This document was too large to scan as a single document. It has been divided into smaller sections.

Section 1 of 2

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RPP-28538 Rev. 1

Double-Shell Tank Integrity Assessment Report, HFFACO M-48-14

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U.S. Department of Energy Contract DE-AC27-99RL14047

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Abstract: DST System Integrity Assessment per M-48-14 and WAC 173-303-640(2). Also called the DSTAR, it is the authoritative document for the overall integrity assessment activity for the tanks, pits, vaults, and buried piping for the post June 30, 2005 DST System configuration.

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Double-Shell Tank System Integrity Assessment, HFFACO M-48-14

Prepared for:

DST Integrity Project
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CERTIFICATION OF

DOUBLE-SHELL TANK SYSTEM INTEGRITY ASSESSMENT

HFFACO M-48-14 (40 CFR 265.191(5)(ii): "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document, and all attachments, and that, based on my assessment of the plans and procedures utilized for obtaining this information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for subitting false information, including the possibility of fine or imprisonment."

3-28-06
Date

Certification

EXECUTIVE SUMMARY

The Hanford double-shell tanks (DSTs) and ancillary equipment are considered a treatment, storage, and disposal unit under regulations implementing the *Resource Conservation and Recovery Act of 1976* (RCRA). Configuration and operation of these facilities is regulated under 40 CFR 265[1] and WAC 173-303-640.[2] 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 leak tight, with adequate structural integrity and otherwise fit for use over the life of the mission.

The integrity assessment is comprised of this document and several supporting documents that specifically assess waste compatibility, the waste transfer system, and the cathodic protection system. The document numbers for these specific assessments are identified in the body of this report.

The goal of this assessment is twofold: to provide an assessment that meets requirements of WAC 173-303-640(2) and also *Hanford Federal Facility Agreement and Consent Order*[3] Milestone M-48-14. The milestone description imposes content upon this report that is beyond that required in the *Washington Administrative Code*.

This assessment (including supporting documents) identifies 5 findings, 43 observations, and 75 recommendations. Definitions of the terms 'finding,' 'observation,' and 'conclusion' are provided in Section 1.2. A table provided in Appendix A identifies which components within the DST system are fit for use, not authorized for use, and not fit for use. Tables provided in Appendix G summarize all findings, observations, and recommendations from this and the supporting documents. Two of the five findings were the result of an earlier released document (RPP-20556) and have since been resolved. One of the findings is with respect to out-of-specification waste; another covers reportable pitting from ultrasonic testing inspection data, and the last is a cathodic protection issue.

All waste tanks are found to be fit for use. Frequencies of ultrasonic testing examinations remain at 8 to 10 years, and frequencies of DST video inspections remain at 5 to 7 years. Pneumatic testing of transfer line encasements should be performed as required by future integrity assessments. One transfer line (241-SY-SL-180) is found to have a ruptured secondary containment and therefore is listed as not fit for use in Appendix A. Recommendations are made to increase the use of in-tank corrosion monitoring probes and to ensure the cathodic protection systems are functional and their maintenance is in compliance with regulations. It is also recommended that 5% of transfer lines be directly examined per the criteria set forth in 5 years following this assessment and every 5 years thereafter, which is intended to provide adequate data for the next assessment.

---

[1] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

[2] WAC-173-303-640, "Tank Systems," *Washington Administrative Code*, as amended.

[3] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended, State of Washington Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

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LIST OF TERMS

Abbreviations, Acronyms, and Initialisms

ACI	American Concrete Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
BPVC	*Boiler & Pressure Vessel Code*
CFR	*Code of Federal Regulations*
DST	double-shell tank
Ecology	Washington State Department of Ecology
ERUL	estimated remaining useful life
EWI	enhanced weld inspection
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
IQRPE	Independent Qualified Registered Professional Engineer
NACE	National Association of Corrosion Engineers
PNNL	Pacific Northwest National Laboratory
SCC	stress corrosion cracking
SST	single-shell tank
TBD	to be determined
TFC	Tank Farm Contractor
TSAFT	tandem-synthetic aperture focusing technique
UT	ultrasonic testing
WAC	*Washington Administrative Code*

Units

%	percent
°F	degrees Fahrenheit
gal.	gallon
gal/min	gallons per minute
ft	feet
ft/hr	feet per hour
in.	inch
in/yr	inches per year
lbf	pounds force
psig	pounds per square inch gauge
SpG	specific gravity
mils/yr	thousandths of an inch per year
mils	thousandths of an inch

1.0 INTRODUCTION

The mission of the U.S. Department of Energy's River Protection Project is to store, retrieve, treat, and dispose of the mixed radioactive Hanford Site tank waste in an environmentally sound, safe, and cost-effective manner (DOE/ORP-2000-10, *River Protection Project Mission Analysis & Requirements Report*). The River Protection Project mission requires providing and maintaining adequate tank capacity for waste storage and waste feed delivery. Thus, functional waste storage and transfer facilities are a key asset for the River Protection Project. Current schedules require the double-shell tank (DST) system to be reliable through 2028.

Concerns related to aging of such facilities throughout the U.S. Department of Energy complex led to the issuance of 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. Structural integrity is defined in the Panel guidelines in BNL-52527 as including leak tightness (barriers to release of waste) and structural adequacy (strength against collapse or failure from normal and abnormal loads). The Panel guidelines advocate a structured 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.

Hanford tank waste is mostly contained in 149 single-shell tanks (SSTs), and 28 DSTs, with minor amounts in ancillary equipment (e.g., transfer piping, pits, other miscellaneous tanks). The design features, operational history, and structural capacity of the SSTs and DSTs are described in WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste*. Failures in SSTs, generally attributed to stress corrosion cracking (SCC), led to a decision by the U.S. Atomic Energy Commission (predecessor to the U.S. Energy Research and Development Administration and subsequently the U.S. Department of Energy) in the 1960s, to replace the failing SSTs with DSTs that are of improved design, material selection, and construction. Eventually, condensed solids and interstitial liquids (i.e., sludge and salt cake) in SSTs will be retrieved and transferred to DSTs for subsequent processing and disposal.

The DSTs and ancillary equipment are considered a treatment, storage, and disposal unit, under regulations implementing the *Resource Conservation and Recovery Act of 1976*. Configuration and operation of these facilities is regulated under Title 40, *Code of Federal Regulations*, Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," (40 CFR 265), and under the Dangerous Waste Regulations of *Washington Administrative Code* (WAC) 173-303-640, "Tank Systems." 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 leak tight, with adequate structural integrity, and otherwise fit for use over the life of the mission.

This assessment is accompanied by several appendices. Each is listed below along with a description of its content.

Appendix A – Contains a matrix of all components within the scope of this assessment and reports its fitness-for-use status.

Appendix B – Contains a status matrix of tasks identified in RPP-17266, *Plan for Development of the Double Shell Tank Integrity Assessment Report.*

Appendix C – Contains a discussion of statistical issues identified with regard to adequacy of ultrasonic testing (UT) examination sample population

Appendix D – Contains a matrix of personnel who were qualified by the IQRPE to perform integrity assessment data acquisition and analysis

Appendix E – Contains review notes from the IQRPE's certified tank inspector who reviewed available tank inspection videos.

Appendix F – Contains a detailed tank farm corrosion monitoring assessment from which the IQRPE's assessment in Section 9 was based

Appendix G – Contains a summary of all findings, conclusions, observations, and recommendations from related DST Integrity Assessment supporting documents.

Appendix H – Contains a compliance matrix against Ecology et al. (1989), *Hanford Federal Facility Agreement and Consent Order* (HFFACO) Milestone M-48-14 showing that this assessment in conjunction with related field activities sufficiently complies with the milestone.

1.1 PURPOSE

The purpose of this document is to report the activities, reviews, analyses, evaluations, and examinations performed to support the assessment of the Hanford DST systems. This report is required per HFFACO M-48-14, "Submit Written Integrity Report for the Double Shell Tank (DST) System." The milestone was developed from the following documents:

- Administrative Orders 00NWPKW-1250 and 00NWPKW-1251, "Failure to Comply with Major Milestone M-32 of the Tri-Party Agreement"
- WAC 173-303-640
- 40 CFR 265.

This report also supports integrity assessment requirements for permitting the DST system under the permitting process in WAC 173-303, "Dangerous Waste Regulations."

This report will be useful in assessing the extended life expectations of the DSTs and their structural adequacy for compliance with programmatic needs and mission requirements.

1.2 APPROACH

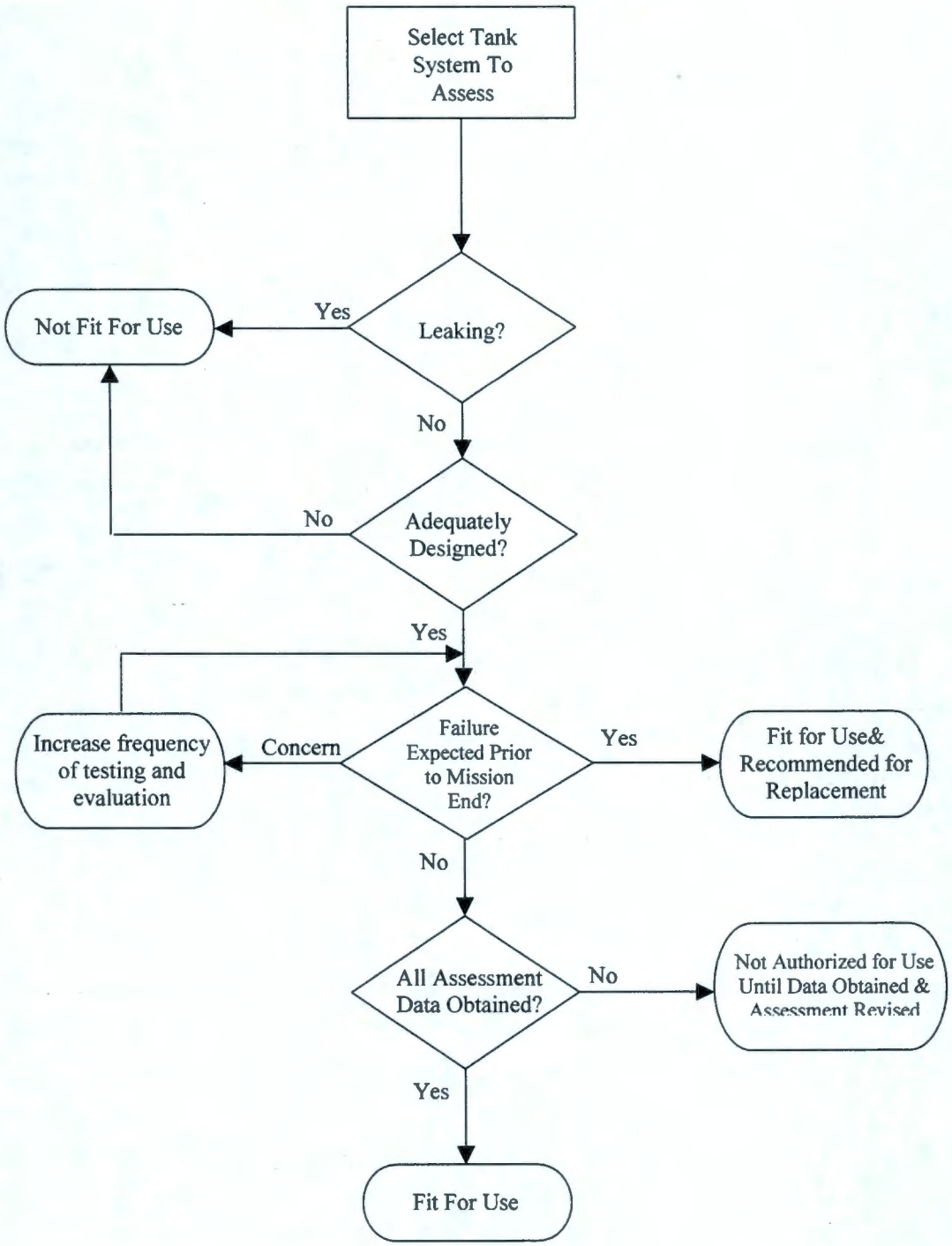
This assessment approaches the determination of fitness for use by first looking at the system macroscopically and then focusing on the finer points of integrity. For instance, determination of fitness for use of a tank system follows the logic in Figure 1-1. This document also assesses the DST Integrity Project in general in an attempt to verify whether the programs will provide adequate data for future assessments and life extension activities. A summary of findings, observations, and recommendations from all assessment documents may be found in Appendix G.

In this document, findings, observations, and recommendations are defined as follows.

- **Finding** – An individual item that does not meet requirements.
- **Observation** – A condition or practice that does not provide or promote effective protection of the health and safety of the public, workers, or the environment.
- **Recommendation** – An activity considered by the IQRPE that, if implemented, will rectify conditions or processes identified by findings, resolve issues raised by observations, or implement activities identified by conclusions.

Engineering consensus codes and standards are also used for certain structural analyses. The assessment philosophy regarding the use of codes and standards is that an existing structure does not necessarily need to meet the criteria of a code or standard that is intended to be used for new construction. For instance, it is unreasonable to require an existing buried tank structure, in its current condition, to meet the requirements of the design standards for which it was designed (e.g., the American Society of Mechanical Engineers [ASME] *Boiler & Pressure Vessel Code* [BPVC] Section VIII). A certain amount of degradation will have occurred in the structure since its installation. The code, being intended for new construction, will allow for a certain amount of degradation over time of the structure. These allowances come in the form of allowable stresses, corrosion allowances, weld inspection criteria, etc. For the purposes of this assessment, it is required, however, that the structure be in an adequate condition to perform its current function under normal operating loads. If the analysis shows the structure may not meet its full mission requirements, this information needs to be captured, but the structure may still be able to perform its current function and be declared fit for use. For example, if a particular tank had experienced general corrosion to the point that all of its corrosion allowance has been consumed, analysis may show that the tank is currently able to perform its function of containing dangerous waste. On the other hand, the tank's ability to perform its function for some number of years is in question. This particular tank would currently be fit-for-use, but the assessment would recommend activities to monitor and extend the design life of the tank. Such recommendations may include (but not be limited to) reduction in the hydrostatic load or reduction in allowable operating temperatures.

Figure 1-1. Fit for Use Determination.



The following documents directly support this assessment

- RPP-25299, *IQRPE Assessment of Cathodic Protection for DST Transfer Lines*
- RPP-25153, *Double-Shell Tank Waste Compatibility Assessment*
- RPP-27097, *Double-Shell Tank Waste Transfer Line Encasement Integrity Assessment Technology Study*
- RPP-27591, *Double-Shell Tank System Pipeline Integrity Assessment*

This document and those listed above are intended to comprise those that fulfill the requirements of HFFACO M-48-14. A compliance matrix has been prepared against M-48-14 and is provided in Appendix H.

Wherever possible, as-built drawings and specifications were used to determine actual conditions, configurations, or activities performed. This assessment does not assume, nor does it seek out, falsified documentation unless evidence indicates otherwise. If a design drawing or specification is designated as 'as-built,' it is assumed that the specification or drawing reflects actual conditions, configurations, or activities performed. No liability is accepted for documentation falsified by others.

2.0 SCOPE

2.1 SKETCH OF THE FACILITY

A sketch of each DST system tank farm facility in schematic form may be found in RPP-20960, *Double-Shell Tank Waste Transfer System*, as it describes the system under 'Set 2,' which is those components that remain active after June 30, 2005. The scope of this assessment includes those components required to be assessed by the regulations as well as additional components based on the requirements of HFFACO M-48-14. The milestone includes ancillary equipment which includes "...all subordinate tank systems and their vaults, transfer pipelines, pump pits, valve pits, lift stations, catch tanks, the 204-AR unloading Stations, *and any other active components identified in interim milestone M-48-01*."

Milestone M-48-01 was reviewed for "other active components identified." The applicable wording in Milestone M-48-01 is "...and any other component necessary to treat, store, or transfer, hazardous and/or mixed waste, within the RCRA permitted boundaries of the DST System."

Tank Farm Contractor's (TFC's) Environmental group was contacted for guidance with regard to the specific components fitting the description found in Milestone M-48-01. This resulted in adding raw water lines up to and including the backflow preventers. However, raw water lines that were not normally pressurized were not assessed.

In general, the following components were assessed:

- DSTs
- Pits
- Vaults (6241-A/V only)
- Transfer lines (supernate and slurry)
- Buried pit drains
- Pressurized raw water lines
- Flush lines
- Catch tanks (241-AZ-301 only)
- Cathodic protection systems.

The 204-AR facility was not assessed at the direction of the TFC. There are no plans for operating this facility, nor does the Tank Farm Authorization Basis authorize it for use.
The booster pumps on the SLL-3160 cross-site transfer line, located in the 6241-A diversion box, were also not assessed. There is a low probability that these pumps will be functional by the time they are needed. An IQRPE will be required to oversee the start up and certify the integrity of these pumps at the time of use.

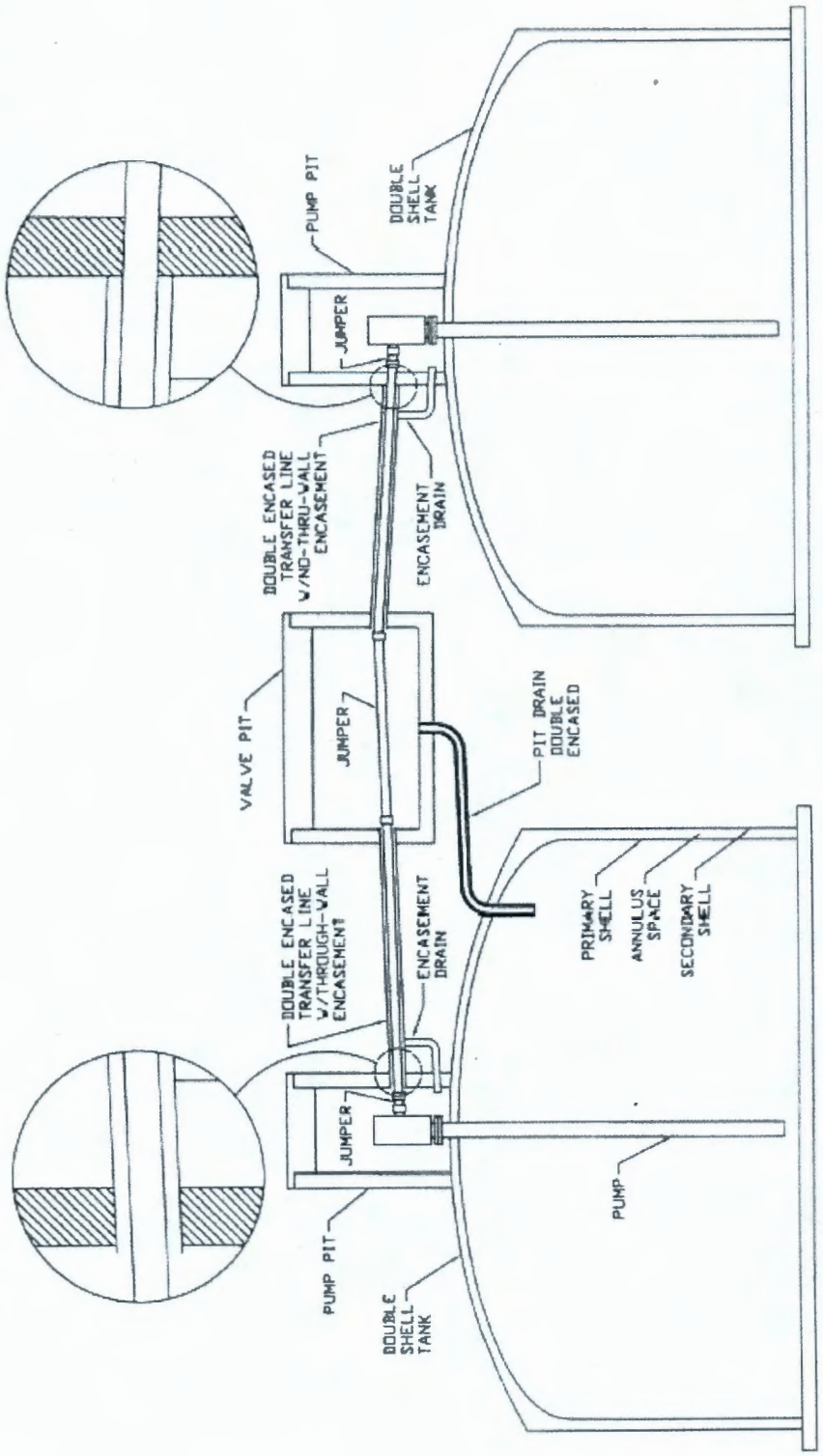
2.2 SKETCH OF THE TANK SYSTEM

Figure 2-1 provides a schematic of the typical DST system. The system, for the purposes of this report, is considered to consist of the DSTs along with their respective pits, drains, raw water lines, and waste transfer piping.

In order for a component to be complaint within the DST system, it must provide double containment, be equipped with leak detection and, if not a tank, leaks must be routed back to a DST. If a particular component does not meet all of these criteria, then a variance must be provided from the Washington State Department of Ecology (Ecology).

Of particular note with regard to variances provided by Ecology are the transfer lines that do not penetrate the pit wall as shown in Figure 2-1. These transfer lines in the DST system do not have secondary containment for the portion of pipe that is embedded in the concrete wall of some pits. Since these lines have been administratively relieved of their design criteria, then that criteria can no longer be used to disqualify those lines. They must therefore be considered administratively compliant and will be assessed along with the rest of the lines of the DST system. These lines must undergo all assessment requirements and activities set forth in this report and RPP-17266, *Plan for Assessment of the Double Shell Tank System*. These requirements are in addition to those specified by Ecology in their variance documentation.

Figure 2-1. Typical Tank System.



3.0 TANK FARM CONTRACTOR PROGRAM ENHANCEMENTS AND ISSUES AFFECTING THE ASSESSMENT

During the course of this assessment, several issues and proposed program enhancements were identified. Each of these is summarized in the following subsections. Their impact, if any, to the assessment is also provided. A more detailed assessment of the issues is provided in subsequent sections.

3.1 REFRACTORY CONCRETE ISSUE

In the summer of 2003, an inspection crew was performing UT examination of the tank 241-AZ-102 bottom via the air slots in the refractory insulating concrete. The camera showed material had fallen from the sides of the air slots as well as cracks in the insulating concrete. The camera itself chipped away portions of insulating concrete as it moved in and out and scraped against the sides of the slot. This situation raised concerns with the current and planned use of the two tanks in 241-AZ tank farm as well as the two in 241-AY tank farm. The 241-AY tank farm tanks were built just prior to those in the 241-AZ tank farm and are almost identical in design. While other tanks (241-AW-101 and 241-AN-106) did not experience or indicate cracking and spalling of the insulating concrete, CH2M HILL Hanford Group, Inc. raised concerns with the current condition of the other DSTs in the Hanford tank farms as well.

An expert consultant was contacted and RPP-19097, *Evaluation of Insulating Concrete in Hanford Double Shell Tanks*, was issued as a result of his findings. This document resulted in a Pacific Northwest National Laboratory (PNNL) analysis performed and reported in PNNL-14706, *DST Primary Tank Settlement Evaluation*. The results of the PNNL analysis showed that, given extremely conservative conditions related to the failure of the refractory concrete, no significant reduction in structural integrity would come to the primary tank. The IQRPE has reviewed the PNNL analysis and concurs with the conclusion. Additional details regarding this issue are discussed in Section 4.8.

3.2 OPERATING LEVEL INCREASE

The TFC has identified a need for additional tank capacity in order to meet waste feed delivery commitments to the Waste Treatment Plant. At present, the plan for increasing tank space capacity is to increase the permitted operating level in several tanks of 241-AP tank farm. A panel of experts was assembled to determine the best approach for effectively re-rating the tanks to the new levels, and what those levels could be. National consensus standards were considered as well as technical experience and expertise. RPP-19438, *Report of Expert Panel Workshop for Hanford Site Double-Shell Tank Waste Level Increase*, contains a report with the results of the expert panel discussions. The findings and recommendations of the expert panel as

well as the plan provided in document RPP-19438 is considered by the IQRPE to be sufficient to re-rate the tanks to the levels stated. However, the tanks cannot be declared fit for use at the new operating levels until the required in-service leak testing is successfully performed.

3.3 CHEMISTRY OPTIMIZATION

SST waste retrieval operations may introduce chemically noncompliant waste into the DST system. Consequently, existing corrosion controls require interruption of the waste retrieval operations for the addition of inhibitors to bring the waste composition into compliance. Such interruptions for caustic additions will impact the SST waste retrieval schedule and cost, occupy scarce DST tank volume, and adversely affect the waste vitrification process by increasing the sodium load.

The TFC has decided not to pursue justification for allowing defined out-of-specification SST waste to temporarily reside in the receiving DST, as long as it can be demonstrated that the resulting potential DST corrosion will not impact the ability of the DST to complete the mission requirements. However, the TFC is pursuing a rigorous waste chemistry versus corrosion propensity testing program to establish the optimum waste chemistry limits on a waste-type by waste-type basis. A panel of experts was assembled to determine the best approach for optimizing the chemistry of the waste tanks. The panel was tasked to provide recommendations on three initiatives. Those recommendations can be found in RPP-RPT-22126, *Expert Panel Workshop for Hanford Site Double-Shell Tank Waste Chemistry Optimization.*

The IQRPE attended the workshop, has reviewed the report and recommendations, and finds the recommendations of the expert panel to be based on sound judgment and appropriate expertise.

3.4 CLEANOUT BOX COB-AW-6 IN 241-AW TANK FARM

During May 2005, while decommissioning 241-AW tank farm cleanout box COB-AW-6, water was found pooled in the encased area. Figure 3-1 illustrates the exterior of the primary line and the mining legs. The piping systems appeared to be severely corroded.

Figure 3-1. Cleanout Box COB-AW-6 Corrosion.

The corrosion was cleaned from the primary line and the mining legs and UT measurements were taken. The maximum wall thickness loss from the mining legs was 0.021 in. (15.7%) due to pitting. The maximum wall thickness loss from the primary line was 0.011 in. (7.1%). Extensive material was observed in the encasement both upstream and downstream of the cleanout box. The CH2M HILL Hanford Group, Inc. corrosion engineer specified a special flush designed to dissolve the corrosion product. Of particular note was the new knowledge that water typically does not drain effectively from the primary, and it was witnessed with video that the secondary also does not drain well. This brings into question the functionality of the secondary containment route to leak detection. This issue is addressed in detail in RPP-27591.

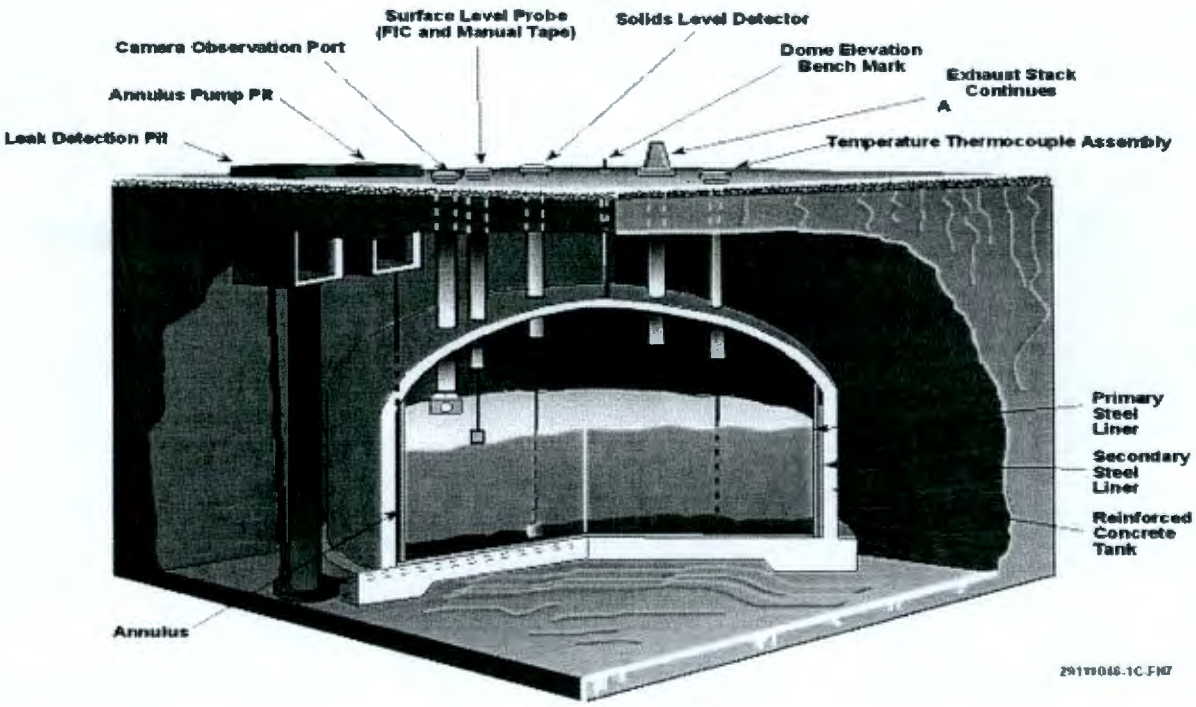
3.5 NEW SEISMIC RESPONSE SPECTRA

In February of 2005 PNNL, under contract with Bechtel Hanford, Inc., developed an updated seismic analysis for the Waste Treatment Plant. The analysis, documented in PNNL-15089, *Site-Specific Seismic Site Response Model for the Waste Treatment Plant, Hanford, Washington*, ultimately revealed that the previous seismic response model used for the tank farms was not sufficiently conservative. While this information was made available late into the DST seismic analysis effort, the new spectra were incorporated into the DST structural analysis model. Section 4.10 discusses the results of the related PNNL structural analyses.

4.0 ASSESSMENT OF THE DOUBLE-SHELL TANK STRUCTURES

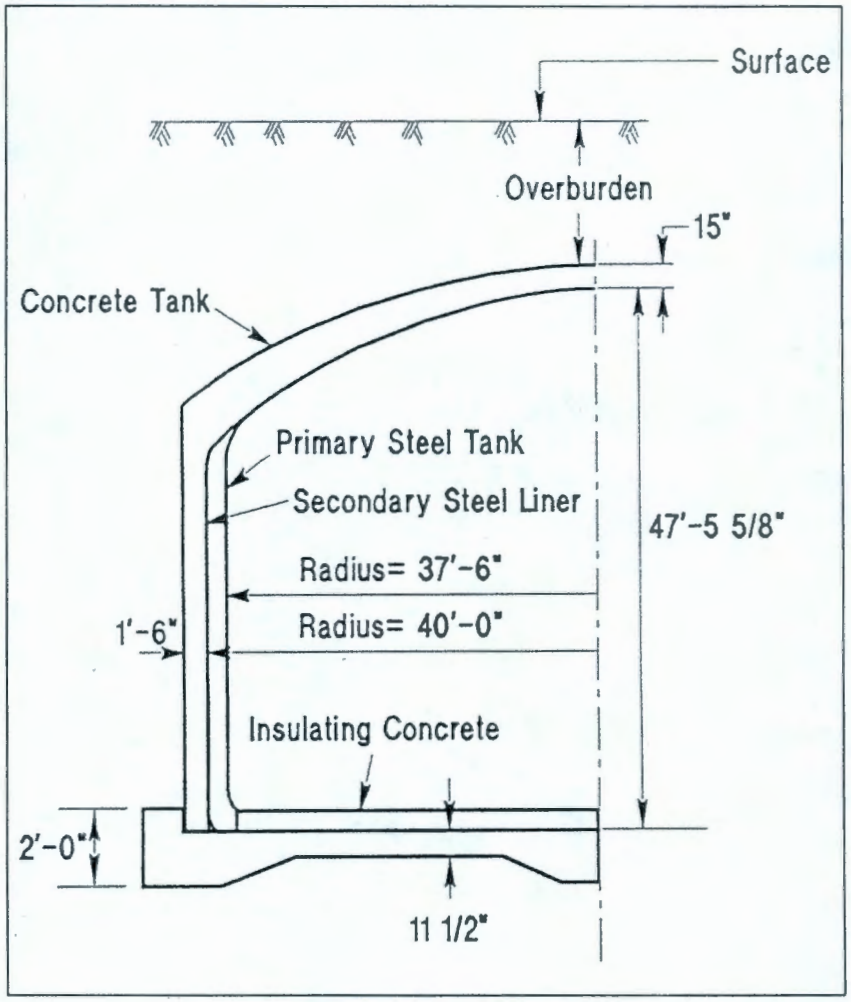
The DSTs are generally configured as shown in Figure 4-1. The DSTs consist of an inner, primary carbon steel tank and an outer secondary carbon steel shell. The secondary steel shell is encased in a rebar reinforced-concrete tank and dome structure to withstand the soil loading and provide radiation shielding. The primary tank is unrestrained at the bottom and rests on an 8-in.-thick layer of low-strength refractory concrete. The tank dome tops are nominally 7 ft below ground with numerous risers of varying sizes extending above grade for monitoring and process equipment access. Primary tank leak detection is provided by in-tank level monitoring probes, and by relatively accurate conductivity (+/-0.5 in.) or buoyancy based probes (+/- 0.04 in.) within the annulus space. Secondary tank leak detection is provided by annulus leak detection pits that use differential pressure based instrumentation, commonly referred to as 'dip tubes.'

Figure 4-1. General Double-Shell Tank Configuration.



The basic dimensions of each DST are provided in Figure 4-2. Not all the DSTs are designed exactly the same, however. There are minor differences in shell thickness, concrete thickness and foundation configuration. These differences are accounted for in the structural analyses discussed in Section 4.10.

Figure 4-2. Typical Dimensions of a Double-Shell Tank.



4.1 MATERIALS USED IN CONSTRUCTION

Table 4-1 provides a listing of the materials used in the construction of each tank farm with respect to the tanks only, along with their associated consensus standard.

Table 4-1. Summary of Material Design Specifications for Double-Shell Tanks.

Tank Farm	Primary and Secondary Tanks			Reinforced-Concrete Outer Tank					
	Carbon Steel	Min. Yield (ksi)	Min. Ult. (ksi)	Specified Compressive Strength (ksi)				Reinforcement	
				Dome	Wall	Foundation	Insulating	Rebar	Ties
241-AN	A537 Class 1	50	70	5	5	4.5	0.130	A615 Gr. 60	A615 Gr. 40
241-AP	A537 Class 1	50	70	5	5	4.5	0.130	A615 Gr. 60	A615 Gr. 40
241-AW	A537 Class 1	50	70	5	5	4.5	0.130	A615 Gr. 60	A615 Gr. 40
241-AY	A515 Gr. 60	32	60	3	3	3	0.200	A432 Gr. 60	A432 Gr. 60
241-AZ	A515 Gr. 60	32	60	3	3	3	0.200	A432 Gr. 60	A432 Gr. 60
241-SY	A516 Gr. 65	35	65	4.5	4.5	3	0.130	A615 Gr. 60	A615 Gr. 40

4.2 CONSTRUCTION METHODS

Review of construction photographs as well as the construction specifications indicates that after the concrete basemat foundation was placed, the secondary tank bottom was fabricated and tested while on temporary supports, lowered to the foundation basemat and then corrected to ensure flatness was within specified tolerances. After lowering it into position, the bottom was cleaned and cleared of debris prior to installing the refractory concrete pad on the secondary liner bottom, upon which the primary tank was constructed. The steel tank wall courses were then welded in place in a sequential manner, and finally the upper knuckles and dome fabricated. At this point, the secondary liner was nearly free standing without external support from the concrete walls.

The j-bolts were attached as the rebar 'cage' was fabricated. The concrete was then formed and poured to enclose the secondary sidewall and dome. After the concrete was appropriately cured for each tank, the belowgrade tank farm was backfilled with soil.

Figure 4-3 illustrates the construction of the tank bottoms at the 241-AN tank farm. The photograph shows the tank bottoms suspended for welding and inspection. Construction of the air slots in the refractory concrete pad is visible in the foreground.

Figure 4-4 illustrates multiple phases of tank construction at the 241-AP tank farm. It is clear that the primary tanks and secondary tanks were built in an alternating fashion. Notice the plate courses lying on the ground in the lower left of the photograph. Also note that the dome on the tank in the upper left is not yet installed.

Figure 4-3. Tank Bottoms Construction at 241-AN Tank Farm.

Figure 4-4. Multiple Phases of Tank Construction at 241-AP Tank Farm.

Figure 4-5 illustrates the final phase of the steel tank construction. Note that the annulus upper knuckle (haunch) pieces are laying on the ground surrounding the tank, ready for placement.

Figure 4-5. 241-AW Farm Tanks Annulus Haunch on Ground.

4.3 QUALITY CONTROL AND TESTING

Review of construction specifications indicates that quality assurance requirements generally were passed on to the construction contractor. It is evident that later specifications address quality control more explicitly than the earlier specifications.

4.3.1 Quality Control

Table 4-2 lists key quality control features addressed in the tank construction for each farm. The table indicates that quality control was thoroughly addressed and implemented for all tank farm construction projects.

4.3.2 Testing

Tables 4-3 and 4-4 list the various initial integrity tests performed on the tanks prior to their being placed into service. Each primary tank received a hydrostatic test to some level and a myriad of nondestructive examinations of the welds. These tables indicate that the primary tanks were fully qualified and rated to a level of at least 420 in.; 241-AP and 241-SY farm tanks were rated to a higher level. Rating of the secondary tanks varied greatly. RPP-22604, *IQRPE Evaluation and Documentation of DST Secondary Liner Issues*, was prepared to address rating of the secondary tanks. This issue is further addressed in Section 4.10.5.

4.4 ENGINEERING CODES REFERENCED FOR CONSTRUCTION

Table 4-5 lists the national consensus standards used in the design and construction of the Hanford waste tanks. ASME standards were used exclusively. ASME BPVC Section VIII was used for all but 241-AZ tank farm, where Section III was used. Table 4-5 demonstrates the proper use and application of national consensus standards in the design and construction of the Hanford waste tanks.

Table 4-2. Quality Control Features Addressed for Double-Shell Tanks. (2 Sheets)

Tank Farm and Spec.	Quality Control Addressed
241-AP farm B-340-C4	Quality control addressed: • Quality Assurance Plan preparation • Quality control personnel to conduct examinations • Qualification of welding procedures • Qualification of welders • Qualification of welding operators • Witnessing of tests by government personnel • Qualification contractor's examination personnel • Examination requirements
241-AP farm B-340-D1	Quality control addressed: • Engineering documentation requirements • Change control • Schedules, calculations • Design reporting • Submittal requirements • Engineering documentation records
241-SY farm B-101-C1	Quality control addressed: • Quality control personnel to conduct examinations • Quality control inspection and test procedures • Roll-out drawings • Castable refractory samples • Stress relief blanket insulation samples • Certification of materials • Qualification of welding procedures • Qualification of welding personnel
241-AN farm B-130-C4	Quality control addressed: • Quality Assurance Plan preparation • Quality control personnel to conduct examinations • Qualification of welding procedures • Qualification of welders • Qualification of welding operators • Qualification contractor's examination personnel • Examination requirements
241-AY farm HWS-7789	Quality control addressed: • Field quality control of concrete • Welder qualifications • Material control • Inspection and testing • Qualifications of procedures • Qualification of welders

Table 4-2. Quality Control Features Addressed for Double-Shell Tanks. (2 Sheets)

Tank Farm and Spec.	Quality Control Addressed
241-AW farm B-120-C4	Quality control addressed: • Field quality control of concrete • Welder qualifications • Material control • Inspection and testing • Qualifications of procedures • Qualification of welders
241-AZ farm HWS-8982	Quality control addressed: • Field quality control of concrete • Welder qualifications • Material control • Inspection and testing • Qualifications of procedures • Qualification of welders

Table 4-3. Tank Farm Hydrostatic Testing – Primary Tank.

Tank Farm	Height of Hydrostatic Tests Performed
241-AN	420 in. (35 ft)
241-AP	480 in. (40 ft)
241-AW	420 in. (35 ft)
241-SY	468 in. (39 ft)
241-AY	468 in. (39 ft)
241-AZ	468 in. (39 ft)

Table 4-4. Tank Farm Nondestructive Examination Testing. (2 Sheets)

Tank Farm and Spec.	Nondestructive Examination Tests Performed
241-AN B-130-C4[1]	**Radiography** 100% primary and secondary tanks including the bottom but excluding upper course to upper knuckle weld and not the dome **Magnetic particle** 100% inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Liquid penetrant** 100% of inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Visual** 100% of multi-pass welds only [1]241-AN-107 was a separate project (B-170), but it used the same inspection procedures as B-130.
241-AP B-340-C4	**Radiography** 100% primary and secondary tanks to and including upper course to upper knuckle weld, including the bottom, but not the dome **Magnetic particle** 100% inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Liquid penetrant** 100% of inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Visual** 100% of all welds
241-AW B-120-C4	**Radiography** 100% primary and secondary tanks, including the bottom, but excluding upper course to upper knuckle weld and not the dome **Magnetic particle** 100% inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Liquid penetrant** 100% of inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Visual** 100% of multi-pass welds only
241-SY B-101-C1	**Radiography** 100% primary to 382 in. and secondary tanks to 324 in. and including upper course to upper knuckle weld and the bottom, but not the dome **Magnetic particle** 100% inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Liquid penetrant** 100% of inside surface of primary and secondary tank bottoms including the top of lower knuckle welds **Visual** 100% of multi-pass welds only

Table 4-4. Tank Farm Nondestructive Examination Testing. (2 Sheets)

Tank Farm and Spec.	Nondestructive Examination Tests Performed
241-AY/-AZ HWS-7789/ HWS-8982	**Radiography** 100% of all butt welds on the primary tank, including the bottoms, except welds above the tangent between the upper knuckle and the side plates. 100% of all butt welds on the secondary tanks joining floor plates, knuckles and first course of side plates (12 in. above bottom on secondary). **Magnetic particle** Only where clips, lugs, etc. were removed or where damage was repaired as well as the first and last pass on all primary and secondary tank penetrations **Liquid penetrant** Each pass of welds joining airlift circulators to dome penetration pipe stubs for 241-AY. Maybe used in lieu of magnetic particle examination (MT) upon approval for 241-AZ. **Visual** 100% of all welds and each pass of multi-pass seams. **Vacuum box** The full length of all welds in the bottoms of the primary and secondary tanks to the top of the bottom knuckles.

Table 4-5. Tank Farm Design Code of Record.

Tank Farm	Design Code (ASME BPVC)
241-AN	Section VIII, Division 2, 1974 with 1976 Addenda
241-AP	Section VIII, Division 2, 1980 with W81 Addenda
241-AW	Section VIII, Division 2, 1974 with S75 Addenda
241-AY	Section VIII, Division 2, 1965
241-AZ	Section III, 1968
241-SY	Section VIII, Division 2, 1971 with 1973 Addenda

4.5 OPERATING SPECIFICATIONS

OSD-T-151-00007, *Operating Specifications for the Double Shell Storage Tanks*, provides specified operating ranges for the following parameters:

- Structural limitations
  - Liquid levels
  - Maximum primary tank waste liquid level
  - Minimum primary tank waste liquid level
  - Leak detection pits maximum liquid levels
- Hydrostatic load
  - Primary tank vapor space and annulus pressure
  - Solution and concrete temperatures
  - Maximum temperature for waste and concrete
  - Temperature changeover time and gradients for solution and concrete
  - Minimum number of operational thermocouples for 241-AY and 241-AZ farm tanks
- Confinement requirements
  - Filter differential pressure
  - High-efficiency particulate air filter temperature
  - High-efficiency particulate air filter in-place leak testing
- Other requirements
  - Air lift circulators operation.

Several safety measures are taken and identified as surveillance requirements (SRs) and Limiting Conditions of Operation (LCOs).

Most of these SRs and LCOs are strictly nuclear safety requirements to ensure operability of the system in question. However, two LCOs are designated as safety features to protect the structural integrity of the DST system. The LCOs in question are more specifically addressed in their associated Administrative Controls (AC) 5.14, "Dome Loading Controls," and AC 5.16, "Corrosion Mitigation Program," of HNF-SD-WM-TSR-006, *Tank Farms Technical Safety Requirements*.

HNF-SD-WM-TSR-006 identifies four parameters important to structural integrity; temperature, pressure, dome load, and corrosion. The Technical Safety Requirements (TSRs) only provide limits for dome load and corrosion. OSD-T-151-00007 provides limits for temperature and pressure.

4.6 CALCULATIONS FOR USEFUL LIFE

To date there has been insufficient data to develop a model or calculation to determine the remaining useful life of the Hanford DSTs. The following information is needed to make this determination:

- A credible degradation process
- A credible rate of degradation
- A credible failure mode
- A known initial wall thickness for each tank and plate course.

WHC-SD-WM-ER-585, *DST Remaining Useful Life Estimates,* was generated in 1996 to address this issue. That document addresses credible degradation process, rate, and failure mode. However, at the time, the actual wall thickness (other than nominal) of the tank plate courses were not known; therefore, an accurate DST remaining useful life was indeterminate. With the UT activities performed since then, this data is now available.

WHC-SD-WM-ER-585 also focuses on leak tightness rather than structural integrity. For that document the end of 'useful life' was defined as through-wall pitting. The earlier PNL-5488, *Prediction Equations for Corrosion Rates of A-537 and A-516 Steels in Double Shell Slurry, Future PUREX, and Hanford Facilities Wastes*, from 1985 presents data that suggests a failure due to non-uniform corrosion (e.g., pitting) is more likely than failure due to uniform (general) corrosion. UT examinations in the Hanford tanks have shown some indications of pitting at the liquid-vapor interfaces and little, if any, wall thinning due to general corrosion.

Table 4-6 summarizes the addresses credible degradation process, rate, and failure mode as provided in WHC-SD-WM-ER-585. Table 4-7 summarizes the results of all UT examinations of the 28 DSTs to date.

Table 4-6. Summary of Useful Life Basis Parameters.

Parameter	Basis
A credible degradation process	Corrosion, which through metal loss, reduces the ability of the tank to perform its function (to contain waste without leakage or structural collapse or rupture).
A credible rate of degradation	Pitting models have been developed in WHC-SD-WM-ER-585. The maximum credible liquid-vapor interface corrosion rate is found in Table 3-1 to be 2.8 mils/yr. A 35 mils/yr value is provided, but is only credible at boiling temperatures of $BiPO_4$ waste at the liquid vapor interface.
A credible failure mode	Through-wall pitting, resulting in waste leakage, as suggested by data in PNL-5488.
Known thickness of each plate course	Table 4-7 provides a listing of actual measured minimum wall thickness of each plate course on each tank (where available). Nominal is assumed otherwise.

Table 4-7. Average Measured Minimum Tank Wall Thickness By Nominal Plate Size.

Tank (241-)	Year Constructed	Fiscal Year Examined	Average Measured Minimum Wall Thickness By Nominal Plate Size (in.)				
			0.375 in. Plate 1	0.500 in.* Plate #1, #2, or #3	0.5625 in. Plate #3	0.750 in. Plate #4	0.875 in. Plate #5
AN-101	1980	2002	NA	0.492	NA	0.723	0.860
AN-102	1980	2001	NA	0.496	NA	0.747	0.870
AN-103	1980	2005	NA	0.503	NA	0.730	0.849
AN-104	1980	2006	NA	0.489	NA	0.744	0.859
AN-105	1980	1999	NA	0.474	NA	0.743	0.874
AN-105	1980	2002	NA	0.485	NA	n/exam.	n/exam.
AN-106	1980	1999	NA	0.494	NA	0.735	0.863
AN-107	1980	1998	NA	0.518	NA	0.765	0.862
AP-101	1983	2003	NA	0.508	0.5655	0.752	0.865
AP-102	1983	2005	NA	0.471	0.5065	0.710	0.810
AP-103	1983	2003	NA	0.492	0.5665	0.759	0.868
AP-104	1983	2004	NA	0.506	0.5785	0.766	0.864
AP-105	1983	2003	NA	0.496	0.5685	0.752	0.865
AP-106	1983	2005	NA	0.507	0.5565	0.762	0.863
AP-107	1983	2000	NA	0.511	0.5745	0.767	0.888
AP-108	1983	2000	NA	0.517	0.5745	0.761	0.880
AW-101	1978	2001	NA	0.492	NA	0.736	0.855
AW-102	1978	2002	NA	0.519	NA	0.756	0.867
AW-103	1978	1997	NA	0.510	NA	0.755	0.871
AW-104	1978	2002	NA	0.536	NA	0.781	0.882
AW-105	1978	2001	NA	0.500	NA	0.742	0.878
AW-106	1978	2002	NA	0.496	NA	0.735	0.875
AY-101	1971	2001	0.386	0.470	NA	0.732	0.863
AY-102	1971	1999	0.396	0.499	NA	0.742	NA
AZ-101	1968	1999	0.354	0.473	NA	0.730	0.872
AZ-102	1968	2003	0.358	0.493	NA	0.761	0.879
SY-101	1974	2004	0.319	0.491	NA	0.724	0.905
SY-102	1974	2004	0.333	0.493	NA	0.741	0.844
SY-103	1974	2004	0.334	0.492	NA	0.731	0.897

Note:

* Some tanks do not have a plate #1 that is 0.375-in. nominal and their plate 1 is 0.500-in. nominal. On others, plates #1, #2, and #3 are all 0.500-in. nominal. The minimum of plates #1, #2, and #3 is noted here in that case.

The credible degradation process does not result in a structural failure due to excessive loads. An assessment of the tank dome load control program was performed per RPP-20556, *IQRPE Assessment of the Dome Load Program for Double Shell Tanks*. The assessment was performed prior to issue of the concentrated load analysis (PNNL-15167 *Increased Concentrated Load Analysis* [same as RPP-RPT-25608]). While the assessment of the program found it to be adequate and sufficiently rigorous (with some minor recommendations), the PNNL concentrated load analysis confirms that the tanks should be able to withstand more load than can practically be applied. In light of this new information, the current program may be more rigorous than is necessary. Calculations for strength are further covered in Section 4.10, "Adequacy of Design."

It was originally planned to develop a table that determined the estimated remaining useful life (ERUL) for each tank. However, as the calculation progressed, it became evident that it would not be necessary. Based on the determined failure mode of through wall pitting and the thinnest wall section obtained from RPP-18444, *Ultrasonic Inspection Results for Double Shell Tank 241-SY-101 – FY2006*, the ERUL for tank 241-SY-101 is an additional 109 years. This is also considered conservative, since the corrosion rate for pitting is expected to slow as the pit deepens. It should be pointed out that the 0.319-in. minimum thickness value found in Table 4-7 is an average and was not used in the ERUL calculation. The inspection report (RPP-18444) indicates that the lowest measured minimum thickness on plate #1 was 0.306 in. This is the value used in the ERUL calculation, which assumes the pit initiates at area of plate that is the thinnest (this is conservative). The calculation is as follows:

$$ERUL = {}^{Minimum_Measured_Wall_Thickness}\!\big/_{Corrosion_Rate}$$

$$ERUL = {}^{0.306}\!\big/_{.0028}$$

Thus, $ERUL$ = 109 years

According to this calculation, tank 241-SY-101 will be the first tank to fail, assuming pitting initiates and continues, in the year 2115. If pitting were assumed to have initiated at construction (1974) with the current wall thickness as the starting point, tank 241-SY-101 would fail due to through-wall pitting in 2083. If pitting were to initiate in any part of tank 241-SY-101 other than plate #1, then the calculated ERUL would be considerably greater than 109 years.

The uncertainty here is the corrosion rate, which is based on laboratory data as opposed to monitored rates from in-tank corrosion monitoring equipment. Electrochemical noise corrosion monitoring, or equivalent, would be beneficial if installed on these tanks, to obtain a better estimate of the actual corrosion rate and improve the calculation. The UT data does provide a conservative rate for the above leak integrity calculations for perforation of the tank wall, since it assumes a constant corrosion rate at the thinnest measured portion of the plate. However, it is misleading to use those plate thickness values for structural integrity calculations, as the UT data only define localized wall thinning at certain locations, and not generalized plate thinning. For structural integrity, a better method would be to use the overall UT data to statistically determine the average plate thickness. This is discussed more fully in Section 4.12.

4.7 AGE OF THE TANKS

4.7.1 Time of Construction

Table 4-8 provides the service date for each tank farm from which the current age of the tank farm can be calculated. Note that the oldest tank farm is 241-AY and has 34 years of service in 2005. By 2028, it will have 57 years of service and be 17 years beyond its design life. Whereas 241-AZ tank farm is listed with a design life of 20 years, this was evidently based on financial data rather than engineering data. Since the designs of the 241-AY and 241-AZ tank farms are nearly identical, it can be safely assumed that the design life for 241-AZ tank farm is 40 years; equivalent to that of 241-AY tank farm. The 241-SY tank farm will also have exceeded its design life in 2028 by one year. The remaining farms will be somewhat inside their design life in 2028 by only a few years.

Table 4-8. Double-Shell Tank Age and Design Life Summary.

Tank Farm	Construction Dates	Service Date	Service Life (yr)[a]	Current Age
241-AN (7 tanks)	1980–81	1981	50	25
241-AP (8 tanks)	1983–86	1986	50	20
241-AW (6 tanks)	1974–76	1980	50	26
241-AY (2 tanks)	1968–70	1971	40	35
241-AZ (2 tanks)	1971–77	1976	20[b]	30
241-SY (3 tanks)	1974–76	1977	50	29

Notes:

[a] Service life is from WHC-SD-TWR-RPT-002.

[b] Based on financial amortization schedule only.

The fact that the above-mentioned tank farms' tanks will have exceeded their design life by 2028 is not to say that they will be unfit for use at that time. No basis for these design lives could be verified, nor is it known what the original designers considered to be minimum wall thickness, nor is it known what corrosion allowance they used.

4.8 REFRACTORY CONCRETE ISSUE

During a UT inspection activity, a video camera showed that material had fallen from the sides of the ventilation air slots located in the insulating concrete pad under the primary tank of 241-AZ-102. Subsequent structural concerns as well as the discovery of a 1971 laboratory test

report that indicated the insulating concrete might 'decompose' when immersed in tank waste raised questions with regard to the ability of the 241-AZ farm tanks to complete the cleanup mission.

The issue was evaluated per document RPP-19097. The evaluation was conducted by an expert in the field of refractory concrete, Dr. M. S. Crowley. Dr. Crowley estimated that the present insulating concrete pad retains about 80% of its original compressive strength. It also determined that there is sufficient margin to conclude that the tanks are safe to operate for more than 30 years from now. PNNL performed additional structural analyses per PNNL-14706. The analysis posed several scenarios of concrete thickness reduction and found that the most extreme loss of refractory concrete resulted in some plastic deformation and reversal of the stresses in the primary tank. A catastrophic failure of the liner due to catastrophic failure of the refractory is not indicated.

4.9 INSPECTIONS, TESTS, AND EXAMINATIONS

This section provides a description of the inspections, tests, and examinations that were performed to provide data for this assessment.

4.9.1 Double-Shell Tank Ultrasonic Testing

Beginning in 1998, the TFC began performing ultrasonic examinations on the DST primary tank walls. Each DST receives a minimum of two 15-in.-wide vertical examinations. While this is a small percentage of the primary tank surface area, several documents have been authored that analyze the overall effectiveness of gathering this amount of data. Based on some extensive UT examinations performed on tank 241-AY-101 and extreme-value statistical analysis, it has been shown that for general corrosion, the two 15-in.-wide examinations are likely adequate for their purpose (as indicated by review of PNNL-15415, *Riser Difference Uncertainty Methodology Based on Tank AY-101 Wall Thickness Measurements with Application to Tank AN-107*. PNNL-15415 was prepared following an inquiry regarding the statistical representativeness of the UT data. A white paper is provided in Appendix C that provides a discussion of the issues. Those issues were addressed in PNNL-15415. However, the TFC has decided to implement a doubling of the DST UT area (i.e., four 15-in.-wide vertical scans), for all new DST UT inspections, which reduces the statistical projection uncertainty by about 35%, for calculating the expected value of the deepest pitting or wall loss, that would be found if 100% of the tank could be inspected.

RPP-17750, *Engineering Task Plan for the Ultrasonic Inspection of Hanford Double Shell Tanks – FY2004*, provides inspection criteria as shown in Table 4-9.

Table 4-9. Ultrasonic Testing Inspection Criteria.

Flaw	Reporting Criteria	Acceptance Criteria
Pit	> 25% of wall thickness	<50% of wall thickness
Crack	> 0.10 in. deep	< 0.18 in. deep
Thinning	> 10% of wall thickness	< 20% of wall thickness

A basis for these criteria was not provided in RPP-17750; however, these criteria are specified in the Tank Structural Integrity Panel guidelines (BNL-52527, Section 7); which cite the ASME nondestructive examination requirements of ASME BPVC Section XI, Appendix III.

According to Table 4-10, several tanks have exceeded acceptable (20% of nominal thickness) wall thinning in some areas. The various structural analyses performed and discussed in Section 4.10 utilize a 0.060-in. corrosion allowance in determining structural integrity. A 0.060-in. allowance corresponds to a 16% loss in wall thickness on a 0.375-in. nominal plate thickness. The greatest percentage of wall thickness loss was on tank 241-SY-101, plate #1, where the wall thinning is approximately 18.4%. Because this is less than the corrosion allowance the structural integrity of the tank could be in question based on the current analyses. However, the 18.4% value does not reflect the average thinning across the plate. A structural analysis would consider the average minimum measured thickness, which is 0.319 in. The wall thinning based on average measured minimum wall thickness is then 15%. This is 1% less than the corrosion allowance.

A corrosion rate based on the average minimum measured wall thickness, the nominal wall thickness, and a corrosion initiation date of 1974, comes to 1.8 mils/yr (0.0018 in./yr). Because the corrosion rate may have varied over time, it is not known – and possibly not knowable –whether this rate is conservative. Projecting this corrosion rate onto tank 241-SY-101 plate #1 at its current average measured minimum wall thickness results in it reaching the end of its corrosion allowance in just over two years. While two years is significant with regard to completion of the 2028 mission, it must be pointed out that this value is based on very conservative inputs; namely, the use of the average minimum measured wall thickness and the corrosion rate. The average minimum measured wall was used since an average wall thickness is not provided in the inspection reports. Another conservative input is the corrosion rate, which is based on an average over the life of the tank. The IQRPE is aware of the history of the tank 241-SY-101 waste rollover events (also referred to as 'burping'). These events frequently caused the waste levels to rise and fall, which may have contributed to accelerated corrosion. If so, then because the rollover events have been eliminated, the corrosion rate may now be considerably less. The current wall thickness measurements may now be considered baseline data and the next round of UT measurements could be used to estimate an actual corrosion rate under tank conditions that exist for the post rollover event period.

Table 4-10. Double-Shell Tank Chronological Inspection Results Findings. (3 Sheets)

Tank	Inspection Year (FY)	Reportable Plate Crack Indication	Reportable Plate Pitting	Reportable Plate Thinning	Reportable Weld Thinning, Pitting or Cracking
241-AW-103	1997	None	None	None	None
241-AN-107	1998	None	None	None	None
241-AN-106	1999	None	None	None	None
241-AN-105	1999	None	None	Two very minute areas of a plate (20% maximum reduction in thickness) [a]	None
241-AZ-101	1999	None	None	One area of a plate (11.4% maximum reduction in thickness)	None
241-AY-102	1999	None	None	None	None
241-AP-107	2000	None	None	None	None
241-AP-108	2000	None	None	Two minute areas of a plate (13.8% maximum reduction in thickness)	None [b]
241-AW-101	2001	None	None	A pit like indication in a very minute area of a plate (16% maximum reduction in thickness).	None
241-AW-105	2001	None	None	None	None
241-AY-101	2001	None	Pit-like indication at historical liquid-air interface	Some pit-like indications identified as thinning	Three areas of 10% wall thinning in vertical welds
241-AN-102	2001	None	None	One minute area of a plate (11% maximum reduction in thickness)	None

Table 4-10. Double-Shell Tank Chronological Inspection Results Findings. (3 Sheets)

Tank	Inspection Year (FY)	Reportable Plate Crack Indication	Reportable Plate Pitting	Reportable Plate Thinning	Reportable Weld Thinning, Pitting or Cracking
241-AN-101	2002	None	None	One small area of a plate (12 % maximum reduction in thickness)	Four local areas near vertical welds (14% maximum reduction in thickness)
241-AW-106	2002	None	None	One small area	10.4% maximum reduction in thickness
241-AY-101	2002	Not Investigated	None	72 areas of >10% wall thinning, most in the historical liquid-air interface in plate #2 (20.2% maximum reduction in thickness)	Not investigated
241-AW-104	2002	None	None	None	None
241-AW-102	2002 & 2003 [c]	None	None	None	None
241-AN-105	2002	None	None	None	Not investigated
241-AP-101	2003	None	None	None	None
241-AP-105	2003	None	None	None	None
241-AP-103	2003	None	None	None	None [d]
241-AZ-102	2003	None	None	Six small areas in the vicinity of the liquid-air interface in plate #2 (13.2 to 17.8% maximum reduction in thickness)	Three small areas of wall thinning near the plate #1 vertical weld (10.9 to 16.8% maximum reduction in thickness)
241-SY-103	2004	None	None	Six small areas in the plate #1 vapor space (10.4 to 12.8% maximum reduction in thickness)	None

Table 4-10. Double-Shell Tank Chronological Inspection Results Findings. (3 Sheets)

Tank	Inspection Year (FY)	Reportable Plate Crack Indication	Reportable Plate Pitting	Reportable Plate Thinning	Reportable Weld Thinning, Pitting or Cracking
241-SY-101	2004	None	None	Numerous areas in the vicinity of the historical liquid-air interface on plate #1 (10.4 to 18.4% maximum reduction in thickness)	Numerous areas in plate #1 and two areas in plate #2 (10.6 to 17.3% maximum reduction in thickness)
241-SY-102	2004	None	None	Numerous areas in plate #1 (10.1 to 12.5% maximum reduction in thickness)	One small area in plate #1 (10.7% maximum reduction in thickness)
241-AP-104	2004	None	None	None	None
241-AP-106	2005	None	None	None	None
241-AP-104	2005 [e]	Not investigated	None	None	Not investigated
241-AP-102	2005	None	None	Two areas of plate #2 (14% maximum reduction in thickness)	Five areas of thinning in the HAZ of plate #4 (13% maximum reduction in thickness)
241-AN-103	2005	None	None	None	None
241-AN-104	2005 & 2006 [f]	None	None	None	None

Notes: This table was taken directly from RPP-RPT-26254.

[a] Based on a review of the tank 241-AN-105 data gathering technique in FY 1999, prompted by the FY 2002 results, the FY 1999 apparent wall thinning data is considered to have been an artifact of improper equipment set-up and operation (viz., grinding down of the transducer crystal as it traversed the tank wall).

[b] Although below reporting criteria at the time, one linear crack-like indication 6 in. long by 0.142 in. deep in a nominal 0.750-in.-thick plate was observed. Subsequent examination of tank 241-AP-108 in FY 2002 revealed no change in size.

[c] Primary knuckle examination using TSAFT conducted in FY 2003.

[d] One linear crack-like indication 2.92 in. long in the weld heat-affected zone of a nominal 0.875-in.-thick plate was detected. A follow-up inspection determined that the indication is a small area of incomplete fusion that is not open to either surface of the tank.

[e] Primary tank upper knuckle examination only.

[f] Primary tank lower knuckle examination using an alternate P-scan technique was conducted in FY 2006.

FY = fiscal year.
TSAFT = tandem-synthetic aperture focusing technique.

4.9.2 Double-Shell Tank Visual Examinations

The TFC performs both primary tank internal video examinations and secondary annulus video examinations. The best practice for these examinations would be to provide personnel with experience in visual inspection and qualified to consensus standards. Qualified personnel in most cases have conducted the video examinations. However, qualified personnel historically have not prepared the video reports. If qualified personnel have ever provided input to the video reports, it is not evident in their content. Video captures are not adequately annotated, nor is there discussion of specific areas of interest identified in the videos. These areas of interest are identified by extreme close-ups or audio narration on the video.

Recent primary and annulus inspection videos for each tank, with the exception of AZ-102 and the AW-101 annulus were reviewed on behalf of the IQRPE by an industry tank inspector who is certified by the American Petroleum Institute (API) under API 510, *Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair, and Alteration*, API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*,, API 570, *Piping Inspection Code - Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems*, and who holds a National Association of Corrosion Engineers (NACE) Level 1 Coating Inspector certification as well. A listing of these videos along with the tank inspector's review notes is provided in Appendix E. At least one video per DST was reviewed.

In general, the tanks exhibit notable vapor space corrosion. However, due to the sparse historic information, it cannot be determined if the corroded vapor space was present at construction or from the uninhibited water used for the acceptance hydrotesting, or from subsequent tank operation. It also cannot be determined with the current video technology used by the TFC whether there is through-wall pitting in the tank domes. It should be noted that upper dome through-wall penetrations would have no operational impact, as long as it was above the highest level that waste could be stored. Also, both the primary tank air and annulus air pass through high-efficiency particulate air filters, so there is also no radiological release concern. Thus, the only region of concern with regard to through-wall pitting would be those regions of the tank wall that are above the present waste level, but below the allowable waste height. Severe pitting corrosion around riser penetrations would have an operational impact for riser-installed heavy equipment should the corrosion reduce the ability of the riser to support a vertical load.

4.9.3 Tank Settlement Surveys

As discussed in RPP-20556, Ecology Guidance Document 94-114 lists one of the items to check for during an external visual inspection of a tank is "evidence of excessive or uneven settlement of the tank foundation such as distortion and cracks around anchor bolts attaching a tank to an underlying concrete pad." Since the tank structure is buried, a visual inspection to this extent is not possible. It is therefore necessary to use other means of detecting evidence of tank settlement. The preferred method selected was tank settlement surveys. Surveys of this nature have been performed in the past on the DSTs and are regularly performed on the SSTs. The last surveys performed on the DSTs were obtained over the time period between 1989 and 1998. The data sheets for those surveys may be found in RPP-25782, *DST Dome Survey Program*.

Appendix D of RPP-25782 provides a detailed analysis of the settlement data available. No significant settling was indicated. A recent survey of each tank farm was performed for the sake of this report. The data sheets for each of those surveys was reviewed and the results are discussed in the following subsections.

4.9.3.1. 241-AN Tank Farm Surveys. The survey data obtained for the 241-AN tank farm is not comparable to the previous surveys. This is because the original survey monument was destroyed and there is no known relationship to the outside control monument. This means that the current survey data for 241-AN tank farm is now the new baseline data. Determination of settling for this tank must rely on the annulus tank videos. The videos show no significant or visible deformation of the tank annulus internal structures. This is an indication that severe settling has not occurred.

4.9.3.2. 241-AP Tank Farm Surveys. Tank settlement surveys have not previously been performed for this farm. This means that the current survey data for 241-AP tank farm is now the baseline data. Determination of settling for this tank must rely on the annulus tank videos. The videos show no significant or visible deformation of the tank annulus internal structures. This is an indication that severe settling has not occurred.

4.9.3.3. 241-AY Tank Farm Surveys. Until recently, only two risers were surveyed on each of the 241-AY farm tanks. The new survey included five additional risers, which are now baseline. The maximum settling detectible on tank AY-101 is 0.132 in. at riser-078, which is located at the perimeter of the tank. No settling is detectible on tank AY-102; in fact, the surveys are showing some slight uplift of 0.13 to 0.18 in. at riser-077 and sluice pit 02C, respectively. These values for settling and uplift on the two tanks in the 241-AY tank farm are insignificant and of no concern.

4.9.3.4. 241-AZ Tank Farm Surveys. Two risers were historically surveyed on the 241-AZ farm tanks. The new survey included five additional risers, which are now baseline. The maximum settling detectible on tank 241-AZ-101 is 0.300 in. at riser-046, which is located at the center of the tank. Settling at this riser may be more dome deflection than tank settling. Riser-078 reports settling of 0.144 in., which is more representative of settling. Tank 241-AY-102 is showing some slight uplift at the perimeter riser-044 of about 0.036 in., and dome deflection of 0.072 in. at riser-067 located on the dome. These values for settling, dome deflection, and uplift on the two tanks in the 241-AZ tank farm are insignificant and of no concern.

4.9.3.5. 241-AW Tank Farm Surveys. The survey data obtained for the 241-AW tank farm is not comparable to the previous surveys. The original survey monument was destroyed and no known relationship to the outside control monument exists. Accordingly, the current survey data for the 241-AW tank farm is now the new baseline data. Determination of settling for this tank must rely on the annulus tank videos and/or above ground observation of risers. The videos show no significant or visible deformation of the tank annulus internal structures. This indicates that severe settling has not occurred. Videos were not obtained in time for the AW-101 annulus;

therefore observation of above ground risers and primary tank videos is the only method for assessing tank settlement. Severely off-vertical risers or visible buckling of the primary tank walls would indicate gross tank settlement. The videos for the AW-101 annulus will need to be obtained and reviewed by an independent certified tank inspector in time for the next revision to this document, scheduled for September 2006.

4.9.3.6. 241-SY Tank Farm Surveys. Two risers were historically surveyed in the SY farm tanks. The new survey included three additional risers, which are now baseline. The maximum settling detectible is 0.156 in. on tank SY-101 at riser-009, which is located near the center of the tank. Settling at this riser may be more dome deflection than settling. Riser-037 reports a settling of about 0.132 in., which is at the perimeter and more representative of settling. Maximum detectible settling at the perimeter on tank SY-103 was 0.074 in. Tank SY-102 indicates some slight uplift of 0.072 in. at the perimeter. These values for settling, dome deflection and uplift on the two tanks in 241-AZ tank farm are insignificant and of no concern.

4.9.4 Tank 241-AN-101 Supplemental Ultrasonic Testing

During a review of the primary tank video of tank 241-AN-101, the API tank inspector noticed some circumferential rings of pitting networks at numerous elevations up the side walls of the tank. It was thought that the rings might correspond to long periods of static waste levels at those elevations, but a review of tank level history proved this to not be the case. Previous UT data samples were reviewed that corresponded with the elevations of suspected pitting networks. No pitting patterns could be seen; however, the responsible American Society for Nondestructive Testing (ASNT) Level III inspector pointed out that there had been some 'lift-off' of the transducers. The lift-off was presumed to be due to some mill scale on the carbon steel plate.

It was decided that a supplemental UT activity would be required to learn whether the pitting patterns were an illusion due to light shadows or residual waste product. A CH2M HILL Hanford Group, Inc. system engineer assisted in mapping the potential pitting locations on a diagram based on a detailed review of the tank video in conjunction with simple geometric formulas. Supplemental UT was performed at an area on the tank that was readily accessible and had a high probability of catching some of the potential pitting. The mill scale was mechanically removed prior to measurement, and the UT crawler was run circumferentially along the suspect areas of potential pitting. As shown in Figures 4-6 and 4-7, linear patterns of horizontal pitting were found along the suspected pitting regions. The depths of the pits were not reportable due to their shallow penetration. However, this demonstrated the value of visual inspections by qualified inspectors and the use of supplemental UT to quantify identified areas of corrosion.

Figure 4-6. Tank 241-AN-101 Plate #2 Pitting with Visual Indications.

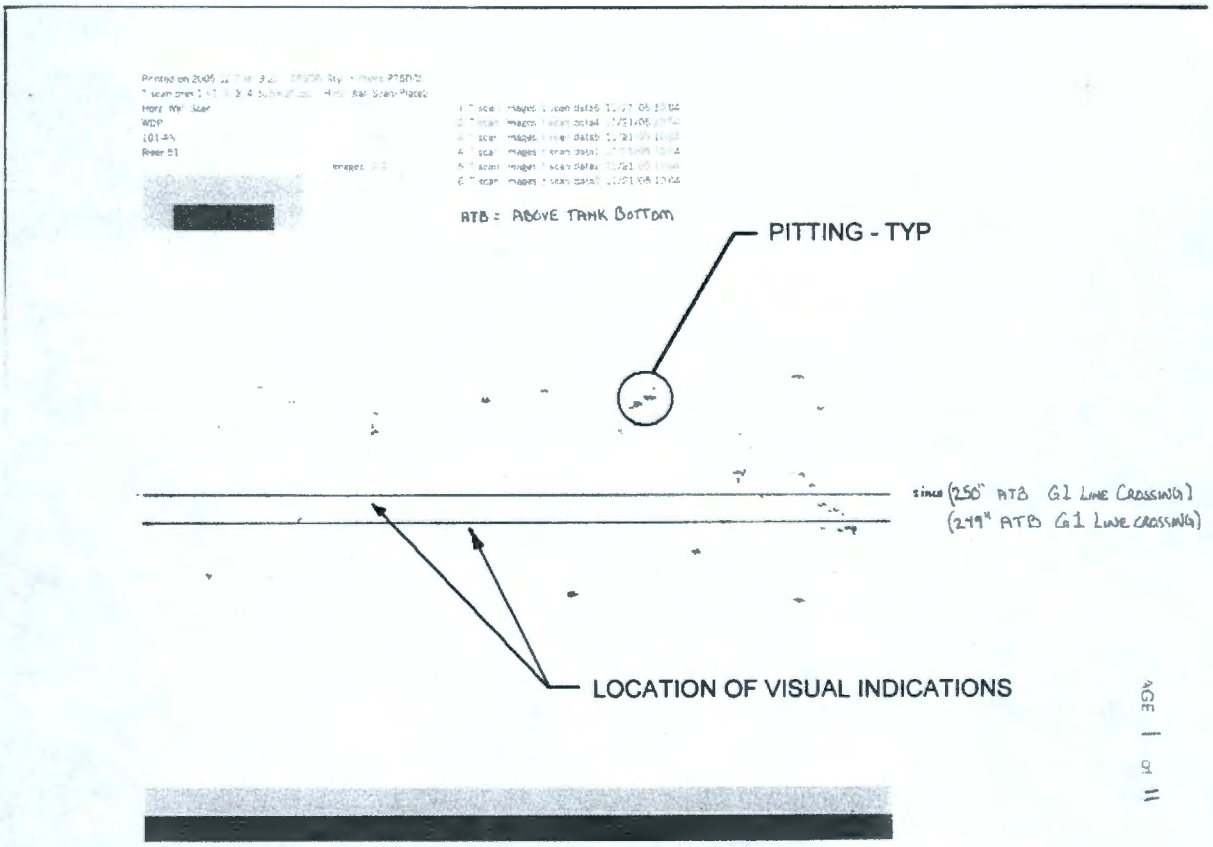
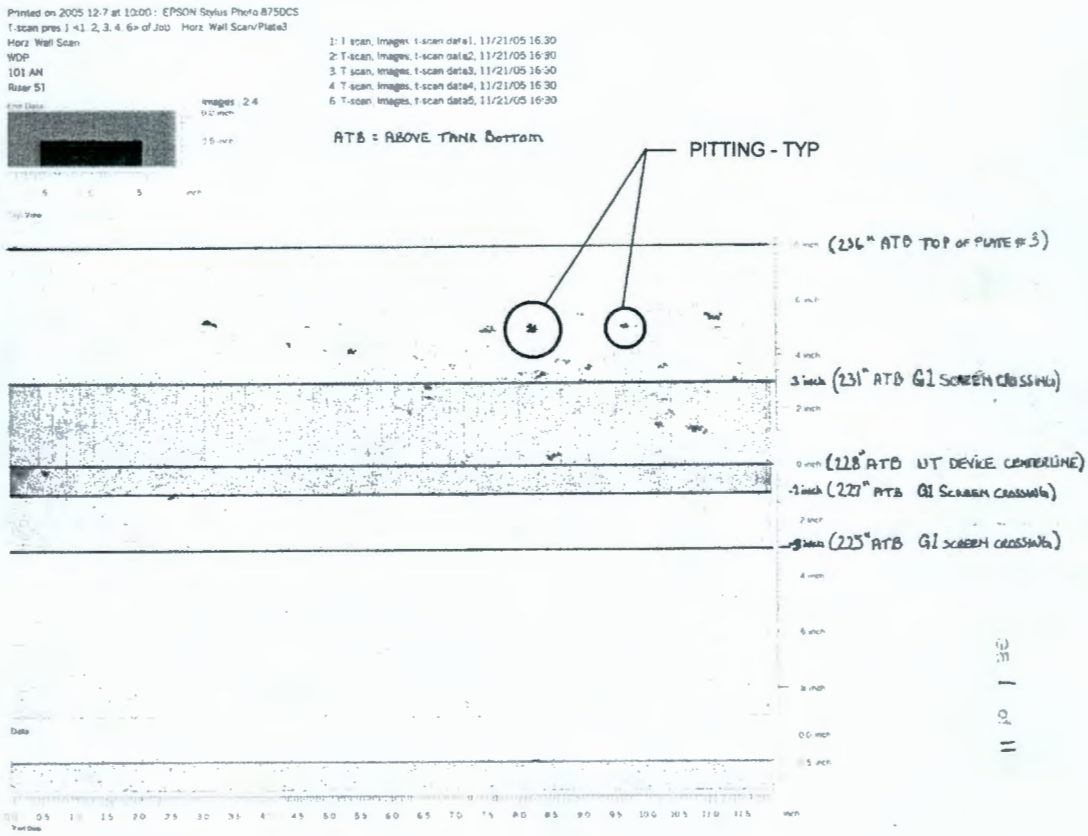


Figure 4-7. Tank 241-AN-101 Plate #3 Pitting Data with Visual Indications.



4.10 ADEQUACY OF DESIGN

All original DST design calculations and decision documents are not available. It was therefore necessary to analyze the loads on the tanks and the resulting stresses to assess the adequacy of the DST design. Further, it was deemed prudent to model the design loads on the tanks that cycle with annual thermal gradients over the current life of the tanks and beyond. This cyclic accounting allows for fatigue of the steel, cracking of the concrete, and creep of the concrete. Several separate analyses were needed to accomplish this, including thermal and operating loads analysis, concentrated loads analysis, buckling loads analysis, and seismic loads analysis. Where appropriate, the analyses incorporated a 0.060-in. corrosion allowance, which was intended to account for an assumed 1 mil/yr corrosion rate for 60 years. The following sections present and assess each analysis performed. These analyses were performed using load criteria that are conservative; for instance, a waste temperature of 350 °F. The tanks do not routinely, if ever, experience temperatures this high. For temperature cycling, maximum permissible increase/decrease rates are used as described in OSD-T-151-00007. In addition, the design for the 241-AY farm tanks was selected as bounding. These tanks feature dimensional configurations that are less robust than the remainder of the tanks in the DST system. Because the 241-AY and 241-AZ farm tanks cannot be filled to the maximum 422 in., the

dimensional differences are appropriate, but represent a bounding model for the other tanks. Simply stated, tanks currently in operation in the tank farms are not experiencing the relatively extreme conditions being analyzed by the documents discussed in this section. The purpose of performing these analyses at these extreme conditions is to provide confidence that the tanks can withstand, and have withstood, any conditions that may occur in the future or may have occurred in the past. The results are favorable in that because the tanks perform well at these extreme conditions, it can be inferred that they are currently performing well at their current normal operating conditions.

Two nationally recognized experts in the field, Mr. Bob Kennedy and Mr. Andy Veletsos, performed an independent review of the seismic portion of the PNNL analyses. These experts concluded that the PNNL analyses were comprehensive and of high quality; however there were some minor issues that required addressing. The issues involved the protocols for application of loads to J-bolts in the upper dome of the tanks, and the application of friction forces and the horizontal seismic component. These concerns are related to establishing a more definitive link between code compliance requirements for new construction and the seismic analyses, and do not affect the normal operating loads of the tanks. Nevertheless, this document will require revision to appropriately incorporate the expected revisions to those analyses once available.

4.10.1 Thermal and Operating Loads Analysis

RPP-RPT-23308, *Hanford Double Shell Tanks Thermal and Seismic Project – Thermal and Operating Loads Analysis*, developed by PNNL, documents a new finite element analysis of the DSTs. The document in its original form did not include seismic loading. The seismic portion of the analysis was scheduled for a later date. RPP-RPT-23308 documents the DST thermal and operating loads analysis and provides a thorough, defensible, and documented analysis that was intended to be a part of the overall analysis of record for the DSTs. The thermal and operating loads analysis included the static loading only and are considered to be very conservative. The seismic demand and associated load combinations is documented in a separate report, which is discussed in Section 4.10.3.

The basis of most of the analytical work presented in RPP-RPT-23308 is an ANSYS® finite element model that was developed to represent a bounding case tank and includes the effects of temperature on material properties, creep, concrete cracking, and various loading conditions. The temperature loads imposed on the model for the finite element analyses are significantly more severe than any service to date, or proposed for the future. The material properties and design/construction parameters were selected to be bounding for all DSTs.

The structural evaluations completed for the representative tank model results do not reveal any major structural deficiencies with the integrity of the DSTs. The analyses are projected to represent 60 years of use, which goes well beyond the current date of this report.

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The highest and most obvious area of concern through each analysis is the potential for SCC evaluation in the primary tank lower knuckle. The tensile stress on the inner surface of the bounding analysis consistently exceeds the original design allowable of 90% of the yield strength, during the temperature increase portion of the thermal cycle. Previous investigators have already made mention of this issue, and PNNL was tasked to evaluate this 90% of yield criteria (RPP-RPT-27574, *Evaluation & Recommendation of Stress Criteria for Stress Corrosion Cracking of Hanford Double Shell Tanks*). As further described in Section 4.10.4, no adequate technical basis could be established for the 90% yield criterion, and no similar requirements for addressing SCC were found in ASME codes or other regulatory requirements.

PNNL developed an alternative fracture mechanics method for predicting SCC growth in the tank to be consistent with the recommendations a panel of experts that was convened to address SCC. The material modeling strategy of the supporting structure (insulating concrete, slab, and the soil below) has a significant impact on these results. The UT inspection program has inspected the high-stress knuckle regions of six DSTs to date, and no evidence of cracking or linear defects has been found. Additionally, there is no evidence of a leak from any of the post-weld stress relieved tanks at Hanford or the Savannah River Site. However, a continued inspection program to periodically monitor this region, as part of the ongoing UT inspections, is warranted.

The other area of some possible concern was the reinforced-concrete slab under the secondary tank. The slab experiences demands higher than capacity for certain combinations of materials. However, the conservative assumptions regarding the slab thickness and concrete strength, which are discussed in the results of RPP-RPT-23308, lead to the conclusion that the concrete slab is adequate.

Analyses were conducted on the reinforced-concrete structure and evaluated as specified in the American Concrete Institute (ACI) for demand-to-capacity ratios per ACI 349. This was completed for six conditions in which variations were allowed for the soil modulus, concrete modulus, concrete strength, and creep. These variations included low, nominal, and high values in combination to create conservative conditions. Three ACI load combinations were evaluated for each of the six conditions. In general, the demand-to-capacity ratios for the reinforced concrete did not exceed 1.0 for all six runs and load combinations. However, there were several instances in which the demand-to-capacity ratio for several sections in the slab exceeded 1.0. These instances were observed during different runs to be either the result of compressive axial loads with flexure or in the shear direction.

After consideration was given to the conservative assumption that the 2.5-in. depth of the cooling channel in the slab was not included in the calculations and the conservatism of the heating and cooling extremes of the waste, all the concrete sections are adequate. Also, there were several instances where there was net tension across the section, which would result in a demand-to-capacity ratio exceeding 1.0. The ACI neglects any tension capacity of the concrete, and the ANSYS® finite element allows for some tension for numerical stability purposes. Therefore, calculations were performed in which the tension load was all transferred to the reinforcement, which showed adequate capacity to carry the demand.

In RPP-RPT-23308, all sections of the primary tank were evaluated to ASME BPVC Section VIII, Division 2, and there were no instances where the membrane stresses exceeded the maximum shear stress limit (S_m), where the local membrane plus bending exceeded 1.5 S_m, or where the local membrane plus bending plus thermal exceeded 3.0 S_m. Therefore, under conditions that did not include seismic loading, the primary tank was compliant with the ASME BPVC and was considered adequate.

Buckling of the primary tank was evaluated under the guidance of ASME BPVC Case N-284-1. The buckling criteria for the cylindrical tank section was satisfied by the respective tank vacuum limits, provided that the vacuum transient loadings are categorized as Service Level C loads. The upper and lower knuckles were demonstrated to readily satisfy the buckling criteria.

The evaluation criteria for the secondary tank liner were strain-based and taken from ASME BPVC Section III, Division 2, Subsection NC for normal service loads. The results in all cases demonstrated that the secondary liner strains were all well below the allowable strain levels; therefore, the secondary liner was considered adequate.

Evaluation of the J-bolts was conducted in accordance with ASME BPVC Section III, Division 2, Subsection CC-3730. Mechanical (non-self-limiting) loads were evaluated against a force criterion after 60 years of tank operation. The thermal loads were included in the displacement limited load evaluation so that the evaluation was conducted at each load step of the final thermal transient. In all cases for the force and displacement evaluations, the J-bolts were within the allowable range.

The insulating concrete was modeled as an elastic material with no plasticity and no cracking or crushing. As a non-structural member, the only code evaluation required was for bearing stress. The results from ANSYS® show that the bearing stress was significantly less than the allowable, and therefore, the insulating concrete was (and is) adequate.

4.10.2 Increased Concentrated Load Analysis

RPP-RPT-25608 documents the increased concentrated load analysis task of the DST analysis program. Tank operations are restricted by the existing limit on concentrated live load. This task provided a detailed analysis of the effects of an increased load above the soil surface on the structural capacity of the DST.

The basis of the analytical work presented in RPP-RPT-25608 is an ANSYS® finite element model previously developed to represent a bounding DST in RPP-RPT-23308. The model included the effects of soil surface loads in addition to the waste level, temperature, thermal creep, and specific gravity. The increased concentrated load analysis does not consider the effects of the seismic demand on the tank structure. It was anticipated that when the seismic demand was included, it would only affect the maximum concentrated load and not change the conclusion regarding structural integrity at a 400,000 lbf concentrated load.

The structural evaluations indicated that current restrictions on concentrated live load are conservative. The results revealed that the concentrated load can exceed 400,000 lbf and still

satisfy code requirements. Additional analyses were conducted on the reinforced-concrete secondary tank structure and evaluated as specified in ACI 349 for demand-to-capacity ratios. The concentrated load limit based on the ACI evaluation is identified as 1,575,000 lbf.

All sections of the primary tank were evaluated to ASME BPVC Section VIII, Division 2. It was observed that the maximum concentrated load was governed by the ACI limits. The primary steel liner showed adequate margin at the concentrated load limit (of 1,575,000 lbf) established by ACI 349.

A nonlinear analysis of the DST was conducted at loads exceeding the code limits to determine the soil surface deflection. It is intended for that data to be used in conjunction with a dome deflection surveillance program to monitor the condition of the tanks. No dome deflection limits are currently set for DSTs.

4.10.3 Seismic Load Analysis

RPP-RPT-28968, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis*, was developed to address the combined thermal and operating loads analysis with the seismic analysis. A significant effort was put into the seismic portion of the analysis, RPP-RPT-28966, *Hanford Double-Shell Tank Thermal and Seismic Project – Seismic Analysis of Hanford Double-Shell Tanks*, which included consideration and inclusion of results from the Waste Treatment Plant analysis (PNNL-15089) as well as loads induced through sloshing of the tank waste.

The resulting analysis on the primary tank indicates that the demands on general membrane stress intensity, general primary membrane plus bending stress intensity and the primary plus secondary stress intensity range are well within the allowable capacity for each of four material combinations analyzed.

Loads due to sloshing of the waste within the tanks during a seismic event were also evaluated. The analysis shows that under these conditions, the stress intensity demand is well below capacity in the upper regions of the tank. Even a substantial increase in the seismic demand would not be cause for concern.

A significant amount of effort was also put into the evaluation of SCC in the primary tank shell. The ensuing discussion included consideration of SCC experiences at the Savannah River Site as well as recent laboratory analysis. It is made clear that under current DST operating conditions, SCC is not a concern. Additional modeling was also performed to determine whether SCC might be of concern following a seismic event. It was found that the event induces load reversal and a subsequent decrease in surface stress, returning the stress state to the normal operating conditions. A more detailed discussion of SCC analysis work performed is provided in Section 4.10.4.

The criteria used to evaluate the combined thermal and operating plus seismic loads were extracted from BNL-52361, *Seismic Design and Evaluation Guidelines for the Department of Energy High Level Waste Tanks and Appurtenances*, guidelines. These guidelines, established

by experts in the field, for underground nuclear waste storage tanks suggested utilization of ASME BPVC Section III, "Service Level D." The DST primary tanks pass the "Service Level D" criteria which means that they will not rupture or leak, or exhibit catastrophic failure following exposure to the loads analyzed in the seismic event. However, it must be pointed out that "Service Level D" (and also "Service Level C") criteria do permit deformations in the tank structure to the extent that the tank may need to be removed from service and/or repaired following exposure to the loads analyzed in the seismic event. It is also noted that the concrete dome and shell comprising the outer containment, are quite robust and readily survive the design basis earthquake (DBE), meaning secondary containment is also maintained in this event. We also note that the majority of the tanks were designed to ASME Section VIII of the BPVC, not Section III, which have a similar description of the effects of a DBE. It is considered acceptable to analyze them at this time to Section III since the Brookhaven National Laboratory guidelines (BNL-52361) from which it came were specifically developed for underground nuclear waste storage tanks, while ASME BPVC Section VIII contains no specific provisions for the design of buried tank structures.

It is also important to consider the combined thermal and operating plus seismic loads with respect to the stress level necessary to cause permanent diametral expansion of the tank, and the even higher stress level that would rupture the primary tank. The steels chosen for the primary tanks have significant ductility, with the ultimate rupture stress being approximately two times the yield strength (at the onset of plastic deformation). In the bounding case of the AY and AZ tanks, the A515-65 steel has an ASME code specified yield strength of 29.2 ksi at 200 °F and 27.85 ksi at 350 °F. The other tanks used higher strength materials. The maximum stress capacity specified in the Brookhaven National Laboratory guidelines allows the primary membrane stress to just reach the yield strength in the low probability event that the maximum earthquake occurs in combination with the maximum thermal and operating loads. This limit ensures that there will be no permanent diametral expansion of the tank under the action of primary (non self limiting) loads. Also built into this allowance is the understanding that the steel is ductile and the ultimate strength is significantly higher than yield. Within this context, the current analysis shows that the thermal and operating plus seismic loads result in a maximum primary membrane stress (Pm=22.5 ksi) that is 81% of the allowable, which is the yield strength at 350 °F (or 77% of the yield strength at 200 °F). Therefore, the conservative loads used in the current analysis would have to be increased by 25% before permanent diametral expansion would occur in the bounding primary tank. The ASME code specified ultimate strength of A515-65 steel is 60 ksi for temperatures up to 500 °F. Comparing against the ultimate strength, the maximum combined loads result in a stress that is only 38% of the stress necessary to rupture the primary tank. Putting this into context:

1. The conservative loads assume in the thermal and operating loads and seismic analyses will not cause permanent diametral expansion of the bounding (241-AY) primary tank design.

2. The loads would have to be increased by approximately 163% to cause rupture of the bounding primary tank.

4.10.4 Special Considerations – Stress Corrosion Cracking

The original design specifications for the Hanford DSTs require that detailed stress calculations be performed. One provision of the functional design specifications imposed a requirement stating that the maximum stress for the inner liner should be less than 90% of the yield strength of the tank material to prevent SCC. The merits of this criterion became an issue because recent calculations have presented stress levels that exceed the 90% limit and because a panel of experts could not establish an adequate technical basis for the criterion.

RPP-RPT-27574 was prepared to study the following objectives: (1) review the merits of the 90% yield criterion; (2) develop and recommend an alternative; and (3) using the alternative criterion, perform a tank-specific evaluation of the potential for SCC crack propagation in tank 241-AN-107. This work, performed by PNNL, involved several activities:

- Reviewing stress limits in the 1981 functional design criteria
- Searching for SCC stress limits in other ASME codes
- Assessing the merits and limitations of the 90% yield criterion
- Considering SCC operating experience at Hanford and the Savannah River Site
- Reviewing data on the initiation and growth of SCC in carbon steel
- Performing finite element calculations of stresses in tank 241-AN-107 (selected due to its extensive experience with out-of-specification waste)
- Reviewing nondestructive examination methods available for inspecting tanks
- Calculating propagation of SCC in the lower knuckle and other tank locations
- Assessing the potential for the propagation of SCC in tank 241-AN-107
- Recommending improved design criteria to address future concerns for SCC.

No adequate technical basis could be established for the 90% yield criterion, and no similar requirements for addressing SCC were found in ASME codes or other regulatory requirements. Even though the relatively low calculated stresses for tank 241-AN-107 were found to meet the 90% yield criterion, PNNL developed an alternative fracture mechanics method for predicting crack propagation by SCC in the tank to be consistent with the recommendations of the tank expert panel.

A technical basis was developed for evaluating SCC based on a damage tolerance approach that parallels that in Appendix L of ASME BPVC Section XI. The size of the postulated flaw for the calculations is based on sizes that can be detected by ultrasonic methods and on the minimum size of SCC whose growth can be predicted using fracture mechanics methods. The appropriate flaw depth was established as 0.05 to 0.10 in. Crack growth rates and threshold stress intensity factors for SCC (K_{ISCC}) were estimated based on ongoing testing of carbon steel specimens for

the temperatures and environments of concern to tank 241-AN-107. Test results showed very low crack propagation rates (i.e., a factor of 100 or less than past measurements) for conditions associated with historical tank failures due to SCC.

Application of the alternative criterion showed a very low potential for SCC propagation in tank 241-AN-107. The evaluation considered both postulated cracks in the lower knuckle, driven by high local bending stress and vertical cracks in the lower region of the tank wall, driven by hoop stresses. Sensitivity calculations were performed to address uncertainties in the evaluations. The potential for SCC growth was found to be particularly sensitive to the level of residual stress, which can be greatly reduced by post-weld heat treatment. Another important input was the estimated value for K_{ISCC}. Because evaluations were based on conservative inputs from limited short-term tests, data from additional testing over a longer time period could confirm that crack growth rates become very low or zero for tank 241-AN-107 even at relatively high levels of stress.

4.10.5 Secondary Liners

RPP-22604 was prepared to address rating of the secondary tanks. A number of tank farm tank secondary liners were not given enhanced weld inspection (EWI) to the upper knuckle weld. This leads to the conclusion that the secondary liners were not designed to hold tank waste above the level at which EWI was provided. At first glance, this would mean that the primary tanks would not be permitted to be filled to a level that, in the event of a leak, the waste would fill the primary tank to a level above that which received EWI. A number of recommendations were made with regard to the secondary liners that stemmed from the issue that it was possible some of the tanks, namely the 241-AY farm tanks, were not designed to contain leaks above the first annulus tank plate course.

RPP-CALC-28703, *Annulus Fill Calculation*, was prepared to address the likely leak scenarios and consequences to the secondary liners. The analysis provides logic which leads to the conclusion that the most likely leak into the secondary liner is not catastrophic and would be detected and mitigated before the EWI levels are reached. The calculation utilizes actual leak scenario data from the Savannah River Site to determine conservative crack sizes and leak-flow rates. The maximum flow rates are determined for the 241-AY, 241-AZ, and 241-SY farm tanks, which are those with the least amount of EWI above the lower secondary knuckles. The maximum leak-flow rates are used to determine minimum fill times of the annulus to each tank's respective EWI level. The fill times are summarized in Table 4-11.

Table 4-11. Time to Fill Annulus to Enhanced Weld Inspection Levels.

Tank	Max. Leak Rate (gal/min)	"Fill" Time (days)
241-AY farm tanks	0.223	14.7
241-AZ farm tanks	0.223	32.8
241-SY-101/241-SY-102	0.268	27.3
241-SY-103	0.294	24.8

An analysis was completed per RPP-ASMT-27936, *Evaluation of Secondary Liner Under Postulated Waste Leakage Scenario in a Double Shell Tank Annulus*. The analysis focused on the stress intensities in the lower knuckle, because that portion of the secondary tank is not supported by the concrete shell. The analysis also focused on 241-AY farm tanks because their lower knuckle plate thickness was ¼ in., which is less than that of any other secondary tank lower knuckle. The analysis was performed using a waste product of 1.77 SpG. This is less than the design value of 2.0, and while the reduction in maximum allowable specific gravity would have little practical effect, the TFC control documents (operating specification documents for Tank Farm Operations) needs to be changed to reflect this limit.

Stress intensities for 241-AW and 241-AY farms tanks were calculated along with their allowable values. Two load conditions were selected as being significant; the details of each load case are not repeated here. The results are summarized in Table 4-12.

Table 4-12. Secondary Tank Lower Knuckle Stress Intensities.

Load Case	Stress Intensity (ksi)		Allowable Stress Intensity (ksi)		Demand/Capacity	
	241-AW DST	241-AY DST	241-AW DST	241-AY DST	241-AW DST	241-AY DST
1	25.72	58.94	82.44	66.96	0.31	0.88
2	24.04	55.80	68.70	55.80	0.35	1.00

Given the demand/capacity ratio of 1.00 for Load Case 2 on the 241-AY farm tanks, increasing the specific gravity to 2.0 SpG will not result in an adequately designed lower knuckle for that specific gravity.

RPP-ASMT-27062, *Stress Corrosion Cracking Evaluation for the Secondary Liner Exposed to In-Specification Waste in a Double Shell Tank Annulus*, was developed to examine the consequences of a leak into the tank annulus with regard to SCC. While the document does not address the possible flaws inherent to visual testing-only welds (which exist at various levels within the secondary liner) and the consequences or possibility of a leak to those levels, it concludes that given the current waste compositions, SCC initiation nor crack growth is likely due to the current composition of the DST wastes. Under worst-case conditions, through-wall penetration of the secondary liner due to SCC would occur no sooner than 12 weeks.
This provides justification for the estimated time-to-pump of 10 days as indicated in HNF-3484, *DST Emergency Pumping Guide*. It is also evident that the waste could reside in the secondary liners for significantly longer than 10 days if necessary, provided the level is less than that which received enhanced nondestructive examination.

To this point, it has been shown that:

- The probability of a leak to the secondary liner is low.
- In the event of a leak, SCC initiation and propagation in the secondary liner will occur 12 weeks following the leak event under worst-case conditions.

- The secondary liner lower knuckles are conservatively structurally qualified to contain 1.77 SpG waste.

- Given the emergency pumping guide's estimated time to pump of 10 days, the probability of leaked waste into the annulus rising above the EWI levels is low.

4.11 FITNESS FOR USE OF THE DOUBLE-SHELL TANKS

This assessment shows that in general, the tanks are adequately designed, are not leaking, and are fit for use under their current operating parameters. The 241-AP farm tanks are intended to eventually operate at levels greater than 422 in. An expert panel, RPP-19438, expanded upon an analysis, RPP-15160, *Evaluation of Proposed Increase to DST Liquid Level*, to conservatively show that the AP tanks are capable of operating at 449 in. However, in-service leak testing of those tanks is not yet complete. Therefore, until in-service leak testing is complete for 241-AP farm tanks intended for operation at raised levels, those tanks are not yet fit for that purpose.

The 241-AY farm tanks' secondary liners have been found to be adequate to contain no greater than 1.77 SpG wastes.

4.12 FINDINGS – DOUBLE-SHELL TANK ASSESSMENT

There are no findings related to the assessment of the DSTs.

4.13 OBSERVATIONS – DOUBLE-SHELL TANK ASSESSMENT

4.13.1 Appendix E contains the raw IQRPE review notes for in-tank videos. Many of the tanks exhibit notable vapor space corrosion, which may or may not be due to waste storage operations (see the last paragraph of Section 4.9.2), but these indications are an area of potential concern. The following tanks exhibited the most apparently extensive vapor space corrosion (see Recommendation 4.14.5):

- 241-AN-101 (ref. Video #9394, 2002)
- 241-AN-103 (ref. Video #9400, 2002)
- 241-AN-104 (ref. Video #8862, 2002)
- 241-AN-107 (ref. Video #9620, 2002
- 241-AP-102 (ref. Video #9210, 2002)
- 241-AP-104 (ref. Video #10038, 1997)
- 241-AP-107 (ref. Video #8503[1997], #9341[2002])
- 241-AP-108 (ref. Video #9343, 2002)
- 241-AW-101 (ref. Video #9150, 2001)
- 241-AW-102 (ref. Video #9151, 2001)
- 241-AW-105 (ref. Video #9670, 2001).

4.13.2 RPP-8212, *Visual Inspection Plan for Double Shell Tank Farms*, is less of a plan and more of a schedule. Engineering Task Plans generally provide criteria. This plan does not provide criteria by which one can determine the standards by which video inspections can be successfully performed. There is also no guidance on what to do if flaws are found (see Recommendation 4.14.9).

4.13.3 Each inspection activity, whether it is UT or video of some kind, is generally treated independently from all other inspection activities. Where UT would allow the quantification of observed anomalies, it was not performed because UT is generally performed prior to video. As a matter of good practice, the video should drive the UT inspection such that observed anomalies may be further quantified with UT equipment.

4.13.4 As discussed in Section 4.10, failure of the refractory concrete will not result in a catastrophic failure of the primary tank. The failure mechanism of the refractory is considered to be its exposure to tank waste in the event of a leak. As the properties of the refractory are possibly changed by exposure to tank waste in the event of a leak, plastic deformations of the primary tank may occur that would result in a new stress condition. This may affect allowable loads on the tank (see Recommendation 4.14.1).

4.13.5 While there are some moves to increase the frequency of UT examinations for the tanks, this assessment could not technically justify an increase. The resolution of the UT measurements is such that at the currently measured corrosion rates, significant changes in wall thickness will not be detectible for approximately 10 years. On the other hand, the TFC decision to double the area of UT inspection is beneficial in that it will allow a more accurate statistical projection of potential worst-case defects (see Recommendation 4.14.2).

4.13.6 The analysis found in RPP-ASMT-27936, which resulted from recommendations from RPP-22604, points out that the 241-AY farm tanks have secondary lower knuckle plate thickness of ¼ in. The analysis structurally analyzes the knuckle to a 1.77 SpG for the waste. Because leaked waste comes from the primary tank, this limits the specific gravity of 241-AY farm primary tank waste to 1.77 SpG.

4.13.7 In Section 4.9.1 (and Table 4-9), it is pointed out that acceptable wall thinning for UT examinations is 20% of the nominal wall thickness. It is also pointed out that structural analyses discussed in Section 4.10 utilize a 0.060-in. corrosion allowance. A disparity exists between the 20% wall thinning acceptance criteria and the 0.060-in. corrosion allowance on the 0.375-in. plate on the DST primary shell. A 20% wall thickness loss is greater than the 0.060 in. corrosion allowance for the 0.375-in. plate. This is complicated by the fact that the structural analyses are based on uniform reduction in wall thickness, but the UT results only provide localized wall thinning information. A better method to use the UT data to statistically establish average plate thickness is needed for more comprehensive assessment of these issues. Nevertheless, allowable wall thinning should not be greater than the corrosion allowance used in the structural analyses unless a

minimum wall thickness analysis is performed for the DSTs that provides a basis for an allowable 20% reduction in thickness of the 0.375-in. plate. Without a structural analysis identifying minimum wall thickness requirements, and a determination of the actual average plate thickness, it is conceivable that a tank with wall thickness measurements having less than a 20% loss will not be structurally sound, yet no action will be taken. When the upcoming PNNL analysis of minimum design wall thicknesses is issued, the TFC should consider revising the UT inspection criteria to correlate with the plate specific minimum wall thickness requirements, as well as institute a statistical determination of average plate thickness from the UT data (see Recommendation 4.14.7).

4.13.8 As a follow-up to the previous finding, the data indicates that on plate #1 of the tank 241-SY-101 primary shell and based on the minimum measured thickness of 0.306 in., the tank has exceeded its corrosion allowance by over 2% in some localized areas. Based on the average minimum wall thickness of 0.319 in., and without knowing the overall average plate thickness (as opposed to the average of the minimum thickness readings), then for structural analysis purposes, plate #1 is potentially only 1% away from exceeding its corrosion allowance. Using a calculated corrosion rate of 1.8 mils/yr, and assuming the present average minimum represents the average overall plate thickness, the tank is projected to exceed its corrosion allowance on plate 1 in the year 2008. The actual UT data should be statistically examined to provide a better representation of the average plate #1 thickness, since while the above assessment is necessary in the absence of ameliorating information, it may be overly conservative (see Recommendation 4.14.8).

4.13.9 Several gouges were observed in the annulus videos for AY-101. The history of this tank with regard to external corrosion on the primary tank is well known. However, the certified tank inspector observed some "gouges" in the primary tank wall that were mentioned in RPP-7814, *Double Shell Tank Integrity Assessment Program Corrosion Report on 241-AY-101.* Resulting recommendations from that report need to be carried out.

4.13.10 Video reviews of the AW-106 (noted as "areas of interest" in Appendix E) tank annulus may show evidence of in-leakage into the annulus through some pits. The scope of this video and applicability to the DST secondary liner is in question. This video should be obtained by TFC engineers, and reviewed and documented in detail.

4.14 RECOMMENDATIONS – DOUBLE-SHELL TANK ASSESSMENT

The following recommendations are provided such that if they are implemented will ensure the continued integrity of the DSTs.

4.14.1 While failure of the refractory concrete in the DSTs has been analyzed (RPP-19097) and determined to not result in catastrophic failure of the primary

tank, it should not be considered a non-issue. The introduction of plastic deformations in the primary tank, from such a postulated refractory cement failure, will change the stress condition of the tank. This may result in a change in the allowable loads. It is therefore considered necessary to include inspection of the refractory concrete for degradation in all annulus videos. In the event of a tank leak, exposure of the refractory concrete to tank waste should be considered a serious condition and the time of exposure should be minimized unless laboratory analysis can be performed that would determine otherwise.

4.14.2 UT examinations should continue on the current frequency and schedule.

4.14.3 An up to 20-ft section of the secondary tank lower knuckle (depending on interferences and concrete splatter) on each of the 241-AY farm tanks should be included in the normal UT examination schedule. These lower knuckles are the thinner of all the tanks secondary liners and are not structurally supported on the underside.

4.14.4 A 20-ft section of the primary tank plate #1 on tank 241-SY-101 should be included in the normal UT examination schedule. The TFC should also consider a near full circumference UT examination of the plate #1.

4.14.5 A workshop of experts should be held to determine a path-forward on vapor space corrosion for the Hanford DSTs. The workshop should:

- Explore the need to quantify corrosion in the vapor space (e.g., determine the need to obtain UT measurements of the dome wall thickness) and the technology needed to obtain the measurements
- Review the consequences of through-wall pitting in the tank dome
- Propose techniques for mitigation of vapor space corrosion and recommend methods for implementation and use, if required
- Evaluate and explore techniques for accelerated laboratory corrosion testing of vapor space conditions.

4.14.6 The DSTs (tanks only) should be assessed for integrity by an IQRPE in 10 years (the year 2016). This assessment should take into account the next round of UT examinations and two additional rounds of video examinations based on the schedules recommended in this document. Assessment frequencies for DST components (e.g., ancillary equipment) are provided in the appropriate sections of this document.

4.14.7 The acceptable wall thinning for UT examinations needs to be based on the corrosion allowance of 0.060 in. afforded to the tanks by the DST structural analyses, or on the established minimum wall determinations from the PNNL analyses due this year. Also, a more consistent method (e.g., statistical analysis of UT data) for determining both average minimum and average overall plate

thicknesses should be instituted for UT data showing a pattern of notable thickness reductions.

4.14.8 An evaluation of the tank 241-SY-101 overall and localized plate thinning (see Recommendation 4.14.7) needs to be performed that identifies life-extension measures, if necessary, to ensure that tank 241-SY-101 can complete its mission before its plate #1 corrosion allowance is depleted. This may include consideration of previous events that may have accelerated the corrosion, verification that the corrosion rate has reduced, a plan for removing the tank from service, or the results of a minimum wall thickness structural analysis. The inspection report (RPP-18444) is clear that no pitting indications were found, which means that at least localized general corrosion is the primary concern on this plate course. It is expected that a near full circumference UT examination is needed on the plate #1 course to determine the extent to which the corrosion allowance has been consumed, and to accurately assess the overall average plate thickness. According to the minimum measured thickness of 0.306 in. (found in RPP-18444); the corrosion allowance has been exceeded in some areas.

4.14.9 RPP-8212 should be revised to reflect a comprehensive plan for the acquisition, review, and retention of video examination data. The plan should include a process for determining the locations of interest identified in previous videos, re-examination of those areas in future videos, acceptance criteria or standards, and integration of the areas of interest with the UT examination program. It should also require cross-comparison with prior results, and close up visual examination and/or UT inspection of questionable areas.

4.14.10 Tank settlement surveys recently performed indicate that there is no significant evidence of tank settlement. It is recommended that the next surveys be performed in 8 to 10 years to coincide with the next DST System Integrity Assessment.

4.14.11 Primary tank inspection videos for tanks 241-AZ-101 and 241-AZ-102, and annulus videos for AW-101 should be obtained within a period of 6 months and reviewed by the IQRPE and an independent certified tank inspector selected by the IQRPE. This report should then be revised to include the results if the AZ-102 and AW-101 annulus video inspections. The 241-AZ-101 video was of poor quality and the AZ-102 and AW-101 videos were not available.

4.15 CONCLUSIONS – DOUBLE-SHELL TANK ASSESSMENT

Through a significant analysis effort that included thermal, operating, and seismic loads, the DSTs have been shown to be adequately designed. UT inspections, video examinations, and tank settlement surveys have been obtained and support the conclusion that the tanks are not leaking and collapse, rupture, and/or failure is not imminent.

RPP-RPT-25608 provides indication that the tanks can withstand concentrated loads that may be greater than can be practically applied. In light of this new information, the current dome-load monitoring program may be more rigorous than is necessary.

The DST secondary liner's ability to contain wastes above levels where EWI was provided at construction was questioned. This concern was only applicable to a the 241-AY, 241-AZ and 241-SY farm tanks. RPP-ASMT-27062 points out that the possibility of a through-wall leak to the annulus due to SCC is improbable. ERUL calculations show that under worst-case conditions, a through-wall leak due to pitting would not occur until the year 2115. The Tank Structural Integrity Panel guidelines (BNL-52527) point out that structural failure due to general corrosion (wall thinning) is not credible. RPP-CALC-28703, *Annulus Fill Calculation*, in conjunction with HNF-3484, provides evidence that a leak to the annulus of these tanks would be pumped or mitigated before the waste levels reached the limit of EWI. Therefore, the secondary liners in these tanks must be considered adequate.

5.0 ASSESSMENT OF THE TRANSFER LINES, DRAINS, AND RAW WATER LINES

The assessment of the DST waste transfer lines, drains, process water, flush water, and raw water lines up to the backflow preventers is documented in RPP-27591. Assessment of supplemental soil and surcharge loading on the buried lines may be found in RPP-18652, *Buried Pipe Analysis for DST System Integrity Assessment*. Assessment of the cathodic protection systems may be found in RPP-25299. Recommendations from these documents are summarized in the Appendix G tables.

6.0 ASSESSMENT OF PITS AND VAULTS

Project W-314 recently inspected and upgraded the majority of the applicable pits in the tank farms. Project W-314 inspection photographs and integrity assessment reports were reviewed and were generally found to be adequate for their intended purposes. Integrity assessment reports were previously prepared under WAC 173-303-640(3). While these reports found the pits to be fit for use, they did not include enough data to satisfy the requirements of HFFACO M-48-14. However, for the most part they met the requirements of WAC 173-303-640(3) and satisfied the requirements of WAC 196-23-020, "Seal/Stamp Usage"; WAC 196-23-030, "Providing Direct Supervision"; and *Revised Code of Washington* (RCW) 18.43.070, "Certificates and Seals."

This section provides the necessary additional data and assessments to satisfy the requirements of HFFACO M-48-14.

Table 6-1 lists all previous integrity assessment reports with regard to Project W-314 pit upgrades. All of these reports were reviewed and found to not contain the rigor necessary to meet the needs of this WAC 173-303-640(2) assessment. This is understandable, since these reports were prepared per WAC 173-303-640(3). In hindsight, these assessments of upgrades should have been performed per WAC 173-303-640(2), since they were and are existing ancillary equipment having not received an assessment prior to service. Nevertheless, this assessment has obtained and documented the additional data needed and determined that no pit fully assessed was found to have failed, no pit was found to lack structural integrity, and no pit was found to lack leak containment integrity.

This section also contains an assessment of diversion box 6241-A, vent station 6241-V, and the 241-AZ-702 vent building and associated seal pot AZ-PC-SP-1 (the piping within the building is considered bounded by the buried piping assessment RPP-27591). The 6241 concrete vault structures were installed per Project W-058 and support cross-site transfer operations. Each contains a sump area that serves as secondary containment for the portion of the transfer lines that enter the buildings. The sump is fully lined with welded stainless steel. These vaults were built in 1996. The diversion box also contains a set of two booster pumps on the slurry line, neither of which has been used. The AZ-702 structure was built per Project W-030 and supports ventilation system condensate collection and management.

Table 6-1. Project W-314 Integrity Assessment Reports. (2 Sheets)

Component	Document	Title
241-AW-B valve pit	RPP-11060, Rev. 0	Project W-314 241-AW-B Valve Pit Turnover Independent Integrity Assessment
241-AY-01A 241-AY-02A SN-633 SN-635	RPP-11217, Rev. 0	Project W-314 241-AY Pump Pits Upgrade Integrity Assessment Report
241-AZ-01A 241-AZ-02A SN-631 SN-632	RPP-11218, Rev. 0	Project W-314 241-AZ Pump Pits Upgrade Integrity Assessment Report
241-AN-05A	RPP-12552, Rev. 0	Project W-314 241-AN-05A Pump Pit Upgrades Integrity Assessment Report
241-AN-06A	RPP-12551, Rev. 0	Project W-314 241-AN-06A Pump Pit Upgrades Integrity Assessment Report
241-AW-A	RPP-13624, Rev. 0	Project W-314 241-AW-A Valve Pit Turnover Independent Integrity Assessment
241-AN-01A 241-AN-04A SN-630 SN-636 SLL-3160 SNL-3150	RPP-15831, Rev. 0	Project W-314 AN Farm to Waste Transfer System Integrity Assessment Report
SN-630 SN-632 SN-633 SN-634 SN-636 SN-637 SNL-3150 SLL-3160 241-AW-B coating 241-AZ-valve pit	RPP-16278, Rev. 0	Project W-314 Waste Transfer System Integrity Assessment Report
241-AN-A 241-AN-B	RPP-16375, Rev. 0	Project W-314 AN Farm Valve Pit Upgrades Construction Integrity Assessment Report
Not stated	RPP-16376, Rev. 0	Project W-314 AN Farm Valve Pit Upgrades Design Integrity Assessment Report
241-AN-02A	RPP-18678, Rev. 0	Project W-314 241-AN-02A Pump Pit Upgrades Integrity Assessment Report
241-AN-03A	RPP-18679, Rev. 0	Project W-314 241-AN-03A Pump Pit Upgrades Integrity Assessment Report
241-AN-07A	RPP-18680, Rev. 0	Project W-314 241-AN-07A Pump Pit Upgrades Integrity Assessment Report

Table 6-1. Project W-314 Integrity Assessment Reports. (2 Sheets)

Component	Document	Title
241-AW-03A	RPP-19430, Rev. 0	Project W-314 Integrity Assessment Report 241-AW-03A Pit Recoat
241-AW-05A	RPP-19431, Rev. 0	Project W-314 Integrity Assessment Report 241-AW-05A Pit Recoat
SNL-5350 SNL-5351	RPP-20512, Rev. 0	Integrity Assessment Report Design & Construction For Project W-314 Tank farm Restoration and Safe Operations 244-S DCRT Bypass
241-AW-02A	RPP-RPT-25161	Project W-314, 241-AW-02A Pit Structure and Coating Independent Integrity Assessment Report
241-AW-02D	RPP-RPT-25162, Rev. 0	Project W-314, 241-AW-02D Pit Concrete Structure and Coating Independent Integrity Assessment Report
241-SY-A	RPP-RPT-25163, Rev. 0	Project W-314, SY-A Pit Concrete Structure and Coating Independent Integrity Assessment Report
241-SY-03A	RPP-RPT-25853, Rev. 0	Project W-314 SY-03A Pit Concrete Structure and Coating Independent Integrity Assessment Report
241-AW-04A	RPP-RPT-25854, Rev. 0	Project W-314 SY-04A Pit Concrete Structure and Coating Independent Integrity Assessment Report
241-AW-01A	RPP-RPT-25855, Rev. 0	Project W-314 241-AW-01A Concrete Structure and Coating Independent Integrity Assessment Report
241-AW-06A	RPP-RPT-25979, Rev. 0	Project W-314 241-AW-06A Pit Concrete Structure and Coating Independent Assessment Report
241-SY-02D	RPP-RPT-25978, Rev. 0	Project W-314 241-SY-02D Concrete Structure and Coating Independent Assessment Report
241-AP-07A	RPP-RPT-26807, Rev. 0	Project W-314 241-AP-07A Concrete Structure and Coating Independent Assessment Report
241-AP-02A	RPP-RPT-26808, Rev. 0	Project W-314 241-AP-02A Concrete Structure and Coating Independent Assessment Report
241-AP-01A	RPP-RPT-26809, Rev. 0	Project W-314 241-AP-01A Concrete Structure and Coating Independent Assessment Report
241-AP-03A	RPP-RPT-26810, Rev. 0	Project W-314 241-AP-03A Concrete Structure and Coating Independent Assessment Report
241-AP-08A	RPP-RPT-27146, Rev. 0	Project W-314 241-AP-08A Concrete Structure and Coating Independent Assessment Report
241-AP-05A	RPP-RPT-27145, Rev. 0	Project W-314 241-AP-05A Concrete Structure and Coating Independent Assessment Report
241-AP-03D	RPP-RPT-26866, Rev. 0	Project W-314 241-AP-03D Concrete Structure and Coating Independent Assessment Report
241-AP-04A	RPP-RPT-26811, Rev. 0	Project W-314 241-AP-04A Concrete Structure and Coating Independent Assessment Report
241-AP-VP	RPP-RPT-29052, Rev. 0	DST Integrity Project AP Valve Pit Concrete Structure and Coating Independent Assessment Report
241-AP-02D	RPP-RPT-29199, Rev. 0	DST Integrity Project AP-02D Concrete Structure and Coating Independent Integrity Assessment Report

6.1 MATERIALS USED IN CONSTRUCTION

The pits and vaults are constructed from reinforced concrete and may contain a stainless steel liner. The majority of the pits are painted with an epoxy coating; some are lined with polyurea. Either coating is appropriate as stated in RPP-25153. The vaults are lined with stainless steel. The walls of each pit generally contain one through-wall nozzle that provides interface with a transfer line. At least one wall of each vault contains through-wall nozzles or lines that pass through the vault to valves for isolation, diversion, or venting. The floors of the pits are sloped to a drain that feeds either directly to the tank or to another header that feeds to a tank. The floors of the vaults are sloped to a collection trough on the north wall, which is then sloped to a sump on the east wall. Conductivity based leak detectors are placed in the bottom of the pits near the drain to detect spray leaks that may occur from the various transfer line jumpers passing through the pit. Spray leaks of this type are extremely rare. The vaults also have conductivity based leak detection next to the sump pumps.

One pit (PPP) in the 241-SY tank farm is constructed entirely from welded stainless steel. This pit does not require coatings of any kind and may be considered low maintenance.

Jumpers within the pits are generally fabricated from butt-welded 304L stainless steel and hydrostatically tested per ANSI B31.3, *Process Piping*. This leaves the weak link in their design to be the Hanford nozzle connectors, which have a good (but not perfect) track record of performance. Hanford connections function by providing a clamping force between two machined surfaces. This method of containing the dangerous wastes leaves open the possibility of human error in effecting the seal. The connections are not conducive to visual or nondestructive testing methods of testing (other than hydrostatic or pneumatic). This leaves the pits and their liner systems providing a critical role in the containment of dangerous waste.

The seal pot in AZ-702 was fabricated from ASTM A240 stainless steel and welded per appropriate standards identified in the construction specification. AZ-702 is constructed of steel reinforced concrete and Techni-Plus EN 25™ chemical resistant coatings applied to the sump and a few inches up the walls.

6.2 CONSTRUCTION METHODS

Concrete pits were constructed using formwork and reinforcement per consensus standards. Concrete was deposited in horizontal layers not to exceed 18 in. The rate of placement was specified to be such that any concrete surface will not have reached its initial set before additional concrete is placed on it and that deformations of the forms were not sufficient to cause the concrete surfaces to exceed the tolerances specified. Concrete was not allowed to rise more than 5 ft/hr in the summer months or 3 ft/hr in the winter months.

Weather protection, joint preparation, embedded items, expansion joints, earth contact, consolidation, etc. were properly specified to be prepared per applicable consensus standards.

The concrete vaults were constructed with cast-in-place reinforced concrete. The stainless steel liners, where applicable, were fabricated per appropriate consensus standards in a controlled manner. Concrete forms were installed in accordance with ACI 301, *Structural Concrete for Buildings, Specifications*, and approved submittals. Concrete was placed per the appropriate sections of ACI 301 and proper controls were employed. For a detailed description of vault construction, refer to W-058-C3, *Construction Specification Diversion Box/Vent Station for Replacement of the Cross Site Transfer*. Building and component design of the cross site transfer vaults was in accordance with ACI 318.

Figure 6-1 illustrates construction of concrete pits using forms and rebar. Notice the plywood forms on the ground surrounding the pit.

Figure 6-1. 241-AZ Tank Farm Pit Construction.

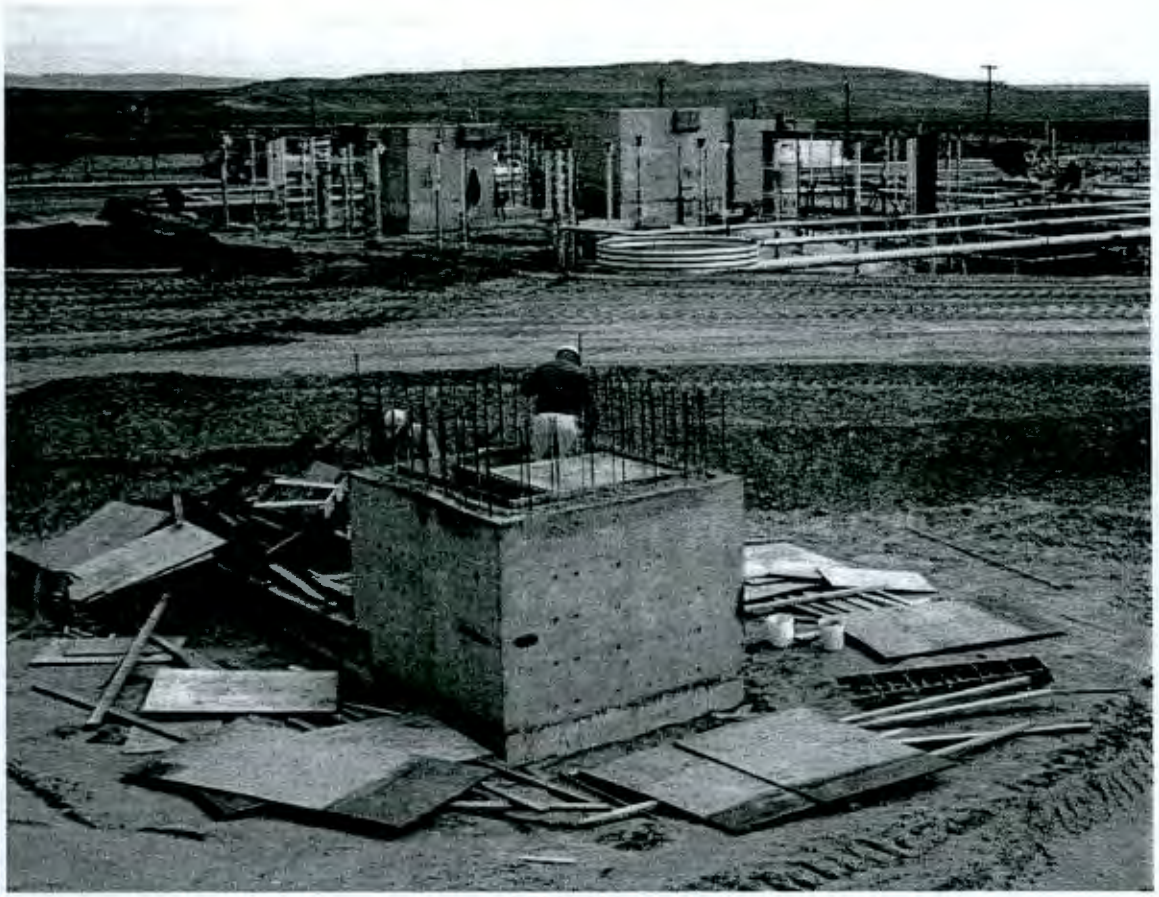


Figure 6-2 illustrates construction of a diversion box in the 241-AP tank farm. Notice the pipes extending through the wall. Nozzles can be seen on the inside far wall of the pit. The ladder gives some perspective as to the size of the pit.

Figure 6-2. 241-AP Tank Farm Diversion Box Construction.

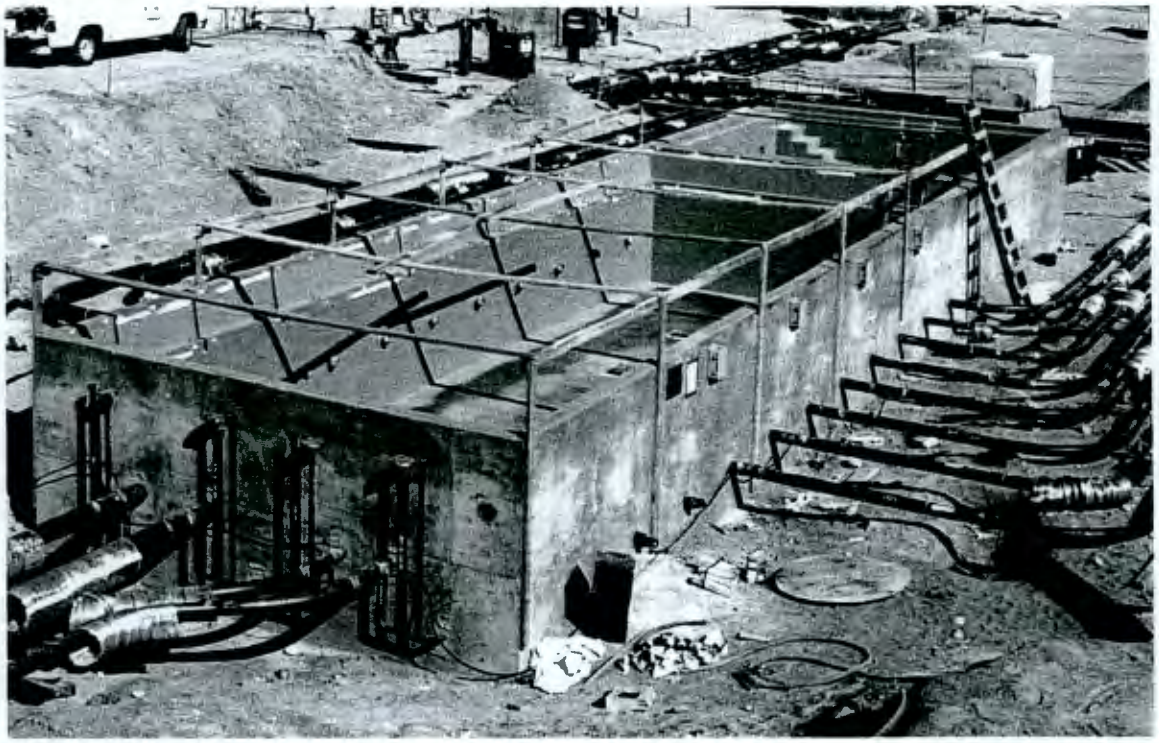


Figure 6-3 illustrates a completed pit with the standards epoxy painted coating. Note that no jumpers or nozzles are designed to be in directly in contact with the pit wall or floor.

Figure 6-3. A Completed Pit in 241-AP Tank Farm.

6.3 QUALITY CONTROL AND TESTING

Review of the construction specifications indicates that appropriate quality control was incorporated into the construction process and applied per the applicable consensus engineering codes and standards listed in Tables 6-2 and 6-3.

6.4 ENGINEERING CODES REFERENCED FOR CONSTRUCTION

Consensus engineering codes and standards referenced for construction are listed in Tables 6-2 and 6-3. The data in the tables indicates that the pits and vaults were designed and constructed to national consensus engineering codes and standards. Further review reveals that codes and standards were appropriately used.

Table 6-3 contains a listing of the consensus engineering codes and standards used in the design/construction activities for the Project W-314 pit upgrades. The data in the table indicates that upgrades to the pits were performed to national consensus engineering codes and standards. Further review reveals that codes and standards were appropriately used.

Review of Table 6-3 indicates that overall, the Project W-314 pit upgrades effectively utilized the necessary and sufficient consensus engineering codes and standards. However, for the 241-AP tank farm, the consensus standards for decontaminable coatings used for the other farms were not cited. This is considered inconsequential to the integrity of the pit.

6.5 OPERATING SPECIFICATIONS

No operating specification documents could be located related to pits or vaults.

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
		Earthwork	
241-AY	AASHO T147-54	Field Determination of Density of Soils In Place	HWS-7792
241-AY	AASHO T180-61	Moisture-Density Relations of Soils Using a 10 lb Ramer and 18 Inch Drop	HWS-7792
241-SY 241-AZ	AASHO T180-73I	Moisture-Density Relations of Soils Using a 10 lb Ramer and 18 Inch Drop	B-101-C3, B-109-C1
241-SY 241-AZ	AASHO T191-61	Density of Soil In-Place by the Sand-Cone Method	B-101-C3, B-109-C1
241-AW 241-AN 241-AP	ASTM D422-63 (1972)	Particle Size Analysis of Soils	B-120-C7, B-130-C7, B-340-C7
241-AW 241-AN	ASTM D1557-70	Moisture – Density Relations of Soils Using a 10 lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop	B-120-C7, B-130-C7
241-AP	ASTM D1557-78	Moisture – Density Relations of Soils Using a 10 lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop	B-340-C7
6241-A/V	ASTM D1557-91	Moisture – Density Relations of Soils Using a 10 lb (4.54 kg) Rammer and an 18-in. (457 mm) Drop	W-058-C3
241-AW 241-AN	ASTM D1556-64 (1974)	Density of Soil In-Place by the Sand-Cone Method	B-120-C7, B-130-C7
241-AW 241-AN	ASTM D2167-66 (1972)	Density of Soil In Place by the Rubber Balloon Method	B-120-C7, B-130-C7
241-AN 241-AP	ASTM D2049-69	Relative Density of Cohesionless Soils	B-130-C7, B-340-C7
241-AW 241-AN	ASTM D2922-71 (1976)	Density of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth)	B-120-C7, B-130-C7
241-AP	ASTM D2922-81	Density of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth)	B-340-C7
6241-A/V	ASTM D2922-91	Density of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth)	W-058-C3
241-AW 241-AN	ASTM D3017-72	Moisture Content of Soil and Soil-Aggregate In Place by Nuclear Method (Shallow Depth)	B-120-C7, B-130-C7

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Earthwork (Cont'd)			
241-AP	ASTM D3017-78	Moisture Content of Soil and Soil-Aggregate In Place by Nuclear Method (Shallow Depth)	B-340-C7
6241-A/V	ASTM D3017-88	Moisture Content of Soil and Soil-Aggregate In Place by Nuclear Method (Shallow Depth)	W-058-C3
241-AW 241-AN	Title 29 CFR Part 1926	Safety and Health Regulations for Construction	B-120-C7, B-130-C7
241-AW 241-AN	Title 29 CFR Part 1926 Subpart P	Excavation, Trenching, and Shoring	B-120-C7, B-130-C7
Cast-in-Place Concrete			
241-AP	ACI 117-81	Standard Tolerances for Concrete Construction and Materials	B-340-C7
6241-A/V	ACI 117-90	Standard Tolerances for Concrete Construction and Materials	W-058-C3
241-SY 241-AZ	ACI 301-72	Structural Concrete for Buildings	B-101-C3, B-109-C1
241-AW 241-AN	ACI 301-72 (Revised 1975)	Structural Concrete for Buildings	B-120-C7, B-130-C7
241-AP	ACI 301-72 (Revised 1981)	Structural Concrete for Buildings	B-340-C7
6241-A/V	ACI 301-89	Structural Concrete for Buildings	W-058-C3
241-AW 241-AN 241-SY 241-AZ	ACI 305-72	Recommended Practice for Hot Weather Concreting	B-120-C7, B-130-C7, B-101-C3, B-109-C1
241-AW 241-AN	ACI 306-66 (Reaffirmed 1975)	Recommended Practice for Cold Weather Concreting	B-120-C7, B-130-C7
241-AY 241-SY 241-AZ	ACI 306-66	Recommended Practice for Cold Weather Concreting	HWS-7792, B-101-C3, B-109-C1
6241-A/V	ACI 306.1-90	Recommended Practice for Cold Weather Concreting	W-058-C3
241-AY	ACI 315-65	Manual of Standard Practice for Detailing Reinforced Concrete Structures	HWS-7792
241-AW 241-AN 241-SY 241-AZ	ACI 315-74	Manual of Standard Practice for Detailing Reinforced Concrete Structures	B-120-C7, B-130-C7, B-101-C3, B-109-C1

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
241-AY	ACI 318-65	Building Code Requirements For Reinforced Concrete	HWS-7792
241-AW 241-AN	ACI 318-71	Building Code Requirements For Reinforced Concrete	B-120-C7, B-130-C7
241-AP	ACI 318-77	Building Code Requirements For Reinforced Concrete	B-340-C7
6241-A/V	ACI 318-95	Building Code Requirements For Reinforced Concrete	W-058-C3
241-AY	ACI 605-59	Recommended Practice for Hot Weather Concreting	HWS-7792
6241-A/V	ASTM A36-94	Carbon Structural Steel	W-058-C3
AZ-702	ASTM A36-91	Carbon Structural Steel	W-030-C2
AZ-702	ASTM A53-90B	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless	W-030-C2
6241-A/V	ASTM A53-95a	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless	W-058-C3
241-AY	ASTM A185-61T	Specifications for Welded Steel Wire Fabric for Concrete Reinforcement	HWS-7792
241-AP	ASTM A185-79	Specifications for Welded Steel Wire Fabric for Concrete Reinforcement	B-340-C7
AZ-702	ASTM A185-90a	Specifications for Welded Steel Wire Fabric for Concrete Reinforcement	W-030-C2
6241-A/V	ASTM A185-94	Specifications for Welded Steel Wire Fabric for Concrete Reinforcement	W-058-C3
241-AY	ASTM A305-65	Minimum Requirements for Deformations of Deformed Steel Bars for Concrete Reinforcement	HWS-7792
AZ-702	ASTM A370-92	Test Methods and Definitions for Mechanical Testing of Steel Products	W-030-C2
6241-A/V	ASTM A370-95a	Test Methods and Definitions for Mechanical Testing of Steel Products	W-058-C3
6241-A/V	ASTM A416-94a	Steel Stranded, Uncoated Seven-Wire for Prestressed Concrete	W-058-C3

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
241-AY	ASTM A432-66	Deformed Billet-Steel Bars for Concrete Reinforcement with 60,000 PSI Minimum Yield Strength	HWS-7792
AZ-702	ASTM A416-90a	Steel Stranded, Uncoated Seven-Wire for Prestressed Concrete	W-030-C2
6241-A/V	ASTM A497-90b	Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement	W-058-C3
6241-A/V	ASTM A615-95b	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	W-058-C3
6241-A/V	ASTM A751-95	Methods, Practices, and Terminology for Chemical Analysis of Steel Products	W-058-C3
6241-A/V	ASTM A853-93	Steel Wire, Carbon, for General Use	W-058-C3
241-AY	ASTM D41-41	Primer for Use With Asphalt in Dampproofing and Waterproofing	HWS-7792
241-AY	ASTM D449-49	Asphalt for Dampproofing and Waterproofing	HWS-7792
241-AY	ASTM D1668-63	Woven Glass Fabrics Treated With Bituminous Substances for Use in Waterproofing	HWS-7792
241-SY	ASTM A615-72	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	B-101-C3
241-AZ	ASTM A615-74	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	B-109-C1
241-AW 241-AN	ASTM A615-76a	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	B-120-C7, B-130-C7
241-AP	ASTM A615-82	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	B-340-C7
6241-A/V	ASTM C31-91	Practices for Making and Curing Concrete Test Specimens in the Field	W-058-C3
241-AP	ASTM C33-71a	Concrete Aggregates	B-101-C3
241-AZ	ASTM C33-74	Concrete Aggregates	B-109-C1
241-AW	ASTM C33-74a	Concrete Aggregates	B-120-C7
241-AN	ASTM C33-77	Concrete Aggregates	B-130-C7
241-AP	ASTM C33-82	Concrete Aggregates	B-340-C7
AZ-702	ASTM C33-92	Concrete Aggregates	W-030-C2
6241-A/V	ASTM C33-93	Concrete Aggregates	W-058-C3
241-AP	ASTM C94-73a	Ready-Mixed Concrete	B-101-C3

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
241-AZ	ASTM C94-74	Ready-Mixed Concrete	B-109-C1
241-AW 241-AN	ASTM C94-74a	Ready-Mixed Concrete	B-120-C7
241-AP	ASTM C94-83	Ready-Mixed Concrete	B-340-C7
6241-A/V	ASTM C94-94	Ready-Mixed Concrete	W-058-C3
6241-A/V	ASTM C143-90a	Test Method for Slump of Hydraulic Cement Concrete	W-058-C3
241-AZ	ASTM C150-74	Portland Cement	B-109-C1
241-AW	ASTM C150-76a	Portland Cement	B-120-C7
241-AN	ASTM C150-77	Portland Cement	B-130-C7
241-AP	ASTM C150-83a	Portland Cement	B-340-C7
AZ-702	ASTM C150-92	Portland Cement	W-030-C2
6241-A/V	ASTM C150-95	Portland Cement	W-058-C3
241-AP	ASTM C156-71	Water Retention by Concrete Curing Materials	B-101-C3
241-AW 241-AN 241-AZ	ASTM C156-74	Water Retention by Concrete Curing Materials	B-120-C7, B-130-C7, B-101-C1
6241-A/V	ASTM C173-94a	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method	W-058-C3
241-AP 241-AZ	ASTM C260-73	Air-Entraining Admixtures for Concrete	B-101-C3, B-109-C1
241-AW 241-AN	ASTM C260-74	Air-Entraining Admixtures for Concrete	B-120-C7, B-130-C7
241-AP	ASTM C260-77	Air-Entraining Admixtures for Concrete	B-340-C7
AZ-702	ASTM C260-86	Air-Entraining Admixtures for Concrete	W-030-C2
6241-A/V	ASTM C260-95	Air-Entraining Admixtures for Concrete	W-058-C3
241-AZ	ASTM C494-71	Chemical Admixtures For Concrete	B-109-C1
6241-A/V	ASTM C494-92	Chemical Admixtures For Concrete	W-058-C3
241-AP	ASTM C476-80	Grout for Reinforced and Nonreinforced Masonry	B-340-C7
6241-A/V	ASTM C618-95	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete	W-058-C3

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
6241-A/V	ASTM C1107-91a	Packaged Dry, Hydraulic-Cement Grout (Nonshrink)	W-058-C3
6241-A/V	ASTM E329-95b	Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction	W-058-C3
6241-A/V	ASCE 7-93	Minimum Design Loads for Buildings and Other Structures	W-058-C3
241-AW 241-AN	CRSI 1976	Manual of Standard Practice; Placing Reinforcing Bars	B-120-C7, B-130-C7
241-AY	HH-F-341c	Filler, Expansion-Joint, Bituminous and Non-bituminous	HWS-7792
241-AY	HH-I-564	Insulation; Mineral Wool, Block and Board	HWS-7792
241-SY	SS-C-192g	Cements; Portland	B-101-C3
241-AY	SS-C-192g	Cements; Portland	HWS-7792
Sealants			
241-AP	TT-S-00227E	Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing and Glazing In Buildings And Other Structures)	B-340-C7
241-AY	TT-S-230a	Sealing Compound, Synthetic Rubber Base, Single Component, Chemically Curing	HWS-7792
241-AW 241-AN 241-AP 241-SY	FS TT-S-00230(C)2	Sealing Compound: Elastomeric Type, Single Component (For, Calking, Sealing, And Glazing in Buildings And Other Structures)	B-120-C7, B-130-C7, B-340-C7, B-101-C3
241-AW 241-AN	NRMCA 1976	Certificate of Conformance for Concrete Production Facilities	B-120-C7, B-130-C7
Stainless Steel Pit Liner			
241-AP	ANSI Z49.1-1973	American National Standard Safety in Welding and Cutting	B-340-C7
241-AP	ASME BPVC 1983 Section II Section IX	ASME *Boiler & Pressure Vessel Code* Material Specifications Welding and Brazing Qualifications	B-340-C7
241-AP	ASTM A108-81	Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality	B-340-C7

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Stainless Steel Pit Liner (Cont'd)			
241-AP	ASTM A240-82c	Standard Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and strip for Pressure Vessels	B-340-C7
241-AP	ASTM A276-82a	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes	B-340-C7
241-AP	ASTM A480-82a	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip	B-340-C7
241-AP	AWS A2.4-79	Symbols for Welding and Non-destructive Testing	B-340-C7
241-AP	AWS A5.4-78	Specification for Corrosion-Resisting Chromium and Chromium-Nickel Steel Covered Welding Electrodes	B-340-C7
241-AP	AWS A5.9-77	Specification for Corrosion Resisting Chromium and Chromium-Nickel Steel Bare and Composite Metal Cored and Stranded Arc Welding Electrodes and Welding Rods	B-340-C7
241-AP	AWS D1.1-83	Structural Welding Code-Steel	B-340-C7
AZ-702	AWS D1.1-92	Structural Welding Code-Steel	W-030-C2
6241-A/V	AWS D1.1-94	Structural Welding Code-Steel	W-058-C3
241-AP	AWS D9.1-81	Specification for Welding of Sheet Metal	B-340-C7
6241-A/V	AWS D1.4-92	Structural Welding Code-Reinforcing Steel	W-058-C3 W-030-C2
241-AP	AWS QC1-83	Standard for Qualification and Certification of Welding Inspectors	B-340-C7
Stainless Steel Pit Liner and Metal Fabrication (6241 only)			
6241-A/V	ASTM A108-95	Steel Bars, Carbon, Cold Finished, Standard Quality	W-058-C3
6241-A/V	ASTM A240-95a	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and strip for Pressure Vessels	W-058-C3
6241-A/V	ASTM A276-95	Stainless Steel Bars and Shapes	W-058-C3

Table 6-2. Construction Codes for Tank Farm Pits and Vaults. (8 Sheets)

Farm/Pit	Code	Title	Specification
Stainless Steel Pit Liner and Metal Fabrication (6241 only) (Cont'd)			
6241-A/V	ASTM A480-95a	Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip	W-058-C3
6241-A/V	AWS A5.4-92	Stainless Steel Electrodes for Shielded Metal Arc Welding	W-058-C3
6241-A/V	AWS A5.9-93	Bare Stainless Steel Welding Electrodes and Rods	W-058-C3
6241-A/V	AWS D1.1-94	Structural Welding Code – Steel	W-058-C3
6241-A/V	AWS D9.1-90	Sheet Metal Welding Code	W-058-C3
6241-A/V	AISC ASD (1989)	Allowable Stress Design (Manual of Steel Construction) Ninth Edition	W-058-C3
6241-A/V	AISC S329-85	Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts	W-058-C3
6241-A/V	AISC S335-89	Structural Steel Buildings – Allowable Stress Design and Plastic Design	W-058-C3
6241-A/V	ASTM A36-94	Structural Steel	W-058-C3
6241-A/V	ASTM A325-94	High-Strength Bolts for Structural Steel Joints	W-058-C3
6241-A/V	ASTM A500-93	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes	W-058-C3
6241-A/V	ASTM A563-94	Carbon and Alloy Steel Nuts	W-058-C3
6241-A/V	ASTM F436-93	Hardened Steel Washers	W-058-C3

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
		Earthwork	
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D653	Terminology Relating to Soil, Rock, and Contained Fluids	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D2922	Density of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth)	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D3017 (W-314-C40 has a typographical error and refers to this standard as ASTM D3047)	Moisture Content of Soil and Soil-Aggregate In Place by Nuclear Method (Shallow Depth)	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Cast-in-Place Concrete			
AP 01A thru 08A & 03D & VP	ACI 117	Standard Tolerances for Concrete Construction and Materials	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ACI 301	Structural Concrete for Buildings	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ACI 306	Recommended Practice for Cold Weather Concreting	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AN Valve	ACI 318	Building Code Requirements For Reinforced Concrete	W-314-C1
AN Valve	ACI-SP66	Detailing Manual	W-314-C1
AW Valve			W-314-C10
AP 01A thru 08A & 03D & VP	ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
AP 01A thru 08A & 03D & VP	ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AW Valve	ASTM A706	Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement	W-314-C10
AN Valve	ASTM A751	Methods, Practices, and Definitions for Chemical Analysis of Steel Products	W-314-C1
AP 01A thru 08A & 03D & VP	ASTM A853	Steel Wire, Carbon, for General Use	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM C33	Concrete Aggregates	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens	W-314-C40
AN Valve			W-314-C1
SY 02A/ 03A/ SY-A/02D			W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
AP 01A thru 08A & 03D & VP	ASTM C94	Ready-Mixed Concrete	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AZ 01A/02A	ASTM C109	Compressive Strength of Hydraulic Cement Mortars	W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM C143	Test Method for Slump of Hydraulic Cement Concrete	W-314-C40
AN Valve			W-314-C1
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM C150	Portland Cement	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method	W-314-C40
AN Valve			W-314-C1
SY 02A/ 03A/ SY-A/02D			W-314-C21
AN Valve	ASTM C231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method	W-314-C1
AP 01A thru 08A & 03D & VP	ASTM C260	Air-Entraining Admixtures for Concrete	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Cast-in-Place Concrete (Cont'd)			
AP 01A thru 08A & 03D & VP AN Valve AW Valve SY 02A/ 03A/ SY-A/02D	ASTM C494	Chemical Admixtures For Concrete	W-314-C40 W-314-C1 W-314-C10 W-314-C21
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM C618	Coal Fly Ash and Raw or Calcine Natural Pozzolan for Use as Mineral Admixture in Portland Cement Concrete	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AZ 01A/02A	ASTM C939	Flow of Grout for Pre-placed Aggregate Concrete	W-314-C4
AP 01A thru 08A & 03D & VP	ASTM C1077	Laboratories Testing and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation	W-314-C40
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM C1107	Packaged Dry, Hydraulic-Cement Grout (Nonshrink)	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C21
AZ 01A/02A	ASTM C1222	Evaluation of Testing Laboratories Hydraulic Cement Grout	W-314-C4
AP 01A thru 08A & 03D & VP AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM C881	Epoxy Resin Based Bonding Systems for Concrete	W-314-C40 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve	ASTM E329	Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction	W-314-C1 W-314-C10

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Metal Fabrications			
AN Valve AW Valve AY 01A/02A	ASME NQA-1	Quality Assurance Program Requirements for Nuclear Facilities	W-314-C1 W-314-C10 W-314-C3
AP 01A thru 08A & 03D & VP	ASME Section XI	B&PVC, Qualification Standard for Weld and Brazing, Procedures, Welders, Brazens, and Welding and Brazing Operators	W-314-C40
AP 01A thru 08A & 03D & VP	AISC ASD M016	Manual of Steel Construction Allowable Stress Design 9th Edition	W-314-C40
AP 01A thru 08A & 03D & VP	AISC S335	Structural Steel Building – Allowable Stress Design and Plastic Design	W-314-C40
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASME A6	Rolled Structural Shapes	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASME A36	Structural Steel	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve	ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service	W-314-C1
AN Valve	ASTM A108	Steel Bars, Carbon, Cold Finished, Standard Quality	W-314-C1
AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM A123	Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products	W-314-C3 W-314-C4 W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Metal Fabrications (Cont'd)			
AP 01A thru 08A & 03D & VP	ASTM A240	Chrome-Nickel Stainless Steel Plate	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM A276	Stainless and heat-Resisting Steel Bars and Shapes	W-314-C40
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM A307	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM A312	Seamless and Welded Austenitic Stainless Steel Pipes	W-314-C40
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Metal Fabrications (Cont'd)			
AP 01A thru 08A & 03D & VP AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM A500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes	W-314-C40 W-314-C10 W-314-C3 W-314-C4 W-314-C21
SY 02A/ 03A/ SY-A/02D	ASTM A554	Welded Stainless Steel Mechanical Tubing	W-314-C21
AP 01A thru 08A & 03D & VP AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM A563	Carbon and Alloy Steel Nuts	W-314-C40 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM A568	Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM A569	Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve	ASTM A751	Methods, Practices, and Definitions for Chemical Analysis of Steel Products	W-314-C1 W-314-C10
AP 01A thru 08A & 03D & VP AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM F844	Washers, Steel, Plain (Flat), Unhardened for General Use	W-314-C40 W-314-C10 W-314-C3 W-314-C4 W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Metal Fabrications (Cont'd)			
AP 01A thru 08A & 03D & VP	AWS A5.1	Covered Carbon Steel Arc Welding Electrodes	W-314-C40
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	AWS D1.1	Structural Welding Code – Steel	W-314-C40
AN Valve			W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	AWS D1.3	Structural Welding Code – Sheet Steel	W-314-C40
AW Valve			W-314-C10
SY 02A/ 03A/ SY-A/02D			W-314-C21
AP 01A thru 08A & 03D & VP	AWS D1.6	Structural Welding Code – Stainless Steel	W-314-C40
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21
AN Valve	AWS QC1	Certification of Welding Inspectors	W-314-C1
AW Valve			W-314-C10
Chemical Resistant Decontaminable Coatings			
AN Valve	ANSI N512	Protective Coatings (paints) for the Nuclear Industry	W-314-C1
AW Valve			W-314-C10
AY 01A/02A			W-314-C3
AZ 01A/02A			W-314-C4
SY 02A/ 03A/ SY-A/02D			W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Chemical Resistant Decontaminable Coatings (Cont'd)			
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D412	Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D570	Test Method for Water Absorption of Plastics	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D638	Test Method for Tensile Properties of Plastics	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D714	Test Method for Evaluating Degree of Blistering of Paints	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D772	Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AZ 01A/02A	ASTM C836	High Solids Content, Cold Liquid Applied Elastomeric Water Proofing Membrane for Use with Separate Wearing Course	W-314-C4
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D1653	Test Methods for Water Vapor Transmission of Organic Coating Films	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Chemical Resistant Decontaminable Coatings (Cont'd)			
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D3912	Test Method for Chemical Resistance of Coatings Used in Light-Water Nuclear Power Plants	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D4060	Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D4082	Test Method for Effects of Gamma Radiation on Coatings for Use in Light-Water Nuclear Power Plants	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D4256	Test Method for Determination of the Decontaminability of Coatings Used in Light-Water Nuclear Power Plants	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D4259	Standard Practice for Abrading Concrete	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D4263	Test Method for Indicating Moisture Content in Concrete by the Plastic Sheet Method	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D4541	Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21

Table 6-3. Construction Codes for Project W-314 Pit Upgrades. (12 Sheets)

Farm (241-)/Pit	Code	Title	Specification
Chemical Resistant Decontaminable Coatings (Cont'd)			
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D5139	Sample Preparation of Qualification Testing of Coatings to be Used in Nuclear Power Plants	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AN Valve AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM D5144	Guide for Use of Protective Coating Standards in Nuclear Power Plants	W-314-C1 W-314-C10 W-314-C3 W-314-C4 W-314-C21
AW Valve AY 01A/02A AZ 01A/02A SY 02A/ 03A/ SY-A/02D	ASTM E84	Test Method for Surface Burning Characteristics of Building Materials	W-314-C10 W-314-C3 W-314-C4 W-314-C21
AW Valve AZ 01A/02A	ASTM E96	Test Methods for Moister Vapor Transmission of Materials	W-314-C10 W-314-C4
AN Valve AW Valve	NACE RP0172	Surface Preparation of Steel and Other Hard Materials by Water Blasting Prior to Coating or Recoating	W-314-C1 W-314-C10
AN Valve AW Valve SY 02A/ 03A/ SY-A/02D	NFPA 225	Model Manufactured Home Installation Standard.	W-314-C1 W-314-C10 W-314-C21
AP 01A thru 08A & 03D & VP AN Valve AW Valve AY 01A/02A SY 02A/ 03A/ SY-A/02D	SSPC SP6	Commercial Blast Cleaning	W-314-C40 W-314-C1 W-314-C10 W-314-C3 W-314-C21

6.6 CALCULATIONS FOR STRENGTH AND USEFUL LIFE

With proper care and inspections, the pits could be utilized almost indefinitely. The integrity of these pits and vaults primarily lies with the integrity of their coatings and/or linings, which can readily be patched, replaced, or upgraded. All applicable pits were recently upgraded and assessed (Table 6-1) per Project W-314. Specific calculations that were performed during the Project W-314 upgrades were reviewed by the IQRPE. The results of this review are provided in Table 6-4. All calculations were found to be prepared with the necessary rigor with the appropriate 'originator' and 'checker' signatures. Calculations were *not* checked for accuracy as that is considered to be beyond the scope of this assessment. However, design inputs and loads and resulting outputs were assessed as to whether reasonably comparable. It must be emphasized that, with the exception of 241-AZ-702, these calculations were already reviewed by a previous IQRPE and the pit upgrades were certified fit for use. Many of the calculations were also performed on existing structures, which have already performed adequately under the normal operating loads. It is also necessary to point out that seismic analyses on the pits and vaults are not as critical compared to that for the tanks. This is because the probability of a seismic event during a transfer (while lines are pressurized and full) is considered extremely low. It is not normally credible to consider seismic loading during sporadic events unless the consequences result in an immediate danger to the public. Such is not the case for buried waste transfer lines or pits, thus seismic loading should not be considered a normal operating load. Nevertheless, seismic analyses were performed on applicable pit and vault structures and are considered adequate.

The applicable calculations were obtained and reviewed for the 241-AZ-702 vent building and the seal pot AZ-PC-SP-1. However, it was clear from the calculations that a static method was used for the seismic analysis, and that a factor of 1.5 was applied to the peak acceleration for that of the seal pot and the AZ-702 building. The peak acceleration used for the seal pot was 0.25g and that for the building was 0.20g. Even though the peak acceleration used for the building was somewhat less than that for the seal pot, inclusion of seismic loads in the calculation provides some conservatism in the conclusion that AZ-702 and AZ-PC-SP-1 will remain fit-for-use under normal operating conditions. In fact, the AZ-702 calculation provides a load table, which shows that the seismic loads, though relatively low, are the greater loads. Roof live load, snow load, and wind load, are included with the seismic loads. Only the walls were analyzed in the model, which is reasonable since the walls receive all applied loads; whereas the floor, for example, would not receive wind loads directly. A damping of 10% was used in the analysis. Natural frequencies of the building are about 40 Hz, compared with that of the modeled soil, at about 6 Hz, which is a large enough difference to indicate relative stability of the building in a seismic event.

Structural evaluations for the SY and AP pits (including the AP valve pit) could not be located. However, their past performance and similarity in design with AN and AW pits lends to the probability that they are adequately designed. See Recommendation 6.11.2-3.

Table 6-4. Assessment of Pit and Vault Calculations. (2 Sheets)

Calculation No.	Title	Design Inputs	Assessment
W314-C-001	AN Valve Pit Structural Evaluation	$W_{concrete}$ = 150 lbf/ft3 E_s = 29EE6 psi S_{ysteel} = 36000psi S_{usteel} = 58000psi S_{yrebar} = 60000psi $S_{c\ conc.\ Wall}$ = 3000psi $S_{c\ cvrblock}$ = 5000psi W_{snow} = 20psf W_{live} = 200psf D_{soil} = 125lb/ft3 $W_{surcharge}$ = 100psf Seismic Importance Factor = 1.5	Utilizes a 1.5 factor on peak horizontal and vertical acceleration at 5% damping as obtained from GC-LOAD-01 and UCRL-15910.
W314-C-029	AN Pump Pit 01A and 04A Structural Evaluation	$W_{concrete}$ = 150 lbf/ft3 E_s = 29EE6 psi S_{ysteel} = 36000psi S_{usteel} = 58000psi S_{yrebar} = 60000psi $S_{c\ conc.\ exist}$ = 3000psi $S_{c\ conc.\ new}$ = 5000psi W_{snow} = 20psf W_{live} = 200psf D_{soil} = 125lb/ft3 $W_{surcharge}$ = 100psf Seismic Importance Factor = 1.5	Utilizes a 1.5 factor on peak horizontal and vertical acceleration at 5% damping as obtained from GC-LOAD-01 and UCRL-15910.
W314-C-054	AW Valve Pit Structural Evaluation	$W_{concrete}$ = 150 lbf/ft3 E_s = 29EE6 psi S_{ysteel} = 36000psi S_{usteel} = 58000psi S_{yrebar} = 60000psi $S_{c\ conc.\ exist}$ = 3000psi $S_{c\ conc.\ new}$ = 4000psi W_{snow} = 20psf W_{live} = 200psf D_{soil} = 125lb/ft3 $W_{surcharge}$ = 100psf Seismic Importance Factor = 1.5	Utilizes a 1.5 factor on peak horizontal and vertical acceleration at 7% damping as obtained from HNF-PRO-097 and UCRL-15910.

Table 6-4. Assessment of Pit and Vault Calculations. (2 Sheets)

Calculation No.	Title	Design Inputs	Assessment
W314-C-020	AY Pump Pits Structural Evaluation	$W_{concrete}$ = 150 lbf/ft3 E_s = 29EE6 psi S_{yrebar} = 40000psi $S_{c\ conc.\ exist}$ = 3000psi W_{snow} = 20psf W_{live} = 200psf D_{soil} = 125lb/ft3 $W_{surcharge}$ = 100psf Seismic Importance Factor = 1.5	Utilizes a 1.5 factor on peak horizontal and vertical acceleration at 7% damping as obtained from UCRL-15910. GC-LOAD-01 is not listed, but is apparent that this is where site-specific inputs were obtained.
W314-C-024	AZ Pump Pits Structural Evaluation	$W_{concrete}$ = 150 lbf/ft3 E_s = 29EE6 psi S_{yrebar} = 40000psi $S_{c\ conc.\ exist}$ = 3000psi W_{snow} = 20psf W_{live} = 200psf D_{soil} = 125lb/ft3 $W_{surcharge}$ = 100psf Seismic Importance Factor = 1.5	Utilizes a 1.5 factor on peak horizontal and vertical acceleration at 7% damping as obtained from UCRL-15910 and GC-LOAD-01.
W058-C-006	Diversion Box and Vent Station Design	Dead Load = 150psf Roof Live Load = 150 psf Wind Load = 25psf Wall and Roof loads = 100 psf	Utilizes 7% damping for vertical seismic load at 0.462g (ASCE 4-86 Table 3100-1).

6.7 AGE OF THE TANK FARM PITS AND VAULTS

Most of the pits are the same age as their respective tank farm. Only a few new pits have been installed since then. The new pits/vaults and their respective ages provided in Table 6-5.

Table 6-5. Age of New Pits and Vaults.

Pit	Install Year	Age
241-AZ-VP	2003	2 years
PPP (241-SY)	1999	6 years
6241-A/V	1997	9 years
241-AZ-702	1997	9 years

6.8 INSPECTIONS, TESTS AND EXAMINATIONS

For the purposes of this assessment, no tests were performed on the pits or vaults, nor were they warranted. However, appropriate examinations and tests were performed at construction as described in the construction specifications. Examinations were generally visual, and for configuration verification. For the 6241 vaults, weld inspections were performed for 100% of stainless steel liner welds on fit up and root passes per appropriate welding standards (e.g., AWS D1.1). Relative density testing was performed for backfill. Concrete was generally tested per ACI 301 Sections 16.1, 16.3, and 16.6 (e.g., B-120-C7, Section 3.07. While specific testing was not called out for AZ-702, all aspects of concrete mixing and pouring was controlled per ACI 301.

Throughout the course of Project W-314, the pits were inspected, with photographs published in the respective "decision documents" listed in Table A-1 of Appendix A in the Inspection Reports column. The sumps of the diversion box 6241-A and vent station 6241-V were inspected personally the IQRPE using remote video technology. The sump liners in those vaults are constructed of stainless steel and there was clearly no corrosion evident in either vault sump. Photographs of the 241-AZ-702 vault were obtained in March of 2005 and examined by the IQRPE. There was no apparent damage or chipping of the coating. Some moisture was noted on the floor but appeared to be rainwater intrusion. No evidence of leakage was noted from any piping or the seal pot. As noted in Section 6.11.2, the 241-AZ-702 vault will not be due for a formal coating inspection by a NACE-certified coating inspector until 2007 to 2009.

6.9 WASTE COMPATIBILITY OF THE TANK FARM PITS AND VAULTS

RPP-25153 examines the compatibility of the waste with the tank farm pits, vaults, and coating materials, with the exception of the coating material in AZ-702. The document raises no major concerns or findings with regard to compatibility.

The coating material used in AZ-702 was a 100% solids epoxy coating having the trade name Techni-Plus EN 25™. Data sheets were obtained for this epoxy brand and reviewed for compatibility with potential constituents of spillage. The constituents assumed are water, sodium hydroxide in low concentrations. The technical bulletin for the coating lists 50% sodium hydroxide to be within the chemical resistance capabilities of Techni-Plus EN 25™.

6.10 FITNESS FOR USE OF THE TANK FARM PITS AND VAULTS

The fitness for use of each pit may be obtained in Table A-1 of Appendix A. A few pits were not assessed due to field labor resource limitations. Such pits are listed as not authorized for use (NAU in Appendix A). See Section 10.0 for a description of the process required to change the fitness-for-use determination of any component.

No pit or vault fully assessed was found to have failed. No pit or vault was found to lack structural integrity. No pit or vault was found to lack leak containment integrity.

6.11 OBSERVATIONS AND RECOMMENDATIONS ON THE TANK FARM PITS AND VAULTS

It should be noted that there were no findings with regard to the tank farm pits and vaults.

6.11.1 Observations

1. Review of pit photographs and previous integrity assessment reports reveals that the pits are generally in good shape. Some pits are coated with epoxy paint; others are coated with polyurea or lined with stainless steel. The latter coatings are highly durable and can withstand drops and strikes from jumpers. Epoxy paint is susceptible to damage from contact with jumpers during installation or storage on the floor of the pit (see Recommendation 6.11.2-2).

2. A program or specification could not be located that identified inspection and cleaning requirements or frequencies for the pit coatings. The inspection frequencies and methods would be based on the type and durability of the respective coating (see Recommendation 6.11.2-1).

6.11.2 Recommendations

1. Pits must be cleaned and have their coatings re-inspected by a qualified NACE coating inspector at the following periodicities with the start date based on those provided in Table 6-6 for the pits, and November 2005 for the 6241 vaults.

   - Pits/vaults with polyurea coatings: every 10 to 12 years.
   - 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.

2. Pits with epoxy paint coatings should not be allowed to have old jumpers stored on the floor of the pit. The use of flex jumpers in these pits should be avoided where possible, if the braided hose contacts the pit floor or wall. Contact between the jumper and the coating could damage the coating. In fact, storing or disposing of jumpers by leaving them on the bottom of the pits threatens the leak integrity of the pits.

3. Structural evaluations for the SY and AP pits could not be located. Structural evaluations for these pits should be performed or obtained within 6 months and reviewed by the IQRPE. This report should then be revised to include the results of those evaluations.

Table 6-6. Pit Upgrade Completion Dates. (2 Sheets)

Pit	Date
241-AN-A	8/9/99
241-AN-B	8/9/99
241-AN-01A	2/26/03
241-AN-04A	2/26/03
241-AN-02A	8/13/03
241-AN-03A	8/13/03
241-AN-05A	8/13/03
241-AN-06A	8/13/03
241-AN-07A	8/13/03
241-AW-A	12/11/02
241-AW-B	12/11/02
241-AW-01A	9/29/03
241-AW-02A	6/3/03
241-AW-03A	5/2/03
241-AW-04A	8/26/03
241-AW-05A	5/2/03
241-AW-02D	6/3/03
241-AY-01A	8/20/03
241-AY-02A	8/20/03
241-SY-A	5/28/03
241-SY-03A	8/26/03
241-AP-01A	6/14/04
241-AP-03A	6/14/04
241-AP-04A	7/28/04
241-AW-06A	12/31/03
241-AW-02E	12/16/03
241-SY-02A	5/6/04
241-SY-02D	12/29/03
241-AP-02A	3/31/05
241-AP-05A	5/26/05
241-AP-07A	2/17/05
241-AP-08A	6/16/05
241-AP-02D	TBD
241-AP-06A	TBD
241-AP-Valve Pit	1/31/06
241-SY-B	TBD
241-AZ-01A	8/20/03

Table 6-6. Pit Upgrade Completion Dates. (2 Sheets)

Pit	Date
241-AZ-02A	8/20/03
241-AZ-Valve Pit	New
6241-V	11/3/05
6241-A	11/3/05
241-AZ-702	10/14/97

7.0 ASSESSMENT OF CATCH TANKS

Catch tanks in the DST system requiring assessment are those that are scheduled for service beyond June 30, 2005 and potentially store or transfer dangerous waste. For the DST system, only one tank will meet this criteria and that is tank 241-AZ-301. This tank 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, tank 241-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. The material, suspended in the vapor space of the tanks, may be drawn into the exhaust system through the action of airflow. No known occurrence reports have been written against the 241-AZ-301 leak detection system to indicate that 241-AZ-301 is leaking or ever has leaked.

The details regarding the construction of tank 241-AZ-301 may be found on design drawing H-14-105905, *Structural AZ-PC-SP-1 Cond. Dist. Sys. Receiver Tank Details*, along with related drawings, and procurement specification E-525-P01, *Procurement Specification Design Package 1 Fabrication of AZ-PC-SP-1 Condensate Distribution System*. A sketch of tank 241-AZ-301 is provided in Figure 7-1.

7.1 MATERIALS USED IN CONSTRUCTION

For the purposes of this assessment, the materials used in construction are listed by those specific to the primary tank and the secondary tank, respectively.

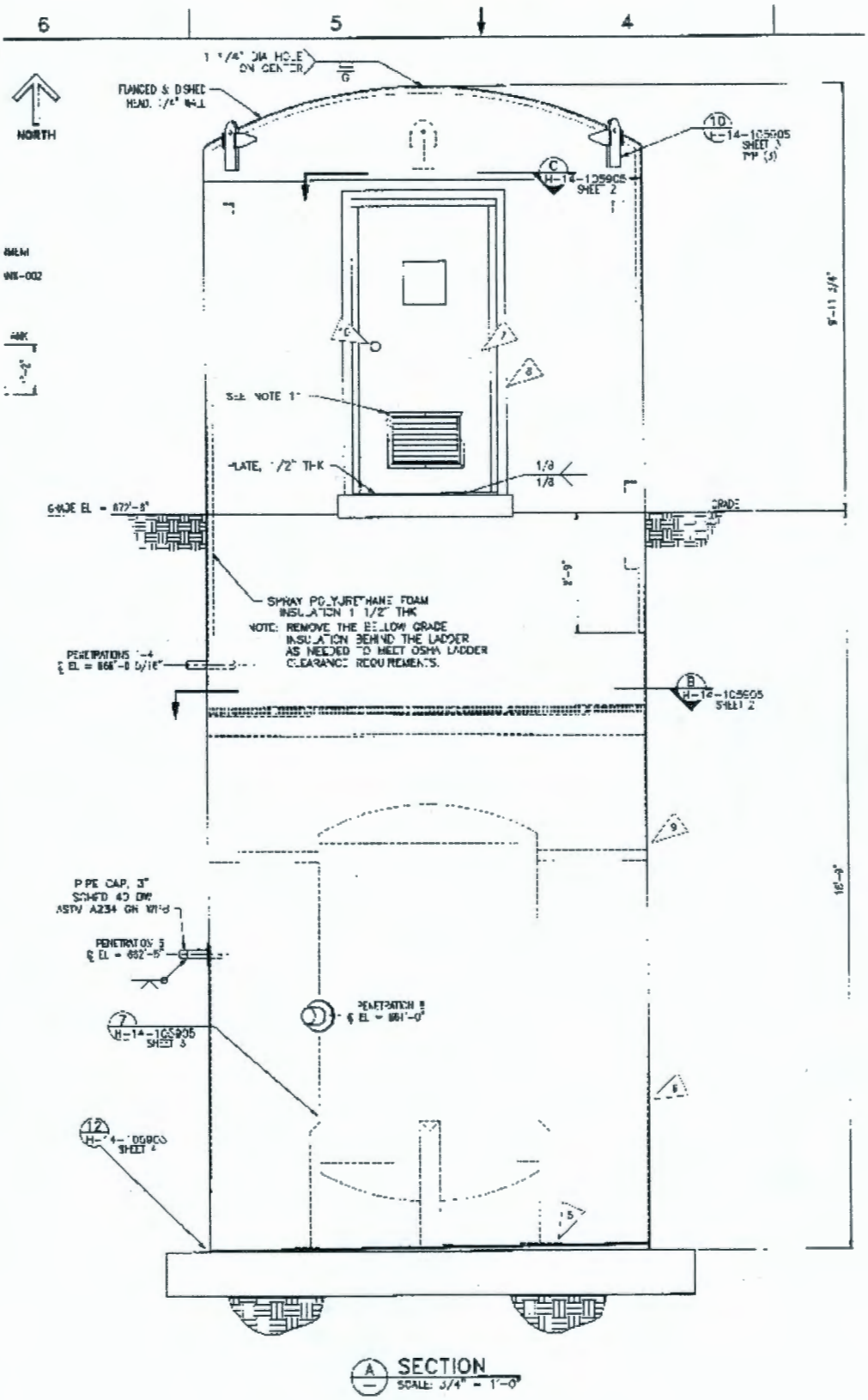
7.1.1 Primary Tank

Review of drawing H-14-105905, Sheet 3, and procurement specification E-525-P01 leads to the conclusion that the primary tank was fabricated from ASTM A312, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*. Tank supports, anchors, and attachments were constructed from ASTM A276 Type 304L stainless steel and ASTM A240 Type 304L stainless steel.

7.1.2 Secondary Containment

The secondary containment is fabricated from carbon steel per ASTM A1011, *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability*. The specification accommodates dissimilar metal welding through the use of filler metals of E309 or higher alloy content.

Figure 7-1. Catch Tank 241-AZ-301.



The secondary containment structure sits on a concrete pad and is partially buried in the soil. Protective coatings are utilized to protect the carbon steel structure from corrosion. No impressed current cathodic protection is explicitly provided; however, nearby anode beds may provide some protection. See RPP-25299 for a detailed assessment of the corrosion protection of catch tank 241-AZ-301.

7.2 CONSTRUCTION METHODS

This section will provide a description of the construction methods employed for each tank system.

7.2.1 Primary Tank

The primary tank was constructed per the design drawings and ANSI B31.3 welding and inspection requirements. Over-sized lifting lugs were incorporated for transport and placement of the tank. The tank was small enough that the walls were constructed of one course of two ¼-in. thick rolled stainless steel plates.

7.2.2 Secondary Containment

The secondary tank was constructed per the design drawings, ANSI B31.3, and AWS D14.1, *Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment*, for welding requirements. Oversized lifting lugs were incorporated for transport. The tank was constructed of an unknown number of courses of ¼-in.-thick rolled carbon steel plates. The lower part of the tank is direct-buried in over 16 ft of compacted backfill meeting specification ASTM D1567, *Standard Test Method for Detergent Cleaners for Evaluation of Corrosive Effects on Certain Porcelain Enamels*, or ASTM D4254, *Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.*

7.3 QUALITY CONTROL

Quality assurance requirements for the catch tank 241-AZ-301 facility involved compliance to 10 CFR 830.122, "Quality Assurance Criteria," and ASME NQA-1 select requirements. The procurement specification for the tank (E-525-P01) required the tank manufacturer to have an established Quality Assurance Program that is recognized by a national consensus standard.

7.3.1 Primary Tank

The primary tank was provided nondestructive examination/testing including 100% visual examination of welds and 100% liquid penetrant examination of welds. The tank was also hydrostatically leak tested to 4 psig.

7.3.2 Secondary Containment

The secondary containment was provided the same nondestructive examination/nondestructive testing as the primary and more. Additional testing included more extensive visual and magnetic particle examination of welds UT of completed circumferential and longitudinal butt welds. The secondary containment was also leak tested per ANSI B31.3, paragraph 345.7.

7.4 ENGINEERING CODES REFERENCED FOR CONSTRUCTION

Necessary and appropriate engineering codes were referenced in construction. A listing of these codes may be reviewed in Section 2.0 of E-525-P01 and in E-525-C01, *Construction Specification, Project E-525 (Design Package 1) 241-AZ-151 Catch Tank Bypass*. All work was performed under the governance of an appropriate national consensus engineering codes and standards.

7.5 OPERATING SPECIFICATIONS

OSD-T-151-00015, *Operating Specifications for Miscellaneous Facilities,* is applicable to catch tanks. However the current revision does not yet include a listing for catch tank 241-AZ-301. When the operating specification document is eventually revised, it is expected that the specifications for catch tank 241-AZ-301 will be very similar to catch tank 241-AZ-151. These specifications for catch tanks simply provide level to volume conversion tables along with level limits of operation.

7.6 CALCULATIONS FOR STRENGTH AND USEFUL LIFE

Catch tank 241-AZ-301 was evaluated per E525DP1-C-001, *Calculation Condensate Distribution System Tanks Structural Analysis*. Appropriate inputs were used and applied to both the primary and secondary tanks based on their proper function. One minor discrepancy was found between the calculations and the construction specification. The calculation for the primary tank was based on a material specification of ASTM A240 Type 304L, while the construction specification required construction of the tank per ASTM A312 Type 304L. This discrepancy is inconsequential because the applicable material strengths are identical between the two specifications.

Calculations for useful life were not performed; however, it was noted that the corrosion allowance for the primary tank was 0.016 in. and the corrosion allowance for the secondary tank was 0 in. The basis for the primary tank corrosion allowance is unknown and was not provided; however, the integrity assessment report, RPP-RPT-26983, *Independent Construction Assessment Report of Project E-525 DST Transfer System Modifications*, reported the design life as 35 years. A 0.016-in. corrosion allowance then corresponds to a 0.4 mils/yr corrosion rate, which seems appropriate and slightly conservative for stainless steel. The secondary tank is specified to be fully coated with two types of coating products, one of which is zinc based. Assuming there were no defects in the coatings at installation and no rocks impinge upon and damaging the coating, the secondary tank material could be considered isolated from the soil and not subject to galvanic corrosion. RPP-25299 provides a detailed assessment of AZ-301 with regard to corrosion protection.

Design criteria utilized for the primary and secondary tanks is provided in Table 7.1

Table 7-1. AZ-301 Structural Calculation Criteria per E525DP1-C-001.

Criteria	Value	
API 650-98, Appendix E	Use to check shell thickness for gravity loads and to develop seismic forces	Use UBC 97 seismic zones
AWWA D-100	Use to check shell thickness for combined gravity and seismic loads	Not applicable
Wind loads	Not applicable – tank fully contained within secondary containment tank	ASCE 7-98
Transportation loads	Not applicable	Primary tank will be shop fabricated in place inside the containment tank, then shipped via truck transport to the jobsite. A separate analysis was performed.
Seismic zone	2B	2B
Importance factor	1	1
Basic wind speed	Not applicable	85 mph
Wind exp. category	Not applicable	C
Allowable soil pressure	Not applicable	3000 psf
Site coefficient	1.5 (API Table E-3)	1.5 (API Table E-3)
Contents	Condensate	Atmospheric
Specific gravity	1.1	Tank is basically empty. Provides containment for 5' dia. × 10' primary condensate tank mounted inside the secondary tank and completely below grade.
Liquid level	100% full for static conditions; 90% full for seismic conditions	Empty

Notice that the calculation assumed the secondary tank to be empty. The calculation proceeded from there and did not analyze the tank for structural adequacy in the event of a leak from the primary tank, thereby causing the secondary tank to not be empty. This is inconsequential with regard to structural integrity under normal operating conditions, since a leak is not considered a normal operating condition. On the other hand, the secondary tank has not been analyzed for its regulatory function.

7.7 AGE OF THE CATCH TANK

Catch tank 241-AZ-301 was installed in 2005 and is less than 1 year old as of March 31, 2006.

7.8 INSPECTIONS TESTS AND EXAMINATIONS

Welding inspections were specified to be in accordance with ASME B31.3 for both the primary and secondary tanks.

Table 7-2 lists the types of testing performed, the associated consensus standard reference and applicable feature receiving the test. Specification E-525-P01 also provides acceptance criteria, which will not be repeated here. The criteria was reviewed, however, and found to be adequate.

7.9 WASTE COMPATIBILITY OF THE CATCH TANK

RPP-25153 addresses waste compatibility of tank farm components including catch tank 241-AZ-301.

7.10 FITNESS FOR USE OF THE CATCH TANK

Catch tank 241-AZ-301 was designed adequately, was not found to lack structural strength, and was not found to lack leak integrity.

Table 7-2. Inspections, Tests and Examinations of Tank AZ-301.

Test/Examination	Consensus Standard	Applicable Feature
Visual examination (VT)	ASME B31.3, paragraph 344.2 with acceptance criteria in accordance with ASME B31.3 Table 341.3.2	100% of the primary and secondary tanks at the fit-up and root pass of circumferential butt welds, full penetration welds on branch connections, structural attachment welds to the pressure boundary, and longitudinal butt welds. On the secondary tank, 100% of cover pass welds, such as circumferential butt welds, full penetration welds on branch connections, and longitudinal butt welds.
Magnetic particle examination (MT)	ASME BPVC, Section V, Article 7	100% of cover pass welds on the secondary tank such as circumferential butt welds, lap joint or fillet joint welds, full penetration welds on branch connections, structural attachment welds to the pressure boundary, and longitudinal butt welds. Liquid penetrant was allowed to be substituted for magnetic particle examination on a weld for weld basis.
Liquid penetrant examination (PT)	ASME BPVC, Section V, Article 6	100% of the cover pass primary tank welds such as circumferential butt welds, and structural attachment welds to the pressure boundary.
Radiographic examination (RT)	ANSI B31.3, Paragraph 344.5, and Normal Fluid Service. Acceptance criteria was in accordance with ANSI B31.3, Table 341.3.2	No tank feature received radiographic examination
Ultrasonic examination (UT)	ASME BPVC, Section V, Article 5	100% of completed welds on the secondary tank such as circumferential butt welds and longitudinal butt welds
Leak/pressure testing	ASME B31.3, paragraph 345.4	Hydrostatic test of primary tank
Leak/pressure testing	ASME B31.3, paragraph 345.7	Secondary tank

7.11 OBSERVATIONS ON THE CATCH TANK

It should be noted that there were no findings on catch tank 241-AZ-301.

1. A schedule for future assessment was not found in the existing integrity assessment for this tank (see Recommendation 7.12.1).

2. Since the tank is still new and project files readily accessible, capturing of any actual wall thickness measurements of the primary and secondary tanks shells would be beneficial to future assessment activities (see Recommendation 7.12.2).

3. The secondary tank was not structurally analyzed for liquid fill. The required shell thickness for the primary tank containing liquid is analyzed to 3/16 in. minimum. The required shell thickness to retain the soil load is also 3/16 in. Condensate leakage into the secondary tank is expected to result in a reversal of some of the stresses due to the soil load, thus reducing the stress in the secondary tank shell. However, it is best practice to analyze the secondary tank for containment of leaked condensate from the primary tank, because this is its primary function.

7.12 RECOMMENDATIONS ON THE CATCH TANK

7.12.1 This tank should be assessed again by an IQRPE in 10 years (the year 2016). The assessment should include physical inspection and UT examination of both the primary and secondary tank.

7.12.2 If actual plate thickness measurements were obtained during construction, those values should be captured and retained by the DST Integrity Project before project files are archived. These measurements will be needed as a baseline for the next integrity assessment.

8.0 WASTE CHARACTERISTICS AND COMPATIBILITY

RPP-25153 was prepared for the IQRPE to assess waste compatibility issues with respect to the DST system.

8.1 SUMMARY OF WASTE COMPATIBILITY RECOMMENDATIONS

A summary of waste compatibility findings, basis for recommendations, and recommendations may be found in Appendix G, Tables G-1 and G-2.

9.0 ASSESSMENT OF THE DOUBLE-SHELL TANK INTEGRITY PROGRAM

The DST Integrity Program is comprised of all activities and fieldwork that is performed for the purpose of acquiring data, which is utilized in the integrity assessment process. The program is an entity in and of itself that could make or break the adequacy of data gathered or the ability to even perform an integrity assessment. For this reason, the program must be assessed to ensure that future integrity assessment activities are provided with adequate data, and that interim problems can be captured and corrected prior to the next assessment.

This assessment will first describe the current program model, and subsequently assess the elements of the model. Finally, the assessment will provide recommendations for improving the model to the point that it is adequate to meet the needs of the next assessment and the capture of interim integrity issues.

9.1 CURRENT PROGRAM MODEL

The current DST Integrity Program is described in RPP-7574 and consists of the following routine periodic activities:

1. UT examinations of roughly 1% surface area of each tank course, plus weld heat-affected zone inspection.

2. Tandem-synthetic aperture focusing technique (TSAFT) and extended arm UT examinations of select tanks lower primary knuckles.

3. Video examination of the internal primary tank.

4. Video examination of the external primary tank and internal secondary tank (annulus space).

5. A commitment to opportunistically examine five diameters of any excavated pipe.

6. Annual leak testing of catch tanks.

7. Corrosion monitoring.

If a DST Integrity Program were developed strictly according to WAC 173 303-640(2), it would need to be inclusive of the following tank system components.

A. DST primary shell
B. DST secondary shell
C. Pipes that potentially transport dangerous waste
D. Pits that provide secondary containment to pipes transporting potentially dangerous waste
E. Applicable catch tanks.

In addition, according to WAC 173-303-640(6)I, any cathodic protection system needs to be inspected for (i) proper operation annually and (ii) functional sources of impressed current bimonthly. Therefore, we must add item "F":

F. Cathodic protection systems.

Table 9-1 provides a compliance matrix that indicates how well the current DST Integrity Program covers the required components.

Table 9-1. Double-Shell Tank Integrity Program Compliance Matrix.

Program Activity	Applicable Component
1	A, B
2	A
3	A
4	A, B
5	C
6	E
7	A

Note that in Table 9-1, nearly all components are covered except D (pits) and F (cathodic protection systems). However, Project W-314 is currently responsible for the assessment and refurbishment of all applicable pits; RPP-16922, *Environmental Specification Requirements*, requires bimonthly inspection of the rectifiers (the source of impressed currents), but it does not require annual inspection of proper operation.

It can therefore be said that the DST Integrity Program, in conjunction with Project W-314 and RPP-16922, assesses all components applicable to the dangerous waste regulations. However, further review of the nature of these assessments (in the following sections) is necessary to determine if the DST Integrity Program adequately assesses all components.

9.2 PROGRAM ELEMENT ASSESSMENTS

This section assesses each element of the DST Integrity Program for adequacy. An adequate program is considered one that provides appropriate and representative data to assess the fitness-for-use of the applicable components.

9.2.1 Ultrasonic Testing Examinations

Each primary tank is inspected using UT apparatus. However, 100% of the primary tank surface is not inspected, nor is it possible to inspect this much surface area. The tanks rest on a

refractory concrete pad that renders the tank bottoms virtually inaccessible to current UT inspection technology. Some access is available through "air-slots" in the refractory concrete, but this document considers examination through those slots of little benefit (only a little more than 0.004% of the bottom can be examined). This raises the question of whether the current amount of UT inspection is adequate in addition to the question of whether the methodologies used in the UT inspection process are sound. These two aspects of the UT inspection program are assessed below.

9.2.1.1. Surface Area Examination. Review of the various UT inspection reports reveals that the UT examinations cover less than 1% of the surface area of each tank examined. The question as to whether this amount of metal examined is enough was raised and answered to some extent in HNF-4529, *241-AW Double Shell Tanks Integrity Assessment Report*, which states that "the preponderance of evidence from the UT examination of these six tanks suggests that the primary steel tanks at Hanford are not degrading to any appreciable extent." Unfortunately, without further analysis it cannot be stated that examination of 1% of surface area constitutes a "preponderate" level of evidence. The present UT program is based on the assumption that the DST wall condition is circumferentially uniform, and the vertical scans will detect any layering effects.

A documented analysis was performed (PNNL-15182, *Riser Difference Uncertainty Methodology Based on Tank AY-101 Wall Thickness Measurements with Application to Tank AN-107*) to answer this question. The analysis essentially asserted that in order to determine if 1% of tank surface area is enough, more data would need to be obtained from more quadrants of the tank. Tanks 241-AY-101 and 241-AN-107 were eventually analyzed using the statistical methods described in PNNL-15182. It was learned that with those tanks, the 1% examination sufficiently assesses for general corrosion. However, the TFC has made the decision to double the UT area to increase the fraction of the DST surface examined, obtain data from different risers, and to more accurately statistically project the defect distribution.

The document further clarifies that nothing less than 100% surface area examinations will detect flaws due to site-specific corrosion or other mechanisms other than the general and pitting corrosion that is derived from the UT scans – unless such unique or isolated flaws happen to occur within the 1% band of examination for that tank.

It is important to note that while only 1% of the surface area of the tank is examined, the specific locations are strategically targeted to include all reachable plate courses; general problem areas (e.g., weld heat-affected zones); liquid-air interface levels; and high-stress areas (e.g., lower knuckle).

9.2.1.2. Ultrasonic Testing Methodology. The UT examination methodology is sufficiently described in the inspection reports; therefore, the methodology will not be repeated here. A corrosion expert and a tank inspection expert reviewed the methodology. Both were satisfied with the way UT examinations were carried out in the DSTs. Some concerns were informally communicated to the inspection lead. The most serious concern was that the calibration block

for the UT sensors was not cared for in a manner that protected the uniformity of the calibrations. The inspection team immediately remedied this, along with the remainder of the concerns.

9.2.1.3. Conclusions and Observations on Ultrasonic Testing Examinations

Observations: PNNL-15415 is considered to contain valuable insights into determining the statistical representativeness of the UT examinations. The analysis in the document has been completed for two tanks, but must be strategically extended to the remaining 26 tanks, since the waste in the tanks is generally not homogeneous. The document outlines methodologies for rounding out this determination for all 28 DSTs (see Recommendation 9.2.1.4).

Conclusions: In light of the PNNL analysis (PNNL-15415) and the expert assessment of UT methodologies, the DST UT inspection program can be considered adequate to assist in this determination of fitness-for-use.

9.2.1.4. Recommendations on Ultrasonic Testing Examinations. It is recommended that the vision of PNNL-15415 be carried to completeness. Specifically, as UT scans progress, different quadrants of the tank should be examined to support the findings of the analysis. Once an examination has been performed at each quadrant of each tank – or until the analysis is satisfied – rotation of quadrant examinations should continue to further ensure that not just a small area of the tank is examined over and over again. This will make it difficult to obtain corrosion rate data from the UT examinations (because different areas are examined). The present TFC program to double the UT area by doing a UT from the same riser as previously done, and another set from a second riser, may be an appropriate compromise with riser rotation. However, UT examinations are not considered to be an adequate means of monitoring both low corrosion rates and rapid onset events (e.g., SCC), and need to be augmented by in-tank corrosion monitors, as will be discussed in Section 9.2.6.3. However, UT examinations are still needed to quantify the general condition of the tank wall.

9.2.2 TSAFT and Extended Arm Examinations of Select Tank's Lower Primary Knuckles

TSAFT projects a special UT signal from the upper knuckle weld through the knuckle plate metal, around to the bottom knuckle weld (where the knuckle joins the bottom plate), and provides for UT detection and measurement of potential SCC in the lower knuckle.
This technology can detect circumferential cracks in the lower knuckle, but cannot isolate their location, nor can it quantify the crack size if it is 0.100 in. or below (which is a reportable crack size).

Extended arm technology is simply a UT sensor mounted on a specially designed arm, which allows both wall thickness and standard crack detection measurements of the curved knuckle surface. While its ability to measure wall thickness and localized cracking complements the long-range TSAFT technology, it is unable to reach and examine much of the area at the intersection of the curved lower knuckle and the flat tank bottom (except where the extended arm

can be moved into the knuckle region exposed by the insulating air slot) that, based on structural analyses, is believed to be the region of maximum tensile stress. Utilization of the air slot accessibility to reach the knuckle tangent point is now uniformly accomplished and feasible.

9.2.2.1. Observations on TSAFT and Extended Arm Examinations

1. Due to the configuration of the primary tank installations, there is no known technology that will provide better or more extensive data than the TSAFT and extended arm systems. The area of maximum tensile stress is resting on the refractory concrete and is generally inaccessible to direct measurement, except where air slots are available. The TFC is therefore left to the capabilities of the TSAFT and extended arm technologies. While crack detection sensitivity is good, crack-dimensioning capability is restricted. Unless a crack is identified that is greater than 0.050 in. in size, it cannot be quantified as being below that dimension. No action has been identified in the event of a TSAFT crack indication that is located outside of the extended arm reach. Since, under certain conditions the crack could be of any size less than or equal to 0.050 in., it would still have to be reported at 0.050 in., even if it were actually much smaller (i.e., crack detectability is more sensitive than crack dimensionability). Should there ever be a TSAFT indication in the area of maximum stress, it will be difficult to base the tank's fitness-for-use on anything other than its leak status. If such a defect were detected (none of the six DST lower knuckle examinations had any crack-like indications), the only recourse would be increased UT surveillance frequency to determine if the defect was growing (see Recommendation 9.2.2.3-1).

2. RPP-RPT-28968 reports on recent laboratory testing regarding SCC in the DSTs. It is apparent that the probability of SCC initiating in the post-weld stress relieved primary tank shell material is very low. Further evaluation could lead to the conclusion that TSAFT examination is no longer required (see Recommendation 9.2.2.3-2).

9.2.2.2. Conclusions on TSAFT and Extended Arm Examinations. The TSAFT and extended arm technologies provide useable data within their limitations. From a purely technical standpoint, the technologies may be used to support fitness-for-use determinations. Programmatically, however, a finding by the TSAFT technology in the area of maximum stress could be unnecessarily detrimental to the DST mission. Further, in light of the findings in RPP-RPT-28968, additional evaluations are necessary to determine the need for future TSAFT examinations. However, use of the extended arm technology is still needed.

9.2.2.3. Recommendations on TSAFT and Extended Arm Examinations

1. Due to the crack measurement limitations of the TSAFT data, it is recommended that the TFC develop a response plan, approved by the facility owner (U.S. Department of Energy, Office of River Protection) and the acting IQRPE that describes a credible response to the possibility of a TSAFT crack indication in the area of maximum stress in the knuckle (e.g., increased UT surveillance). The plan will need to determine the limits of capability of the TSAFT device and whether further development will allow it to

quantify cracks of sizes less than 0.050 in. The plan will also need to rely heavily on leak detection indications and video examinations in the area of the identified crack.

2. In light of the findings in RPP-RPT-28968, further evaluation should be performed to determine the need for further TSAFT examinations. The evaluation should include consideration and benefits of all data that can be obtained from the TSAFT device other than crack detection and sizing.

9.2.3 Video Examination of the Double-Shell Tanks

Trained personnel operate the cameras for video examination of the tanks. Until recently, the examinations were generally witnessed and directed by a qualified corrosion engineer having a doctorate level degree in metallurgy. The engineer has since retired and the TFC is not actively seeking a similarly qualified replacement. However, a chemical engineer with corrosion experience has been assigned as a technical point of contact.

Procedures are used to guide the video examination, the setup, and the archiving of the video data. The cameras are lighted and can provide good illumination across much of the primary tank interior depending on the location of the camera. The cameras are unable to provide good resolution of the far side of the tank when the camera is located near an edge. Because the light is located on the camera, as opposed to inserted in a different riser, images are sometimes washed out and shadows are not available to help determine the topography of the areas being examined.

9.2.3.1. Observations on Video Examination of the Double-Shell Tanks

1. Video inspection of the primary tank interior is challenging due to the nature of the video. A certified inspector without a camera would normally perform a commercial industry tank inspection. The inspector would hold a light to the surface and look for abnormal indications and shadows. This is sometimes called 'profiling the surface.' A video inspection provides a two-dimensional view of the tank walls. The success of a video inspection depends on several factors including tank waste height, camera resolution, lighting, and the experience of the inspector reviewing the tape or watching the monitor. Any indications can only be verified by a subsequent UT examination in the exact area of the indication (if accessible from the annulus). Success of the UT examination depends on the certain capabilities of the UT equipment (e.g., cable length, accessibility). Indications discovered on videos in the dome, for instance, are not generally accessible by the UT equipment and cannot be quantified with current technology. If the tank were empty and an indication was discovered on the tank bottom, that area is not accessible by the UT equipment and cannot be quantified with current technology (see Recommendation 9.2.3.2-1).

2. TFC policies regarding mandatory procedure compliance is commendable and do contribute to obtaining quality data. However, placing the Field Work Supervisor in charge of obtaining quality, useful videos is a conflict of interest and risks failure.

At best it results in a loss in ownership of the inspection. The only way to remedy this situation is to ensure that a single individual is responsible for a quality video and is independent of the labor forces. It is also evident that some individuals directing the video examinations are not aware of areas of interest identified on previous videos. Areas of interest need to be subsequently re-videoed at each inspection interval to determine whether corrosion is progressing (see Recommendation 9.2.3.2-2).

3. The person directing the videos has often been qualified as a metallurgist or has been trained in corrosion. Those videos performed without such qualified individuals are apparent in that key features or areas of concern are missed (on the other hand, Observation 9.2.3.1-2 could also be the cause). However, it is acceptable to utilize a graded approach in establishing a group of qualified inspectors, starting with Quality Control inspectors who are at least trained in visual inspection of welds. Over time, the Quality Control inspectors could receive training in basic corrosion from NACE and eventually receive their NACE inspector certifications (see Recommendation 9.2.3.1-3).

4. The person writing the video reports has not been qualified to review and report on inspection videos. This has resulted in reports with minimal or inadequate technical discussion of the corrosion or indications otherwise observed by qualified inspectors. The reports are not authoritative and do not provide specific recommendations for further quantitative examination with UT equipment (see Recommendation 9.2.3.2-2).

5. Visits to the video archives by the IQRPE revealed that original videos were stored on shelves and little or no access control was provided. Each video represents thousands of dollars worth of data. In fact, because each video is a snapshot in time of an ongoing corrosion process, no video can be replaced through re-performance (see Recommendation 9.2.3.1-6).

9.2.3.2. Recommendations Regarding Future Video Examinations. An internal primary tank video inspection with the current technology can only be somewhat effective provided (1) the examinations are performed by qualified individuals, (2) the examinations are performed prior to UT examination, and (3) the UT examinations can be targeted at accessible indications identified by the video inspection team. This section provides recommendations that, when implemented, will ensure useful, quality video data is obtained and reported.

1. Technology exists that allows the use of three-dimensional camera deployment on the end of an articulated arm. This technology, if used, would best simulate the performance of a tank inspection on a human-enterable tank. Use of this technology may also avoid unnecessary deployments of UT equipment. In some cases, indications found by two-dimensional video that result in supplemental deployment of UT equipment, may be easily resolved with three-dimensional video, precluding the need for a corresponding UT examination.

2. Procedures, whether explicitly followed or not, are not ensuring the acquisition of quality video data. Further, it is clear that blindly following procedures will not necessarily result in the consistent acquisition of quality video data. A video inspection program,

integrated with the UT inspection program, is needed to ensure quality video data is obtained and reported. The program should consist of inspectors belonging to a non-operations or DST Integrity Project organization, qualified to visual inspection standards and trained in the identification of the various common types of corrosion. A qualified engineer, metallurgist, or scientist should be dedicated to the UT and video inspection programs to provide general direction, reporting, and integration of the inspection activities to the end that meaningful data is obtained and utilized.

3. Inspectors tending to the video inspections should have already viewed previous videos for areas of interest that need to be revisited. Tracking specific areas of corrosion in subsequent inspections will provide an indication of how the corrosion is progressing.

4. Videos need to precede UT examinations. This will allow UT examinations to be targeted at areas of interest without the monetary and schedule expense of supplemental re-deployment of UT equipment.

5. The video examinations are not code inspections. It is not possible to visually inspect the DSTs to any consensus engineering code or standard, nor is such a code or standard required. However if the video examination director does not have an applicable engineering degree, he/she is required to have some experience with or qualification in some visual inspection standard. Non-engineer video examination directors should also be trained in the construction of the tanks and have some awareness of tank pre-commissioned condition as well as a general understanding of corrosion. This ensures that the video examination director has an understanding of the need to obtain the best image possible and which visual indications may be worthy of capturing additional detail by zooming, panning, or tilting. A qualified engineer with knowledge or training in corrosion and tank construction could fulfill the role of the video examination director.

6. The original videos themselves represent invaluable data sets that must be archived, protected from degradation, and properly access controlled. A program for archiving the video data per appropriate quality assurance standards is necessary to ensure their availability for future integrity examinations and assessments. At a minimum, the videos need to be kept in fire-proof cabinets in an area with fire sprinklers, and under controlled access. It is also recommended that back-up DVDs, using the new archival quality discs (300-year guaranteed life) be made for each of the inspections and stored in a separate location.

9.2.4 A Commitment to Opportunistically Examine Five Diameters of Any Excavated Pipe

The TFC commits in RPP-7574 to examine five diameters of transfer pipe whenever one happens to be excavated. However, no pipes were examined from October 2002 to December 2005, even though several pipes were excavated because no program was in place to integrate such examinations with excavations. In addition, the value added of the opportunistic examination activity is not apparent in light of encasement pressure testing.

Observations and recommendations regarding buried transfer line inspection are provided in RPP-27591. Any findings and recommendations from RPP-27591 are summarized in the Appendix G tables.

9.2.5 Annual Leak Testing of Catch Tanks

The TFC has committed to perform annual leak testing of catch tanks. The tanks are filled to a specified level and then monitored for loss of liquid via level measurement devices over the course of several hours.

9.2.5.1. Observations of Annual Leak Testing of Catch Tanks. According to regulatory requirements (WAC 173 303-640(2)(c)(v)(A) and 173 303-640(2)(c)(v)(B)), leak testing is a preferred method of tank integrity assessment on tanks that are buried and do not have secondary containment. There are no tanks meeting this description that are currently in service in the tank farms (catch tank 241-AZ-301 is double contained). Therefore, leak testing of catch tanks in the tank farms is no longer needed (see Recommendation 9.2.5.2).

9.2.5.2. Recommendations on Annual Leak Testing of Catch Tanks. There is little benefit from performing annual leak tests on catch tank 241-AZ-301 because it is double contained and provided with leak detection. It is therefore recommended that catch tank 241-AZ-301 not receive annual leak testing.

9.2.6 Corrosion Monitoring

Primary corrosion monitoring for the Hanford Site waste storage tanks has been conducted through a waste chemistry sampling and analysis program. In this program, the tank waste is sampled, analyzed, and compared to corrosion control specifications derived from laboratory exposures. The corrosion rates for the walls of the waste storage tanks have been deduced by matching the measured tank chemistries with those from laboratory studies, and then extracting the corrosion rates from tables, as determined from laboratory studies. This approach was based on corrosion study PNNL-5488. PNNL performed tests using various environments, and statistically interpreted the data. The studies have determined that the corrosion processes are controlled by the concentrations of hydroxide, nitrate, and nitrite within the waste. Hence, the control of the concentration of these anions has been the basis for controlling corrosion rates within the waste tanks.

Operational specification documents (e.g., OSD-T-151-00007) specify that the tank contents must be within the compositional limits. Process chemistry documents RPP-7795, *Technical Basis of DST Chemistry Control*, and RPP-8532, *DST Chemistry Control Data Quality Objectives*, specify time intervals between successive sampling and analysis of the waste chemistries from the individual storage tanks, as well as require calculated projections of waste chemistry time to go out of specification. Acceptable corrosion rates are not defined within

those documents, as the assumption is that chemistry control will maintain the tanks at or below the design corrosion rate of 1 mil/yr.

The primary corrosion monitoring program at Hanford has been periodic or calculated collection and analysis of samples from the waste tanks, maintaining the waste chemistry in specification, and then using the UT and visual inspections as the basis for deducing the corrosion rates of the walls within the tanks. The waste chemistry sampling results and projected depletion rates are used as the basis for making chemical additions to maintain or bring the waste products into compliance. Recently, this chemical analysis and UT/visual inspection program for corrosion control and monitoring has been supplemented by the use of electrochemical noise techniques in several of the DSTs.

Other corrosion monitoring techniques have been considered at the Hanford tank farms (e.g., the use of metal coupons, electrical resistance probes, or linear polarization resistance techniques), but reported only a limited degree of success. RPP-5694, *A Plan to Develop and Demonstrate Electrochemical Noise Based Corrosion Monitoring System in Hanford Site Waste Tanks,* reports that metal coupons, electrical resistance probes, and linear polarization resistance techniques were most effective for monitoring uniform corrosion, but were not well-suited for early detection of localized forms of corrosion (e.g., pitting and SCC). Pitting and SCC have been identified as the most likely mode of failure for Hanford DSTs (ARH-ST-111, *Compilation of Hanford Corrosion Studies*; WHC-SD-WM-ER-414, *Hanford Waste Tank System Degradation Mechanisms Report*). Hence, Hanford tank farm engineers desired a comprehensive monitoring technique better suited to detect the onset of localized or general corrosion mechanisms.

9.2.6.1. In-Tank Corrosion Monitoring Probes at the Tank Farms. The TFC has been developing tank corrosion probes in-house for several years. Table 9-2 provides a chronology of their development.

Table 9-2. Chronology of Corrosion Probe Development.

Date	Description
Probes Currently Out of Service	
08/01/96	241-AZ-101 installed - prototype. 3 channels, only 1 channel immersed in waste.
09/16/97	241-AN-107 (first one) installed - 1st generation. Major upgrades: field hardy digital hardware, 8 channels @ 8 elevations top-to-bottom in tank plus weight loss coupons. Major problems: Near total loss of analog data signal on long cables in tank farms.
09/01/98	241-AN-102 installed - 2nd generation. Major upgrades: field hardy, digital hardware, 8 channels @ 8 elevations. Major problems: serious concerns over square cut electrode gaskets and probe never operated due to funding cuts.
Probes in Service	
01/13/00	241-AN-105 installed - 3rd generation. Major upgrades: probe actually monitored, electrode gaskets changed to O-rings, 22 thermocouples, gas sampling ports, and strain gauges added to probe body. Major problems: assuring continuous power supply in tank farms, signal cross-talk and loss in short analog cables in probe body, serious concerns over crevice corrosion around O-rings and fear of hitting tank bottom or hard sludge during install.
01/03/01	241-AN-104 installed - 4th generation. Major upgrades: changed data cables to match "fix" applied to 3rd generation cables, added integral water lance to facilitate installation and added adjustable collar at probe top in case tank depth less than expected. Major problems: assuring continuous power supply in tank farms, serious concerns over crevice corrosion around O-rings.
08/09/01	241-AN-107 installed - Probe identical to 241-AN-104 probe with same good and bad features.
Fiscal year 2006	New probe to be installed - 5th generation, not designed yet. Major upgrades: total redesign to add linear polarization resistance and electrical resistance electrodes and hardware to existing electrochemical noise electrodes, add retractable/replaceable stressed and unstressed coupons, eliminate O-ring gaskets on electrochemical noise electrodes, address constant power supply issues in tank farms.

The formally recognized corrosion-control and corrosion-monitoring program is currently provided at the tank farms through waste chemistry sampling and adjustment, plus periodic UT/visual inspections. In this process, tank waste is sampled, analyzed, and compared to specified waste chemistry and, as necessary, adjusted to meet corrosion control specifications derived from laboratory exposure of coupons in simulated waste. Tank wall corrosion is monitored by periodic UT and visual inspections. This approach is expensive, time consuming, and does not yield real-time data on the extent or degree of tank corrosion.

9.2.6.2. Double-Shell Tank Waste Transfer Line Corrosion Monitoring. No corrosion monitoring exists at the tank farms that specifically target the waste transfer lines. There are commercially available probes that can be deployed in a jumper to monitor corrosion-erosion (see Appendix F). However, two transfer lines were selected for internal visual examination.

The examinations were performed in 2005 and 2006 on transfer lines 241-AN-SN-261 and 241-AP-SN-615. These examinations confirmed that on carbon steel lines, a passive layer is formed on the interior of the pipe due to the caustic in the waste product. No signs of significant corrosion were indicated and there were no signs of erosion at all.

Sections of lines SNL-3150 and SLL-3160 were forensically examined after a section of the lines were removed during some upgrades. Line SNL-3150 was used several times and line SLL-3160 had never been used. There were only slight signs of corrosion on either line. In fact, there was little noticeable difference between the two from a corrosion standpoint. Each of these primary lines, however, was stainless steel and not comparable to the carbon steel primary waste transfer lines in the farms.

There were some carbon steel lines planned for forensic examination in the 241-SY tank farm. However, funding issues precluded the examination of those lines in time for this report.

9.2.6.3. Observations of Corrosion Monitoring at the Tank Farms

1. UT inspections typically provide a resolution of ten mils, or 10/1000 in. Thus, at least 10 mils of metal loss must occur to the base metal before the corrosion could be detected with a level of confidence. In fact, on a 0.375-in.-thick plate, thinning is detectable near 10 mils, but is not reportable on that plate until it has experienced a 20% loss, which is about 75 mils. If the corrosion rates were 100 mils/yr, then corrosion would become detectable (but not yet reportable) within just 36 days. If the corrosion rates were 10 mils/yr, then the corrosion processes would have to continue for a full year before they would become detectable. However, the actual corrosion rates, which have been measured within the DST using linear polarization resistance techniques, were found to generally be less than 1 mil/yr. Thus, at the present corrosion rates, it could take over 10 years before corrosion would be detectable, using ultrasonic techniques. This is the justification for the 8- to 10-year periodicity of UT inspections. However, any accelerated corrosion (e.g., liquid-air interface) or slow initiation, rapid progression corrosion (e.g., SCC) might be missed by this approach. This is why in-tank corrosion monitoring instrumentation is needed. The monitoring could detect the onset of corrosion before the cumulative effects of the corrosion processes become detectable by the inspection techniques, or detect rapidly deteriorating conditions in a timely manner. Thus, with in-tank corrosion monitoring, the appropriate remedial actions could be implemented to stop or at least slow down (inhibit) the corrosion processes.
   A combination of in-tank corrosion monitors that detect uniform corrosion (e.g., electrical resistance and linear polarization resistance probes) along with detection of pitting and cracking (electrochemical noise probe) would protect the DSTs from long-term corrosion thinning and the most likely leak failure mechanism due to corrosion from through-wall pitting. While the UT equipment can detect pitting, 100% of the tank cannot be inspected and reportable pitting could be missed (see Recommendation 9.2.6.5-1).

2. The 5th generation tank probes presently under design and procurement for limited application, are the key to monitoring corrosion in real time and determining corrosion

rates in the Hanford waste tanks. The probes utilize several monitoring methods including corrosion potential, electrochemical noise, electrical resistance, linear polarization resistance, with pre-stressed and neutral electrodes, along with passive coupons. Using the various methods is important because they are complementary. For instance, each electrochemical noise reading is independent from the previous reading. During down times, electrochemical noise provides no indication of the corrosive conditions in the tank. On the other hand, electrical resistance continues to provide a means of assessing the corrosive conditions that occurred once power is restored to the system. Once actual corrosion rates can be measured, it is possible that UT examination frequencies can be fine tuned and probably relaxed for those tanks that employ corrosion probes instrumentation. Or, perhaps, the UT examinations could be refocused to levels of the tank experiencing higher than expected corrosion, or the vapor space and liquid/vapor interfaces, complementing the corrosion probes, which have minimal capability with regard to detecting vapor space corrosion (see Recommendation 9.2.6.5-1).

Interviews with TFC engineers indicate that tank waste chemistry has been informally characterized and grouped into seven basic waste types to this extent that it may prove feasible that the installation of only seven probes might provide adequate representative monitoring of the DSTs. However, different temperature and other conditions may require individual monitoring probes for each DST. Nevertheless, it is considered that the corrosion probe program must be completed with probes installed, at a minimum, in all representative waste types.

3. Not enough data exists to determine the need for corrosion monitoring in the transfer lines. A representative carbon steel sample is needed for forensic analysis. Ideally, the 241-SY transfer lines will eventually be examined, since they represent a good amount of use and are sufficiently aged to get an idea of their corrosion-erosion performance over the years (see Recommendation 9.2.6.5-2).

9.2.6.4. Observations of the Tank Farm Corrosion Control Program

1. Recent measurements of the general and localized corrosion rates within the waste storage tanks have resulted in the reporting of low corrosion rates (i.e., less than 1 mil/yr [0.001 in./yr]). Ultrasonic inspections of the interior surface of the waste storage tanks have not revealed significant patterns or areas of pitting, and the ultrasonic inspections have not resulted in the detection of networks of SCC. Hence, it is understandable that coupons and the electrical resistance probes, which had been installed within some of the Hanford tanks in earlier testing, did not detect significant corrosion rates.

   Therefore, it can be deduced that the current method of managing corrosion within the liquid covered surfaces of the tanks by maintaining the chemistry as currently specified (>12 pH) is effective in minimizing tank corrosion.

2. In order for the DST systems to be fit for use for the duration of their design life and beyond, it is essential for the TFC to maintain the integrity of the waste storage tanks,

pits, and transfer piping system until the end of their mission. This requires that the tanks and piping be appropriately monitored for indication of active corrosion. In addition, chemical treatments or other remedial actions should continue to be undertaken to keep the system within specifications. Monitoring should also be used to confirm the effectiveness of any treatments (see Recommendation 9.2.6.5-1).

3. Some tanks have exceeded their 20% wall thinning criteria in some areas. Others may have used up nearly all of their corrosion allowance (e.g., tank 241-SY-101 plate #1). Much of the corrosion on the tanks is most pronounced in the vapor space, and at any long-term liquid-vapor interface. Vapor space corrosion monitoring, or the development of laboratory techniques for accelerated testing, would be beneficial in quantifying the rates at which the vapor space corrosion is occurring, and if any remedial actions are required.

9.2.6.5. Recommendations on Tank Farm Corrosion Monitoring and Control

1. Current plans to build and install the fifth generation probes are one of the keys to rounding out the DST corrosion-monitoring program. These probes need to be designed, installed, and tested as soon as possible. Obtaining baseline data is of highest priority once testing is complete. The probes should be configured to include monitoring of vapor space corrosion in addition to the liquid and condensed solids regions of the waste. It is recommended that a program and funding be provided for immediate deployment of corrosion probes in each waste type representative DST at a minimum.
   This recommendation also includes the retention of the knowledgeable probe development engineer until such time as the system is fine-tuned for non-expert operation and analysis.

2. Document RPP-27591 provides further recommendations regarding corrosion monitoring and control on buried waste transfer lines. These are summarized in the Appendix G tables.

9.2.7 Inspection of Cathodic Protection Systems

The cathodic protection systems are assessed by the IQRPE in RPP-25299.

10.0 FITNESS FOR USE

The assessment matrix provided in Appendix A lists each component applicable to this assessment, its method of assessment, the applicable document or section that assessed it, and whether or not it is authorized for use. Some components are listed as being 'deferred use' or 'emergency use' as identified by two letters from Ecology (Lyons 2003; Lyons 2005). Components that are not buried pipe in the 'deferred use' or 'emergency use' categories generally have not been assessed. Components that are buried pipe in these categories have generally been assessed to the point that only an encasement leak test is required to complete their assessment. If a component is listed as not authorized for use (NAU in Appendix A), then there is likely additional field data that needs to be obtained for it to be fit for use (FFU in Appendix A). Not authorized for use does not necessarily mean the component is not fit for use (NFFU in Appendix A), but that sufficient data is not available to make that determination. If a component is listed as not fit for use, then that component is recommended to be removed from service immediately.

The process for changing the status of any component generally depends on the reason for its current status. Most of the transfer lines, however, that are listed as not authorized for use simply need to have their encasement pressure tested to complete their assessment. If they pass the pressure test, then they may be changed to fit for use by the IQRPE via appropriate document change procedures and re-stamping the assessment.

Components listed as not fit for use can only be changed to fit for use on a case-by-case basis with the involvement of the IQRPE.

It must be emphasized that the fitness-for-use determination is not intended to mean that there is no chance the component will fail prior to 2028. This document meets the intent of the regulations in that it determines the current fitness for use of the DST system components. ERUL calculations are only provided as evidence supporting this document's recommendations for future assessments and their frequency.

The DST system should be re-assessed by an IQRPE in 10 years. The assessment should consider additional data gathered since the issuance of this assessment.

11.0 REFERENCES

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40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

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APPENDIX A

ASSESSMENT MATRIX

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AN-01A	Central Pump Pit	AN	H-2-71991	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-15831 Rev. 0 This Doc, Section 6	FFU
241-AN-01B	Annulus Pump Pit	AN	H-2-71991	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AN-01D	Drain Pit	AN	H-2-71991	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AN-02A	Central Pump Pit	AN	H-2-71992	Inspection / Refurbishment	6A, 6B, W-314	RPP-12427 Rev. 0	RPP-18678 Rev. 0 This Doc, Section 6	FFU
241-AN-02B	Annulus Pump Pit	AN	H-2-71992	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AN-03A	Central Pump Pit	AN	H-2-71993	Inspection / Refurbishment	6A, 6B, W-314	RPP-12426 Rev. 0	RPP-18679 Rev. 0 This Doc, Section 6	FFU
241-AN-03B	Annulus Pump Pit	AN	H-2-71993	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AN-04A	Central Pump Pit	AN	H-2-71994	Inspection / Refurbishment	6A, 6B, W-314	RPP-10375 Rev. 0	RPP-15831 Rev. 0 This Doc, Section 6	FFU
241-AN-04B	Annulus Pump Pit	AN	H-2-71994	Inspection / Refurbishment	6A, 6B	N/A	Emergency Use	NAU
241-AN-04D	Slurry Receiver Pit	AN	N/A	Not to be assessed	N/A	N/A	N/A	Fed by SLL-3160, No secondary Containment Function
241-AN-05A	Central Pump Pit	AN	H-2-71995	Inspection / Refurbishment	6A, 6B, W-314	RPP-11598 Rev. 0	RPP-12552 Rev. 0 This Doc, Section 6	FFU

[4] FFU = Fit For Use; NAU = Not Authorized for Use; NFFU = Not Fit For Use

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AN-05B	Annulus Pump Pit	AN	H-2-71995	Inspection / Refurbishment	6A, 6B	N/A	Emergency Use	NAU
241-AN-06A	Central Pump Pit	AN	H-2-71996	Inspection / Refurbishment	6A, 6B, W-314	RPP-11152 Rev. 0	RPP-12551 Rev. 0 This Doc, Section 6	FFU
241-AN-06B	Annulus Pump Pit	AN	H-2-71996	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AN-07A	Central Pump Pit	AN	H-2-72039	Inspection / Refurbishment	6A, 6B, W-314	RPP-12425 Rev. 0	RPP-18680 Rev. 0 This Doc, Section 6	FFU
241-AN-07B	Annulus Pump Pit	AN	H-2-72039	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AN-101	1,200,000 Gallon Waste Tank	AN	H-2-71991	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-10199 Rev. 0 (2002)	This doc, Section 4	FFU
241-AN-102	1,200,000 Gallon Waste Tank	AN	H-2-71992	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-11581 Rev. 0 (2002)	This doc, Section 4	FFU
241-AN-103	1,200,000 Gallon Waste Tank	AN	H-2-71993	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-RPT-24476 Rev. 0 (2005)	This doc, Section 4	FFU
241-AN-104	1,200,000 Gallon Waste Tank	AN	H-2-71994	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-RPT-26254 Rev. 1 (2006)	This doc, Section 4	FFU
241-AN-105	1,200,000 Gallon Waste Tank	AN	H-2-71995	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	HNF-4816 Rev. 0 (1999) RPP-13259 Rev. 0 (2003 sup)	This doc, Section 4	FFU
241-AN-106	1,200,000 Gallon Waste Tank	AN	H-2-71996	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	HNF-4817 Rev. 0 (1999)	This doc, Section 4	FFU
241-AN-107	1,200,000 Gallon Waste Tank	AN	H-2-72039	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	HNF-3353 Rev. 1 (1999)	This doc, Section 4	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AN-A	Valve Pit	AN	H-2-71989	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-16375 Rev. 0 RPP-16376, Rev. 0, RPP-15831 This Doc, Section 6	FFU
241-AN-B	Valve Pit	AN	H-2-71989	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-16375 Rev. 0 This doc, Section 6	FFU
COB-AN-7	Clean Out Box	AN	H-2-71992	N/A – Removed from service in 2004	N/A	N/A	N/A	E-525
COB-AN-8	Clean Out Box	AN	H-2-71995	N/A – Removed from service in 2004	N/A	N/A	N/A	E-525
COB-AN-9	Clean Out Box	AN	H-2-71986	N/A – Removed from service in 2004	N/A	N/A	N/A	E-525
RW-AN01	Raw Water Line	AN	H-2-71907	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AN02	Raw Water Line	AN	H-2-71907	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AN03	Raw Water Line	AN	H-2-71907	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AN05	Raw Water Line	AN	H-2-71907	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AN06	Raw Water Line	AN	H-2-71907	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-364	Drain Line	AN	H-2-71991	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-366	Drain Line	AN	H-2-71991	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-368	Drain Line	AN	H-2-71991	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-369	Drain Line	AN	H-2-71989	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AN-01	Drain Line	AN	H-14-104389	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AN-02	Drain Line	AN	H-14-104389	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AN-03	Drain Line	AN	H-14-104389	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
DR-AN-04	Drain Line	AN	H-14-104389	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AN-05	Drain Line	AN	H-14-104389	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-401	Diluent/Flush	AN	H-14-104614	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-402	Diluent/Flush	AN	H-14-104614	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-461	Annulus Leak Detection Return	AN	H-2-71991	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-462	Annulus Leak Detection Return	AN	H-2-71992	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-463	Annulus Leak Detection Return	AN	H-2-71993	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-464	Annulus Leak Detection Return	AN	H-2-71994	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-465	Annulus Leak Detection Return	AN	H-2-71995	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-466	Annulus Leak Detection Return	AN	H-2-71996	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-467	Annulus Leak Detection Return	AN	H-2-72039	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-471	Annulus Pump Pit Return	AN	H-2-71991	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-472	Annulus Pump Pit Return	AN	H-2-71992	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-473	Annulus Pump Pit Return	AN	H-2-71993	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-474	Annulus Pump Pit Return	AN	H-2-71994	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-475	Annulus Pump Pit Return	AN	H-2-71995	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
PW-476	Annulus Pump Pit Return	AN	H-2-71996	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-477	Annulus Pump Pit Return	AN	H-2-72039	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-161	Slurry Transfer Line	AN	H-2-71991	Inspection/Test/ Analysis	4B, 11A	2E-04-01595/W 7/19/05 68psig	RPP-27591 Rev. 0	FFU
SL-162	Slurry Transfer Line	AN	H-2-71992	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-163	Slurry Transfer Line	AN	H-2-71993	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-164	Slurry Transfer Line	AN	H-2-71996	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-165	Slurry Transfer Line	AN	H-2-71996	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-166	Slurry Transfer Line	AN	H-2-71996	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-167	Slurry Transfer Line	AN	H-2-72038	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-168	Slurry Transfer Line	AN	H-2-72038	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-261	Supernate Transfer Line	AN	H-2-71991	Inspection/Test/ Analysis	4B, 11A	2E-04-01595/W 7/19/05 67 psig	RPP-27591 Rev. 0	FFU
SN-262	Supernate Transfer Line	AN	H-2-71992	Inspection/Test/ Analysis	4B, 11A	2E-04-01337/W 1-3-2005 Enc. Tested at 69 psig	RPP-27591 Rev. 0	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SN-263	Supernate Transfer Line	AN	H-2-71993	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-264	Supernate Transfer Line	AN	H-2-71994	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-265	Supernate Transfer Line	AN	H-2-71995	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-266	Supernate Transfer Line	AN	H-2-71996	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-267	Supernate Transfer Line	AN	H-2-72038	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-268	Supernate Transfer Line	AN	H-2-71989	Inspection/Test/ Analysis	4B, 11A	WFO-WO-000258 8/9/05 66 psig	RPP-27591 Rev. 0	FFU
SN-636	Supernate Transfer Line	AN/AP	H-14-103271	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-10535 Rev. 0 RPP-15831 Rev. 0 RPP-27591 Rev. 0	FFU
241-AP-01A	Central Pump Pit	AP	H-2-90553	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25645 Rev. 0	RPP-RPT-26809 Rev. 0 This doc, section 6	FFU
241-AP-01B	Annulus Pump Pit	AP	H-2-90553	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AP-02A	Central Pump Pit	AP	H-2-90554	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25883 Rev. 0	RPP-RPT-26808 Rev. 0 This doc, Section 6	FFU
241-AP-02B	Annulus Pump Pit	AP	H-2-90554	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AP-02D	Valve Pit	AP	H-2-90554	Inspection / Refurbishment	6A, 6B	RPP-RPT-29198 Rev. 0	RPP-RPT-29199 Rev. 0 This doc, Section 6	FFU
241-AP-03A	Central Pump Pit	AP	H-2-90555	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25655 Rev. 0	RPP-RPT-26810 Rev. 0 This doc, section 6	FFU
241-AP-03B	Annulus Pump Pit	AP	H-2-90555	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AP-03D	Drain Pit	AP	H-2-90555	Inspection / Refurbishment	6A, 6B	RPP-RPT-25836 Rev. 0	RPP-RPT-26807 Rev. 0 This doc, Section 6	FFU
241-AP-04A	Central Pump Pit	AP	H-2-90556	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25458 Rev. 0	RPP-RPT-26811 Rev. 0 This doc, section 6	FFU
241-AP-04B	Annulus Pump Pit	AP	H-2-90556	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AP-05A	Central Pump Pit	AP	H-2-90557	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-26835 Rev. 0	RPP-RPT-27145 Rev. 0 This Doc, Section 6	FFU
241-AP-05B	Annulus Pump Pit	AP	H-2-90557	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AP-06A	Central Pump Pit	AP	H-2-90558	Inspection / Refurbishment	6A, 6B, W-314	TBD	TBD	NAU
241-AP-06B	Annulus Pump Pit	AP	H-2-90558	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AP-07A	Central Pump Pit	AP	H-2-90559	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25836 Rev. 0	RPP-RPT-26807 Rev. 0 This Doc, Section 6	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AP-07B	Annulus Pump Pit	AP	H-2-90559	Inspection / Refurbishment	6A, 6B	N/A	Emergency Use	NAU
241-AP-08A	Central Pump Pit	AP	H-2-90560	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-26823 Rev. 0	RPP-RPT-27146 Rev. 0 This Doc, Section 6	FFU
241-AP-08B	Annulus Pump Pit	AP	H-2-90560	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AP-101	1,200,000 Gallon Waste Tank	AP	H-2-90553	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-13546 Rev. 0 (2003)	Section 4	FFU
241-AP-102	1,200,000 Gallon Waste Tank	AP	H-2-90554	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-RPT-23573 Rev. 0 (2005)	Section 4	FFU
241-AP-103	1,200,000 Gallon Waste Tank	AP	H-2-90555	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-13802 Rev. 0A (2003)	Section 4	FFU
241-AP-104	1,200,000 Gallon Waste Tank	AP	H-2-90556	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-RPT-24379 Rev. 0 (2005)	Section 4	FFU
241-AP-105	1,200,000 Gallon Waste Tank	AP	H-2-90557	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-15764 Rev. 0 (2003)	Section 4	FFU
241-AP-106	1,200,000 Gallon Waste Tank	AP	H-2-90558	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-RPT-23205 Rev. 0A (2005)	Section 4	FFU
241-AP-107	1,200,000 Gallon Waste Tank	AP	H-2-90559	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-6231 Rev. 0A (2000)	Section 4	FFU
241-AP-108	1,200,000 Gallon Waste Tank	AP	H-2-90560	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-6684 Rev. 0B (2002)	Section 4	FFU
241-AP-VP	Valve Pit	AP	H-2-90547	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-28933 Rev. 0 (2006)	RPP-RPT-29052 Rev. 0 This Doc, Section 6	FFU
RW-AP01	Raw Water Line	AP	H-2-90544	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP02	Raw Water Line	AP	H-2-90544	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
RW-AP03	Raw Water Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP04	Raw Water Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP05	Raw Water Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP06	Raw Water Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP07	Raw Water Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP08	Raw Water Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP09	Raw Water Line	AP	H-2-90548	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP10	Raw Water Line	AP	H-2-90548	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP11	Raw Water Line	AP	H-2-90548	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP12	Raw Water Line	AP	H-2-90548	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP13	Raw Water Line	AP	H-2-90547	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AP14	Raw Water Line	AP	H-2-90547	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-712	Drain Line	AP	H-2-90555	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-713	Drain Line	AP	H-2-90555	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-714	Drain Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-715	Drain Line	AP	H-2-90546	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-716	Drain Line	AP	H-2-90547	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-811	Annulus Pump Pit Return	AP	H-2-90553	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-812	Annulus Pump Pit Return	AP	H-2-90554	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-813	Annulus Pump Pit Return	AP	H-2-90555	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-814	Annulus Pump Pit Return	AP	H-2-90556	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
PW-815	Annulus Pump Pit Return	AP	H-2-90557	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-816	Annulus Pump Pit Return	AP	H-2-90558	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-817	Annulus Pump Pit Return	AP	H-2-90559	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-818	Annulus Pump Pit Return	AP	H-2-90560	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-823	Leak Detection Pit Return	AP	H-2-90555	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
PW-825	Leak Detection Pit Return	AP	H-2-90557	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-509	Slurry Transfer Line	AP/ AW	H-2-90544	Inspection/Test/ Analysis	4B, 11A	2E-03-01489/W 11-2-05 Enc. Tested at 70 psig	RPP-27591 Rev. 0	FFU
SL-510	Slurry Transfer Line	AP/ AW	H-2-90544	Inspection/Test/ Analysis	4B, 11A	2E-03-01489/W 11/2/05 70psig	RPP-27591 Rev. 0	FFU
SL-511	Slurry Transfer Line	AP	H-2-90553	Inspection/Test/ Analysis	4B, 11A	2E-03-01287/O 5/28/04 69 psig	RPP-27591 Rev. 0	FFU
SL-512	Slurry Transfer Line	AP	H-2-90554	Inspection/Test/ Analysis	4B, 11A	2E-04-00759/W 4/5/05 67 psig	RPP-27591 Rev. 0	FFU
SL-513	Slurry Transfer Line	AP	H-2-90555	Inspection/Test/ Analysis	4B, 11A	2E-03-01437/W 5/27/04 68 psig	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SL-514	Slurry Transfer Line	AP	H-2-90556	Inspection/Test/ Analysis	4B, 11A	2E-03-01438/W 6/9/04 69 psig	RPP-27591 Rev. 0	FFU
SL-515	Slurry Transfer Line	AP	H-2-90557	Inspection/Test/ Analysis	4B, 11A	2E-03-01436/W 7/14/05 68 psig	RPP-27591 Rev. 0	FFU
SL-516	Slurry Transfer Line	AP	H-2-90558	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SL-517	Slurry Transfer Line	AP	H-2-90559	Inspection/Test/ Analysis	4B, 11A	2E-03-1439 2-18-2005 Enc. tested at 69 psig	RPP-27591 Rev. 0	FFU
SL-518	Slurry Transfer Line	AP	H-2-90560	Inspection/Test/ Analysis	4B, 11A	2E-03-01440/W 7/13/05 68 psig	RPP-27591 Rev. 0	FFU
SN-611	Supernate Transfer Line	AP	H-2-90553	Inspection/Test/ Analysis	4B, 11A	2E-03-01287/W 5/20/04 67 psig	RPP-27591 Rev. 0	FFU
SN-612	Supernate Transfer Line	AP	H-2-90554	Inspection/Test/ Analysis	4B, 11A	2E-04-00759/W 4/5/05 67 psig	RPP-27591 Rev. 0	FFU
SN-613	Supernate Transfer Line	AP	H-2-90555	Inspection/Test/A nalysis	4B, 11A	2E-03-01437/W 5/26/04 68 psig	RPP-27591 Rev. 0	FFU
SN-614	Supernate Transfer Line	AP	H-2-90556	Inspection/Test/ Analysis	4B, 11A	2E-03-01438/W 6/11/04 68 psig	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SN-615	Supernate Transfer Line	AP	H-2-90557	Inspection/Test/ Analysis	4B, 11A	2E-03-01436/W 7/14/05 68 psig	RPP-27591 Rev. 0	FFU
SN-616	Supernate Transfer Line	AP	H-2-90558	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to use	RPP-27591 Rev. 0	NAU
SN-617	Supernate Transfer Line	AP	H-2-90559	Inspection/Test/ Analysis	4B, 11A	2E-03-1439 2-18-2005 Enc. tested at 69 psig	RPP-27591 Rev. 0	FFU
SN-618	Supernate Transfer Line	AP	H-2-90560	Inspection/Test/ Analysis	4B, 11A	2E-03-01440/W 7/13/05 68 psig	RPP-27591 Rev. 0	FFU
SN-622	Supernate Transfer Line	AP	H-2-90554	New Installation/ Analysis	4B, 11A	N/A	RPP-10535 Rev. 0 RPP-27591 Rev. 0	FFU
SN-634	Supernate Transfer Line	AP/AZ	H-14-103270	New Installation/ Analysis	4B, 11A	N/A	RPP-10535 Rev. 0 RPP-27591 Rev. 0	FFU
SN-700	Supernate Transfer Line	AP	H-14-104900	New Installation/ Analysis	4B, 11A	N/A	RPP-10535 Rev. 0 RPP-27591 Rev. 0	FFU
SN-701	Supernate Transfer Line	AP	H-14-104892	New Installation/ Analysis	4B, 11A	N/A	RPP-10535 Rev. 0 RPP-27591 Rev. 0	FFU
204-AR	1,450 Gallon Waste Tank	AR	H-2-70682	Proposed Deferred Use	N/A	N/A	N/A	NAU, not included in the RCRA Part B Permit
241-AW-01A	Central Pump Pit	AW	H-2-70403	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25320 Rev. 0	RPP-RPT-25855 Rev. 0 This Doc, Section 6	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AW-01B	Annulus Pump Pit	AW	H-2-70403	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AW-02A	Central Pump Pit	AW	H-2-70404	Inspection / Refurbishment	6A, 6B, W-314	RPP-16466 Rev. 0	RPP-RPT-25161 Rev. 0 This Doc, Section 6	FFU
241-AW-02B	Annulus Pump Pit	AW	H-2-70404	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AW-02D	Drain Pit	AW	H-2-70404	Inspection / Refurbishment	6A, 6B, W-314	RPP-16542 Rev. 0	RPP-RPT-25162 This Doc, Section 6	FFU
241-AW-02E	Pump Pit	AW	H-2-70404	Inspection / Refurbishment	6A, 6B	RPP-RPT-25384 Rev. 0	RPP-27147 Rev. 0 This doc, Section 6	FFU
241-AW-03A	Central Pump Pit	AW	H-2-70405	Inspection / Refurbishment	6A, 6B, W-314	RPP-16470 Rev. 0	RPP-19430 This Doc, Section 6	FFU
241-AW-03B	Annulus Pump Pit	AW	H-2-70405	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AW-04A	Central Pump Pit	AW	H-2-70406	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25458 Rev. 0	RPP-RPT-25854 Rev, 9 This Doc, Section 6	FFU
241-AW-04B	Annulus Pump Pit	AW	H-2-70406	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AW-05A	Central Pump Pit	AW	H-2-70407	Inspection / Refurbishment	6A, 6B, W-314	RPP-16465 Rev. 0	RPP-19431 Rev. 0 This Doc, Section 6	FFU
241-AW-05B	Annulus Pump Pit	AW	H-2-70407	Inspection / Refurbishment	6A, 6B	N/A	Emergency Use	NAU
241-AW-06A	Central Pump Pit	AW	H-2-70408	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25506 Rev. 0	RPP-RPT-25979 Rev. 0 This Doc, Section 6	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AW-06B	Annulus Pump Pit	AW	H-2-70408	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AW-101	1,200,000 Gallon Waste Tank	AW	H-2-70403	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-7018 Rev. 0A (2001)	Section 4	FFU
241-AW-102	1,200,000 Gallon Waste Tank	AW	H-2-70404	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-8698 Rev. 0A (2001) RPP-11581 Rev. 1 (2003)	Section 4	FFU
241-AW-103	1,200,000 Gallon Waste Tank	AW	H-2-70405	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	SD-WM-TRP-282 Rev. 0 (1997)	Section 4	FFU
241-AW-104	1,200,000 Gallon Waste Tank	AW	H-2-70406	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-11582 Rev. 0 (2002)	Section 4	FFU
241-AW-105	1,200,000 Gallon Waste Tank	AW	H-2-70407	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-8149 Rev. 0A (2001)	Section 4	FFU
241-AW-106	1,200,000 Gallon Waste Tank	AW	H-2-70408	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-10776 Rev. 0 (2002)	Section 4	FFU
241-AW-A	Valve Pit	AW	H-2-70401	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-13624 Rev. 0 This Doc, Section 6	FFU
241-AW-B	Valve Pit	AW	H-2-70401	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-11060 Rev. 0 This Doc, Section 6	FFU
COB-A-30	Clean Out Box	AW	H-2-70398	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-1	Clean Out Box	AW	H-2-70398	N/A – to be removed from service	N/A	N/A	N/A	E-525

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
COB-AW-10	Clean Out Box	AW	H-2-70406	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-11	Clean Out Box	AW	H-2-70398	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-12	Clean Out Box	AW	H-2-70399	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-2	Clean Out Box	AW	H-2-70398	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-3	Clean Out Box	AW	H-2-70398	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-4	Clean Out Box	AW	H-2-70398	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-5	Clean Out Box	AW	H-2-70399	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-6	Clean Out Box	AW	H-2-70399	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-7	Clean Out Box	AW	H-2-70399	N/A – to be removed from service	N/A	N/A	N/A	E-525
COB-AW-8	Clean Out Box	AW	H-2-70399	N/A – to be removed from service	N/A	N/A	N/A	E-525

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
COB-AW-9	Clean Out Box	AW	H-2-70405	N/A – to be removed from service	N/A	N/A	N/A	E-525
RW-AW01	Raw Water Line	AW	H-2-70998	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AW02	Raw Water Line	AW	H-2-70998	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-AW03	Raw Water Line	AW	H-2-70999	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
FL-AW09	Flush Water Line	AW	H-2-70999	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-334	Drain Line	AW	H-2-70404	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-335	Drain Line	AW	H-2-70404	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-338	Drain Line	AW	H-2-69354	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-339	Drain Line	AW	H-2-69183	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-343	Drain Line	AW	H-2-70404	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-361	Drain Line	AW	H-2-70401	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-362	Drain Line	AW	H-2-70401	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-369	Drain Line	AW	H-2-70401	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-371	Drain Line	AW	H-2-70404	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-374	Drain Line	AW	H-2-70399	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AW-01	Drain Line	AW	H-14-105333	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AW-02	Drain Line	AW	H-14-105333	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AW-03	Drain Line	AW	H-14-105337	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AW-04	Drain Line	AW	H-14-105337	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AW-05	Drain Line	AW	H-14-105337	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-461	Annulus Leak Detection Return	AW	H-2-70403	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-462	Annulus Leak Detection Return	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
PW-463	Annulus Leak Detection Return	AW	H-2-70405	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-464	Annulus Leak Detection Return	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-465	Annulus Leak Detection Return	AW	H-2-70407	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-466	Annulus Leak Detection Return	AW	H-2-70408	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-471	Annulus Pump Pit Return	AW	H-2-70403	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-472	Annulus Pump Pit Return	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-473	Annulus Pump Pit Return	AW	H-2-70405	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-474	Annulus Pump Pit Return	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-475	Annulus Pump Pit Return	AW	H-2-70407	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-476	Annulus Pump Pit Return	AW	H-2-70408	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-162	Slurry Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-163	Slurry Transfer Line	AW	H-2-70405	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-164	Slurry Transfer Line	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-165	Slurry Transfer Line	AW	H-2-70405	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SL-166	Slurry Transfer Line	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-167	Slurry Transfer Line	AW	H-2-70398	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-168	Slurry Transfer Line	AW	H-2-70398	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SL-169	Slurry Transfer Line	AW	H-2-70401	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-220 / LIQW-702	Supernate Transfer Line	AW	H-2-70401	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-261	Supernate Transfer Line	AW	H-2-70403	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-262	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	2E-04-01337/W 1/3/05 69 psig	RPP-27591 Rev. 0	FFU
SN-263	Supernate Transfer Line	AW	H-2-70405	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-264	Supernate Transfer Line	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-265	Supernate Transfer Line	AW	H-2-70405	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-266	Supernate Transfer Line	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-267	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	WFO-WO-05-000867 12/1/05 69 psig	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SN-268	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-269	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-270	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-271	Supernate Transfer Line	AW	H-2-70401	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-272	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-274	Supernate Transfer Line	AW	H-2-70406	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-609	Supernate Transfer Line	AW	H-2-70404	Inspection/Test/ Analysis	4B, 11A	2E-03-01489/W 11-7-05 Enc. Tested at 70 psig	RPP-27591 Rev. 0	FFU
SN-610	Supernate Transfer Line	AW	H-2-70399	Inspection/Test/ Analysis	4B, 11A	2E-03-01287/W 11/7/05 69 psig	RPP-27591 Rev. 0	FFU
241-AY-01A	Central Pump Pit	AY	H-2-64405	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-11217 Rev. 0 This Doc, Section 6	FFU
241-AY-01B	Sluice Pit	AY	H-2-64405	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-01C	Sluice Pit	AY	H-2-64405	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-01D	Sluice Pit	AY	H-2-64405	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AY-01E	Sluice Pit	AY	H-2-64405	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-01F	Annulus Pump Pit	AY	H-2-64405	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AY-02A	Central Pump Pit	AY	H-2-64406	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-11217 Rev. 0	FFU
241-AY-02B	Sluice Pit	AY	H-2-64406	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-02C	Sluice Pit	AY	H-2-64406	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-02D	Sluice Pit	AY	H-2-64406	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-02E	Sluice Pit	AY	H-2-64406	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AY-02F	Annulus Pump Pit	AY	H-2-64406	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AY-101	1,000,000 Gallon Waste Tank	AY	H-2-64405	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-8519 Rev. 0A (2001)	Section 4	FFU
241-AY-102	1,000,000 Gallon Waste Tank	AY	H-2-64406	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-4818 Rev. 0 (1999)	Section 4	FFU
RW-3501 (4")	Raw Water Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3501 (1 ½")	Raw Water Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3558	Raw Water Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3559	Raw Water Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3571	Raw Water Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3575	Raw Water Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0068	Drain Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
DR-0069	Drain Line	AY	H-2-64406	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0070	Drain Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0072	Drain Line	AY	H-2-64405	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0073	Drain Line	AY	H-2-64406	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-AY1	Drain Line	AY	H-2-131085	New Installation/ Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-4531	Annulus Pump Pit Return	AY	H-2-64405	Inspection/Test/ Analysis	4B, 11A	Primary Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-4532	Annulus Pump Pit Return	AY	H-2-64406	Inspection/Test/ Analysis	4B, 11A	Primary Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-404	Diluent/Flush	AY	H-14-106441	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-406	Diluent/Flush	AY	H-14-106441	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
SL-100	Slurry Transfer Line	AY	H-2-64406	Inspection/Test/ Analysis	4B, 11A	None	Deferred Use	NAU
SN-200	Supernate Transfer Line	AY	H-2-64406	Inspection/Test/ Analysis	4B, 11A	None	Deferred Use	NAU
SN-633	Supernate Transfer Line	AY	H-14-102620	New Installation/ Analysis	4B, 11A	N/A	RPP-11217 Rev. 0 RPP-27591 Rev. 0	FFU
SN-635	Supernate Transfer Line	AY	H-14-102620	New Installation/ Analysis	4B, 11A	N/A	RPP-11217 Rev. 0 RPP-27591 Rev. 0	FFU
241-AZ-01A	Central Pump Pit	AZ	H-2-68353	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-11218 Rev. 0 This Doc, Section 6	FFU
241-AZ-01B	Sluice Pit	AZ	H-2-68353	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AZ-01C	Sluice Pit	AZ	H-2-68353	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-AZ-01F	Annulus Pump Pit	AZ	H-2-68353	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AZ-02A	Central Pump Pit	AZ	H-2-68413	Inspection / Refurbishment	6A, 6B, W-314	N/A	RPP-11218 Rev. 0 This Doc, Section 6	FFU
241-AZ-02B	Sluice Pit	AZ	H-2-68413	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AZ-02C	Sluice Pit	AZ	H-2-68413	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-AZ-02F	Annulus Pump Pit	AZ	H-2-68413	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-AZ-101	1,000,000 Gallon Waste Tank	AZ	H-2-68413	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-4819 Rev. 0 (1999)	Section 4	FFU
241-AZ-102	1,000,000 Gallon Waste Tank	AZ	H-2-68353	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-15765 Rev. 0 (2003)	Section 4	FFU
241-AZ-702	Vent Building	AZ	H-2-131012	Inspection / Analysis	6A, 6B	This document	Section 6	FFU
241-AZ-PC-SP-1	Seal Pot	AZ	H-2-131106	Inspection/ Analysis	6A, 6B	This document	Section 6	FFU
241-AZ-VP	Valve Pit	AZ	H-14-103263	New Installation	6A, 6B, W-314	N/A	RPP-16278 Rev. 0	FFU
RW-3600	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3601 (2")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3601 (3")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3604	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3611 (1 ½")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3611 (2")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3612	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3613	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
RW-3614	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3615	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3616 (3")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3616 (4")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3618	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3633	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3634	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3635	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3636	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3640 (1/2")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3640 (2")	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-3655	Raw Water Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0077	Drain Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0080	Drain Line	AZ	H-2-68353	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0090	Drain Line	AZ	H-2-68413	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-0091	Drain Line	AZ	H-2-68413	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-100	Drain Line	AZ	H-14-103263	New Installation/ Analysis	7C	N/A	RPP-11218 Rev. 0 RPP-27591 Rev. 0	FFU
PC-AZ-503	Drain Line	AZ	H-14-105765	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PC-AZ-503a	Drain Line (above grade portion)	AZ	H-14-105765	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-403	Diluent/Flush	AZ	H-14-102973	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-405	Diluent/Flush	AZ	H-14-102973	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
PW-4609	Annulus Pump Pit Return	AZ	H-2-68353	Inspection/Test/ Analysis	4B, 11A	Primary Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
PW-4623	Annulus Pump Pit Return	AZ	H-2-68413	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0	NAU
SN-630	Supernate Transfer Line	AZ/ AN	H-14-101110	New Installation/ Analysis	4B, 11A	N/A	RPP-15831 Rev. 0 RPP-27591 Rev. 0	FFU
SN-631	Supernate Transfer Line	AZ	H-2-68413	New Installation/ Analysis	4B, 11A	N/A	RPP-11218 Rev. 0 RPP-27591 Rev. 0	FFU
SN-632	Supernate Transfer Line	AZ	H-2-68413	New Installation/ Analysis	4B, 11A	N/A	RPP-11218 Rev. 0 RPP-27591 Rev. 0	FFU
SN-637	Supernate Transfer Line	AZ	H-14-103263	New Installation/ Analysis	4B, 11A	N/A	RPP-10535 Rev. 0 RPP-27591 Rev. 0	FFU
241-SY-01A	Central Pump Pit	SY	H-2-37801	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU
241-SY-01B	Annulus Pump Pit	SY	H-2-37801	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-SY-02A	Central Pump Pit	SY	H-2-37802	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25574 Rev. 1	RPP-RPT-25980 Rev. 0 This Doc, Section 6	FFU
241-SY-02B	Annulus Pump Pit	SY	H-2-37802	Inspection / Refurbishment	6A, 6B	None	Emergency Use	NAU
241-SY-02D	Drain Pit	SY	H-2-37802	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25595 Rev. 0	RPP-RPT-25978 Rev. 0 This Doc, Section 6	FFU
241-SY-02E	Drain Pit	SY	H-2-37802	Inspection / Refurbishment	6A, 6B	None	Deferred Use	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
241-SY-03A	Central Pump Pit	SY	H-2-37803	Inspection / Refurbishment	6A, 6B, W-314	RPP-RPT-25606 Rev. 0	RPP-RPT-25853 Rev. 0 This Doc, Section 6	FFU
241-SY-03B	Annulus Pump Pit	SY	H-2-37803	Inspection / Refurbishment	6A, 6B	N/A	Emergency Use	NAU
241-SY-101	1,200,000 Gallon Waste Tank	SY	H-2-37801	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-18444 Rev. 1	Section 4	FFU
241-SY101-PPP	Prefabricated Pump pit	SY	H-14-103571	Analysis	6A, 6B	N/A	Section 6	FFU
241-SY-102	1,200,000 Gallon Waste Tank	SY	H-2-37802	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-18445 Rev. 0	Section 4	FFU
241-SY-103	1,200,000 Gallon Waste Tank	SY	H-2-37803	Inspection / Analysis	5A, 5B, 5C, 5D, 5E	RPP-18446 Rev. 0	Section 4	FFU
241-SY-A	Valve Pit	SY	H-2-37780	Inspection / Refurbishment	6A, 6B, W-314	RPP-16447 Rev. 0	RPP-RPT-25163 Rev. 0 This Doc, Section 6	FFU
241-SY-B	Valve Pit	SY	H-2-37780	Inspection / Refurbishment	6A, 6B, W-314	TBD	TBD	NAU
RW-SY03	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY05	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY07	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY08	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY09	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY10	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY13	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
RW-SY14	Raw Water Line	SY	H-2-70835	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
FL-SY18	Flush Water Line	SY	H-2-37780	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
FL-SY19	Flush Water Line	SY	H-2-37780	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-376	Drain Line	SY	H-2-37778	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-377	Drain Line	SY	H-2-37778	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-378	Drain Line	SY	H-2-37778	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-379	Drain Line	SY	H-2-37778	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-385	Drain Line	SY	H-2-37802	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-386	Drain Line	SY	H-2-37802	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-387	Drain Line	SY	H-2-37778	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-503	Drain Line	SY	H-2-37746	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
DR-504	Drain Line	SY	H-2-37746	Analysis	7C	N/A	RPP-27591 Rev. 0	FFU
PW-475	Annulus Pump Pit Return	SY	H-2-37802	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior To Use	RPP-27591 Rev. 0	NAU
PW-476	Annulus Leak Detection Return	SY	H-2-37802	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior To Use	RPP-27591 Rev. 0	NAU
PW-477	Annulus Pump Pit Return	SY	H-2-37801	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior To Use	RPP-27591 Rev. 0	NAU
PW-478	Annulus Leak Detection Return	SY	H-2-37801	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior To Use	RPP-27591 Rev. 0	NAU
PW-479	Annulus Pump Pit Return	SY	H-2-37803	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior To Use	RPP-27591 Rev. 0	NAU
PW-480	Annulus Leak Detection Return	SY	H-2-37803	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior To Use	RPP-27591 Rev. 0	NAU
SL-177	Slurry Transfer Line	SY	H-2-37802	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU
SL-178	Slurry Transfer Line	SY	H-2-37801	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SL-179	Slurry Transfer Line	SY	H-2-37803	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU
SL-180	Slurry Transfer Line	SY	H-2-37778	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0	NFFU
SLL-3160	SLL Transfer Line	SY	H-2-822210	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0	NAU
SN-277	Supernate Transfer Line	SY	H-2-37802	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU
SN-278	Supernate Transfer Line	SY	H-2-37801	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU
SN-279	Supernate Transfer Line	SY	H-2-37803	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU
SN-280	Supernate Transfer Line	SY	H-2-37778	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-27591 Rev. 0 Variance Use	NAU
SN-285	Supernate Transfer Line	SY	H-2-37802	Inspection/Test/ Analysis	4B, 11A	CLO-WO-05-002555 Enc. Tested to 66psig Primary Tested to 352 psig	RPP-27591 Rev. 0 Variance Use	FFU Until 2/14/07
SN-286	Supernate Transfer Line	SY	H-2-37802	Inspection/Test/ Analysis	4B, 11A	N/A	RPP-27591 Rev. 0 Variance Use	NAU
SNL-3150	Supernate Transfer Line 6241-V to AN-101	SY	H-2-822210	Inspection/Test/ Analysis	4B, 11A	W314-WTS-TIE-IN-004-87 40 psig 2//23/06	RPP-16278 Rev. 0 RPP-27591 Rev. 0	FFU

Table A-1. Double-Shell Tank System Integrity Assessment Matrix. (28 Sheets)

Component ID	Description	Farm	Drawing	Assessment Method	Applicable Task ID (App. B)	Inspection Reports	Assessment Reference	Comments[4]
SNL-3150	Supernate Transfer Line 6241-V to 6241-A	SY	H-2-822210	Inspection/Test/ Analysis	4B, 11A	WFO-WO-05-002224 Enc. Tested to 41psig 3/21/06	RPP-16278 Rev. 0 RPP-27591 Rev. 0	FFU
SNL-3150	Supernate Transfer Line 6241-A to SY-A	SY	H-2-822210	Inspection/Test/ Analysis	4B, 11A	WFO-WO-05-002224 Enc. Tested to 41psig 3/27/06	RPP-16278 Rev. 0 RPP-27591 Rev. 0	FFU
SLL-3160	Slurry Transfer Line	SY	H-2-822210	Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use; and Assess Pumps Prior to use	RPP-16278 Rev. 0 RPP-27591 Rev. 0	NAU
SNL-5350	Supernate Transfer Line	SY	H-14-105612	New Installation, Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-20512 Rev. 0 RPP-27591 Rev. 0	NAU
SNL-5351	Supernate Transfer Line	SY	H-14-105612	New Installation, Inspection/Test/ Analysis	4B, 11A	Enc. Leak Test Prior to Use	RPP-20512 Rev. 0 RPP-27591 Rev. 0	FFU
HOSE-SY101-PPP/SXA	Hose In Hose Transfer Line	SY	H-14-103595	Inspection/Test/ Analysis	4B, 11A	RPP-4892 Rev. 0	RPP-27591 Rev. 0 RPP-15286 Rev. 0A	FFU Until June 2006
6241-A	Diversion Box	200W	H-2-822202	Inspection / Analysis	6A, 6B	Section 6	Section 6	FFU
6241-V	Vent Station	600	H-6-13978	Inspection / Analysis	6A, 6B	Section 6	Section 6	FFU

APPENDIX B

TASK REPORT

Document RPP-17266, *Plan for DST Integrity Assessment*, identifies a number of tasks that required performance in order to successfully produce this report. Table B-1 summarizes these tasks, their descriptions, and the outcome of their performance.

Table B-1. Double-Shell Tank Integrity Assessment Plan Task Report. (6 Sheets)

Task	Description of Activity	Ref. Section From RPP-17266	Summary of Activity	Associated Regulation or Requirement Supported	Result
1	Determine the age and remaining useful life	3.2	This task is rolled into the results of several other tasks, namely 3, 7A, and 7B.	WAC 173-303-640(2)(c)(iv)	The age was reported for all components in this report and supporting documents. Remaining useful life was estimated for the transfer lines and the tanks.
2	Review data acquisition processes	3.3	Several data acquisitions processes are involved in the DST Integrity Project. Methods of data acquisitioning and processing must be assessed from a quality standpoint.	M-48-14	The data acquisition process was reviewed for the UT and video acquisition. Informal recommendations were made which resulted in almost immediate improvements to the processes and acquisition systems.
3	Develop a representative DST thermal and loading model	3.4	A three-dimensional model in ANSYS is developed, which includes soil modeling. The model is used to determine the structural adequacy of design.	WAC 173-303-640(2)	A DST Thermal and Operating Loads model was developed and is described in RPP-RPT-23308, Rev. 0.
4A	Develop and implement a program for leak test of catch tanks and DCRTs	4.1	Catch tanks in service beyond June 30, 2005 must have a leak test program associated with each. At the present time, no currently existing direct buried catch tank is scheduled to be in service beyond June 30, 2005.	WAC 173-303-640(2)(c)(v)(A)	A program was already in place. The program was reviewed and is accepted as adequate.

Table B-1. Double-Shell Tank Integrity Assessment Plan Task Report. (6 Sheets)

Task	Description of Activity	Ref. Section From RPP-17266	Summary of Activity	Associated Regulation or Requirement Supported	Result
4B	Develop and implement a program for periodic leak testing of transfer line encasements	4.1	Leak testing is considered the most effective means of determining integrity of a buried line. Each piping system will require a leak check prior to release of the DSTAR – otherwise, removed from service. Thereafter, an evaluation should be performed to determine a plan and schedule for periodic leak testing of these lines.	WAC 173-303-640(2)(c)(v)(B)	A program was developed and described in RPP-17266.
5A	Perform 20 Foot circumference UT examinations in accordance with M-48-14	4.2.1	The current DST Integrity Project program, in compliance with M-48-14 (WDOE 1994), requires 20 foot sections of the exterior primary tank wall be UT examined.	WAC 173-303-640(2)(c)(v)(B), 94-114, Section 2.1; M-48-14; 40 CFR 265.191(5)(i)	The 20 foot scans as required per M-48-14 were competed as of October 2006.
5B	Document the basis for the statistical validity of current sample populations	4.2.1	Statistically an argument must be made that the surface areas planned for examination in tasks such as 5A is a representative sample.	94-114, Section 2.1; M-48-14	Document PNNL-15415, was developed by a statistician which discusses the statistical representativeness of the current sampling methods and provides a means of validating the sample populations currently being acquired.
5C	Perform UT Examination on DST secondary liner	4.2.1	Three tanks to receive UT examinations. All 28 tank secondary liners receive video inspections.	94-114, Section 2.4	Three tanks (AN-105, AY-101, and AP-104) received secondary liner UT examinations.
5D	Evaluate DST secondary liner issues	4.2.1	Evaluate and develop a path-forward on certain issues with regard to the construction and commissioning of the secondary tank structure.	94-114, Section 2.4	Document RPP-22604 was developed by the IQRPE. The issue is further discussed in Section 4.10.5 of this document.

Table B-1. Double-Shell Tank Integrity Assessment Plan Task Report. (6 Sheets)

Task	Description of Activity	Ref. Section From RPP-17266	Summary of Activity	Associated Regulation or Requirement Supported	Result
5E	Perform internal and external video examinations of DSTs	4.2.1	All 28 tanks to receive video inspection of the internal primary tank, as well as the external primary tank via annulus riser access.	94-114, Section 2.1	All 28 tanks received video examinations as of March 2006. A certified API tank inspector reviewed the videos. Review notes can be found in Appendix E.
6A	Assess Concrete Pits and Walls	4.2.2.1	The interior surfaces of concrete pits must be assessed for cracks, spalls and other conditions, which may result in a release to the environment. The assessment should be performed in accordance with Ecology publication #95-420. Project W-314 is currently performing activities that address this task.	95-420	Project W-314 completed initial assessment and upgrade of the pits as of June 2005. The DST Integrity Project completed one pit in January 2006. The pits are assessed per section 6 of this report. The remaining pits within scope are planned for assessment and upgrade later this year.
6B	Periodic Inspection of Coatings	4.2.2.1	A plan must be prepared and approved by the W-314 IQRPE for a re-inspection program and periodicity for the refurbished pits.	95-420; 94-114, Section 2.4	A document was prepared by CH2 to establish a plan and periodicity for pit re-inspection. The plan was never released; therefore, this document provides some brief requirements for the future development of a plan. These requirements may be found in Section 6.10, Recommendation DSTAR-PIT-02.
7A	Assess Active Underground Transfer piping	4.2.2.2	Document an investigation and evaluation of alternate technologies, which permit assessment of a large portion of the pipe length, while only uncovering small portions of the pipe.	94-114, Section 2.4	Five documents were produced which, together, provide a full assessment of the underground transfer piping. RPP-25153, RPP-18652, RPP-25299, RPP-27097, and RPP-27591.

Table B-1. Double-Shell Tank Integrity Assessment Plan Task Report. (6 Sheets)

Task	Description of Activity	Ref. Section From RPP-17266	Summary of Activity	Associated Regulation or Requirement Supported	Result
7B	Inspection of Underground Transfer Piping	4.2.2.2	Perform video inspection of five transfer lines. Alternately, obtain samples of the piping from decommissioned lines planned for removal by various projects.	94-114, Section 2.3	Two transfer lines were inspected internally: 241-AN-261 and 241-AP-615. Discussions of these inspections are found in RPP-27591.
7C	Assess Drain Lines	4.2.2.2	Review the designs and service dates of applicable drain lines.	94-114, Section 2.4	Drain lines were assessed in RPP-27591.
8A	Assess and resolve Effects of Couplant Fluids	4.2.3	Water is being used as the couplant for transmitting the ultrasonic transducer vibrations to the base metal (and back), and there does not appear to be any provisions for removal of that water, following each inspection. This water may accelerate corrosion at the tank bottom.	M-48-14	CH2 was not able to technically justify the use of non-corrosion inhibited couplant fluid. CH2 is scheduled to start adding inhibiting agents to couplant fluid on April 26, 2006 for AN-107 UT examination.
9A	Qualification of Individuals	4.2.4	Certifications of individuals supporting inspections of DSTs, piping, and ancillary integrity assessments must be documented and included within the integrity assessment reports.	WAC 173-303-640(3)(a)(iii), 94-114, Section 3.6; 40 CFR 265.191(b)(3)	Individuals performing inspections and evaluating data have been qualified by the IQRPE. Documentation of these qualifications is found in Appendix D.
10A	Review historical excursions	5.1.1	Attempt to document and assess excursions, if any, when the DST Systems were outside of operating parameters.	94-114, Section 2.2; WAC 173-303-640(2)(a)(c); 40 CFR 265.191(b)(2)	RPP-25153, *Waste Compatibility Assessment Report*, includes a look at historical excursions.
10B	Assess the effect of contacted waste on DST system materials	5.1.2	Current practices, that bring dangerous/hazardous wastes into contact with the DST System materials, must be reviewed and evaluated.	94-114, Section 2.2; WAC 173-303-640(2)(a)(c); 40 CFR 265.191(b)(2)	RPP-25153, *Waste Compatibility Assessment Report*, includes a look at contacted waste on DST system materials.

Table B-1. Double-Shell Tank Integrity Assessment Plan Task Report. (6 Sheets)

Task	Description of Activity	Ref. Section From RPP-17266	Summary of Activity	Associated Regulation or Requirement Supported	Result
10C	Evaluate and document worst case transfer and storage projections	5.1.3	Review future transfer plans in an effort to determine the corrosive, and possibly erosive, nature of waste products planned for transfer or storage in the DST Systems.	94-114, Section 2.2; WAC 173-303-640(2)(a)(c); 40 CFR 265.191(b)(2)	RPP-25153, *Waste Compatibility Assessment Report*, looks at future dangerous waste compositions and projections and their potential impact on DST system materials.
11A	Assess the condition of existing cathodic protection systems	6.1	The need for and/or condition of existing cathodic protection systems must also be assessed.	94-114, Section 2.5; WAC 173-303-640(2)(c)(iii); 40 CFR 265.191(b)(3)	Document RPP-25299 assesses the DST cathodic protection systems.
12A	Assess the current corrosion monitoring program	6.1.1	An assessment of the current corrosion monitoring program must be performed to address many points associated with the present operations and inspection programs associated with the DSTs.	40 CFR 265.191(b)(3); WAC 173-303-640(2)(c)(iii)	Section 9.2.7 addresses the corrosion-monitoring program at Hanford.
12B	Develop ongoing inspection program recommendation	6.1.2	A program for ongoing inspections beyond the release of the DSTAR must be developed.	94-114	Section 9.2.7 makes recommendations regarding ongoing corrosion monitoring and inspections.
13A	Assess the existing corrosion control program	6.2.1	It must be determined whether the current administrative controls regarding corrosion monitoring, inspections, chemical controls and treatments, and integrity assessments, are adequate.	94-114, Section 2.2; WAC 173-303-640(2)(a)(c); 40 CFR 265.191(b)(2)	Section 8.2.7 addresses the existing corrosion control program at Hanford.
14A	Develop dome deflection survey program	6.2.2	Monitoring tank settlement should be implemented.	94-114, Section 2.8; WAC 173-303-640(2)(a)	Dome/Tank settlement surveys were completed in March 2006. The results of the surveys are discussed in section 4.10.3.

Table B-1. Double-Shell Tank Integrity Assessment Plan Task Report. (6 Sheets)

Task	Description of Activity	Ref. Section From RPP-17266	Summary of Activity	Associated Regulation or Requirement Supported	Result
14B	Develop DST System loading control program	6.2.2	Some lines cross roads outside of the tank farms, or high vehicle traffic areas in and out of the tank farms. Each of these lines needs to be identified, classified and analyzed (if previous analysis is inadequate or cannot be located) for potential loads.	WAC 173-303-640(2)(c)	The dome-load monitoring program was assessed per document RPP-20556. Surcharge loads on transfer lines were assessed in document RPP-18652. It was determined that programs currently in place are adequate and conservative.

APPENDIX C

STATISTICS DISCUSSION

Discussion of Statistical Aspects of DST Integrity Assessment

Cary Burrup, Denny Weier
01/23/2004

Introduction:

Several questions have arisen regarding the statistical aspects associated with RPP-17266, *Plan for Development of the DST Integrity Assessment Report*. This write-up is intended to discuss some of those aspects, in particular what can and cannot be done in the statistical arena, and to propose a path forward for implementing the suggestions given here.

Topics with a Statistical Component:

The following lists those features of the report that likely have a statistical component, that is, that require some type of decision based on gathering representative measurement data regarding some feature of DSTs.

1. 20' × 30" horizontal Ultrasonic Testing (UT) of the primary wall on all DSTs.
2. 20' × 30" vertical UT of the primary wall on all DSTs.
3. 20' × 15" UT of the liquid/vapor interface on 6 DSTs.
4. 20' long circumferential UT of tank lower knuckle on 6 DSTs.
5. UT of secondary liner on 3 DSTs.
6. Primary tank bottom examination for 6 DSTs.
7. Testing of underground transfer piping and destructive testing of decommissioned underground transfer piping.

Data Quality Objectives Process:

The EPA proposed, and the DOE endorsed, the application of the Data Quality Objectives (DQO) process prior to gathering data for environmental decision-making. The process is intended to ensure that sufficient data, and not extraneous data, will be obtained for making required decisions while maintaining reasonable control of the likelihood of making decision errors.

The process consists of assembling the key stakeholders, such as DOE, contractor, and regulator personnel, and rigorously describing and agreeing upon the objectives and approach of the upcoming activity. Initially, the problem statement is agreed upon, and the boundaries of the problem are well defined. What inputs are, or will be available, to support decision-making are listed. The specific decisions to be made are established, and the criteria that will be applied to the data to support the decision-making are developed. The final steps are then statistical and generate efficient sampling and analysis plans.

The relative impact of falsely deciding criteria are not met based on sample data, when in fact they actually are met by the underlying feature, or conversely, in falsely deciding criteria are met based on sample data, when in reality they are not met by the underlying feature, are discussed. The probability bounds on these errors that can reasonably be tolerated are established. Given additional information on expected variability in the data, the number of measurements required can then be developed.

For example, for transfer piping in item 7 listed above, the problem statement is developed, and the particular subsystem of piping for which data will be gathered to make a decision is identified. The inputs, such as UT testing and historical use records are established. The specific criterion that indicates the subsystem is satisfactory is developed. This could be that the minimum estimated wall thickness, or perhaps the average estimated wall thickness, is greater than some specified value. Or the criteria could be stated in terms of loss due to corrosion instead. A tolerance for mistakenly accepting piping that does not in fact meet the criteria, and a tolerance for rejecting piping that does in fact meet the criteria, each by some specified amount, are generated, and then a sampling plan that achieves these tolerances and is acceptable to all parties can be developed.

Without some analogous process that accomplishes the intent of this example and the DQO process, the statistician can offer few recommendations in terms of the adequacy of planned data collection.

Representativeness Issues:

The report uses the term "statistical validity" of the proposed sampling. One of the features of such validity would be the representativeness of the sample measurements obtained. Is obtaining UT measurements from a single DST riser sufficient in items 1 and 2 above because such data are representative of the entire tank? Or is a relatively short section of piping sufficient for UT inspection to represent an entire subsystem in item 7? The statistician cannot make such a statement unless some type of historical data is available on which to base appropriate analyses and conclusions. Multiple risers, or multiple piping sections, would need to have been analyzed with insignificant differences shown between them. Then statistically the decision to only use a single riser or a single section of piping could be defended. Without such data, the representativeness decision for the single riser, or single piping section, would have to be based on engineering aspects and defended accordingly.

Tank AY-101 is the tank with the most UT data available, and it was obtained from multiple risers. Initial analyses by riser suggest that statistical differences between risers do exist, making it difficult to statistically defend the representativeness of measurements from a single riser.

Sufficient Numbers of Measurements:

Without the final steps of the DQO process, which establish tolerances for the different types of decision errors that can be made, the statistician can do little to claim that sufficient data are available. This is especially true if the data shows that the actual conditions observed are quite close to the borderline conditions described in the decision criteria. If on the other hand, actual conditions are nowhere near the borderline conditions, being either considerably better or worse,

the data adequacy can readily be defended. The DQO process attempts to quantify these aspects as to what "close" to the borderline conditions really means.

The methodology that applies to the particular decision criteria developed also plays an important roll in determining sufficient numbers of measurements or sample size. To calculate an average remaining wall thickness at a given confidence level may not take as much data as extrapolating to the minimum remaining wall thickness at the same confidence level. This relates back to the problem statement and the decisions to be made.

Recommended Path Forward:

For those decisions that will be data-based using statistical methods as listed above, some course of action that accomplishes the intent of the DQO process is needed. The key personnel need to meet to agree on what a particular problem statement is, what subsystem is being considered, and what decisions are to be made based on what type of criteria. Then the statistician will ask some often-difficult questions about willingness to tolerate decision errors and expected variability in subsequent measurements. Once these decision criteria have been established and the pertinent questions answered, then data adequacy and the required number of measurements can be addressed. The statistician working alone is relatively restricted in being able to justify the representativeness and adequacy of sampling and analysis activities. Instead, multi-disciplinary team interactions are required in the meeting intended to accomplish the intent of the DQO process.

Of particular importance in the meeting of key personnel will be the approach to demonstrating and defending representativeness. More thorough analyses of the AY-101 wall thickness data, with respect to differences between risers, will give a better understanding of within tank wall thickness variability and help answer tank homogeneity questions with respect to items 1 and 2 above. However, these analyses would do little for understanding transfer piping homogeneity in item 7 or the differences between tank farms or even between tanks in items 3 through 6. Additional studies are needed using data from multiple piping sections, multiple risers, multiple tanks, etc. to give a statistical defense of representativeness. Otherwise, as stated earlier, decisions must be made based on engineering criteria and knowledge and be defended accordingly. This latter approach may well be completely satisfactory to all parties, but the key personnel would need to establish that in their discussions.

APPENDIX D

PERSONNEL QUALIFICATIONS

Table D-1. Summary of Individual Qualifications – Inspection Team. (3 Sheets)

Name	Degree	Relevant Certifications	Summary of Experience	Key Skills
Barb Aftanas	BSEE, BSCSci		20 years in engineering with an emphasis in project management, networking, telecommunications controls, interactive database design and management, software and systems engineering.	Instrumentation, robotics, telecommunications, and documentation. Her documentation skills ensure the images are properly documented to identify the specific locations of the images.
Earl Schwenk	MSMetEng.		30 years experience on programs and projects related to materials selection, application, and evaluation for service, as structures, systems, or components in nuclear, chemical, mechanical, and aerospace environments.	Integrity inspections, videographic inspections, fracture mechanics, welding and corrosion, extensive Hanford experience.
Augi Ermi, Ph.D.	Ph.D. Mat. Sci.		17 years of experience in irradiation testing for the U.S. Fusion Materials Program, including experiment design, sample preparation, experiment operation, sample recovery and testing, and overall project management.	Strong background in fracture mechanics, and crack growth, data acquisition.
Albert Smith	Course Work in ME, NDE, Electronics	ASNT LIII and LII	40 years of experience in application, research and development in nondestructive examination. *Noted discrepancy on resume regarding Level III and Level II certifications*	Extensive inspection experience and certifications. Level III examiner in five methods; X-ray and gamma radiography (RT), ultrasonics (UT), magnetic particle (MT), liquid penetrant (PT), and leak testing. He has also been certified Level II in electromagnetic testing (ET), and visual examination (VT-1, -2 and-3). He has additional experience in acoustic emission, infrared, neutron radiography, nonintrusive liquid flow measurement and subsurface interface RADAR. Developer of NDE hardware.
George McDonald	AA		20 years; experienced process piping Field Test Engineer, planning and directing piping system tests for conformance to ASME and NQA codes.	Long history of working with radioactive sludge at the Hanford site, experience in collecting data within the vapor space of the tanks.

Table D-1. Summary of Individual Qualifications – Inspection Team. (3 Sheets)

Name	Degree	Relevant Certifications	Summary of Experience	Key Skills
Wesley Nelson	NDE Apprenticeship, CBC Coursework (NDE)	ASNT LII and ASNT LIII	24 years experience in the field of NDE working at construction and operating nuclear power plants, chemical plant, and petroleum refinery and fabrication shops. Of particular interest is Mr. Nelson's experience with Real Time Radiography (RTR).	Extensive experience in NDE along with ASNT certifications, LIII for UT and PT. Solid training and experience with the P-Scan system. Experience in procedure preparation and conducting training classes.
Ed Selle	AA		20 years of extensive experience in development, design, fabrication, testing, and operating analytical equipment.	Intimate knowledge of analytical monitoring equipment and the DST environment.
Brad Sewart	ASMET	ASNT LII	23 years of experience with development, fabrication, and use of specialized NDE equipment.	ASNT Level II certification in RT, UT, MT, PT, ET, and LT. Diversified background in inspection techniques.
Bill Purdy	Course work at McCook Jr. College	ASNT LII	27 years of Hanford experience, 17 of which as a fabrication technician.	ASNT Level II certification in UT, MT, PT, HT. Experience with UT inspection of AN-105, AN-107 and AP-103 (not mentioned on resume).
Jeff Pintler	AAS		27 years experience in building, designing, and operating electronic, mechanical and pneumatic equipment.	ASNT Level I course work completed (certification not listed on resume). Experience in design-build of electro-mechanical equipment.
Will Willingham	BSEE	PE	20 years experience in the development, design, fabrication and testing of instrumentation and electrical systems, related primarily to the nuclear industry.	Experience in fabricating and testing instrumentation and electrical systems. Direct knowledge of tank monitoring and control systems.

Table D-1. Summary of Individual Qualifications – Inspection Team. (3 Sheets)

Name	Degree	Relevant Certifications	Summary of Experience	Key Skills
Jim Elder	Two-Year certs in NDE and Nuclear Metallurgy	ASNT LIII; ASNT LII	20 years experience in nondestructive testing, including experience in nuclear power, fossil fuel, aerospace, petrochemical and DOE nuclear facilities.	ASNT LIII in UT and MT. ASNT LII in VT and PT. Previous experience and certifications in Eddy Current and Radiography. Has experience with the Hanford waste tanks weld knuckle, floor and slot inspection. Also experienced in job planning, oversite and instruction.