste surface.

The TSIP guidelines identify a number of aging mechanisms that have the potential to cause degradation in tank systems. Their significance depends on tank-specific conditions and plausible failure modes. The TSIP guidelines recommend that "in order to produce a realistic and cost-effective program" only those aging mechanisms that would be expected to cause significant degradation for the tank-specific conditions and that affect the likely failure modes should be included in the tank structural integrity evaluation.

3.2.1 Aging Mechanisms for Double-Shell Tank Primary Tanks

The tanks have three main areas of vulnerability to corrosion: the interior surfaces of the primary tank exposed to the headspace air, the interior surface of the primary tank wall in contact with the waste, and the exterior surface of the primary tank wall exposed to the annulus air or water intrusion. These surfaces are subject to corrosion from general chemical attack, pitting, and stress corrosion cracking and may also be vulnerable to other more specialized forms of attack as the tank ages.

WHC-SD-WM-ER-414, Rev. 0, *Hanford Waste Tank System Degradation Mechanisms,* indicates that localized pitting and concentration cell corrosion caused by the formation of localized regions of aggressive waste are the most threatening degradation mechanisms for the DST primary tanks.

The most significant form of corrosion found to date in the DST system is LAI corrosion (see Table 3-1). The LAI corrosion occurred when out of specification waste was left at a static level in the tank for years at a time. Fortunately, this LAI corrosion usually occurs high up on the tank wall, in an area of the tank that has low stress. As such, this corrosion does not present a challenge to structural integrity, but could challenge the leak integrity of the tanks.

Table 3-1. Liquid-Air Interface Corrosion In Double-Shell Tanks.

Tank	Report	Comments
AN-102	RPP-8698	Waste surface was constant at approximately 400-inch level for 20 years leading to waterline corrosion. Pits of 59 mils and 89 mils were observed between 0-59.28 cm (0-23.34 inch) from top of plate 1.
AW-101	RPP-7018	The waste level was constant at approximately 400-inch level for 19 years. Horizontal weld scan of plate 1 indicated 48 mil of pitting.
AW-102	RPP-11581	The waste level at 375-380 in. for 5 years. The measured minimum of 0.49-inch at 382.6-inch level.
AY-101	RPP-11169	The waste level was constant at 343 in. for at least 8.5 years. At the time of UT examination, the minimum average thickness was 0.51 in. with a maximum pit depth of 101 mils.
AZ-102	RPP-15765	The waste level was between 330-370 inches for at least 17 years. Wall thinning of plate 2 observed in this range of heights. Exceeded 10% criterion for the minimum measured 367-379 inch levels exceeded 10% criterion.
SY-101	RPP-18444	These reportable indications in plate #1 have been attributed to waterline corrosion near the previous waste surface, which was fairly constant (at an average level of 407 inches) from 1981 to 1996.

No clear evidence of LAI corrosion was observed in the remaining DSTs examined ultrasonically.

DST = double-shell tank.
LAI = liquid/air interface.
UT = ultrasonic testing.

The TSIP guidelines identified concentration cell or waterline corrosion and corrosion of external tank surfaces by in-leakage as potentially significant mechanisms for steel tanks. The DSTs do not have stagnant water in contact with the external tank surface; this is not considered a problem area. However, tank interior waterline corrosion at the liquid-air interface remains a matter of concern particularly because a reaction with the carbon dioxide in the dome air space depletes hydroxide at the waste surface. Corrosion of the secondary tank external surface by the groundwater table in-leakage is not a concern because the DSTs are above the water table. However, since water intrusion has been observed through the top of the annuli in 241-AY tank farm, the source of this water and its impact on the tanks is under investigation.

The DST integrity assessment reports also differentiate between general (uniform) corrosion at tank surfaces in contact with waste and general (uniform) corrosion at tank surfaces in contact with the atmosphere in the interior of the primary tank and in the annulus region. The DST integrity assessment reports consider both to be potentially significant.

3.2.2 Aging Mechanisms for the Double-Shell Tank Secondary Liner

Under normal operation, the aging mechanisms for the secondary liner are the same as those for exterior of the primary tank. During leak events from the primary tank to the secondary liner, the lower knuckle of the secondary liner would be the area of highest stress. The reinforced concrete backs the liner on the side wall and base of the liner, but at the lower knuckle there is no concrete backing to the liner. Therefore, this portion of the secondary liner is load bearing.

3.2.3 Aging Mechanisms for the Double-Shell Tank Reinforced Concrete

For the reinforced-concrete portions of waste storage tanks, the TSIP identified elevated temperature, freezing and thawing, leaching of calcium hydroxide, aggressive chemical attack, and corrosion of reinforcing steel as potentially significant aging mechanisms. The latter four mechanisms are not of concern because the reinforced concrete structural elements of DSTs are below ground, above the water table, and not in contact with tank waste. However, the effects of periods of elevated temperature caused by heat-generating waste needed to be modeled.

Effects of elevated temperature on degradation of structural properties of reinforced concrete were addressed in the finite element modeling used for the RPP-RPT-28968, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads*. All of the DSTs concrete temperatures to date are well within design limits and should have had no significant effect on degradation of material properties. However, since initial operations with high temperatures in the four aging waste tanks (AY and AZ tank farms) indicated possible significant structural effects, the integrity assessment reports for the "bounding DST" (i.e., worst-case DST) used maximum operating conditions and cycles to predict the temperature effects on material properties and aging.

Another concern it the level of liquid in the leak detection pits. If the level in these wells is too high, the concrete collection slots underneath the secondary liner would have water in contact with concrete. Work has been initiated to lower the allowable liquid level in these pits.

3.3 CORROSION MITIGATION

The TSR AC 5.16, "Corrosion Mitigation Controls" (HNF-SD-WM-TSR-006), requires that the waste be maintained within specification for hydroxide and nitrite concentration for a given nitrate ion concentration. If waste is not maintained within the specification, the propensities for pitting and SCC are increased. These types of degradation have the possibility to affect the leak integrity of the tanks.

Waste chemistry can be adjusted via waste transfer or chemical addition. Before waste transfers or chemical additions, waste samples are evaluated to characterize the end-state chemistry requirements of the waste to be adjusted and waste compatibility. Waste transfers to adjust chemistry will typically occur from tank to tank using the DST system infrastructure (e.g., pumps, pits, valves, and piping systems).

Chemical adjustments typically will occur by additions from a tanker truck, via an above ground transfer system. The DST chemical adjustments typically are accomplished using direct or gravity feed injection through an above-ground riser. An adjustment also could occur by adding chemicals with a mixing process using a transfer or mixer pump. This ensures that more immediate mixing of the waste occurs.

To ensure compliance with TSR AC 5.16, the DSTs will be sampled in accordance with RPP-7795, *Technical Basis for the Chemistry Control Program*, and RPP-8532, *Double-Shell Tanks Chemistry Control Data Quality Objectives*, to identify those tanks that are either out of specification or approaching specification boundaries. These documents require that all DSTs be sampled at least once every 5 years. The amount of solid material contained in a DST will determine whether a grab sample or a core sample will be taken. If a tank contains less than 64 cm (25 inches) of solids, a grab sample will be taken at the surface of the waste, or at multiple levels if stratification is suspected. If a tank contains greater than 64 cm (25 inches) of solids, a core sample will be taken, which includes sampling both supernate and solids regions. Analysis of the samples will be performed in accordance with RPP-8532.

Though not part of the DSTIP AC 5.13, *Bulk Chemical Addition Controls*, provides an additional level of protection for the DST's integrity. To prevent, the reaction of incompatible chemicals AC 5.13 requires that all liquids added to the DSTs have a pH 7 or higher. This requirement is controlled by performing field-testing of the chemical for pH, prior to the addition material to the DSTs. If the measured pH is less than 7, the operation is halted, and the shift manager is notified.

3.3.1 Waste Chemistry Control

Laboratory work performed at the Pacific Northwest National Laboratory on simulated waste stored in Hanford Site tanks (PNL-5488, *Prediction Equations for Corrosion Rates of A-537 and A-516 Steels in Double Shell Slurry, Future PUREX, and Hanford Facilities Waste*) and work performed at the Savannah River Laboratory on Savannah River Site waste and DP-1478, *Prediction of Stress Corrosion of Carbon Steel by Nuclear Process Liquid Wastes,* led to the establishment of present waste chemistry controls to minimize DST corrosion and the risk of tank failure from general corrosion, pitting, or stress corrosion cracking.

The basic principles of corrosion protection are as follows:

- Use appropriate materials of construction and techniques (e.g., stress relieving)
- Set appropriate chemistry limits

- Operate within chemistry limits
- Perform periodic in-service inspections to verify structural and leak integrity.

The selection of tank materials was fixed at the time of construction (i.e., ASTM A-515, A-516, and A-537 steels) and is no longer a variable to protect against corrosion. The DSTs were all post-weld heat treated during construction to relieve welding stresses.

DST chemistry controls are specified in terms of limits on nitrate, nitrite, and hydroxide concentrations. TSR AC 5.16 (HNF-SD-WM-TSR-006) was developed in March 2001 to incorporate the waste chemistry limits formerly in the OSD, so that specific actions are mandated if the chemistry falls out of specification. This administrative control implements the chemistry control program.

Waste transfers or caustic/nitrite additions to DSTs are utilized to adjust waste chemistry to meet the specified chemistry limits. However, chemical changes can occur during waste storage. Hydroxide concentrations in tank waste are affected by ongoing chemical reactions with organics in the waste and with reaction from carbon dioxide in the vapor space. These reactions generally deplete the free hydroxide concentration with time. Reaction rates for these hydroxide consumption mechanisms increase with increasing temperature. Hydroxide depletion caused by reaction with carbon dioxide generally is more pronounced near the waste surface. Out-of-specification conditions generally are corrected by blending during planned waste transfers. Occasionally, caustic addition has been necessary to raise the pH level in DST waste (00-OSD-108, Attachment 4, "Summary of Corrosion Inhibiting Chemical Adjustments for Double-Shell Tanks").

3.3.2 Chemistry Control Technical Safety Requirements Recovery Plans

The TSR, AC 5.16, requires actions be taken to either maintain or restore the proper levels of hydroxide and nitrite ion concentrations for given concentrations of nitrate ions in DST waste. Waste found outside the chemistry limits for corrosion control requires a TSR recovery plan identifying activities to restore the chemistry to within limits (see Tables 3-2 and 3-3).

Table 3-2. Double-Shell Tanks Closed TSR Recovery Plans and Justification for Continued Operation (JCO) to Comply with AC 5.16, Corrosion Mitigation Controls.

Double-Shell Tank	TSR Recovery Plan or JCO Opened	TSR Recovery Plan or JCO Closed	Comment
241-AN-107	July 2002	April 2007	Chemistry optimization testing showed low propensity for pitting and SCC with the existing composition, and installed Integrated Multi-Purpose Corrosion Probe as defense in depth, letter CH2M-0502867 R5.
241-AZ-102	December 2002	March 2006	Core sample to show that the interstitial liquid complied with AC 5.16, letter CH2M-0303434 R22.
241-SY-102	December 2003	June 2005	Chemistry restored to AC 5.16 limits, letter 04-TED-113.

Table 3-3. Double-Shell Tanks Open TSR Recovery Plans to Comply with AC 5.16, Corrosion Mitigation Controls.

Double-Shell Tank	TSR Recovery Plan or JCO Opened	Comment
241-AN-102	June 2003	Chemistry optimization testing showed low propensity for pitting and Stress Corrosion Cracking (SCC) with the existing composition. Passive corrosion probe to be installed in FY 2008, and the TSR limits changed at that time.
241-AP-105	August 2007	CH2M HILL to resolve by concentrating dilute supernatant and blending with concentrated waste in AP-104.
241-AY-101	June 2007	CH2M HILL to resolve by chemistry optimization testing and installation of a passive probe, or installation of waste mixing capability.
241-AY-102	August 2003	CH2M HILL to resolve by chemistry optimization testing and installation of a passive probe, or installation of waste mixing capability.
241-AY-101 and 241-AY-102	February 2007	CH2M HILL to develop an evaluation report for remediation of the corrosion from annulus side water intrusion.

3.4 NONDESTRUCTIVE EXAMINATION OF DOUBLE-SHELL TANK SYSTEM INTEGRITY

For each potentially significant aging mechanism, examination or testing may be warranted to quantify the degree of degradation that already may have occurred. Ideally, degradation would be quantified in terms of changes in geometry or material properties. Qualitative examination (e.g., visual inspection) also may provide useful information.

In addition to visual examination and leak testing, Ecology's guidance on tank system integrity assessment [Publication 94-114, *Guidance for Assessment and Certifying Tank Systems that Store and Treat Dangerous Waste* (Ecology 1994)] identifies ultrasonic examination, radiography, liquid penetrant examination, and magnetic particle examination as acceptable test methods. To satisfy as low as reasonably achievable (ALARA) principles, remote applications of such methods are required in hazardous environments. Ultrasonic examination using robotic equipment and other remotely controlled techniques has been demonstrated successfully and used effectively for components of the DST System.

3.4.1 Visual Examination

Ecology Publication 94-114 identifies external and visual inspection as acceptable tank examination methods. Visual examination of tanks by remote video camera has been demonstrated to provide valuable information for assessing tank conditions and to support deployment of remotely operated NDE equipment.

The DSTs are examined visually for conditions both inside the primary tank (above the waste level) and on the annulus surfaces of the primary tank and secondary liner, using remote video equipment during planned periodic visual assessments. The present approach for conducting visual examinations of DSTs is to perform a video examination of each tank's interior and annulus regions in conjunction with the tank's ultrasonic examination inspection or approximately every 5 years (not to exceed 7 years between inspections) whichever occurs first.

The Tri-Party Agreement M-48 series milestones required submittal of a plan for conducting video examinations in the interior of the DST primary tanks. This plan was approved and incorporated into Tank Farm Operating Procedure TO-020-142, *Video Examination of DST Interiors, DST Annuli and Exposed Waste Transfer Piping*. This tank video plan was revised in FY 2002 and submitted to Ecology [02-TOD-03, "Submission of an Updated Plan for Examination of Double-Shell Tanks (DST) Contained in Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-48 Series, M-48-05"] and approved by Ecology.

Visual examinations will be conducted under the following conditions:

- Visual examinations will be performed, as much as possible in conjunction with periodic scheduled ultrasonic testing, approximately every 5 years (not to exceed 7 years between inspections).
- Visual examinations of selected regions will be performed when ultrasonic testing of the primary tank walls exhibit conditions or indications requiring additional assessments.
- The primary tank interior should be visually inspected following complete pump-down of the tank to view previously inaccessible surfaces that have not been documented for at least 5 years.

The primary tank's interior visual examination (including the dome space) will be performed through one of the primary tank's risers; the primary tank annulus side wall and secondary liner annulus visual examination will be performed via four of the annulus risers located so that a near 360-degree visual examination is conducted. These DST visual examinations (completed in 2006) established a baseline that will be used for comparison for future planned reexaminations. The visual baseline information is documented in the Tank Integrity Inspection Guide (TIIG). The TIIG contains photographic information of notable indications (areas of interest) and specifies their location on each DST, as well as showing the tank regions examined by UT.

To develop a TIIG, a variety of information is used, which includes previous inspection results, construction drawings, certified vendor information, etc. The information provided by the construction drawings provides the ability to pinpoint the location of the vertical welds along the primary and secondary walls of the DST. This mapping process is then linked with the steel plate data to form the TIIG.

Figure 3-1 represents an example of the inspection map section of the TIIG while Figure 3-2 represents an illustration of the information in the guide section of a TIIG. These figures are annotated with descriptions for each item. These example figures can be used as a template for understanding the TIIGs. Each item of interest has been mapped and is given a unique tank specific photo identification number, which enables the region to be identified and explained in the TIIG.

Figure 3-1. AN Tank Integrity Inspection Map Example.

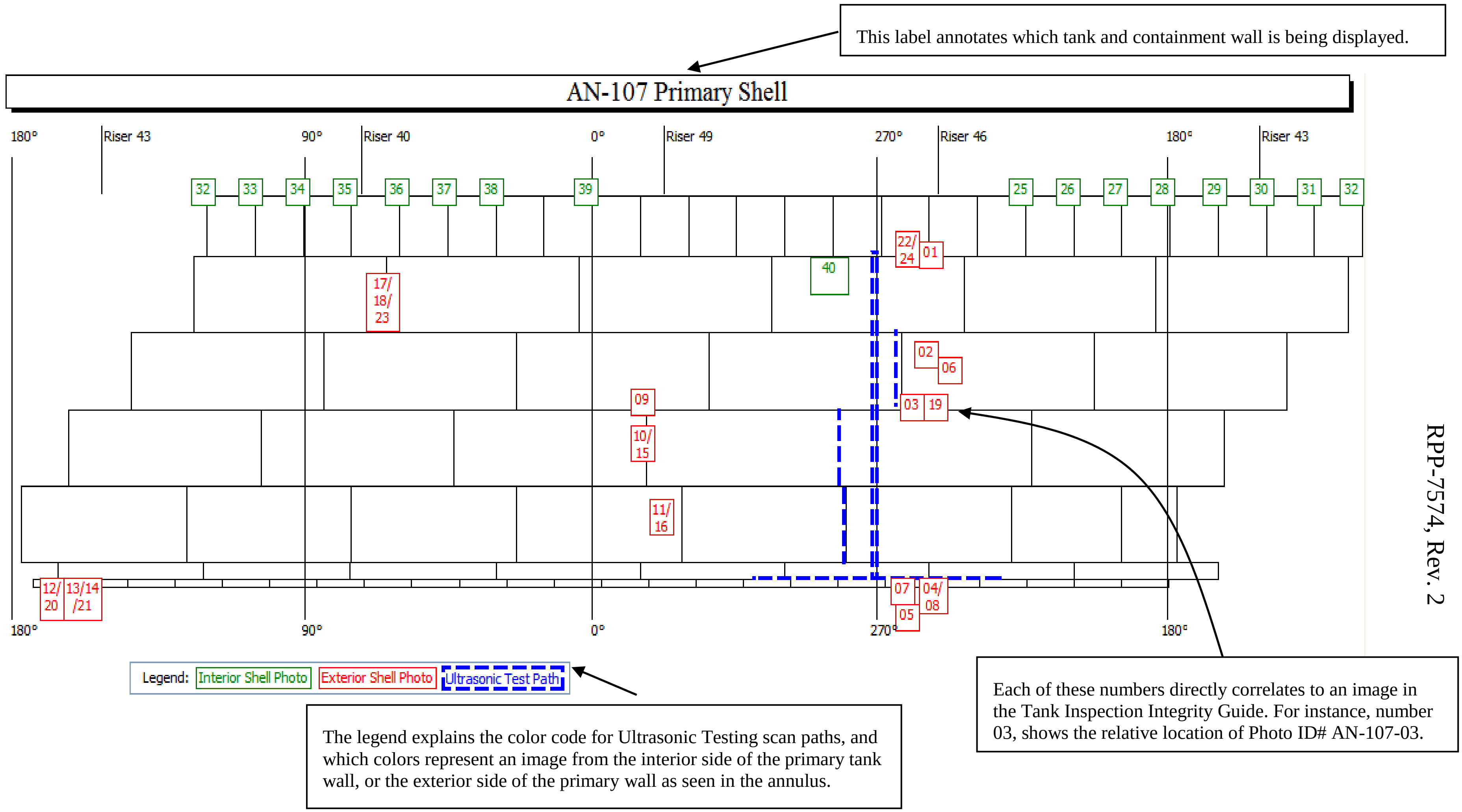


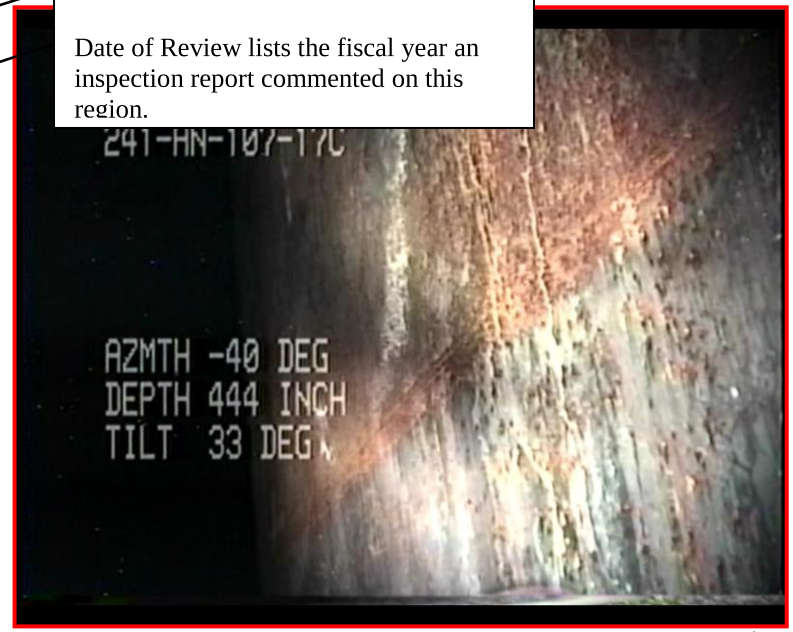
Figure 3-2. AN Tank Integrity Inspection Guide Example.

The Photo ID is the number used to identify the picture and relevant data. The first five characters (i.e. AN-107) identify which tank the photo is from, while the last two digits of this number (i.e. 03) are used to correlate this entry with the Tank Integrity Inspection Map.

Date of Inspection lists the date the video inspection was performed.

Date of Review lists the fiscal year an inspection report commented on this region.

Photo ID:	AN-107-03
Date of Inspection	5/19/1992
Date of Review	FY2006
Location	Exterior of primary tank shell, along Courses 3 and 2, joining bottom edge of primary shell plate F7301M2 number 5A and primary shell plate F7301M2 number 5B. Riser 46.
Description	DVDID# 10258
	Corrosion along circumferential weld joining Course 2 and 3. Noticeable corrosion product directly above weld continues up to Course 1. Possible surface condensation on the outside of primary shell has accelerated corrosion along this area.



The Description and Location fields give a verbal description of the area of interest and how to locate it, respectively.

The DVDID# is the reference number used to identify the DVD from which the photo was taken. The number represents the number of the DVD stored in the Visual Inspection Archive

Shipping Mark	*Heat #*	*Ingot & Cut*	*Nominal Thickness*	*Nominal Length*	*Nominal Width*
F7301M2	3G5922	0400C	0.500	471.25	92.75
F7301M2	3G5922	0600C	0.500	471.25	92.75

Details indicate wall plate data taken from the Certified Material Test Reports.

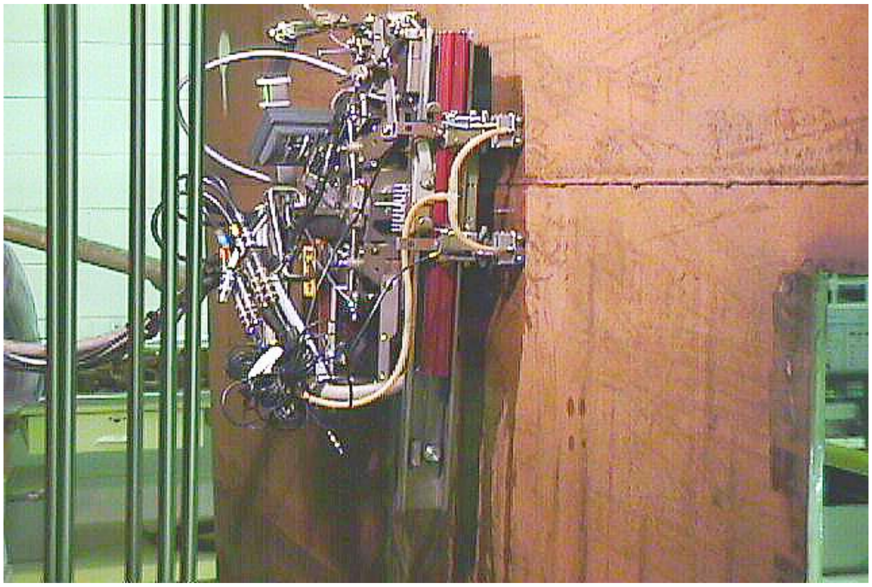
Color photo of area of interest.

3.4.2 Ultrasonic Testing Examination of Double-Shell Tanks

The DSTIP uses ultrasonic testing (UT), with remote robotic crawlers, to examine the DSTs for thinning, pitting, and cracking. This type of inspection provides a volumetric examination of the metal examined. The examinations are performed using a crawler that holds the transducers to conduct the examination.

The crawler is remotely controlled device and delivers the ultrasonic transducers to the tank walls. The crawler used during most Pulse-echo ultrasonic inspection (P-scan) imaging is shown below in Figure 3-3. The traveling bridge on the crawler can be outfitted with various ultrasonic transducer configurations. The crawler system is deployed through a 24-inch annulus inspection riser using customized deployment tools. Water is used as the couplant (to maintain contact between the transducer and metal) and it is continuously fed to all transducers at a rate needed to maintain an acceptable signal.

Figure 3-3. P-scan Crawler System on Tank Mock-up.



The P-scan[3] system is manufactured by FORCE Technology. It acquires data from zero and angle beam transducers mounted on the crawler. FORCE Technology has designated "P-scan mode" to represent the angle beam (flaw length) view and "T-scan mode" to represent the zero beam (thickness) view. T-scan mode is used for normal operation and, if crack-like indications are detected, then the P-scan mode is employed.

During normal T-scan and P-scan operations, the waveforms of the reflected sound wave signals for each transducer are displayed in the "A-scan monitoring mode." The displays are

[3] P-scan is a trade name used by FORCE Technology, Brøndby, Denmark.

continuously monitored, but not saved. The A-scans are primarily used to verify that the transducers are functioning properly (e.g., there is proper probe contact, adequate water flowing, and correctly operating transducer cables). When an indication is detected, the area is rescanned using the "A-scan recording mode," and serve as an additional tool in the evaluation of the indication.

3.4.2.1 Ultrasonic Testing Inspection Performance

Tank inspections are performed under the Computerized History and Maintenance Planning System (CHAMPS) generated work packages. All work steps, guidelines, procedures, personnel responsibilities, and protocol for the inspection prepared by CH2M HILL in annual updates, which are included or referenced in a work package. The AREVA NC Inc. procedure that establishes the methods, equipment and requirements for the P-scan imaging system UT measurements and flaw detection is COGEMA-SVUT-INS-007.3, *Automated Ultrasonic Examination for Corrosion and Cracking*.

Generally, ultrasonic examination of DSTs through FY 2000 followed the recommendations in Chapter 5, "Nondestructive Examination (NDE)," of the TSIP guidelines. In 1997, members of the TSIP reviewed the ultrasonic examination results for the first DST examined, Tank 241-AW-103, presented in HNF-SD-WM-TRP-282, *Final Report: Ultrasonic Examination of Tank 241-AW-103 Walls*. Deviations to TSIP guidelines resulting from these examinations were analyzed by the TSIP members and were determined to be acceptable.

Ultrasonic examination of the all 28 DSTs were carried out in accordance with the HFFACO Milestone M-48 Series, and the baseline measurements were completed in 2005. The examination scope required under the Tri-Party Agreement M-48 series milestones was as follows:

- Thirty-inch wide vertical scan of the primary tank wall for all DSTs.
- Twenty-foot length of circumferential weld joining the primary tank vertical wall to the lower knuckle and adjacent heat-affected zone for all DSTs.
- Twenty-foot length of vertical weld joining shell plate courses of the primary tank, extended as necessary to include at least one foot of vertical weld in the nominally thinnest wall plate and adjacent heat-affected zones for all DSTs.
- Twenty-foot long circumferential scan at a location in the vertical portion of the primary tank wall corresponding to a static liquid/vapor interface level that existed for any 5-year period, extending at least 1 foot above that liquid/vapor interface for six DSTs.
- Twenty-foot long circumferential scan of the predicted maximum stress region of the primary tank lower knuckle for six DSTs.
- Primary tank bottoms in each accessible air slot over a length of 10 feet toward the center of the tank from the lower knuckle joint for six DSTs (including Tank 241-AN-107, which was examined in FY 1998). Due to potential damage of the insulating concrete

slab air slots and equivalent information gleaned from the lower knuckle examination, this requirement was deleted in 2005, as agreed to by Ecology.

The TSIP guidelines provided criteria for thinning, pitting, and cracking, which when detected would require further evaluation of a tank's integrity by a Tank Inspection Assessment Panel. The DSTIP uses those criteria and have adopted a second set of reportable values, which are half of the TSIP criteria. If the UT results are less than the reportable values, no evaluation/reporting is required.

Table 3-4. Ultrasonic Testing Evaluation Guidelines and Reportable Values.

Parameter	Tank Structural Integrity Panel's Evaluation Guidelines	Double-Shell Tank Integrity Program Reportable Value
Thinning	20% thickness	10 % thickness
Pitting	50% thickness	25 % thickness
Cracking	>12 inches 20% of thickness ≤12 inches 50% of thickness	Any detectable crack

In addition to this scope, ultrasonic examinations of the secondary tanks were performed on three DSTs, in accordance with the TSIP guidelines. Repeat examinations will be conducted on an interval not to exceed 10 years through the operating life of the DSTs. See Appendix B for the specific examination and frequency requirements for each DST.

3.4.2.2 Examination of Tank Walls and Knuckle

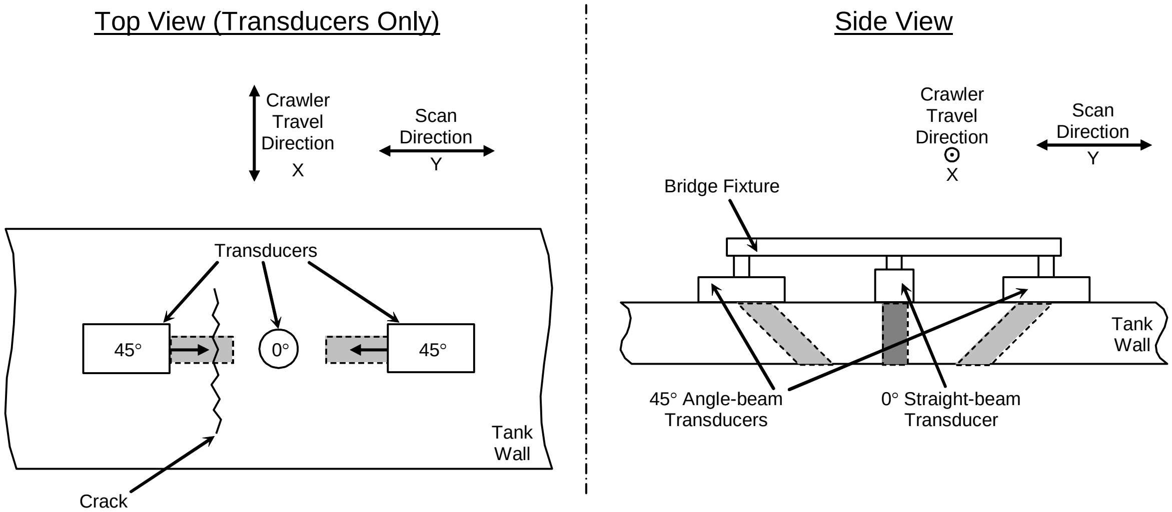
The P-scan crawler inspects the primary tank vertical walls using one dual-element 0° transducer to detect wall thinning and corrosion pitting, and two 45° shear-wave transducers to detect cracking transverse to the scanning direction. This examination setup is illustrated in the Figure 3-4 schematic.

3.4.2.3 Examination of Welds

The examination of the welds and HAZ actually consists of angle beam examinations in the HAZ. The welds are not directly examined since the physical weld bead configuration (weld bead contour or crown) does not permit transducer placement on the weld. The DSTs were not designed or fabricated for in-service inspection, and therefore the weld crowns were not prepared for examination (i.e., ground flat).

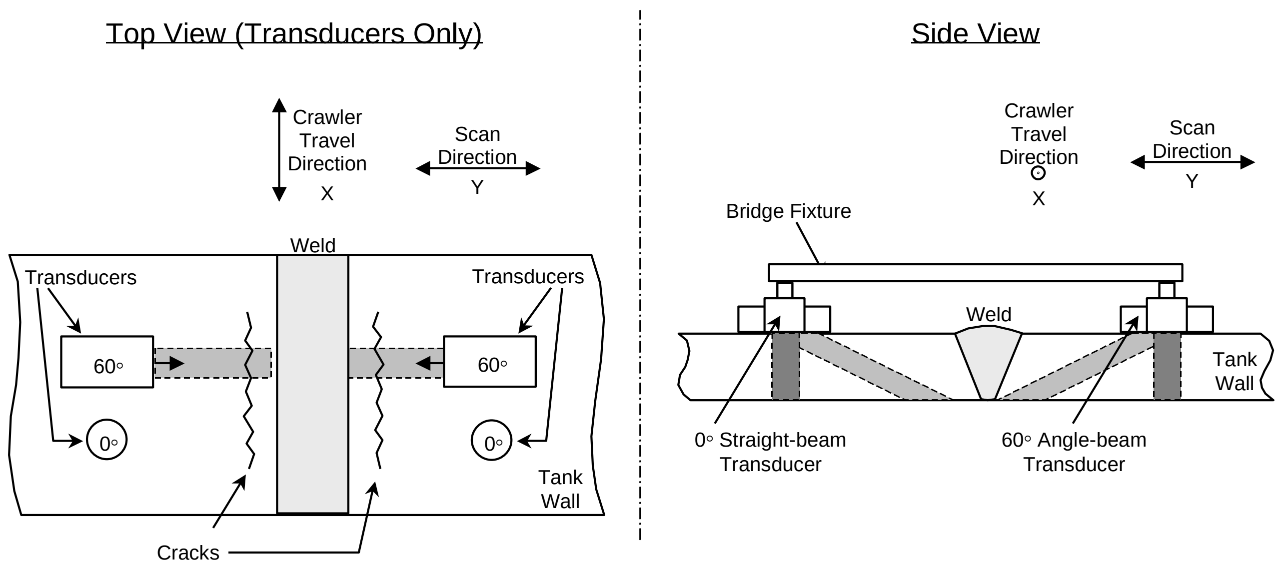
To detect cracks parallel to the weld, a 60°-shear-wave transducer is directed toward the weld and a dual-element 0° transducer is also included to detect wall thinning and corrosion pitting (Figure 3-5). The examination of the HAZ using 60°-angle beams does provide some coverage of the actual weld metal, through to the inside surface.

Figure 3-4. Schematic of UT Setup for Vertical Wall Scan Inspections.



Vertical Wall Scan Inspection Setup – Uses two 45° Transducers and one 0° Transducer (Inspect for Wall Thinning, Pitting and Axial Cracks)

Figure 3-5. Schematic of UT Setup for First Pass of Weld Inspections.



First Pass of Vertical and Horizontal Weld Inspection – Uses two 60° Transducers and two 0° Transducers (Inspect for Wall Thinning, Pitting and HAZ Cracks Parallel to the Weld)

To detect cracks oriented perpendicular to welds, two opposing 45° shear-wave transducers are directed parallel to the weld. Welds were examined from both sides of the weld crown

(Figure 3-5). For example, in a previous UT examination, a "lack of fusion" between weld passes (i.e., internal to the weld) was identified (RPP-13802, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-103*).

3.4.2.4 Tandem-Synthetic Aperture Focusing Technique

Structural analysis indicates that the most highly stressed region of the lower knuckle, which would be most susceptible to stress corrosion cracking, is from the middle to lower part of the knuckle. The HFFACO Milestone M-48-02 Series required the development of technology for examining the lower knuckle. The flexible extended arm for the AWS-5d crawler was selected, tested, and was deployed in FY 2002. Also, during FY 2003, technology development was completed for the tandem-synthetic aperture focusing technique (T-SAFT) for lower knuckle examination. The T-SAFT was successfully deployed, and was used for knuckle examination starting in December 2002.

3.5 CORROSION MONITORING IN DOUBLE-SHELL TANKS

The DSTIP has monitored corrosion for many years in several DSTs using Electrochemical Noise (EN), which was developed as a DOE technology initiative. Additional sensors were installed that monitor tank corrosion potential (E_{corr}), and general corrosion with Linear Polarization Resistance (LPR) and Electrical Resistance (ER). Additionally, stressed and unstressed corrosion coupons to monitor SCC were also explored. As the corrosion monitoring project progresses, with guidance from the Expert Panel Oversight Committee (EPOC), the approach for in-tank corrosion monitoring will use a tailored approach for selected DSTs.

The work to date has identified two groups of tank in the DST system: active and inactive. Active tanks that are subject to relatively frequent changes in their chemical conditions may require a more robust monitoring program than passive tanks in which the chemical composition remains relatively static. Evaluation of the use of more passive systems (i.e., stressed and unstressed coupons) in conjunction with E_{corr} measurements and Electrical Resistance probes is under consideration. A prototype of such a system is scheduled for installation in tank AN-102 in 2008.

Development and adaptation of in-tank corrosion monitoring technology has been under way at the Hanford Site to provide better understanding of corrosion mechanisms in DSTs and to support more effective control of tank waste chemistry to minimize corrosion. Table 3-5 summarizes the program efforts to date.

Table 3-5. Double-Shell Tank Corrosion Probe Installations.

Number	Tank	Dates in Tank	Design
1.	241-AZ-101	August 1996 to present	Prototype Electrochemical Noise (EN) System
2.	241-AN-107	September 1997 to August 2001	First generation Full-Scale EN System, which was removed in August 2001 and was forensically examined.
3.	241-AN-102	August 1998 to present	Second Generation Full-Scale EN System
4.	241-AN-105	January 2000 to present	Third Generation Full-Scale EN System
5.	241-AN-104	January 2001 to present	Fourth Generation Full-Scale EN System
6.	241-AN-107	August 2001 to September 2006	Fourth Generation Full-Scale EN System, which was removed in September of 2006 and was forensically examined.
7.	241-AN-107	September 2006 to present	Integrated Multi-Function Corrosion Probe, which Electro-Chemical Resistance, Linear Polarization Resistance, EN, and Reference Electrodes.

Table 3-6. Double-Shell Tanks with Planned Corrosion Probe Installation.

Number	Double-Shell Tank	Proposed Installation Date Fiscal Year	Comment
1.	241-AN-102	2008	New passive probe array with reference electrode (Ecorr) test array and electrical resistance sensors.
2.	241-AY-102	2009	New passive probe with Ecorr sensors.
3.	241-AN-107	2010	Replacement for active portion of the Integrated Multifunction Corrosion Probe.
4.	241-AY-101	2010	New passive probe with Ecorr sensors.

3.5.1 Electrochemical Noise

Any gross corrosion process is the sum of many stochastic electrochemical corrosion events, which can be measured as random fluctuations in corrosion current and corrosion potential between electrodes. These fluctuations are known as electrochemical noise (EN). For many years, EN has been observed during corrosion and other electrochemical reactions, and the phenomenon is well established. Typically, EN consists of low-frequency (<1 Hz) and small-amplitude signals that are spontaneously generated by electrochemical reactions occurring at corroding or other surfaces. Laboratory studies and recent reports on field applications have reported that EN analysis is well suited for monitoring and identifying the onset of localized corrosion and for measuring uniform corrosion rates (RPP-25244, *Integrated Multi-Function Corrosion Probe: Laboratory Assessment and Baseline Data Generation*).

3.5.2 Electrical Resistance

In the case of general corrosion, the electrical resistance (ER) technique is a proven technology and is the most common technique used in a variety of industries to monitor corrosivity. It can be used in the air, liquid, or at the liquid-air interface (LAI). In the latter case, a floating electrode or some other method would be required to position the ER probe at the interface. This technique operates by measuring the change in electrical resistance of a metallic element immersed in solution relative to a reference element sealed within the probe body. Since temperature changes can have an effect on the resistance of both the exposed and protected element equally, measuring the resistance ratio minimizes the influence of changes in the ambient temperature. Therefore, any net change in the resistance ratio is solely attributable to metal loss from the exposed element once temperature equilibrium is established.

The ER technique is less effective for monitoring pitting corrosion, especially where the pits have large depth to diameter aspect ratios. This technique is generally not considered to be a true continuous monitoring technique because measurable metal loss must occur for the technique to register a corrosion rate. Therefore, the technique is sometimes referred to as a semi-continuous monitoring technique.

3.5.3 Linear Polarization Resistance

The general corrosion rate can be estimated from the linear polarization resistance (LPR) using the Stern-Geary equation ("Electrochemical Polarization: A Theoretical Analysis of the Shape of Polarization Curves" [Stern and Geary 1957]). Polarization resistance may in some circumstances provide less reliable estimates of the general corrosion rate, either because of a poor estimation of the Tafel slopes (*Zeitschrift für Physikalische Chemie* [Tafel et al. 1905]) (constants in the Stern-Geary equation [Stern and Geary 1957]) or the presence of redox reactions in complicated electrolytes that contribute an electrochemical current but are not related to corrosion. However, laboratory measurements with actual waste have found the technique to be applicable for use in DSTs (RPP-25244).

3.5.4 Reference and Surrogate Reference Electrodes

The DSTIP has undertaken a program to find surrogate reference electrodes to measure the open circuit potential (OCP) also known as the free corrosion potential (E_{corr}) in the DSTs. Laboratory testing accomplished for the Tank Waste Chemistry Optimization Expert Panel work has shown a strong dependence between the value of the OCP/E_{corr} and the propensity for pitting and cracking corrosion by waste simulants. Safe regions of Ecorr values are known, and as such, the ability to measure the OCP/E_{corr} in DSTs would be a key parameter to ensure the long-term integrity of the DSTs. The typical approach to measuring the OCP/E_{corr} is to monitor potential in a chemical environment versus a reference electrode.

The design of available reference electrodes does not allow for continued operation in DSTs for extended periods of time because of the fragile nature of these laboratory instruments. Testing at the direction of the EPOC has shown the importance of monitoring the E_{corr} in the DSTs and therefore has led to the need to develop a robust method for gathering this data. A preliminary screening program identified six potential surrogate electrodes, which will be tested in-tank in the probe assembly for AN-102.

3.5.5 Probe Deployment Strategy

As noted, the probe strategy has developed over the course of experimentation using laboratory simulants. The initial approach proposed has been modified based on the results of that testing.

3.5.5.1 Non-Active Tanks

Tanks with a stagnant chemical composition do not need a wide range of corrosion monitoring devices. These tanks would receive an ER probe and an E_{corr} monitoring electrode, along with a passive array of stressed and unstressed corrosion coupons. Readings from the ER probe and E_{corr} would be taken on a periodic basis. The coupons would be removed from the DST and examined for signs of corrosion on a specified basis.

3.5.5.2 Active Tanks

Tanks with changing chemical compositions may be equipped with the above array for static tanks, plus it may be desirable to add additional active corrosion monitoring probes such as LPR or EN. Active tanks would include the 241-AW-102 (the evaporator feed tank) and the DSTs that receive SST waste (e.g., 241-AN-101 and 241-SY-102). Readings from all of the instruments could be done on a real-time basis, or frequent manual readings. Corrosion coupons installed in the tank would also be removed on a specified periodic basis to look for signs of corrosion. The EPOC will make recommendations regarding probe design and deployment, which will be evaluated for tank farm implementation.

3.5.6 Chemistry Optimization Testing

The optimization of chemistry control was initiated in FY 2005. This work implements a number of the recommendations from RPP-RPT-22126. To date testing has been concluded on tanks 241: -AN-107 and 241-AN-102. Testing is ongoing for tanks 241-AY-101 and 241-AY-102. This testing has been key to identifying appropriate corrosion probe parameters for monitoring tank conditions.

The testing for 241-AN-107 and 241-AN-102 was conducted with laboratory simulants representative of the waste in these two tanks using metal specimens made from material similar to the DST metal walls, RPP-RPT-31680, *Hanford Tanks 241-AN-107 and 241-AN-102 Effect of Chemistry and Other Variables on Corrosion and Stress Corrosion Cracking*. This testing showed that if a pH 10 is maintained in the saltcake interstitial solution, the chemistry composition and open circuit potential (OCP or Ecorr), present in the tanks, led to a low propensity for SCC to occur in the tanks. This low propensity for SCC was attributed to nitrite present in the waste. Further testing was recommended to explore the degree of this phenomenon.

The testing for 241-AY-102 is coming to completion in September 2007. This testing was conducted in a fashion similar to approach used for the other DSTs. The results from this testing showed a low propensity for SCC in tank than as compared to the 241-AN-107 and 241-AN-102 testing. In addition, the pitting potential in this tank was reduced in comparison to the other waste simulant. The decrease in pitting was attributed to the concentration of total inorganic carbon present in the waste.

3.5.7 Waste Corrosion Potential Measurement

In FY 2002, a laboratory-based procedure was developed to perform electrochemical corrosion testing on DST waste obtained from core samples. The test procedure is patterned after ASTM procedure G5-94, *Standard Reference Test Method for Making Potentiostatic and Potentiodynamic Anodic Polarization Measurements*.

The test procedure is designed to evaluate the corrosion potential of the carbon steel wall in the knuckle-region of the DST where the sludge is in contact with the wall. Sample collection, sample extrusion, and the electrochemical corrosion testing are performed while maintaining the waste under anaerobic conditions like those found in the bottom of the tank. The tests use potentiodynamic polarization scans to establish such factors as open circuit potential, Tafel constants, polarization resistance, and passivation regions. These parameters are used to determine corrosion rates and assess whether carbon steel similar to that used in the DST construction is susceptible to aggressive corrosion mechanisms when in contact with the waste under tank storage conditions. Cyclic polarization measurements also can be performed to evaluate the propensity of the steel to undergo pitting in the waste environment.

The corrosion potential tests as required by RPP-7795 are performed primarily on DST sludge that does not meet the AC 5.16 chemistry control limit. However, the procedure can be employed to evaluate the corrosion characteristics of liquid waste as well. Future application of this corrosion potential testing will establish a baseline for DST waste not meeting the AC 5.16 limits and periodic reanalysis if sampling shows the waste remains outside the chemistry control limits beyond the time frame expected for mixing to occur following a chemical adjustment to the tank waste.

3.5.8 Electrochemical Corrosion Rate Measurements

To assist in the evaluation of the DST integrity, electrochemical corrosion measurements can provide the general corrosion rate for a tank. These measurements should be made during the same year as the UT measurements for the tank to allow comparison of the two techniques. The electrochemical corrosion rate measurements should be made using waste samples from the tank and metal coupons made for the same alloy as the tank. These measurements were made recently on the six tanks UT as part of the M48-15 Milestone (RPP-RPT-34697, *Electrochemical Corrosion Report for Tanks 241-AW-103, 241-AZ-102, 241-AN-106, 241 AN 107, 241 AY-101, and 241 AY-102*).

Corrosion is a process involving electrochemical oxidation and reduction reactions. When a metal is immersed in a given solution, electrochemical reactions characteristic of the metal-solution interface occur at the surface of the metal causing the metal to corrode. These reactions create an electrochemical potential called the corrosion potential (E_{CORR}) or the OCP measured in volts at the metal-solution interface.

At E_{CORR}, the rate of oxidation is exactly equal to the rate of the reduction process, and the system is in equilibrium. If a potential is imposed on the metal specimen, other than E_{CORR}, the specimen is polarized. This polarization results in the oxidation or reduction reaction to become predominate at the metal surface, giving rise to a current. The current can be related to the rate of the electrochemical reactions.

Potentials positive to E_{CORR} will accelerate the oxidation reaction creating an anodic current and is displayed with a positive polarity. Potentials negative to E_{CORR} will accelerate the reduction reaction and create a cathodic current displayed with a negative polarity. Only the total current can be measured at the metal specimen. At E_{CORR}, the total current equals zero because the anodic and cathodic currents flow in opposite directions. By polarizing the specimen in a systematic manner and measuring the resulting current, the value of cathodic and anodic currents can be determined at E_{CORR}. These polarization measurements are the basis for electrochemical corrosion studies.

3.5.9 Vapor Space Corrosion

The concerns for DST vapor space corrosion (VSC) arose from notable VSC in some Savannah River Site tanks and some apparent VSC tank wall thinning at Hanford. Additional VSC concerns arose when tank primary ventilation ducting exhibited cracking and deposits (WHC-SD-WM-TI-478, *Evaluation of Cracking in 241-AZ Tank Farm Ventilation Line*). While the apparent Hanford VSC wall thinning turned out to be an artifact of the measurement (RPP-RPT-27467, *Supplemental Ultrasonic Inspection Results for Double-Shell Tank 241-AN-105 FY-005*), there has been concern for DST corrosion at the liquid waste surface level or “waterline,” known officially as the LAI.

Ultrasonic testing measurements are done at long-term LAIs and in accessible plates above the waste. DST visual examinations show many areas of rusting in the interior dome. However, uncertainty of the initial plate conditions and the effect of unihibited hydrotest water resident during the construction of the DSTs make interpretation difficult. Actual measured VSC corrosion rate, from probe coupons in the AN-107 vapor space (4 years), was ~0.1 mil per year.

Vapor space corrosion is only of concern for those areas of the DSTs that may at some time be wetted by tank waste. This type of corrosion has not had an impact on the operational or safety aspects of DST waste storage to date. This phenomenon is being investigated to quantify potential dome degradation that could lead to structural issues. However, understanding VSC is important relative to being able to optimize waste chemistry controls to minimize all corrosion in the DSTs. As such, a VSC program is underway to

a. Identify vapor components that are likely to be the main concern in causing or contributing to VSC (e.g., ammonium nitrate) and those that may inhibit such corrosion (e.g., ammonia).

b. Explore the effects of waste chemistry changes (e.g., pH) on VSC and/or derive experimental or calculational methods to analyze the importance to VSC.

c. Explore any methods and approaches that might allow accelerated laboratory testing for VSC and LAI corrosion, such as is presently being accomplished for waste chemistry testing by slow strain rate tests (e.g., effect of present and changed tank waste chemistry).

Based on the results of the VSC program and the subsequent laboratory test results, waste chemistry requirements may be further changed to minimize VSC.

4.0 PIPING SYSTEMS

4.1 AGING MECHANISMS FOR DOUBLE-SHELL TANK SYSTEM TRANSFER PIPING

For waste transfer piping, the TSIP guidelines recommend focusing only on potentially significant aging mechanisms. External pipe corrosion is identified as the predominant failure mechanism. An important contributor to pipe corrosion failure is the lack adequate cathodic protection. The TSIP guidelines regard the following aging mechanisms as irrelevant for piping:

- Thermal embrittlement
- Radiation embrittlement
- Creep/stress relaxation
- Fatigue
- Erosion
- Wear
- Hydrogen embrittlement
- Stress corrosion (except potentially in austenitic stainless steel or at welds in carbon steel.

4.2 VISUAL EXAMINATION OF WASTE TRANSFER PIPING

The Tri-Party Agreement M-48 series milestones required submittal of a plan for conducting video examinations of the exterior of underground piping that is exposed during construction or other activities. This plan was approved and incorporated into RPP-16922, *Environmental Specifications Requirements*.

The following criteria, as good DSTIP management practice, will be applied as the basis for determining when DST transfer piping video data will be collected.

- A length of pipe at least equal to five times the nominal diameter must be exposed.
- No equipment, components, or other items will be removed specifically to obtain video data of DST System transfer piping.
- The collection of all DST transfer piping video data shall be performed in consonance with ALARA) principles.

4.3 LEAK TESTING OF WASTE TRANSFER PIPING

Waste transfer piping is periodically leak tested (see Appendix C) in accordance with OSD-T-151-00010, *Operating Specifications for Pressure Checking of All Direct Buried and Cross-Site Transfer Lines*; TO-140-170, *Pressure Testing of Process Pipelines and Pipe-in-Pipe Encasements*, and RPP-16922, *Environmental Specifications Requirements*.

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Periodic integrity testing of certified pipelines as listed in Appendix C, but only the secondary piping of the double-contained piping, will be tested. Presently, the integrity assessments utilizes pressure testing to determine pipeline integrity. However, some new technologies are being evaluated (e.g., long-range ultrasonic testing), and may be used for future determinations.

5.0 242-A EVAPORATOR

The 242-A Evaporator System at Hanford is utilized to concentrate radioactive waste by removing water content. Portions of the 242-A Evaporator System must be assessed to meet the requirements of the permit WA 7890008967 under the WAC 173-303-640. The assessment is limited to the provisions of Section 173-303-640 (2) for assessment of existing tank system integrity. This assessment is performed on a 10-year cycle, following the FY 2007 work.

The DSTIP is responsible for the integrity assessment, specified in RPP-PLAN-32530, *IQRPE Integrity Assessment Plan for the 242-A Evaporator System and PC-5000 Process Condensate Transfer Line*, as follows:

- Visual inspection of the vapor-liquid separator, reboiler, condenser, and all accessible pipelines, pumps, instruments, valves and flanges.
- UT inspection of the 242-A Evaporator at 2042 test points at 18 locations (945 UT points in the Evaporator Room, and 1107 UT points in the Condenser Room).
- Hydrostatic testing of the 242-A Evaporator vessel.
- Pressure leak testing of the PC-5000 transfer line, vapor-liquid separator subsystem and condensate collection subsystem.

6.0 241-AZ-301 CATCH TANK

Tank 241-AZ-301 (AZ-301) was installed as a replacement for the old catch tank 241-AZ-151; however, its mission is slightly different. Whereas tank 241-AZ-151 collected drainage from other pits and condensate, AZ-301 is only used to collect condensate from the primary tank exhaust system for the aging waste tanks: 241-AZ and 241-AY tank farms. This condensate is potentially contaminated through migration of radioactively contaminated material into the exhaust system, which can be suspended in the vapor space of the tanks and may be drawn into the exhaust system through the action of airflow

The leak tightness of this catch tank must be verified annually. Liquid-level monitoring data and data from leak detection instruments may be documented and used for the assessment of leak tightness and compliance with the leak test requirement for this tank RPP-16922, *Environmental Specifications Requirements*.

7.0 BASELINE

As part of the RPP planning process, work breakdown structure (WBS) dictionary sheets and milestone description sheets have been prepared. The DSTIP charter is to provide all deliverables associated with the Tri-Party Agreement M-48 milestones and actions to maintain and improve the longevity of the DST system. A summary baseline schedule is included as Appendix B. A summary baseline budget by WBS Element and fiscal year is included as Appendix C.

This work scope includes project management, engineering studies, and field execution activities.

a. DSTIP management

b. DST System integrity assessments

c. Preparation of an integrity assessment report for the DST System in accordance with WAC 173-303-640(2), and Tri-Party Agreement Milestone Series M-48

d. Generic (non-tank-specific) activities supporting DST system integrity assessment (e.g., training and nondestructive examination procedure/operator qualification, services of the independent qualified registered professional engineer)

e. DST structural analysis in support of the DST integrity assessment report and periodic updates (10-year cycle)

f. NDE equipment procurement and development

g. DST periodic annulus and primary video examinations

h. Project management activities supporting DST chemistry addition and corrosion mitigation field activities

i. Integrity testing and certification of pipelines

j. Nondestructive testing and certification of the 242-A Evaporator facility (10-year cycle)

The previous and remaining Tri-Party Agreement milestones are listed in Table 7-1.

Table 7-1. Tri-Party Agreement Milestones Remaining.

Milestone	Description	Due Date
M-048-11	Submit Results of four DSTs Not Previously Examined	09/30/2003 Completed
M-048-12	Submit Results of four DSTs Not Previously Examined	09/30/2004 Completed
M-048-13	Submit Results of four DSTs Not Previously Examined	09/30/2005 Completed
M-048-14	Submit Written Integrity Report for the Double-Shell Tank System	03/31/2006 Completed
M-048-15	Submit A Report To Ecology for the Reexamination of Six DSTs by Ultrasonic Testing.	09/30/2007
M-048-00	Complete Tank Integrity Assessment Activities for Hanford's Double Shell Tank (DST) System.	09/30/2007

8.0 MANAGEMENT APPROACH

Success of the DST Integrity Project requires a structured and disciplined management process. This process starts with a clear definition of objectives and requirements, is supported by solid planning to establish technical, cost, and schedule baselines, and implements proven management controls to guide the work process and adjust to change. Sections 8.1 through 8.4 describe the key elements of the management approach.

8.1 ORGANIZATIONAL STRUCTURE

The DST Integrity Project is an element of the Waste Feed Operations organization. Project responsibility rests with the Director for the DST Life Extension Project and the Project Manager for the DST Integrity Project.

8.2 ROLES AND RESPONSIBILITIES

Waste Feed Operations is responsible for the DST System's day-to-day operations, which include waste storage, waste transfer, surveillance, and maintenance, to ensure compliance with DOE orders and Federal, state, and local laws and regulations. Activities of the DST Integrity Project must be integrated with and carried out with the support of Waste Feed Operations, in accordance with applicable procedures and work control processes. Each project is responsible for accomplishing its work scope. The Waste Feed Operation is shown in Figure 8-1.

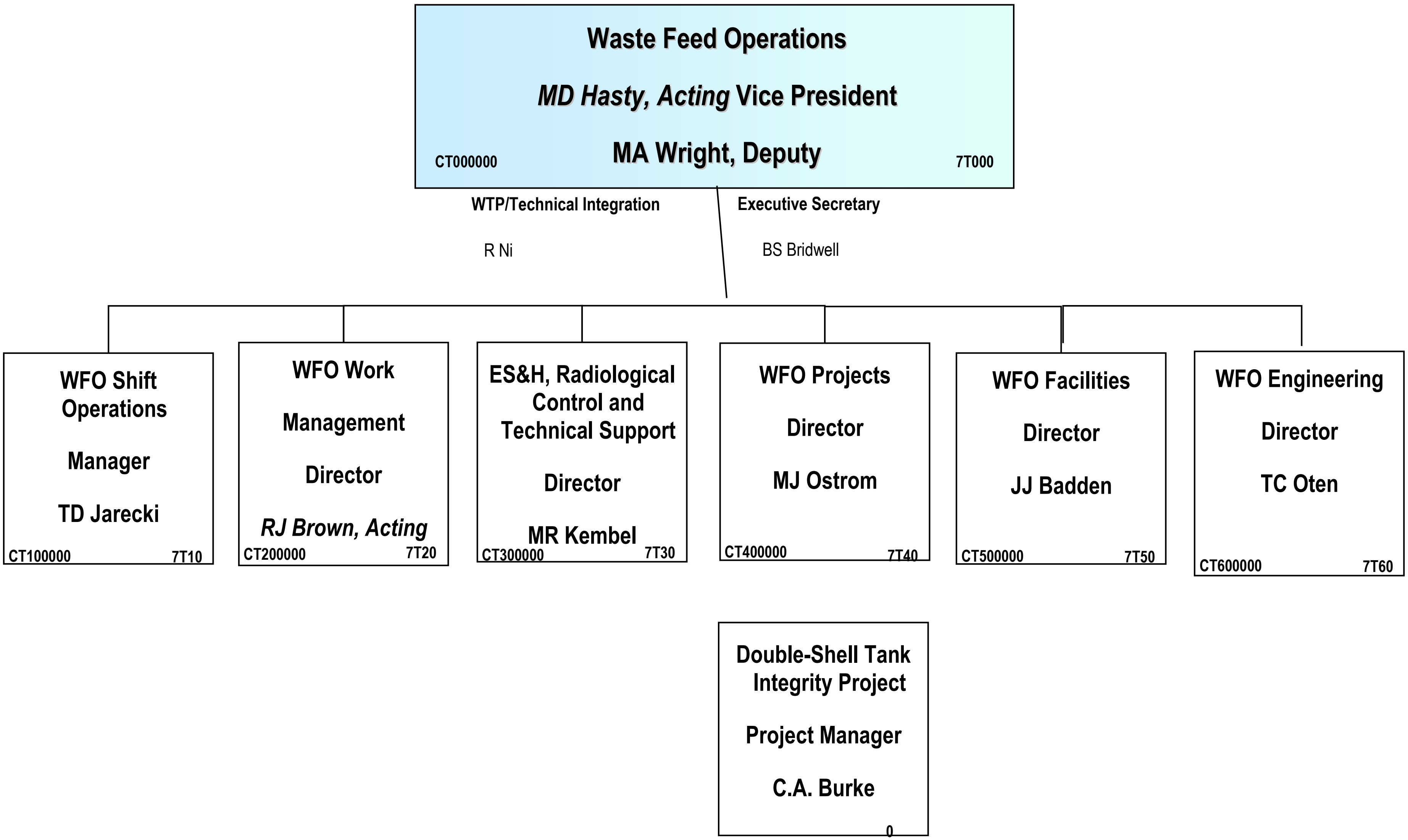
8.3 STRATEGIC PLANNING AND PROJECT CONTROLS

Business operations include those activities necessary to establish and maintain the technical, cost, and schedule baseline, to manage activities in accordance with those baselines, and to adjust to change as necessary. The processes are covered in TFC-PLN-84, *Tank Farm Contractor Project Execution Plan*.

8.4 QUALITY ASSURANCE

The DST Integrity Project will operate under TFC-PLN-02, *Quality Assurance Program Description*.

Figure 8-1. Waste Feed Operations Organization.



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APPENDIX A

DOUBLE-SHELL TANK INTEGRITY PROJECT COMPARISION OF PROGRAM ELEMENTS WITH TANK STRUCTURAL INTEGRITY PLANEL GUIDELINES

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Tank Selection	At least 10% (or 1 if < 10%); select based on age, severity of operating conditions, and transients; if not homogenous, >10% may be required to represent worst-case	• Tank selection based on weighted averages of waste composition, least waste height variation, temperature, age, and material. All 28 DSTs prioritized based on this criterion. • All 28 DSTs will have initial inspection (UT baseline) by the end of FY 2005. UT inspections will be repeated in successive 8-10 year cycles. • 6 DSTs selected for examination of tank bottoms and 6 DSTs selected for examination of lower knuckles were selected based on a variety of factors as documented in “Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks – FY 2001” (RPP-6839)	• N/A—exceeds TSIP guidance • Examination of all 28 DSTs will be performed in accordance with M-48 milestone agreement with state of Washington • Number of DSTs selected for examination of tank bottoms and lower knuckles were agreed upon by the Washington State Department of Ecology.	Rationale for UT of all 28 DSTs versus 3 required by DSTIP is that the DSTs have different service dates and different types of waste. Reference: “Description of Double-Shell Tank Selection Criteria for Inspection” (WHC-SD-WM-ER-529).
	If >10% are examined, option to reduce percent per tank accordingly.	No reduction used	Required scope by M-48 milestone agreement with state of Washington	None

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Extent of Examination	5% of liquid-vapor interface	The liquid/vapor interface on 6 DSTs will be examined over a 20 ft. length, 15 in. wide centered on the estimated location of the static liquid/air interface that existed for a minimum of 5 years. This area will be examined for pits, cracks, and wall thinning.	This scope of examination is as agreed to by DOE and Ecology in draft HFFACO milestone M-48-14. A 20 ft. length in a 75 ft. diameter tank exceeds 5% of the liquid/air interface. 15 inches centered on the liquid air interface does not comply with the TSIP guidance of +/- 1 foot, but can be accomplished in a single scan—otherwise 2 scans would be required to encompass 12" above and 12" below the interface. However this scope can be and has been increased depending on the condition of the tank. For example, on AY-101 two scans were done on the liquid/air interface because thinning was found over a fairly large vertical range in the two 15-in. wide vertical scans on the east side of the tank. In all 28 DSTs, any previous or existing liquid/air interface is examined in the top-to-bottom 30-in. wide vertical strip (consisting of two 15-in. wide vertical strips) that is scanned in each tank.	Should there be more than one interface of 5 or more years, an evaluation will be performed to determine if it needs examination as well.
	5% of liquid-sludge interface	Any liquid/sludge interface above the lower knuckle weld is examined over a 30-in. length, within the 30-in. vertical strip examined on each DST. No horizontal scan of the liquid/sludge interface is conducted.	UT results to date for vertical scans in 11 DSTs have not found any evidence of accelerated degradation or flaws at a liquid/sludge interface that exists now, or may have existed during the tank operating history. By FY 2005, all 28 DSTs will be examined over a ~35-ft. by 30-in. wide vertical strip. Evidence of accelerated degradation or flaws at a liquid/sludge interface could potentially cause expansion of the examination scope for that tank.	None

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Extent of Examination (cont.)	5% divided between knuckle* base metal and lower weld if accessible. Otherwise 5% of knuckle divided into two or more segments. *Lower knuckle of primary tank. Predicted maximum stress region of base metal plus lower weld if accessible.	• 6 DSTs have been identified for examination of a 20-ft. circumferential length of the lower knuckle. Examinations are to be conducted on the entire 20-ft. length in each interval, rather than partially in sub-intervals. • SAFT/TSAFT will inspect the lower knuckle region to the lower knuckle/bottom plate weld. • Extended arm P-scan will overlap the synthetic aperture focusing technique/tandem-synthetic aperture focusing technique (SAFT/T-SAFT) inspection from the lower knuckle top weld to just above the maximum stress region. • The bottom/lower knuckle weld is not examined, except through air slots when tank bottoms are examined. • 20 ft of weld and HAZ joining the vertical wall to lower knuckle is examined, if accessible.[4] The entire 20-ft. length is examined at one time—not in 2 or more subintervals.	• N/A exceeds TSIP guidelines for lower knuckle region. Examination scope is not presently planned to be apportioned among sub-intervals due to higher costs associated with multiple tank entries. Examination of lower knuckle region is dependent upon accessibility. • Frequency of successive lower knuckle region examinations will be increased if significant degradation or evidence of SCC, or any cracking is observed. • No cracks, significant wall thinning, or other problems have been observed to date in examination of the welds and HAZ in 11 DSTs.	Development of a tandem synthetic aperture focusing technique (TSAFT) was accomplished and deployed on one DST (January 2003), demonstrating the ability to examine the high stress region and lower knuckle to bottom weld. An extended arm for UT examination allows more area of the knuckle to be examined above the high stress region.

[4] Exceptions: On AY-101 and AY-102, lower knuckle weld could not be examined due to concrete splatter. Instead, 20 ft of the lowest accessible horizontal weld is examined—which in AY-102 was the weld joining plate #2 to plate #3. On AW-103 (the first tank examined—in 1997) welds were not examined, except where included in the 10.25 in. wide vertical strips.

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Extent of Examination (cont.)	Examine primary tank bottom as practical for cracks, pits, and wall thinning, on a "best effort" basis.	Primary tank bottoms are scheduled to be examined through accessible air-slots for wall thinning and circumferential cracks, on 6 DSTs. Per HFFACO Milestone M-48, the examination shall extend at least ten feet toward the center of the tank from the lower knuckle joint or to the length practical within the limits of best available equipment. Extent of examination is dependent on surface conditions, obstructions, and geometry constraints.	N/A—current approach complies with TSIP guidance for tank bottoms	None
	External surface of primary tank In accessible regions, UT 10 areas of 1 ft^2 area for thickness measurement.	Each of 28 DSTs is examined over a ~35-ft. by 30-in. wide vertical strip, regardless of waste surface level. Overall coverage of vertical wall exam is approximately 87 ft^2 . Wall examinations also include 20-ft. of vertical welds, and 20-ft. of vertical wall/lower knuckle weld.	N/A—current approach complies with and exceeds TSIP guidance	None
	Secondary tank - 5 areas of 1 ft^2 and 5% of knuckle region welds	Examination of a 20-ft. length of the secondary tank knuckle and 10 square feet of the secondary tank floor, for wall thinning, pits, and cracks is planned for 3 DSTs.	N/A—current approach exceeds TSIP guidance	None

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Evaluation Criteria/ Acceptance Levels	• Wall thinning: 20% of nominal wall thickness (t) • Pits: 50% t • Cracks <12": 50% t • Cracks >12": 20% t	Action Level for Review • Wall thinning: ≥20% t • Pits: ≥50% t • Cracks <12": 3/16" • Cracks >12": 3/16" Reportable Level for Documentation • Wall thinning: ≥10% t • Pits: ≥25% t • Cracks – Any observed Cracks	• N/A for wall thinning and pits (same as TSIP) • Hanford acceptance criteria for crack depth is equal to or more stringent than TSIP guidance for crack length <12 in., but less stringent for crack length >12 in. Hanford acceptance criteria for crack length >12 in. is consistent with WHC-SD-WM-AP-036, issued 9/27/95. Rationale: a single conservative value for crack depth acceptance criteria, independent of plate thickness, is less prone to error than one that varies with plate thickness (i.e. used 50% of 3/8" plate). In practice, all detectable cracks have been reported	ASME Section XI, IWC-2424 was used as references in developing Hanford Standards
	Additional Examinations are to follow IWC-2430: Examination results that exceed acceptance criteria require extending the examination to include additional areas of similar material and service	Where indications are found, additional examinations are performed, as directed by an expert panel (UT Inspection Panel).	N/A—practice at Hanford has involved: • increasing the sample size to all 28 DSTs vs. original scope of 6 DSTs, • extending examinations, in the same tank, when acceptance criteria was triggered or approximated, based on recommendations of the UT Inspection Panel consistent with WHC-SD-WM-AP-036.	ASME Section XI, IWC-2430 and IWA-2430 were used as references in developing Hanford Standards
	Repair or corrective action for > 75% t	Repair not currently an option. Management decision not to pursue development of specialized repair technology/equipment, based on projected DST life cycle/cost benefit (i.e., repair need unlikely before mission completion).	N/A	None

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Acceptance Criteria	None	Evaluation of indications exceeding the acceptance levels are documented, tracked, and dispositioned via the Hanford occurrence reporting system. Part of this disposition includes assembling a UT inspection review panel comprised of appropriate subject matter experts. Analysis of indications is performed in accordance with industry accepted methods, such as, but not limited to, ASME XI, API, EPRI, or NASA.	N/A – not covered by TSIP guidelines	None
Frequency	10 years	• Initial inspection occurred more than 10 years after DSTs placed in service. This is scheduled to be complete in FY2005 • Repeat inspections planned at an 8 to 10 year intervals	• UT program for DSTs established when draft TSIP guidelines became available, codified in HFFACO Milestone M series. • Intervals for repeat inspections are consistent with TSIP guidelines	ASME Section XI, IWA-2432 is used as a reference for development of frequency
Schedule	None	See Frequency	N/A	
Equipment	Capability of detection and sizing – must detect 50% of nominal wall thickness (t) pits, 20% t thinning, 20% t for 1 ft length and 50% t for shorter cracks; uncertainty no more than ±20% of these values	• Wall thinning: +/- 0.02". • Pits: +/- 0.05" • Cracks: +/- 0.1"	Rationale: Accuracy limits for Hanford DSTs were established not as a function of plate thickness, but based on actual equipment capability as demonstrated in Performance Demonstration Tests administered by PNNL in 1998 and 2000. Accuracy limits for thinning and pitting in Hanford DSTs are equal to or more stringent than TSIP recommendations for ½" or heavier plate sizes, but less stringent for 3/8" plate size. Accuracy limits for crack depth in Hanford DSTs are less stringent than TSIP recommendations.	ASME Section XI Appendix VIII used for stress corrosion cracking

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Inspector Qualifications	ANSI/ANST CP-189	NDE personnel are qualified in accordance with ASNT Recommended Practice SNT-TC-1A-92	Both ASNT CP-189 and SNT-TC-1A-92 were considered in establishing qualification requirements for personnel. SNT-TC-1A was considered adequate for tank inspections, and was selected. At the time of selection most NDE technicians were being qualified to SNT-TC-1A. Additionally, Inter-granular Stress Corrosion Cracking (IGSCC) training is required for NDE Level III technicians.	None
UT Procedure Requirements	Applicable portions of ASME Section XI Appendix VIII should be limited to 2100 (a), (b), (c), and (d); and Supplements 2 and 3.	UT contractor procedure includes all elements in VIII-2100, does not include supplements 2 and 3 since they do not apply to tanks.	N/A—UT procedure for DSTs complies with TSIP guidance. Supplements 2 and 3 apply to piping—not to tanks.	None
Action Limits	See evaluation criteria.	See evaluation criteria.	See evaluation criteria	None
Records Management	None	36 CFR (Code of Federal Regulations), 1234 DOE O 1324.5B, DOE O 414.1, 10 CFR 820, DOE O 200.1	None	None
Tank Selection	At least 10% (or 1 if < 10%); select based on age, severity of operating conditions, and transients; if not homogenous, >10% may be required to represent worst-case	All DSTs, both primary interior and annulus examinations	Exceeds TSIP guidelines	None
	If >10% are examined, option to reduce percent per tank accordingly.		No reduction used	None

Table A-1. Hanford Double-Shell Tank Integrity Program Elements. (8 sheets)

UT	TSIP (BNL-52527 –UC-406)	Hanford DST Integrity Program	Rationale for Departure from TSIP Guidelines	Comments
Extent of Examination	External surface of primary tank if accessible, and internal surface of secondary tank if such exists. Overall scan of accessible regions;	Examination form 4 risers providing close to 360 degree coverage of primary tank external and secondary liner internal surfaces	Accessible areas examined	None
	Vapor region at top of primary tank.	The internal dome and wall above the liquid level	Accessible areas examined	None
	Overall scan of internal surface when tank is essentially empty.	Examination to be performed	Accessible areas examined	None
Evaluation Criteria	Any signs of degradation must be evaluated.	Signs of degradation or leakage or both must be evaluated. Compare results to previous inspections for signs of change.	Meets guidelines	None
Acceptance Criteria	Any signs of degradation must be evaluated.	Signs of degradation and/or leakage must be evaluated.	Meets guidelines	None
Frequency	At least once each inspection interval (10 years).	Examinations done routinely on a 5 to 7 year frequency and when UT examinations indicate conditions requiring visual examination	Exceeds guidelines	Visual baseline complete in FY 2003
Schedule	None	See frequency	See frequency	None
Equipment	None	S-VHS video cameras are used to visually examine areas	N/A	CH2M HILL qualifications for equipment and operators are used
Inspector Qualifications	ANSI/ANST CP-189	No certified visual examiners are used. Engineers with experience are used to determine degradation	ASME Code examinations are not performed. However, Inspection Team member qualifications have been reviewed and approved by the IQRPE (per LATA-JHH-03-014 letter of 2/7/03)	None
Action Limits	See evaluation criteria.	See evaluation criteria.	See evaluation criteria.	None
Records Management	None	36 CFR (Code of Federal Regulations), 1234 DOE O 1324.5B, DOE O 414.1, 10 CFR 820, DOE O 200.1	N/A	None

TABLE A-1 REFERENCES

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APPENDIX B

DOUBLE SHELL TANK INTEGRITY PROJECT BASELINE SCHEDULE

This appendix contains the schedule for the frequency and type of nondestructive examinations for the 28 double-shell tanks through Fiscal Year (FY) 2028. These inspections will continue beyond FY 2028 on the same frequency. Table B-1 contains the abbreviations for the type of ultrasonic testing that need to occur during an inspection. Table B-2 contains the abbreviations for the type of visual examinations that need to occur during an inspection. Table B-3 shows the timing and types of the examinations that need to occur.

Table B-3 uses numbers (1, 2, 3, etc.) to indicate the sequence of the UT to occur. A typical UT examination includes a full length scan of the primary tank side wall (about 40 feet), 20 feet horizontal weld, 20 feet or more vertical weld. The initial round of UT scanned to two 15-inch sections of side wall starting with the second UT examination four 15-inch vertical strips will be accomplished. During 2, 3, 4 UT examinations, primary and annulus videos will be conducted same fiscal year as the UT examination.

Table B-1. Ultrasonic Testing Abbreviations

Area of Inspection	Table Abbreviation
Primary tank bottom	Superscript B
Primary tank upper knuckle (Haunch)	Superscript H
Primary tank lower knuckle	Superscript K
Liquid/air interface	Superscript L
Secondary tank knuckle and floor	Superscript S
Partial examination	Superscript h,k,l,s,h (lower case)
Major reexamination	R
Minor reexamination	r

Table B-2. Visual Examination Abbreviations

Area of inspection	Table Abbreviation
Primary riser only	V_p
Annulus riser only	V_a
One primary and four annulus riser video	V

Table B-3.
Schedule for Nondestructive Examinations in the Double-Shell Tanks. (2 sheets)

Double-Shell Tank	Fiscal Year of Nondestructive Examination																														
	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	2028
AN-101						1v			V$_{P}$	R^{L}Va					2					V					3				V			
AN-102					1	V						2^{K}						V			3^{K}						V			4^{K}		
AN-103						V			1^{KL}				V				2^{KL}				V					3^{KL}				V		
AN-104						V			1^{KL}					V					2^{KL}				V					3^{KL}				
AN-105			X^{S}			Va	R			1Vp				V					2					V				3^{S}				V
AN-106			1			V					2				V					3				V					4			
AN-107		1^{B}			V$_{p}$	V				2^{K}Va	V$_{P}$				3^{K}							4^{K}				V				5^{K}		
AP-101							1^{K} V$_{p}$			Va							2^{K}					V					3^{K}				V	
AP-102									1V$_{A}$	Vp				V				2					V				3					V
AP-103							1			V						2				V					3					V		
AP-104								1	L^{SH}Va	Vp			V					2^{S}				V					3^{S}					V
AP-105							1^{L}		Va	Vp						2^{L}					V				3^{L}					V		
AP-106									1Va	Vp			V					2					V					3				
AP-107				1		V						2					V						3				V					4
AP-108				1		r V						2				V						3				V					4	
AW-101					1^{BL} V								2^{L}			V					3^{L}				V						4^{L}	
AW-102					V	1^{K}								2^{K}					V					3^{K}					V			
AW-103	1^{S}					V				2^{S}Va	V$_{P}$				V				3^{S}					V					4^{S}			
AW-104						1^{L} V								2^{L}					V				3^{L}					V				4^{L}
AW-105					1 V								2					V										V				
AW-106					V	1								2					V					3				V				

Table B-3.
Schedule for Nondestructive Examinations in the Double-Shell Tanks. (2 sheets)

Double-Shell Tank	Fiscal Year of Nondestructive Examination																														
	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	2028
AY-101					1^{L} V	R	R^{S}				2^{3L}			r^{3L}			3^{3L}				4^{3L}					V					5^{3L}	
AY-102			1		V						2				V					3					V				4			
AZ-101			1		V						2					V				3					V					4		
AZ-102					V^{s}		1^{K}				V				2^{K}					V				3^{K}					V			
SY-101							V	1^{L}	^{K}			V				2^{KL}					V					3^{KL}					V	
SY-102							V	1					2					V				3					V					4
SY-103							V	1					rV				2					V				3					V	
Number of Ultrasonic Tests	1	1	2	2	4	7	4	5	4	3	4	3	4	4	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Number of Visual Inspections					8	10	5	7	5	8	3	1	4	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

APPENDIX C

VALVE PIT AND TRANSFER LINE INSPECTIONS

This appendix contains the list of planned inspections for the transfer system supporting the DST System. The system consists of 128 pipes and 84 valve pits.

Table C-1 provides a description of the type inspections schedule in Table C-2. The piping system requires a inspection of five percent of the transfer piping every five years and pressure testing of the encasements either annually or before transfers occur whichever is less. The Valve pits must be cleaned and have their coatings re-inspected by a qualified NACE coating inspector at the following periodicities for the pits. Pits/vaults with poly urea coatings: every 10 to 12 years. Valve pits with epoxy paint coatings: every 5 to 7 years or after every two jumper installation or disconnect activities, whichever is shorter. Vaults with epoxy paint coatings: every 10 to 12 years. Pits/vaults with stainless steel liners: every 12 to 15 years. Even though this recommendation calls for a qualified NACE coating inspector, it is understood that the radiological condition of the pits may preclude a full inspection per NACE specifications. The qualified NACE coating inspector should be included in the planning phases of the inspection to employ due diligence in the execution of the inspection, while maintaining ALARA (as low as reasonably achievable) principles.

Table C-1. Examinations Codes.

Work Description	Code	Color Code
Assess during start-up	#	
Poly urea 10-12 years		(green)
Transfer Lines or Pit Not Assessed by IQRPE		(gray)
Drain Pits		(yellow)
Stainless Steel 12-15 years		(blue)
New Systems	N	
Pit Job requiring lifting of the cover blocks. Pit Inspection, clean, assess, and all transfer line in the Pit will be tested during the same Pit entry	P	
Pit Assessment Using Video Camera above the Pit	V	
Transfer encasement pressure test	T	

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																	
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
6241-A	X-site	Pit										V																V										
X-site	X-site	SLL-3160	6241-A	6241-V	Line has never completed a readiness evaluation																							#										
6241-V	X-site	Pit										V																V										
X-site	X-site	SLL-3150	6241-A	6241-V								T									T										T							
AN-101A	AN	Pit						P						V				P					V					P					V					
AN-101A	AN	SN-261	01A	AN-B							T							T										T										
AN-101A	AN	SL-161	01A	AN-B							T							T										T										
AN-101A	AN	SN-630	01A	AZ VP				N										T										T										
AN-101A	X-site	SNL-3150	01A	6241-V								T						T										T										
AN-102A	AN	Pit						P						V				P					V					P					V					
AN-102A	AN	SN-262	02A	AN-B														T										T										
AN-102A	AN	SL-162	02A	AN-B														T										T										
AN-103A	AN	Pit						P						V				P					V					P					V					
AN-103A	AN	SN-263	03A	AN-B														T										T										
AN-103A	AN	SL-163	03A	AN-B														T										T										
AN-104A	AN	Pit						P						V				P					V					P					V					
AN-104A	AN	SN-264	04A	AN-A														T										T										
AN-104A	AN	SL-164	04A	AN-A														T										T										
AN-104A	AN	SN-630	04A	AP-02D				N										T										T										
AN-104D	AN	Pit			Does not require assessments																																	
AN-104D	X-site	SLL-3160	04A	6241-V	Line has never completed a readiness evaluation																							#										

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																	
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
AN-105A	AN	Pit						P						V				P					V					P					V					
AN-105A	AN	SN-265	05A	AN-A														T										T										
AN-105A	AN	SL-165	05A	AN-A														T										T										
AN-106A	AN	Pit						P										P					V					P					V					
AN-106A	AN	SN-266	06A	AN-A									T					T										T										
AN-106A	AN	SL-166	06A	AN-A									T					T										T										
AN-107A	AN	Pit									P				V			P					V					P					V					
AN-107A	AN	SN-267	07A	AN-A														T										T										
AN-107A	AN	SL-167	07A	AN-A														T										T										
AN-A VP	AN	Pit			P								P					P					V					P					V					
AN-A VP	AN	SN-268	AN-A	AN-B							T							T										T										
AN-A VP	AN	SL-168	AN-A	AN-B									T					T										T					V					
AN-B VP	AN	Pit			P								P					P					V					P										
AP VP	AP	Pit										P									P					V					P					V		
AP VP	AP	SN-610	AP-VP	02A								T									T										T							
AP VP	AP	SN-609	AP-VP	02A								T									T										T							
AP VP	AP	SL-510	AP-VP	AW-A								T									T										T							
AP VP	AP	SL-509	AP-VP	AW-B								T									T										T							
AP-101A	AP	Pit								P						V					P					V					P					V		
AP-101A	AP	SN-611	01A	241-AP-VP						T											T										T							
AP-101A	AP	SL-511	01A	241-AP-VP						T											T										T							
AP-102A	AP	Pit								P						V					P					V					P					V		
AP-102A	AP	SN-612	02A	241-AP-VP						T											T										T							
AP-102A	AP	SL-512	02A	241-AP-VP						T											T										T							

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																	
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
AP-102D	AP	Pit										P					V				P					V					P					V		
AP-102D	AP	SN-622	02D	AP-02A					N												T										T							
AP-102D	AP	SN-700	WTP	AP-02D					N												T										T							
AP-102D	AP	SN-701	WTP	AP-02D					N												T										T							
AP-103A	AP	Pit								P						V					P					V					P					V		
AP-103A	AP	SN-613	03A	AP-VP						T											T										T							
AP-103A	AP	SL-513	03A	AP-VP						T											T										T							
AP-103D	AP	Pit								P						V					V					V					V					V		
AP-104A	AP	Pit									P					V					P					V					P					V		
AP-104A	AP	SN-614	04A	AP-VP							T										T										T							
AP-104A	AP	SL-514	04A	AP-VP							T										T										T							
AP-105A	AP	Pit									P						V				P					V					P					V		
AP-105A	AP	SN-615	05A	AP-VP							T										T										T							
AP-105A	AP	SL-515	05A	AP-VP							T										T										T							
AP-106A	AP	Pit										P						V			P					V					P					V		
AP-106A	AP	SN-616	06A	AP-VP								T									T										T							
AP-106A	AP	SL-516	06A	AP-VP								T									T										T							
AP-107A	AP	Pit									P						V				P					V					P					V		
AP-107A	AP	SN-617	07A	AP-VP							T										T										T							
AP-107A	AP	SL-517	07A	AP-VP							T										T										T							
AP-108A	AP	Pit									P						V				P					V					P					V		
AP-108A	AP	SN-618.	08A	AP-VP							T										T										T							
AP-108A	AP	SL-518	08A	AP-VP							T										T										T							
AW-101A	AW	Pit							P			P								P					V					P					V			

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																	
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
AW-101A	AW	SN-261	01-A	AW-A								T								T										T								
AW-102A	AW	Pit							P				P	V						P					V					P					V			
AW-102A	AW	SN-267	02A	AW-A								T								T										T								
AW-102A	AW	SL-162	02A	AW-B									T							T										T								
AW-102A	AW	SN-262	02A	AW-B							T									T										T								
AW-102A	AW	SN-268	02A	AW-B									T							T										T								
AW-102D		Pit							P						V					V					V										V			
AW-102E	AW	Pit							P						V					P					V					P					V			
AW-102E	AW	SN-272	02E	02A								T								T										T								
AW-102E	AW	SN-269	02E	242-A								T								T										T								
AW-102E	AW	SN-270	02E	242-A								T								T										T								
AW-103	AW	Pit							P						V					P					V					P					V			
AW-103	AW	SN-263	03A	AW-A																T										T								
AW-103	AW	SL-163	03A	AW-A																T										T								
AW-104A	AW	Pit							P						V					P					V					P					V			
AW-104A	AW	SN-264	04A	AW-B																T										T								
AW-104A	AW	SN-274	04A	AW-B																T										T								
AW-104A	AW	SL-164	04A	AW-B																T										T								
AW-105A	AW	Pit							P						V					P					V					P					V			
AW-105A	AW	SN-265	05A	AW-A																T										T								
AW-105A	AW	SL-165	05A	AW-A																T										T								
AW-106A	AW	Pit							P											P					V					P					V			
AW-106A	AW	SN-266	06A	AW-B								T								T										T								
AW-106A	AW	SL-166	06A	AW-B								T								T										T								

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																	
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
AW-A VP	AW	Pit						P						V						P					V					P					V			
AW-A VP	AW	SN-220 /LIQW-702	AW-A	204-AR	Deferred use; Line needs to be re-routed															T										T								
AW-A VP	AW	SL-168	AW-A	242-A	Deferred use; Line needs upgrade								T							T										T								
AW-B VP	AW	Pit						P								V				P					V					P					V			
AW-B VP	AW	SL-169	AW-B	AW-A								T								T										T								
AW-B VP	AW	SN-271	AW-B	AW-A								T								T										T								
AW-B VP	AW	SL-167	AW-B	242-A								T								T										T								
AY-101A	AY	Pit						P						V					P					V					P					V				
AY-101A	AY	SN-635	01A	02A				N											T										T									
AY-102A	AY	Pit						P						V					P					V					P					V				
AZ VP	AZ	Pit						N												V										V								
AZ VP	AZ	SN-633	AZ VP	AY-02A				N												T										T								
AZ VP	AZ	SN-634	AZ VP	AP-02D				N												T										T								
AZ VP	AZ	SN-637	AZ VP	WTP				N												T										T								
AZ-101A	AZ	Pit						P											P										P									
AZ-101A	AZ	SN-632	01A	AZ VP				N											T										T									
AZ-101A	AZ	SN-631	01A	02A				N											T										T									
AZ-102A	AZ	Pit						P											P										P									
SY-101A	SY	Pit			Deferred Use														P					V					P					V				
SY-101A		SN-278			Line Need to be replaced; Under a variance														T										T									

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																	
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
SY-101A		SL-178			Line Need to be replaced; Under a variance														T										T									
SY-102A	SY	Pit								P						V			P					V					P					V				
SY-102A		SN-285			Line Need to be replaced; Under a variance														T										T									
SY-102A		SN-286			Variance							T							T										T									
SY-102A		SN-277			Line Need to be replaced; Under a variance														T										T									
SY-102A		SL-177			Line Need to be replaced; Under a variance														T										T									
SY-102D	SY	Pit								P						V							V						P					V.	V			
SY-103A	SY	Pit							P						V				P					V					P					V				
SY-103A		SN-279			Line Need to be replaced; Under a variance														T										T									
SY-103A		SL-179			Line Need to be replaced; Under a variance														T										T									
SY-A VP	SY	Pit							P							V			P					V					P					V				
SY-A VP	X-site	SNL-3150	SY-A	6241-A								T							T										T									
SY-A VP		SN-280			Line Need to be replaced; Under a variance														T										T									
SY-A VP		SL-180			Line Need to be replaced; Under a variance														T										T									
SY-B VP	SY	Pit										P							V					V					P					V				

Table C-2.
Schedule Examinations for
Valve Pits and Transfer Lines.
(7 sheets)

System	Location	Component	Transfer Line Terminals		Fiscal Year of Scheduled Examination																																
					99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
SY-B VP	X-site	SLL-3160	SY-A	6241-A	Line has never completed a readiness evaluation																								#									
Pit Video Inspections											5	2	0	9	7	9	4	1	1	2	1		10	7	10	11				1	1		9	8	11	11		
Pit Inspections												4	3																									
Pressure Tests											12	22	6					9	8	9	10							9	10	9	10							

APPENDIX D

PERMITTED PIPING

This appendix contains the lines associated with the double-shell tank (DST) system. These lines have been divided into two categories: transfer and support. The transfer lines are used to move waste from one DST to another or to the WTP. The support lines are used to move waste, but transfer liquid to the DSTs.

Table D-1 identifies the 89 transfer lines in the DST system. Table D-2 identifies the 39 support lines in the DST system. Both tables provides the component identification, the description of use, tank farm the line is location in, whether the DSTAR identified the line as having cathodic protection, reference for the cathodic protection, corrosion protection method, and additional comments pertaining to the line.

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
1.	LIQW-702	Supernate Transfer Line	AW	Protected (A-Farm, 204-AR)	H-2-91033 Sheet 1 & 2	Cathodic	Deferred Use: requires upgrade to tie into SN-220
2.	SL-100	Slurry Transfer Line	AY	Not Protected	H-2-91041 Sheet 2	Cathodic	Deferred Use: C-106 to AY-102 retrieval line
3.	SL-161	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	
4.	SL-162	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484
5.	SL-162	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
6.	SL-163	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484
7.	SL-163	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
8.	SL-164	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484
9.	SL-164	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
10.	SL-165	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
11.	SL-165	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
12.	SL-166	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484
13.	SL-166	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
14.	SL-167	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484
15.	SL-167	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
16.	SL-168	Slurry Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484
17.	SL-168	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use: back-up 242-A slurry line requires COB upgrades
18.	SL-169	Slurry Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
19.	SL-177	Slurry Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - secondary doesn’t penetrate the pit wall
20.	SL-178	Slurry Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - secondary does not penetrate the pit wall

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
21.	SL-179	Slurry Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - secondary doesn't penetrate the pit wall
22.	SL-509	Slurry Transfer Line	AP	Protected	H-2-94077-87	Cathodic	
23.	SL-510	Slurry Transfer Line	AP	Protected	H-2-94077-87	Cathodic	
24.	SL-511	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
25.	SL-512	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
26.	SL-513	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
27.	SL-514	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
28.	SL-515	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
29.	SL-516	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Deferred use per HNF-3484
30.	SL-517	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
31.	SL-518	Slurry Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
32.	SLL-3160	Slurry Transfer Line	SY	Not Protected		Insulated	Deferred use per HNF-3484 Never Activated, Requires Upgrade
33.	SLL-3160	Slurry Transfer Line	SY	Not Protected		Insulated	Deferred use per HNF-3484 Never Activated, Requires Upgrade
34.	SLL-3160	Slurry Transfer Line	SY	Not Protected		Insulated	Deferred use per HNF-3484 Never Activated, Requires Upgrade
35.	SN-200	Supernate Transfer Line	AY	Not Protected	H-2-818706 Sheet 1	Cathodic	Deferred Use: C-106 to AY-102 retrieval line
36.	SN-220	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred Use: requires upgrade to tie into LIQW-702
37.	SN-261	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	
38.	SN-261	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
39.	SN-262	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
40.	SN-262	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Emergency use

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
41.	SN-263	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
42.	SN-263	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
43.	SN-264	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
44.	SN-264	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
45.	SN-265	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
46.	SN-265	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
47.	SN-266	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
48.	SN-266	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
49.	SN-267	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
50.	SN-267	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Emergency use

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
51.	SN-268	Supernate Transfer Line	AN	Protected	H-2-91040 Sheet 2	Cathodic	Emergency use
52.	SN-268	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
53.	SN-269	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484 Emergency use
54.	SN-270	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
55.	SN-271	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Deferred use per HNF-3484
56.	SN-272	Supernate Transfer Line	AW	Protected	H-2-91033 Sheet 2 & 5	Cathodic	Deferred use per HNF-3484
57.	SN-274	Supernate Transfer Line	AW	Protected	?	Cathodic	Deferred use per HNF-3484
58.	SN-277	Supernate Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - secondary does not penetrate the pit wall
59.	SN-278	Supernate Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - secondary does not penetrate the pit wall
60.	SN-279	Supernate Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant – secondary does not penetrate the pit wall
61.	SN-280	Supernate Transfer Line	SY	Protected	H-2-91023	Cathodic	Non-Compliant - Secondary

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
					Sheet 1		does not penetrate the pit wall
62.	SN-285	Supernate Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - secondary does not penetrate the pit wall
63.	SN-286	Supernate Transfer Line	SY	Protected	H-2-91023 Sheet 1	Cathodic	Non-Compliant - Secondary does not penetrate the pit wall
64.	SN-609	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	
65.	SN-610	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
66.	SN-611	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
67.	SN-612	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
68.	SN-613	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
69.	SN-614	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
70.	SN-615	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
71.	SN-616	Supernate Transfer Line	AP	Protected	H-2-94080	Cathodic	Deferred use per HNF-3484

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
					Sheet 1		for emergency use
72.	SN-617	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
73.	SN-618	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use
74.	SN-622	Supernate Transfer Line	AP	Protected	H-2-94080 Sheet 2	Cathodic	Emergency use
75.	SN-630	Supernate Transfer Line	AN	Not Protected	Not Applicable	Insulated	New, emergency use
76.	SN-631	Supernate Transfer Line	AZ	Not Protected	Not Applicable	Insulated	New, emergency use
77.	SN-632	Supernate Transfer Line	AZ	Not Protected	Not Applicable	Insulated	New, emergency use
78.	SN-633	Supernate Transfer Line	AY	Not Protected	Not Applicable	Insulated	New, emergency use
79.	SN-634	Supernate Transfer Line	AZ	Not Protected	Not Applicable	Insulated	New, emergency use
80.	SN-635	Supernate Transfer Line	AY	Not Protected	Not Applicable	Insulated	New, emergency use
81.	SN-636	Supernate Transfer Line	AN/AP	Not Protected	Not Applicable	Insulated	New, emergency use
82.	SN-637	Supernate Transfer Line	AZ	Not Protected	Not Applicable	Insulated	New, emergency use
83.	SN-700	Supernate Transfer Line	AP	Not Protected	Not Applicable	Insulated	New, Lines to WTP
84.	SN-701	Supernate Transfer Line	AP	Not Protected	Not Applicable	Insulated	New, Lines to WTP

Table D-1. Double-Shell Tank System Compliant Transfer Lines. (9 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
85.	SNL-3150	Supernate Transfer Line	SY	Not Protected	Not Applicable	Insulated	
86.	SNL-3150	Supernate Transfer Line	SY	Not Protected	Not Applicable	Insulated	
87.	SNL-3150	Supernate Transfer Line	SY	Not Protected	Not Applicable	Insulated	
88.	SNL-5350	Supernate Transfer Line	SY	Not Protected	Not Applicable	Non Metallic	Deferred use per HNF-3484
89.	SNL-5351	Supernate Transfer Line	SY	Not Protected	Not Applicable	Non Metallic	Deferred use per HNF-3484

Table D-2. Double-Shell Tank System Support Lines. (4 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
1.	PW-4531	Annulus Pump Pit Return	AY	Protected	H-2-91041 Sheet 2	Cathodic	Emergency use HNF-3484, test primary before use
2.	PW-4532	Annulus Pump Pit Return	AY	Non-Protected	H-2-91041 Sheet 2	Cathodic	Emergency use HNF-3484, test primary before use
3.	PW-4609	Annulus Pump Pit Return	AZ	Non-Protected	?		Emergency use HNF-3484, test primary before use
4.	PW-4623	Annulus Pump Pit Return	AZ	Non-Protected	?	Cathodic	Emergency use HNF-3484, test primary before use
5.	PW-471	Annulus Pump Pit Return	AN	Not Protected	H-2-71991	Cathodic	Emergency use HNF-3484, test primary before use
6.	PW-471	Annulus Pump Pit Return	AW	Non-Protected	H-2-70403	Cathodic	Emergency use HNF-3484, test primary before use
7.	PW-472	Annulus Pump Pit Return	AN	Not Protected	H-2-71992	Cathodic	Emergency use HNF-3484, test primary before use
8.	PW-472	Annulus Pump Pit Return	AW	Not Protected	?		Emergency use HNF-3484, test primary before use
9.	PW-473	Annulus Pump Pit Return	AN	Not Protected	H-2-94010 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
10.	PW-473	Annulus Pump Pit Return	AW	Non-Protected	?	Cathodic	Emergency use HNF-3484, test primary before use

Table D-2. Double-Shell Tank System Support Lines. (4 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
11.	PW-474	Annulus Pump Pit Return	AN	Not Protected	H-2-94010 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
12.	PW-474	Annulus Pump Pit Return	AW	Non-Protected	?	Cathodic	Emergency use HNF-3484, test primary before use
13.	PW-475	Annulus Pump Pit Return	AN	Not Protected	H-2-94010 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
14.	PW-475	Annulus Pump Pit Return	AW	Not Protected	?	Cathodic	Emergency use HNF-3484, test primary before use
15.	PW-475	Annulus Pump Pit Return	SY	Non-Protected	?		Emergency use HNF-3484, test primary before use
16.	PW-476	Annulus Pump Pit Return	AN	Not Protected	H-2-94010 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
17.	PW-476	Annulus Pump Pit Return	AW	Not Protected	?	Cathodic	Emergency use HNF-3484, test primary before use
18.	PW-477	Annulus Pump Pit Return	AN	Not Protected	H-2-94010 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
19.	PW-477	Annulus Pump Pit Return	SY	Not Protected	?		Emergency use HNF-3484, test primary before use
20.	PW-479	Annulus Pump Pit Return	SY	Not Protected	?		Emergency use HNF-3484, test primary before use

Table D-2. Double-Shell Tank System Support Lines. (4 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
21.	PW-811	Annulus Pump Pit Return	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
22.	PW-812	Annulus Pump Pit Return	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
23.	PW-813	Annulus Pump Pit Return	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
24.	PW-814	Annulus Pump Pit Return	AP	Protected	H-2-94080 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
25.	PW-815	Annulus Pump Pit Return	AP	Protected	H-2-94082 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
26.	PW-816	Annulus Pump Pit Return	AP	Protected	H-2-94082 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
27.	PW-817	Annulus Pump Pit Return	AP	Protected	H-2-94082 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
28.	PW-818	Annulus Pump Pit Return	AP	Protected	H-2-94082 Sheet 1	Cathodic	Emergency use HNF-3484, test primary before use
29.	DR-334	Drain Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Lines used by 242-A Evaporator
30.	DR-335	Drain Line	AW	Not Protected	H-2-91033 Sheet 2	Cathodic	Lines used by 242-A Evaporator
31.	DR-338	Drain Line	AW	Protected	H-2-91033	Cathodic	Line used by 242-A

Table D-2. Double-Shell Tank System Support Lines. (4 sheets)

Number	Component Identification	Description	Farm	Cathodically Protected (DSTAR)	Reference	Corrosion Protection Method	Comments
					Sheet 2 & 5		Evaporator
32.	DR-339	Drain Line	AW	Not Protected	H-2-91033 Sheet 2 & 5		Line used by 242-A Evaporator
33.	DR-343	Drain Line	AW	Protected	H-2-91033 Sheet 2	Cathodic	Line used by 242-A Evaporator
34.	DR-AY1	Drain Line	AY	Not Protected	?		Line used by 241-AZ-301
35.	DR-AY2		AY		?		Line used by 241-AZ-301
36.	PC-AZ-503		AZ	Protected	H-2-131378 Sheet 2		Line used by 241-AZ-301
37.	PC-AZ-503a		AZ	Not Protected (Physically connected to PC-AZ-503)	?		Line used by 241-AZ-301
38.	DR-AZ1	Drain Line			?		Line used by 241-AZ-301
39.	DR-AZ2	Drain Line (above grade portion)			?		Line used by 241-AZ-301