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RPP-RPT-58441, Rev. 0

# Double-Shell Tank System Integrity Assessment Report (DSTAR)

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Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

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| | | | |
|---|---|---|---|
| EDT/ECN: | DRCF | UC: | N/A |
| Cost Center: | N/A | Charge Code: | N/A |
| B&R Code: | N/A | Total Pages: | 607 |

Key Words: DST System, DSTAR, IQRPE, integrity assessment, integrity, DSTs, waste transfer system, pipelines, ancillary systems, waste compatibility, corrosion, structural integrity, leak integrity, inspection, cathodic protection

Abstract: This integrity assessment report determined that the DST System is fit for use such that the tanks and ancillary systems are not leaking, are adequately designed, and are structurally adequate and compatible with the waste to ensure that the tank or ancillary system will not collapse, rupture, or fail. This report documents the activities, reviews, analyses, evaluations, and examinations performed by the Independent Qualified Registered Professional Engineer to support his determination.

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APPROVED
By Julia Raymer at 12:56 pm, Mar 02, 2016

Release Approval Date

DATE:
Mar 02, 2016
HANFORD RELEASE

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S-2-3

RPP-RPT-58441
Rev. 0

# Double-Shell Tank System Integrity Assessment Report (DSTAR)

## Subcontract No. 55510/58207

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At the request of:

washington river protection solutions

Washington River Protection Solutions
Richland, Washington 99352

February 2016

INDEPENDENT QUALIFIED REGISTERED
PROFESSIONAL ENGINEER (IQRPE)
CERTIFICATION OF
DOUBLE-SHELL TANK SYSTEM
INTEGRITY ASSESSMENT

As stated in 40 CFR 270.11(d):

*"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."*

And as stated in WAC 173-303-810(13)(a):

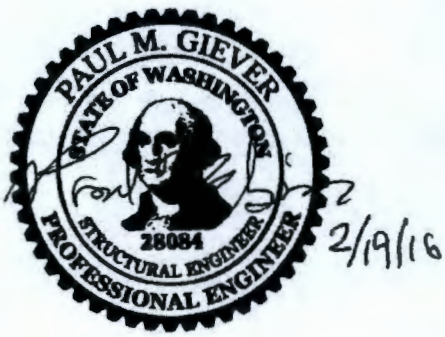
*"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."*

Signed and Certified:

Paul M. Giever 2/19/16

Paul M. Giever, S.E. Date

Independent Qualified Registered Professional Engineer (IQRPE)



## EXECUTIVE SUMMARY

Integrity assessments are required to determine that the existing Hanford Double-Shell Tank (DST) System is sound and fit for use. The DST System is considered a treatment, storage, and/or disposal unit under the *Resource Conservation and Recovery Act of 1976*. Integrity assessments are required in accordance with 40 CFR 265 Subpart J (40 CFR 265.191), "Assessment of existing tank system's integrity," and WAC 173-303-640(2), "Tank Systems: Assessment of existing tank system's integrity." Certification of this integrity assessment by an Independent Qualified Registered Professional Engineer (IQRPE) is required by 40 CFR 270.11(d), "Signatories to permit applications and reports," and WAC 173-303-810(13)(a), "General permit conditions: Certification."

The purpose of this integrity assessment report is to determine if the DST System is fit for use such that the tanks and ancillary systems are not leaking, are adequately designed, and are structurally adequate and compatible with the waste to ensure that the tank or ancillary system will not collapse, rupture, or fail and to certify the DST System as fit for use. This report documents the activities, reviews, analyses, evaluations, and examinations performed to support the IQRPE assessment of the DST System. In the process of performing this assessment, findings are discussed, observations of current DST parameters are enumerated, and recommendations for improvements are developed.

The scope of the DST System includes 27 DSTs and ancillary systems including 77 pipelines, 38 pits, and other ancillary systems. Because it was previously determined to be leaking, tank AY-102 is not fit for use and is not assessed in this report. However, tank AY-102 is used for comparison to other tanks as part of the assessment of the other tanks.

This integrity report of the DST System is the second such report. The first DST System Integrity Assessment Report (DSTAR) was published in seven volumes issued between 2006 and 2008. These volumes are referred to collectively herein as the 2006 DSTAR. The 2006 DSTAR specified that another DSTAR should be completed in 10 years. Thus, this 2016 DSTAR is fulfilling that recommendation.

The conclusion of this report is that the 27 DSTs are fit for use. Additionally, the 77 pipelines and 38 pits and other ancillary systems are also fit for use. There are no findings that the DST System was not operated or maintained per code or legal or industry standards. There are several recommendations to improve the DST System. Most notably, a third DSTAR should be completed in 2026 (10 years from this report). At that time, some of the tanks will be approaching their design lives. Other recommendations are that ultrasonic testing and visual observations be continued in the annulus of the tanks at a 10-year maximum cycle.

Because tank AY-102 has leaked through the bottom, a recommendation is made to develop methods and perform measurements of tank thicknesses at the bottom of the DSTs.

As part of this 2016 assessment, the 2006 DSTAR recommendations were reviewed and confirmed to be closed by either concurrence with previous reviews or by issuing new recommendations. Observations are provided throughout this report.

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# LIST OF TERMS

## Acronyms and Abbreviations

| | |
|---|---|
| ALARA | as low as reasonably achievable |
| ASTM | ASTM International |
| ASME | American Society of Mechanical Engineers |
| AWWA | American Water Works Association |
| AWS | American Welding Society |
| BBI | best-basis inventory |
| BDGRE | buoyant displacement gas release event |
| CAM | continuous air monitor |
| CFR | *Code of Federal Regulations* |
| CHAMPS | Computerized History and Maintenance Planning System |
| CIPS | close-interval potential survey |
| DCVG | direct current voltage gradient |
| DLL | dome load limit |
| DLRSS | Dome load record summary sheet |
| DOE | U.S. Department of Energy |
| DSA | Documented Safety Analysis (RPP-13033) |
| DST | double-shell tank |
| DSTAR | Double-Shell Tank System Integrity Assessment Report |
| EAM | Enterprise Asset Manager |
| EOC | Extent of Condition |
| EMW | electro-magnetic wave |
| EPDM | ethylene propylene diene monomer |
| ER | electrical resistance |
| ERUL | estimate of remaining useful life |
| FFU | fit for use |
| FY | fiscal year |
| GPS | global positioning system |
| GRE | gas release event |
| HAZ | heat-affected zone |
| HFFACO | *Hanford Federal Facility Agreement and Consent Order* |
| HIHTL | hose-in-hose transfer line |
| HLW | high-level waste |
| IQRPE | Independent Qualified Registered Professional Engineer |
| LAI | liquid/air interface |
| LFL | lower flammability limit |
| NACE | National Association of Corrosion Engineers, NACE International, The Corrosion Society |
| NDE | non-destructive examination |
| ORP | U.S. Department of Energy, Office of River Protection |
| OSD | operating specification document |
| PER | problem evaluation request |
| POC | point of contact |

| | |
|---|---|
| PUREX | plutonium-uranium extraction |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| SCE | saturated calomel electrode |
| SCC | stress corrosion cracking |
| SST | single-shell tank |
| TOLA | thermal and operating loads analysis |
| TSR | Technical Safety Requirement |
| TMACS | Tank Monitoring and Control System |
| TWINS | Tank Waste Information Network System |
| UT | ultrasonic testing |
| WAC | *Washington Administrative Code* |
| WCA | waste compatibility assessment |
| WRPS | Washington River Protection Solutions, LLC |
| WSPS | Waste Stream Profile Sheet |
| WTP | Waste Treatment and Immobilization Plant |
| WTS | waste transfer system |

**Units**

| | |
|---|---|
| % | percent |
| ‘ | foot |
| “ | inch |
| ≈ | approximately equal to |
| ~ | approximately |
| < | less than |
| ≤ | less than or equal to |
| > | greater than |
| ≥ | greater than or equal to |
| ± | plus or minus |
| ° | degree |
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| µm | micron |
| amp | ampere |
| Btu | British thermal unit |
| DC | direct current |
| $cm^3$ | cubic centimeter |
| ft | foot |
| $ft^2$ | square foot |
| gal | gallon |
| hr | hour |
| in. | inch |
| $in^2$ | square inch |
| kgal | thousand gallons |
| L | liter |
| lb | pound |
| m | meter |

| | |
|---|---|
| M | molar |
| Mgal | million gallons |
| mil | one thousandth of an inch |
| min | minute |
| mV | millivolt |
| ppm | parts per million |
| psi | pounds per square inch |
| psig | pounds per square inch gauge |
| rms | root mean square |
| sec | second |
| V | volt |
| wg | water gauge |
| yr | year |

*NOTE: All Hanford Site tank farm system and component numbers begin with suffix '-241.' For ease of reading, use of the suffix has been omitted in this document.*

## TRADEMARK DISCLOSURE

**Allegro MX Field Data PC** is a trademark of American Innovations

**Amercoat** is a registered trademark of PPG Industries

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# 1.0 INTRODUCTION

The U.S. Department of Energy (DOE), Office of River Protection (ORP) manages Hanford Site Tank Operations. As stated in DE-AC27-08RV14800, *Tank Operations Contract*, the mission is to retrieve and treat Hanford Site tank waste and close the tank farms to protect the Columbia River. The current strategy for executing the mission is defined in ORP-11242, *River Protection Project System Plan*. The River Protection Project mission requires providing and maintaining adequate tank capacity for waste storage and waste feed delivery. Thus, functional double-shell tank (DST) waste storage and transfer facilities are a key asset for the River Protection Project until the waste has been transferred to and treated by the Waste Treatment and Immobilization Plant (WTP).

**40 CFR 265 Subpart J and WAC 173-303 Compliance Requirements**

The Hanford Site DSTs and ancillary equipment are considered a treatment, storage, and/or disposal unit — herein referred to as the DST System — under the *Resource Conservation and Recovery Act of 1976* (RCRA). Configuration and operation of these facilities is regulated under Title 40, *Code of Federal Regulations* (CFR), Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities" (40 CFR 265), Subpart J, "Tank Systems," incorporated by reference in *Washington Administrative Code* (WAC) 173-303-400(3), "Interim Status Facility Standards." Per WAC 173-303, the DST System is designated as an existing tank system. Periodic integrity assessments are required to comply with the RCRA requirements for an existing tank system, as implemented in Washington State under WAC 173-303, "Dangerous Waste Regulations."

As part of WAC 173-303, theWAC-173-303-640(2)(e) regulations require periodic integrity assessments of tank systems that store mixed radioactive and hazardous waste and a determination by an Independent Qualified Registered Professional Engineer (IQRPE) to determine if the tank system is leak-tight, with adequate integrity and otherwise fit for use over the projected life of the DST System. The DSTs are expected to operate under 40 CFR 265 Subpart J standards during the time of the integrity assessment activities; however, this 2016 double-shell tank integrity assessment report (DSTAR) must satisfy both sets of requirements, as the projected life of the tank system likely will extend into the time period where WAC 173-303-640(2)(e) applies.

The initial assessment for the DST System was fulfilled when Milestone M-48-14, "Submit Written Integrity Report for the Double-Shell Tank System," of the *Hanford Federal Facility Agreement and Consent Order* (HFFACO; Ecology et al. 1989) was completed in 2006. Periodic integrity assessments are required for DST System units that will continue to operate. That DST integrity assessment report (DSTAR) was updated through 2008 to include comments, to account for additional certification of transfer equipment, and to provide additional structural adequacy calculations for the tanks. Although portions of the previous DSTAR were not completed until 2008, for consistency in this report, the seven-volume report is collectively referred to as the 2006 DSTAR. The seven volumes are as follows:

- RPP-28538, *Volume 1: IQRPE Double-Shell Tank System Integrity Assessment Report HFFACO M-48-14* (2008)

- RPP-27591, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity* (2007)
- RPP-25153, *Volume 3: IQRPE DST System Integrity Assessment – Waste Compatibility* (2007)
- RPP-25299, *Volume 4: IQRPE DST System Integrity Assessment – Cathodic Protection for DST Transfer Lines* (2007)
- RPP-27097, *Volume 5: IQRPE DST System Integrity Assessment – Waste Transfer Line Encasement Integrity Technology Study* (2007)
- RPP-22604, *Volume 6: IQRPE DST System Integrity Assessment – Evaluation and Documentation of DST Secondary Liner Issues* (2007)
- RPP-20556, *Volume 7: IQRPE DST System Integrity Assessment – Evaluation of the Dome Load Program for Double-Shell Tanks* (2007).

The actions taken to close the 78 recommendations made in those reports are documented in RPP-RPT-50440, *2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions*. This 2016 DSTAR also considers DST System Independent Qualified Registered Professional Engineer (IQRPE) integrity assessments performed since 2006.

## 1.1 BACKGROUND

The DST System currently consists of 27 fit for use DSTs and ancillary equipment (e.g., transfer piping, fittings, flanges, valves, and pumps used to distribute, meter, or control the flow of dangerous waste). Since the 2006 DSTAR IQRPE Integrity Assessment was completed, it was determined that DST AY-102 is leaking from the primary containment and, as such, the tank is designated as not fit for use. The DST System tanks, pipelines, and ancillary equipment currently fit for use are listed in Appendix D.

## 1.2 PURPOSE

The purpose of this report is to document the activities, reviews, analyses, and evaluations performed by the IQRPE to create this 2016 DSTAR. This assessment is the second IQRPE DSTAR, the first having been completed on March 31, 2006, as required to maintain compliance with the following CFR and WAC rules.

**40 CFR 265.191 Assessment**

The scope of the IQRPE Integrity Assessment per 40 CFR 265.191, "Assessment of Existing Tank System's Integrity," includes the following elements:

(a) Determine that the tank system is not leaking and is fit for use or is unfit for use.

(b) Determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following:

1. Design standard(s), if available, according to which the tank and ancillary equipment were constructed;

2. Hazardous characteristics of the waste(s) that have been or will be handled;
3. Existing corrosion protection measures;
4. Documented age of the tank system, if available, (otherwise an estimate of the age); and
5. Results of a leak test, internal inspection, or other tank integrity examination such that:

   (i) For non-enterable underground tanks, this assessment must consist of a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects,

   (ii) For other than non-enterable underground tanks and for ancillary equipment, this assessment must be either a leak test, as described above, or an internal inspection and/or other integrity examination, certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that addresses cracks, leaks, corrosion, and erosion.

**WAC 173-303-640(2) Assessment**

The scope of the IQRPE integrity assessment per WAC 173-303-640 includes the following elements:

(2)(a) Determine the DST System is not leaking or is unfit for use.

(2)(c) Determine the DST System is adequately designed and has sufficient structural strength and compatibility with the wastes(s) to be stored or treated to ensure it will not collapse, rupture, or fail. At a minimum, the assessment must consider the following:

(i) Design standards, if available, according to which the tank and ancillary equipment was constructed;

(ii) Dangerous characteristics of the waste(s) that have been or will be handled;

(iii) Existing corrosion protection measures;

(iv) Documented age of the tank system, if available, (otherwise an estimate of the age); and

(v) Results of leak test, internal inspections, or other tank integrity examinations such that:

(A) For non-enterable underground tanks, the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects; and

(B) For other than non-enterable underground tanks and for ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an independent, qualified registered professional engineer, in accordance with WAC 173-303-810 (13)(a), that addresses cracks, leaks, corrosion, and erosion.

(2)(e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure the tank retains its structural integrity and will not collapse, rupture

or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and other relevant factors.

## 1.3 METHODOLOGY

The DST System has been in operation for decades and has previously been assessed by an IQRPE. For this current assessment, an emphasis was made in areas where the operation/time has affected the system's integrity with the objective to ensure operating parameters are within the appropriate design criteria, and to verify there are adequate programs of inspections. Previous IQRPE recommendations and findings were evaluated to assess the effect on DST System integrity.

The IQRPE assessed DST System integrity and documented the information reviewed for the DST System to meet the code requirements identified in Section 1.2. This report describes the documents, reviews, evaluations, studies, and other applicable data used by the IQRPE to satisfy the tank integrity regulations of an existing tank system. Subject Matter Experts were used as senior technical advisors possessing extensive experience in specific technical fields and who are uniquely qualified to review, interpret, and/or clarify specific technical issues. The Subject Matter Experts worked under the direct supervision of the IQRPE and were assigned and prepared sections of this DSTAR in their areas of expertise. The Subject Matter Experts coordinated their evaluations in areas where there was overlap in the report preparation. Appendix A lists team resumes. Appendix W lists all of the documents reviewed by the Subject Matter Experts.

The IQRPE assessed DST System integrity and documented the information reviewed for the DST System to meet the code requirements identified in Section 1.2. This report describes the documents, reviews, evaluations, studies, and other applicable data used by the IQRPE to satisfy the tank integrity regulations of an existing tank system. Subject Matter Experts were used as senior technical advisors possessing extensive experience in specific technical fields and who are uniquely qualified to review, interpret, and/or clarify specific technical issues. The Subject Matter Experts worked under the direct supervision of the IQRPE and were assigned and prepared sections of this DSTAR in their areas of expertise. The Subject Matter Experts coordinated their evaluations in areas where there was overlap in the report preparation. Appendix A lists team resumes.

The compliance matrix included as Appendix B was used to ensure that the regulations identified in Section 1.2 were evaluated for compliance. The matrix provides a summary assessment of compliance, including a cross-reference to the reviews, analyses, and documents that demonstrate meeting the requirements.

Using a graded approach, the IQRPE reviewed the following items from the Washington River Protection Solutions, LLC (WRPS) DST Structural/Leak Integrity Examination Program conducted since the 2006 DSTAR IQRPE assessment:

- Ultrasonic testing (UT) wall thickness measurements of the primary tank and secondary containment
- Video examinations performed within both the primary and annulus tank spaces on the DSTs

- P-scan (pulse-echo ultrasonic inspection) crawler inspection results for primary tank vertical walls
- Extent of Condition (EOC) reports
- Examination results for welds and weld heat-affected zone (HAZ)
- Corrosion studies
- Cathodic protection system test results
- Temperature and pressure monitoring data (verify DSTs are operating within prescribed structural limits).

This 2016 DSTAR also includes a review of all relevant IQRPE assessments completed since 2006 through August 30, 2015. The IQRPE reports reviewed are listed in Table 3-1.

## 1.4 CERTIFICATION DISCUSSION

Based on the conclusions of this 2016 DSTAR, the IQRPE must choose to either not certify the DST System or to certify the integrity of the DST System in part or in its entirety. In compliance with both the 40 CFR 265 interim status regulations and the WAC 173-303-640, "Tank Systems," final status regulations, the IQRPE has maintained a direct supervisory role over the development of this 2016 DSTAR. To complete this certification, the IQRPE is required to stamp and sign this report with the Professional Engineer stamp/seal. As such, this 2016 DSTAR bears the Professional Engineer's stamp and signature of the IQRPE, because it was prepared using qualitative engineering judgment and specifies engineering-related criteria in accordance with the prevailing laws related to registered professional engineers in Washington State.

The certification wording states that the information contained in this integrity report is believed to be "true, accurate, and complete." The nature of this DST integrity assessment requires that a significant amount of data interpretation and some engineering judgment be applied to obtain meaningful conclusions.

The certification statement word 'complete' means that the data reviewed for the integrity assessment, extracted from the voluminous DST System data, were reasonably sufficient to perform a meaningful integrity evaluation. It also means that in the IQRPE's judgment, the information included in this integrity report is sufficient for the reader to understand the basis for the conclusions reached in the assessment.

The following certification language from both 40 CFR 270.11(d) and WAC 173-303-810(13)(a) must be used.

The certification language in 40 CFR 270.11(d) states:

> *I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.*

The certification language in WAC 173-303-810(13)(a) states:

> *I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment for knowing violations.*

## 1.5 INTEGRITY ASSESSMENT REPORT DESCRIPTION

This 2016 DSTAR is composed of the following main IQRPE assessment sections:

- Integrity Assessment Conclusions (Section 3)
- DST Structural Adequacy (Section 4)
- DST Waste Transfer System (WTS) Integrity (Section 5)
- Cathodic Protection for DST Transfer Lines (Section 6)
- Pit Secondary Liners/Coatings for DST System (Section 7)
- Leak Detection Systems (Section 8)
- Waste Characterization for DST System (Section 9)
- Waste Compatibility with the DST System Materials of Construction (Section 10)
- Corrosion Assessment and Status (Section 11).

# 2.0 SCOPE

## 2.1 DOUBLE-SHELL TANK SYSTEM

The DST System includes 27 DSTs, 77 pipelines, 38 pits, and other ancillary systems. Because it was determined to be leaking, tank AY-102 is not fit for use and is not included in this report. However, tank AY-102 is used for comparison to other tanks as part of the assessment of the other tanks. The entire system is shown diagrammatically in Appendix R. A list of the fit for use DST System is in Appendix D. The DST System integrity program is under the WRPS DST Integrity Project Plan which is shown in Appendix C.

This is not a review of future program plans or an estimate of remaining useful life (ERUL). The assessment provides review of analyses completed since the 2006 DSTAR and it may recommend additional analysis, but the scope does not require new analysis of components or reevaluation of prior IQRPE work. This assessment addresses data available through August 30, 2015. The scope of this assessment includes the DSTs and the related pits and transfer piping, as described in the specific project scope subject to IQRPE certification.

The DST System leak detection system is reviewed to confirm that an adequate system is in place, and that the system is maintained and operational. Many of the pipes have cathodic protection to reduce the possibility of corrosion. The cathodic detection system is thus assessed.

## 2.2 40 CFR 265 AND WAC 173-303-640 INTEGRITY ASSESSMENT AND IQRPE ASSESSMENT REQUIREMENTS

The 40 CFR 265 Subpart J and WAC 173-303-640 integrity assessment requirements are comparable and are shown in Table 2-1.

**Table 2-1: 40 CFR 265 and WAC 173-303-640 IQRPE Assessment Requirements (2 sheets)**

| 40 CFR 265 Subpart J | WAC 173-303-640 |
|---|---|
| 265.191, Assessment of existing tank system's integrity.<br><br>(a) For each existing tank system that does not have secondary containment meeting the requirements of 265.193, the owner or operator must determine that the tank system is not leaking or is unfit for use. Except as provided in paragraph (c) of this section, the owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that attests to the tank system's integrity by January 12, 1988 | (2) Assessment of existing tank system's integrity.<br>(a) For each existing tank system, the owner or operator must determine that the tank system is not leaking or is unfit for use. Except as provided in (b) of this subsection, the owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by an independent, qualified registered professional engineer, in accordance with WAC 173-303-810(13)(a), that attests to the tank system's integrity by January 12, 1988, for underground tanks that do not meet the requirements of subsection (4) of this section and that cannot be entered for inspection, or by January 12, 1990, for all other tank systems. |

**Table 2-1: 40 CFR 265 and WAC 173-303-640 IQRPE Assessment Requirements (2 sheets)**

| 40 CFR 265 Subpart J | WAC 173-303-640 |
|---|---|
| (b) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following:<br>(1) Design standard(s), if available, according to which the tank and ancillary equipment were constructed; | (2) (c) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following:<br>(i) Design standard(s), if available, according to which the tank system was constructed; |
| (2) Hazardous characteristics of the waste(s) that have been or will be handled; | (ii) Dangerous characteristics of the waste(s) that have been and will be handled; |
| (3) Existing corrosion protection measures; | (iii) Existing corrosion protection measures; |
| (4) Documented age of the tank system, if available (otherwise, an estimate of the age); and | (iv) Documented age of the tank system, if available (otherwise, an estimate of the age); and |
| (5) Results of a leak test, internal inspection, or other tank integrity examination such that:<br>(i) For non-enterable underground tanks, this assessment must consist of a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects,<br>(ii) For other than non-enterable underground tanks and for ancillary equipment, this assessment must be either a leak test, as described above, or an internal inspection and/or other integrity examination, certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that addresses cracks, leaks, corrosion, and erosion. | (v) Results of a leak test, internal inspection, or other tank system integrity examination such that:<br>(A) For nonenterable underground tanks, the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects; and<br>(B) For other than nonenterable underground tanks and for ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an independent, qualified registered professional engineer, in accordance with WAC 173-303-810 (13)(a), that addresses cracks, leaks, corrosion, and erosion. |
| (40 CFR 265 Subpart J does not have a comparable section to WAC 173-303-640) | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. |

The references in Table 2-1 are copied verbatim. However, 40 CFR 265 Subpart J requirements are modified by WAC 173-303-400(3)(ix). These modifications are not shown in the table because they are in line with WAC 173-303-640 requirements and do not add any additional requirements. If shown, the WAC 173-400 modifications would be as follows:

- 40 CFR 265.191 (a) would be modified by changing 1988 to 1990.
- 40 CFR 265.191 (a) would be modified by changing "qualified professional engineer" to "independent qualified registered professional engineer."
- 40 CFR 265.191 (b)(5)(ii) would be modified by changing "qualified professional engineer" to "independent qualified registered professional engineer."

## 2.3 IQRPE INTEGRITY ASSESSMENT EXCLUSIONS

The following tanks and ancillary equipment are excluded from this 2016 DSTAR:

- Tank AY-102 is leaking from the primary containment and, as such, the tank is designated as not fit for use.
- Pits at tank AY-102.
- The 242-A Evaporator Facility except the supernatant waste feed pipelines connecting the AW-02E feed pump pit and slurry waste concentrate pipelines connecting the AW-A and AW-B valve pits are included in this assessment.
- Hose-in-hose transfer lines (HIHTL) used for single-shell tank (SST) waste retrieval operations, except for:
    - The ethylene propylene diene monomer (EPDM) HIHTLs connecting DSTs and flexible EPDM pipe jumpers located in DST pump and valve pits are included and listed on drawing H-14-106249, *HIHTL Tracking Table*.
- Pipelines that require Washington State Department of Ecology or ORP approval before next use.
- Pipelines that the 2006 DSTAR identified as requiring pressure testing before next use.
- Pipelines and facilities for which construction or construction acceptance have not been completed.
- Air handling systems used to ventilate the DSTs and ancillary structures, such as tank AZ-301.
- Raw water, potable water, compressed air, and other utility systems supporting the DSTs and the WTS.
- Electrical and instrumentation circuitry, except for:
    - Tank and pipeline integrity protection circuitry associated with the WTS cathodic protection system is included.
    - The leak detection devices for the tanks are included; leak detection pits for the secondary liner are excluded.

## 3.0 INTEGRITY ASSESSMENT CONCLUSIONS

The conclusions of this 2016 DSTAR are summarized in this section. The conclusions include:

- Review of the 2006 DSTAR recommendations
- Review of the IQRPE assessments completed since the 2006 DSTAR
- Discussion of findings, observations, and recommendations.

More details and discussions are provided in Sections 4 to 11 and the appendices.

### 3.1 REVIEW OF THE 2006 DSTAR RECOMMENDATIONS

The 2006 DSTAR contains 78 formal recommendations. WRPS reviewed and dispositioned each of these recommendations in RPP-RPT-50440. To provide an independent assessment, this 2016 DSTAR assesses each of those recommendations. Some review and commentary is provided in Sections 4 to 11 concerning the 2006 DSTAR and recommendations. Because there have been many changes since 2006, the 2006 DSTAR discussions will be limited to the major issues that are still part of the current DST System.

Of the 78 2006 DSTAR recommendations:

- Five were not within the scope of this 2016 DSTAR
- 51 were considered completed with no further recommendations needed
- 22 were considered completed but a new 2016 recommendation was developed that was similar and is listed in Section 3.3.3.

Appendix H covers all of the 78 formal recommendations, the RPP-RPT-50440 dispositions, and the 2016 DSTAR dispositions.

### 3.2 DESCRIPTION OF PROJECTS REVIEWED BY IQRPE AFTER 2006 DSTAR

There have been new constructions and/or modifications to the DST System since 2006. To ensure that there are no gaps in IQRPE assessments, the new constructions and modifications were reviewed. Table 3-1 lists the IQRPE assessments completed since the 2006 DSTAR. The conclusion is that new constructions and modifications to the DST System have been appropriately assessed by an IQRPE and the associated reports appear complete.

Table 3-1 is historical and may not reflect the DST System as it is today. For example, some of the construction (e.g., jumpers) may have been replaced and thus are not part of the current DST System. Nevertheless, all of the construction was done under an IQRPE assessment as listed in Table 3-1.

**Table 3-1: IQRPE Assessments Completed Since 2006 (3 sheets)**

| Document Number | Date of Publication | Title | Comments |
|---|---|---|---|
| RPP-RPT-33906, Rev. 1 | 6/11/2007 | 241-AW-02A Pit Concrete Coating – Independent Integrity Assessment Report | Pit coating was performed to meet the 5- to 7-year inspection interval required by the 2006 DTSAR (Volume 1). |
| RPP-RPT-34475, Rev. 1 | 8/20/2007 | 241-AN-A and AN-B Valve Pits Concrete Coating Independent Integrity Assessment Report | Pit coating was performed to meet the 5- to 7-year inspection interval required by the 2006 DSTAR (Volume 1). |
| RPP-RPT-39121, Rev. 0 | 11/12/2008 | 241-AN-01A Pit Concrete Coating Independent Integrity Assessment Report | Pit coating was performed to meet the 5- to 7-year inspection interval required by the 2006 DSTAR (Volume 1). |
| RPP-RPT-40011, Rev. 0 | 3/12/2009 | 241-AW-02A Pit Certified NACE Coating Inspector Report | Pit coating was performed to meet the 5- to 7-year inspection interval required by the 2006 DSTAR (Volume 1). |
| RPP-45569, Rev. 0 | 3/11/2010 | AW-B Rigid Jumper A-D Independent Integrity Assessment Report | Installed rigid jumper has sufficient structural integrity and is acceptable for transferring waste. |
| RPP-RPT-46378, Rev. 2 | 9/4/2012 | Integrity Assessment Report for Project W-566 Waste Feed Delivery – Transfer Line Upgrades for Clean-Out Boxes Modifications | Transfer lines have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-46637, Rev. 0 | 5/25/2010 | AY02A Pumps and Jumpers Independent Integrity Assessment Report | Pumps and jumpers have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-46860, Rev. 0 | 6/17/2010 | Independent Integrity Assessment Report for 241-AW-02E Pit Jumper Replacement | Jumper replacements have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-47645, Rev. 0 | 9/03/2010 | Integrity Assessment for AN-101 Pump Replacement in the C-104 Waste Retrieval System | Tank AN-101 pump replacement has sufficient structural integrity and is acceptable for transferring waste. |
| RPP-RPT-52463, Rev. 0 | 5/4/2012 | IQRPE Integrity Assessment for Design and Installation of AN06A Hydraulic Supernate Pump and Support Components | Hydraulic supernate pump and associated support components have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-50752, Rev. 1 | 6/1/2012 | Independent Integrity Assessment Report – Project W-566, SY Transfer Lines Upgrades | SY transfer line upgrades have sufficient structural integrity and are acceptable for transferring waste. |

**Table 3-1: IQRPE Assessments Completed Since 2006 (3 sheets)**

| Document Number | Date of Publication | Title | Comments |
|---|---|---|---|
| RPP-RPT-49533, Rev. 1<br><br>RPP-RPT-49534, Rev. 1 | 6/1/2012 | Independent Design Integrity Assessment Report for 241-AP Valve Pit Jumper<br><br>Independent Construction Integrity Assessment Report for 241-AP Valve Pit Jumpers | AP valve pit jumper replacements have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-52719, Rev. 0<br><br>RPP-RPT-52720, Rev. 0 | 6/6/2012 | IQRPE Design Assessment Report for the 241-AP Valve Pit Jumper 13-C-(N) Nozzle Spacer<br><br>IQRPE Installation Assessment Report for the 241-AP Valve Pit Jumper 13-C-(N) Nozzle Spacer | New design of extending existing nozzle 13 in AP-VP 3/8 in. to allow the existing jumper assembly 13-C-(N) to be properly installed for the safe transfer of dangerous waster through the jumper. |
| RPP-RPT-49517, Rev. 1 | 10/19/2012 | Final IQRPE Report for Design on AW Farm Infrastructure Upgrades Project T3W13 | New diluents and flush lines routed from diluent and flush pad to the diluent and flush pit, and DSTs AW-101 through AW-106 have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-50836, Rev. 1 | 11/14/2012 | Project W-566 AZ-102 Jumper and Pump Integrity Assessment Report | AZ-02A jumper, supernate pump, and AZ-02A pump pit have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-50191, Rev. 1 | 11/15/2012 | Independent Integrity Assessment Report for Design and Construction of 241-AN-A Pit Jumpers | Replacement AN-A pit jumpers have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-50192, Rev. 1 | 11/15/2012 | Independent Integrity Assessment Report for Design and Construction of 241-AN-B Valve Pit Jumpers | Replacement AN-A pit jumpers have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-54092, Rev. 0 | 2/4/2013 | IQRPE Design and Installation Assessments for the AN-101 Pump Replacement and Related Equipment | AN-101 supernate pump, slurry distributor, and jumper have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-54860, Rev. 0 | 3/28/2013 | IQRPE Design and Installation Assessment Reports for AN-106 Pump Replacement and Related Equipment | AN-06A supernate pump and jumper have sufficient structural integrity and are acceptable for transferring waste. |
| RPP-RPT-55788, Rev. 0 | 8/29/2013 | IQRPE Integrity Assessment Reports for AN-06A Supernatant Pump Anti-Siphon Hoses and Drop Leg Repair | Replacement anti-siphon hose discharge piping from jumper AN-06A-WT-J-(2-4), and drop leg repair, at tank AN-106 has sufficient structural integrity and is acceptable for transferring waste. |

**Table 3-1: IQRPE Assessments Completed Since 2006 (3 sheets)**

| Document Number | Date of Publication | Title | Comments |
|---|---|---|---|
| RPP-RPT-56412, Rev. 0 | 12/12/2013 | Independent Qualified Registered Professional Engineer Inspection Report for 241-AW05A, SN-265 Encasement Pressure Test | Encasement pressure test was performed on the secondary encasement. |
| RPP-56932, Rev. 0 | 2/26/2014 | Independent Qualified Registered Professional Engineer Integrity Assessment Report for AW-B Valve Pit R1-R3-C Jumper Replacement | New jumper has sufficient structural integrity and is acceptable for transferring waste. |

## 3.3 DISCUSSION OF REVIEW

The DST System assessment review process is outlined in the Figure 3-1 diagram. For each tank, waste transfer pipe, or pit, an assessment was made as to whether the feature is in scope, leaking, appropriately designed, structurally adequate and compatible with the waste such that the feature will not collapse, rupture, or fail. Once those steps are completed, findings, observations, and recommendations are developed.

The conclusion of this report is that the 27 DSTs are fit for use. Additionally, the 77 pipelines and 38 pits are also fit for use. See Appendix D for a full list of fit for use components.

For this report, the following definitions apply:

- Finding – An individual item that does not meet requirements.
- Observation – A condition that helps perpetuate the DST System as fit for use. Observations were made for enhancements of the DST System and operation.
- Recommendation – An activity considered by the IQRPE that, if implemented, will rectify conditions or processes identified by findings, address issues raised by observations, or implement activities identified by conclusions.

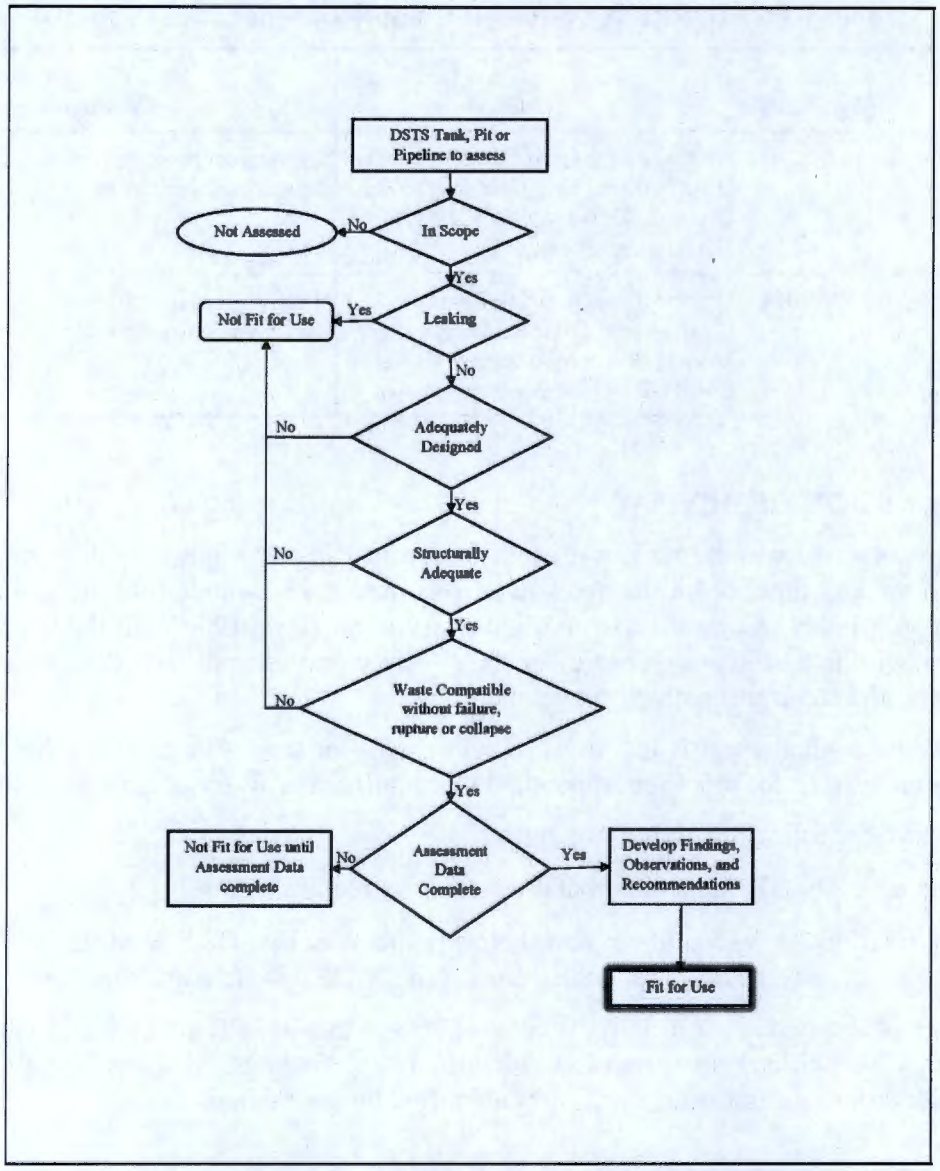


**Figure 3-1: Assessment Review of the DST System**

### 3.3.1 Discussion of Findings

After careful consideration, there are no findings of conditions that failed to meet requirements.

### 3.3.2 Discussion of Observations

Observations were made for enhancements of the DST System and operation. The observations are listed in Sections 4 through 11 and Appendix G and, as such, are not repeated in this section. Any recommendation that was generated from an observation is listed in Section 3.3.3.

### 3.3.3 Discussion of Recommendations

The following recommendations are activities considered by the IQRPE that, if implemented, will rectify conditions or processes identified by findings, address issues raised by observations, or implement activities identified by conclusions. The recommendations are grouped by topic. Additionally, within each topic, the recommendations are prioritized from most important to least important. The priorities are based on most impactful to preserving integrity of the DST System.

**DSTAR Interval:**

R16-1. The next DSTAR should be in 2026 (a 10-year interval from this 2016 DSTAR). At that time, tank AY-101 will be 6 years from its currently analyzed life expectancy of 60 years. As systems age, it is appropriate that assessments, inspections, and observations become more frequent or at least no less frequent.

**Tank:**

R16-2. Tank waste should continue to be managed in accordance with the Waste Compatibility Program (HNF-SD-WM-OCD-015) and specification OSD-T-151-00007, including the practice of performing WCAs prior to transfers or additions. When management of the tank operations changes and or falls outside of the scope of investigated reports (e.g., prior to waste delivery to the WTP), then a reevaluation of operating specifications should be required. (For additional information, see Sections 8 and 9.)

R16-3. Visual inspections of the refractory and primary DST base should be conducted. (For additional information, see Section 4.)

R16-4. Development of a primary tank bottom inspection tool should be done to reduce concerns about the DST bottoms. It must be determined whether it is more feasible to access the bottom through the refractory or to develop a robot that can access the bottom of the primary from the waste side. In any case, inspections should include non-destructive examination (NDE) techniques, such as UT. However, because no obviously applicable techniques currently exist, emphasis should be placed on tracking investigative techniques as they develop in the industry and with continued communications with developers. (For additional information, see Sections 4 and 11.)

R16-5. UT measurements of the primary DST and the secondary liner lower knuckle should be conducted at least every 8 to 10 years. (For additional information, see Section 4.)

R16-6. As UT measurement processes evolve, both old and new methods should be compared on the same systems to assist in interpreting results. (For additional information, see Sections 4 and 11.)

R16-7. Tank dome elevation surveys should be repeated utilizing the current schedule. (For additional information, see Section 4.1.)

R16-8. Visual inspections of the DST annuli should be conducted at least every 8 to 10 years preceding UT and can help direct where UT measurements are taken. (For additional information, see Section 4.)

R16-9. The life expectancy of the DST's should be reassessed by 2025. The life expectancy developed in the existing thermal and seismic study (RPP-RPT-28968, Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis) was 60 years. In 2025, tank AY-101 will be 53 years old, which is 7 years from its current life expectancy. By completing the assessment by 2025, the information would be available for the 2026 DSTAR. (For additional information, see Section 4.)

R16-10. In conjunction with R16-9, additional assessment should be performed to determine the minimum wall thicknesses of the AP Tank Farm. This analysis should include the effects of the yield strength of the plate material due to heat up times and the 460 in. tank waste level. (For additional information, see Section 4.)

R16-11. Laboratory testing of corrosion probes in waste samples along with the electrochemical tests to better understand the potential for error in the corrosion readings obtained in the DSTs should be completed. (For additional information, see Section 11.)

R16-12. The steel annulus temperature should be determined at the time and location of the UT measurements. Determine if these temperature measurements provide better accuracy for the UT thicknesses determined. An improved temperature more closely representing the wall temperature is needed for the UT measurements of the DSTs. Inaccurate temperatures can lead to large measurement errors. The UT experts should clarify their needs for reliable data. (For additional information, see Sections 4 and 11.)

R16-13. UT calibration tests should be tried on corroded 'waste' filled 'tanks.' UT instrumentation should be able to differentiate between metal and waste, but this has not been confirmed and may be a source of error. (For additional information, see Section 11.)

R16-14. When future treatment options are exercised, instrumented (e.g., UT, coupons, ER probes) spool pieces should be considered to monitor input lines to critical tanks in accordance with requirement WTI-3 in the tank farms WTS Fitness-for-Service requirements and recommendations (RPP-RPT-52206). This would provide a more rapid indication of the potential for corrosion when practicable and consistent with ALARA principles. Alternatively, evaluate the possibility of remote monitoring of the LAI to detect unwanted changes. An obvious but often neglected point is the collection of baseline data for any new WTS component prior to use especially if only one set of measurements is available. Once two or more sets of reliable data sets are available, the use of baseline data is not needed. (For additional information, see Section 11.)

**Pits:**

R16-15. Inspection cycles of the pit coatings and lining materials should be completed every 10 to 12 years for epoxy coated pits, 15 to 18 years for polyurea coated pits, and 15 to 20 years for steel liners. (For additional information, see Section 7.)

R16-16. At time of coating, pit coating inspection reports should include the following:

- Environmental conditions within the coating area (surface temperature, wet and dry bulb temperatures, dew point, and relative humidity). Environmental conditions

should be recorded every 4 hours or when changes in weather occur, such as going from sunny to cloudy sky conditions.

- Coating material data.
- Data regarding coating application.
- (For additional information, see Section 7.)

R16-17. In instances where the recommended inspection cycles have not been met for pits that are not being used, the pit coatings should be inspected prior to use. (For additional information, see Section 7.)

R16-18. If holes or cracks in the concrete are noted, information regarding the defect (diameter, width, length, orientation) should be provided along with photographs and a legible scale. When pit coating inspections are conducted, record the numerical crack width and length. Significant cracks should be evaluated by a structural engineer to determine the structural adequacy of the pit. (For additional information, see Sections 4 and 7.)

**Pipelines:**

R16-19. Pressure testing of the encasements of the DST WTS piping should continue on a 10-year schedule, except pipeline SL-167 should be on a 5 year schedule. (For additional information, see Section 5.)

R16-20. The use of the "Fit-for-Use" program for opportunistic forensic analysis should continue to monitor piping for signs of corrosion and erosion. (For additional information, see Section 5.)

R16-21. The use of synchronizable interrupters (JR-1) should be considered as an improvement over the pulse generator and wave form analyzer technology. However, a majority of cathodic protection system operators and testers are using GPS-based interrupters and data collection equipment. Incorporating this type of equipment will make downloading data to a database quicker and reduce errors. Additionally, test station data can be preloaded into the data logger along with records of previous potential measurements. Having this information will make locating test stations easier and allow the determination of a testing anomaly immediately. (For additional information, see Section 6.)

R16-22. The use of monitor coupons and ER probes should be continued. Based upon the information collected, consideration should be given to expanding their use. Installation of these supplemental system evaluation tools should also be considered at locations of shielding and at areas where the piping is in close proximity to bonded copper grounding systems (bi-metallic couples). Because use of the 100-mV polarization criterion is not allowed (per NACE SP0169) where bi-metallic couples exist, these instruments would be beneficial in providing polarization and protective current density information. (For additional information, see Section 6.)

R16-23. Whenever pits are opened and it is possible to verify as-built dimensions of nozzle locations prior to the design, fabrication, and installation of new jumpers,

measurements should be taken and documented to ensure proper fit-up of new components. (For additional information, see Section 5.)

**Leak Detection System:**

R16-24. A common leak detection instrument database or a program that extracts data from the multiple databases should be developed to identify issues relating to a particular instrument or location that has repeating issues. (For additional information, see Section 8.)

# 4.0 DOUBLE-SHELL TANK STRUCTURAL ADEQUACY

**Introduction/Purpose**

The purpose of this section is to document the structural adequacy of the DST structures as required by 40 CFR 265 Subpart J, 265.191(b). "This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail" (40 CFR 265 Subpart J, 265.191(b); WAC 173-303-640). Structural adequacy is the strength against collapse or failure from normal and abnormal loads (RPP-7574, *Double-Shell Tank Integrity Program Plan*). Leak tightness, the other component of structural integrity is covered elsewhere in this document.

**Scope/Requirements**

The scope of this DST assessment is to determine the structural adequacy of the DSTs. This assessment includes tank AY-101 and the AZ, SY, AW, AN, and AP Tank Farms, including the pits associated with these tanks. DST AY-102 and the pits associated with that tank are specifically excluded from the scope of this assessment.

**Method of Assessment**

The 2006 DSTAR sets a baseline for the structural adequacy. Calculations evaluated for the 2006 DSTAR documented the structural design loads for the DSTs and their pits. These calculations indicate that the life expectancy of the existing DSTs is 60 years.

After tank AY-102 was found to be leaking in August 2012, all the DST Farms were evaluated by reviewing original construction documentation and reported in the EOC review reports. These reports evaluate the construction of the tank farms and compare them to the construction of tank AY-102. This report outlines the similarities and differences in the construction practices of the tank to determine the structural adequacy of the DST System.

Once the construction was evaluated, the temperature, supernate levels, wall thickness, etc. were evaluated to determine if the DSTs are being operated within the established operating parameters.

**DST Overview**

The DSTs are comprised of steel primary and secondary tanks with a concrete shell as shown in Figure 4-1.

A view of tank AY-101 is shown in Figure 4-2. See Appendix J for a section of each tank farm tank, and Appendix I for additional information on the tanks.

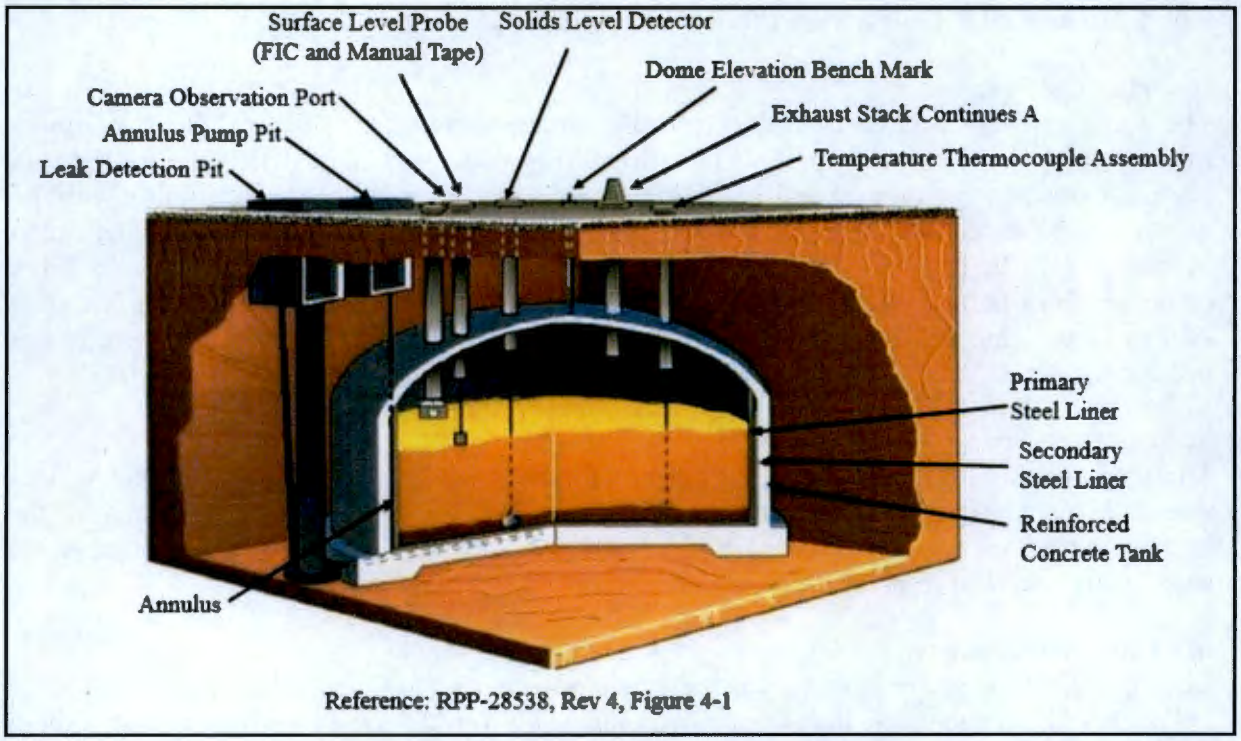


**Figure 4-1: Double-Shell Tank AY-101**

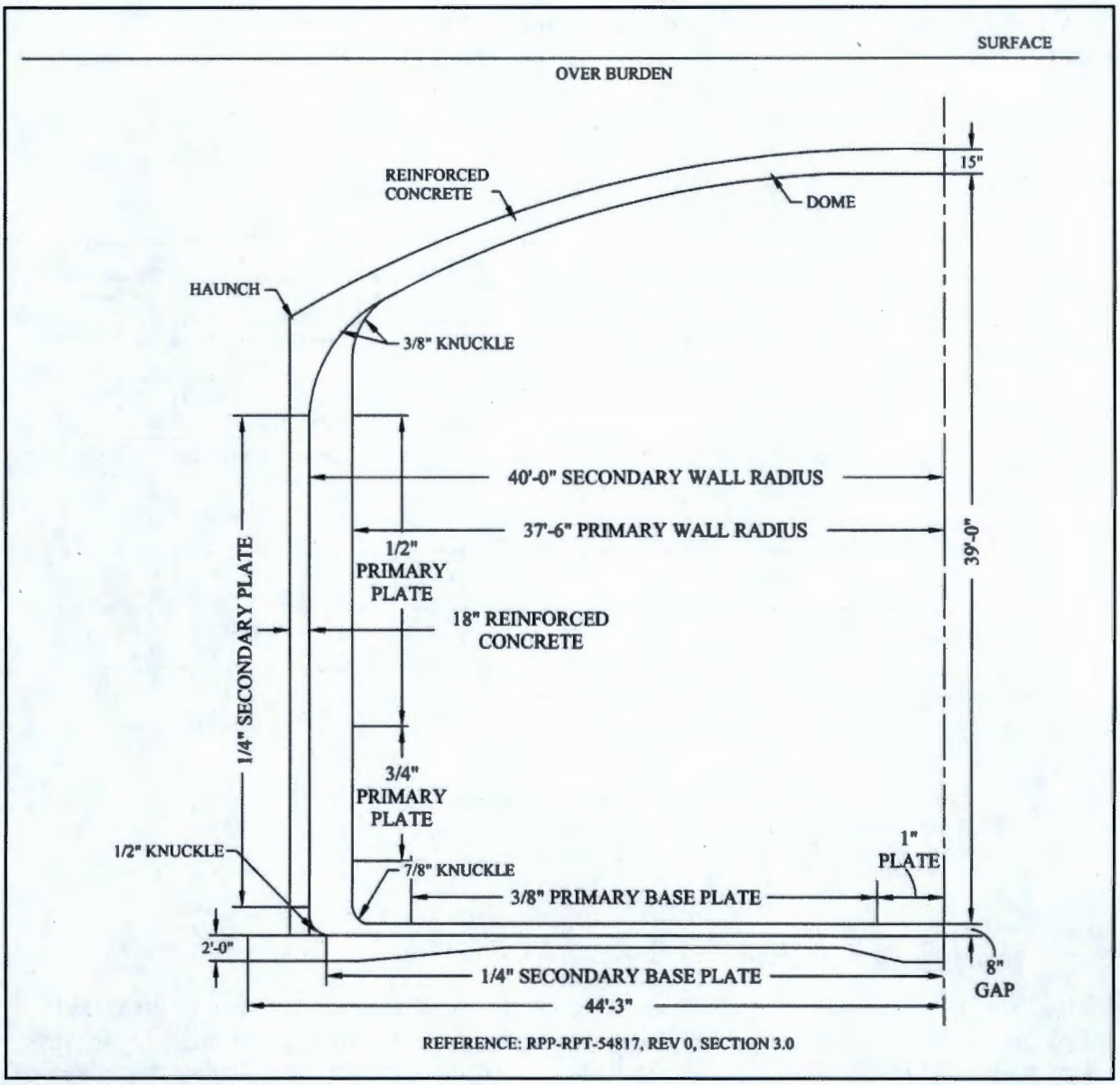


**Figure 4-2: Structural Section of a Typical Double-Shell Tank**

Table 4-1 identifies each tank, the age, the contractor, and the most recent tank integrity review date. This meets the requirement in both the Federal and Washington State documents for "Documented age of the tank system, if available" (40 CFR 265 Subpart J, 265.191(4); WAC 173-303-640(2)(c)(iv)).

**Table 4-1: Tank Age and Contractor**

| | Initial Operation | Original Design Service Life | Current Age | Design Service Life Per Seismic Study | Tank Integrity Review | Contractor | Number of Tanks |
|---|---|---|---|---|---|---|---|
| **Tank AY-101** | 1971 | 40 | 44 | 60 | 2013 | Pittsbburg Des Moines Steel Company | 1 |
| **Tank AY-102*** | 1971 | 40 | 44 | 60 | Leaking 8-10-12 | Pittsbburg Des Moines Steel Company | 1 |
| **AZ Tank Farm** | 1976 | 20 | 39 | 60 | 2013 | Pittsbburg Des Moines Steel Company | 2 |
| **SY Tank Farm** | 1977 | 50 | 38 | 60 | 2013 | Chicago Bridge and Iron Company | 3 |
| **AW Tank Farm** | 1980 | 50 | 35 | 60 | 2013 | American Bridge Company | 6 |
| **AN Tank Farm** | 1981 | 50 | 34 | 60 | 2014 | American Bridge Company | 7 |
| **AP Tank Farm** | 1986 | 50 | 29 | 60 | 2014 | American Bridge Company | 8 |

Notes: *Tank is leaking and is not part of this DST assessment

References:
A) AY Tank Farm, RPP-RPT-54817, Rev 0
B) AZ Tank Farm, RPP-RPT-54818, Rev 0
C) SY Tank Farm, RPP-RPT-54819, Rev 0
D) AW Tank Farm, RPP-RPT-55981, Rev 0
E) AN Tank Farm, RPP-RPT-55982, Rev 0
F) AP Tank Farm, RPP-RPT-55983, Rev 0
G) RPP-RPT-28968, Rev 1

## 4.1 2006 DSTAR VOLUME 1

The 2006 DSTAR Volume 1 sets a baseline for the structural adequacy. As part of 2006 DSTAR Volume 1, several analyses were performed to determine the structural adequacy of the DST structures. Included in the report were finite element models used to calculate the bounding minimum design wall thicknesses for the primary tank. Failure mechanisms – including seismic events, through wall pitting corrosion, general wall thinning, settling of the structure and excessive equipment loading to the top of the tank – were considered. These studies were projected to represent 60 years of tank age, and were based on structural knowledge and technology that was not available when the tanks were originally designed. An analysis of the bolts were performed using the cracked concrete properties which verified the structural adequacy of the anchorage using current (2006) code methods. The bolts are the anchor bolts that attach the steel tank to the concrete dome. Assessments that were included in the 2006 DSTAR are indicated in the Table 4-2. These assessments evaluated the existing DSTs and compared them to 2006 seismic data and ACI 349-06, *Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary*.

**Table 4-2: Assessments Included in the 2006 DSTAR**

| Subject | Analysis Document(s) (Section) | 2006 DSTAR Section |
|---|---|---|
| Thermal and Operating Loads | RPP-RPT-23308, *Hanford Double Shell Tank-Thermal and Operating Loads Analysis* | 4.10.2.1 |
| Minimum Wall Thickness | RPP-RPT-32238, *Hanford Double Shell Tank Thermal and Seismic Project – Primary Tank Mission Wall Thickness Analysis* | 4.10.2.4 |
| Refractory Degradation | PNNL 14706, *DST Primary Tank Settlement Evaluation* | 3.1, 4.10.2.6 |
| Operating Level Increase | RPP-RPT-32237, *Hanford Double-Shell Tank Thermal and Seismic Project – Increased Liquid Level Analysis for 241-AP Tank Farms* | 3.2, 4.10.2.7 |
| Anchor Bolts | RPP-RPT-28968, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis (6.6)* | 4.10.2.3 |
| Buckling | RPP-RPT-28968 (6.4) | 4.10.2.3 |
| Sloshing | RPP-RPT-28968 (6.2.4) | 4.10.2.3 |
| Seismic | RPP-RPT-28968 | 4.10.2.3 |
| Stress Corrosion Crackling | RPP-RPT-27574, RPP-RPT-28968 (6.3) | 4.10.2.5 |
| Secondary Liner | RPP-ASMT-27986, *Evaluation of Secondary Liner Under Postulated Waste Leakage Scenario in a Double Shell Tank Annulus, and RPP-RPT-28968 (6.5)* | 4.10.2.8 |
| Increased Concentrated Load Analysis | RPP-RPT-25608, *Hanford Double Shell Tank Thermal and Seismic Project – Increased Concentrated Load Analysis* | 4.10.2.2 |

**(Summary of Structural Analysis from RPP-28538, Rev 5, Page 4-53, Table 4-25)**

After reviewing the 2006 DSTAR and some of the reports referenced in the 2006 DSTAR, it is concluded as part of this 2016 DSTAR that:

- Evaluations performed for the 2006 DSTAR meet the current design requirement for the structural adequacy of the DST System
- No new structural analyses of the DSTs are required for this 2016 DSTAR.

The 2006 IQRPE recommended the following:

- Operating conditions were modified to the following parameters (2006 DSTAR Volume 1).
  - AY Tank Farm DSTs may not contain waste of a density greater than 1.77 g/cm$^3$
  - Maximum dome temperature for re-rated AP Tanks is 135 °F
  - Maximum waste level for re-rated AP Tanks is 460 in.
  - Allowable specific gravity of waste for re-rated AP Tank Farm tanks is 1.83.

- Dome temperatures for AY, AZ, SY, AN, and AW Tank Farm tanks must not exceed 160 °F for a maximum vacuum level of 6 in. wg
- Dome temperatures for re-rated AP Tank Farm tanks must not exceed 135 °F for a maximum vacuum level of 12 in. wg.

These revised operating conditions were reviewed during this 2016 IQRPE assessment. For a discussion of operating parameters, see Section 4.3.

- Inspection of refractory concrete should be considered in all annuli 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 (DSTAR 2006 Volume 1). See Section 4.2.4 for a discussion of refractory concrete. It is not possible to perform these inspections under the tanks. If a method for performing these inspections is developed, they are still recommended.
- Recommend tank dome elevation surveys be repeated every 2 years ±4 months in accordance with the operating procedures (OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks,* Table 1.6.1). No settlement of the DSTs was documented when these surveys were repeated.
- The dome loading monitoring program may be revised because RPP-RPT-25608, *Hanford Double-Shell Tank Thermal and Seismic Project – Increased Concentrated Load Analysis,* indicates that the tanks can withstand concentrated loads that may be greater than can be practically applied (2006 DSTAR Volume 1). The allowable dome loading monitoring program is still maintained. See Section 4.3.6 for discussion of dome loading.

## 4.2 CURRENT TANK INTEGRITY

### 4.2.1 Construction Extent of Condition Review for Tank Integrity

After tank AY-102 was found to be leaking in August 2012, all the DST farms were evaluated by reviewing original construction documentation and reported in the EOC review reports. Those reports are as follows:

- RPP-RPT-54817, *241-AY-101 Tank Construction Extent of Condition Review for Tank Integrity*
- RPP-RPT-54818, *241-AZ Tank Farm Construction Extent of Condition Review for Tank Integrity*
- RPP-RPT-54819, *241-SY Tank Farm Construction Extent of Condition Review for Tank Integrity*
- RPP-RPT-55981, *241-AW Tank Farm Construction Extent of Condition Review for Tank Integrity*
- RPP-RPT-55982, *241-AN Tank Farm Construction Extent of Condition Review for Tank Integrity*

- RPP-RPT-55983, *241-AP Tank Farm Construction Extent of Condition Review for Tank Integrity*.

The EOC reports evaluate the construction of the tank farms and compare them to the construction of tank AY-102 (RPP-ASMT-53793, *Tank 241-AY-102 Leak Assessment Report*).

The tank farms were constructed by three different contractors. Each of the contractors utilized different methods for shoring and constructing the DSTs. For the contractors that constructed each tank farm, see Table 4-1.

The tank farms were designed under the codes current for the time the tank was constructed. See Table 4-3 for the material requirements used for the construction of each DST farm. See Table 4-4 for the design standard used for each DST farm. Table 4-4 fulfills the DSTAR requirement for both the Federal and Washington State assessment requirements (40 CFR 265 Subpart J, 265.191(b)(1); WAC 173-303-640(2)(c)(i)).

**Table 4-3: DST Material Properties**

| | Primary And Secondary Tank Steel Material | Wall Concrete | Dome Concrete | Foundation Concrete | Reinforcing Steel | Refractory Material |
|---|---|---|---|---|---|---|
| **AY Tank Farm (Ref A)** | ASTM A515-65 | 3000 psi Type V | 3000 psi Type III | 3000 psi | A432 | Kaolite 2200LI |
| **AZ Tank Farm (Ref B)** | ASTM A515-69 Grade 60 | 3000 psi Type V | 3000 psi Type III | 3000 psi | ASTM 615 grade 60 | Kaolite 2000 |
| **SY Tank Farm (Ref C)** | ASTM 516-72 Grade 65 | 4500 psi Type II | 4500 psi Type III | 4500 psi Type II | ASTM 615 grade 60 | Lite Wate 50 |
| **Tank AW-101 (Ref D)** | ASTM A537-74a, Grade 65 | 5000 psi Type II | 5000 psi Type II | 4500 psi Type II | ASTM 615 grade 60 #3 ties Gr 40 | Lite Wate 50 w/ 1 segment enriched with Ciment Fondu |
| **Tank AW-102 (Ref D)** | ASTM A537-74a, Grade 65 | 5000 psi Type II | 5000 psi Type II | 4500 psi Type II | ASTM 615 grade 60 #3 ties Gr 40 | Lite Wate 50 enriched with Ciment Fondu |
| **Tank AW-103 through AW-106 (Ref D)** | ASTM A537-74a, Grade 65 | 5000 psi Type II | 5000 psi Type II | 4500 psi Type II | ASTM 615 grade 60 #3 ties Gr 40 | Lite Wate 70 |
| **AN Tank Farm (Ref E)** | ASTM A537-75, Class 1 | 5000 psi Type II | 5000 psi Type II | 4500 psi Type II | ASTM 615 grade 60 #3 ties Gr 40 | Lite Wate 70 |
| **AP Tank Farm (Ref F)** | ASTM A537-79, Class 1 | 5000 psi Type II | 5000 psi Type II | 4500 psi Type II | ASTM 615 grade 60 #3 ties Gr 40 | Litecrete 60M |

References:
A) RPP-RPT-54817, Rev 0
B) RPP-RPT-54818, Rev 0
C) RPP-RPT-54819, Rev 0
D) RPP-RPT-55981, Rev 0
E) RPP-RPT-55982, Rev 0
F) RPP-RPT-55983, Rev 0

**Table 4-4: Design Standards for Construction of DSTs**

| TANK FARM | HANFORD CONSTRUCTION SPECIFICATIONS | DESIGN CODE | | SEISMIC CRITERIA |
|---|---|---|---|---|
| | | PRELIMINARY LINER | SECONDARY LINER | |
| AY | HWS-7789 TO HWS-7791 | ASME | ASME | UBC-TID-7024 |
| AZ | HWS-8981 TO HWS-8982 | ASME SECTION III | ASME SECTION III | TID-7024 |
| SY | B-101-C1, C2 & C3 | ASME SECTION III | ASME SECTION III | TID-7024 |
| AW | B-120 C3, C4, C5 & D1 | ASME SECTION VIII DEV 2 | ASME SECTION VIII DEV 2 | SDC 4.1 TID-7024 |
| AN | B-130-C1, C3, C4 & D1 | ASME SECTION VIII DEV 2 | ASME SECTION VIII DEV 2 | SDC 4.1 TID-7024 |
| AP | B-340-C3, C4 & D1 | ASME SECTION VIII DEV 2 | ASME SECTION VIII DEV 2 | SDC 4.1 TID-7024 |

Reference: RPP-28538, Rev 5, Table 4-1

### 4.2.2 Concrete Foundation

All of the DSTs are supported by concrete foundations designed to distribute the loads uniformly to the soil below. The structural foundations contain slots, drain lines, and leak detection wells. Appendix I shows the configurations for the tank foundations.

The tanks in AY Tank Farm foundations were 88 ft, 6 in. in diameter, constructed of 3000 psi concrete (tank AY-101, RPP-RPT-54817). The diameter changed to 89 ft, 6 in. for the AZ, SY, AW, AN, and AP Tank Farms (AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983). As indicated in Table 4-3, the strength of foundation concrete increased from 3000 psi for tanks in the AY and AZ Tank Farms to 4500 psi for tanks in the remainder of the DST farms. The thicknesses of these foundation pads are diagramed in Appendix I.

### 4.2.3 Secondary Tank Base

The secondary (liner) tank base for AY Tank Farm had 1/4 in. thick steel for the entire tank base, knuckle, and walls (tank AY-101, RPP-RPT-54817; tank AY-102, RPP-ASMT-53793). Due to many construction issues with the lower knuckle of the AY Tank Farm tanks, the lower knuckle thickness increased to 1/2 in. for the AZ, SY, AW, and AN Tank Farm tanks and 9/16 in. for the AP Tank Farm tanks. The thickness of the secondary tank base was 3/8 in. for the AZ, SY, AW, AN, and AP Tank Farms (AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983), which was a 50% increase in the thickness.

The secondary tank bases were either (a) constructed on a tank foundation and raised to allow welding of the underside or (b) constructed on cribbing. All tank secondary bases were inspected on top and bottom prior to setting on their foundations. The non-destructive

examinations used during construction are listed in Table 4-5. All welds were accepted prior to pouring refractory concrete.

**Table 4-5: Secondary Tank Inspection**

| | Secondary Tank Inspections | Tank Farms | | | | | |
|---|---|---|---|---|---|---|---|
| | | AY | AZ | SY | AW | AN | AP |
| Tank Bottom | 100% Radiography | X | X | X | X | X | X[3] |
| | 100% Magnetic Particle | X | X | | | X | X |
| | 100% Liquid Penetrant | | | X | X | X | X |
| | 100% Visual | X | X | X | X | X | X |
| | Vacuum Leak Test | X | X | | | | |
| Bottom Knuckle | 100% Radiography | X | X | X | X | X | X[3] |
| | 100% Magnetic Particle | X | X | | | X | X |
| | 100% Liquid Penetrant | | | X | X | X | X |
| | 100% Visual | X | X | X | X | X | X |
| | Vacuum Leak Test | X | X | | | | |
| Vertical Wall | 100% Radiography | X[1] | X | X[2] | X | X | X[4] |
| | 100% Magnetic Particle | X | X | | | | |
| | 100% Visual | X | X | X | X | X | X |
| Upper Knuckle and Tank Dome | 100% Visual | X | X | X | X | X | X |

Notes

[1]Random spot radiography

[2]Radiography up to 324 inches above floor plates

[3]All butt welds

[4]All butt welds including the welds of the cylindrical shell upper knuckle

Bulges in the secondary tank bases were noted for all tank farms except AN and AP Tank Farms. Additional calculations were performed to justify the acceptance of these bulges. All these secondary tank bases were approved at the time of construction (AY Tank Farm, RPP-ASMT-53793; AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981).

### 4.2.4 Refractory

The refractory is the nominal 8 in. thick insulating layer of concrete between the primary tank base and the secondary tank base. The purpose of the refractory is to insulate the concrete foundation from the high temperatures required during the heat treatment of the primary tank. "The refractory pad also housed ventilation piping, thermocouple conduit, and air distribution slots. The air distribution slots allowed airflow to cool the primary tank bottom and to direct potential leaks to the tank annulus where leak detection instrumentation is installed" (RPP-ASMT-53793). See Table 4-3 for refractory material used in each of the tank farms.

The stiffener ring for the AY Tank Farm tanks were a 3/16 in. bent plate 6 1/2 in. tall with a 2 in. base (RPP-ASMT-53793). The remaining DST farms used a 7 in. × 3/4 in. steel stiffener ring (AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983).

The pattern used for air distribution slots varied in the DST farms (RPP-RPT 54818).

Some of the refractories were deeper than the 8 in. nominal depth to maintain at least 5 in. above the bulges in the secondary liner base. The refractory concrete was cured during the stress relief of the primary tank by raising the temperature inside the tank and holding it for a time noted in Appendix O.

Cold weather froze some of the refractory material in tanks AY-101, AZ-101, SY-101, and SY-102. A portion of the frozen material was removed and replaced. In addition, some of the refractory material got wet. Concern is that "the post stress relief of the tank would leave behind voids in the material following evaporation, reducing overall material strength" (tank AY-101, RPP-RPT-54817). Several DSTs had refractory repairs that were approved at time of construction. There has also been concern that if tank waste leaks into a refractory that is not totally cured, that the refractory may disintegrate.

"It is estimated that the primary tank could settle only up to 1 in. even in the hypothetical event of total bond loss within the insulating concrete pad due to immersion in tank waste" (tank AY-101, RPP-RPT-54817). If the primary tank were to settle 1 in., the structural adequacy of the tank would not be compromised.

During the time of DSTs construction, it was determined by tests or by certification by the refractory manufacturer that once the refractory was heat cured, there would be no compatibility issues with the contents of the waste in the DSTs. All of the refractories were accepted as cured at the time of construction.

### 4.2.5 Primary Tank Base

The primary tank base for the AY Tank Farms DSTs consists of a 1 in. thick by 4 ft. diameter center plate with 3/8 in. thick base plate welded to the 7/8 in. thick bottom knuckle (tank AY-101, RPP-RPT-54817). The AZ, SY, AW, and AN Tank Farms primary tank bases consist of a 1 in. thick by 4 ft. diameter center plate with 1/2 in. thick base plate welded to the 7/8 in. thick bottom knuckle (AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982). The AP Tank Farm primary tank bases consist of a 1 in. thick by 4 ft. diameter center plate with 1/2 in. thick base plate welded to the 7/8 in. transition plate that is welded to a 15/16 in. thick bottom knuckle (RPP-RPT-55983). The diameters of all the primary tanks are 75 ft. Each of the tanks used similar methods for construction of the primary tank base as was used for the secondary liner base.

All of the joints in the tanks are butt welded together (RPP-ASMT-53793). The welds were inspected per the inspection requirements shown in Table 4-6. Weld rejection rates for the tanks are found in Appendix K and are summarized in Table 4-7. As indicated in Table 4-7, although some of the tanks had better total weld rejection rates than AY-102, some of the tank weld rejections rates were comparable to those of tank AY-102.

Bulging of the tank bases was noted for tanks SY-101, SY-103, AN-102 and AP-104: "reworking welds created added distortions. It is likely that weld rejection and repair was a contributor to tank bottom bulging" (SY Tank Farm, RPP-RPT-54819). All primary tank bases were accepted as satisfactory prior to completing the tanks.

## Table 4-6: Primary Tank Inspections

| | Primary Tank Inspections | Tank Farms | | | | | |
|---|---|---|---|---|---|---|---|
| | | AY | AZ | SY | AW | AN | AP |
| Tank Bottom | 100% Radiography | X | X | X | X | X | X[2] |
| | 100% Magnetic Particle | X | X | X | X | X | X |
| | 100% Liquid Penetrant | | | X | X | X | X |
| | 100% Visual | X | X | X | X | X | X |
| | Hydrostatic Leak Test | X | X | X | X | X | X[1] |
| | Vacuum Leak Test | X | X | | | | |
| Bottom Knuckle | 100% Radiography | X | X | X | X | X | X[2] |
| | 100% Magnetic Particle | X | X | X | X | X | X |
| | 100% Liquid Penetrant | | | X | X | X | X |
| | 100% Visual | X | X | X | X | X | X |
| | Hydrostatic Leak Test | X | X | X | X | X | X[1] |
| | Vacuum Leak Test | X | X | | | | |
| Vertical Wall | 100% Radiography | X | X[3] | X[3] | X | X[4] | X |
| | 100% Magnetic Particle | X | X | X | X | X | X |
| | 100% Liquid Penetrant | | | | X | | |
| | 100% Visual | X | X | X | X | X | X |
| | Hydrostatic Leak Test | X | X[1] | X | X | X | X[1] |
| Upper Knuckle and Tank Dome | 100% Visual | X | X | X | X | X | X |
| | Hydrostatic Leak Test | X | X | X | | X | X[1] |

Notes

[1]See Table 8 for hydrostatic test heights

[2]All butt welds

[3]Radiography up to 422 inches

[4]Not including tank wall to upper knuckle

**Table 4-7: Tank Farm Primary Tank Bottom Weld Comparison**

| Tank | Total Weld Rejection Rate (%) | References |
|---|---|---|
| AY-101 | 10.2% | RPP-RPT-55982, Rev 0 Table 5-7, pg 5-4 |
| AY-102 | 33.8% | |
| AZ-101 | 14.5% | RPP-RPT-54818, Rev 0 Table 5-7,pg 5-2 |
| AZ-102 | 6.3% | |
| SY-101 | 30.1% | RPP-RPT-54818,Rev 0 Table 5-2,pg 5-2 |
| SY-102 | 22.0% | |
| SY-103 | 25.7% | |
| AW-101 | 30.0% | RPP-RPT-55981,Rev 0 Table 5-1,pg 5-1 |
| AW-102 | 31.0% | |
| AW-103 | 27.0% | RPP-RPT-55981,Rev 0 Table 5-2,pg 5-2 |
| AW-104 | 34.0% | |
| AW-105 | 31.0% | RPP-RPT-55981,Rev O Table 5-3,pg 5-2 |
| AW-106 | 24.0% | |
| AN-101 | 13.0% | RPP-RPT-55982, Rev 0 Table 5-2, pg 5-2 |
| AN-102 | 13.0% | |
| AN-103 | 9.0% | |
| AN-104 | 9.0% | |
| AN-105 | 15.0% | |
| AN-106 | 10.0% | |
| AN-107 | 20.0% | |
| AP-101 | 6.0% | RPP-RPT-55983, Rev 0 Table 5-2, pg 5-2 |
| AP-102 | 9.0% | |
| AP-103 | 10.0% | |
| AP-104 | 9.0% | |
| AP-105 | 12.0% | |
| AP-106 | 6.0% | |
| AP-107 | 7.0% | |
| AP-108 | 5.0% | |

### 4.2.6 Secondary Tank Walls

The secondary tank walls provide secondary DST containment. These tank walls also provide the interior form for the concrete shell surrounding the tank. In the completed state, the bottom knuckle is the only portion of the secondary tank wall that is not supported by concrete. Therefore, the only area that needs to be considered for the structural adequacy of the DSTs after the concrete has cured is the bottom knuckle. The load that this knuckle was designed to resist was for the primary tank wall to leak and fill the secondary containment tank. For tank AY-101, the specific gravity of the waste must be kept below 1.77. The design thickness for tank AY-101 is 1/4 in. with 60 mil loss in thickness for a total thickness of 0.19 in. For AP Tank Farm tanks with 460 in. of waste, the maximum specific gravity of the waste in the secondary containment tank is 1.83 (2006 DSTAR Volume 1). Apparent thinning of the secondary containment floor reported in RPP-RPT-58276, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-102 –*

*FY 2015,* does not pose a structural adequacy concern because these areas are supported by the concrete foundation.

The nominal thicknesses of the secondary tank walls are shown in Figure 4-3. As indicated, the plate thickness for the secondary liner of the AY Tank Farm tanks is 1/4 in. while all other tanks utilize 3/8 in. wall thickness.

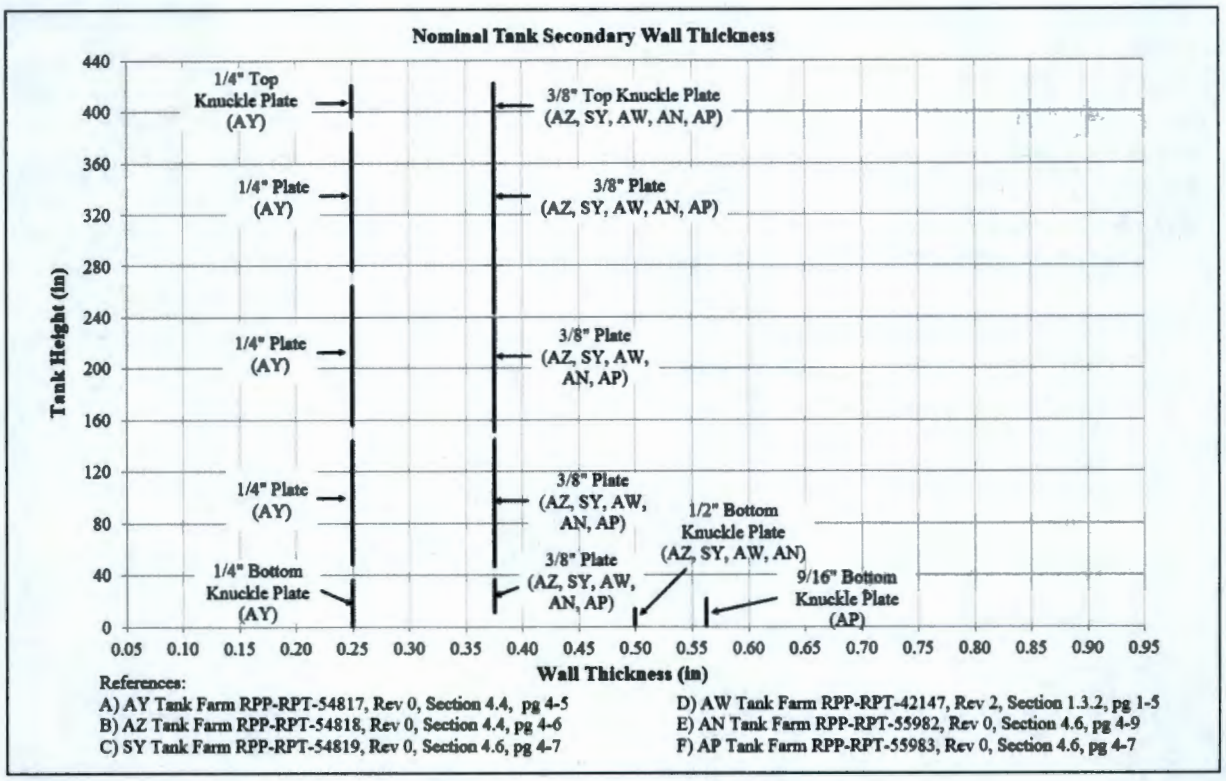


**Figure 4-3: DST Secondary Wall Nominal Thickness**

In all of the DSTs, the top knuckle of the secondary tank wall was not installed until tank heat treatment and hydrostatic testing was complete. The top of the top knuckle does not attach to the primary tank. A gap is maintained to allow movement between the two tanks. Flashing attached to the primary tank covers the gap to prevent the concrete dome material from entering the annulus (AY Tank Farm, RPP-ASMT-53793; AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983).

An evaluation of the bottom knuckle of the secondary liners was conducted and is summarized in RPP-ASMT-27936, *Evaluation of the Secondary Liner under Postulated Waste Leakage Scenario in a Double-Shell Tank Annulus*. That evaluation concludes that "the secondary liners of all six sets of DSTs will maintain their structural integrity, accounting for appropriate design input loads, in the event of a leakage from primary tank to secondary steel liner shell. As a result of this evaluation, there is no change to the design and operating conditions of DSTs, except for AY DSTs where the bulk waste specific gravity has been changed from 2.0 to 1.77 for operating conditions" ( pg. 11).

### 4.2.7 Primary Tank Walls

The thicknesses of the primary tank walls are shown in Figure 4-4. Also in the figure is a line representing the minimum primary tank wall thickness for structural adequacy. All of the other tank farms have thicker primary tank walls than tank AY-101. The complete set of figures showing primary tank wall thickness with current primary tank wall thickness is shown in Appendix L. The thickness of the primary tank walls are adequate to resist the design forces shown in Table 4-8 (RPP-RPT-28968, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis*). In addition, the waste temperature for operation is to be 350 °F for the first 20 years, then 160 °F for the next 40 years. A 60-year lifespan for the tanks was used in the structural analysis (RPP-RPT-28968). Note that the 422 in. (35 ft, 2 in.) design supernate height is higher than the actual operating supernate levels for most of the tanks. The AP Tank Farm was re-rated for a 460 in. (38 ft, 4 in.) supernate height (2006 DSTAR Volume 1).

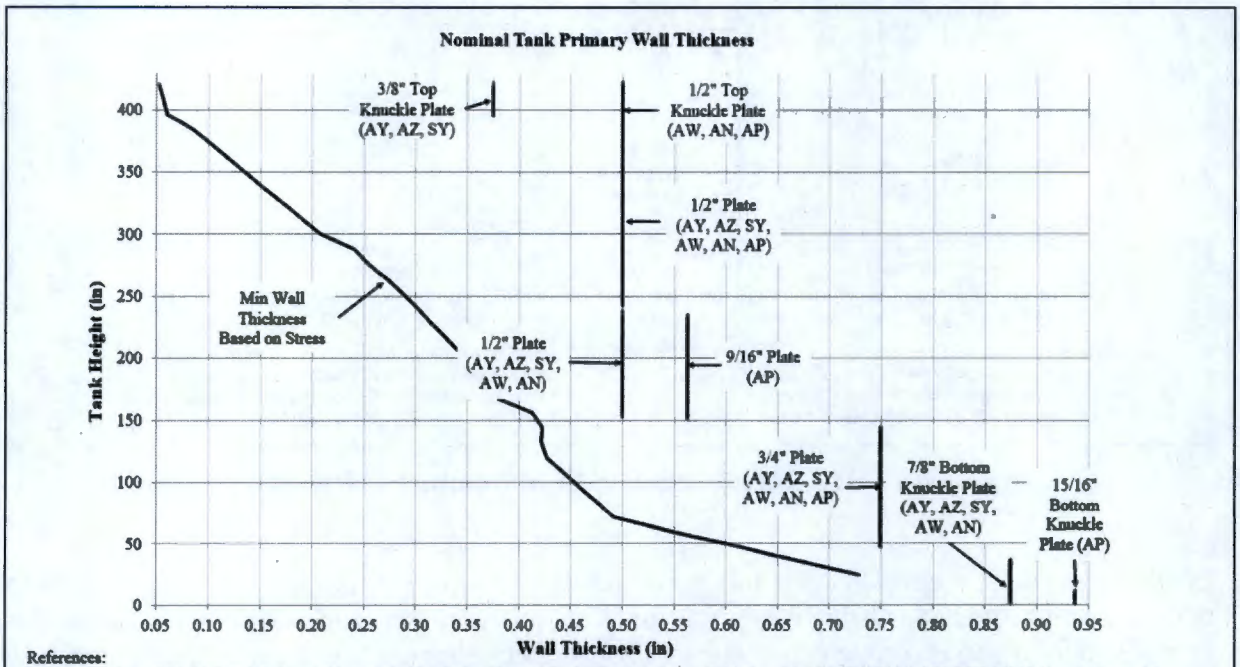


**Figure 4-4: DST Primary Wall Nominal Thickness**

**Table 4-8: Double-Shell Tank Load Conditions for Analysis**

| Design Load | Value | Notes |
|---|---|---|
| **Design Life** | > 50 years | A 60-year design life in used. |
| **Maximum Corrosion Rate** | 1 mill/yr | Atotal corrosion allowance of 0.060 inch is applied to the specified nominal thicknesses. |
| **Soil Cover** | 8.3 ft @ 125 lb/ft$^3$ | relative to dome apex |
| **Hydrostatic** | 422 inches @ 1.77 SpG | Tank Farms: AY, AZ, SY, AN, AW |
| | 460 inches @ 1.83 SpG | Tank Farm: AP |
| **Pressure** | -6 or -12 in. wg (water gauge) ≤ $P_{primary}$ ≤ +60 in. wg | Primary tank; -12 in w.g. applies to AP only |
| | -20 in. wg ≤ $P_{annulus}$ ≤ +60 in. wg | Annulus; -20 applies to AP; -6 for all others |
| | -6 in. wg ≤ $P_{primary}$ - $P_{annulus}$ | Tank Farms: AY, AZ, SY, AN, AW |
| | -12 in. wg ≤ $P_{primary}$ - $P_{annulus}$ | Tank Farm: AP |
| **Live Load** | 40 lb/ft$^2$ | Uniform |
| | 200,000 lb. nominal | Concetrated |
| **Thermal** | 350°F | Maximum bulk temperature of waste first 20 years |
| | 160°F | Maximum bulk temperature of waste after first 20 years |
| | 20°F/day | Waste maximum heatup/cooldown rate |
| | 1/yr | Cyclic rate |

Reference: RPP-RPT-28968, Rev 1, Page 53

### 4.2.8 Primary Steel Dome

The primary plate thickness used was 3/8 in. for the construction of the domes in all the DST farms (AY Tank Farm, RPP-RPT-54817; AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983).

All of the tank domes have penetrations for monitoring and equipment. Appendix N shows the penetrations in each dome. Some of the penetrations are directly into the primary tank and some are through the secondary top knuckle into the annulus. The primary tank penetrations were made and welded into place prior to stress relief of the tank except for tank AP-107, which had an additional 42 in. riser installed after the completion of the tank (AP Tank Farm, RPP-RPT-55983).

The primary steel dome provided the interior form for the concrete dome of the DSTs. Anchor bolts were used to attach the steel dome to the concrete dome. The primary steel dome is not required for the structural adequacy of a DST after the concrete dome is complete.

### 4.2.9 Primary Tank Stress Relieving

All of the primary DSTs were heat treated to provide stress relief for the primary DSTs. Heat treatment times and temperatures for each tank are shown in Appendix O. After the completion of the primary DSTs before the installation of the secondary top knuckle, the tanks were insulated and heated. The first stage of the heating was performed and held to allow the refractory to cure, then the tank was heated and held a prescribed length of time. The purpose of this heat treatment was to remove the residual stresses caused by welding the tank (AY Tank Farm, RPP-RPT-54817; AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819;

AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983).

"After stress relieving, it was noted…AW-101 exhibited reverse curvature and flat spots near the risers that were used for the stress relief burners" (AW Tank Farm, RPP-RPT-55981). Reverse curvature and flat spots were also observed in tanks AW-102, AW-103, and AW-104 although they were less than that of tank AW-101 (RPP-RPT-55981). "Four of the seven tanks in the AN Tank Farm exhibited areas of flat spots or reverse curvatures" (AN Tank Farm, RPP-RPT-55982). Tanks AP-103, AP-104, AP-105, and AP-107 all had domes that dropped 2 to 5 in. All of these were accepted as is or had additional anchor bolts added for concrete dome support (AP Tank Farm, RPP-RPT-55983).

All DSTs were accepted as meeting the stress relief of the primary tanks prior to completion.

### 4.2.10 Hydrostatic Testing

All of the tanks in the DST farms were hydrostatically tested prior to completing the concrete dome over the tanks. All tanks passed this test (AY Tank Farm, RPP-RPT-54817; AZ Tank Farm, RPP-RPT-54818; SY Tank Farm, RPP-RPT-54819; AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983). The heights used for the hydrostatic water tests are shown in Table 4-9.

**Table 4-9: Hydrostatic Water Test Height**

| Tank Farm | Depth of Hydrostatic Test | Reference |
|---|---|---|
| AY | 39 ft | RPP-RPT-54817, Rev 0, pg 4-10 |
| AZ | 39 ft | RPP-RPT-54818, Rev 0, pg 4-12 |
| SY | 39 ft | RPP-RPT-54819, Rev 0, pg 4-10 |
| AW | 35 ft | RPP-RPT-55981, Rev 0, pg 4-12 |
| AN | 35 ft | RPP-RPT-55982, Rev 0, pg 4-12 |
| AP | 40 ft | RPP-RPT-55983, Rev 0, pg 4-10 |

Water was utilized in the AW, AN, and AP Tank Farms tanks as part of the support for the domes during the concrete pours (AW Tank Farm, RPP-RPT-55981; AN Tank Farm, RPP-RPT-55982; AP Tank Farm, RPP-RPT-55983). See Section 11.2 for corrosion due to water in the tanks.

The DSTs were all accepted as watertight prior to completion.

### 4.2.11 Concrete Shell

The configuration of the concrete shell for each DST farm is shown in Appendix I. The concrete shell consisted of a reinforced nominally 18 in. wide wall section that utilized the secondary liner for the interior form and the reinforced concrete dome section that was attached to the primary tank dome with anchor bolts. The base of the concrete wall section was supported by a steel bearing plate on the concrete foundation (RPP-RPT-54817). The base of the wall had headed studs that attached to a steel slide plate that rested on the bearing plate. Sealant was used between the slide plate and the secondary liner. The concrete shell was designed to slide on the foundation as required by the expansion and contraction of the tank (RPP-RPT-55981).

The anchor bolts used to attach the concrete dome to the primary tank dome were evaluated as part of the 2006 DSTAR. These analyses used cracked concrete assumptions and are identical to the current code required anchor bolt designs. This report finds that the anchorage was acceptable by current design standards (RPP-RPT-28968).

## 4.3 CONFORMANCE WITH OPERATION REQUIREMENTS FOR DOUBLE-SHELL TANK STRUCTURAL ADEQUACY

The DST operating parameters are shown in Table 4-10. DST operations have been maintained below these limits except as discussed in the following sections.

**Table 4-10: Double-Shell Tank Operating Parameters Showing Supernate Level, Temperature, and Specific Gravity.**

| Tanks | Normal Operating Limit (inches) Ref A | Max Authorized Limit (inches) Ref A | Structural Limit (inches) Ref A | Max Hydrostatic Load (in wg) Ref B | Max Bulk Specific Gravity Ref B | Primary Tank Vacuum | | Annulus Vacuum | | Max Temp for Waste and Steel (°F) Ref E | Max Temp for Concrete (°F) Ref E |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Max Vacuum (in wg) Ref C | Min Vacuum (in wg) Ref C | Max Vacuum (in wg) Ref D | Min Vacuum (in wg) Ref D | | |
| 241-AY-101 thru 102 | 364 | 370 | 370 | 655 | 1.77 | - 6 (+6 vacuum) | 0 | - 20 (+20 vacuum) | 0 | 260 | Dome: 160 Wall: 350 |
| 241-AZ-101 thru 102 | 364 | 370 | 370 | 655 | 1.77 | - 6 (+6 vacuum) | 0 | - 6 (+6 vacuum) | 0 | 260 | Dome: 160 Wall: 350 |
| 241-SY-101 thru 102 | 416 | 422 | 422 | 717 | 1.7 | - 6 (+6 vacuum) | 0 | - 6 (+6 vacuum) | 0 | 250 | Dome: 160 Wall: 250 |
| 241-AW-101, 103 thru 106 | 416 | 422 | 422 | 717 | 1.7 | - 6 (+6 vacuum) | 0 | - 20 (+20 vacuum) | 0 | 350 | Dome: 160 Wall: 236 |
| 241-AW-102 | 409 | 422 | 422 | 717 | 1.7 | - 6 (+6 vacuum) | 0 | - 20 (+20 vacuum) | 0 | 350 | Dome: 160 Wall: 236 |
| AN-101 thru 107 | 416 | 422 | 422 | 717 | 1.7 | - 6 (+6 vacuum) | 0 | - 6 (+6 vacuum) | 0 | 350 | Dome: 160 Wall: 236 |
| 241-AP-102, 104, 106, 107 | 416 | 422 | 460 | 841 | 1.83 | - 8.7 (+8.7 vacuum) | 0 | - 20 (+20 vacuum) | 0 | 210 | Dome: 135 Wall: 236 |
| 241-AP-101, 103,105,108 | 454 | 458 | 460 | 841 | 1.83 | - 8.7 (+8.7 vacuum) | 0 | - 20 (+20 vacuum) | 0 | 210 | Dome: 135 Wall: 236 |

Reference:
A) OSD-T-151-00007, Rev 12, Table 1.1.1, Page 1
B) OSD-T-151-00007, Rev 12, Table 1.2.1, Page 8
C) OSD-T-151-00007, Rev 12, Table 1.3.1, Page 9
D) OSD-T-151-00007, Rev 12, Table 1.3.2, Page 10
E) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

### 4.3.1 Primary Tank Wall Thickness

The nominal and actual measured DST wall thicknesses are shown in Appendix L. The required wall thickness for structural adequacy is also shown. Minimum wall thicknesses of the primary tank due to stress are provided for the 422 in. tank waste height. Determine the minimum wall thicknesses of the primary tank due to stress for the 460 in. tank waste. This minimum required wall thickness will provide guidance for determination of the life span of the DSTs.

Verification of the structural adequacy of the primary tank walls is made by visual inspection and by UT measurement every 8 to 10 years.

#### 4.3.1.1 Ultrasonic Testing Inspections

A complete list of tanks inspected using UT is in Table 1 of RPP-RPT-58301, *Double-Shell Tank Ultrasonic Testing Summary*. That report also contains comprehensive summaries of all UT inspections.

As noted in Table 4-11, the reporting criteria for UT inspections were set at 50% of the Brookhaven National Laboratory (BNL-52527, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*) criteria:

- Wall thinning: >10% of nominal wall thickness
- Pit depth: >25% of nominal wall thickness
- Linear indication: >6 in. long and 0.1 in. deep.

**Table 4-11: Ultrasonic Testing Evaluation Guidelines and Reportable Values**

| Parameter | BNL-52527 Evaluation Levels | Double-Shell Tank Integrity Program Reportable Value |
|---|---|---|
| Thinning | 20 % plate thickness | 10 % plate thickness |
| Pitting | 50 % plate thickness | 25 % plate thickness |
| Cracking | >12-inch, 20% plate thickness<br><12-inch, 50% plate thickness | All detectable linear indications<br>> 6-inches and 10% plate thickness |

Reference: RPP-RPT-39149, Rev. 1.

The following lists the accuracy required in order to be approved as UT operators for this work:

- Wall thinning: ± 0.020 in.
- Pits, depth: ± 0.050 in.
- Linear, depth: ± 0.1in.
- Location, reportable indications: ± 1.0 in.

Nominally, all UT measurements provide results to the nearest 1 mil (0.001 in.). Demonstration tests on test plates were able to obtain a repeatability of measurements to ±5 mil (PNNL-19010, *Evaluation of Ultrasonic Measurement Variation in the Double-Shell Tank Integrity Project*). However, in demonstration tests on clean unused steel plate, the reproducibility was about 12 mil due to the irreproducibility of location, operator, software, and equipment error

(RPP-RPT-57127, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-106 – FY 2014*). A review of 13 DSTs that were examined twice suggests the error can be reduced to about 6 mil for average thicknesses while the minima have an error of 8 mil (RPP-RPT-46309, *Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks,* pg. 18; PNNL-19242, *Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks*). Nevertheless, a review of a recent UT summary document (RPP-RPT-58301) suggests an error of 10 to15 mil is not unreasonable in part because of the use of different risers can lead to an error of 10 to12 mil (with a compromise/consensus value of 10 mil) (PNNL-15182, *Riser Difference Uncertainty Methodology Based on Tank AY-101 Wall Thickness Measurements with Application to Tank AN-107*); even so the variability between plates outweighs that of the risers (RPP-RPT-46309; PNNL-19242).

As seen from the various UT reports (RPP-RPT-58301), thicknesses in the 2006-2013 period can be significantly different than in the pre-2006 data (RPP-RPT-46309; PNNL-19242). See Appendix L for average wall thickness of the tanks.

Further, tank/couplant temperature difference data are critical; if the couplant is too cool, thickness is underestimated (PNNL-19010, pg. iv); if the couplant temperature is less than the calibration block (test surface), the wall thickness can be underestimated by as much as 35 mil (PNNL-10910). Even if the tank/couplant temperature changes are within the specified 25 °F, the under/over estimation of wall thickness can be as great as ±14 mil (PNNL-19010). The temperature that was used for the calibration of the UT measurements appears to be the temperature of the liquid in the tanks. This is not the temperature of the primary wall steel. It is recommended that the temperature of the steel be taken at the same time and location of the UT measurements to provide more accurate wall thickness measurements.

The temperature used for determining the UT wall thicknesses was based on the interior waste temperature of the couplant. It is unclear what the temperature is of the couplant at the primary wall. The temperature of the steel inside the annulus is unclear. It should be determined if the steel temperature varies throughout the height of the tank. As the tanks approach the end of life for structural adequacy, the steel wall thickness measured by UT may or may not be affected by the variations in temperature. Therefore, temperature readings of the primary wall steel inside the annulus should be made in conjunction with the UT measurements to determine if this improves the accuracy of the UT measured wall thicknesses.

Despite being unable to predict the actual thinning of the tank walls at this time, the UT measurements provided do show that the double-shell primary wall thickness is satisfactory for structural adequacy of the DSTs.

### 4.3.2 Liquid Level

The liquid level of the DST System is maintained below the design tank liquid levels. See Appendix M for a historical summary of tank waste levels. The maximum operating waste levels for the tanks are included in that appendix. The structural adequacy liquid level used for tank analysis is 422 in. (RPP-RPT-28968). The AP Tank Farm was re-rated for a 460 in. liquid height (2006 DSTAR Volume 1; OSD-T-151-00007).

### 4.3.3 Temperature

The operating temperatures for supernate listed in the DST operating specification documents (OSD) show the maximum temperatures for waste and steel ranging from 210 °F for the AP Tank Farm to 350 °F for the AN and AW Tank Farms (OSD-T-151-00007). See Appendix P for a historical summary of tank temperatures. The waste in all DSTs, with exception of the AZ Tank Farm tanks, has been kept at or below 130 °F. The waste in tank AZ-101 had a 194.4 °F liquid temperature spike in October 2005. Since 2006, the liquid temperature in tanks AZ-101 and AZ-102 have generally been maintained below 160 °F. Tank AZ-102 waste exceeded 160 °F one time in late 2007; tank AZ-101 waste has exceeded 160 °F three times since 2006. In all cases, the liquid waste has been kept well below the 260 °F design limit (RPP-11801, *Analysis of Record Summary for Double-Shell Tanks*; OSD-T-151-00007). The temperature of the DST tanks has met the requirements of the operating conditions (OSD-T-151-00007) and has met the intention of the Thermal and Seismic Project design parameters (RPP-11801).

### 4.3.4 Specific Gravity

Each DST farm tank is rated for a design specific gravity of the waste based on the ability of the lower knuckle to support the waste. Table 4-8 lists the specific gravity design limits for each DST farm. Table 4-10 lists the specific gravity operating limits. The tank wastes have been kept within these design specifications. The rated specifications of specific gravity and liquid level of the waste fall within the allowable stress for the secondary tank lower knuckle for secondary containment of the waste (2006 DSTAR Volume 1; OSD-T-151-00007).

Therefore, there is no anticipated structural degradation of the tanks due to the specific gravity of the material stored within them. See Section 9.3.2 for a discussion on specific gravities of the tank waste.

### 4.3.5 Waste Compatibility

The waste is compatible with the materials of construction as summarized in Section 10.5. Section 10.5 addresses the Federal and Washington State requirements that the assessment must determine that the tank system has sufficient compatibility with the waste to be stored (40 CFR 265 Subpart J(b); WAC 173-303-640(2)(c)).

### 4.3.6 Dome Loading

The total concentrated allowable loads have been established and are documented in RPP-11801. The dome loading control is currently under the oversight of the Waste Storage Cognizant Engineer. Loading calculation requirements have been revised to allow a maximum of 10,000 lb of dome load in a 10 ft radius. (TFC-ENG-FACSUP-C-10, *Control of Dome Loading and SSC Load Control*). Historic dome loading including survey information for the DST farms is up to date. The procedures used and documented are adequate for the structural adequacy of the tank domes. No out of tolerance deflections or overloads were documented (RPP-20260, *241-AY Tank Farm Historic Dome Load Record Data*; RPP-20261, *241-AZ Tank Farm Historic Dome Load Record Data*; RPP-20262, *241-SY Tank Farm Historic Dome Load Record Data*; RPP-20259, *241-AW Tank Farm Historic Dome Load Record Data*; RPP-20257, *241-AN Tank Farm Historic Dome Load Record Data*; RPP-20258, *241-AP Tank Farm Historic Dome Load Record Data*).

## 4.4 PITS

Reinforced concrete pits were constructed as the top of the tanks were backfilled to provide access to some of the risers and equipment. Typical pit construction is shown in Figure 4-5. The locations of the pits are shown in Appendix N. The pits are listed in Table 7-1 with their date of construction and current age as of September 2015; this meets the requirements of WAC 173-303-640(2)(c)(iv) and 40 CFR 265 Subpart J4 to document the age of the DST System.

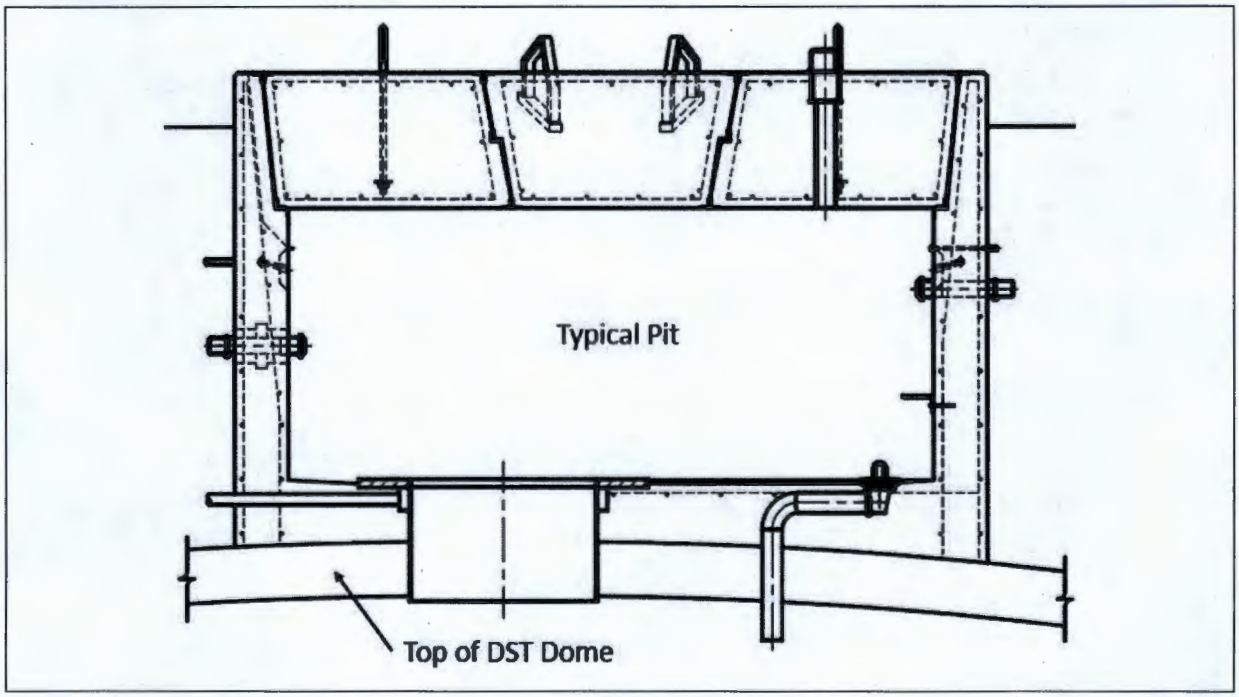


**Figure 4-5: Typical Pit Cross-Section**

The materials used in pit construction and design are documented in Appendix Q. The design of the tanks meet requirements for structural adequacy of the structures. The structural evaluations for pits in the SY and AP Tank Farms were not located (RPP-29539) for the 2006 DSTAR Volume 1, and have not been performed since the 2006 DSTAR. These pits were constructed after the AY pits. The materials used became stronger as each successive tank system was installed. For example, Appendix Q, Table Q-2 shows that the AY pump pit and AZ pump pit were constructed using 40,000 psi reinforcing and 3,000 psi concrete. The AW valve pit was constructed after the AY and AZ pits. It was constructed using 60,000 psi reinforcing and a combination of 3,000 psi and 4,000 psi concrete. Therefore, these pits constructed for the SY and AP Tank Farms meet or exceed the design for the AY pits. Therefore, the construction of the pits is acceptable for structural adequacy. This, along with the visual inspections of the cracks in the pits, meets the requirements of 40 CFR 265 Subpart J(b) and WAC 173-303-640(2)(c).

Per the coating inspection of the pits, the cracks were all nonexistent or structurally insignificant. Pit SY-02A was the only pit with a crack that was not repaired approximately 18 in. below the

lid lip. This crack was determined not to be a concern (RPP-RPT-25980, *Project W-314, SY-02A Pit Concrete Structure and Coating Independent Integrity Assessment Report*). No width or length was given in the report for this crack. All concrete cracks when under load and hairline cracks inside the pits are expected and acceptable. It is recommended that the future pit inspections made when the pits are recoated provide a numerical crack width and length in the documentation if significant. The crack width may be determined using a scale or by using a feeler gauge. Diagonal or horizontal cracks should be evaluated by a structural engineer to determine if the structural adequacy of the pit is in question or if the concrete is adequate. Diagonal cracks may indicate shear yielding in the pit wall. Horizontal cracks may indicate vertical steel yielding due to horizontal pressure on the exterior of the pit.

The pits and their coatings are compatible with the waste per Section 7.0 and Section 10.0, as required by 40 CFR 265 Subpart J(b) and WAC 173-303-640(2)(c).

The pits are adequately designed and have sufficient structural strength to ensure that they will not collapse, rupture, or fail as required by 40 CFR 265 Subpart J(b) and WAC 173-303-640(2)(c).

## 4.5 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

- 2006 DSTAR Item R5: An effort is currently underway to model DST loading. This effort should be carried through to include dome deflection studies such that a basis can be provided for dome deflection survey allowable dome deflections which would then be translated into allowable riser deflections. The effort should also be carried through to determine failure loads for the DSTs, including both uniform and concentrated.
    - 2016 DSTAR: Load analysis is completed.
- 2006 DSTAR Item R6: Dome Load Calculations clarified which loads are considered computations.
    - 2016 DSTAR: This has been clarified.
- 2006 DSTAR Item R7: Dome Load procedures and schedule for assessment.
    - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R8: The Tank Farm Contractor should consider centralizing dome load and dome deflection responsibility under one engineer. This engineer would track and maintain an independent database of dome deflections, correlated with loads, and serve as a central point of contact (POC) for operations resolution of DLL and DLRSS issues.
    - 2016 DSTAR: This has been completed. Dome elevation measurements to continue per R16-7.
- 2006 DSTAR Item R9: Develop model for maximum waste load height in secondary containment.
    - 2016 DSTAR: This has been completed.

- 2006 DSTAR Item R13: Secondary Liner analysis for ability to contain waste.
  - 2016 DSTAR: This has been completed for structural integrity.
- 2006 DSTAR Item R16: Visual and UT inspections.
  - 2016 DSTAR: The initial comparison of visual inspections has been completed, but UT and Visual Inspections are on-going and should continue per R16-3, R16-5, and R16-8.
- 2006 DSTAR Item R17: UT inspections of the primary tank walls in conjunction with visual inspections.
  - 2016 DSTAR: UT inspections are ongoing and should continue per R16-5.
- 2006 DSTAR Item R19: Design Life differences between AY and AZ tank farms.
  - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R50: Refractory Concrete Analysis.
  - 2016 DSTAR: This has been completed but is actually an ongoing activity. R16-3 recommends visual inspections of the refractory concrete.
- 2006 DSTAR Item R51: UT Examination of AY Tanks.
  - 2016 DSTAR: UT examinations have been done and R16-5 recommends frequency for continued UT examinations.
- 2006 DSTAR Item R52: UT examination of the secondary liner lower wall and lower knuckle.
  - 2016 DSTAR: UT examinations have been done and R16-5 recommends frequency for continued UT examinations.
- 2006 DSTAR Item R53: UT examination of the primary tank plate #1 on SY-101.
  - 2016 DSTAR: UT examinations have been done and R16-5 recommends frequency for continued UT examinations.
- 2006 DSTAR Item R55: Repeat of DST IQRPE integrity assessment.
  - 2016 DSTAR: This 2016 DSTAR is in response to this 2006 recommendation. Additionally, R16-1 recommends frequency for next DSTAR assessment.
- 2006 DSTAR Item R56: Allowable wall thinning determination.
  - 2016 DSTAR: This has been completed. Additionally, R16-5 recommends frequency for continued UT examinations.
- 2006 DSTAR Item R57: Evaluation of Plate #1 wall thinning on SY-101.
  - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R59: Tank settlement surveys.
  - 2016 DSTAR: This has been completed. R16-7 recommends frequency for continued tank dome elevation surveys.

- 2006 DSTAR Item R60: Visual inspection of primary AZ-101 and AZ-102 tanks.
  - 2016 DSTAR: This has been completed. Visual Inspections to continue per R16-3, and R16-8.
- 2006 DSTAR Item R60.1: Thermal and operating loads analysis (TOLA) revision.
  - 2016 DSTAR: This has been completed. Additionally, R16-9 recommends using actual tank data to determine new expected life for the DST's.
- 2006 DSTAR Item R63: Structural Evaluations of SY and AP pits.
  - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R66: UT inspections of tanks.
  - 2016 DSTAR: This has been completed, but is an ongoing activity. R16-5 recommends frequency for continued UT examinations.
- 2006 DSTAR R69: Three Dimensional Video inspections.
  - 2016 DSTAR: UT examinations provide much more valuable data, so three dimensional video inspections are not needed as long as UT examinations are continued.
- 2006 DSTAR Item R70: Video inspections.
  - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R71: Video inspections.
  - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R72: Video inspections.
  - 2016 DSTAR: This has been completed. Furthermore, R16-8 recommends the frequency of additional Visual Examinations and coordination with UT measurements.
- 2006 DSTAR Item R73: Video inspections by qualified personnel.
  - 2016 DSTAR: This has been completed.
- 2006 DSTAR Item R74: Video inspections preservations.
  - 2016 DSTAR: This has been completed.

## 4.6 IQRPE SUMMARY DISCUSSION OF 2016 DST PIPELINE INTEGRITY ASSESSMENT

### 4.6.1 Findings

There are no findings related to the structural adequacy for the DST System.

### 4.6.2 Observations

- Evaluations performed for the 2006 DSTAR meet the current design requirement for the structural adequacy of the DST System.

- To reassess the DST's life expectancy in 2025, the DST thermal and seismic study (RPP-RPT-28968, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis)* should be reviewed thoroughly. That study assumed corrosion rates and thermal cycles that probably exceed actual conditions. Based on the current shell wall thicknesses measured by UT and the limited number and extent of temperature variations, it is anticipated that this reassessment of life expectancy could be as simple as comparing the input and assumptions of that original report to the latest wall thicknesses available in 2025. This type of comparison would not necessitate the recalculation of that entire study. Of course, if the inputs and assumptions are not within the parameters of that original study, a more in depth analysis might be necessary to determine the current life expectancy of the DSTs.
- No new structural analyses of the DSTs are required for this 2016 DSTAR.
- The review of the tank farms EOC indicates that, in general, the construction of the remaining fit for use DSTs was better than that of tank AY-102. The weld rejection rates on the primary and secondary tank bases are a concern. These welds were all deemed acceptable at the time of construction.
- The refractories were deemed compatible with the waste in the DSTs at the time of construction.
- The secondary lower haunch is the only portion of the secondary tank that needs to be considered in tank structural adequacy, since the exterior concrete shell is poured.
- All tanks were accepted as meeting the stress relief of the primary tanks prior to completion of the DSTs.
- The anchorage of the primary dome to the concrete dome meets the current anchorage requirements for cracked concrete sections.
- The primary and secondary tanks are structurally adequate.
- The pits are structurally adequate.
- Continue existing Dome Loading Monitoring Program.
- The procedures for structural assessments after a seismic event are outlined in TF-ERP-008, *Emergency Response Procedure 008 Seismic Event Response,* and TFC-ENG-DESIGN C-30, *Post-Natural Phenomenon Hazard Assessment.*

### 4.6.3 Recommendations

- Based on current structural adequacy and no evidence of significant corrosion, a 10-year interval for the next DSTAR is appropriate. (Summarized in recommendation R16-1 in Section 3.3.3.)
- Develop means to measure thickness and provide thickness measurements of the primary DST bases. (Summarized in recommendation R16-4 in Section 3.3.3.)

- UT measurements of the primary DST and the secondary liner lower knuckle should be conducted at least every 8 to 10 years. (Summarized in recommendation R16-5 in Section 3.3.3.)
- As UT measurement processes evolve, both old and new methods should be compared on the same systems to assist in interpreting results. (Summarized in recommendation R16-6 in Section 3.3.3.)
- Tank dome elevation surveys should be repeated utilizing the current schedule. (Summarized in recommendation R16-7 in Section 3.3.3.)
- Visual inspections of the refractory and primary DST base should be conducted. (Summarized in recommendation R16-3 in Section 3.3.3.)
- Visual inspections of the DST annuluses should be conducted at least every 8 to 10 years preceding UT and can help direct where UT measurements are taken. (Summarized in recommendation R16-8 in Section 3.3.3.)
- The life expectancy of the DST's should be reassessed by 2025. The life expectancy developed in the existing thermal and seismic study (RPP-RPT-28968, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis)* was 60 years. In 2025, tank AY-101 will be 53 years old, which is 7 years from its current life expectancy. By completing the assessment by 2025, the information would be available for the 2026 DSTAR. (Summarized in recommendation R16-9 in Section 3.3.3.)
- In conjunction with previous recommendation, additional assessment should be performed to determine the minimum wall thicknesses of the AP Tank Farm. This analysis should include the effects of the yield strength of the plate material due to heat up times and the 460 in. tank waste level. (Summarized in recommendation R16-10 in Section 3.3.3.)
- Determine the steel annulus temperature in conjunction with the time and location of the UT measurements. Determine if these temperature measurements provide better accuracy for the UT thicknesses determined. (Summarized in recommendation R16-12 in Section 3.3.3.)
- When pit coating inspections are conducted, record the numerical crack width and length. In addition, provide photographs with legible scale to show the size of the cracks. Significant cracks should be evaluated by a structural engineer to determine the structural adequacy of the pit. (Summarized in recommendation R16-18 in Section 3.3.3.)

### 4.6.4 Conclusions

- In regards to structural adequacy of the DSTs and DST pits, the DST System is fit for use as listed in Appendix D.
- The DSTs and pits are adequately designed and have sufficient structural strength that they will not collapse, rupture, or fail.
- Tank designs provide structural adequacy until 60 year tank life with respect to design adequacy and structural strength.

- Operating parameter limits are properly maintained.
- The DST Dome Loading Program is adequate and proper controls are implemented. The Dome Loading Program is now under control of one authority.
- Pits for DST farms meet or exceed the pit design requirements for the AY Tank Farm. Therefore, all pits are structurally adequate because no structurally significant cracks were noted during the coating replacements.

# 5.0 DOUBLE-SHELL TANK WASTE TRANSFER SYSTEM INTEGRITY

## Introduction/Purpose

The transfer lines and encasements for the Hanford Site DSTs and ancillary equipment are considered a treatment, storage, and/or disposal unit under regulations stemming from RCRA. Both 40 CFR 265 and WAC 173-303-640 regulate the configuration and operation of these facilities. The DST System pipelines in these subsystems have been categorized as RCRA-compliant, non-RCRA-compliant, and other. A general overview of the WTS is shown in Figure 5-1. The figure shows both single-shell tank farms, which are not in scope, and double-shell tank farms. A more detailed layout of interconnecting piping systems can be found in Appendix R. General information on the WTS is contained in Appendix S.

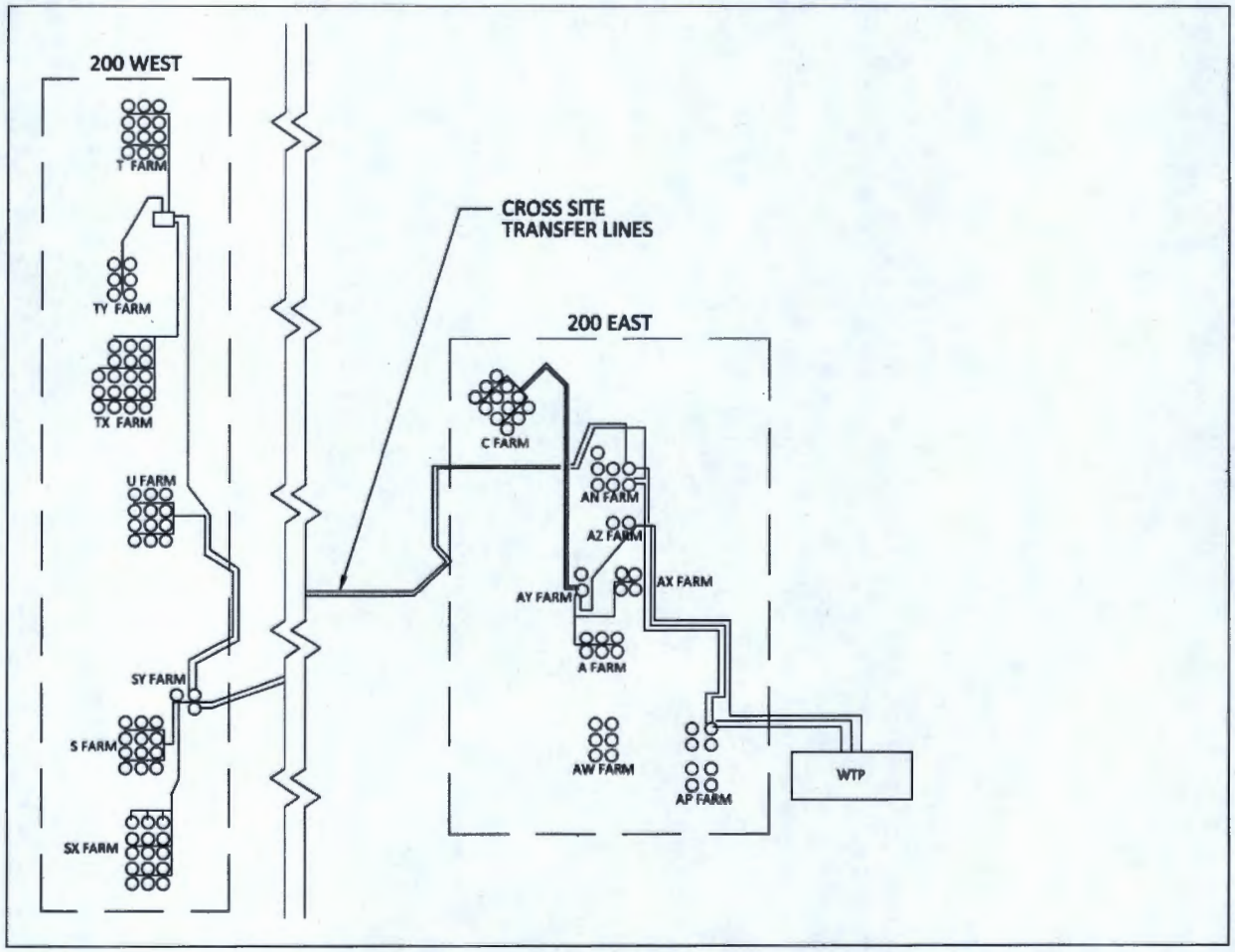


**Figure 5-1: Waste Transfer System Overview**

The DST WTS is comprised of the pipes and components that interconnect the DSTs for the purpose of transferring waste. The DST System is broken down into three subsystems:

- 200 East Area DST WTS
- 200 West Area DST WTS
- Cross-site transfer system between the 200 East and 200 West Area tank farms.

The purpose of this chapter is to provide a review of the WTS within the DST System. The WTS includes piping, jumpers, and ancillary equipment (e.g., valves, pumps) used to transfer waste between tanks and eventually transfer waste to the WTP. The DST WTS is used to transfer product to and from the tanks and is regulated by state and federal statutes. Incorporation of recommendations provided in the 2006 DSTAR is also reviewed.

**Scope/Requirements**
40 CFR 265 Subpart J and WAC 173-303-640 require that "the owner or operator must determine that the tank system is not leaking or is unfit for use." The DST System pipeline integrity assessment is to determine if DST System pipelines are fit for use and will not collapse, rupture, or fail under normal operating conditions. Also, the assessment is to determine if the system is adequately designed and if adequate leak testing is being performed. Non-RCRA-compliant lines are outside of the scope of this assessment.

**Method of Assessment**
Assessment of the WTS was completed by reviewing available documentation concerning past and current provisions for the fit for use program, failures in the piping system since the 2006 DSTAR, and the leak test program and results. The information gathered was reviewed in the context of meeting established criteria for the fit for use designation and to determine if the operating strategies support this requirement. The piping system design standards and leak testing programs were also reviewed.

## 5.1 SUMMARY OF 2006 DSTAR PIPELINE INTEGRITY REPORT

### 5.1.1 Waste Transfer Line Integrity

The 2006 DSTAR Volume 2 reviews the design standards, hazardous waste compatibility, existing corrosion protection measures, past pipeline integrity assessments, and results of leak tests, internal inspections, and examinations necessary to support the integrity assessment. That pipeline integrity assessment concludes the following:

- Appropriate industry standards and codes (at the time of construction) were used for the DST System pipeline installation, fabrication, inspection, and testing.
- Material selections (e.g., piping, fittings, valves, flanges, gaskets, thread sealant, coatings) of the original design were appropriate for their use.
- Design standards used for specifying fabrication, installation, examination and testing requirements were consistently and appropriately used for the DST System pipelines within the scope of the assessment and were adequate for their intended purpose.
- Existing corrosion protection measures (e.g., an active cathodic protection system, exterior protective coatings, control of waste chemical composition, waste temperature control, waste transfer line flushing requirements) are suitable corrosion protection

measures implemented as a result of recommendations from previous corrosion studies, pipeline failure analyses, and integrity assessments.

- The buried pipe analysis for the DST System (RPP-18652, *Buried Pipe Analysis for DST System Integrity Assessment*) maintains the conclusions relevant to the structural integrity of the DST System pipelines due to soil pressure and surcharge loads on the WTS pipelines.
- Recorded DST System failures are limited to only a few. The failure mechanisms from DSTs and SSTs are categorized into four groups: (1) stray currents, (2) poorly designed heat trace system, (3) erosion-accelerated corrosion, and (4) other. The stray currents were addressed with the redesign of a new cathodic protection system in 1980. The poorly designed heat trace system was limited to S Tank Farm; SX Tank Farm; portions of the U, A, and AX Tank Farms; and all SST systems. The DST farms heat trace system designs are either significantly different or non-existent. Erosion accelerated corrosion failures may be an issue over the life of the mission. However, erosion-accelerated corrosion failures within the life of the mission are not expected with (a) the frequency and duration of future waste transfers estimated to be very low, (b) abrasiveness of the tank waste considered to be low, (c) results of inspections revealing very little erosion-accelerated corrosion to date, and (d) ERUL calculations revealing nearly all pipelines analyzed will maintain sufficient wall thickness.
- There is an identified low spot in transfer line SL-167 at cleanout box AW-COB-6. This line has shown signs of corrosion product on the exterior of the 2 in. primary pipe due to standing uninhibited water. Although line SL-167 has been declared fit for use (7G110-05-003), there is still a potential for continued corrosion.
- Results of active waste transfer line inspections and encasement testing revealed little to no indication of corrosion and no encasement leaks to date.
- The oldest pipelines were in service for approximately 38 years at the time of the 2006 DSTAR.
- ERUL results indicated that all DST System pipelines will reach the 2028 milestone with enough remaining wall thickness to support internal pressure. Exceptions are DR-504, SNL-5350, and SNL-5351, in which ERUL calculations were not performed. (Note: DR-504 is not included in the scope of this 2016 DSTAR.)
- Based on a lack of empirical test data developed to established relevant corrosion/erosion allowances or rates for DST System waste transfer lines, or relevant data points established from failed/corroded/eroded pipeline analyses, ERUL determination is an estimate only, and should not be used to make programmatic decisions for maintenance to or replacement of DST System waste transfer lines.
- HIHTLs are considered fit for use provided their design, testing, and installation is overseen by an IQRPE under WAC-173-303-640(3).

The 2006 DSTAR Volume 2 contains 10 observations and 7 recommendations. No findings are reported.

### 5.1.2 Waste Transfer Line Encasement Integrity

The 2006 DSTAR Volume 5 reviewed the buried DST System waste transfer lines that were constructed of ASTM A53 or ASTM A106 carbon steel. Fiberglass reinforced plastic is not susceptible to corrosion and was therefore not addressed by the report. Due to the expense of pneumatic testing of the encasements, alternative methods of evaluation were researched and evaluated. The waste transfer line encasement integrity technology study investigated several alternative methods for determining the rate of corrosion in the piping system. These methods included external corrosion direct assessment, direct current voltage gradient (DCVG), and close-interval potential survey (CIPS) techniques. Due to the configuration and construction of the pipeline system in the DST WTS, it was determined that the only technique that would give accurate results was the external corrosion direct assessment method. Thus far, seven lines (SL-509/510, SN-609/610, PW-4531, and SN-285/286) have been evaluated with this method.

Additionally, DST waste transfer line encasements were protected from corrosion via corrosion protection measures such as cathodic protection and exterior protective coatings. DST waste transfer line encasements also had a very low failure rate and, most importantly, present a low risk to workers and the public if failure did occur (buried encasements will leak to the soil). Therefore, an external corrosion direct assessment program for the DST System waste transfer line encasements was not warranted.

Per the IQRPE's recommendation, all encasements within the scope of this document were to be pneumatically leak tested. In 2008, leak testing was underway, and was scheduled for completion by the end of that year. Leak testing was the only method of verifying encasement structural integrity. Furthermore, the recommendation states that, considering the historical record of waste transfer line encasement failures, future leak testing may not be necessary if proper indirect DCVG and CIPSs reveal an encasement had no coating faults and is being effectively protected by the cathodic protection system, and follow-up DCVG and CIPSs are performed at scheduled intervals for continued monitoring of the cathodic protection system effectiveness and integrity of the exterior protective coatings.

The 2006 DSTAR Volume 5 contains two observations and eight recommendations. No findings are reported.

### 5.1.3 Disposition of Recommendations

All of the recommendations from the DSTAR 2006 Volume 2 and Volume 5 were responded to and statused as complete in the 2006 DST Integrity Assessment Recommendation Disposition (RPP-RPT-50440).

## 5.2 REVIEW OF PIPING, EQUIPMENT, AND TEST ABNORMAL CONDITIONS AND ABNORMAL CONDITIONS IDENTIFIED AFTER 2006 DSTAR

Several equipment and piping abnormal conditions have been discovered since the 2006 DSTAR. The abnormal condition types associated with the integrity of the DST WTS are listed in Table 5-1.

**Table 5-1: Piping Abnormal Conditions**

| Equipment Type | Abnormal Conditions |
|---|---|
| Jumpers | Leakage from jumper connections (identified during jumper leak test activities or based on evidence of waste residue identified during post transfer pit inspections), leakage from valve stem packing during transfer and valve alignment activities, leakage from anti-siphon hoses, leakage from jumper/valve during transfer. |
| Primary Piping | Low point identified on transfer line SL-167. Line SL-167 subjected to pressure transients during in-service leak test. Piping sections had design pressure below the maximum discharge pressure, transfer line SL-164 integrity determined to have failed during pneumatic test performed on encasement pipe. |
| Encasements | Presence of standing liquid, drain valve stuck in position that did not support waste transfer operations and could not be repositioned. |

The majority of the abnormal conditions were discovered in leak checks or pre-waste transfer activities, indicating the maintenance and operating processes in place are satisfactory. Equipment abnormal conditions were corrected by proper evaluation and correction of adverse conditions or replacement of failed equipment prior to waste transfer activities. When followed, the processes provide for safe operation of the WTS. A discussion of a portion of these abnormal conditions is included in the following sections.

### 5.2.1 Jumpers

#### 5.2.1.1 Manometer Effect in Transfer Lines

During a jumper repair activity, standing water was discovered in the lines at pit AP-08A. Flush water was discovered in the AP-08A slurry distributor nozzle and pump discharge nozzle. The tank contains high density liquid and is being maintained at a high operational level. When the system is flushed with water, a manometer effect is created and the low density flush water is unable to drain from the system. This leaves portions of the WTS full of fluid that could freeze and cause damage.

#### 5.2.1.2 Nozzle U12 in AZ-01A Failed Leak Check

On March 24, 2014, a leak check was performed on pits AZ-01A and AZ-02A. During the leak check, a leak was identified at nozzle U12 in pit AZ-01A when a valve was closed to place the system under service water pressure. After the 15-minute hold time was completed for the leak check of several nozzles, water was diverted to tank AZ-101 through nozzle A to complete a free flow leak check. Raw water continued to flow through nozzle U12 during the free flow leak check of nozzle A. During the check of nozzle A, the video camera was redirected to nozzle U12 and it was observed the leak had stopped. The remainder of the leak check activities were terminated after nozzle A was leak checked.

#### 5.2.1.3 Waste Discovered on Floor of Valve Pit AW0A during Leak Check of Jumper Connections

A leak check of select nozzles in valve pit AW-A was performed on January 23, 2014. At that time, residue was discovered on the floor of the pit under nozzle L-2. The last waste transferred through the pit was in 2005 and the residue was not present when the jumpers in the pit were removed in 2010. Nozzle L-2 was connected to an isolated non-compliant system. An investigative survey was performed to determine if the residue was waste, and an additional video was taken showing the presence of crystalized waste residue on nozzle L-2 and the back side of the isolation blank. Line SN-220 was part of a waste transfer route that contained jumpers at the low point of the route that prevented the system from draining (lines SN-264 and SN-274 are part of this route). The jumper connected to line SN-220 was removed in 2010 to isolate the non-compliant system from the active WTS. The jumper and line were allowed to drain at that time, prior to placing the isolation blank on nozzle L-2. The residual material in line SN-220 is expected to be liquid that did not completely drain when the jumper was removed in 2010. This issue is documented in problem evaluation request (PER) WRPS-PER-2014-0156.

#### 5.2.1.4 Leak from Jumper AN06A-WT-J-(2-(4))

Video inspection of pump pit AN-06A was performed May 30, 2013 to investigate the cause of several leak detector alarms received during retrieval/closure waste transfer operations. During the video inspection, jumper AN06A-WT-J-(2-(4)) was identified as an area of concern. The pump mechanical adapter plate assembly contained a white powder on the plate near the 1/2 in. anti-siphon hose connection. When the pump in pit AN-06A was restarted, a leak was immediately identified originating from the 1/2 in. anti-siphon hose.

#### 5.2.1.5 Improper fit-up on Jumper AW02E-WT-J-(3-D)

During the review of the installation of jumper AW02-WT-J-(3-D), it was noted the connecting jumper AW02E-WT-J-(B-(3)-PUMP) showed signs of improper fit-up. It was determined that nozzle locations did not match the as-built dimensions on the drawings. During the installation, the nozzle was contaminated and could not be released for modifications. As a result, the jumper was disposed of and spare jumper AW02E-WT-J-(3-D) had to be modified for installation.

#### 5.2.1.6 Improper Fit-Up on Jumper AWVPB-WT-J-(R1-R3-C)

During jumper removal attempts to support the transfer line SL-167 hydrostatic pressure test, it was noted that jumper AWVPB-WT-J-(R1-R3-C) required significant effort to remove. A laser scan of the jumper was performed. It was determined that the nozzle as-built dimensions and the current dimensions of the jumper did not match and created fit-up issues. The jumper was evaluated for potential stresses it would be subjected to while installed and it was determined that the jumper would exceed code allowable stress by a significant margin and therefore required replacement.

#### 5.2.1.7 AP Valve Pit Nozzle M Failed Leak Check

Three jumpers were removed to install a spacer on nozzle 13. The jumpers were then reinstalled with a successful leak test on nozzle 13. Nozzle M did leak, however, requiring investigation and another leak check.

#### 5.2.1.8 AN-01A Nozzle A Failed Leak Check

On October 31, 2012, a leak check was performed on jumper AN01A-WT-J-(A-G-4-(12)) in pump pit AN-01A to qualify a new blind flange. A leak was identified on the plutonium-uranium extraction (PUREX) process connection of the jumper to pit AN-01A nozzle A. The PUREX connector was eventually tightened to 600 ft-lb and the connection passed the leak check on November 5, 2012. It was suspected that the leak was a result of the connector not seating properly, most likely due to a vertical misalignment between nozzles A and G. This could have caused additional stresses to the jumper resulting from deformation of the pipe between the joints. Technical evaluation RPP-TE-53995 was issued about this condition.

### 5.2.2 Primary Piping

#### 5.2.2.1 Transfer Line SL-164 Failed Pneumatic Test

The encasement for transfer line SL-164 failed a pneumatic test. Initially, it was thought the failure was caused by the presence of epoxy paint on the sealing surface of the encasement drain PUREX nozzle. Attempts to remove the epoxy from the sealing surface were unsuccessful. Several attempts were made during May and June of 2014 to fix the suspected leakage; all attempts were unsuccessful. On June 30, 2014, during the performance of an additional pneumatic test of the encasement pipe for line SL-164, it was determined that the primary pipe integrity was compromised. This was determined by installing a modified isolation blank/vapor seal on the nozzle. A bag was installed on a fitting connected to the isolation blank. When air pressure was applied to the encasement pipe, the bag inflated showing that the primary pipe was compromised. Subsequently, transfer line SL-164 was removed from the active line list.

A follow-up construction review (RPP-RPT-58233, *Slurry Line SL-164 Construction Review*) was conducted to investigate construction issues or events that may have contributed to the slurry line failure. The report concludes that line SL-164 was constructed and tested in accordance with applicable construction specifications and was acceptable upon completion of construction. Further investigation was conducted to determine if there was any grading disturbance caused by the installation of other lines close to the existing line SL-164. The analysis did not support a disturbance to line SL-164 grading. TFC-ENG-STD-22, *Piping, Jumpers, and Valves* requires a minimum slope of 0.25% on new lines from the high point to the low point. RPP-RPT-58233 indicates that the minimum slope on any segment of the slurry line SL-164 is 0.4%. The installed line meets or exceeds the design minimum slope requirements.

Transfer line SL-164 was designed, constructed, and tested per industry standard codes and specification current at the time of construction. All welds on the primary piping underwent both visual examination per Section 4.2 of HPS-220-W, *Welding Carbon Steels*, and radiographic examination per the *Boiler and Pressure Vessel Code* (ASME BPVC [2013]), Section VIII, Division 2, Article I-5. Hydrostatic testing was performed at the time of construction to ASME B31.1, *Power Piping,* standards and construction specification B-120-C7. Without further investigation into the location and mode of the failure in the primary piping, it is impossible to determine the cause.

#### 5.2.2.2 Transfer Lines SN-264 and SN-274 Full of Liquid

During jumper installation efforts in valve pit AW-B, liquid was discovered in a jumper connected to transfer line SN-264. After a review of the system and associated waste transfer

history, it was determined the existing system could not be drained based on field configuration. Both of these lines were dedicated to supporting waste transfers from the 204-AR Facility. The last transfer of waste to the DST System was in 2005. Both lines run from a high point at AW-B to pump pit AW-04A (low point of the lines). There is no near term use for these lines. However, both lines were deferred use components and are not certified to contain liquid. Engineering recommended that the flexible metal jumper connected to nozzles A and L in pit AW-04A be removed and disposed of so the lines can be adequately drained.

### 5.2.3 Encasements

#### 5.2.3.1 Standing Liquid Transfer Line SL-167 Encasement

In October/November 2012, dry air was diverted from the 242-A Evaporator compressor through the transfer line SL-167 encasement to remove any residual liquid that may be present. Humidity reading in the encasement was 100% initially and reduced to 5.4% when the activity was completed on November 1, 2012. The initial humidity readings confirmed the presence of liquid in the low point of line SL-167. Fitness-for-Service testing and inspections were conducted and documented in RPP-RPT-55204, *Summary of Fitness-for-Service Testing and Inspection of SL-167*. Multiple tests and visual inspections, including video inspections, were performed and confirmed that the water was removed and the environment in the encasement had significantly improved. The primary line was hydrostatically tested to 1.5 times the design pressure. The encasement was also pneumatically tested. The testing confirmed the integrity of line SL-167. Transfer line SL-167 in the AW Tank Farm was subsequently replaced on the active line list and declared fit for service.

RPP-RPT-55204, *Summary of Fitness-for-Service Testing and Inspection of SL-167* noted that no significant progression of corrosion inside the encasement or on the outside of the primary line had occurred in the eight (8) years since the initial inspection. Based on a recommendation in the report, the encasement pressure testing interval has been changed from 10 years to 5 years as a precaution since the line contains a known low spot capable of holding flush water or AW-102 head space condensate. With the lack of corrosion progression and the more frequent pressure testing of this line, this line is not considered an issue of concern.

## 5.3 REVIEW OF TRANSFER PIPING FIT-FOR-SERVICE DESIGN PARAMETERS

40 CFR 265 and WAC 173-303-640 require that the DST WTS be adequately designed and has sufficient structural strength and compatibility with the waste that it will not collapse, rupture, or fail. The following sections describe the design standards and industry standards used in the design and construction of the DST WTS. A listing of modifications to the DST WTS since the 2006 DSTAR is included in Table 3-1. Modifications to the DST System are required to undergo a review by an IQRPE for design, fabrication, and installation.

### 5.3.1 Piping, Jumpers, and Valves

Guidance for the design of piping, jumpers, and valves is provided in engineering standard TFC-ENG-STD-22, *Piping, Jumpers, and Valves*. RPP-RPT-28500, *Technical Basis Document for TFC-ENG-STD-22*, is the technical basis document for the engineering standard. The engineering standard implements the requirements of RPP-13033, *Tank Farms Documented*

*Safety Analysis* (hereafter DSA). Piping systems are designed, fabricated, tested, inspected, and installed to meet the requirements of national consensus codes or the strictest applicable state and local codes. RPP-8778 indicates that the tank farm WTSs designed prior to 1995 were designed, constructed, inspected, and tested to ASME B31.1. Since 1995, the piping systems are designed, fabricated, constructed, and tested to the requirements of ASME B31.3, *Process Piping*. Appropriate design temperatures and pressures are used in the design process for new piping systems in the tank farms. In addition to meeting the design requirements of 10 CFR 851, "Worker Safety and Health Program," WAC 173-303-640 requires the waste storage tank piping systems be certified by an IQRPE prior to use. New or modified piping systems in the DST WTS are certified by an IQRPE to meet the WAC 173-303-640 requirement.

Further design requirements and standards are typically stated in the project specifications, statements of work, and design requirements documents. Verification of design with respect to the design requirements is typically accomplished in system design descriptions, design compliance documents, and project calculations.

### 5.3.2 Industry Standards

Fabrication, installation, inspection, and testing requirements for the DST WTS are stated in construction specifications or in design drawing notes. Table 5-2, copied from the 2006 DSTAR, provides a listing of the various codes, including the applicable revision utilized in the applicable DST System construction specifications. Table 5-2 shows that fabrication, installation, inspection, and testing practices for the various DST WTS pipelines have been consistent throughout the years with regard to the use of national consensus standards.

**Table 5-2: Construction Specification Code Reference (4 sheets)**

| Standard Number | Title | Specification Reference |
|---|---|---|
| AWWA C203-66 | Coal-Tar Protective Coatings for Steel Water Pipe | B-109-C1 (AZ-101), B-101-C3 (SY) |
| AWWA C203-77 | Coal-Tar Protective Coatings for Steel Water Pipe | B-120-C7 (AW), B-130-C7 (AN) |
| ANSI B16.3-1971 | Malleable-Iron Screwed Fittings, 150 and 300 lb. | B-109-C1 (AZ-101), B-120-C7 (AW), B-130-C7 (AN), B-101-C3 (SY) |
| ANSI B16.3-1977 | Malleable-Iron Screwed Fittings, 150 and 300 lb. | B-340-C7 (AP) |
| ANSI B16.3-1992 | Malleable-Iron Screwed Fittings, 150 and 300 lb. | W-030-C3 |
| ANSI B16.5-1973 | Steel Pipe Flanges and Flanged Fittings | B-109-C1 (AZ-101), B-120-C7 (AW), B-130-C7 (AN), B-101-C3 (SY) |
| ANSI B16.5-1981 | Steel Pipe Flanges and Flanged Fittings | B-340-C7 (AP), B-621-C1 (SN-274) |
| ANSI B16.5-1988 | Steel Pipe Flanges and Flanged Fittings | W-058-C1, W-030-C3 |

**Table 5-2: Construction Specification Code Reference (4 sheets)**

| Standard Number | Title | Specification Reference |
|---|---|---|
| ANSI B16.5 | Steel Pipe Flanges and Flanged Fittings | W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2 |
| ANSI B16.9-1971 | Factory-Made Wrought Steel Butt-welding Fittings | B-109-C1 (AZ-101), B-120-C7 (AW), B-130-C7 (AN), B-101-C3 (SY) |
| ANSI B16.9-1978, B16.9a-1981 | Factory-Made Wrought Steel Butt-welding Fittings | B-621-C1 (SN-274) |
| ANSI B16.9-1993 | Factory-Made Wrought Steel Butt-welding Fittings | W-058-C1, W-030-C3 |
| ANSI B16.9 | Factory-Made Wrought Steel Butt-welding Fittings | W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2 |
| ANSI B16.11 | Forged Steel Fittings, Socket Welding and Threading | B-120-C7 (AW) |
| ANSI B16.11-1973 | Forged Steel Fittings, Socket Welding and Threading | B-130-C7 (AN), B-101-C3 (SY) |
| ANSI B16.11-1991 | Forged Steel Fittings, Socket Welding and Threading | W-058-C1, W-030-C3 |
| ANSI B16.22-1973 | Wrought Copper and Bronze Solder-Joint Pressure Fittings | B-109-C1 (AZ-101), B-120-C7 (AW), B-130-C7 (AN) |
| ANSI B1.20.1-1983 (R1992) | Pipe Threads, General Purpose (in.) | W-030-C3 |
| ANSI B31.1-1973 w/Addenda thru Summer 1974 | Power Piping | B-109-C1 (AZ-101), B-101-C3 (SY) |
| ANSI B31.1-1977 | Power Piping | B-120-C7 (AW), B-130-C7 (AN) |
| ANSI B31.1-1980 | Power Piping | B-340-C7 (AP) |
| ANSI B31.1-1995 | Power Piping | W-058-C1 |
| ANSI B31.3-1993 w/addenda a & b | Chemical Plant and Petroleum Refinery Piping | W-058-C1, W-030-C3 |
| ANSI B31.3 | Process Piping | W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2 |
| ANSI B31.3 | Process Piping | Jumpers |
| ANSI B70.1-1969 | Refrigeration Flare Type Fittings | B-109-C1 (AZ-101) |
| ANSI B70.1-1974 | Refrigeration Flare Type Fittings | B-120-C7 (AW) |
| ASME BPVC-1974 Ed. w/1974 Summer Addenda | Section VIII Pressure Vessels Section IX Welding and Brazing Qualifications | B-109-C1 (AZ-101), B-101-C3 (SY) |

**Table 5-2: Construction Specification Code Reference (4 sheets)**

| Standard Number | Title | Specification Reference |
|---|---|---|
| ASME BPVC-1974 Ed. w/1976 Winter Addenda | Section V Nondestructive Examination<br>Section VIII Pressure Vessels<br>Section IX Welding and Brazing Qualifications | B-120-C7 (AW) |
| ASME BPVC-1977 Ed. w/1977 Winter Addenda | Section V Nondestructive Examination<br>Section VIII Pressure Vessels<br>Section IX Welding and Brazing Qualifications | B-130-C7 (AN) |
| ASME BPVC-1983 | Section V Nondestructive Examination<br>Section IX Welding and Brazing Qualifications | B-340-C7 (AP) |
| ASME BPVC-1985 | Section II Material Specifications<br>Section IX Welding and Brazing Qualifications | B-621-C1 (SN-274) |
| ASME BPVC-1992 w/ 1994 Addenda | Section V Nondestructive Examination | W-058-C1 |
| ASME BPVC | Section IX Welding and Brazing Qualifications | W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2 |
| ASME BPVC | Section IX Welding and Brazing Qualifications | Jumpers |
| AWS D1.1-85 | Structural Welding Code – Steel | B-261-C1 (SN-274) |
| AWS D1.1 | Structural Welding Code – Steel | Jumpers |
| AWS D1.3-81 | Structural Welding Code – Sheet Steel | B-621-C1 (SN-274) |
| AWS D1.6 | Structural Welding Code – Stainless Steel | Jumpers |
| AWS QC1-85 | Standard for Qualification and Certification for Welding Inspectors | B-621-C1 (SN-274) |
| AWS QC1-88 | Standard for Qualification and Certification for Welding Inspectors | W-058-C1 |
| AWS QC1 | Standard for Qualification and Certification for Welding Inspectors | W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2, Jumpers |
| ASME NQA-1 (1994) | Quality Assurance Program Requirements for Nuclear Facilities | W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2 |

**Table 5-2: Construction Specification Code Reference (4 sheets)**

| Standard Number | Title | Specification Reference |
|---|---|---|
| ASME NQA-1 | Quality Assurance Program Requirements for Nuclear Facilities | Jumpers |
| ASNT SNT-TC-1A | Personnel Qualifications and Certification in Non-Destructive Testing | B-120-C7 (AW), B-101-C3 (SY), W-030-C3, W-211-TP-C1, W-211-TP-C2, W-211-AZ1-C1, W-211-AZ2-C1, W-211-AY2-C1, W-211-AY2-C2 |
| ASNT SNT-TC-1A (1975 Edition) | Personnel Qualifications and Certification in Non-Destructive Testing | B-120-C7 (AN) |
| ASNT SNT-TC-1A (1980 Edition) | Personnel Qualifications and Certification in Non-Destructive Testing | B-130-C7 (AN) |
| ASNT SNT-TC-1A (1984 Edition) | Personnel Qualifications and Certification in Non-Destructive Testing | B-621-C1 (SN-274) |
| ASNT SNT-TC-1A | Personnel Qualifications and Certification in Non-Destructive Testing | Jumpers |
| ES-24 4/1985 | Pipe Bending Tolerances-Minimum Bending Radii-Minimum Tangents | B-621-C1 (SN-274) |
| HPS-220-W | Welding Carbon Steels | B-109-C1 (AZ-101) |
| HPS-220-W Rev. 2 | Welding Carbon Steels | B-120-C7 (AW), B-130-C7 (AN) |
| HPS-230-W | Welding Austenitic Stainless Steels | B-109-C1 (AZ-101) |
| HPS-230-W Rev. 2 | Welding Austenitic Stainless Steels | B-120-C7 (AW), B-130-C7 (AN) |
| HPS-240-W | Stud Welding | B-120-C7 (AW), B-130-C7 (AN) |
| SSPC-SP3-63 | Power Tool Cleaning | B-130-C7 (AN) |
| SSPC-SP3-82 | Power Tool Cleaning | B-621-C1 (SN-274) |
| SSPC-SP6-63 | Commercial Blast Cleaning | B-130-C7 (AN) |
| SSPC-SP6-85 | Commercial Blast Cleaning | B-621-C1 (SN-274) |
| ANSI/FCI 70-2 | Control Valve Seat Leakage | Jumpers |

Reference: RPP-27591, Volume 2, Rev. 1

### 5.3.3 Purchased Items

Although this is an existing piping system, new items and components are being purchased, fabricated, and installed into the system. These components may be replacement of parts, or the addition of new jumpers or other components to support the waste transfer efforts. To ensure quality and maintain the pressure boundary, the purchased and fabricated items need to meet appropriate standards. There are processes in place to ensure that all purchased items are specified and reviewed to meet the project requirements. Engineering and construction

specifications are produced and provided to vendors. Submittal reviews are conducted to ensure the products meet the requirements of the project. Quality oversight is provided to ensure the process meets the requirements of the project.

For example, the process for transfer pumps is governed by TFC-ENG-STD-25. This engineering standard defines the standards, design and construction, and vender information evaluation requirements for the purchase of new pumps. Additional technical engineering standards are referenced in this document to provide further guidance and standards for pump construction and installation. Proper industrial standards are listed and referenced in relation to the transfer pumps. The processes in place should ensure that properly designed equipment is installed in the DST WTS.

## 5.4 REVIEW OF TRANSFER PIPING FIT-FOR-SERVICE OPERATING PARAMETERS

### 5.4.1 Operating Specifications

Operating specifications cover WTS integrity testing and verification requirements including pressure testing of transfer lines, automated leak detection, and life cycle management controls for HIHTLs. OSD-T-151-00010, *Operation Specifications for Pressure Testing and Leak Detection for Tank Farm Systems & for Control and Use of Temporary Transfer Lines,* requires transfer lines be pressure tested to 150% of maximum operating pressure for 1 hour. The lines must show less than a 5% pressure drop during the test to meet the acceptance criteria. Construction specifications for RCRA-compliant lines require pressure testing in accordance with ANSI/ASME B31 series piping codes following installation and prior to service. Periodic testing of these lines may be performed based on engineering judgment of factors such as date of the last transfer and age of the line, but additional pressure testing requirements are not specified by OSD-T-151-00010.

### 5.4.2 Activation of a Deferred Use Line

Although deferred use lines are not part of the scope of this report, this section is included to demonstrate that a process is in place to activate a deferred use line if the need arises. Once the deferred use line is activated, it would be added to drawing H-14-107346, *Waste Transfer Piping Diagram* (sheets 1 to 8), which is often referred to as the 'fit for use line list / interface diagram' or 'routing board'.

Deferred use lines are RCRA-compliant lines that have not been pressure-tested after construction was completed. These lines have not been certified by an IQRPE and do not have a fit for use designation. In order for these lines to be placed into service, the following process is used:

- A pneumatic pressure test is performed and witnessed by an IQRPE or Qualified Inspectors.
- An IQRPE report for the testing is produced and, if the line passes the pressure test, an integrity assessment is completed and a fit for use letter is produced by the IQRPE.
- The routing board (H-14-107346) is updated to include the line 'Fit for Use.'

The design and construction for the existing DST System lines was certified by the 2006 DSTAR. The encasement design pressure is typically 60 psi (some lines have a higher encasement design pressure). The primary line design pressures are either 275 psi or 400 psi. Typical operating pressures for the primary lines are 100 to 150 psi. Prior to using an activated deferred use line, the design, fabrication, and installation documentation is reviewed to ensure that proper testing and approvals have been performed.

### 5.4.3 Deactivation of a Fit for Use Component

All safety equipment and components are tracked in a Safety Equipment Compliance Database. When a failed or leaking component is found, the component is listed as 'not active' in the Safety Equipment Compliance Database if it is an operational concern. The failure is also noted on configuration control drawings/routing board H-14-107346 by Quality Assurance and Engineering. The change control process is then used to follow up on the notation on the routing board. Prior to any waste transfer, the Safety Equipment Compliance Database is used to determine if all of the lines and components being used in the transfer are listed as active. If a component is not listed as active, the waste transfer plan is revised to use alternate components.

Repairs are then made to the system or components that have failed. If internal components of valves or other devices have failed, the entire jumper is replaced. Repairs are made to the components if a gasket or external part that is easily fixed has failed. The decision is made based on ALARA principles and worker safety concerns.

If a transfer line fails, the line is physically disconnected from the WTS by means of an equipment air gap (removal of a section of piping) or by an administrative lock. The administrative lock typically consists of a valve lock out to prevent actuation of the valve. Double valve isolation is typically required for administrative controls.

### 5.4.4 Reporting Process

A PER is the first reporting mechanism for WTS failures. Failures are also reported in the System Health Report for Waste Transfer Containment (RPP-RPT-25749; RPP-RPT-53179). The system health reports are quarterly reports containing information on system availability, reliability, and component failures. Changes to interface diagram H-14-107346 are controlled by change control processes, including incorporation of Engineering Change Notices into the drawing sheets.

## 5.5 REVIEW OF TRANSFER PIPING PRESSURE TESTING

The OSDs listed in Section 5.4.1 outline the pressure testing requirements for the WTS pipelines. RPP-RPT-52206 provides additional pressure testing recommendations as outlined in this section.

HIHTLs are considered part of the SST WTS and are not considered in this report.

Table 5-3 shows the historical information, test pressures, operating pressures, and maximum operating temperatures for the transfer lines in the DST System.

**Table 5-3: Transfer Line Historical Information and Specifications (4 sheets)**

| Line | Test Pressure | Material | Maximum Operating Pressure | Maximum Operation Temperature | Reference |
|---|---|---|---|---|---|
| AN Tank Farm – Slurry | 600 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 400 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for 241-AN Tank Farm Completion Project B-101, Rev 1, June 27, 1978 |
| AN Tank Farm – Supernate | 450 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 230 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for 241-AN Tank Farm Completion Project B-101, Rev. 1, June 27, 1978 |
| AN Tank Farm – Process Waste | 175 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 115 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for 241-AN Tank Farm Completion Project B-101, Rev. 1, June 27, 1978 |
| AP Tank Farm – SN-621 | 415 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 275 psig | 200° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for Completion of 241-AP Tank Farm Project B-340, Rev. 1, Amendment 1, Dec. 4, 1986. |
| AP Tank Farm - Slurry | 600 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 400 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for Completion of 241-AP Tank Farm Project B-340, Rev. 1, Amendment 1, Dec. 4, 1986. |
| AP Tank Farm - Supernate | 600 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 400 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for Completion of 241-AP Tank Farm Project B-340, Rev. 1, Amendment 1, Dec. 4, 1986. |

**Table 5-3: Transfer Line Historical Information and Specifications (4 sheets)**

| Line | Test Pressure | Material | Maximum Operating Pressure | Maximum Operation Temperature | Reference |
|---|---|---|---|---|---|
| AP Tank Farm - Process Waste | 600 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 400 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for Completion of 241-AP Tank Farm Project B-340, Rev. 1, Amendment 1, Dec. 4, 1986. |
| AP Tank Farm – Permanent Valve Pit Piping | Not Listed in spec. | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 400 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for Completion of 241-AP Tank Farm Project B-340, Rev. 1, Amendment 1, Dec. 4, 1986. |
| Tank AZ-102 - Process Waste | 400 psig | 1/2 in. to 1 1/2 in. (Schedule 40) Black Steel (ASTM A 53, Type E or S, Gr. A or B; or ASTM A106, Gr. A or B) 2" and larger (Schedule 40) Black Steel (ASTM A53, Type S, Gr. A or B or ASTM A106, Gr. A or B) | 275 psig | 220° F | Pipe Code M-5 / ANSI B31.1.0<br>HWS-08867, Specification for Completion of tank 102 Project HAP-647, Tank Farm Expansion, 241-AZ Tank Farm, Rev. 0, Sept 30, 1972 |
| Tank AZ-102 - Process Waste | 400 psig | 1/2 in. or smaller (Schedule 40S) Stainless Steel (per ASTM A312, Grade TP 304L, seamless or welded. 3/4 in. thru 12 in. (Schedule 10S) 14 in. or larger (Schedule 10S) Stainless Steel (per ASTM A240, fabricated per ASTM A358, Class 2) | 275 psig | 220° F | Pipe Code M-9 / ANSI B31.1.0<br>HWS-08867, Specification for Completion of tank 102 Project HAP-647, Tank Farm Expansion, 241-AZ Tank Farm, Rev. 0, Sept 30, 1972 |
| AW Tank Farm - Slurry | 600 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 400 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for 241-AN Tank Farm Completion Project B-101, Rev. 1, June 27, 1978 |

**Table 5-3: Transfer Line Historical Information and Specifications (4 sheets)**

| Line | Test Pressure | Material | Maximum Operating Pressure | Maximum Operation Temperature | Reference |
|---|---|---|---|---|---|
| AW Tank Farm - Supernate | 450 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 275 psig | 340° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for 241-AN Tank Farm Completion Project B-101, Rev. 1, June 27, 1978 |
| AW Tank Farm - Process Waste | 175 psig | 2 in. and 3 in. - Schedule 40 Carbon Steel, ASTM A53, Type S, Gr. B, or ASTM A106, Gr. B | 115 psig | 250° F | Pipe Code M-25 / ANSI B31.1<br>B-130-C7, Construction Specification for 241-AN Tank Farm Completion Project B-101, Rev. 1, June 27, 1978 |
| Tank AZ-101 - Process Waste | 415 psig | 1/2 in. to 1 1/2 in. (Schedule 40), 2 in. and larger (Schedule 40) Black Steel (ASTM A53, Type S, Gr. A and B or ASTM A106, Gr. A or B) | 275 psig | 250° F | Pipe Code M-5 / ANSI B31.1<br>B-109-C1, Construction Specification for 241-AZ-101 tank Additions, Project B-109, Rev. 0, Feb 26, 1975 |
| Tank AZ-101 - Process Waste | 415 psig | 1/2 in. or smaller (Schedule 40S) Stainless Steel (per ASTM A312, Grade TP 304L, seamless or welded. 3/4 in. thru 12 in. (Schedule 10S) 14 in. or larger (Schedule 10S) Stainless Steel (per ASTM A240, fabricated per ASTM A358, Class 2) | 275 psig | | Pipe Code M-9<br>B-109-C1, Construction Specification for 241-AZ-101 Tank Additions, Project B-109, Rev. 0, Feb 26, 1975. |
| SY Tank Farm - Slurry | 550 psig | 1 in. through 6 in. - Schedule 40, 8 in. through 12 in. - Schedule 20 (0.250 in. wall) Carbon Steel (C.S.; ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B) | 375 psig | 330° F | Pipe Code M-25 / ANSI B31.1<br>B-101-C3, Construction Specification for Completion of 241-SY Tank Farm Project B-101, Rev. 1, Nov 8, 1974 |

**Table 5-3: Transfer Line Historical Information and Specifications (4 sheets)**

| Line | Test Pressure | Material | Maximum Operating Pressure | Maximum Operation Temperature | Reference |
|---|---|---|---|---|---|
| SY Tank Farm - Supernate | 350 psig | 1 in. through 6 in. - Schedule 40, 8 in. through 12 in. - Schedule 20 (0.250 in. wall) Carbon Steel (C.S.; ASTM A53, Type S, Gr. B or ASTM A106, Gr. A or B) | 230 psig | 330° F | Pipe Code M-25 / ANSI B31.1<br>B-101-C3, Construction Specification for Completion of 241-SY Tank Farm Project B-101, Rev. 1, Nov 8, 1974 |

Reference: OSD-T-151-00010, Rev. 1, Appendix A.

RPP-RPT-52206 recommends that pneumatic tests be performed on the encasement of all transfer lines in the Fitness-for-Service scope (excluding HIHTLs). Further, the document recommends the encasements be re-tested on a 10-year schedule or prior to next use, whichever is greater. The pneumatic test of the encasement complies with the test requirements specified by the IQRPE in RPP-17266. The test is typically performed at 66 psi and held for a minimum of 30 minutes. No more than a 5% drop in pressure is allowed. Additional pressure testing of the WTS encasements has been conducted. Results of the encasement pressure testing are included in Table 5-4.

As indicated in Table 5-4, only one failure was noted in the pressure testing reviewed. This was for line SL-164. It was later discovered that the failure was not in the secondary enclosure but was actually a failure of the primary pipe. Subsequently, line SL-164 was removed from service.

## Table 5-4: Pressure Test Results

| LINE NUMBER | WORK ORDER NUMBER | DATE | TEST DATA TIME AND PRESSURE DATA | | | | | | | | | PASS/ FAIL | TEST DATA TIME AND TEMPERATURE READINGS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | START TIME | START | +5 MIN | +10 MIN | +15 MIN | +20 MIN | +25 MIN | +30 MIN | END TIME | | START TIME | START | END | END TIME |
| SL-509 | TFC-WO-10-3862 | 12/15/2010 | 0 | 65.96 | 65.96 | 65.95 | 65.95 | 65.95 | 65.94 | 65.93 | 10 | PASS | N/A | N/A | N/A | N/A |
| SN-609 | TFC-WO-10-3862 | 12/15/2010 | 0 | 65.99 | 65.98 | 65.98 | 65.98 | 65.97 | 65.96 | 65.95 | 30 | PASS | N/A | N/A | N/A | N/A |
| SN-610 | TFC-WO-10-3862 | 12/15/2010 | 0 | 65.95 | 65.94 | 65.94 | 65.93 | 65.92 | 65.92 | 65.9 | 30 | PASS | N/A | N/A | N/A | N/A |
| SL-510 | TFC-WO-10-3862 | 12/16/2010 | 0 | 67.75 | 67.74 | 67.73 | 67.71 | 67.71 | 67.7 | 67.68 | 30 | PASS | N/A | N/A | N/A | N/A |
| SN-631 | TFC-WO-10-4846 | 6/6/2011 | 204 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | 234 | PASS | N/A | N/A | N/A | N/A |
| SN-632 | TFC-WO-10-4848 | 6/7/2011 | 951 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 1021 | PASS | N/A | N/A | N/A | N/A |
| SN-622 | TFC-WO-10-4848 | 9/7/2011 | 1759 | 65.0 | 64.5 | 64.4 | 64.3 | 64.4 | 64.5 | 64.4 | 1829 | PASS | 1746 | 96.0 | 94.5 | 1758 |
| SN-633 | TFC-WO-10-4850 | 1/3/2012 | 1035 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.4 | 65.3 | 1105 | PASS | 937 | 36.7 | 41.5 | 1038 |
| SN-634 | TFC-WO-10-4850 | 1/3/2012 | 710 | 65.2 | 65.2 | 65.2 | 65.1 | 65.1 | 65.1 | 65.1 | 740 | PASS | 1319 | 46.9 | 38.7 | 1402 |
| SL-166 | N/A | 3/7/2012 | 1335 | 79.9 | 79.9 | 80.0 | 79.9 | 79.9 | 79.9 | 79.9 | 1405 | PASS | N/A | N/A | N/A | N/A |
| SN-166 | TFC-WO-11-5951 | 3/7/2012 | | 66.2 | | | | | | 66.2 | | | N/A | N/A | N/A | N/A |
| SN-266 | TFC-WO-11-5951 | 3/7/2012 | 1030 | 79.9 | 79.9 | 80.0 | 79.9 | 79.9 | 80.0 | 80.0 | 1100 | PASS | 1002 | 66.1 | 75 | 1100 |
| SN-635 | TFC-WO-12-4191 | 9/19/2012 | 718 | 66.8 | 66.8 | 66.8 | 66.8 | 66.8 | 66.8 | 66.8 | 748 | PASS | 648 | 83.3 | 78.7 | 718 |
| SN-269 | TFC-WO-11-4827 | 3/18/2013 | 1110 | 65.8 | 65.7 | 65.5 | 65.4 | 65.5 | 65.5 | 65.5 | 1140 | PASS | 1110 | 55.3 | 56.7 | 1140 |
| SN-270 | TFC-WO-11-4827 | 3/18/2013 | 1414 | 65.8 | 65.8 | 65.9 | 66.0 | 66.1 | 66.1 | 66.2 | 1440 | PASS | 1414 | 61.9 | 62.4 | 14.44 |
| SL-169 | TFC-WO-13-1362 | 4/1/2013 | 1332 | 65.7 | 65.7 | 65.7 | 65.7 | 65.7 | 65.7 | 65.7 | 1402 | PASS | 1302 | 86.8 | 86.8 | 1332 |
| SN-271 | TFC-WO-13-1362 | 4/1/2013 | 1003 | 66.5 | 66.3 | 66.2 | 66.3 | 66.5 | 66.7 | 66.8 | 1033 | PASS | 930 | 65.5 | 65.7 | 1000 |
| SL-167 | TFC-WO-12-4109 | 5/6/2013 | 1134 | 66.3 | 66.3 | 66.2 | 66.2 | 66.2 | 66.2 | 66.1 | 1204 | PASS | 1103 | 91.6 | 86.9 | 1133 |
| SN-272 | TFC-WO-11-4827 | 5/22/2013 | 1342 | 66.6 | 66.2 | 65.8 | 65.4 | 65.0 | 65.6 | 64.2 | 1412 | PASS | 1312 | 58.9 | 51.0 | 1346 |
| SN-630 | TFC-WO-13-3209 | 7/30/2013 | 1028 | 67.0 | 67.0 | 67.0 | 67.0 | 67.0 | 67.1 | 67.1 | 1058 | PASS | 0941 | 82.8 | 96.4 | 1027 |
| SN-630 | TFC-WO-13-3209 | 7/30/2013 | 1028 | 67.0 | 67.0 | 67.0 | 67.0 | 67.0 | 67.1 | 67.1 | 1058 | PASS | 941 | 82.8 | 96.4 | 1027 |
| SN-265 | TFC-WO-12-5408 | 10/29/2013 | 1059 | 65.96 | 65.96 | 65.95 | 65.95 | 65.95 | 65.94 | 65.94 | 1129 | PASS | 1014 | 53.7 | 52.4 | 1044 |
| SL-511 | TFC-WO-13-6009 | 2/25/2014 | 1528 | 67.0 | 67.0 | 67.0 | 67.0 | 67.0 | 67.0 | 67.0 | 1558 | PASS | 1307 | 56.9 | 55.2 | 1353 |
| SN-611 | TFC-WO-13-6009 | 2/25/2014 | 1353 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | 65.0 | 1423 | PASS | 1458 | 60.0 | 55.2 | 1528 |
| SL-513 | TFC-WO-13-6010 | 3/3/2014 | 1037 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 66.7 | 1107 | PASS | 1004 | 63.6 | 61.5 | 1034 |
| SN-613 | TFC-WO-13-6010 | 3/3/2014 | 1423 | 66.4 | 66.4 | 66.4 | 66.4 | 66.4 | 66.4 | 66.4 | 1453 | PASS | 1352 | 74.2 | 73.0 | 1422 |
| SL-514 | TFC-WO-13-6011 | 3/24/2014 | 1336 | 65.3 | 65.3 | 65.3 | 65.3 | 65.2 | 65.2 | 65.2 | 1406 | PASS | 1306 | 89.2 | 89.7 | 13.36 |
| SN-614 | TFC-WO-13-6011 | 3/24/2014 | 1040 | 65.6 | 65.6 | 65.6 | 65.6 | 65.6 | 65.6 | 65.6 | 1110 | PASS | 1010 | 25.7 | 75.8 | 1040 |
| SN-264 | TFC-WO-14-1905 | 5/28/2014 | 1038 | 65.3 | 65.5 | 65.4 | 65.4 | 65.8 | 63.7 | 65.2 | 1108 | PASS | 1003 | 76.9 | 74.0 | 1038 |
| SN-274 | TFC-WO-14-1905 | 5/29/2014 | 1003 | 68.1 | 67.4 | 66.7 | 66.6 | 66.5 | 66.9 | 66.6 | 1033 | PASS | 0927 | 79.6 | 75.5 | 1002 |
| SL-164 | TFC-WO-14-1905 | | | | | | | | | | | FAIL | N/A | N/A | N/A | N/A |

## 5.6 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

Discussion associated with each of the DST WTS-related recommendations is presented in this section. Full wording of each of the recommendations along with dispositions is outlined in RPP-RPT-50440.

- 2006 DSTAR Item R1: Basis for recommendations was concern over shallowness of some pipe burials. It is recommended that the potentially shallow burial depths of some transfer lines mentioned in this document (RPP-18652, Rev. 1) be reviewed and inspected to ensure compliance with applicable safety requirements, but it is not within the scope of this analysis to determine the adequacy of the present soil cover to comply with current shielding requirements. PER-2004-1039 has been written to address the above recommendation.
    - 2016 DSTAR Assessment: RPP-21726, Rev. 0, *Vehicle and Equipment Access over buried Utilities in and Around Tank Farms,* concluded that a bury depth of as little as 19 inches is sufficient for vehicle and equipment loads for on buried utility lines including transfer lines. RPP-18652, Rev 1, *Buried Pipe Analysis for DST System Integrity Assessment*, indicates that the transfer lines have a minimum of 24 inches of cover. These depths should be sufficient to protect the transfer lines from damage due to vehicle and equipment crossings. Shielding requirements are not a part of this integrity assessment. This disposition satisfies the recommendation outlined in Item R1.
- 2006 DSTAR Item R2: In addition, due to the shallowness of some of the transfer lines mentioned in this document (RPP-18652, Rev. 1), it is recommended that an analysis or evaluation of frost heave and its effects is in order to determine the corrective action needed. Inspections and/or testing of identified pipes might also be in order, if it is determined that frost heave is a concern and that its damaging effects could have occurred in the past.
    - 2016 DSTAR Assessment: RPP-RPT-39400, Rev 0, *Evaluation of Frost Heave on Waste Transfer Lines with Shallow Depths in DST Farms*, was issued in May of 2009 and concludes that waste transfer lines with as little as 12 inches of cover are not expected to undergo frost heave damage due to the well compacted sandy material around the transfer lines. Also, there has been no report of frost heave damage to waste transfer lines since 1972 when the Occurrence Reporting system at Hanford was implemented. This disposition satisfies the recommendation outlined in Item R2.
- 2006 DSTAR Item R3: PER No. 2004-5678, which was written against this document (RPP-18652, Rev. 1), indicated that the soil cover for SN-631 of Tank Farm AZ should be much greater as indicated by drawing H-I4-102671 Sht. 1. The increase in soil cover was credited to a berm. Upon further investigation, the height of the berm was still not conclusive. Berms on other transfer lines, in other tank farms, called out on numerous related drawings are simply stated as "as required." This is not definite enough to be included in this evaluation. Thus, as previously recommended, inspections on suspected

shallow transfer lines are in order. This should provide a more accurate assessment of the soil cover above the suspect transfer line.

- 2016 DSTAR Assessment: Drawing H-14-102671, sheets 1 and 4, provide traceable documentation that there is a berm over SN-631; however, there is no elevation information for the berm. Drawing H-14-102671, sheet 1, indicates that the berm does not extend to the area of deepest burial location (the face of Pump Pit 241-AZ-01A) and that the maximum depth already calculated is greater than the minimum specified on sheet 4. Review of the issue indicated that no changes to the document in question were required. This disposition satisfies the recommendation outlined in Item R3.

- 2006 DSTAR Item R40: Consider for adoption: Performance of a detailed laboratory examination of any DST System waste transfer line encasements that are removed permanently from service for coating defects, and internal and external corrosion.
  - 2016 DSTAR Assessment: Samples of piping have been analyzed on several occasions with no significant areas of corrosion damage being found. Opportunistic sampling and erosion monitoring is incorporated into RPP-7574. This disposition satisfies the recommendation outlined in Item R40. R16-20 provides for a recommendation of continued opportunistic sampling.

- 2006 DSTAR Item R42: Flush all DST System waste transfer lines following waste transfer with hot inhibited water (see TFC-ENG-STD-26 for inhibited flush water composition and temperature). Any non-process transfers should also be performed using inhibited water.
  - 2016 DSTAR Assessment: This recommendation was the result of a misinterpretation of a recommendation in SD-RE-TI-044, Analysis of Pipeline Failures, SL-176. The failure of line SL-176 was the result of the pipe being under significant stress, not corrosion. TFC-ENG-STD-26, Waste Transfer, Dilution, and Flushing Requirements, indicates that flushing with raw water is sufficient as long as compliant waste is being transferred. The transfer of non-compliant waste is to be evaluated to determine if a chemical flush is needed. No action was taken on this recommendation. This disposition satisfies the recommendations outlined in Item R42.

- 2006 DSTAR Item R43: This document in conjunction … finds that the following actions are necessary to reduce the possibility of continued corrosion in AW tank farm slurry line SL-167:
  1. Evaluate the use of a biocide to the exposed portions of the line encasement and exterior surface of the 2 in. primary pipe and 1 in. pipes at cleanout box AW-COB-6 as soon as possible.
  2. Evaluate the performance of an inhibited water flush of the line to fill the low spot with inhibited water. An inhibited water flush should also follow any transfers in this line as recommended in paragraph 5.4.3(3) above. Evaluate the using inhibited water flush of the line for all verification activities that introduce water into the line or its encasement.

- 2016 DSTAR Assessment: This recommendation was evaluated in Duncan 2007, Letter Report for Microbially Influenced Corrosion, SL-167. The report evaluates the material on the pipes inside cleanout box AW-COB-6 and concludes that it is microbially influenced corrosion. Subsequently, the cleanout box was removed from line SL-167. The response to this recommendation indicates there is no simple way of introducing inhibited water to the system. At the completion of each campaign, the 242-A Evaporator vessel is deep flushed to remove residual supernate. A portion of the deep flush is drained through line SL-167. Further, if raw water is used in the line instead of residual supernate, the line must be used for a waste transfer or flushed with inhibited water or a portion of the deep flush from the 242-A Evaporator within 12 months after the line's last usage as described in TFC-ENG-STD-26. This disposition satisfies the recommendations outlined in Item R43.

- 2006 DSTAR Item R45: A formal integrity assessment should be performed on all DST System waste transfer, drain, and process waste lines eight years after the issuance of this integrity assessment.
  - 2016 DSTAR Assessment: This recommendation is inconsistent with other portions of the DSTAR. Pneumatic pressure testing of the 75 active transfer pipeline encasement has been implemented on a 10-year interval. This disposition satisfies the recommendations outlined in Item R45.
- 2006 DSTAR Item R46: There is no indication, via either the documented video inspections, pneumatic encasement leak test results, observed material loss and resulting corrosion rate for line SL-167 or ERUL calculation results that provides evidence that the encasements are susceptible to failure due to a common failure mechanism. Thus, these systems do not warrant periodic encasement leak testing, other than testing as required in the future DST System pipeline integrity assessment recommended above, or as required for deferred use, emergency use only, or approved variance pipelines within one year or prior to use.
  - 2016 DSTAR Assessment: The recommendation to discontinue periodic encasement testing is inconsistent with other IQRPE recommendations. Pneumatic pressure testing of pipeline encasements on an 8- to 10-year interval has evolved to be the chosen indirect inspection technique to evaluate active transfer pipeline encasement integrity. No action was taken on this recommendation. The 2016 IQRPE concurs that pneumatic pressure testing of the encasements is acceptable in evaluating the encasement integrity. This disposition satisfies the recommendations outlined in Item R46.
- 2006 DSTAR Item R47: A formal ERUL calculation should be performed to assess the structural impact of corrosion/erosion on the DST System pipelines.
  - 2016 DSTAR Assessment: In order to develop an ERUL, the both total flow through the primary pipe and the flow composition are required. Transfer records are discontinuous, the composition of the waste was a calculated composition, and solids content was rarely determined. A workaround was suggested to monitor pipeline jumpers for evidence of erosion/corrosion. It is unclear if monitoring of the jumpers has begun or what the results have been. The 2016 IQRPE agrees

that ERUL analysis on the primary waste piping would be difficult and inaccurate without accurate records of flow volume and waste/solids composition. However, monitoring of accessible piping jumpers for corrosion/erosion would provide information on the state of the rest of the system.

- 2006 DSTAR Item R48: An ECN (Engineering Change Notice) should be written to update the hose information table on H-14-103596 (via ECN-720301-R0) to reflect the June 1, 2006 HOSE-SY101-PPP/SYA expiration date.
    - 2016 DSTAR Assessment: The HIHTL HOSE-SY101-PPP/SYA was replaced in January 2007. ECN-720301-R2 reflects the installation and new service date.

      Drawing H-14-106249 was created to describe and monitor all in-service HIHTLs and to ensure the lines are not used after they have reached the end of their service life. The drawing documents the in-service date, service life expiration date, mission description, mission completion date, required removal date, and the actual removal date, among other pertinent information. This disposition satisfies the recommendations outlined in Item R48.
- 2006 DSTAR Item R49:

  *a.) Any statistically representative samples of DST pipelines removed from service (via failure, end of life, or other cause for removal from service) should be unearthed and examined in a laboratory for corrosion/erosion, and failure mode as necessary.*

  *b.) Please provide copies of the associated reports, if available, that describe the actions that have been taken, or are currently planned to address the IQRPE recommendations, cited above, for the primary piping system*

  *c.) Has a program plan to address the IQRPE recommendations for the primary piping system been developed similar the plan developed for the cathodic protection system (RPP-PLAN-45268)?*

    - 2016 DSTAR Assessment: Several lines have been exhumed and inspected. None of the tested lines showed significant areas of corrosion damage at the inspection site. RPP-7574 incorporates activities from the recommendations. RPP-RPT-52206 includes recommendations and requirements for the primary piping. This disposition satisfies the recommendations outlined in Item R49. R16-20 provides for a recommendation of continued opportunistic sampling.
- 2006 DSTAR Item R77 (Item 2): Section 5.4.3, "Existing Corrosion Protection Measures," in RPP-27591, Rev. 1, recommends flushing all DST system waste transfer lines following waste transfer with hot inhibited water (see TFC-ENG-STD-26 for inhibited flush water composition and temperature).
    - 2016 DSTAR Assessment: This recommendation was the result of a misinterpretation of a recommendation in SD-RE-TI-044, Analysis of Pipeline Failures, SL-176. The failure of line SL-176 was the result of the pipe being under significant stress, not corrosion. TFC-ENG-STD-26, Waste Transfer, Dilution, and Flushing Requirements, indicates that flushing with raw water is sufficient as long as compliant waste is being transferred. The transfer of non-compliant waste is to be evaluated to determine if a chemical flush is needed. No

action was taken on this recommendation. This disposition satisfies the recommendations outlined in Item R77.

## 5.7 IQRPE SUMMARY DISCUSSION OF 2016 DST PIPELINE INTEGRITY ASSESSMENT

### 5.7.1 Findings

There are no findings in this report with respect to the DST WTS.

### 5.7.2 Observations

- Operation of the DST WTS limits the pressure and velocity in the piping system to well within the limits of the piping materials. None of the piping examined to date has shown corrosion or erosion that is above expected values.
- Although there have been abnormal conditions in the DST WTS, the conditions were found during testing processes prior to the transfer of waste and replaced or repaired. The system and process in place are ensuring the safe operation of the WTS. It is understood that a study is currently in progress to determine if the minimum required slope stated in TFC-ENG-STD-22 is adequate to protect the piping. If the results of this study indicate a minimum slope of greater than 0.25% is needed, this should be incorporated into the design standard.
- Several instances of duplicate pipe numbers exist within the DST WTS. As an example, there is a line numbered SL-167 in the AN Tank Farm and another line numbered SL-167 in the AW Tank Farm. These are completely separate lines and are in no way related to each other. The line in the AN Tank Farm is listed as not approved for use while the AW Tank Farm line is fit for service. The line numbers are unique if the entire line number is used. However, it is the practice to use shortened line numbers. To avoid confusion when using shortened line numbers, a reference to the tank farm where the line is located should be used along with the line number.

### 5.7.3 Recommendations

- The next integrity assessment for the DST WTS should be conducted in 10 years. (Summarized in recommendation R16-1 in Section 3.3.3.)
- Pressure testing of the encasements of the DST WTS piping should continue on a 10-year schedule, except pipeline SL-167 should be on a 5 year schedule. (Summarized in recommendation R16-19 in Section 3.3.3.)
- The 2016 IQRPE agrees that ERUL analyses on the primary waste piping would be difficult and inaccurate without accurate records of flow volume and waste/solids composition. However, monitoring of accessible piping jumpers for corrosion/erosion would provide information on the state of the rest of the system. Recommend continuing the use of the "Fit-for-Use" program for opportunistic forensic analysis to monitor the piping for signs of corrosion and erosion. (Summarized in recommendation R16-20 in Section 3.3.3.)

- Several instances of improper fit-ups of jumpers have been recorded. Whenever pits are opened and it is possible to verify as-built dimensions of nozzle locations prior to the design, fabrication, and installation of new jumpers, measurements should be taken and documented to ensure proper fit-ups of new components. (Summarized in recommendation R16-23 in Section 3.3.3.)

### 5.7.4 Conclusions

In regards to DST WTS, the DST System is fit for use as listed in Appendix D.

# 6.0 CATHODIC PROTECTION FOR DOUBLE-SHELL TANK TRANSFER LINES

**Introduction/Purpose**

The purpose of this section is to provide a review of the external corrosion control systems of the buried metallic piping associated with the DST System. The conveyance method for product transferred to/from the tanks is regulated by state and federal statutes and, as such, is required to include provisions for external corrosion control. Recommendations provided in the 2006 DSTAR were also reviewed for their inclusion in the operation of the cathodic protection systems.

**Scope/Requirements**

Hazardous materials transported by metallic materials in contact with corrosive media are required to have provisions for external corrosion control. To meet this requirement, the use of impressed current cathodic protection to supply protective current to exposed portions of the steel piping material is used in conjunction with protective coatings. Criteria for corrosion control are outlined in multiple documents, including the following:

- 40 CFR 265 Subpart J, "Tank Systems"
- 49 CFR 195, "Transportation of Hazardous Liquids by Pipeline"
- NACE SP0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*
- NACE SP0285, *External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.*

**Method of Assessment**

Assessment of the corrosion control methodology was completed by reviewing available documentation concerning past and current provisions for cathodic protection, as well as the types of protective coatings applied to the buried piping. Included with the document review were several years of field data collection and previous assessment reports submitted by independent parties. A substantial amount of useful information was presented during an informal meeting with Hanford Site personnel responsible for operation of the cathodic protection equipment.

The information gathered was reviewed in the context of meeting established criteria for effective corrosion control, and to determine if current and future operating strategies are in support of this requirement.

## 6.1 CATHODIC PROTECTION SYSTEM DESCRIPTION

### 6.1.1 System Design Basis

WAC 173-303-640(2) states that tank systems be certified as fit for use by an IQRPE. At a minimum, the assessment must consider "Existing corrosion protection measures" (Item iii). From a corrosion engineering standpoint, the most common examples of protective measures include (1) material selection; (2) design considerations (i.e., corrosion allowance); (3) protective coatings, (4) control of environmental conditions, (5) use of corrosion inhibitors, and (6) cathodic protection. From a practical standpoint, the combination of protective coatings and

cathodic protection yields the greatest measure of corrosion control, both from a monitoring standpoint and from a typical life cycle cost analysis.

Components of the DST System transfer piping include supernate transfer lines, slurry transfer lines, drain lines, process waste lines, process wash lines, raw water lines, flush lines, and process condensate lines.

As described in 2006 DSTAR Volume 4, in the period between 1944 and 1947 severe corrosion in the form of pitting was noted on the direct-buried stainless steel waste transfer piping. These failures led to the introduction of cathodic protection for the piping materials. The original cathodic protection systems were operated from 1947 to 1980. These systems utilized a multitude of different anode materials including railroad rails, scrap iron, and high silicon cast iron anodes. A large inspection/repair effort of the cathodic protection equipment associated with the 200 East and West Areas was completed in 1970 to 1971. Recommendations for a complete rehabilitation of the cathodic protection equipment were submitted by Harco Corporation in 1977. Battelle Columbus Laboratories conducted an inspection of the cathodic protection systems in 1980 and recommended that the corrosion control equipment be turned off in an effort to better understand the complex corrosion conditions associated with the 200 Areas.

In 1982, Ebasco Services Inc. designed a retro-fit cathodic protection system for the majority of the present-day cathodically protected piping. Installation of the retro-fit designs were completed between 1986 and 1995.

### 6.1.2 Cathodic Protection Equipment

The cathodic protection equipment includes 14 oil-cooled rectifiers and 179 test stations.

The impressed current anodes are surrounded by cokebreeze in a prepackaged canister. The majority of anodes (90%) are 8 in. diameter with the remaining 10% consisting of 4 in. diameter materials.

The anodes are evenly spaced along the piping to be protected and are located throughout the tank farms. This close-coupled array of materials provides for very good protective current distribution so long as shielding of the piping does not occur. Away from the tanks, the anodes are installed vertically while above the tanks the anodes are installed horizontally.

The anodes are powered via header cables or are branched from distribution boxes. The anode header cables are installed in a looped fashion with both ends of the positive header cable being powered. This ensures that a broken header cable will not result in anodes downstream of the electrical break being ineffective. Looped conductors can also serve to assist in system troubleshooting as well as system balancing (increasing or decreasing circuit resistance). The anode distribution boxes offer the advantage of being able to quantify individual anode current outputs as well as the ability to disconnect individual anodes should the need arise.

### 6.1.3 Equipment to be Protected

There are a total of 246 post-2005 pipelines evaluated, as defined by the 2006 DSTAR Volume 2 and Attachment 3 of RPP-20960.

### 6.1.4 Monitoring Protocol

In accordance with provisions outlined in WAC 173-303-640 (6)(c):

i) The proper operation of the cathodic protection system must be confirmed within six months after initial installation and annually thereafter; and

ii) All sources of impressed current must be inspected and/or tested, as appropriate, at least bi-monthly (i.e., every other month).

These requirements are consistent with current industry standards including:

- Code of Federal Regulations:
  - 40 CFR 265 Subpart J, "Tank Systems"
  - 49 CFR 195, "Transportation of Hazardous Liquids by Pipeline"
- NACE:
  - NACE SP0169, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*
  - NACE SP0285, *Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.*

As stated within 2006 DSTAR Volume 4, each rectifier is to be inspected bi-monthly and all test stations are to be inspected annually unless directed by the Tank Farm Contractor environmental organization.

## 6.2 REVIEW OF SYSTEM MODIFICATIONS SINCE 2006 DSTAR

A review of the major improvements since the 2006 DSTAR, along with pertinent discussion, is provided in this section.

- Replacement of pulse generators and wave form analyzers with synchronizable interrupters (McMiller JR-1):
  - Daisy-chain type interrupters such as the JR-1 are an upgrade from the previously employed pulse generator methodology. However, it is important to verify at the beginning and end of each day that the daisy-chain interrupters are in synchronization. Industry is transitioning away from this type of interrupter and moving toward GPS synchronizable interrupters. GPS units have the advantage of using satellite clocks for determining on- and off-cycling. These units also update their internal clock several times per second to ensure accurate timing. In addition, handheld cathodic protection collection devices (e.g., American Innovations Allegro MX Field Data PC™) also use GPS timing to determine when to collect on and instant off readings in a synchronized fashion with the GPS interrupters.
- Development of a database for collected data Computerized History and Maintenance Planning Software (CHAMPS):
  - Data collection and storage is of utmost importance. Databases provide the ability to review data trends of the system as a whole or at specific locations.

Multiple database programs are commercially available that are specific to the cathodic protection industry or customized databases can be developed.

- Incorporation of coupons and ER probes:
  - At locations where pipe-to-soil potential measurements are not practical, the use of coupons to simulate a coating holiday are becoming much more common in the industry. Coupons have the advantage of being able to be disconnected from the cathodic protection system to measure error-free readings, as well as able to provide current density information (an important aspect of corrosion control that is often overlooked). ER probes provide very good information concerning corrosion rates so long as the equipment is installed and monitored correctly. Errors can be made in data interpretation, and the manufacturer should be consulted to assist in determining actual corrosion rates of the test specimen. These two important tools used in corrosion control monitoring may require additional training for the cathodic protection data collection personnel.
- Removal of the requirement to measure resistances with the positive conductors:
  - This previous testing requirement provided negligible value and has been correctly removed as part of the testing methodology.
- Collection of system-wide depolarization data:
  - This important step was vital to establish potentials used for verification of the 100-mV criteria. Recommendations from other corrosion consultants suggest that system-wide depolarized potentials should be collected every 5 years. Changes in depolarized values result from a drastic change in environmental (soil) conditions or if additional metallic structures are electrically bonded into the piping network.
- NACE Training for individuals performing testing:
  - Having properly trained and competent testing personnel will provide a consistency throughout the data collection process. It was noted in the 2014 cathodic protection status report (RPP-RPT-47435, Rev. 4) that all cathodic protection individuals have been certified as NACE CP-2 Cathodic Protection Technicians. This is an important step in maintaining the integrity of the cathodic protection program. Along these same lines, it would be beneficial for the head of the corrosion department (or their designee) to have NACE CP-3 Cathodic Protection Technologist certification. A Cathodic Protection Technologist will be able to conduct advanced rectifier troubleshooting, perform non-routine interference testing, analyze data for anomalies, conduct current flow measurements on sections of piping, and perform in-depth bell-hole evaluations when the pipeline is exposed.

## 6.3 ANNUAL SYSTEM TEST RESULTS REVIEW

### 6.3.1 Testing Methodology

Cathodic protection testing requirements are described in 3-CATH-690, *Cathodic Protection System Testing*. The steps include: lockout/tag out of electrical equipment when installing current interrupting devices, worker safety regarding radiation and contamination control, testing

tools and documents, testing procedures, and datasheets for locating equipment and recording data. A review of 3-CATH-690 shows that measuring of the pipe-to-soil potentials, along with rectifier input/output data, is being completed in accordance with industry standards. In addition, reference is made to NACE TM0497, *Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping.* NACE TM0497 is extensively used as a guide for field data collection associated with buried piping.

### 6.3.2 Field Equipment Used During Survey Work

Equipment used for performing the bi-monthly rectifier readings and annual test station survey include the following:

- Calibrated digital multimeter
- Calibrated clamp on ammeter
- Current interrupter (McMiller synchronizable)
- Calibrated portable copper-copper sulfate reference electrodes
- Test leads with alligator clips
- Personal protective equipment.

The items described within the testing document are standard for performing test station surveys for buried piping. It is important to note that all meters and reference electrodes are properly calibrated for accurate results. There are no discrepancies noted while reviewing the testing equipment list.

## 6.4 REVIEW RECENT SYSTEM-WIDE ASSESSMENT RESULTS

Cathodic protection system testing is conducted on an annual basis (test station surveys) as outlined in Annual Select Line CP Status Report RPP-RPT-47435 based on 'current year' annual survey data reports. Table 6-1 summarizes results of the test station surveys completed from 2008 to 2013.

**Table 6-1: Historical Cathodic Protection System Performance**

| Criteria | 2008/2009 Survey Data | 2010 Survey Data | 2011 Survey Data | 2012 Survey Data | 2013 Survey Data | 2014 Survey Data |
|---|---|---|---|---|---|---|
| Effective | 82% | 71% | 77% | 71% | 83% | 83% |
| Overprotected | 11% | 10% | 10% | 10% | 10% | 1% |
| Underprotected | 6% | 15% | 3% | 5% | 4% | 13% |
| No Data | 1% | 4% | 10% | 14% | 4% | 3% |

Data reproduced from Table 5-1 RPP-RPT-47435, Rev. 5

Results of the survey show that a majority of the readings meet corrosion control criteria. The 10% of piping described as 'overprotected' are areas that exhibited instant off (error free) readings more negative than -1200 mV DC. In certain situations, instant off potentials of carbon steel more negative then approximately -1200 mV can lead to atomic hydrogen migration into the grain boundaries of the steel resulting in hydrogen embrittlement. In order to reduce this possibility, the site has determined that instant off potentials more negative than -1200 mV are considered overprotected and an attempt is made to reduce these voltages. Information

pertaining to the manner in which the data are collected, particularly through the use of pulse generator, has resulted in a reevaluation of these measurements. Additional testing with updated equipment (i.e., synchronizable interrupters) will alleviate what is likely an error in these readings.

The most significant concern centers around the 3 to 6% of readings that did not meet corrosion control criteria (with a 15% outlier in 2010). A majority of these test sites are associated with the SL lines and exhibited instant off potentials that were significantly more positive than the other test stations. In response to this condition, the site has installed several ER probes in these areas to monitor actual corrosion rates of buried specimens. Data collected from these probes will help quantify any corrosion that exposed steel would be subjected to in these areas.

Due to modifications being made to the cathodic protection system, the annual 2014 pipe-to-soil potential survey was not completed in a manner similar to previous years. Bi-monthly rectifier inspections were performed in accordance with 5-CATH-221 and 2S22036, fulfilling the regulatory requirements for verification of equipment operation. Pipe-to-soil potential data was collected in the fall of 2014 and in January 2015 upon completion of system modifications and was reported in RPP-RPT-47435, Rev. 5 "Annual Protected Pipeline CP Status Report Based on 2014 Annual Survey Data", April 2015.

The incorporation of synchronizable interrupters is now being employed as opposed to the use of pulse generators and wave form analyzers. The use of this equipment will provide much more accurate polarized potential (error free) readings. Bi-monthly rectifier readings continue to be collected.

When using the McMiller JR1 current interrupters, it is important to verify that the on and off cycles of each unit (one per rectifier) remain constant throughout the testing period. Verification can be made throughout the day, or at a minimum, and the end of each day, by selecting one of the interrupters and testing it to each of the others. This can be completed by measuring the direct current millivolts or resistance (ohms) between the output terminals of the interrupters to determine if they are cycling in unison.

## 6.5 DISCUSSION OF BELOWGROUND PIPING CORROSION PROTECTION CRITERIA

Corrosion protection criteria are determined using industry guidelines described in NACE SP0285. Specifically, the criteria listed in the annual cathodic protection survey reports include the following:

- A negative (cathodic) potential of at least 850 mV with the cathodic protection current applied. This potential is measured with respect to a copper sulfate electrode contacting the electrolyte. Voltage drops other than those across the structure/electrolyte boundary must be considered for valid interpretation of this potential measurement.
- A negative polarized potential of at least 850 mV relative to a copper sulfate electrode.
- A minimum of 100 mV of cathodic polarization. The formation or decay of polarization may be used to satisfy this criterion.

As allowed by standard practice, the use of any one of these criteria can be used to establish effective corrosion control. For example, the use of a negative voltage shift of at least -850 mV

can be used at one testing location while the formation of 100 mV of polarization can be used at an adjacent test location. The testing methodology used at the Hanford Site correctly allows for the intermixing of these criteria to determine if corrosion control criteria are being met.

Of note are two special considerations applicable to the tank farm piping as described in NACE SP0285:

- Section 5.4.2, Abnormal conditions in which protection is ineffective or only partially effective sometimes exists. Such conditions may include elevated temperature, disbonded coatings, shielding, bacterial attack, and unusual contaminants in the electrolyte.
- Section 5.4.3, When structures that have dissimilar metals are protected, a negative structure-to-soil potential equal to that for protection of the most anodic metal should be maintained.

These two considerations are applicable to the DST System piping. Portions of the coating system consist of multi-layer non-bonded coatings covering a casing pipe that houses the carrier pipeline. The nature of disbonded coatings are such that moisture could migrate through a coating breach, travel some distance down the exterior casing and come into contact with exposed metal at a holiday on the dielectrically coated surface. This scenario results in a high resistance path that would discourage protective current flow to the holiday. Given this particular type of installation, other forms of corrosion control verification are needed to complement the use of pipe-to-soil potential measurements. These other techniques are discussed in the criteria documents and are expanded on below.

Galvanic corrosion occurs when two dissimilar metals are in electrical contact with each other in the presence of an electrolyte. Two common examples include carbon steel in contact with copper, and carbon steel in contact with steel embedded in concrete. In these instances, criteria for corrosion control state that protection for the most anodic material must be used. Following this caveat, the use of the 100 mV polarization criterion would not be applicable. The reasoning for this statement in the criteria is that exterior surface of the steel could be polarized by 100 mV; however, current flow could still exist between the carbon steel and the copper resulting in degradation of the carbon steel. A deficiency in the criteria is that they do not address surface area ratios between the carbon steel and copper nor the proximity between the two metals. In the strictest sense, if these dissimilar metal construction methods are used, the -850 mV polarized potential criteria would be most applicable.

The annual reports also note that field data collection is completed in accordance with NACE TM0497.

In most instances, the criteria outlined above and in the annual reporting documents are effective for establishing that corrosion control criteria are being met. However, there are instances where additional evaluation techniques can be used to determine the effectiveness of the corrosion control system including the following:

- NACE SP0285, Section 5.1.4(d), determining whether or not there is physical evidence of corrosion.
- NACE SP0285, Section 5.2.2, interruptible cathodic protection coupons may be installed for the purpose of determining the true level of cathodic polarization.

The use of coupons has gained popularity within the industry as a means to help establish that the methods of corrosion control being employed are effective. Coupons are small representative samples of the same type of material as the piping. The coupons are installed within the same soil environment as the buried piping and are connected to the cathodic protection system. At established time intervals, the coupons are removed and inspected for signs of deterioration. If no losses are noted, it is reasonable to expect that any exposed steel of the pipeline (casing) in the same soil environment would react in a similar manner. The Hanford Site has started employing the use of coupons as an additional inspection tool and their continued use is encouraged.

Similar to coupons are instruments know as linear polarization probes or ER probes. These small metal samples with a known cross-sectional area are installed in the soil adjacent to the piping. Measuring the ER of these probes over time will give an indication of corrosion rates. As the cross-sectional area is decreased (corrodes), the ER across the element increases. This increase in resistance is directly proportional to corrosion rates. These probes are currently being used at the WTP for monitoring of the belowground piping. Installation of ER probes has been completed at multiple locations including lines SL-509, SL-510, SN-609, and SN-610 within AP Tank Farm; lines SN-285 and SN-286 within SY Tank Farm; and line PW-4531 within AY Tank Farm.

Continued use of coupon and ER probe technology will help validate the effectiveness of the corrosion control equipment.

An additional method of assessing the operational effectiveness of the cathodic protection systems would be to institute a program of routine pipeline exposure and subsequent visual examination. The number and frequency of these bell-hole examinations would be based upon several factors including age of piping; sites that may be subject to electrical shielding from the cathodic protection systems; locations adjacent to dissimilar metals (e.g., copper grounding systems); or locations where pipe-to-soil potentials have failed to meet corrosion protection criteria. Given the construction method of the double-walled piping system, the inspection may simply be a matter of determining by visual means if cracks, gouges, or other damaged or deterioration is observed. Proper documentation and repair procedures would need to be developed for this type of examination.

The use of long-range UT was introduced as a potential inspection technique for the piping. A cost analysis was completed that described that multimillion-dollar expenditures would be required to perform this type of inspection. Long-range UT is more commonly known in the pipeline industry as guided wave. A large number of oil and gas companies that utilize transmission pipelines incorporate the use of guided wave technology to assess the condition of carrier pipelines within cased crossings. Piping within casings cannot be tested using traditional aboveground electrical testing methodology. To properly assess this piping, a transducer array is connected to the piping under investigation and torsional waves are directed down the wall of the piping. Defects, metal loss, welds, and etc. cause reverberation of the wave back to the transducer; software then provides feedback as to the extent of the anomaly.

With the extensive array of piping in a DST farm, it would not be practical to establish a system of conducting guided wave testing on all concerned lines. However, a few select lines that would readily accommodate guided wave field tests should be considered for this technology. Condition and type of the pipeline coating, number of bends, and wall thickness all contribute to

the length of piping that can be tested. However, testing up to 400 ft on each side of the temporarily installed transducer is a reasonable figure. Based upon the results, expansion of the testing could be completed. Given the configuration of the ACT-100 piping, the use of guided wave technology would provide the most accurate depiction of the actual condition of the casing and/or carrier pipe.

## 6.6 VERIFICATION THAT TESTING IS BEING COMPLETED TO INDUSTRY STANDARDS

A review of the testing procedures shows that the field data collection is being completed in accordance with industry standards, specifically NACE TM0497 and NACE SP0285. During a meeting with managers of the corrosion department, it was relayed that the Hanford Site uses a dedicated cathodic protection crew to take readings (ensures consistency), that the crews hold monthly meetings to discuss testing issues, and that the testers have gone through NACE CP1 and CP2 training. All of these items are important to maintain the integrity of the testing program.

## 6.7 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

Discussion associated with each of the 2006 DSTAR cathodic protection related recommendations is presented in this section. Full wording of each of the recommendations along with dispositions is outlined in RPP-RPT-50440.

- 2006 DSTAR Item R20: Inspect excavated pipelines and specified abandoned pipelines.

  ARES Corporation, acting as the Architect/Engineer, was tasked with developing a listing of pipelines with differing coating/installation configurations as well as differing levels of cathodic protection for excavation and examination.

  Results of the multiple inspections did not reveal any instances of significant corrosion-related degradation. It was also noted that installation of stationary reference electrodes and ER probes were added at select lines where traditional methods of indirect examination (pipe-to-soil potentials) will not typically yield accurate results. Specifically, this condition exists with the application of the sprayed-in-place foam insulation on the exterior of the casing pipe.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R20.

- 2006 DSTAR Item R21: Obtain native potentials at test stations.

  Depolarized potential surveys are conducted every 5 years or after major construction work. The last depolarized potential survey was completed in 2013. It is agreed that the use of native potentials as described in the recommendation is inaccurate. As noted within the disposition, the correct term is depolarized potential. Depolarized potentials were collected in accordance with industry standards and documented procedures utilized by the site.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in R21.

- 2006 DSTAR Item R22: Troubleshoot aberrant readings of last survey.

  All items listed in this recommendation appear to have been properly addressed. A 5-year depolarized potential survey (unless significant earthwork has occurred) is listed as a recommendation to verify pipe-to-soil potentials without the application of protective current in order to satisfy NACE criteria.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R22 with the inclusion that should additional electrically continuous piping be introduced into the network adjacent to the location of depolarization testing, a new depolarized value at that location will need to be established.

- 2006 DSTAR Item R23: Document, trend and analyze data from bi-monthly rectifier inspection and annual polarization surveys.

  Bi-monthly rectifier readings and annual test station survey data collection is being completed as required by WAC 173-303-640. Recommendations for collection of data associated with stationary reference electrodes are not being performed, as the stationary reference electrodes are no longer being monitored. The use of stationary reference electrodes can be problematic, as they can drift and deviate from the 10 mV requirement when tested against a calibrated portable reference electrode. Removing these stationary reference electrodes from the monitoring protocol is acceptable so long as the testing requirements outlined in 3-CATH-690 continue to be adhered.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R23.

- 2006 DSTAR Item R24: Clarify need for resistance testing in annual test procedure.

  The requirement for resistance testing has been removed. Continuity of leads within individual test stations (within ±1 mV) of each other is used to verify test lead continuity (it is correctly noted that these readings must be taken without moving the reference electrode). Industry practice typically allows for a ±2 mV difference between test leads to confirm continuity.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R24.

- 2006 DSTAR Item R25: Analyze "waterproof" assumptions and methods of jacketed pipelines.

  Multiple sources are referenced regarding the use of the jacketed pipeline and the requirement for additional methods of corrosion control. However, the IQRPE specifically recommends "obtaining physical evidence at selected test sites confirming the efficacy of the waterproof jacketing."

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R25.

- 2006 DSTAR Item R26.1: Establish the 0.03 amp/anode output limit near the tanks as a temporary measure.

The use of the 0.03 amp/anode was intended as a guide as opposed to an operational limit. The concern appears to reside with applying a greater than 1.7 V potential to the tank rebar. It was not detailed if this measurement was taken with the current on or an instant off (error free reading). Regardless of the intent, the 0.03 amp/anode is not a guideline adopted by industry and has been correctly removed as part of this disposition.

- 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R26.

- 2006 DSTAR Item R27: Incorporate design, testing, and operating parameters.

  The recommendations described in Item R27 are valid from a cathodic protection design standpoint and are not related to routine monitoring and inspection.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in R27.

- 2006 DSTAR Item R28: Measure and document anode current outputs.

  The IQRPE recommends recording anode current output using shunts installed within "an anode current measuring box." The disposition to this recommendation is that individual anode current outputs, anode feeder cables, and loop cables are being measured using a calibrated clamp-on ammeter. This is an industry accepted method of collecting current data.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R28.

- 2006 DSTAR Item R30: Analyze pipelines of figures 1 through 11 for the applicability for receiving new or additional cathodic protection features.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R30.

- 2006 DSTAR Item R31: Improve document accessibility.

  Based on the information reviewed as part of this assessment, it appears that an updated database with the ability to search records, drawings, as-builts (where available) has been implemented.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R31.

- 2006 DSTAR Item R32: Determine whether inaccessible test stations are post-2005 test stations.

  There was one missing test station noted in the report. As a response to this missing test station, multiple other adjacent test stations are available and indicate that corrosion protection criteria are being met. RPP-RPT-41570, *Locating Missing Test Stations on Select List Lines,* notes that T(77-3) did not need to be replaced given the protected nature of the surrounding piping.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R32.

- 2006 DSTAR Items R33 and R33.1: Determine whether inaccessible test stations are post-2005 test stations.

  Item 1 (R33) concerning the frequency of testing has been properly addressed with this disposition.

  Item 2 (R33.1) suggests paring down the number of test stations, on non-regulated piping, that receive annual polarization testing. The recommendation is also made to determine if it is economically justifiable to remove the anodes from the cathodic protection circuit that provide protective current to these non-Post-2005 and Post-2005 non Select List lines. To date, this task has not been completed. The operation of these anodes does not pose a threat to the integrity of the piping system, and indeed provides for protective current to these non-regulated lines. Leaving the anodes operational while awaiting an economic analysis is prudent asset management.

  - Procedures for removal of non-essential test stations (not associated with the 128 Select List lines) have been implemented. Allowing the continued operation of the anodes associated with these test stations while evaluating the need for an economic analysis is a satisfactory disposition. <u>2016 DSTAR Assessment:</u> This disposition satisfies the recommendation outlined in Items R33 and R33.1.

- 2006 DSTAR Item R34: Perform a cost benefit analysis for performing a close interval potential survey.

  This recommendation was completed and resulted in dismissal of the CIPS as it was deemed ineffective (RPP-RPT-47180, *"Waterproof" Pipeline Assessment Report*).

  - <u>2016 DSTAR Assessment:</u> This disposition satisfies the recommendation outlined in Item R34.

- 2006 DSTAR Item R35: Perform a cost benefit analysis for performing a direct current voltage gradient test.

  This recommendation was completed and resulted in dismissal of the DCVG as is was deemed ineffective (RPP-RPT-47180).

  - <u>2016 DSTAR Assessment:</u> This disposition satisfies the recommendation outlined in Item R35.

- 2006 DSTAR Item R36: Perform a cost benefit analysis for using direct inspection technologies.

  The disposition notes that a cost analysis was conducted for using long-range ultrasonics and electro-magnetic wave technologies for determining pipeline integrity. Costs ranged from $31M to $117M. Conclusions of RPP-47175 (2010) note that no viable alternatives for pressure testing were available. This disposition satisfies the response to Item R36.

  - <u>2016 DSTAR Assessment:</u> This disposition satisfies the recommendation outlined in Item R36. However, additional information provided in the 2016 DSTAR expands upon the use of guided wave technology for evaluating pipeline integrity and proposes conducting this type of inspection on selected lines to determine its applicability to the tank farm piping.

- 2006 DSTAR Item R37: Investigate the feasibility of replacing the annual test station survey with an annual CIPS.

  This recommendation has been addressed in Item R34, and by extension Item R35, and is shown to not be technically correct.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R37.

- 2006 DSTAR Item R38: Develop a waste transfer line future integrity assessment.

  - 2016 DSTAR Assessment: Referencing the inadequacy of a CIPS or DCVG, the disposition of the cathodic protection portion of this recommendation has been adequately addressed. This disposition satisfies the recommendation outlined in Item R38.

- 2006 DSTAR Item R39: Continue to investigate and assess advancements in long-range UT, specifically EMW (electro-magnetic wave) technologies.

  The Hanford Site continues to investigate this form of advancing technology and would benefit from its use. Even if the locations where this current technology can be used are limited, the results would be beneficial in validating the effectiveness of the cathodic protection systems.

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R39.

- 2006 DSTAR Item R41: Consideration for supplementing or replacing annual survey with CIPS.

  - 2016 DSTAR Assessment: Disposition of this item is adequately addressed by referencing R34 and R37.

- 2006 DSTAR Item R44: Recommendation for direct inspection of piping.

  - 2016 DSTAR Assessment: The disposition notes several instances of pipe exposure and evaluation and satisfies the recommendation outlined in Item R44.

- 2006 DSTAR Item R77 (Item 1): Document RPP-27591 provides further recommendations regarding corrosion monitoring and control on buried waste transfer lines. These are summarized in the tables of Appendix G (in RPP-28538, Rev. 4).

  - 2016 DSTAR Assessment: This disposition satisfies the recommendation outlined in Item R77.

## 6.8 IQRPE SUMMARY DISCUSSION OF 2016 DST CATHODIC PROTECTION ASSESSMENT

### 6.8.1 Findings

There are no findings related to cathodic protection for DST System transfer lines.

### 6.8.2 Observations

- Cathodic protection system testing is in accordance with regulatory and industry standards.
- The addition of coupons and ER probes will provide additional important corrosion related information for the DST farms piping.
- Certifying individuals to NACE CP-1 and NACE CP-2 will provide for a more knowledgeable team that will be able to more readily recognize and respond to noted areas of concern.
- The cathodic protection equipment installed to protect the regulated piping meets industry standards for fit for use requirements. It is understood that not all locations met criteria for corrosion control; however, system adjustments are made after testing is completed to address these locations.
- Monitoring protocol and system operations are performed in accordance with industry standards and comply with NACE requirements.
- Discussions with Hanford Site personnel indicate that evaluation of long-range guided wave inspection methodology continues to be evaluated as a means to determine locations of defects on the pipe and/or casing walls. It is understood that at this time pipe diameters, elbows, and the number of required access points do not allow for a reasonable use of this inspection tool. However, the rate at which this inspection methodology is advancing suggests that it will become a viable manner to evaluate the existing condition of the pipe/casing.

### 6.8.3 Recommendations

- For existing cathodic protection systems, the next overall DSTAR integrity assessment should follow the current 10-year schedule. (Summarized in recommendation R16-1 in Section 3.3.3.)
- The use of synchronizable interrupters (JR-1) are an improvement over the pulse generator and wave form analyzer technology. However, a majority of cathodic protection system operators and testers are using GPS-based interrupters and data collection equipment. Incorporating this type of equipment will make downloading data to a database quicker and reduce errors. Additionally, test station data can be preloaded into the data logger along with records of previous potential measurements. Having this information will make locating test stations easier and allow the determination of a testing anomaly immediately. (Summarized in recommendation R16-21 in Section 3.3.3.)
- Continue to use monitor coupons and ER probes. Based upon the information collected, consideration should be given to expanding their use. Installation of these supplemental system evaluation tools should also be considered at locations of shielding and at areas where the piping is in close proximity to bonded copper grounding systems (bi-metallic couples). Because use of the 100-mV polarization criterion is not allowed (per NACE SP0169) where bi-metallic couples exist, these instruments would be beneficial in

providing polarization and protective current density information. (Summarized in recommendation R16-22 in Section 3.3.3.)

### 6.8.4 Conclusions

In regards to DST cathodic protection, the DST System is fit for use as listed in Appendix D.

# 7.0 PIT SECONDARY LINERS/COATINGS FOR DOUBLE-SHELL TANK SYSTEM

**Introduction/Purpose**

Protective coatings are used as a means to prevent damage to the concrete pit structures should a leak event occur. Waste materials have the potential to degrade the concrete matrix. Sound engineering and the CFR and WAC requirements for double encasements of hazardous waste dictates that a barrier be used to prevent damage.

This investigation focused on reviewing past pit coating inspection reports, the manner in which the coatings are applied, and the frequency of inspections. Information regarding these topics along with recommendations based upon past experience with these and similar structures are provided.

**Scope/Requirements**

Previous DSTAR reporting provided a recommended inspection cycle for each of the pits. Data was presented relative to the last inspection (including documentation reports) and outlined when the next review of the coating is to be completed. In conjunction with this, a review of the coating inspection procedures is being provided for additional consideration.

**Method of Assessment**

The assessment includes a review of past pit coating inspection reports and a review of the 2006 DSTAR. The manner in which the pit coatings are inspected, methodology used to determine if repairs are required, and the subsequent repair inspections are also assessed. Lastly, the pit coating inspection cycle is analyzed to determine if inspection intervals were reasonable based upon the coating material used and if the inspection cycles were consistent with stated requirements.

## 7.1 REVIEW OF OPERATING PROCEDURES

### 7.1.1 Inspection and Repair of Coatings

Inspection intervals for the pit liners and coatings are established based upon the type of coating materials used:

- Polyurea coatings every 15 to 18 years
- Pits with epoxy paint coatings every 10 to 12 years or after every 2 jumper installations or disconnect activities, whichever is shorter
- Vaults with epoxy paint coatings every 12 to 14 years
- Pits/vaults with stainless steel liners every 15 to 20 years.

Procedures describing the inspection and repair of pit coatings are outlined in TO-040-050, *Performance Inspections of Pit Coatings.* By reference, inspection tasks included in this report refer to WAC-173-303-640. Additional inspection documentation is described in Hanford Site forms Pit Protective Coating Inspection (A-6006-537) and Pit Protective Coating Engineering Review (A-6006-538).

All pit surfaces are required to be cleaned such that an appropriate visual inspection can be conducted. Given the radiological hazards associated with these areas, inspection is normally

completed by reviewing photographs provided by individuals specifically trained to be in the pit vicinity. Once cleaning is completed to the satisfaction of the NACE Level 2 Coating Inspector, the exposed surfaces are reviewed for punctures, scrapes, cracks, corrosion, and blistering.

All noted anomalies are repaired using an appropriate and compatible coating material (currently Amerlock® 400). The surrounding sound surfaces are scarified to provide a surface with an appropriate anchor profile, the coating is properly mixed and applied to the defect area(s). Proper cure is allowed, and additional coats are applied as required. Documentation of environmental conditions, coating batch numbers, and final dry film thickness are to be measured and recorded. Photographs of each step are to be taken.

Standardized visual inspection forms are used whenever coating repairs are completed. These forms have check box areas for verifying that defects are no longer present.

Additional visual inspection requires noting any holes or cracks in the concrete or coating, any exposed concrete or exposed reinforcing metal within the concrete, excessive water puddles, or general signs of degradation.

Coating inspection forms should note the following items:

- **Environmental Conditions** – Surface temperature, wet and dry bulb temperatures, dew point, and relative humidity. The environmental conditions must be measured within the immediate area of coating application every 4 hours and whenever there is a change in weather conditions (i.e., changing from sunny to cloudy conditions). A variety of portable instruments are available to measure and log these environmental conditions.
- **Protective Coating** – Batch numbers, shelf life, mixing time, induction (sweat-in) time, and pot life.
- **Coating Thickness** – When ALARA conditions allow access into the pits, wet film thickness during application, dry film thickness between coats, and final dry film thickness should be recorded. If measuring dry film thickness between coats is not practical, a total dry film thickness would suffice. In instances of ALARA concerns, a review of photographs depicting conditions after completion of coating application in lieu of coating thickness measurements would be acceptable.

## 7.2 COATING COMPATIBILITY FOR VARIOUS COATING OPTIONS

Amerlock 400 is currently the accepted epoxy repair material. Assumptions concerning constituent compatibility include water and sodium hydroxide (2006 DSTAR Volume 1, Section 6.9). This coating material has been reviewed by multiple IQRPEs as part of pit coating inspection reviews and found to be acceptable for this service environment. Instances where polyurea was used as the repair coating material were not found. Typically, this fast cure coating material requires extensive expertise and equipment capable of accurately monitoring fluid temperatures and pressures and would not normally be used for spot repairs. Additional information regarding coating compatibility can be found in Section 10.2.2.4.

## 7.3 REVIEW OF INSPECTION AND REPAIR REPORTS

### 7.3.1 Certification of Inspection Personnel

Individuals conducting inspection of the pit surfaces are to be NACE Level 2 Coating Inspectors. Due to radiological concerns, coating inspectors often complete their assessments by viewing photographs of the surfaces and any noted damage along with subsequent repair work. This often requires several iterations, but does result in an inspection that is as thorough as reasonably possible. Along with a review of the surfaces and repairs, the inspection should also include verifying the coating materials, environmental conditions, application procedures (wet and dry film thicknesses) and any subsequent repair work that may be necessary. Once completed, the inspection materials are forwarded to an IQRPE for review. The IQRPE has the authority to accept or reject the inspection results.

### 7.3.2 Certification of Individuals Performing Upgrades/Repair

A record of requirements for qualifications of individuals performing coating repairs has not been located. Because the work is overseen by a NACE Level 2 Coating Inspector and given the constraints of working in close proximity to the pits, it is reasonable that craftsmen following direction from a certified coating applicator would be able to properly perform small isolated repairs. The most important aspects of the repair work include proper surface preparation, mixing of coating materials in accordance with manufacturer's recommendations, and applying the material to the appropriate thickness.

### 7.3.3 Inspection and Repair Reports

The reviewed pit coating inspection reports show that the inspections and subsequent repairs (as required) were completed to the satisfaction of the onsite coating inspector and IQRPE. Overview photographs of the inspected pits, with before and after repair views, are typically included with the IQRPE reports. This type of documentation will prove valuable the next time the pits are opened and their protective coatings are inspected.

## 7.4 MATRIX OF PIT COATING INSPECTION HISTORY AND PLANNED INSPECTIONS

A pit coating schedule was provided with the review documents. The schedule outlines pertinent information regarding inspection dates (past and upcoming), documentation numbers relative to the previous inspections, and comments describing the type of coating material utilized within the pit structure. Table 7-1 details information excerpted from the provided matrix, updated to include recent inspections completed since the matrix was published.

Table 7-1 is organized to list the planned sequence of future pit inspections as described by criteria outlined in the 2006 DSTAR (10 to 12 years for epoxy coated pits, 15 to 18 years for polyurea coated pits, and 15 to 20 years for steel liners). In addition, Table 7-1 includes known inspections completed since the 2006 DSTAR. Interpretations of pit coating inspection results, materials used for repairs, and inspection cycles are included in the respective Section 7.0 subsections.

**Table 7-1: Pit Coating Matrix (3 sheets)**

| Pit | Approx. Year of Construction (Current Age) | Date of Last Pit Coating Inspection (Report Number) | Next NACE Inspection Due | Comments |
|---|---|---|---|---|
| AW-02D | 1980 (35) | 2/15/2005 (RPP-RPT-25162)<br>5/19/2003 (photos)<br>10/13/2015 (WO-165830) | 10/2025 to 10/2027 | Pit Coating: Epoxy |
| AW-01A | 1980 (35) | 4/19/2005 (RPP-RPT-25855) | 9/2013 to 9/2015 | Pit Coating: Epoxy |
| AW-06A | 1980 (35) | 5/5/2005 (RPP-RPT-25979) | 12/2013 to 12/2015 | Pit Coating: Epoxy |
| AW-04A | 1980 (35) | 4/26/2005 (RPP-RPT-25854) | 8/2013 to 8/2015 | Pit Coating: Epoxy |
| AW-03A | 1980 (35) | 8/13/2003 (RPP-19430) | 5/2013 to 5/2015 | Pit Coating: Epoxy |
| AN-05A | 1981 (34) | 9/20/2002 (RPP-12552) | 8/2013 to 8/2015 | Pit Coating: Epoxy |
| AN-02A | 1981 (34) | 10/13/2003 (RPP-18678) | 8/2013 to 8/2015 | Pit Coating: Epoxy |
| AN-03A | 1981 (34) | 10/13/2003 (RPP-18679) | 8/2013 to 8/2015 | Pit Coating: Epoxy |
| AN-07A | 1981 (34) | 10/13/2003 (RPP-18680) | 8/2013 to 8/2015 | Pit Coating: Epoxy |
| AP-04A | 1986 (29) | 5/17/2005 (RPP-RPT-26811)<br>3/27/2014 (TFC-WO-13-6005) | 3/2024 to 3/2026 | Pit Coating: Epoxy |
| AP-03A | 1986 (29) | 5/17/2005 (RPP-RPT-26810)<br>3/13/2014 (TFC-WO-13-6004) | 3/2024 to 3/2026 | Pit Coating: Epoxy |
| AP-01A | 1986 (29) | 5/17/2005 (RPP-RPT-26809)<br>9/5/2003 (photos)<br>3/12/2014 (TFC-WO-13-6003) | 3/2024 to 3/2026 | Pit Coating: Epoxy |
| SY-A Valve Pit | 1977 (38) | 2/2/2005 (RPP-25163) | 2/2015 to 2/2017 | Pit Coating: Epoxy |
| SY-03A | 1977 (38) | 4/26/2005 (RPP-RPT-25853) | 4/2015 to 4/2017 | Pit Coating: Epoxy |
| SY-02D | 1977 (38) | 5/5/2005 (RPP-RPT-25978) | 5/2015 to 5/2017 | Pit Coating: Epoxy |
| AP-07A | 1986 (29) | 6/22/2005 (RPP-RPT-26807) | 2/2015 to 2/2017 | Pit Coating: Epoxy |
| AP-05A | 1986 (29) | RPP-27145 dated 7/26/2005<br>WO-165826 (10/29/2015) | 10/2025 to 10/2027 | Pit Coating: Epoxy |
| AP-08A | 1986 (29) | 7/26/2005 (RPP-RPT-27146)<br>9/30/2014 (TFC-WO-14-2816) | 9/2024 to 9/2026 | Pit Coating: Epoxy |
| AP-03D | 1986 (29) | 7/25/2005 (RPP-RPT-26866) | 7/2015 to 7/2017 | -- |
| SY-02A | 1977 (38) | 8/15/2005 (RPP-RPT-25980) | 8/2015 to 8/2017 | Pit Coating: Epoxy |
| AP-06A | 1986 (29) | 4/20/2006 (RPP-RPT-29426) | 4/2016 to 4/2018 | Pit Coating: Epoxy |
| SY-B Valve Pit | 1977 (38) | 6/8/2006 (RPP-RPT-29962) | 6/2016 to 6/2018 | Pit Coating: Epoxy |

**Table 7-1: Pit Coating Matrix (3 sheets)**

| Pit | Approx. Year of Construction (Current Age) | Date of Last Pit Coating Inspection (Report Number) | Next NACE Inspection Due | Comments |
|---|---|---|---|---|
| AZ Valve Pit | 1976 (39) | 5/11/2003 (RPP-16278)<br>1/4/2012 (TFC-WO-10-4850) | 1/2027 to 1/2032 | Steel Liner |
| AW-02A | 1980 (35) | 2/17/2005 (RPP-RPT-25161)<br>Re-inspected 05/21/2007 (RPP-RPT-33906)<br>Re-inspected 9/23/2008 (RPP-RPT-40011 & TFC-WO-08-1012 per work package work record) | 9/2018 to 9/2020 | Pit Coating: Epoxy |
| AY-01A | 1971 (44) | 5/19/2002 (RPP-11217)<br>9/17/2009 (RPP-RPT-42472)<br>8/25/2015 (WO-174813) | 8/2025 to 8/2027 | Pit Coating: Epoxy |
| AP-02A | 1986 (29) | 6/22/2005 (RPP-RPT-26808)<br>3/29/10 (TFC-WO-09-2387) | 3/2020 to 3/2022 | Pit Coating: Epoxy |
| AW-02E | 1980 (35) | 9/1/2005 (RPP-RPT-27147)<br>4/21/2010 (TFC-WO-10-0760)<br>8/9/2013 (TFC-WO-11-5518) | 8/2023 to 8/2025 | Pit Coating: Epoxy |
| AP-02D | 1986 (29) | 3/14/2006 (RPP-29199)<br>3/7/2006 (photos)<br>6/22/10 (WFO-WO-06-000440) | 6/2020 to 6/2022 | Pit Coating: Epoxy |
| AN-01A | 1981 (34) | 4/11/2003 (RPP-15831)<br>Re-inspected 9/18/2008 (RPP-39121)<br>7/2/2010 (TFC-WO-10-1825)<br>10/2012 (TFC-WO-1050) | 10/2022 to 10/2024 | Pit Coating: Epoxy |
| AP-Valve Pit | 1986 (29) | 3/7/2006 (RPP-RPT-29052)<br>1/31/2011 (TFC-WO-10-2775) | 1/2021 to 1/2023 | Pit Coating: Epoxy |
| AN-B Valve Pit | 1981 (34) | 7/28/1999 (RPP-16375)<br>Re-inspected 8/8/2007 (RPP-16375)<br>4/22/11 (TFC-WO-10-4563) | 4/2021 to 4/2023 | Pit Coating: Epoxy |
| AN-A Valve Pit | 1981 (34) | 7/28/1999 (RPT-16375)<br>Re-inspected 8/8/2007 (RPP-RPT-34475)<br>6/12/2011 (TFC-WO-10-4562) | 6/2021 to 6/2023 | Pit Coating: Epoxy |
| AN-06A | 1981 (34) | 9/20/2002 (RPP-12551)<br>6/8/2011 (TFC-WO-11-1252) | 6/2021 to 9/2023 | Pit Coating: Epoxy |
| AN-04A | 1981 (34) | 4/11/2003 (RPP-15831)<br>Re-inspected 9/19/2012 (TFC-WO-11-4676) | 9/2022 to 9/2024 | Pit Coating: Epoxy |
| AW-05A | 1980 (35) | 8/18/2003 (RPP-19431)<br>11/4/2013 (TFC-WO-12-5408) | 11/2023 to 11/2025 | Pit Coating: Epoxy |

**Table 7-1: Pit Coating Matrix (3 sheets)**

| Pit | Approx. Year of Construction (Current Age) | Date of Last Pit Coating Inspection (Report Number) | Next NACE Inspection Due | Comments |
|---|---|---|---|---|
| AW-B Valve Pit | 1980 (35) | 3/25/2002 (RPP-11060)<br>8/2009 (WFO-WO-07-2333) | 8/2024 to 8/2027 | Pit Coating: Polyurea |
| AW-A Valve Pit | 1980 (35) | 11/14/2002 (RPP-13624)<br>9/2010 (TFC-WO-09-2386) | 9/2025 to 9/2028 | Pit Coating: Polyurea |
| AZ-02A | 1976 (39) | 5/19/2002 (RPP-11218)<br>4/30/2011 (TFC-WO-10-4297) | 4/2026 to 4/2029 | Pit Coating: Polyurea |
| AZ-01A | 1976 (39) | 5/19/2002 (RPP-11218)<br>6/2011 (WFO-WO-07-1730)<br>3/17/2015 (TFC-WO-14-3937) | 3/2030 to 3/2033 | Pit Coating: Polyurea |

Reference: Engeman, Jason, "Re: Pit Coating Inspection Schedule". Message to Jeremy Hailey, 2015, email.

## 7.5 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

Discussion associated with each of the pit and vault coatings related recommendations is presented in this section. Full wording of each of the recommendations along with dispositions is outlined in RPP-RPT-50440.

- 2006 DSTAR Item R61: Pit cleaning and coating inspection cycles and qualifications of coating inspector.

  There is a contradiction between the inspection cycles described in RPP-RPT-50440 and the inspection cycles outlined in 2006 DSTAR Volume 1. It appears that the pit coating matrix table (Table 7-1) was developed with the inspection dates described in the 2006 DSTAR.

  Whereas the recommendations described a NACE Coating Inspector, the Hanford Site has determined that the NACE Coating Inspector must hold a minimum Level 2 Coating Inspection Certification. All inspection work is to be completed in accordance with TO-040-050.

  - <u>2016 DSTAR Assessment:</u> This disposition satisfies the recommendation outlined in Item R61.

- 2006 DSTAR Item R62: Pits with epoxy coatings should not be allowed to have old jumpers stored on the floor.

  The disposition states that there are no longer any abandoned jumpers residing on epoxy coated pit floors. The disposition also notes that a jumper is resting on the floor of the stainless steel lined AZ valve pit.

  - <u>2016 DSTAR Assessment:</u> The jumper on the floor of the AZ valve pit will not detrimentally affect the integrity of the stainless steel liner. Photographs also show that a braided jumper may be in contact with the floor in pit AW-04A.

Although the jumper has been removed, verification of this condition should be noted during the next inspection cycle of this pit and photographs of the floor at the possible contact point should be made to determine if any coating damage has occurred. This disposition satisfies the recommendation outlined in Item R62.

## 7.6 IQRPE SUMMARY DISCUSSION OF THE 2016 DST PIT SECONDARY LINERS/COATINGS ASSESSMENT

### 7.6.1 Findings

There are no findings related to the pit secondary liners/coatings for the DST System.

### 7.6.2 Observations

- Pit coating inspection intervals based upon the type of secondary containment protection (epoxy, polyurea, and stainless steel) are reasonable and prudent.
- Conducting a visual inspection using photographs is reasonable considering the potentially hazardous conditions. However, the inspector must continue to be given the authority to require additional photographs of suspect areas as required.
- The protective coatings and liners were determined to be compatible with the waste being transferred and will provide protection to the concrete in the event of a leak or spill.
- Table 7-1 lists multiple pits that have not had their coatings inspected within their recommended cycle. So long as these pits continue to not be used, inspection of the pit coatings is not warranted. However, prior to their use, the pits must have their coatings evaluated as outlined in the inspection documents.

### 7.6.3 Recommendations

- For the pit secondary liners/coating, the next overall DSTAR integrity assessment should follow the current 10-year schedule. (Summarized in recommendation R16-1 in Section 3.3.3.)
- Inspection cycles of the pit coatings and lining materials should be completed every 10 to 12 years for epoxy coated pits, 15 to 18 years for polyurea coated pits, and 15 to 20 years for steel liners and as outlined in Table 7-1. (Summarized in recommendation R16-15 in Section 3.3.3.)
- At time of coating, pit coating inspection reports should include the following:
    - Environmental conditions within the coating area (surface temperature, wet and dry bulb temperatures, dew point, and relative humidity). Environmental conditions should be recorded every 4 hours or when changes in weather occur, such as going from sunny to cloudy sky conditions.
    - Coating material data.
    - Data regarding coating application.
    - (Summarized in recommendation R16-16 in Section 3.3.3.)

- In instances where the recommended inspection cycles have not been met for pits that are not being used, the pit coatings should be inspected prior to use. (Summarized in recommendation R16-17 in Section 3.3.3.)
- If holes or cracks in the concrete are noted, information regarding the defect (diameter, width, length, orientation) should be provided along with photographs and a legible scale. (Summarized in recommendation R16-18 in Section 3.3.3.)

### 7.6.4 Conclusions

In regards to DST pit liners and coatings, the DST System is fit for use as listed in Appendix D.

# 8.0 LEAK DETECTION SYSTEMS

**Introduction/Purpose**

The purpose of this assessment is to determine that DSTs are not leaking and are fit for use. Additionally, this assessment is to determine that the leak detection system is in place, maintained, and operated adequately to ensure the ability to detect a leak. The leak detection systems are used to determine if the primary shell is leaking or if the tank liquid level changes rapidly. This section addresses the primary tank liquid level and the tank annulus between the primary and secondary shells for leak detection. This section is to evaluate the tank leak detection systems fit for purpose, inspections, maintenance and compliance with regulations.

**Scope/Requirements**

The applicable regulation is WAC 173-303-640(2)(a). This section addresses the primary tank liquid level and any liquid level detected in the tank annulus between the primary shell and the secondary shell. An adequate leak detection system must exist, operate, be maintained, and monitored. An adequate leak detection system is further defined in the HFFACO and clarified in PCHB 98-249 and PCHB 98-250.

PCHB 98-249 and PCHB 98-250 require three leak detector probes in the annulus of each DST and at least one surface level monitor installed in the primary tank of each DST. Also, "all DSTs equipped with operating annulus CAMs will be monitored daily for airborne releases into the annulus that could give an indication of a leak from the primary tank structure into the annulus." The annulus leak detection continuous air monitor (CAM) is located in the annulus ventilation system prior to the high-efficiency particulate air filters.

**Method of Assessment**

The information gathered was primarily from Hanford Site released documents, drawings, interviews, and supplied information. The primary documents used were the following:

- RPP-15131, *System Design Description for AW Tank Farm Double-Shell Tank Waste Storage System (DSA Based)*
- RPP-15132, *System Design Description for AN Tank Farm Double-Shell Tank Waste Storage System (DSA Based)*
- RPP-15133, *System Design Description for AP Tank Farm Double-Shell Tank Waste Storage System*
- RPP-15134, *System Design Description for SY Tank Farm Double-Shell Tank Waste Storage System*
- RPP-15135, *System Design Description for AY/AZ Tank Farm Double-Shell Tank Waste Storage System (Documented Safety Analysis [DSA] Based).*

## 8.1 SUMMARY OF 2006 DSTAR LEAK DETECTION SYSTEM

The 2006 DSTAR did not assess nor address leak detection.

## 8.2 DISCUSSION OF LEAK DETECTION SYSTEMS

### 8.2.1 Tank Leak Detection

All of the DSTs have three annulus leak detectors and at least one level detector that report to the Tank Monitoring and Control System (TMACS). There is also a manual level detector on each DST. These are the Enraf automatic servo level gauges. The DST level detectors are Honeywell Enraf Model 854 ATG. The annulus leak detectors are also Honeywell Enraf Model 854 ATG. Very simply, the Enraf style uses a calibrated float on a cable connected to a drum on the top of the DST that has a calibrated spring. The float and spring are a "pair" and must be installed together for accurate results. The Enraf leak detectors are able to detect 0.25 in. or less of liquid from the bottom of the tank and are read to the nearest 0.01 in. All of the DST leak detectors and level detectors are checked by Operations during both 'daily rounds' and 'nightly rounds.' The local reading is recorded and compared to upper and lower limits. If the reading is outside those limits, further action is taken by Operations. These leak detectors also transmit alarms to the TMACS, including an instrument 'trouble' alarm. This Enraf instrument was introduced by Honeywell in the 1950s. It has been and continues to be a very reliable device.

The annulus Enrafs are initially lowered until they are in contact with the bottom of the annulus, then assigned a reference level of 0.15 in. This is done so that any liquid level beneath the Enraf displacer will register as an increase in level. The Enrafs have a backup power system. If backup power is required, a portable generator is connected to a receptacle and the manual transfer switch is positioned so that the Enrafs are powered from the generator. The Enrafs, as well as the signal transmitters, are able to be powered from the generator. The signals are transmitted to the TMACS. The Enrafs have a fail-safe circuit so that if an individual instrument fails, there is an alarm in TMACS.

The Enrafs in each of the DSTs and all of the Enrafs in the tank annuli are monitored and data recorded on both daily and nightly rounds. If there is an abnormality such as a reading out of limits, that is reported in the logs.

#### 8.2.1.1 AY Tank Farm Leak Detection

The AY Tank Farm contains two DSTs. Tank AY-102 is not evaluated in this report. Tank AY-101 has a level detector and three annulus leak detectors. All of these are Enrafs.

The annulus CAM system that monitors the individual annulus exhaust ventilation ducts for radiation is in service and alarms to the monitor control system in control room AZ-271.

The AY Tank Farm level and leak detection instruments are numbered as shown in Table 8-1.

**Table 8-1: AY Tank Farm Level and Leak Detection Instruments**

| Instrument Number | Location | Drawing |
|---|---|---|
| AY AY101-WST-LIT-101 | AY101 DST Riser 39 | H-14-010506 Sh. 1 Rev. 18 |
| AY AY101-WSTA-LDT-151 | AY101 DST Riser 88 | H-14-010506 Sh. 1 Rev. 18 |
| AY AY101-WSTA-LDT-152 | AY101 DST Riser 90 | H-14-010506 Sh. 1 Rev. 18 |
| AY AY101-WSTA-LDT-153 | AY101 DST Riser 91 | H-14-010506 Sh. 1 Rev. 18 |
| AY AY101-WSTA-CAM-101 | AY101 Annulus Exhaust | H-14-020506 Sh. 3 Rev. 6 |

Note: Complete drawing reference information is provided in Section 12.0, References.

#### 8.2.1.2 AZ Tank Farm Leak Detection

The AZ Tank Farm contains two DSTs. The two DSTs each have a level detector and three annulus leak detectors. All of these are Enrafs.

The annulus CAM system that monitors the individual annulus exhaust ventilation ducts for radiation is in service and alarms to the monitor control system in control room AZ-271.

The AZ Tank Farm Level and Leak Detection instruments are numbered shown in Table 8-2.

**Table 8-2: AZ Tank Farm Level and Leak Detection Instruments**

| Instrument Number | Location | Drawing |
|---|---|---|
| AZ AZ101-WST-LIT-135 | AZ101 DST Riser 68 | H-14-010507 Sh. 1 Rev. 15 |
| AZ AZ101-WSTA-LDT-151 | AZ101 DST Riser 90 | H-14-010507 Sh. 1 Rev. 15 |
| AZ AZ101-WSTA-LDT-152 | AZ101 DST Riser 91 | H-14-010507 Sh. 1 Rev 15 |
| AZ AZ101-WSTA-LDT-153 | AZ101 DST Riser 92 | H-14-010507 Sh. 1 Rev. 15 |
| AZ AZ101-WSTA-CAM-101 | AZ101 Annulus Exhaust | H-14-020507 Sh. 3 Rev. 6 |
| AZ AZ102-WST-LIT-101 | AZ102 DST Riser 72 | H-14-010507 Sh. 2 Rev. 12 |
| AZ AZ102-WSTA-LDT-151 | AZ102 DST Riser 89 | H-14-010507 Sh. 2 Rev. 12 |
| AZ AZ102-WSTA-LDT-152 | AZ102 DST Riser 91 | H-14-010507 Sh. 2 Rev. 12 |
| AZ AZ102-WSTA-LDT-153 | AZ102 DST Riser 92 | H-14-010507 Sh. 2 Rev. 12 |
| AZ AZ102-WSTA-CAM-102 | AZ102 Annulus Exhaust | H-14-020507 Sh. 3 Rev. 6 |

Note: Complete drawing reference information is provided in Section 12.0, References.

#### 8.2.1.3 SY Tank Farm Leak Detection

The SY Tank Farm contains three DSTs. The three DSTs each have a level detector and three annulus leak detectors. All of these are Enrafs.

The annulus CAM system that monitors the individual annulus exhaust ventilation ducts for radiation is currently out of service and the CAMs have been removed.

The SY Tank Farm level and leak detection instruments are numbered as shown in Table 8-3.

**Table 8-3: SY Tank Farm Level and Leak Detection Instruments**

| Instrument Number | Location | Drawing |
|---|---|---|
| SY SY-101-WST-LIT-101 | SY101 DST Riser 01 | H-14-010531 Sh. 1 Rev. 13 |
| SY SY-101-WST-LIT-102 | SY101 DST Riser 02 | H-14-010531 Sh. 1 Rev. 13 |
| SY SY-101-WSTA-LDT-151 | SY101 DST Riser 33 | H-14-010531 Sh. 1 Rev. 13 |
| SY SY-101-WSTA-LDT-152 | SY101 DST Riser 34 | H-14-010531 Sh. 1 Rev. 13 |
| SY SY-101-WSTA-LDT-153 | SY101 DST Riser 39 | H-14-010531 Sh. 1 Rev. 13 |
| SY SY-102-WST-LIT-101 | SY102 DST Riser 04 | H-14-010531 Sh. 2 Rev. 17 |
| SY SY-102-WSTA-LDT-151 | SY102 DST Riser 32 | H-14-010531 Sh. 2 Rev. 17 |
| SY SY-102-WSTA-LDT-152 | SY102 DST Riser 33 | H-14-010531 Sh. 2 Rev. 17 |
| SY SY-102-WSTA-LDT-153 | SY102 DST Riser 38 | H-14-010531 Sh. 2 Rev. 17 |
| SY SY-103-WST-LIT-101 | SY103 DST Riser 04 | H-14-010531 Sh. 3 Rev. 8 |
| SY SY-103-WSTA-LDT-151 | SY103 DST Riser 32 | H-14-010531 Sh. 3 Rev. 8 |
| SY SY-103-WSTA-LDT-152 | SY103 DST Riser 33 | H-14-010531 Sh. 3 Rev. 8 |
| SY SY-103-WSTA-LDT-153 | SY103 DST Riser 38 | H-14-010531 Sh. 3 Rev. 8 |

Note: Complete drawing reference information is provided in Section 12.0, References.

#### 8.2.1.4 AW Tank Farm Leak Detection

The AW Tank Farm contains six DSTs. The six DSTs each have a level detector and three annulus leak detectors. All of these are Enrafs.

The annulus CAM system at the AW Tank Farm has been retired. The annulus CAMs that monitored the individual annulus exhaust ventilation ducts for radiation have all been removed.

The AW Tank Farm level and leak detection instruments are numbered as shown in Table 8-4.

**Table 8-4: AW Tank Farm Level and Leak Detection Instruments**

| Instrument Number | Location | Drawing |
|---|---|---|
| AW AW101-WST-LIT-106 | AW101 DST Riser 04 | H-14-010502 Sh. 1 Rev. 9 |
| AW AW101-WSTA-LDT-151 | AW101 DST Riser 62 | H-14-010502 Sh. 1 Rev. 9 |
| AW AW101-WSTA-LDT-152 | AW101 DST Riser 63 | H-14-010502 Sh. 1 Rev. 9 |
| AW AW101-WSTA-LDT-153 | AW101 DST Riser 64 | H-14-010502 Sh. 1 Rev. 9 |
| AW AW102-WST-LIT-106 | AW102 DST Riser 04 | H-14-010502 Sh. 2 Rev. 8 |
| AW AW102-WSTA-LDT-151 | AW102 DST Riser 62 | H-14-010502 Sh. 2 Rev. 8 |
| AW AW102-WSTA-LDT-152 | AW102 DST Riser 63 | H-14-010502 Sh. 2 Rev. 8 |
| AW AW102-WSTA-LDT-153 | AW102 DST Riser 64 | H-14-010502 Sh. 2 Rev. 8 |
| AW AW103-WST-LIT-106 | AW103 DST Riser 04 | H-14-010502 Sh. 3 Rev. 7 |
| AW AW103-WSTA-LDT-151 | AW103 DST Riser 62 | H-14-010502 Sh. 3 Rev. 7 |
| AW AW103-WSTA-LDT-152 | AW103 DST Riser 63 | H-14-010502 Sh. 3 Rev. 7 |
| AW AW103-WSTA-LDT-153 | AW103 DST Riser 64 | H-14-010502 Sh. 3 Rev. 7 |
| AW AW104-WST-LIT-106 | AW104 DST Riser 04 | H-14-010502 Sh. 4 Rev. 10 |
| AW AW104-WSTA-LDT-151 | AW104 DST Riser 62 | H-14-010502 Sh. 4 Rev. 10 |
| AW AW104-WSTA-LDT-152 | AW104 DST Riser 63 | H-14-010502 Sh. 4 Rev. 10 |
| AW AW104-WSTA-LDT-153 | AW104 DST Riser 64 | H-14-010502 Sh. 4 Rev. 10 |
| AW AW105-WST-LIT-106 | AW105 DST Riser 04 | H-14-010502 Sh. 5 Rev. 8 |
| AW AW105-WSTA-LDT-151 | AW105 DST Riser 62 | H-14-010502 Sh. 5 Rev. 8 |
| AW AW105-WSTA-LDT-152 | AW105 DST Riser 63 | H-14-010502 Sh. 5 Rev. 8 |
| AW AW105-WSTA-LDT-153 | AW105 DST Riser 64 | H-14-010502 Sh. 5 Rev. 8 |
| AW AW106-WST-LIT-106 | AW106 DST Riser 04 | H-14-010502 Sh. 6 Rev. 8 |
| AW AW106-WSTA-LDT-151 | AW106 DST Riser 62 | H-14-010502 Sh. 6 Rev. 8 |
| AW AW106-WSTA-LDT-152 | AW106 DST Riser 63 | H-14-010502 Sh. 6 Rev. 8 |
| AW AW106-WSTA-LDT-153 | AW106 DST Riser 64 | H-14-010502 Sh. 6 Rev. 8 |

Note: Complete drawing reference information is provided in Section 12.0, References.

#### 8.2.1.5 AN Tank Farm Leak Detection

The AN Tank Farm contains seven DSTs. The seven DSTs each have a level detector and three annulus leak detectors. All of these are Enrafs. The annulus CAM system at the AN Tank Farm has been removed. Following that, the CAMs that monitored the individual annulus exhaust ventilation ducts for radiation were also removed.

The AN Tank Farm level and leak detection instruments are numbered as shown in Table 8-5.

**Table 8-5: AN Tank Farm Level and Leak Detection Instruments**

| Instrument Number | Location | Drawing |
|---|---|---|
| AN AN101-WST-LIT-104 | AN101 DST Riser 04 | H-14-010501 Sh. 1 Rev. 22 |
| AN AN101-WSTA-LDT-151 | AN101 DST Riser 59 | H-14-010501 Sh. 1 Rev. 22 |
| AN AN101-WSTA-LDT-152 | AN101 DST Riser 60 | H-14-010501 Sh. 1 Rev. 22 |
| AN AN101-WSTA-LDT-153 | AN101 DST Riser 61 | H-14-010501 Sh. 1 Rev. 22 |
| AN AN102-WST-LIT-104 | AN102 DST Riser 04 | H-14-010501 Sh. 2 Rev. 14 |
| AN AN102-WSTA-LDT-151 | AN102 DST Riser 59 | H-14-010501 Sh. 2 Rev. 14 |
| AN AN102-WSTA-LDT-152 | AN102 DST Riser 60 | H-14-010501 Sh. 2 Rev. 14 |
| AN AN102-WSTA-LDT-153 | AN102 DST Riser 61 | H-14-010501 Sh. 2 Rev. 14 |
| AN AN103-WST-LIT-104 | AN103 DST Riser 04 | H-14-010501 Sh. 3 Rev. 11 |
| AN AN103-WSTA-LDT-151 | AN103 DST Riser 59 | H-14-010501 Sh. 3 Rev. 11 |
| AN AN103-WSTA-LDT-152 | AN103 DST Riser 60 | H-14-010501 Sh. 3 Rev. 11 |
| AN AN103-WSTA-LDT-153 | AN103 DST Riser 61 | H-14-010501 Sh. 3 Rev. 11 |
| AN AN104-WST-LIT-104 | AN104 DST Riser 04 | H-14-010501 Sh. 4 Rev. 12 |
| AN AN104-WSTA-LDT-151 | AN104 DST Riser 59 | H-14-010501 Sh. 4 Rev. 12 |
| AN AN104-WSTA-LDT-152 | AN104 DST Riser 60 | H-14-010501 Sh. 4 Rev. 12 |
| AN AN104-WSTA-LDT-153 | AN104 DST Riser 61 | H-14-010501 Sh. 4 Rev. 12 |
| AN AN105-WST-LIT-104 | AN105 DST Riser 04 | H-14-010501 Sh. 5 Rev. 10 |
| AN AN105-WSTA-LDT-151 | AN105 DST Riser 59 | H-14-010501 Sh. 5 Rev. 10 |
| AN AN105-WSTA-LDT-152 | AN105 DST Riser 60 | H-14-010501 Sh. 5 Rev. 10 |
| AN AN105-WSTA-LDT-153 | AN105 DST Riser 61 | H-14-010501 Sh. 5 Rev. 10 |
| AN AN106-WST-LIT-104 | AN106 DST Riser 04 | H-14-010501 Sh. 6 Rev. 15 |
| AN AN106-WSTA-LDT-151 | AN106 DST Riser 59 | H-14-010501 Sh. 6 Rev. 15 |
| AN AN106-WSTA-LDT-152 | AN106 DST Riser 60 | H-14-010501 Sh. 6 Rev. 15 |
| AN AN106-WSTA-LDT-153 | AN106 DST Riser 61 | H-14-010501 Sh. 6 Rev. 15 |
| AN AN107-WST-LIT-104 | AN107 DST Riser 04 | H-14-010501 Sh. 7 Rev. 16 |
| AN AN107-WSTA-LDT-151 | AN107 DST Riser 59 | H-14-010501 Sh. 7 Rev 16 |
| AN AN107-WSTA-LDT-152 | AN107 DST Riser 60 | H-14-010501 Sh. 7 Rev. 16 |
| AN AN107-WSTA-LDT-153 | AN107 DST Riser 61 | H-14-010501 Sh. 7 Rev. 16 |

Note: Complete drawing reference information is provided in Section 12.0, References.

#### 8.2.1.6 AP Tank Farm Leak Detection

The AP Tank Farm contains eight DSTs. The eight DSTs each have a level detector and three annulus leak detectors. All of these are Enrafs.

The CAMs that monitor the individual annulus exhaust ventilation ducts for radiation normally are not in operation. They can be made temporarily operational for special activities such as when a tank is qualified at a higher level than the previous maximum capacity.

The AP Tank Farm level and leak detection instruments are numbered as shown in Table 8-6.

**Table 8-6: AP Tank Farm Level and Leak Detection Instruments (2 sheets)**

| Instrument Number | Location | Drawing |
|---|---|---|
| AP AP101-WST-LIT | AP101 DST Riser 04 | H-14-101503 Sh. 1 Rev. 10 |
| AP AP101-WSTA-LDT-151 | AP101 DST Riser 69 | H-14-101503 Sh. 1 Rev. 10 |
| AP AP101-WSTA-LDT-152 | AP101 DST Riser 70 | H-14-101503 Sh. 1 Rev. 10 |
| AP AP101-WSTA-LDT-153 | AP101 DST Riser 71 | H-14-101503 Sh. 1 Rev. 10 |
| AP AP102-WST-LIT | AP102 DST Riser 04 | H-14-101503 Sh. 2 Rev. 9 |
| AP AP102-WSTA-LDT-151 | AP102 DST Riser 69 | H-14-101503 Sh. 2 Rev. 9 |
| AP AP102-WSTA-LDT-152 | AP102 DST Riser 70 | H-14-101503 Sh. 2 Rev. 9 |
| AP AP102-WSTA-LDT-153 | AP102 DST Riser 71 | H-14-101503 Sh. 2 Rev. 9 |
| AP AP103-WST-LIT | AP103 DST Riser 04 | H-14-101503 Sh. 3 Rev. 10 |
| AP AP103-WSTA-LDT-151 | AP103 DST Riser 69 | H-14-101503 Sh. 3 Rev. 10 |
| AP AP103-WSTA-LDT-152 | AP103 DST Riser 70 | H-14-101503 Sh. 3 Rev. 10 |
| AP AP103-WSTA-LDT-153 | AP103 DST Riser 71 | H-14-101503 Sh. 3 Rev. 10 |
| AP AP104-WST-LIT | AP104 DST Riser 04 | H-14-101503 Sh. 4 Rev. 10 |
| AP AP104-WSTA-LDT-151 | AP104 DST Riser 69 | H-14-101503 Sh. 4 Rev. 10 |
| AP AP104-WSTA-LDT-152 | AP104 DST Riser 70 | H-14-101503 Sh. 4 Rev. 10 |
| AP AP104-WSTA-LDT-153 | AP104 DST Riser 71 | H-14-101503 Sh. 4 Rev. 10 |
| AP AP105-WST-LIT | AP105 DST Riser 04 | H-14-101503 Sh. 5 Rev. 9 |
| AP AP105-WSTA-LDT-151 | AP105 DST Riser 69 | H-14-101503 Sh. 5 Rev. 9 |
| AP AP105-WSTA-LDT-152 | AP105 DST Riser 70 | H-14-101503 Sh. 5 Rev. 9 |
| AP AP105-WSTA-LDT-153 | AP105 DST Riser 71 | H-14-101503 Sh. 5 Rev. 9 |
| AP AP106-WST-LIT | AP106 DST Riser 04 | H-14-101503 Sh. 6 Rev. 10 |
| AP AP106-WSTA-LDT-151 | AP106 DST Riser 69 | H-14-101503 Sh. 6 Rev. 10 |
| AP AP106-WSTA-LDT-152 | AP106 DST Riser 70 | H-14-101503 Sh. 6 Rev. 10 |

**Table 8-6: AP Tank Farm Level and Leak Detection Instruments (2 sheets)**

| Instrument Number | Location | Drawing |
|---|---|---|
| AP AP106-WSTA-LDT-153 | AP106 DST Riser 70 | H-14-101503 Sh. 6 Rev. 10 |
| AP AP107-WST-LIT | AP107 DST Riser 04 | H-14-101503 Sh. 7 Rev. 11 |
| AP AP107-WSTA-LDT-151 | AP107 DST Riser 69 | H-14-101503 Sh. 7 Rev. 11 |
| AP AP107-WSTA-LDT-152 | AP107 DST Riser 70 | H-14-101503 Sh. 7 Rev. 11 |
| AP AP107-WSTA-LDT-153 | AP107 DST Riser 71 | H-14-101503 Sh. 7 Rev. 11 |
| AP AP108-WST-LIT | AP108 DST Riser 04 | H-14-101503 Sh. 8 Rev. 10 |
| AP AP108-WSTA-LDT-151 | AP108 DST Riser 69 | H-14-101503 Sh. 8 Rev. 10 |
| AP AP108-WSTA-LDT-152 | AP108 DST Riser 70 | H-14-101503 Sh. 8 Rev. 10 |
| AP AP108-WSTA-LDT-153 | AP108 DST Riser 71 | H-14-101503 Sh. 8 Rev. 10 |

Note: Complete drawing reference information is provided in Section 12.0, References.

## 8.3 SYSTEM DESIGN REVIEW

### 8.3.1 Tank Leak Detection

Each DST has a level detector and three annulus leak detectors meeting the requirements of WAC 173-303-640(2)(a). These instruments are checked on each operating shift. The measurements are compared with a high and low limit and logged. If there is an issue, it is noted and procedures are in place to address the issue. This is evidenced by the shift log noting the issue for several entries, followed by correct readings.

When the DST annuli are inspected with a camera, the results are compared with the previous images. The camera inspection is not primarily for leak detection, but differences on the outer side of the primary tank wall, differences on the inner secondary tank wall, and differences on the floor of the annulus are noted and analyzed. With the exception of tank AY-102, no evidence of a primary tank leak has been observed. While the camera system provides information, it is not a tool that will meet the requirements of a leak detection system, since it is not timely enough.

## 8.4 TESTING AND CALIBRATION OPERATING PROCEDURES

### 8.4.1 Tank Leak Detection

The Enrafs used for DST level detection and leak detection are noted each operating shift. The level is compared to upper and lower limits. If the observed level is outside these limits, it is noted and investigated. The Enrafs also alarm in the TMACS, and they will also alarm on instrument failure. An alarm is investigated. The instruments are tested and calibrated at least annually, adjusted as required, and any issues found between testing are addressed. There is a formal procedure for testing and calibration, 5-LCD-300, *ENRAF Series 854 Displacer Weight Check and Obtain Sediment Levels.*

## 8.5 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

The 2006 DSTAR did not assess nor address leak detection.

## 8.6 IQRPE SUMMARY DISCUSSION OF 2016 DST LEAK DETECTION SYSTEMS ASSESSMENT

### 8.6.1 Findings

There no findings pertaining to DST leak detection systems.

### 8.6.2 Observations

Each DST has a level detector and three annulus leak detectors meeting the requirements of WAC-173-303-610(2)(a). The logs show any issue with a level/leak detector and any out-of-limit reading, as well as an instrument malfunction. The repair history of any individual instrument is maintained in the CHAMPS and Enterprise Asset Manager (EAM) database. Performance issues of the leak detection system are addressed in the Corrective Action database, and compliance with regulatory requirements are identified in the Environmental Notification database.

### 8.6.3 Recommendations

- For the leak detection, the next overall DSTAR integrity assessment should follow the current 10-year schedule. (Summarized in recommendation R16-1 in Section 3.3.3.)
- A common leak detection instrument database or a program that extracts data from the multiple databases should be developed to identify issues relating to a particular instrument or location that has repeating issues. It is difficult to manually go through the multiple databases and collate data that can identify an issue. (Summarized in recommendation R16-24 in Section 3.3.3.)

### 8.6.4 Conclusions

In regards to DST leak detection, the DST System is fit for use as listed in Appendix D.

# 9.0 WASTE CHARACTERIZATION FOR DOUBLE-SHELL TANK SYSTEM

**Introduction/Purpose**

The purpose of tank assessments is "to determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture or fail" (WAC 173-303-640(2)(e). This assessment addresses waste compatibility. Assessments are completed on the compatibility between the waste (1) received in the past; (2) currently being stored; or (3) projected to be received in the future including combinations of all three wastes and tanks, piping, and other ancillary equipment.

Waste compatibility with tank system components is addressed in Section 10.0. This section focuses on the review of the characteristics of the tank waste so that the physical, chemical, or radiological properties do not compromise the integrity of the tank system.

**Scope/Requirements**

40 CFR 265 Subpart J(b)(2), as well as WAC 173-303-640(2)(c)(ii), require the "review of hazardous characteristics of the waste(s) that have been or will be handled" in assessing the integrity of tank systems. The following activities were conducted to support this requirement:

- Review the estimated concentrations for all chemicals of concern as a baseline for future assessments. This may include toxic and organic constituents and those that contribute to corrosion mechanisms.
- Review the Transfer Compatibility Program to determine how chemical inventories are being managed in order to avoid combinations that create concerns.

**Method of Assessment**

The following major documents were utilized in the assessment of waste properties:

- 2006 DSTAR Volume 3
- RPP-RPT-50440
- Best-Basis Inventory (BBI) summary tables
- Waste compatibility assessment (WCA) reports (see list in Appendix U).

## 9.1 SUMMARY OF THE 2006 DSTAR WASTE COMPATIBILITY REPORT

In addition to meeting the same relevant portions of 40 CFR 265.191 and WAC 173-303-640 applicable to tank systems, the 2006 DSTAR was driven by HFFACO Milestone M-48-14, which requires determination of the following:

- Ability of DSTs to adequately fulfill their role to receive and transfer high-level waste (HLW) during ongoing Hanford Site cleanup and vitrification activities.
- Confidence in the continued operation of the DST farms to support the mission duration.
- Final RCRA permitting for waste feed operation to the WTP.

Therefore, the 2006 DSTAR Development Plan (RPP-17266) expanded the scope of the previous assessment past what is necessary to determine compliance with 40 CFR 265.191 and WAC 173-303-640, the governing regulations for this 2016 DSTAR. For topics covered in the

2006 DSTAR that are outside of the scope of this 2016 assessment, conclusions will be briefly summarized and no further review will be performed.

Chemical composition of the tank waste was defined by HFFACO Milestone M-48-14 to include the following:

- Corrosivity
- Temperature
- Homogeneity
- Organic content
- Specific gravity
- Gas generation, retention, and release
- Flammability.

Parameters of interest to tank longevity that were reviewed included the following:

- Times at elevated temperature
- Excessive fluid levels
- Number of empty/fill cycles
- Episodes of low/high pH
- Fire/explosion events
- Gas generation, retention, and release events including:
    - Buoyant displacement gas release events (BDGRE)
    - Steady state gas releases.

The general chemical composition of waste that has been stored within the DSTs and parameters that could have an effect on corrosion rates and tank structural integrity were investigated, documented, and determined to have been mostly within acceptable limits. No concerns were noted.

## 9.2 WASTE TRANSFERS AND ADDITIONS

Waste transfers into and out of the DSTs as well as chemical/water additions were investigated from the Tank Waste Information Network System (TWINS) database, and Table T-1 of Appendix T provides a comprehensive list of all transfers and additions since March 31, 2006. Waste is received from the DSTs from the SST System and from laboratory operations for storage until it can be sent to the WTP for final remediation. The DST Corrosion Protection Program is no longer a Technical Safety Requirement (TSR) Administrative Control (WRPS-0900715; 09-NSD-024). Chemical adjustments are also made to the DSTs for corrosion protection measures as required by the Tank Farm Contractor in OSD-T-151-00007. Such chemical adjustments are achieved either by waste blending operations or by chemical (caustic and/or nitrite) additions. Waste in the DSTs is transferred between tanks to maximize the utilization of the limited volume.

Table T-2 of Appendix T provides a matrix of the number of transfers and additions into and out of all of the DSTs since the 2006 DSTAR. There were 516 waste transfers and chemical additions through July 31, 2015. Of those, 76 transfers were between DSTs.

Although not tabulated in this report, the TWINS data show 1,693 adjustments to the volume within tanks as a result of: sampling, recalibrated liquid level devices, bringing the TWINS data into agreement with quarterly BBI data, and gas expansion/compression.

Table T-3 of Appendix T provides a matrix of the volume of transfers and additions into and out of the DSTs since the 2006 DSTAR. The following summarizes the Table T-3 data:

- 22 Mgal of waste was transferred between DSTs
- 20 kgal of waste from 222-S Laboratory was received into tank SY 101
- Transfers between the DSTs and C Tank Farm
  - 2.5 Mgal of waste received into the DSTs from C Tank Farm:
    - 1.1 Mgal to tank AN-101
    - 1.4 Mgal to tank AN-106
  - 249 kgal of waste sent from the DSTs to the C Tank Farm:
    - 114 kgal from tank AN-101
    - 135 kgal from tank AN-106
- Transfers between DSTs and the 242-A Evaporator:
  - 9.4 Mgal of waste was sent from the DSTs to the 242-A Evaporator; most waste was from tank AW-102 with 133 kgal from tank AP-107
  - 4.6 Mgal of waste was received by the DSTs from the 242-A Evaporator; AP Tank Farm received 3.5 Mgal and AW Tank Farm received 1.1 Mgal
- 1.5 Mgal of waste was received by tank SY-102 from S Tank Farm
- 660 kgal of evaporator water was received into the DSTs; AW Tank Farm received most, except for 1 kgal that was received into tank AP-107
- 77 kgal of flush water was sent to the DSTs
- 200 kgal of caustic additions, with concentrations ranging from 1M to 19.4M depending on the individual transfer, were received by the DSTs:
  - Tank AN-101: 19 kgal
  - Tank AN-102: 36 kgal
  - Tank AN-106: 46 kgal
  - Tank AY-101: 51 kgal
  - Tank SY-102: 48 kgal
- 431 kgal of raw water was sent to the DSTs.

The Tank Farm Waste Transfer Compatibility Program (HNF-SD-WM-OCD-015) requires the evaluation of proposed waste transfers and chemical additions into the DST System. Such evaluations are documented as WCAs. Assessments include a summary table of the compliance status of the proposed transfer against decision rules based on resulting tank chemistry, physical properties, and nuclear criticality safety. In addition, a completed, current Waste Stream Profile Sheet (WSPS) is required for each waste stream entering the DST System. Appendix U lists the WCAs that were evaluated as part of this 2016 DSTAR. See Section 10.3.3.1 for further

discussion on documentation requirements prior to waste transfers. Appendix F shows overall DST contents.

## 9.3 COMPREHENSIVE REVIEW OF TANK WASTE CHEMISTRY

A waste tank summary report (HNF-EP-0182) is updated with new revisions monthly. That report is the official inventory for radioactive waste stored in underground tanks at the Hanford Site. Data that depict the status of stored radioactive waste and tank vessel integrity are contained within the report. The report provides data on each of the existing 177 large underground waste storage tanks and smaller miscellaneous underground storage tanks and special surveillance facilities, as well as supplemental information regarding tank surveillance anomalies and ongoing investigations.

### 9.3.1 Current Status

The DST chemical and radiological inventories have been developed using a combination of recent data from tank sampling and analyses, historical tank data, waste transfer records, and process knowledge. There are extensive databases that contain this information. The most relevant databases for waste compatibility purposes are the TWINS and the BBI. The BBI is based off the best available information, which includes analyses of waste samples, process knowledge calculations, and waste type templates based on samples or model estimates.

Tank waste samples can only be taken where an available riser is located and require elaborate, expensive, remote sampling equipment and techniques. The two primary types of samples include grab samples and core samples. Grab samples are used for supernate only, as the collection method consists of opening and then resealing sample collection bottles in the waste. Grab samples are typically performed simultaneously at three depths, starting just below the waste surface. Core samples are drawn utilizing a drill-type setup to force a sample collection tube into the waste where it occurs as condensed solids/sludge to obtain one or more waste cores approximately 20 in. long. Appendix V provides a tank-by-tank tabulation of the samples taken.

The link between waste constituent/concentration and general corrosive effect on the materials of construction of the container has long been known. The original acidic waste from reactor fuel reprocessing was routinely converted into a high pH liquid (typically pH 12 or higher) before transfer to any of the tank farms waste tanks. This acidic to basic conversion was made because the carbon steel material of the tanks would rapidly corrode in an acid solution, but is generally suitable with caustic solutions at moderate temperatures. Additional experimental and literature knowledge about the roles of chemical species important to corrosion behavior (rates and mechanisms) contained within the Hanford Site HLW has led to the formalized waste acceptance criteria specified in Table 10-4 and Table 10-5.

The primary constituents that affect corrosion are hydroxide, nitrate, and nitrite. The concentrations of these components are strictly controlled as part of the Corrosion Control Program (see Section 10.3.1), and the acceptable ranges of each are dependent upon the temperature and nitrate concentration (see Table 10-4). Appendix E lists the current estimated status of the free hydroxide, nitrite, and nitrate concentrations for each DST from BBI data for the supernatant portions of the waste as well as the interstitial liquid portions of the waste, when present. Table 9-1 summarizes the in-specification status of each tank and tabulates the nitrite/nitrate ratios as well as the last time each tank was sampled. All tanks are within the

chemistry control specifications, and there have been no pitting or wall-thinning concerns identified to date (see Section 11.0).

**Table 9-1: Summary of Tank Conditions Important to Corrosion**

| Tank | Average Temp. (°F) | Corrosion Chemistry* | Supernate Nitrite / Nitrate Ratio | Saltcake Interstitial Liquids Nitrite/Nitrate Ratio | Sludge Interstitial Liquids Nitrite/Nitrate Ratio | Last Sampling Date |
|---|---|---|---|---|---|---|
| AN-101 | 115 | In spec | 0.80 | 0.84 | 0.90 | 9/17/2014 |
| AN-102 | 85 | In spec | 0.61 | -- | -- | 7/15/2013 |
| AN-103 | 100 | In spec | 1.32 | -- | -- | 2/15/2000 |
| AN-104 | 95 | In spec | 0.82 | -- | -- | 8/7/2000 |
| AN-105 | 95 | In spec | 0.99 | -- | -- | 12/20/2001 |
| AN-106 | 75 | In spec | 0.82 | -- | -- | 4/8/2014 |
| AN-107 | 90 | In spec | 0.39 | -- | -- | 6/17/2010 |
| AP-101 | 75 | In spec | 0.44 | -- | -- | 5/13/2015 |
| AP-102 | 70 | In spec | 0.72 | -- | -- | 3/14/2007 |
| AP-103 | 70 | In spec | 0.61 | -- | -- | 6/25/2015 |
| AP-104 | 70 | In spec | 0.52 | -- | -- | 3/26/2003 |
| AP-105 | 75 | In spec | 0.65 | -- | -- | 5/5/2011 |
| AP-106 | 75 | In spec | 0.79 | -- | -- | 6/27/2014 |
| AP-107 | 75 | In spec | 0.45 | -- | -- | 5/7/2010 |
| AP-108 | 75 | In spec | 0.58 | -- | -- | 3/17/2008 |
| AW-101 | 95 | In spec | 0.80 | -- | -- | 1/28/2003 |
| AW-102 | 70 | In spec | 0.60 | -- | -- | 1/19/2015 |
| AW-103 | 100 | In spec | 0.45 | 0.49 | -- | 11/2/2005 |
| AW-104 | 80 | In spec | 0.86 | 0.91 | 0.81 | 1/29/2003 |
| AW-105 | 65 | In spec | 0.15 | -- | -- | 12/13/2007 |
| AW-106 | 90 | In spec | 0.37 | -- | -- | 12/20/2013 |
| AY-101 | 112 | In spec | 0.35 | -- | 13.63 | 6/11/2015 |
| AY-102 | 130 | In spec | 0.48 | -- | 24.43 | 8/16/2005 |
| AZ-101 | 155 | In spec | 1.81 | -- | -- | 3/23/2010 |
| AZ-102 | 140 | In Spec | 0.62 | -- | -- | 9/5/2014 |
| SY-101 | 70 | In spec | 0.21 | -- | -- | 6/19/2007 |
| SY-102 | 70 | In spec | 0.22 | -- | 0.58 | 2/19/2015 |
| SY-103 | 90 | In spec | 1.18 | -- | -- | 5/10/2007 |

* See Appendix E for additional information.

The minimum nitrite-to-nitrate ratio identified in Table 9-1 is 0.15 in the supernate of tank AW-105. Although not a specification within the Corrosion Control Program, it is known

that nitrite-to-nitrate ratios of at least 0.15 inhibit pitting in the vapor phase (SRNL-STI-2013-00743, *Liquid-Air Interface Corrosion Testing Simulating the Environment of Hanford Double-Shell Tanks*). See Section 11.3.3 for further discussion on dome and vapor phase considerations.

### 9.3.2 Tank History

Because the DSTs and ancillary equipment have been in existence and service for several decades, the effects of past, current, and projected waste must be carefully considered. Records of normal, off-normal, and excessive fluid levels, or unique situations that occurred one or more times during DST lifetimes were reviewed and documented as part of the 2006 DSTAR. In determining whether past wastes were within the DST waste acceptance criteria (e.g., chemical, thermal, specific gravity), it was stated that corrosion control limits for estimates for the tanks may be conservative because tank AN-107 was out of spec for 18 years and is acceptable. Other unknowns that were also identified were (1) the exact operational history including fill/drain cycles, (2) time duration at elevated temperatures, and (3) the number or frequency of waste discharges that did not meet waste acceptance criteria.

Operating conditions experienced by the DSTs have the potential to interact with corrosion mechanisms. In general, high temperatures and stresses (e.g., high heat generation, high specific gravity, overfilling) will accelerate corrosion or at times initiate new corrosion. For example, higher temperatures typically accelerate general corrosion, and a threshold stress level is required before stress corrosion cracking (SCC) can occur. Higher temperatures also increase the propensity for SCC. The design temperature limits for the DSTs are from 210 to 350 °F. Only the AY and AZ Tank Farms, which were designed to receive self-boiling HLW, have seen maximum operating temperatures from 247 to 263 °F, well within design specifications. All the other tanks have had maximum temperatures from 118 to 155 °F, again within design specifications.

Similarly, the nominal tank waste specific gravity has been well below the maximum specific gravity. The tanks are rarely filled to maximum level because of operational considerations of contingency volume for pipe flushes and chemical additions, and to avoid violating the documented safety analysis waste height limits. Fill height of waste in the tank and the waste density create the mechanical stress on the tanks.

### 9.3.3 Future Tank Waste Additions

The majority of future waste additions would come from SST waste retrieval operations. Decontamination and decommissioning activities at inactive facilities on the Hanford Site may also contribute some wastes, which would be classified as dilute, non-complexed wastes that are low-level liquid waste and would be sent to the DSTs because of their large volume. Some future tank waste additions may be HLW or mixed waste that would come from cleanout of existing site facilities. These future waste additions would be typical of the types of waste currently stored in the tanks. This includes the vast majority of waste to be received, which is retrieved waste from the SSTs. It is forecasted that the SST waste will be retrieved by sluicing (i.e., converting the SST waste into a slurry followed by pumped transport to a DST).

Any required chemical addition(s) to bring the slurry to the DST waste acceptance criteria (OSD-T-151-00007) will be completed in the DSTs.

### 9.3.4 Toxic Chemicals

The toxic chemical species and concentrations for DST waste solids and liquids were summarized in Tables 3-2 and 3-3 of RPP-25153, respectively. The toxicological effects of the waste constituents are outside of the scope of this 2016 DSTAR. Dangerous waste compounds are identified in the DST Dangerous Waste Permit Application, Section XIV, dated January 14, 2009.

### 9.3.5 Organics

Organic constituents in the waste were extensively reported on in the 2006 DSTAR. Of the 81 different organic chemicals that had been found during analyses of DST waste samples, only a few were used in large quantities during fuel reprocessing or used at various Hanford Site facilities to become part of a waste stream eventually discharged to the tank farms. The 81 identified organics in liquid and solid samples from the tank farms originated from chemical or radiolytic reactions. Chemical reactions include degradation (e.g., hydrolysis or oxidation); condensation (e.g., polymerization); conversion (e.g., formation of esters); combinations of the preceding reactions; or others. Ionizing radiation can induce the creation of many chemical species from 'ordinary' compounds.

Table 3-4 in 2006 DSTAR Volume 3 lists the organic compounds found to date and includes normal and chlorinated hydrocarbons; alcohols; ketones; aldehydes; esters; amines; complexants that retain metal ions in solution; and hydrocarbons with combinations of functional groups attached. The functional groups classify the types of reactions of which they are capable. There is a very high probability that other organic compounds exist within the tanks in the few parts per million and less range. However, neither concentrated nor very dilute solutions of organics found in the tanks have been identified to have an effect on corrosion, especially at the high pH of the tank waste.

Trace quantities have been detected because extensive analyses were performed for organics. Most are present in parts per million or less. A few of the organics are present in SST wastes in concentrations of 1 to 10 g/L. Even then, the bulk solution properties of high pH, nitrite, and nitrate dominate the corrosion mechanisms. New chemical species are routinely either found or rediscovered that were used long ago. None of the identified organics have been identified as corrosive. No reactions involving the organics have been postulated that would lead to unexpected corrosion of the tanks, and they are not present in sufficient quantity to produce a deflagration hazard. Organic constituents in the tank waste will therefore not be further analyzed as part of this 2016 scope, but it should be noted that they are identified in the DST Dangerous Waste Permit Application.

## 9.4 REACTION MECHANISMS OF CONCERN AND POTENTIAL CONCERN

The waste in the DST System falls into two reactivity groups per the U.S. Environmental Protection Agency (USEPA 1994): (1) Group 10 caustics and (2) Group 106 waters and mixtures containing water. Wastes entering the DST System must be categorized according to the reactivity groups specified in USEPA (1994). If a potential hazard is identified for mixing of wastes by reactivity groups with the receiver tank waste, then a technical justification explaining how the waste may be safely transferred and stored in light of the potential hazard is required.

The main concerns of waste reactions are the physical implications that result. The following sections examine the reaction mechanisms that can affect the integrity of the DST System.

### 9.4.1 Corrosion

The DST waste chemistry limits listed in Table 10-4 and Table 10-5 are in place to mitigate corrosion of tank materials. The receipt or transfer of waste that is outside of specification limits is permitted if the receiving DST will remain within specification after the transfer. To ensure protection of piping, each transfer of non-compliant waste is evaluated for the need of a post-transfer chemical flush. For carbon steel piping, inhibited water with at least 0.01M hydroxide and 0.011M nitrite is specified. For stainless steel, flushes are specified to consist of raw water (uninhibited service water) or an ionic solution (0.1M) that promotes the formation of an oxide layer. With few exceptions, post-transfer water flushes are made with uninhibited service water since few transfers are non-compliant. Pipes are sloped for drainage of flush water, and it is important that any future repairs and additions be appropriately sloped to avoid microbe-induced corrosion and pitting corrosion.

Section 10.2 provides a comprehensive analysis of corrosion mechanisms. HNF-SD-WM-OCD-015 provides the transfer compatibility program, which ensures that waste within the DST System stays within specification to limit corrosion.

### 9.4.2 Gas Generation

Waste generates hydrogen through the radiolysis of water and organic compounds, radiothermolytic decomposition of organic compounds, and corrosion of the tanks' carbon steel walls. Hydrogen is the flammable gas of most concern, with a lower flammability limit (LFL) of 4%. For salt slurries, gas is generated mostly through thermolysis of organics (complexants and degradation products). For sludges, gas is generated mostly through radiolysis. Nonflammable gases, such as nitrous oxide and nitrogen, are also produced. Additional flammable gases (e.g., methane LFL = 5%; ammonia LFL = 15%) are generated by chemical reactions between various degradation products of organic chemicals present in the tanks.

If a transfer from a Waste Group B DST could uncover solids in the tank, the transfer must be evaluated using the methodology in PNNL-13781 to determine if an induced gas release due to uncovering solids is sufficient to achieve a flammable gas concentration of 100% of the LFL in the sending DST headspace assuming zero ventilation (HNF-SD-WM-OCD-015).

### 9.4.3 Flammability

Hazards associated with flammable gas accumulation and ignition are described in Section 3.3.2.4.1, "Flammable Gas Accidents," of the DSA. A number of flammable gas accident scenarios are described and the resulting consequences are estimated.

The control strategy for these accidents is largely focused on preventing flammable gas accidents by establishing ventilation, process, flammable gas monitoring, and ignition controls. The emergency preparedness program addresses flammable gas hazards caused by natural phenomena (e.g., damage to DST primary ventilation systems from seismic or high wind events, seismically induced flammable gas deflagrations) and by a waste leak into a waste transfer-associated structure, such as the DST annulus.

There are three safety functions identified for this control in HNF-SD-WM-TSR-006, *Tank Farms Technical Safety Requirements*. The first safety function is to verify that DST primary ventilation systems can perform their safety function following significant, relevant natural events (e.g., seismic events, high winds), thus decreasing the frequency of a flammable gas accident. The second safety function is to decrease the consequences of a seismically-induced gas release event (GRE) flammable gas accident. The third safety function is to take action for waste leaks into waste transfer-associated structures, double-contained receiver tanks, active catch tanks, or DST annuli to maintain the flammable gas concentration in the structures, double-contained receiver tanks, active catch tanks, or DST annuli below the LFL or to reduce the frequency of ignition sources, thus decreasing the frequency of a flammable gas accident. Furthermore, equipment installed in the DSTs and external to the tanks must meet the requirements of TSR Administrative Control Key Element 5.9.2, Ignition Controls, to ensure that a spark is not present in the flammable gas environment.

The DSA considers two mechanisms by which waste-generated flammable gases can reach high concentrations in tank farm facilities. Nearly continuously generated and released gas from sludge can be managed effectively by headspace ventilation. However, it is much more difficult to manage flammability when a large amount of the gas retained within waste is released rapidly in a BDGRE. These releases can potentially create flammable gas concentrations in the tank headspace exceeding the LFL for short durations.

### 9.4.4 Buoyant Displacement Gas Release Events

As noted, gas generation in DST wastes results in the production of primarily hydrogen, nitrous oxides, nitrogen, as well as small amounts of ammonia, methane, and other hydrocarbons. Some Hanford Site radioactive waste storage tanks with deep layers of sediment and supernatant liquid are subject to a gas release phenomenon that has been called BDGRE. The theory of buoyant displacement describes the behavior of a sediment permeated with discrete gas bubbles that displace the surrounding solid particles. In a buoyant displacement, bubbles form and grow, imparting their buoyant force to the surrounding sediment. When a portion of the sediment becomes sufficiently buoyant to overcome its weight and the strength of the surrounding material restraining it, this portion breaks away and rises through the liquid layer above it. The trapped gas bubbles expand as the buoyant sediment rises, failing the surrounding material and allowing the gas to escape. The mechanisms for spontaneous gas releases from waste without supernate are less understood but probably are the result of 'percolation' of individual bubble systems. The potential volume of this kind of release is orders of magnitude smaller than that of a BDGRE.

If a BDGRE is possible, the event must have enough mechanical energy to yield the solids and release the gas (i.e., exceed the energy ratio). The amount of energy available depends on the driving force and distance the buoyant solids rise which depends on the supernatant liquid depth and the retained gas volume fraction at buoyancy. The amount of energy required is proportional to the solids shear strength. Unless the ratio of energy available to energy required is sufficiently high, a large gas release cannot occur even if the settled solids become buoyant.

Waste Group A tanks — SY-103, AW-101, AN-103, AN-104, AN-105, and SY-101 — have exhibited periodic BDGREs that released trapped hydrogen and other gases. Large spontaneous GREs have resulted in flammable concentrations only three times, which occurred in tank SY-101 prior to its remediation. No rises in temperatures or fires were ever observed during the short periods of time that the hydrogen LFL was exceeded, and there are no

opportunities for a deflagration since ignition controls have been implemented. Controls were put into place to manage the waste chemistry of streams sent to the DSTs so as not to create the convective layering conditions within tanks that are required for such episodic GREs (RPP-10006, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*; PNNL-13337, *Preventing Buoyant Displacement Gas Release Events in Hanford Double-Shell Waste Tanks*). Only tank SY-101 has been remediated, and the other Waste Group A tanks are still subject to BDGREs.

Prior to waste transfers into DSTs, the endstate of the receiving tank is evaluated to verify that at least one of the following criteria are met (HNF-SD-WM-OCD-015):

1. Total tank heat load is <58,000 Btu/hr.
2. Non-convective layer thickness is < 12 in.
3. Supernate depth is < 39 in.
4. The non-condensable gas generation rate at saturation temperature in the nonconvective layer is sufficiently low, such that the ratio of vertical void fraction profile to the neutral buoyant void fraction (buoyancy ratio) is < 1.0 (RPP-6213, Addendum 1, Table 4-2).
5. For tank AN-106 only, the supernate temperature is < 177 °F.

The first three criteria are evaluated automatically as part of the required WCAs. If those criteria are not met, then further evaluation of the buoyancy ratio is necessary. These criteria used to prevent making new waste configurations that could exhibit BDGREs (RPP-10006, PNNL-13337) are based on the behavior observed in low shear strength (average about 150 pascal) waste in the six DSTs that historically had BDGREs. BDGRE behavior is evaluated using two criteria: the buoyancy ratio and the energy ratio. Both criteria must be met for a tank to exhibit BDGREs. That is, the waste must retain sufficient gas to be buoyant, and the stored gas must have sufficient potential energy such that the rising buoyant waste breaks apart releasing a significant fraction of the retained gas. Work was performed that shows tank waste height (a) does not lead to gas accumulation to higher void fractions, (b) will not affect gas retention behavior, and (c) does not predict the conditions that would lead to an unstable configuration within the sludge layer where a lower region could be buoyant compared to an upper region (RPP-RPT-26836, *Gas Retention and Release from Hanford Sludge Waste*).

## 9.5 RESOLUTION OF 2006 DSTAR WASTE COMPATIBILITY REPORT FINDINGS, OBSERVATIONS, AND RECOMMENDATIONS

Concerns were raised over the accuracy of TWINS data due to the limited number of samples, limited sample access points, and stratification within the waste especially when coupled with failures during sampling to obtain an entire core sample. However, a statistically-designed sampling program would not eliminate the possibility that a unique pocket of solids had been missed and would adversely impact schedule for the final remediation, treatment, and disposal of the tank waste. The existing tank characterization data were determined to be sufficient for making determinations (e.g., waste compatibility) based on the large number of samples, process knowledge, chemical behavior, and the known tank corrosion status. Corrosion of the tanks over many years correlates well with bulk waste properties.

RPP-13639 also reports on the chemistry of the settled solids interstitial liquids and indicates four DSTs have non-compliant solids regions. It was concluded that the non-compliant

interstitial liquid region would have to extend to the tank wall or base to be a corrosion concern. Review of past DST records shows that several of the DSTs were previously out of compliance with the waste acceptance criteria for varying lengths of time, in one case 18 years (from 1984 to 2002). UT and similar examinations of other out-of-specification DSTs did not find any unusual corrosion at this out-of-compliance tank compared to other DSTs.

## 9.6 IQRPE SUMMARY DISCUSSION OF 2016 DST WASTE CHARACTERIZATION ASSESSMENT

No concerns were found while going through the WCAs to suggest that operations are not adhering to the requirements of the Tank Farm Waste Transfer Compatibility Program or that any waste transfers have resulted in incompatible waste conditions within any of the DSTs. For some waste transfers, the status of certain decision rules resulted in non-compliance. When this occurred, further engineering analyses were performed to determine the significance of the non-compliance and whether or not the proposed waste transfer posed a realistic risk to any controlled properties. One example, reported in RPP-RPT-29865, was a WCA for the transfer of 222-S Laboratory waste into tank SY-101. Based on waste samples, the source waste did not meet the chemistry control requirements as dictated by the Waste Compatibility Compliance Table. Although the source waste was adjusted to meet the limits, bounding upper and lower confidence values were used in the WCA. Because the source was not a DST and the receiver DST would remain within required waste chemistry limits after the transfer, the disposition was that the transfer met the requirements of the Tank Farms Waste Transfer Compatibility Program.

The waste chemistry requirements, which were previously part of the tank farms authorization basis (Administrative Control 5.16 in HNF-SD-WM-TSR-006), are now included in OSD-T-151-00007. As of the 2006 DSTAR, all DST wastes have been within specification or have had a DOE-approved recovery plan.

Because the waste's specific gravity has been well below the maximum values, overfilling would not generate stress levels above design values.

Nothing in this 2016 DSTAR raises any new concerns for waste compatibility issues, so no findings are presented. Observations and recommendations are presented in the following sections.

### 9.6.1 Findings

This report contains no findings.

### 9.6.2 Observations

The general observations from the assessment of tank waste chemistry are as follows:

- The Tank Farm Waste Transfer Compatibility Program (HNF-SD-WM-OCD-015) is comprehensive and being properly implemented.
- WCAs prior to transfers and chemical additions are being properly completed. Future waste additions will likely be of similar properties and present no concerns assuming continued management per HNF-SD-WM-OCD-015.
- Physical and chemical properties have been kept almost entirely within specification.

- The knowledge of waste constituents is sufficient for compatibility purposes. Additions to and transfers between DSTs, adjustments to volume due to sampling, and chemical additions have been documented in the TWINS.
- Tanks that have been known to or that have the waste chemistry and rheological properties that make BDGREs possible are continuously monitored to ensure flammable gas concentrations remain below 25% of the LFL.

### 9.6.3 Recommendations

- For waste characterization, the next overall DSTAR integrity assessment should follow the current 10-year schedule. (Summarized in recommendation R16-1 in Section 3.3.3.)
- Tank waste should continue to be managed in accordance with the Waste Compatibility Program (HNF-SD-WM-OCD-015), including the practice of performing WCAs prior to transfers or additions. (Summarized in recommendation R16-2 in Section 3.3.3.)

### 9.6.4 Conclusions

In regards to DST waste characterization, the DST System is fit for use as listed in Appendix D.

# 10.0 WASTE COMPATIBILITY WITH DOUBLE-SHELL TANK SYSTEM MATERIALS OF CONSTRUCTION

**Introduction/Purpose**

The purpose of tank assessments is to determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. This assessment addresses waste compatibility. Assessments are completed on the compatibility between the wastes (1) received in the past; (2) currently being stored; or (3) projected to be received in the future including combinations of all three wastes and tanks, piping, and other ancillary equipment.

Any part of the DST and ancillary equipment that comes into direct contact with the waste during transport, storage, or treatment (e.g., tank shell, process piping, and fittings) must be confirmed to be sufficiently compatible with the waste. It must also be confirmed that parts of the DST and ancillary equipment designed for secondary contact with the waste (e.g., secondary containment tanks, drain lines, pit liners) will not deteriorate during routine operation or upon exposure to tank waste.

**Scope/Requirements**

40 CFR 265 Subpart J(b) and WAC 173-303-640(2)(c) require the determination that the tank system be adequately designed and have sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment is required to consider design standard(s), if available, according to which the tank system was constructed in assessing the integrity of tank systems. The following activities were conducted to support this requirement:

- Review prior corrosion assessments
- Review new corrosion reports after 2006.

Furthermore, based on the results of past integrity assessments, the age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors, WAC 173-303-640(2)(e) requires the development of a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. This section recommends an assessment schedule based upon current tank system materials and associated chemistries, proposed future tank chemistries, and proposed operations.

**Method of Assessment**

The following major documents were utilized in the assessment of waste properties:

- 2006 DSTAR Volume 3
- RPP-RPT-50440
- IQRPE reports
- OSD-T-151-00007.

## 10.1 SUMMARY OF 2006 DSTAR WASTE COMPATIBILITY REPORT

The 2006 DSTAR contains the following six general conclusions related to waste compatibility with DST materials of construction. The 2016 DSTAR dispositions follow:

- 2006 DSTAR: Waste and the acceptance criteria for additional waste in the DSTs and the ancillary equipment are compatible with the materials of construction of the DSTs and ancillary equipment.
    - 2016 DSTAR Assessment: It is agreed that the statement in its entirety is correct.
- 2006 DSTAR: Stress relief of the primary tank has helped to guard against localized corrosion mechanisms.
    - 2016 DSTAR Assessment: Stress relief of the primary tank as well as the chemistry control program have helped to guard against SCC, and pitting (i.e., localized corrosion mechanisms).
- 2006 DSTAR: Operation of the DSTs and their ancillary equipment has generally been within their design limits. Enhanced corrosion has not been observed for the few cases where waste outside the approved criteria was stored or handled.
    - 2016 DSTAR Assessment: It is agreed that the statement in its entirety is correct.
- 2006 DSTAR: Material selection, corrosion, and imposed stress allowances of the original design were appropriate.
    - 2016 DSTAR Assessment: It is agreed that the statement in its entirety is correct.
- 2006 DSTAR: Nothing was identified during the preparation of the 2006 DSTAR indicating that the DST design lifetimes should not be attained, and with continuation of then-current practices even be exceeded.
    - 2016 DSTAR Assessment: It is agreed that the statement in its entirety is correct.
- 2006 DSTAR: There was no logical reason for the discrepancy between the design lives prescribed to the AY and AZ Tank Farm tanks. The AZ Tank Farm tanks were to reach their upper design lifetime of 30 years in calendar year 2006. Both AZ Tank Farm tanks were constructed out of the same carbon steel (A515 Grade 60) as the AY Tank Farm tanks, yet the AY Tank Farm tanks were given a 30- to 40-year design lifetime.
    - 2016 DSTAR Assessment: It is agreed that the statement in its entirety is correct.

It was further pointed out that no DSTs had leaked or were leaking at the time of the report writing, and detected corrosion rates were low. The conclusion was that past DST farm practices that were outside of the Corrosion Control Program limits were not detectably harmful to the DSTs.

## 10.2 TYPICAL CORROSION MECHANISMS

The possible corrosion mechanisms for Hanford Site waste tank components were well-studied and documented in 2006 DSTAR Volume 3, Sections 4.1 and 4.5, and are summarized in Table 10-1. Other mechanisms listed in PNNL-13571, *Expert Panel Recommendations for Hanford Double-Shell Tank Life Extension*, were considered but dismissed.

**Table 10-1: Types of Possible Corrosion for Double-Shell Tanks**

| Material | Corrosion Mechanism, Surface | Trigger(s) | Inhibitor(s) |
|---|---|---|---|
| Carbon steel | General corrosion; bulk or uniform, I & E | pH < 9, pH >14 | pH between 11 & 14 |
| | Pitting/crevice corrosion, I | Electrochemical cell formation, Cl, $NO_3$, $SO_4$, sediment | Nitrites, high pH (>10) |
| | Stress-corrosion cracking, I | Sustained tensile stress, high temperature, nitrate & caustic cone. | Stress relief, nitrite for nitrate solutions, pH & $OH/NO_3$ ratio |
| | Waterline, I | Intrinsic evaporation & condensation to pH < 9.5 | Level changes, diffusion and convection |
| Stainless steel | General corrosion; bulk or uniform, I & E | Extreme temperatures and/or concentrations | Normal Hanford tank conditions |
| | Pitting/Crevice corrosion, I | Chlorides/halogens, low pH (<5) | Nitrates |
| | Stress-corrosion cracking, I | Sustained tensile stress, high temperature (>90 °C or so), halogens, oxygen | Stress relief, nitrite for nitrate solutions |
| | Waterline, I | Intrinsic evaporation/condensation | Material is generally resistant |
| Concrete | Elevated temperature weakening, I & E | Threshold temperature reported around 95 °C | Waste blending between tanks |
| | Aggressive chemical attack, I | Strong acids, sulfates, chlorides | DST waste acceptance criteria |
| | Re-enforcing steel corrosion | pH at steel <11.5, chlorides | Quality of concrete, depth of coverage |

Source: Table 4-1 from DSTAR 2006 Volume 3.
I = internal. E = external.

### 10.2.1 Relevant Degradation Mechanisms

The three mechanisms relevant to the DST System are (Anantatmula 2004, *DST Corrosion Mechanisms and Experience*):

- Uniform corrosion
- Pitting/crevice corrosion
- SCC.

The requisite conditions for each mechanism to occur are discussed in the following sections. Section 11.0 concludes that even though the theoretical risk exists for these corrosion mechanisms in the DST System, measured thinning is still less than measurement detection thresholds, and pitting cannot be confirmed to be any worse than what was observed after the initial hydrostatic testing of the tanks.

#### 10.2.1.1 Uniform Corrosion

Uniform corrosion, also known as general attack corrosion, is a chemical or electrochemical reaction that proceeds relatively uniformly over the entire surface. For the DSTs, uniform corrosion is expected to involve the oxidation/dissolution of iron and reduction of nitrates to nitrites. Although other oxidation reactions are possible and have been hypothesized, nitrate is known to be a corrosive medium to carbon steel, and mitigation of its effect through the corrosion control program (Section 10.3) has proved effective. It is therefore reasonable to assume that the reduction of nitrate is the predominate reaction coupled with iron oxidation in the DSTs.

Internal carbon steel surface areas of the Hanford Site DSTs and their ancillary equipment are viewed to be the most susceptible to corrosion due to contact with tank waste, rinse water, or high humidity. All DST surfaces that come in contact with HLW are subject to general corrosion. In alkaline wastes, with a pH in the range of 11 to 14, carbon steel forms a protective oxide at the surface that slows the rate of corrosion. Any mechanical activity, therefore, that disrupts the oxide film could increase the corrosion rate due to general attack. See Section 10.2.3.1 for a further discussion of erosion corrosion.

Oxygen generation, depletion, and mixing analyses were performed for two representative DSTs to determine if wall and floor general corrosion rates may be oxygen limited (i.e., oxygen poor environment near the tank wall). The model was based on experimental data and flammable gas studies (RPP-RPT-22126, *Expert Panel Workshop on Tank Chemistry Optimization, Status of Oxygen Generation and Depletion Modeling*).

It was found that, in general, the oxygen depletion rates exceeded the generation rates. The wall corrosion model assumed 3 M of $O_2$ consumed for 4 M iron. Although the dynamic mixing model was not sufficient for oxygen diffusion near the tank wall, conservative hand calculations, which assumed 25% $O_2$, showed that diffusion rates near the tank AY-102 wall limited the wall corrosion rate to 0.4 mil/yr. The oxygen concentration near the tank wall for tank AY-102 was expected to be limited by oxygen diffusion (maximum corrosion rate of 0.1 mil/yr).

The waste composition varies widely from tank to tank, between regimes in the same tank, and even, to a degree, within tank regimes due to the non-uniformity within waste layers. The potential for uniform corrosion therefore varies greatly; however, it is not believed to be a failure concern as long as the waste is maintained within the appropriate pH range. Many studies in a wide variety of environments indicate that uniform corrosion rates are much less than 1 mil/yr, and although it is an actively-occurring degradation mechanism, uniform corrosion is considered an improbable failure mechanism.

#### 10.2.1.2 Pitting/Crevice Corrosion

Pitting/crevice corrosion is a localized attack dependent on the concentration of aggressive anions (e.g., chlorides, fluorides) that results in holes or cavities by oxidation of iron and reduction of nitrates to nitrites. Pitting corrosion can also occur on a surface when some microstructural component within the metal (usually a manganese sulfide inclusion) forms an electrochemical cell where the corroding area acts as the anode and the uncorroded surrounding surface acts as a cathode. Pitting is characterized by a localized corrosive loss of material, leading to holes in the metal, which are surrounded by large regions that are unattacked.

Pitting/crevice corrosion may occur in the vapor space, vapor/liquid interface, or liquid space if the in-contact waste is not within specifications.

Hanford Site experience has indicated that the highest pitting rates are in the vapor region, just above the 'waterline,' rather than in the liquid-wetted region, possibly due to hydroxide neutralization by carbon dioxide. Droplets of liquid waste created by escaping gas bubbles may splash onto the tank interior surfaces near the waste level. Water vapor condensation on the walls will tend to dilute the waste and wash the dissolved solids back into the liquid. The resulting liquid wetting the exposed surfaces will be equilibrated with air and subject to the pH-controlling effects of carbon dioxide. The dilute (low dissolved solids) solution will have a pH controlled by the carbonate/bicarbonate buffer, resulting in a pH below 10. Corrosion literature amply indicates that carbon steels are vulnerable to pitting attack under these conditions. Vapor space corrosion studies have shown that ammonia is a very effective inhibitor for pitting (Anantatmula 2004). Work at Savannah River National Laboratory (SRNL-STI-2013-00739) has shown that if the waste contains 550 ppm ammonia, there will be a sufficient amount in the vapor to inhibit vapor phase corrosion.

Pitting kinetics experiments (Anantatmula 2004) indicate that steel in contact with low hydroxide solution near the waterline is protected when coupled with steel in contact with high hydroxide solution below the waterline. Pitting attack was observed during tests using low hydroxide solutions with no nitrite. Vapor phase pitting penetration rates were found to be higher than uniform corrosion rates, but both rates were found to decrease with time. Vapor phase pitting rates have been shown to rapidly decrease with time, so short-term pitting data from studies result in a gross overestimation of the corrosion rates for wall penetration.

Experiments at the Savannah River Site (Zapp 2004, *General Pitting Corrosion Experiments at the Savannah River Site*) found that nitrite inhibits pitting corrosion on partially immersed steel coupons in a nitrate solution. The minimum effective concentration is a function of temperature with a ratio of nitrate to nitrite of 4:1 at 23 °C and 1:7 at 60 °C.

Pitting and crevice corrosion rates for carbon steel surfaces in contact with liquid waste are dependent on waste composition. The presence of chloride and other halogen ions can cause localized breakdown on the surface, and the presence of nitrates and sulfates can also encourage pitting. Test data indicate that the pH must be < 10 for pitting to occur. Testing performed in 2011 (RPP-47895, *FY2011 DNV DST Corrosion and Stress Corrosion Cracking Testing Report*) further supports the claim that relatively low pitting risk exists if the pH is maintained above 11.5 to 12.

Concentration cell corrosion processes are variations of crevice/pitting corrosion. Oxygen or aggressive anion concentration cells may develop at stagnant vapor/liquid interfaces. The concentration gradient anodically polarizes the area of the tank wall slightly below the surface, resulting in preferential dissolution of tank wall material at this area. Corrosion products, formed from the reaction of dissolved metal with hydroxide, precipitate just below the waterline and accelerate the dissolution of the tank metal. In tanks with constant waste levels, concentration cell corrosion could be a severe source of degradation.

Pitting of carbon steel in contact with liquid wastes containing nitrates can be prevented by adding nitrite and hydroxide, which act as inhibitors. Pitting is not generally expected in solutions containing hydroxide at pH >10. In solutions of pH <10, the addition of nitrite in sufficient quantity has been found to be effective at preventing chloride- and sulfate-induced

pitting. However, after pitting corrosion has started, the addition of nitrite does not arrest further corrosion, thus reinforcing the importance of the tank waste acceptance criteria.

Concentration gradients within the waste solids in contact with the wall could lead to local oxygen concentration cells. Chelating or complexing species could also affect the anodic reaction. It is virtually impossible to assess the extent of the potential of this type of corrosion occurring in any of the DSTs because it would require precise knowledge of the local structure of the waste and exhaustively detailed tank history. It is more reasonable to consider it as simply part of the corrosion caused by pitting and crevice corrosion because the steps to mitigate or correct it are essentially the same (PNNL-13571, Section 1.3.4).

A vulnerability to pitting corrosion also exists in the annulus region if liquid comes in contact with the tank walls due to entry of groundwater or reflux condensation of moisture from the annulus air. UT couplant, which is left to evaporate, can also contribute to pitting corrosion.

Determining overall rates of corrosion for this mechanism is very difficult because the length of the initiation period is difficult to characterize. Pitting corrosion generally causes leaks rather than mechanical failure of a material but can also compromise structural integrity if the pitting leads to SCC.

#### 10.2.1.3 Stress Corrosion Cracking

SCC is caused by the simultaneous presence of tensile stress and specific corrosive media, resulting in the localized oxidation of iron and reduction of nitrate to nitrite. Nitrate is a corrosive medium for carbon steel.

The highest tensile stresses in the DSTs are expected to be near the lower knuckle because of the combination of hydrostatic load, bending moment, and residual welding stresses. SCC could occur only when in-contact waste is not within specifications and a local flaw exists that exceeds the threshold level stress intensity factor. The vapor/liquid interface, liquid space, and bottom knuckle of the tanks are the potential sites for SCC. Even though the tank vapor chemistry and vapor/liquid interface composition may drift into a pH and concentration regime where SCC becomes possible, neither dead weight nor residual stresses are high in those areas of the primary shell.

The 2006 DSTAR provides account of a significant number of tanks that show leaking from SCC (Wiersma 2004, "Stress Corrosion Cracking Experience and Effect on Design"). Somewhat elevated temperatures above 50 °C have been shown to enhance SCC at the Savannah River Site. This experience only emphasizes the importance of stress relief and waste acceptance criteria. The A285 carbon steel used for constructing the Type I and II tanks have proven to be susceptible to SCC. The A537 steel of the newer Type III tanks was selected for resistance to SCC. All of the Hanford Site DSTs were stress-relieved after construction and, the waste chemistry has been monitored and adjusted as required for the majority of the DSTs. Section 4.2.9 discusses stress relief of the DSTs during construction.

Testing was overseen in 2009 by the Expert Panel Oversight Committee on DST Corrosion Monitoring and Testing to optimize chemistry control for corrosion limits in DSTs (RPP-RPT-43115, *Summary and Recommendations of the Expert Panel Oversight Committee Meeting on Double-Shell Tank Corrosion Monitoring and Testing Held June 1-3*). Testing was performed over a broad temperature span with simulants having a wide range of compositions.

Test results indicate that the risks of SCC are minimized under the following chemistry control conditions:

- Temperature < 122 °F
- Hydroxide ion concentration with > 11 pH but < 6 M
- Nitrate ion concentration < 5.75 M
- Nitrite ion/nitrate ion ratio > 0.12.

Waste in all tanks meet the above-recommended specifications with the exception of the AZ Tank Farm tanks, whose temperatures exceed 122 °F because they were designed to contain self-boiling waste.

### 10.2.2 Component Degradation

Carbon steels, austenitic stainless steels, and concrete are the principal materials used in the construction of the DST System. It is important to note that although all plausible degradation mechanisms are discussed, the relative consequences of a component failure – that is a minor leak or a gross rupture – are equally important considerations.

The DST outer shell is made of reinforced concrete designed to sustain soil loadings, dead loads, live loads and temperature gradients generated by the radioactive waste contained within the primary tank. The reinforced concrete tank is lined with a carbon steel liner referred to as the secondary steel tank. The inner, freestanding, completely enclosed carbon steel tank is referred to as the primary tank. It sits on top of an 8 in. thick slab of insulating concrete formed from aluminate cement and slate aggregate, and an annular space separates the steel tanks. DST component materials and functions are summarized in Table 10-2.

**Table 10-2: DST Components**

| Hanford Waste Facility | Component | Function |
|---|---|---|
| Double-shell tanks | Primary tank (carbon steel) | Structural stability and primary containment |
| | Secondary liner (carbon steel) | Secondary containment |
| | Concrete vault (cylindrical walls, dome, and basemat) | Structural stability |
| Transfer lines: Pipe-in-pipe | Primary pipe (carbon steel or stainless steel) | Structural stability and primary containment |
| | Secondary pipe (carbon steel) | Structural stability and secondary containment |

#### 10.2.2.1 DST Primary Liner

Pitting and crevice corrosion can occur in the primary tank at any of the waste regions; however, the vapor space and the vapor-liquid interfaces are especially susceptible. The chemical composition of the condensed vapor phase on tank walls and equipment in the vapor space is representative of a dilute waste composition. The resulting wetted surfaces, equilibrated by the

pH-controlling effects of carbon dioxide in the air, will result in dilute waste chemistry with pH ≤10, controlled by the carbonate/bicarbonate buffer.

Caustic solution pH has been shown to drop naturally to approximately 10 over a period of a few months at the vapor-liquid interface due to reaction of the hydroxide with atmospheric carbon dioxide. If there is little or no sediment, the temperature of the liquid waste is essentially uniform due to the continuous mixing by convection (PNNL-13571, Section 1.1.3).

Chemical compositions for wastes in a tank are typically assumed to contain a uniform distribution of constituents. Tank waste is typically in a saltcake, sludge, or liquid form, and there is a vapor phase above the liquid. Furthermore, within each region waste chemistry can vary from point to point, resulting in localized regions that are out of specification. Pitting corrosion in the liquid phase has already been detected at the Hanford Site and has the potential to be an important failure mechanism. The metal/salt interface in the saltcake region is also a prime crevice corrosion environment, although no pitting corrosion has been identified in this region.

Although SCC remains a theoretical corrosion mechanism, it is believed that the DSTs have been constructed and operated in such a way as to mitigate such a failure type. All butt-welded joints in the tank were full penetration, the primary tanks were subjected to a post-weld stress relieve heat treatment following construction, and the bulk waste chemistries have been adjusted to comply with DST waste specifications. See Section 10.3.1 for a detailed discussion on waste acceptance criteria.

#### 10.2.2.2 DST Annular Space

All DSTs have active systems in place for ventilation of the annular space, but these have not always been maintained in continuous operations (PNNL-13571, Section 1.1.3). Operational availability of the annulus ventilation systems has usually been much lower than that of the primary tank ventilation systems because requirements for system operation do not demand continuous active ventilation of the annulus and, as a result, extended operation with only passive ventilation of the annulus has not been unusual in many of the DSTs.

A vulnerability to pitting corrosion exists in the annulus region if liquid comes in contact with the tank walls due to reflux condensation of moisture from the annulus air. Pitting corrosion could be further encouraged by contaminants, particularly chloride, in the water that are absorbed after running over metal surfaces.

The propensity for corrosion due to leaked waste was evaluated in RPP-RPT-57774, *Evaluation of Tank 241-AY-102 Secondary Containment System*, to determine if it is corrosive and must be promptly removed or if it is benign and may remain in the annulus. The inside surface of the secondary containment, which would contact HLW only if a leak were to occur, is carbon steel for all the DSTs. Carbon steel is suitable for containment of HLW, as has been proven by its successful use for primary containment. However, the secondary liners of the tanks are not stress relieved, so it will depend on waste chemistry as to whether SCC and pitting are possible effects after long-term exposure if waste is in contact with the liner. Testing performed on tank AY-102 leaked waste for non-stress-relieved samples and welded samples showed no major difference in testing performance.

Testing with liquid waste simulants expected to be on the waste floor did not show a propensity for corrosion. The short timeline for tank retrieval after a leak would be detected provides

further confidence of secondary liner integrity until waste can be safely removed. See Section 11.4 for further discussion on SCC and Section 8.0 for the leak detection system integrity assessment.

The outside surface of the secondary containment is in contact with the concrete encasement. The alkaline environment of concrete (pH of 12 to 13) provides steel with corrosion protection through the formation of a thin oxide layer on the steel that prevents metal atoms from dissolving.

#### 10.2.2.3 Pipelines

The transfer line system, which is used for transporting waste product to and from waste processing facilities and for transporting waste between tanks, is pipe-in-pipe construction. Both plain carbon and austenitic stainless steels are used as the primary pipe materials, and the secondary boundary is provided on most lines by carbon steel. The inside and outside surfaces of waste transfer lines are subject to the effects of corrosion.

Stainless steel and carbon steel, which are the primary containment metals of construction, are resistant to corrosion by a high pH, saturated or unsaturated high hydroxide/nitrite/nitrate salt solution. According to published texts (*Corrosion Resistant Materials Handbook* [De Renzo 1976]; *Perry's Chemical Engineering Handbook* [Perry 1963]; vendor specification sheets) and Hanford experience, general corrosion rates are expected to be less than 0.002 in./yr. UT of removed pipe section from the SY Tank Farm did not show any thinned locations outside the expected range (LAB-RPT-12-00007, *Final Report for the Erosion and Corrosion Analysis of Waste Transfer Primary Pipeline Sections from 241-SY*), further supporting this assertion.

Although waste slurries flow through transfer lines, the flow velocity is insufficient to cause erosion or erosion corrosion. The low temperatures, high pH, and low oxygen content of the waste solutions are also beneficial factors in minimizing the risk of degeneration by erosion/corrosion processes (see Section 10.2.3.1 for further discussion of erosion corrosion).

With properly sloped, self-draining transfer lines, there should be little concern over corrosion due to their brief exposure to tank wastes if the required flow velocity range during transfer prevents the deposition of solids in the lines, which is the intent. Under such conditions, the formation of corrosion cells, an insulated cathodic area under deposits and an anodic area at the edge of the deposits, would be prevented.

Any environment that creates a locally anodic and locally cathodic area on the pipe, such as when dissimilar materials are coupled, will lead to corrosion. Factors that create changes in the surface conditions along a pipe made of a single material include changes in soil, changes in soil oxygen content, changes in pipeline finish (mill scaled areas adjacent to clean metal surfaces) changes in the pipe surface due to repair (e.g., a new pipe section welded to old pipe), and many others.

The outer surface of the DST piping is also protected by the cathodic protection system, which is regularly maintained and tested. The protective coatings and cathodic protection provide complementary defense. See Section 6.0 for a detailed assessment of the cathodic protection system.

#### 10.2.2.4 Valves

Bronze, as trim in the valves, is indicated in documentation to be nearly as corrosion resistant to the same solutions as steel, although it is susceptible to cracking in nitrate/ammonia solutions. Exact valve materials of construction have been difficult to determine given the number of acceptable valve suppliers in the construction specifications, change in valve numbering, and lack of detailed information on ±30 year old valves. A similar conclusion can be reached about the materials of construction used for the secondary containment (e.g., epoxy or polyurea coatings, stainless steel or epoxy pipe).

All of the identified elastomers, Garlock® 900 and Teflon® tape/paste/sheet, are rated excellent for chemical resistance to DST type wastes according to published texts (De Renzo 1976; Perry 1963). Common valve packing material, such as nitrile butadiene rubber (NBR), which is generic, or Hypalon®, also have excellent chemical resistance. Table 5-1 of 2006 DSTAR Volume 3 summarizes this information and is reproduced here as Table 10-3.

**Table 10-3: Materials Compatibility to Service**

| Material | Present in / Specifics | Recommended $NaOH/NO_3/NO_2$ | Radiation Limit (rad) | Comments |
|---|---|---|---|---|
| Carbon steel A537 class I, A515Gr60, A516Gr65 | Primary tank of DSTs / all DSTs | Yes | 1.0E+11 | Vapor space corrosion expected |
| Carbon steel; A53, A106, A312, D2996 | Piping, fittings, valves / many | Yes | 1.0E+11 | Vapor space corrosion expected |
| 304L or other stainless steel; ASTM 106 | AZ, AN, AW, AP piping / 219S Mod., W-211 | Yes | 1.0E+11 | -- |
| Bronze | Trim in valves | Yes | 1.0E+11 | Susceptible to SCC in $NO_3^-$ / $NH_3$ solutions |
| Compressed asbestos with SBR, graphite | Gaskets of piping / many | Yes | 1.0E+10 | -- |
| Teflon® | Thread sealant, valve seals / many | Yes | 1.0E+4 | Radiation limit probably exceeded |
| Kynar® | Valve seals / AN farm valve pit | Yes | 1.0E+8 | -- |
| PEEK | Valve seals / SLL 3160 pipelines of SY farm | Yes | 1.0E+9 | -- |

Reproduced from 2006 DSTAR Volume 3, Table 5-1.

Although the cumulative radiation exposure may marginally exceed the rated limits of valves or threaded fittings where Teflon seals or sealant are used, it has been repeatedly demonstrated that Teflon, in confined configurations such as connector head gaskets, performs successfully at

radiation doses greater than the published $10^4$ rad limit. The outer edge of the seals would be subjected to the highest radiation exposure because they are unshielded except for the bulk shielding from the fluid itself. Radiolysis of Teflon produces corrosive fluorine compounds (e.g., hydrofluoric acid) that would generally be neutralized/diluted and swept away by the HLW flow. However, after some of the sealing material has degraded and been lost, a crevice type feature could be formed where corrosive compounds are only slowly removed by diffusion through the liquid.

#### 10.2.2.5 Pump and Valve Pits

The secondary containment within pump and valve pits is concrete lined with stainless steel (AZ valve pit) or concrete lined with some type of polymer film. The identified polymer films are Amercoat®, Amerlock 400FD epoxy, or polyurea. Reviews of the vendor literature for these coatings was performed as part of the 2006 DSTAR and found to be suitable for service. Both carbon and stainless steel are suitable for containment of HLW as has been proven by their successful use for primary containment. See Section 7.0 for a comprehensive discussion of pit coatings including generic pit coating materials.

### 10.2.3 Non-Significant Corrosion Mechanisms

The 2006 DSTAR addresses a variety of corrosion mechanisms deemed to be non-significant to the DST System for steel and concrete. There have been no indications in any research or failure reports since to suggest otherwise from that conclusion. The following subsections are presented as abridged excerpts from 2006 DSTAR Volume 3, Section 4.5 (originally appearing in BNL-52527).

#### 10.2.3.1 Non-Significant Corrosion/Failure Mechanisms for Carbon and Stainless Steels

The postulated condition(s) leading to corrosion mechanisms for carbon and stainless steels are explained in the following paragraphs, along with the reasons they are believed to be either theoretical in nature only or entirely impractical for the DST System. It is worth noting that only corrosion and waste compatibility related mechanisms are addressed. Compatibility includes the physical properties of the waste and their potential effects on the DSTs and ancillary equipment, including temperature, solids content, and weight. Fatigue caused by pump vibration, or other mechanisms that have nothing to do with the waste's properties, are not within the scope of this chapter.

**Microbiologically-Induced Corrosion**

It is speculated that microorganism growth rates are inhibited within the DSTs, and only minor evidence exists to suggest that microorganisms may be present within the annulus of transfer piping (LAB-RPT-11-00006, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline for SY Tank Farm*), and even so, no corrosion attributable to the microorganisms could be substantiated. It is reasonable to assume, therefore, that microbially induced corrosion remains purely theoretical that it plays a minor role, if any, in waste tank system degradation.

**Thermal Embrittlement**

The combination of conditions (low temperatures and stress) for the greatest embrittlement has not occurred. Stainless steel does not have a ductile to brittle transition temperature around tank

operating temperatures. Even non-stress relieved weld areas would not have stress levels required for severe effects. If a DST or associated ancillary equipment were to become embrittled at low temperatures, the material of construction would not fail. The reduced ductility of the steel alone is not considered to be a concern and some substantial mechanical force sufficient to strongly bend or otherwise deform the component is required.

**Neutron Embrittlement**

The maximum fast neutron flux estimated for the waste tanks is many, many orders of magnitude too low to even reach the lowest threshold effect. Criticalities could be another source of neutron flux; however, no criticalities have ever occurred in the tank farms, much less repeatedly occurred, as would be required to achieve any significant neutron flux. The calculated high energy gamma flux for 'fresh canyon waste' for 50 years, a worst case type scenario, is more than 20-fold lower than the most conservative threshold value for embrittlement. Similar to thermal embrittlement, even if a DST or associated ancillary equipment were to become embrittled by neutron flux, the material of construction would not fail without substantial mechanical force applied.

**Creep and Stress Relaxation**

Creep is the time-dependent inelastic deformation of a metal subjected to a stress that is typically below the elastic limit. The DSTs have experienced temperatures above 800 °F only once, and this was during heat treatment to relieve weld stresses. Such tank temperatures have not occurred since. Stainless steel is equally resistant to creep and stress relaxation.

**Fatigue**

Fatigue caused by cyclic physical stress or thermal cycling normally becomes apparent after around 1 million cycles. The number and intensity of alternating stress from loading/unloading of wastes is insignificantly small so that fatigue is not expected. Thermal and seismic study addresses this, see RPP-RPT-28968.

**Erosion-Corrosion**

Erosion corrosion occurs when flowing waste slurries impinge on the carbon steel surface and mechanically erode away the protective oxide film leaving a bare metal surface open to rapid re-oxidization. An endless cycle of renewed film removal continues to occur. Fluid velocities have to be substantial for erosion to occur. In-tank mixers do not create velocities typically required for erosion-corrosion in the 50 ft/sec range. Even the waste transfer piping operates far below this threshold velocity with the requirement to maintain a slurry velocity of 3 to 10 ft/sec over the slurry pump range of 32 to 100 gal/min to keep slurry solids from settling in the pipe. Because the slurry piping is all 2 in. Schedule 40 piping, these flow rates produce velocities of 3.1 to 9.6 ft/sec (RPP-15138, *System Design Description for the 200 West Area Waste Transfer System (DSA Based)*). Low temperatures, high pH, and low oxygen content of the waste solutions further minimize the potential for erosion-corrosion. This mechanism would be most pronounced in the carbon steel piping, especially at elbows or other flow direction change points, however evidence of erosion-corrosion has not been found to date during inspections of the piping systems. Stainless steel has an inherent resistance to erosion-corrosion. Further discussion on the transfer system is provided in Section 5.0.

**Wear**
Mechanical rubbing of one material against another because of physical (loading/unloading) or thermal (hot waste addition, cold water addition) stresses from expansion/contraction could cause thinning of the material. The number of cycles and relative motion stroke for either physical or thermal stress in the DSTs are small, and there are a very limited number of locations on a DST or associated ancillary equipment where wear could even occur. Wear has not been shown to be a significant mechanism for deterioration of metals within the DSTs and ancillary equipment.

**Hydrogen Embrittlement**
The required conditions for hydrogen attack of high-strength carbon steel are (1) temperatures in excess of 500 °F combined with partial pressures of hydrogen of several hundred pounds per square inch or (2) hydrogen generation intimately with the carbon steel surface at temperatures below 200 °F. The first conditions have never been and could never be physically achieved within the DSTs or their ancillary equipment. For the second set of conditions, hydrogen generation by corrosion of the steel is greatest for a new metal surface and thermally hot HLW, however at temperatures above 200 °F, hydrogen is not held within the steel but diffuses out. Nitrite tends to react with nascent hydrogen further reducing the chance for hydrogen buildup.

Similar to thermal and neutron embrittlement, even if a DST or associated ancillary equipment were to become embrittled by hydrogen, the material of construction would not fail without substantial mechanical force applied.

#### 10.2.3.2 Non-Significant Corrosion/Failure Mechanisms for Concrete

The postulated condition(s) leading to corrosion mechanisms for concrete are explained in the following subsections, along with the reasons they are believed to be either theoretical in nature only or entirely impractical for the DST System.

**Irradiation**
Neutrons usually cause aggregate growth, water decomposition, and heating of the concrete. Gamma radiation produces heating and water migration. The energy flux from the tank waste is many orders of magnitude too low to reach the threshold for radiation damage.

**Creep**
Increased inelastic strain occurs within the concrete as a result of sustained stress from dead load, live loads, and effects of elevated temperature. Creep can induce small cracks that do not result in concrete deterioration. So creep may or may not have happened, but without an observable effect.

**Others**
There are other deterioration mechanisms that apply to concrete, including the following:

- Freeze/thaw – Depends on weather and saturation, not waste
- Leaching of calcium – Requires continuous or near-continuous water flowing over the concrete, which does not occur at the Hanford Site
- Reaction of aggregates with alkalis – Requires the combination of saturated conditions and susceptible aggregate, neither of which exist at the Hanford Site

- Shrinkage – Depends on concrete design and installation, not the waste properties.

Evidence from the concrete dome plug cut from tank C-107 (poured in 1944) and the vertical sidewall core from tank A-106 (poured in 1955) show that carbonation of concrete has not occurred further than a few millimeters beyond the surface (RPP-RPT-50934, *Inspection and Test Report for the Removed 241-C-107 Dome Concrete*). Furthermore, these mechanisms are independent of the waste chemistry, temperature, and density and therefore are not considered further in this section.

## 10.3 CORROSION CONTROL PROGRAM

The purpose of the corrosion mitigation program is to minimize corrosion of the inner wall of the primary tanks that are in contact with the waste by requiring that the waste chemistry be maintained within limits, and to minimize corrosion of the outer walls by requiring operation of the annulus ventilation system to remove moisture and minimize the potential for condensation to form on the tanks. By reducing the potential for corrosion on both the inner and outer walls, the program helps to protect the potential for loss of integrity of the DST primary tank. Operation of the annulus ventilation system also reduces the potential for corrosion of the secondary steel tank liner.

Corrosion protection measures are very important to the mission of the Tank Farms due to the limited amount of available storage space, and failure of a primary tank would further reduce that capacity while also requiring immediate transfer of the stored waste (WAC 173-303-640(7)(b)).

DST corrosion protection measures are required by the Tank Farm Contractor in OSD-T-151-00007, Section 1.5, "Corrosion Mitigation". The following are the key program elements.

### Tank Chemistry Detection and Control

1. Conduct periodic sampling of the waste in DSTs to determine the nitrite, nitrate, and hydroxide concentrations and to verify that measured concentrations are within the limits established in Tables 1.5.1-1 and 1.5.1-2 of OSD-T-151-00007 (provided in this report as Table 10-4 and Table 10-5). The technical basis for establishing sampling frequencies is provided in RPP-7795, *Technical Basis for Chemistry Control Program.*
2. Establish and maintain a database to track the nitrite, nitrate, and hydroxide concentrations in each DST. This database is used to monitor compliance with the waste chemistry limits and to identify patterns of caustic consumption that are important in determining tank sampling frequencies. The database also is used for trending to help predict when chemical adjustments are required to ensure DST waste chemistry is within the established limits. The database is published annually as part of RPP-13639.
3. Prior to waste transfers, the final states of the sending and receiving DSTs shall be evaluated for compliance with the waste chemistry limits. Compliance may be demonstrated by sample analysis or calculations of final waste chemistry conditions. The evaluation of compliance with the waste chemistry limits will be documented in a WCA performed in accordance with HNF-SD-WM-OCD-015.
4. Waste samples are analyzed per the requirements of a tank sampling and analysis plan and when results are not in compliance with the plan, the 222-S Laboratory and Tank

Farm Inventory personnel invoke TFC-ENG-CHEM-P-18, *Response to Anomalous Sample Results.* When a DST is identified to be outside the established limits for the nitrite, nitrate, or hydroxide concentrations:

a. Notify the Shift Manager. Shift Manager shall treat OSD non-compliance as a significant operational issue and make appropriate notifications per TFC-OPS-OPER-C-57, *Event Notification*

b. Evaluate for reportability in accordance with TFC-OPS-OPER-C-24, *Occurrence Reporting and Processing of Operations Information*

c. Ensure a PER has been submitted

d. Restore the nitrite, nitrate, or hydroxide concentrations within the established limits within 30 days and verify by sample analysis that the waste chemistry is within the established limits within 90 days
-OR-
Process Engineering shall complete an OSD Recovery Action Plan Form (A-6005-240), submit the Recovery Action Plan to the WRPS Chief Engineer (with notification to the ORP Assistant Manager Tank Farms when it is approved) within 30 days, and restore the nitrite, nitrate, or hydroxide concentrations within the established limits in accordance with the approved Recovery Action Plan.

**Annulus Tank Ventilation System Controls and Inspection**

1. Annulus tank ventilation systems shall be operating except for outages not to exceed 30 days. Annulus ventilation system operation is verified as follows:

   a. Verify that at least one fan is operating

   b. Verify that inlet annulus ventilation dampers/valves are not closed (except SY Tank Farm emergency pump out isolation station valves SY101-VTA-V-202, SY102-VTAV- 212, and SY103-VTA-V-222) by either (1) visual inspection or (2) indication of differential pressure across the annulus inlet high-efficiency particulate air filter.

2. If the annulus tank ventilation system is out of service for longer than 30 days:

   a. Notify the Shift Manager. Shift Manager shall treat OSD non-compliance as a significant operational issue and make appropriate notifications per TFC-OPS-OPER-C-57

   b. Evaluate for reportability in accordance with TFC-OPS-OPER-C-24

   c. System Engineering shall complete an OSD Recovery Action Plan Form (A-6005-240) in accordance with TFC-CHEM-P-14, *Operating Specification Documents*, submit the Recovery Action Plan to the WRPS Chief Engineer (with notification to the ORP Assistant Manager Tank Farms when it is approved) and restore the annulus ventilation to operation in accordance with the approved Recovery Action Plan.

3. Each DST annulus shall be video inspected on a 5-year frequency not to exceed 7 years (calendar years).
4. At least one DST in each of the six DST farms shall be video inspected on an 18 month frequency not to exceed 2 years (calendar years).
5. Annulus video inspections shall be conducted in one riser in each of the four quadrants, wherever possible (beginning December 21, 2007), to maximize the surface area and locations that will be inspected. The expectation is that there should be an available riser in each quadrant that allows access to the annulus, but it is possible that there may be equipment obstructions which preclude camera access. In situations where there is a physical access constraint, only three quadrants may be inspected.

   If video inspection indicates ingress of water into the annulus:

   a. Notify the Shift Manager. Shift Manager shall treat OSD non-compliance as a significant operational issue and make appropriate notifications per TFC-OPS-OPER- 57
   b. Evaluate for reportability in accordance with TFC-OPS-OPER-C-24
   c. Ensure a PER has been submitted
   d. Stop the ingress of water into the annulus within 30 days
      –OR-
      Process Engineering shall complete an OSD Recovery Action Plan Form (A-6005-240), submit the Recovery Action Plan to the WRPS Chief Engineer (with notification to the ORP Assistant Manager Tank Farms when it is approved) within 30 days, and stop the ingress of water into the annulus in accordance with the approved Recovery Action Plan.
6. Annual video inspections (i.e., not to exceed 365 days since completion of the last inspection) shall be performed in specific DSTs where new patches of heavy corrosion and/or efflorescence stains/streaks have appeared since the last inspection. The annual inspections shall continue until the condition is stabilized/mitigated.
7. The results of the video inspections shall be documented in an engineering document. Annulus video inspection schedules are tracked as Preventative Maintenance (PM) using CHAMPS.

The following Sections 10.3.1 through 10.3.4 evaluate implementation of the key elements.

### 10.3.1 Tank Chemistry

DST corrosion protection measures are required by the Tank Farm Contractor in OSD-T-151-00007, Section 1.5. Periodic sampling to verify the corrosion inhibitor chemicals, hydroxide, and nitrite anions must verify that tank wastes are remaining within the chemistry specifications specified in Table 10-4 and Table 10-5.

**Table 10-4: Waste Chemistry Limits for All DST Waste Except the Interstitial Liquid in Tanks AN-102, AN-106, AN-107, AY-101, and AY-102**

| For $[NO_3^-]$ Range | Variable | For Waste Temperature (T) Range | | |
|---|---|---|---|---|
| | | T < 167 °F | 167 °F < T < 212 °F | T > 212 °F |
| $[NO_3^-] < 1.0M$ | $[OH^-]$ | $0.010M < [OH^-] < 8.0M$ | $0.010M < [OH^-] < 5.0M$ | $0.010M < [OH^-] < 4.0M$ |
| | $[NO_2^-]$ | $0.011M < [NO_2^-] < 5.5M$ | $0.011M < [NO_2^-] < 5.5M$ | $0.011M < [NO_2^-] < 5.5M$ |
| | $[NO_3^-] / ([OH^-] + [NO_2^-])$ | < 2.5 | < 2.5 | < 2.5 |
| $1.0M < [NO_3^-] < 3.0M$ | $[OH^-]$ | $0.1 ([NO_3^-]) < [OH^-] < 10M$ | $0.1 ([NO_3^-]) < [OH^-] < 10M$ | $0.1 ([NO_3^-]) < [OH^-] < 4.0M$ |
| | $[OH^-] + [NO_2^-]$ | $> 0.4 ([NO_3^-])$ | $> 0.4 ([NO_3^-])$ | $> 0.4 ([NO_3^-])$ |
| $[NO_3^-] > 3.0M$ | $[OH^-]$ | $0.3M < [OH^-] < 10M$ | $0.3M < [OH^-] < 10M$ | $0.3M < [OH^-] < 4.0M$ |
| | $[OH^-] + [NO_2^-]$ | > 1.2M | > 1.2M | > 1.2M |
| | $[NO_3^-]$ | < 5.5M | < 5.5M | < 5.5M |

Reference: From Table 1.5.1-1 of OSD-T-151-00007

**Table 10-5: Waste Chemistry Limits for the Interstitial Liquid of Tanks AN-102, AN-106, AN-107, AY-101, and AY-102**

| Temperature | Variable | Limit |
|---|---|---|
| ≤ 122 °F | $[NO_2^-]/[NO_3^-]$ | ≥ 0.32(1) |
| | pH | ≥ 10 |
| > 122 °F | Limits in Table 10-4 apply(2) | |

Notes:
(1) The [NO2-]/[NO3-] limit ≥ 0.32 does not apply to tank AY-102
(2) Tank AY-102 chemistry limits apply for temperatures not in excess of 170°F
Reference: From Table 1.5.1-2 of OSD-T-151-00007

Past studies have shown that the corrosion of low carbon steels (ASTM A516 and ASTM A537) used in the DSTs is dependent on nitrite, nitrate, and hydroxide concentrations and that low concentrations of minor constituents such as carbonate, phosphate, sulfate, silicate, fluoride, and chloride were found to have little effect on corrosion potential at temperatures up to 212 °F (Miller 2000).

The concentration limits for nitrite, nitrate, and hydroxide concentrations are based on past corrosion studies and are intended to limit the rate of uniform corrosion to less than or equal to the design basis of the tanks of 1 mil/yr and to minimize the potential for SCC (OSD-T-151-00007, pg. A-11). These limits were established to minimize corrosion by ensuring pH, hydroxide/nitrite/nitrate ratios were correct for oxide film formation and maintenance on the carbon steel of the primary DST. This pH and chemical species ratio is also protective to other

carbon steel components within the ancillary equipment, and does not have any corrosive effect on stainless steel material of construction.

If a DST waste chemistry is identified to be outside the waste chemistry limits, waste chemistry can either be adjusted or a recovery plan developed. If the waste chemistry is to be adjusted, the administrative controls incorporated into OSD-T-151-00007 require waste chemistry adjustment to restore the inhibitor levels to within limits and completed within 30 days of identification. These chemical adjustments are achieved by either waste blending operations or chemical (caustic and/or nitrite) additions. Appendix T details transfers that have occurred since the 2006 DSTAR including chemical additions.

If a DST is outside the established limits with respect to waste chemistry and a recovery plan is developed, then the recovery plan must be submitted to the Chief Engineer within 30 days of identification. The recovery plan identifies corrective measures that will typically involve waste transfers and caustic additions. Implementation schedules, which are expected to result in the corrective actions being completed as soon as practical, are also identified in the recovery plan.

### 10.3.2 Sampling

Periodic sampling is required by OSD-T-151-00007 to ensure that the waste chemistry is monitored. Based on observed and predicted rates of caustic consumption, sampling frequencies are established for each DST to determine nitrite, nitrate, and hydroxide concentrations and to verify that the measured concentrations are within the established limits. The technical basis for establishing sampling frequencies is provided in RPP-7795.

RPP-7795 establishes chemistry control sampling and analysis requirements for DST waste in accordance with OSD-T-151-00007, Section 1.5. Specific requirements for analysis of waste samples are established in RPP-8532, *Double-Shell Tanks Chemistry Control Data Quality Objectives,* and incorporated in specific tank sampling and analysis plans.

The sampling and analysis requirements are based on the evaluation of waste chemical compositions, mechanisms for chemistry change, hydroxide ion depletion modeling, and waste tank operations. The document provides sample schedule requirement input to RPP-26781, *Tank Operations Contractor Process Sampling Requirements for FY2015 through FY2019.* DST sampling is conducted in accordance with the Tank Farms Contractor chemistry control program. This program requires the Contractor to take a supernate sample just below the supernate surface. It is taken at this level because operating experience shows this area as most susceptible to hydroxide depletion due to carbon dioxide absorption from the ventilation air, resulting in potential vapor/liquid interface corrosion at this point.

The DST waste composition data for nitrite, nitrate and hydroxide ions, pH and recent sample results used by the evaluation in RPP-7795 were extracted from RPP-13639. Maintaining minimum specified free hydroxide ion and nitrite ion concentrations within the DST waste is central to the corrosion mitigation chemistry control program. Hydroxide ion concentrations were estimated by either applying the hydroxide depletion calculations described in RPP-8974, *Chemistry Control Program Calculation Methodology for Prediction of Hydroxide Depletion in Double-Shell Tanks*, or one of two mechanistic hydroxide depletion and mixing models: (1) supernatant chemistry evaluation model or (2) dynamic mixing model.

Analysis was performed in a supporting spreadsheet, *RPP-13639_R10_Rev1.xlsx,* as verified in SVF-2900. The results of the evaluation showed five tanks that were of potential concern at the

time or within the next 5 years, not including tank AY-102. The following summarizes the analysis findings:

- Both tanks AN-101 and AN-106 had supernate predicted by one of the empirical depletion equations (the Hobbs equation) to go out of specification before fiscal year (FY) 2018. These tanks each received a caustic addition in FY 2014 which brought them into specification for continued C Tank Farm waste retrieval.
- Tank AN-107 supernate is predicted to go out of specification in late FY 2018. A grab sample is recommended in FY 2017 to better assess the condition of the waste.
- Tank AY-101 supernate is predicted by one of the empirical depletion equations (the Hobbs equation) to go out of specification in FY 2018. The tank was recirculated in June 2013 and was an active receiver of condensate from AZ301-COND-TK-001 (AZ-301) condenser until January 2014. Tank AZ-301 receives process condensate from the 702-AZ primary tank ventilation system serving the AY and AZ Tank Farm tanks. Prior to January 24, 2014, when tank AZ-301 filled, it was pumped to either tank AY-101 or tank AZ-102. Quarterly mixing of the supernate had been recommended to prevent formation of dilute surface layers, but equipment changes now allow for condensate to be removed from the system by tanker trucks for transfer to the Effluent Treatment Facility or the Liquid Effluent Retention Facility, thus eliminating the need for quarterly recirculation. Planned waste transfers, as well as SST waste retrievals, are expected to significantly alter the supernate chemistry before FY 2018. If these scheduled events do not take place, a grab sample will need to be completed in FY 2017, 1 year before the out of specification date to ensure chemistry limits are not exceeded.
- Tank AZ-102 received periodic condensate additions from the tank AZ-301 condenser prior to January 2014. The condensate additions can cause a dilute surface layer to form in the supernate. The surface layer of tank AZ-102 is currently estimated to be out of specification based on mechanistic modeling and has been since April 2013. WRPS-PER-2013-1219 was generated to document the out-of-specification layer and recirculation of the tank supernate was recommended. Since 2014, tank AZ-301 contents have been transferred by an over-the-road tanker to the Effluent Treatment Facility for treatment and disposal. This tank is currently scheduled for grab sampling prior to the future 242-A Evaporator campaign.

Corrosion mitigation sampling requirements are incorporated into the Hanford Site Integrated Mission Execution Schedule, and actions are coordinated with the Base Operations sampling organization. A database has been established and maintained to track the nitrite, nitrate, and hydroxide concentrations in each of the DSTs. This database is used to monitor compliance with the concentration limits established by OSD-T-151-00007, Section 1.5, and to identify patterns of caustic consumption that are important in determining tank sampling frequencies. The database also is used for trending to help predict when chemical adjustments are required to ensure DST waste chemistry is within the established limits.

### 10.3.3 Waste Transfers

Section 1.5 of OSD-T-151-00007 requires that the effect of waste transfers on nitrite, nitrate, and hydroxide concentrations in the sending and receiving tanks be evaluated to ensure that the

established concentration limits are maintained. An option to verify compliance with the concentration limits through sample analysis or calculations allows operational flexibility.

HNF-SD-WM-OCD-015 provides a formal process for evaluating waste transfers and chemical additions through the preparation of documented WCAs. That document implements the requirements established in HNF-SD-WM-DQO-001, *Data Quality Objectives for Tank Farms Waste Compatibility Program,* and RPP-29002, *Double-Shell Tank Waste Analysis Plan*. The tank farms waste transfer compatibility program helps ensure continued safe and prudent storage and handling of the wastes within the tank farms by providing a formal process for evaluating waste transfers and chemical additions through the preparation of documented WCAs.

The decision rules in the document relate to waste transfers within the DST System, to waste and chemical additions to the DST System and to waste transfers to and from the DST System resulting from 242-A Evaporator operations. Decision rules encompass the following:

- Administrative Controls:
  - AC 5.9.1, DST and SST Time to Lower Flammability Limit
  - AC 5.9.4, Waste Characteristics Controls
- Regulatory Controls:
  - RPP-29002
- Operational Controls:
  - HNF-SD-WM-OCD-015
  - TFC-ENG-STD-26.

Waste tanks are evaluated using methodologies in RPP-10006 to determine the waste group and consider interim waste levels as well as expected final state of the DST. The basis for the WSPS and chemical compatibility is documented in RPP-29002.

The decision rules of HNF-SD-WM-OCD-015 apply to all liquid and solid phase waste transfers, including the following:

- Combining wastes within the DST System (includes catch tanks)
- Transferring waste between the DSTs and interfacing tank farm facilities (e.g., 242-A Evaporator and 222-S Laboratory)
- Transferring waste between SSTs and the DST System
- Adding bulk chemicals to the DST System or to 100-series SSTs
- Adding waste or making large water additions to DSTs or SSTs.

Certain additions to tanks are unlikely to cause any waste compatibility problems and are exempt from the WCA requirement, which must include a summary against each compliance rule in a compliance table (TFC-ENG-CHEM-P-13, *Tank Waste Compatibility Assessments*). The following types of additions may occur on a regular basis, and conducting WCAs each time is neither feasible nor technically justified. Therefore, the following types of additions to DSTs are exempt from WCAs when originating within the TFC facilities or the 242-A Evaporator:

- Up to 10,000 gal/yr of small water accumulations or potentially contaminated water with no chemicals added except for those used for tank corrosion control (i.e., sodium

hydroxide and sodium nitrite). Examples include process condensate from tanks on active ventilation, cooling water, rainwater, snowmelt, pipeline flush water, line drain backs, pipeline pressure test water, de-entrainer flush water, airlift circulator flush water, 242-A Evaporator process condensate, and water/flush water in the evaporator vessel.

- Small volumes (<5 gal) of non-waste liquids with pH >7 added for a useful purpose such as cleaners, lubricants, and decontaminants.
- The potential introduction of small volumes of chemical products that have been evaluated in RPP-11192, *Tank Farms Chemical Compatibility Evaluation*.
- Up to 100 gal of saltwater used for conductivity testing.

It should be noted that special attention must be paid to ensure that salt water does not come into direct contact with austenitic stainless steel, particularly those with less than 6% molybdenum.

The final state of source and receiver DSTs must be evaluated for compliance with tank chemistry controls (see Section 10.3.1). The evaluation includes an assumed water addition of 10,000 gal. If a DST is identified to be outside of tank chemistry control limits, recovery action must be followed as specified in OSD-T-151-00007.

The receipt or transfer of waste that is outside of the specification limits is permitted if the receiving DST will remain within specification after the transfer. To ensure protection of piping, each transfer of non-compliant waste is evaluated for the need of a post-transfer chemical flush. Pipes are sloped for drainage of flush water, and it is important that any future repairs and additions be appropriately sloped to avoid microbe-induced and pitting corrosion. No waste transfer shall make an in-specification DST out-of-specification unless the transfer is approved by the Plant Review Committee.

#### 10.3.3.1 Documentation Requirements

Prior to acceptance of a planned waste transfer or chemical addition, the proposed transfer or addition must be evaluated to ensure that the transfer will comply with the decision rules as specified in HNF-SD-WM-OCD-015. The evaluation is documented in a WCA prepared and formatted in accordance with TFC-ENG-CHEM-P-13. A summary of the compliance status of the proposed transfer against each decision rule is provided in a compliance table included in the assessment. Appendix U lists the WCAs that were evaluated as part of this 2016 DSTAR.

The data and analytes required to evaluate waste compatibility are discussed in HNF-SD-WM-DQO-001. Data may be taken from a variety of sources including the BBI, laboratory testing, sample analyses not yet included in the BBI, or other WCAs. Where sufficient data are not available to provide an adequate representation of the waste, sampling and analysis in accordance with HNF-SD-WM-DQO-001 are requested prior to transfer.

A completed, current WSPS is required for each waste stream entering the DST System, even if there will be only a single transfer of the waste. A WSPS is not required for transfers within the DST System or for transfers to and from the 242-A Evaporator when DST waste is the only waste stream being processed. The WSPS form is found in RPP-29002. The WSPS is updated, resubmitted, and approved each year for ongoing transfers. For each batch transfer into the DST System, the DST customer must provide written certification that the waste conforms to the approved information in the WSPS.

Periodic management assessments, as well as specialty assessments, of the Tank Farms Waste Transfer Compatibility Program are conducted to assess the overall health of the program in accordance with TFC-PLN-10, *Assessment Program Plan*. Assessments are conducted and documented in accordance with TFC-ESHQ-AP-C-01, *Management Assessment*.

The Tank Farms Waste Transfer Compatibility Program contains appropriate checks and balances to ensure that waste transfers do not create hazardous conditions or lead to corrosive conditions within tanks. Management assessments adequately ensure that the program requirements are being followed.

### 10.3.4 Annulus Protection

Section 10.2.2.2 overviews the corrosion protection measures as they relate to the annulus between the primary tank and secondary liner. The purpose is to minimize corrosion of the outer walls by requiring operation of the annulus ventilation system to remove moisture and minimize the potential for condensation to form on the tanks. By reducing the potential for corrosion on both the inner and outer walls of the primary tank, the program helps to protect the potential for loss of integrity of the primary tank.

### 10.3.5 Investigation of Removed Pipe

The 2006 DSTAR details the protection that has been applied to the outer surfaces of the secondary containment piping, typically the following:

- A factory applied, coal tar enamel
- An epoxy coating with or without felt overwrap
- Kraft paper overwrap
- Fusion-bonded epoxy
- Bondstrand® 400 fiberglass
- Field-applied wraps designed to be equivalent and compatible with the adjacent factory protective coating:
    - Tapecoat® 20
    - Tapecoat CT
    - Scotchrap™ 50.

The majority of the piping was covered by a foamed-in-place polyurethane foam, further isolating the pipeline from the environment, but at the same time preventing cathodic protection from being effective. Based on the published data for Ameron Bondstrand, Shell Company amine resin coatings, A.O. Smith red/green/poly thread piping, R.P. Morrison Company isophthalic and vinyl ester resins and Celanex® resins, all of these materials should have and will provide adequate protection for the outer surface of the pipe to corrosion from the slightly alkaline water that infiltrates the soil occasionally (De Renzo 1976). Hanford Site soils are not aggressive for pipeline corrosion because they are typically well-drained, dry, low temperature, and alkaline.

LAB-RPT-11-00006 documents the evaluation of two sample sections from the SY Tank Farm pipe-in-pipe transfer line to determine the level of corrosion and which forms of degradation had

occurred with particular attention paid to the outside surface of the secondary, 6 in.-diameter pipe. The inner surface of one sample contained a few small sand particles covered in an iron oxide/hydroxide layer whose structures could have been bacterial in origin. The thin iron oxide layer on the outside of the sand particles contained features such as small chains of round particles, suggesting evidence that a bacterium may have played a role in its development.

Sections from the SY Tank Farm pipe-in-pipe transfer line that were analyzed to determine the level of corrosion on the exterior of the secondary containment supports the protective nature of the pipe coatings for a limited time. A glossy, brownish organic layer existed in spots on the outside surface of the secondary pipe, which is believed to have originally been a lacquer or epoxy. Areas around the organic layer appeared less corroded suggesting that the protective layer did reduce corrosion of the pipe before falling off the surface.

LAB-RPT-12-00007 summarizes the results of the examination of three sections of primary, carbon steel, transfer pipelines (3 in. diameter, Schedule 40) located at SY Tank Farm. The analysis was directed at the inner surface of the inside waste transfer pipe to document erosion and corrosion caused by the in-field use of these primary pipes in the transfer of tank waste.

All three pipe sections had a layer of material composed largely of insoluble tank waste coating the inside of the pipe. The layers were different in each section; however, report 7S110-GAC-05-035 finds the coatings consisted largely of gibbsite and an aluminum and chromium-rich amorphous phase. Underneath the waste residue were continuous layers of corrosion up to 100 μm and scattered pitting up to 50 μm. Such pit depths may have been a result of the presence of nodules of an amorphous phase containing a large variety of elements within aluminum oxide patches. In a different sample, corrosion was most noticeable at grain boundaries. Grains of the metal appeared as rounded nodules, and there were two morphologies in the corrosion phase—granular and acicular—on top of the exposed grains of the metal. This corrosion appeared to progress by attacking metallic grain boundaries. In yet another sample, small (<10 μm) particles of silver were detected throughout the surface. Table 10-6 provides a summary of findings. Further discussion of pipeline corrosion examinations and tests are contained in Section 11.5.

**Table 10-6: Summary of Corrosion Findings on SY Tank Farm Transfer Line Section**

| Sample ID | SN-285 | SN-286 | SN-278 |
|---|---|---|---|
| Tank Waste Residue | Amorphous phase ~20 µm rich in chromium, magnesium, (and to a lesser degree aluminum, chlorine, calcium, and phosphorous) | Two distinct phases:<br>1. Amorphous phases rich in iron, aluminum, calcium, sodium, chromium, and phosphorus (plus lower-level elements: manganese, silver, bismuth, and chlorine.<br>2. Phase containing sodium aluminate. | Two separate layers of tank waste that easily scraped off:<br>Underlying layer ~350 µm composed of a cementation of small aluminum oxide (possibly gibbsite) particles and calcium.<br>Thinner overlaying layer rich in carbon, chlorine and phosphate. |
| Uniform Corrosion | Continuous layers of corrosion ~100 µm thick | Continuous iron oxide/hydroxide corrosion with pockets of aluminum oxide (possibly gibbsite). The corrosion layer was ~50 µm thick. | A thick layer (~350 µm) of aluminum oxide (possibly gibbsite) was present on both sides of the corrosion. |
| Pitting | Small pits throughout the inside pipe surface with depths up to ~50 µm | Non-continuous pits < 50 µm deep. | Scattered pitting as deep as 200 µm. |
| Additional Noteworthy Findings | Small (<10 µm) particles of silver were detected throughout the surface | Corrosion with small amounts of tank waste were detected.<br>Small particles of aluminum oxide were also detected under the corrosion layer. Aluminum oxide was also the tank waste phase on top of the corrosion. In some parts of the aluminum oxide patches, nodules of an amorphous phase containing a large variety of elements were detected. | Corrosion was most noticeable at grain boundaries. Grains of the metal appeared as rounded nodules. There were two morphologies in the corrosion phase—granular and acicular—on top of the exposed grains of the metal. This corrosion appeared to progress by attacking metallic grain boundaries. |

Reference: LAB-RPT-12-00007, *Final Report for the Erosion and Corrosion of Waste Transfer Pipeline Sections from SY Tank Farm.*

## 10.4 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

The waste compatibility related recommendations from the 2006 DSTAR are presented in this section. Some are best discussed in other sections of this report because they deal only tangentially with waste compatibility issues discussed in this section. Full dispositions are outlined in RPP-RPT-50440.

- 2006 DSTAR Item R11: Emergency pumping procedures currently estimate that the pumping of a secondary tank will begin on the tenth day from discovery of the leak. According to stated functional requirements for the secondary tanks, pumping needs to be

completed on the seventh day. It was further recommended that the Tank Farm Contractor perform one of three actions.

- 2016 DSTAR Assessment: As detailed in Section 10.2.2.2, the secondary liner can contain the waste for a reasonable period of time, well in excess of that necessary to empty the annulus in the event of an emergency.

- 2006 DSTAR Item R14: Waste streams sent to the DSTs should continue to be managed using the methodology of RPP-10006 to not create convective and non-convective layers that are required for episodic gas release events as given in PNNL-13337.
  - 2016 DSTAR Assessment: HNF-SD-WM-OCD-015, *Tank Farms Waste Transfer Compatibility Program*, Section 3.1.1.1, "Waste Group Prohibitions," prohibits waste transfers into tanks with a potential flammable GREs or waste transfers that could create flammable GREs without prior written approval from the ORP Manager.
- 2006 DSTAR Item R58: AP Tanks certified to operate at a maximum of 460 in. of tank waste should not be permitted to receive evaporator discharges.
  - 2016 DSTAR Assessment: The decision rules of HNF-SD-WM-OCD-015 apply to all liquid and solid phase waste transfers, including those between the DSTs and the 242-A Evaporator. Decision rules take into consideration both waste compatibility and specific gravity. The management of tank waste in accordance with the Waste Compatibility Program (HNF-SD-WM-OCD-015) and specification OSD T 151 00007, Rev. 14, including the practice of performing WCAs prior to transfers or additions, provides sufficient protection. See Section 4.3.4 for further discussion of specific gravity limits on tank waste.

## 10.5 IQRPE SUMMARY DISCUSSION OF 2016 DST WASTE COMPATIBILITY ASSESSMENT

The engineers and designers of the DSTs and ancillary equipment had intimate knowledge of the HLW to be handled or contained, as well as access to the Hanford Site experience of leaking SSTs. Leaks from the Hanford Site SSTs have been attributed to poor welding, lack of heat treatment, thinner and poor quality metal, and operation outside of their normal range. DST materials of construction and their installation were found to have been appropriate for their service environment.

Tank chemistry has also been tracked and reviewed for the known relationships between the chemical species that have been established as important to the corrosion mechanisms found from commercial and DOE actual experience, laboratory testing, literature information, and various types of modeling. This information was the basis for post-construction heat stress relief and development of the waste acceptance criteria for the DSTs.

The thermodynamic modeling of the tank waste (RPP-6965) indicates that the prevalent solid compounds are sodium diuranate, sodium fluoride, and zirconium dioxide. The prevalent liquid chemicals for the DSTs are sodium nitrite, sodium hydroxide, and sodium nitrate. Solid compounds do not normally participate in corrosion reactions and, in this case, sequestering the fluoride into the solid phase helps to remove a typically aggressive ion from corrosion scenarios.

The three dissolved compounds are the same three around which the waste acceptance criteria are based. Maintenance of a high pH and presence of a significant concentration of nitrite both inhibit corrosion of carbon steel.

Nothing in this 2016 DSTAR raises any new concerns for corrosion or material compatibility, so this report contains no findings. Observations and recommendations are presented in the following sections.

### 10.5.1 Findings

This report contains no findings.

### 10.5.2 Observations

The general observations from the assessment of the compatibility of the DST System with tank waste are the following:

- The conclusions of the 2006 DSTAR regarding adequate design, material selection, and operation of the DST System are still valid. Operation of the DSTs has continued to be within their design limits; therefore, the corrosion allowances and imposed stresses are within the design values and the DST design lifetimes should be attained or even exceeded.
- No new corrosion mechanisms have been identified since the 2006 DSTAR, and no previously-identified mechanisms present any additional concerns than at that time.
- The waste contents are not believed to have had any contributory effect on the leak in tank AY-102.

### 10.5.3 Recommendations

- For waste compatibility, the next overall DSTAR integrity assessment should follow the current 10-year schedule. (Summarized in recommendation R16-1 in Section 3.3.3.)
- Tank waste should continue to be managed in accordance with specification OSD-T-151-00007. When management of the tank operations changes or falls outside of the scope of investigated reports (e.g., prior to waste delivery to the WTP), then a reevaluation of operating specifications should be required. (Summarized in recommendation R16-2 in Section 3.3.3.)

### 10.5.4 Conclusions

In regards to DST waste compatibility, the DST System is fit for use as listed in Appendix D.

# 11.0 CORROSION ASSESSMENT AND STATUS

**Introduction/Purpose**

Regulatory requirements mandate corrosion protection and/or assurance that vessels containing hazardous waste will not fail by corrosion. Specifically, the DST Inspection Program must be seen to meet the requirements of BNL-52527 and WAC 173-303-640 as noted elsewhere in this report. The DST Integrity Program Plan (RPP-7574) provides the overview of the process. The plan includes corrosion mitigation as reviewed in this section as well as topics covered in the remainder of the document.

**Scope/Requirements**

Based on the 2006 DSTAR, if the design and construction of the tanks are consistent with good practice, then most likely the most critical failure mode is due to corrosion. Thus, corrosion became a primary concern for any future assessment. At present, though the design of the tanks is not in question, the recent leakage and evaluation of tank AY-102 suggests in some cases the construction was not wholly consistent with good practice and therefore may be a greater concern than corrosion, as long as the tank chemistry meets stated requirements. The corrosion assessment can only provide assurance that if the tanks meet design requirements, then corrosion is not a concern for wastes within operating limits.

**Method of Assessment**

The 2006 DSTAR reports that only pitting, particularly at the LAI, and concentration cell corrosion, such as under deposits, were likely to be of concern. Uniform corrosion and SCC are not deemed as significant. This is based on a review by an independent expert panel (PNNL-13571).

A review of earlier corrosion work (PNL-5488) provides concurrence, in general, with Edgemon and Anantatmula. Because waste that meets the DST System standards (OSD-T-151-00007) results in uniform corrosion at or below the design limit of 1 mil/yr and will not affect SCC of either stressed or unstressed steel or pitting, none of these corrosion mechanisms are of concern. Only if the waste composition departs from the stated limits is there a potential problem.

Even if the primary tank chemistry is out of specification, the tank is expected to be immune from SCC because of its heat treatment after construction. The out-of-specification compositions are likely to occur at the LAI or at occluded sites. The LAI affects are likely due to hydroxide neutralization by carbon dioxide and possibly due to dilution by condensate from above or by introduction of inappropriate solutions. Occluded sites result from the bulk solutions being shielded from the metal by deposits (e.g., from the waste, from blow-sand during construction) or by other materials (e.g., mill scale flakes).

A review of the current status of UT measurements is available in comprehensive report RPP-RPT-58301. An excellent compendium of the methodology and analysis of the erosion and corrosion in the tank farm WTS is also available (RPP-RPT-52791, *Tank Farm Waste Transfer System Fitness-for-Service Erosion and Corrosion Basis*).

## 11.1 SUMMARY OF 2006 DSTAR COMMENTS WITH 2016 COMMENTS

- The following summarizes general conclusions drawn in the 2006 DSTAR Volume 3 corrosion report along with 2016 comments:

- 2006 DSTAR: Waste and the acceptance criteria for adding waste in the DSTs and the ancillary equipment are compatible with the materials of construction of the DSTs and ancillary equipment.
    - 2016 DSTAR Assessment: This conclusion remains correct.
- 2006 DSTAR: Stress relief of the primary tank has helped to guard against localized corrosion mechanisms.
    - 2016 DSTAR Assessment: This remains true for SCC. Stress relief does not affect other localized corrosion mechanisms.
- 2006 DSTAR: Operation of the DSTs and their ancillary equipment has generally been within their design limits. Enhanced corrosion has not been observed for the few cases where waste outside the approved criteria was stored or handled.
    - 2016 DSTAR Assessment: Bulk solutions are acceptable. For example, even tank AN-107 that was out of specification for years (2006 DSTAR Volume 7) shows little corrosion. The LAI has the greatest potential for high corrosion tendencies but, in fact, has seen little effect based on UT evaluations.
- 2006 DSTAR: Material selection, corrosion, and imposed stress allowances of the original design were appropriate.
    - 2016 DSTAR Assessment: A correct statement.
- 2006 DSTAR: Nothing was identified during the preparation of this report indicating that the DST design lifetimes should not be attained, and with continuation of current practices, even be exceeded.
    - 2016 DSTAR Assessment: The 'failure' of tank AY-102 notwithstanding. The conclusion is reasonably correct, with the caveat that unknown construction defects can still be a concern.

## 11.2 REVIEW OF THE EXTENT OF CONDITION

After the appearance of leakage and designation of tank AY-102 as not fit for use, a review of the construction data for the remaining tanks was performed with the data consolidated into EOC reports for each tank farm. This review is discussed in the following sections in the order of construction of the six tank farms: AY, AZ, SY, AW, AN, and AP. Mention is made of the heat treatment time and temperature, exposure time and conditions of the hydrotest, the examination of the tank for leaks, as well as some comments on the degree of weld failure repair. None of these points appear to be of significant concern to corrosion inasmuch as reviews at the time of construction accepted all the tanks as fit for use. The EOC reports also note primary tank bulging but as the bulging occurred pre-stress relief, it does not impact the corrosion aspects of the tanks.

**AY Tank Farm: RPP-RPT-54817**

"In tank AY-102, over two days of heating were required to remove the water from the refractory and increase the tank bottom to a temperature over 210 °F, with escaping steam evidenced for an extended period. An additional two days of heating in tank AY-102 was required to approach temperatures required for stress relieving. Excessive rainwater in the

refractory was attributed to long delay in the stress-relieving process and the resulting badly damaged refractory seen in both AY tanks" (RPP-RPT-54819). Further, during the process it was held at 600 °F for 2 hours to 'cure' the refractory before moving up to 1000 °F. The AY Tank Farm was stress relieved for 3 hours (tank AY-102) or 4 hours (tank AY-101) at 1000 °F, not the originally specified 1100 °F ±50° for 1 hour. ASME BPVC (2013) says 1000 °F is acceptable for preventing SCC. Based on industrial experience, that conclusion was probably made on the basis of caustic SCC with no consideration of the behavior of nitrate affected SCC. However, because the post-weld heat treatment is designed to be a stress relief process, any time/temperature process that does this is acceptable. Because of the extended heating period and the large amounts of water in the refractory, an unknown amount of corrosion may have occurred on the exterior of the bottom of the primary tank.

It was also noted (RPP-RPT-54817, pg. 5-9) that chlorofluorocarbons might have been present in the styrene foam used to preserve voids observed after the heat treatment process. Thus, corrosion due to decomposition products, produced at the tank operating temperatures and radiation levels, may have occurred. Estimating the extent of corrosion is not feasible because the presence of the alkaline refractory that may have affected the behavior of the halides.

Tank AY-101 had about a 10% weld rejection rate compared to nearly 34% for tank AY-102. It was noted specifically that the weld quality was superior in tank AY-101.

In the construction of the tank AY-101 secondary tank bottom, warpage up to 3 in. was observed. An engineering evaluation stated that the reduction of the refractory thickness from the expected 8 in. to 5 in. in the warped area was acceptable. After completion of the refractory installation, it was observed the minimum measured thickness was 7 in. and the average was 9 in. and was acceptable.

The difficulties observed in tank AY-102 construction potentially left its bottom in a mechanically weakened condition. The improved welding observed in tank AY-101 is expected to have left the bottom in better condition. Nevertheless, because the tanks are stated to have been properly stress relieved, no effect on corrosion behavior is anticipated as long as the waste meets approved limits.

**AZ Tank Farm: RPP-RPT-54818**

According to the report, fewer weld problems occurred than in AY Tank Farm.

Laminations of less than 1/16 in. were found in the bottom prior to heat treatment and were removed by surface grinding. Laminations were also found in the primary wall but the affected plates were replaced prior to heat treatment.

During the hydrotest, leaks occurred above normal waste level. They were repaired without further heat treatment.

The EOC report suggests tanks AZ-101 and AZ-102 should remain on an enhanced visual inspection schedule because of laminations in tank AZ-102, a square groove in the knuckle of tank AZ-101, and fires in the AZ-102 primary tank and annulus. OSD-T-151-00007, Rev. 14, Table 1.5.2 has been revised to include a larger area of visual inspections on all tanks in response to this recommendation in RPP-RPT-54818.

Tank AZ-101 held hydrotest water for about 5 weeks (see Table 11-1). No comment is made about tank AZ-102.

**Table 11-1: Pitting Characteristics of the Double-Shell Tanks**

| DST | Hydrotest water exposure (months) | Extent of Condition Report RPP-RPT- | Estimated Hydrotest pit depth (mil) [a] | Source RPP-RPT- | Potential Estimated Hydrotest pit depth [b] | UT pit depth (mil) | Source |
|---|---|---|---|---|---|---|---|
| AY-101 | 0.3 | Note c | | | 2 | 70 | RPP-RPT-58301, Table 4-3 |
| AY-102 | 0.3 | 54817 | | | 2 | 59 | RPP-RPT-58301, Table 4-3 |
| AZ-101 | 1.2 | 54818 [c] | 10 | 54818 | 9 | | no pitting, RPP-RPT-58301 |
| AZ-102 | 0.3 | Note c | | | 2 | 98 | RPP-RPT-58301, Table 4-3 |
| SY-101 | 0.7 | Note c | | | 5 | 45 | RPP-RPT-58301, Table 4-3 |
| SY-102 | 0.3 | Note c | | | 2 | 41 | RPP-RPT-58301, Table 4-3 |
| SY-103 | 1.5 | Note c | | | 10 | 52 | reported as thinning, RPP-RPT-53884 |
| AW-101 | 9 | 55981 | | | 63 | | no pitting, RPP-RPT-58301 |
| AW-102 | 8 | 55981 | | | 56 | | no pitting, RPP-11581 |
| AW-103 | 7 | 55981 | | | 49 | | no pitting, RPP-RPT-58301 |
| AW-104 | 8 | 55981 | 60 | 55981 | 56 | | no pitting, RPP-11582 |
| AW-105 | 6 | 55981 | | | 42 | | no pitting, RPP-RPT-40887 |
| AW-106 | 7 | 55981 | | | 49 | | no pitting, RPP-RPT-41840 |
| AN-101 | 8 | 55982 | | | 56 | | no pitting, RPP-RPT-58301 |
| AN-102 | 7 | 55982 | | | 49 | | no pitting, RPP-RPT-58301 |
| AN-103 | 7 | 55982 | | | 49 | | no pitting, RPP-RPT-58301 |
| AN-104 | 10 | 55982 | | | 70 | | no pitting, RPP-RPT-58301 |
| AN-105 | 6 | 55982 | | | 42 | 100 | RPP-RPT-58301, Table 4-3 |
| AN-106 | 5 | 55982 | | | 35 | | no pitting, RPP-RPT-58301 |
| AN-107 | 5 | 55982 | 30 | 55982 | 35 | | no pitting, RPP-RPT-58301 |
| AP-101 | 2 [d] | 55983 | | | 14 | 56 | non-reportable, RPP-RPT-58301 |
| AP-102 | 2 [d] | 55983 | | | 14 | 84 | non-reportable, RPP-RPT-58301 |
| AP-103 | 2 [d] | 55983 | | | 14 | | no pitting, RPP-RPT-58301 |
| AP-104 | 2 [d] | 55983 | | | 14 | 84 | RPP-RPT-58301, Table 4-3 |
| AP-105 | 2 [d] | 55983 | | | 14 | | no pitting, RPP-RPT-58301 |
| AP-106 | 2 [d] | 55983 | | | 14 | | no pitting, RPP-RPT-58301 |
| AP-107 | 2 [d] | 55983 | | | 14 | | no pitting, RPP-RPT-58301 |
| AP-108 | 2 [d] | 55983 | | | 14 | | no pitting, RPP-RPT-58301 |

Legend:
[a] Average pitting rate for the three tanks is about 7 mil/month.
[b] Ignoring possible inhibitors, based on the average of 7 mil/month.
[c] Based on data email JR Gunter to JR Divine 1/26/2015.
[d] Report states "several months" but may be similar to AW and AN Tank Farms.

Pits, generally of 7 to 8 mil depth (deepest 10 mil), were found in tank AZ-101 (pg. 5-8). Moore, Atlantic Richfield Hanford Company (pg. C-13), says they were not a concern but to add sodium hydroxide as an inhibitor when leaving long-term water in tank AZ-102. No mention is made as to whether the addition was made.

No particular concerns are noted for the AZ Tank Farm. As noted later, enhanced inspection does not appear to be a necessary requirement.

**SY Tank Farm: RPP-RPT-54819**

No unusual data are noted in this report, though steam was observed coming from the refractory during heat up. (It is likely steam was generated during the heat treatments of all farms even when not observed or reported because the process of curing the refractory consisted of dehydration and the water had to exit the edges.) The bottom was held at 600 °F for 2 hours to 'cure' the refractory. The actual heat treatment for tank SY-101 was 3 hours at 1000 °F; for tank SY-102 was 1 hour at 1100 °F; and for tank SY-103 was 1 hour at 1100 °F.

The weld rejection rates for the farm were similar to those of tank AY-102. Weld repair tends to cause bulges in the plates. For tanks SY-101 and SY-102, the distortions were within the acceptable tolerances.

For tank SY-103, the bulges were sufficiently large that strain gauge measurement had to be made. The results showed the resulting strains were acceptable. Additionally, the initial evaluation of strain gauge data, installed on the primary tank, suggested a bulge in the tank bottom was strained beyond yield during the hydrotest. Later analysis showed the original analysis had failed to consider temperature, lead length, and capacitance effects and no such strain had occurred.

According to the EOC report, the SY Tank Farm tanks appear to be in significantly better condition than tank AY-102, despite the welds because of much less water being present and shorter heating times. Stress analyses showed the bulges were not a threat and all tanks were accepted.

**AW Tank Farm: RPP-RPT-55981**

According to the report, the typical weld rejection rate was 20 to 34% and required three to five attempts to properly weld the seams (pg. 5-1). These rejection rates were similar to those in tank AY-102; nevertheless, the overall condition of the AW Tank Farm was considered better than tank AY-102.

There is no reported hold at 600 °F to cure the refractory though mention is made of a 600 °F transition. Steam was observed coming from tanks AW-105 and AW-106 during heat treatment (probably occurred on the remaining four tanks even if not observed/reported for the same reason as given with SY Tank Farm). Though thermocouples failed, the primary bottoms of tanks AW-102 to AW-106 were accepted as to having been properly heat treated (pg. 5-15); tank AW-101 was held at 1100 °F for 1 hour, while the remaining tanks were held at 1000 °F for 3 hours.

Hydrotest water remained in the tanks for 6 to 9 months depending on the tank (see Table 11-1), possibly without corrosion inhibitors. Residual water in tank AW-104 did show a pH of 9.3 and a nitrite content of 1400 ppm so inadequate inhibition may have been present (RPP-RPT-55981). In any case, tank AW-104, after about 8 months with about 10% of the tank surface inspected, reportedly had a total of 73 pits found, the deepest about 50 mil and rest about 7 to 34 mil; the average was about 23 mil – the tank was considered sound. The inspector was *99% certain that pits greater than 1/16 in. are fewer than 0.53 per 50 ft$^2$*. This suggests there might be roughly 130 pits in the tank that deep or deeper. A letter from the tank farm operator (pg. 235-236) recommends keeping the tanks dry or, if filled with water, to use 'inhibited water' that had a pH of 12 and at least 500 ppm nitrite. There is no indication of what was done post hydrotest.

Except for an increased probability of pits produced prior to the addition of waste, the condition of the tanks is expected to be similar to the earlier tanks.

**AN Tank Farm: RPP-RPT-55982**

Table 4-4 of the report gives data used to list hydrotest water retention times for the tank farm, which are also repeated in Table 11-1 of this report.

Construction specification B-130-C4 allows gouges or deep scratches up to 31 mil deep on the inner surface. PNL-5488 suggests sharp edges/scratches are not expected to be a concern with the mandated chemistry even without stress relief.

In tank AN-107, pitting after hydrotesting was 20 to 30 mil deep with ≈1/4 in. diameter (depth may have included thickness of mill scale (pg. 5-12). Part of the pitting was due to the corrosiveness of the water but it was probably enhanced by the presence of mill scale. After inspecting the interior of the tank, Divine, Battelle-Northwest, recommended removing the mill scale but Moore says it was not cost effective but suggested doing so for future tanks (see letter pg. C-40 through C-43 of the EOC report).[1]

The condition of the AN Tank Farm is expected to be similar to that of AW Tank Farm.

**AP Tank Farm: RPP-RPT-55983**

Tanks AP-101 to AP-107 were stress-relieved at 1000 °F for 3 hours. However, tank AP-108 was heat-treated at 950 °F for 5 hours. In addition, tank AP-102 had many failed thermocouples; based on the technical evaluation of adjacent temperature readings, the tank was accepted as having been properly stress relieved. According to construction specification B-340-C4, the tanks also were to be held at 220 °F for 6 hours. The 600 °F refractory hold used in earlier farms is not noted in the Construction Event Table in the EOC report. Construction specification B-340-C4 does note a requirement that above 800 °F, temperatures are to be uniform within 200 °F and that the time to reach 1100 °F not exceed 12 hours.

Table 6-1 (pg. 6-3) of the EOC report summarizes stress relief of the tanks. Scratches and gouges less than 1/32 in. were ground out prior to heat treatment. Deeper ones were filled with weld metal. Any existing pits were accepted.

Because of corrosion in prior tank farms due to hydrotesting, construction specification B-340-C4 states all hydrotest water should contain 0.01 M hydroxide and 0.011 M nitrite (inhibited water). It is unknown whether this requirement was fulfilled, especially because it calls out that tank AP-102 contained 350 ppm sodium carbonate as a corrosion inhibitor. Cathodic protection was also an option. The photographs in Figure 11-1 illustrate the use of cathodic protection in AP Tank Farm.

As noted, all of the AP Tank Farm tanks are accepted as being properly heat treated. There is a possibility of hydrotest water induced minor pitting because the water may not have been inhibited though cathodic protection is expected to minimize pitting. No conditions are identified that would exacerbate corrosion during operation.

[1] RPP-RPT-38738, *Double-Shell Tank Integrity Inspection Report for 241-AP Tank Farm,* states the mill scale was removed during AP Tank Farm construction. It is assumed that the debris was removed from the floor but that is unknown.

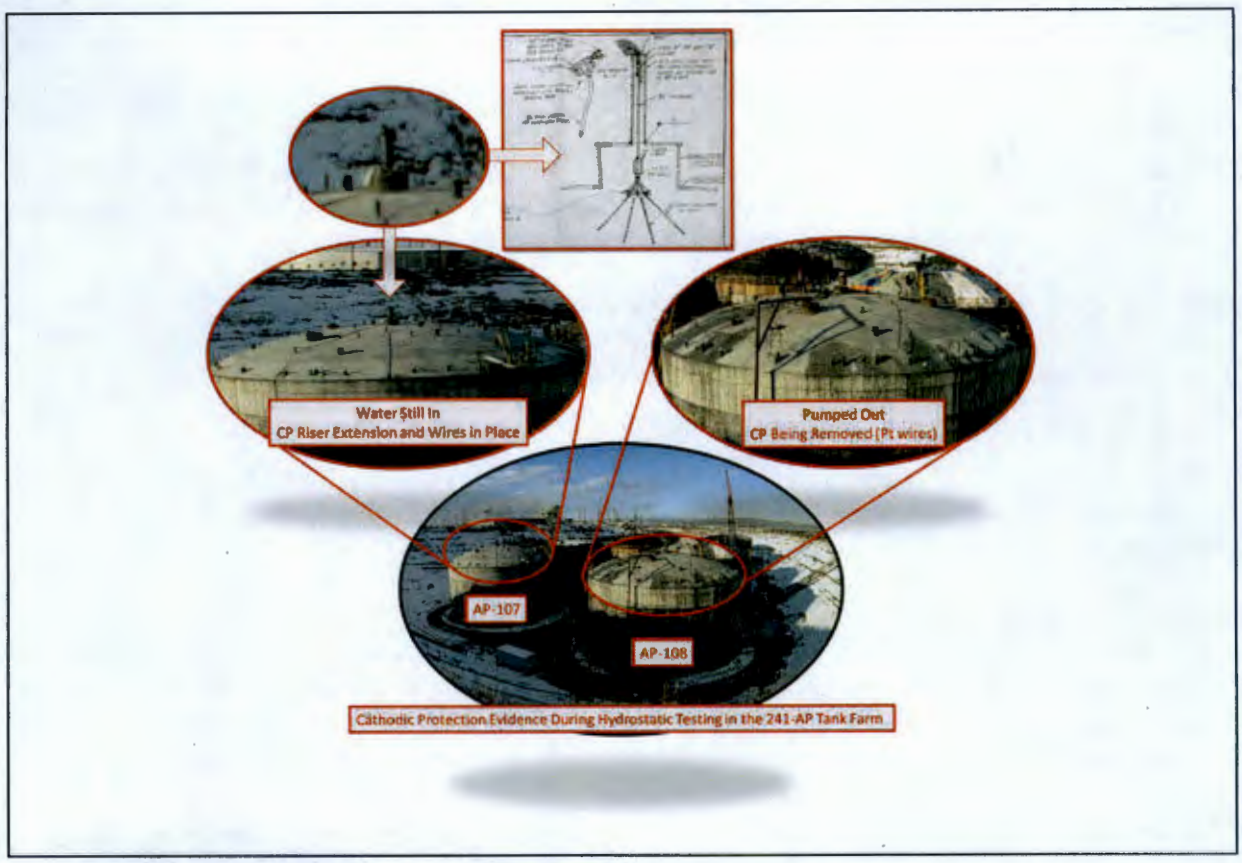


**Figure 11-1: AP Farm Internal Cathodic Protection with Hydrotest Water**

## 11.3 DOUBLE-SHELL TANK PRIMARY CONTAINMENT

While periodic visual inspections of the annular regions are still conducted, visual inspections of the interiors of the primary tanks were terminated in 2014 based on a technical evaluation (WRPS-1302595, *Recommended Double-Shell Tank Visual Inspection Changes Resulting from Tank 241-AY-102 Primary Tank Leak Extent of Condition Evaluation*). Thus, a strong emphasis on UT methods has been promoted. There are still uncertainties in the use of UT to measure corrosion in part because of changes in methodology and in part due to the process that results in significant error, estimated at 15 to 20 mil, that makes detection of corrosion difficult at this time. With this magnitude of error, the only rationale for the UT exams more frequent than every 15 to 20 years is to determine if an improper, corrosive, chemistry has been present. (By design, the tanks can withstand at least 20 mil of corrosion in a 20-year period, which is at the limit of detection.)

### 11.3.1 Visual Inspections

Beginning in 2014, in-tank (inside the primary tank) visual inspections were determined to no longer be required (RPP-RPT-31599, *Double-Shell Tank Integrity Inspection Report for 241-AN Tank Farm,* Rev. 6).

'Normal' visual inspections that examine about 50% of the annulus area on a 5- to 7-year interval have been replaced by 'enhanced' inspections that cover over 95% of the annulus area at a 3-year interval.

**AY Tank Farm**

Tank AY-101 waste was out of specification from 1999 to 2001 when it was corrected (RPP-RPT-34311, Rev. 0). In 2005, tank AY-101 was designated a condensate receiver. Initially, the condensate had the incorrect pH but this was corrected in 2007.

In 2014, tank AY-101 showed no signs of cracking, leaking, or significant pitting in the annular area (RPP-RPT-34311, Rev. 2). Stains that had been observed in-tank were confirmed to be not due to through wall leaks by tracer gas tests (PNNL-14176).

Visually, tank AY-101 has been confirmed as operable.

Tank AY-102 was a condensate receiver until 2005 and the waste was out-of-specification from 1999 until 2001 when it was corrected. The tank was reported to be leaking in 2012 and was confirmed to still have indications of a leak in 2014 (RPP-RPT-34311, Rev. 2).

**AZ Tank Farm**

AZ Tank Farm apparently had, initially, a humid atmosphere. In 2001 tank AZ-101 was reported to be foggy inside and no inspection occurred. In 2007 during a normal inspection, the annulus was found to have a rounded pit that was of concern (RPP-RPT-34310, Rev. 0) but it is too regular to be a pit and looks more like a spot-weld or other fabrication artifact (see Figure 11-2). In the 2013 inspection the spot was noted to be unchanged (RPP-RPT-34310, Rev.1).

Though some rusting is present, the interiors and annuli of tanks AZ-101 and AZ-102 appear to be in satisfactory condition.

Enhanced inspections of tanks AZ-101 and AZ-102 annuli were performed in 20[1]4 (RPP-RPT-34310, Rev. 1). There was no evidence of active water intrusion in primary tanks noted. It was noted, on pg. 33 of RPP-RPT-34310, Rev. 1, that the visual inspections in 2012 of the interior showed the tanks in good condition.

Based on visual observations, the AZ Tank Farm tanks are acceptable though rust is present.

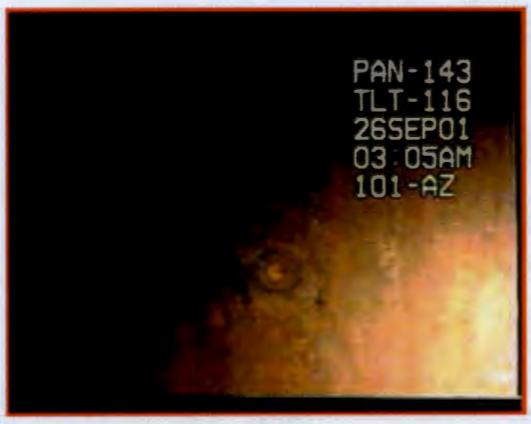


**Figure 11-2: Rounded Pit in Tank AZ-101.**

**SY Tank Farm**

In the 1992 visual inspection of the annulus (RPP-RPT-39149, *Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm*), there were no apparent changes from the time of construction. The interior of the primary tank was not inspected.

During the second inspection of the annulus in 2003 there were no significant changes, though in tank SY-103 some slight corrosion was noted; that was not observed to have changed in 2009. The 2003 inspection of the interiors showed nothing adverse, though tank SY-103 did show evidence of some slight pitting at the LAI; that too showed no change in 2009.

Interestingly, on pg. A20 of RPP-RPT-39149, tank SY-101 is reported to have a pit in the annulus area with no other obvious corrosion nearby suggesting that some pits originated before or during construction, Figure 11-3.

Overall, nothing of significance appears to have occurred by 2009.

SY-101-013
4/29/2003

Exterior of primary tank, Bottom Knuckle, along Riser 43.

DVDID# 10117
Reference ID# SY-101-031 for the 2008 inspection.
Indications of potential light pitting located on the primary bottom knuckle. This region should be monitored to track the appearance of additional corrosion.

**Figure 11-3: Pits in Tank SY-103**

### AW Tank Farm

Through 2009, nothing of significance was noted in either the annuli or in-tank of any of the six tanks (RPP-RPT-42147, Rev. 0). Generally, only light rusting was noted. In 2001/2002 'deep' pits were noted in tank AW-103 that were later determined to be artifacts of the lighting.

Only an enhanced inspection of tank AW-105 annulus was made in 2013/2014 (RPP-RPT-42147, Rev. 2). No other tanks were inspected. Nothing of significance was noted. There was no evidence of active water intrusion or primary tank leakage. Findings were similar in late 2014 and early 2015 for tanks AW-101, AW-102, and AW-104 (RPP-RPT-42147, Rev. 3).

### AN Tank Farm

By 2009, there was nothing significant noted in the annulus (RPP-RPT-31599, Rev. 3).

In 2014 RPP-RPT-39149 enhanced inspections of only tanks AN-102 and AN-107 annuli were performed (RPP-RPT-31599, Rev. 6). In these inspections no evidence of active water intrusion or primary tank leaks were noted. It was noted that couplant water from the UT inspections leaves watermarks.

### AP Tank Farm

In 2012, there were no noted changes in the primary tank or the secondary liner regions for the eight tanks (RPP-RPT-38738). There were no significant changes since construction and the conclusion drawn was that there were no significant anomalies that affect operation. The report

provides a summary of the interior inspection of the eight tanks performed in 2002 but overall, the only thing noted was light corrosion and light pitting of portions of the domes with the most obvious corrosion along the weld seams either of the dome plates or the dome/knuckle weld.

### 11.3.2 Ultrasonic Testing Inspections

A complete list of tanks inspected using UT is in Table 1 of RPP-RPT-58301. The report also contains comprehensive summaries of all UT inspections.

As noted in Table 11-2, the reporting criteria for UT inspections were set at 50% of the Brookhaven National Laboratory criteria:

- Wall thinning > 10% of nominal wall thickness
- Pit depth > 25% of nominal wall thickness
- Linear indication > 6 in. long and 0.1 in. deep.

**Table 11-2: Ultrasonic Testing Evaluation Guidelines and Reportable Values**

| Parameter | BNL-52527 Evaluation Levels | Double-Shell Tank Integrity Program Reportable Value |
|---|---|---|
| Thinning | 20 % plate thickness | 10 % plate thickness |
| Pitting | 50 % plate thickness | 25 % plate thickness |
| Cracking | >12-inch, 20% plate thickness<br><12-inch, 50% plate thickness | All detectable linear indications<br>> 6-inches and 10% plate thickness |

Reference: RPP-RPT-39149.

In order to be approved as UT operators for this work, the following accuracy is required by operators:

- Wall thinning: ±0.020 in.
- Pits, depth: ±0.050 in.
- Linear, depth: ±0.1 in.
- Location, reportable indications: ±1.0 in.

Nominally, all UT measurements provide results to the nearest 1 mil (0.001 in.). Demonstration tests on test plates were able to obtain a repeatability of measurements to ±5 mil (PNNL-19010). However, in demonstration tests on clean unused steel plate, the reproducibility was about 12 mil due to the irreproducibility of location, operator, software, and equipment error (RPP-RPT-57127). A review of 13 DSTs that were examined twice suggests the error can be reduced to about 6 mil for average thicknesses while the minima have an error of 8 mil (RPP-RPT-46309; PNNL-19242). Nevertheless a review of a recent UT summary document (RPP-RPT-58301) suggests an error of 10 to 15 mil is not unreasonable in part because of the use of different risers can lead to an error of 10 to 12 mil (with a compromise/consensus value of 10 mil) (PNNL-15182; even so the variability between plates outweighs that of the risers [RPP-RPT-46309; PNNL-19242]).

As seen from the various UT reports (RPP-RPT-58301), thicknesses in the 2006 to 2013 period can be significantly different than in the pre-2006 data.

Interpreting the data in PNNL-15415 suggests that lacking original thicknesses it cannot (yet) be determined whether the 'losses' are due to corrosion or to the lack of baseline conditions. Estimates of the maximum loss for the whole tank, based on Weibull Extreme Value theory have to be discounted at this time because of the need for more and better data and the lack of baseline data.

Further, tank/couplant temperature difference data are critical; if the couplant is too cool, thickness is underestimated (PNNL-19010, pg. iv); if the couplant temperature is less than the calibration block (test surface), the wall thickness can be underestimated by as much as 35 mil (PNNL-10910). Even if the tank/couplant temperature changes are within the specified 25 °F, the under/over estimation of wall thickness can be as great as ±14 mil (PNNL-19010).

Conclusions on corrosion rate are risky due to current methods of analysis – new methods under study may eliminate errors (PNNL-19010, pg. iii). Indeed, without baseline data, that is data on the thicknesses at the time of installation, a single thickness measurement, UT or otherwise, cannot define a corrosion rate. In theory, if the plates or pipes were originally of uniform thickness a maximum thickness could be estimated statistically. This not being the case, no reliable corrosion rate can be developed from a single set of data. Using statistically repeatable measurements, a minimum of two cycles of testing should be satisfactory. Hence, at this time, estimating corrosion rates from the paucity of consistent measurable UT data is not practicable despite the fact that in 2005 corrosion was "the actual feature of interest" (PNNL-15415, pg. iii). The change in emphasis is implied in the DST UT Summary (RPP-RPT-58301) which notes that UT is for the volumetric inspection of the tank wall though thinning, pitting, and cracking are still listed as to be monitored which implies corrosion remains of interest. It is expected that the third cycle of UT measurements will provide sufficient data that the lack of a baseline becomes moot.

Specific results for various tanks and tank farms are provided in the following paragraphs.

**AY Tank Farm**

Data for tank AY-101 (RPP-RPT-47563, *Ultrasonic Inspection Results for Double-Shell Tank 241-AY-101 – FY 2010*) note that there were 14 areas of reportable thinning all less than 1 $in^2$ and no reportable pits. The interpretation by the 2016 DSTAR IQRPE is that there was minimal thinning with most of the 'thin' spots appearing to be non-reportable pitting because of the small sizes of the thin spots.

**AZ Tank Farm**

Tank AZ-101 had about 4 $in^2$ of thinning reported in 2001 but it was attributed to a construction defect (RPP-RPT-34310, Rev. 0).

PNNL-15415 provides the 2005 wall thickness loss for tank AZ-102. According to the report, tank AZ-102 had a loss (maximum) of 12 mil. Most of the loss was in plate 1 and may have been due to thin plate. In 2011, three small areas of thinning were reported with areas of 1.8 $in^2$ to 5.1 $in^2$ and depths of 73 to 86 mil; there was no reportable pitting or cracks. On the other hand, this 'thinning' having occurred in such small areas is more likely to be non-reportable pitting.

Despite the EOC report recommendation for enhanced inspection for the tank farm, no reason for such action is apparent.

**SY Tank Farm**

PNNL-15415 provides the 2005 wall thickness loss for tank SY-101. According to the report, tank SY-101 had a loss (maximum) of 15 mil. Most of the loss was in plate 1 and may have been due to thin plate. Thinning of 40 to 68 mil (11 to 18% of nominal) was observed in plate 1 at the LAI (the LAI was about constant for 1981–1996) (RPP-18444, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-101, FY 2004 and FY 2006*). In addition, there were 24.8 $in^2$ that were 39 to 69 mil less than nominal. The greatest average minimum was, again, in plate 1 and was 56 mil; a total of 6.85 $in^2$ thinned to 53 to 65 mil; this is probably non-reportable pitting.

Plate 2 near the weld had a few spots of reportable thinning, $\leq$0.053 $in^2$ (or ~0.25 in. diameter) with a depth of ≈50 to 60 mil, which is clearly non-reportable pitting. There was no reportable thinning in other plates or in lower knuckle and no pitting/cracking in any plate.

In the 2012 evaluation for tank SY-101 (RPP-RPT-52572, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-101 – FY 2012*), the vertical scan had no reportable thinning, two non-reportable pits, and no linear indications. The lower knuckle had no reportable sightings, as was the case in the HAZ. The LAI had 12 areas of reportable thinning, four non-reportable pits, and no linear indications. Based on the areas of the thin spots, the thinning, again, likely to be non-reportable pitting in carbon steel.

In tank SY-102, six small areas of reportable thinning, no reportable pitting, and no linear indications were noted. The 2013 report yielded no reportable thinning, pitting, or linear indications (RPP-RPT-54594, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-102 – FY 2013*).

The initial examination of tank SY-103 in FY 2004 reported six areas of reportable thinning, no reportable pitting, or linear indications. The vertical examination in 2013 (RPP-RPT-53884, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-103 – FY 2013*) showed one area of thinning, no pitting, and no linear indications. Because the thinning was about 0.25 in. × 0.30 in. × 52 mil, it is more properly described as non-reportable pitting. The HAZ had no reportable conditions.

The tanks remain in acceptable condition.

**AW Tank Farm**

PNNL-15415, *Estimation of Maximum Wall Thickness Loss of Five DSTs (AN-107, AP-102, AW-101, AZ-102, and SY-101),* provides the 2005 wall thickness loss for tank AW-101. According to the report, tank AW-101 had a loss (maximum) of 10 mil. Most of the loss was in plate 1 and is thought to have been due to a thin plate.

RPP-RPT-11581, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-102,* notes that for tank AW-102 in FY 2002 there was no reportable thinning, pitting, or crack-like indications. Similarly, in 2010 there were no reportable results for the primary wall, the HAZ, or the bottom knuckle (RPP-RPT-43609, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-102 – FY 2010*).

In 2006, tank AW-103 had no reportable thinning, pitting, or crack indications (PNNL-19242).

The inspection of tank AW-104 (RPP-11582, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-104*) noted that in both 2002 and 2010 there was no reportable thinning, pits, or cracks; there was no indication of an LAI effect. The minimum measured thicknesses of the plates were thicker than nominal though the 2010 results were thinner than those of 2002 (RPP-RPT-45110, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-104 – FY 2010*).

Based on the initial examination (2001) of tank AW-105, it showed no reportable thinning, pitting, or crack-like indications (RPP-RPT-40887, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-105 – FY 2009*). Similarly, in 2009 there was no reportable thinning, no non-reportable pitting indications and, no crack-like indications. The greatest, non-reportable thinning was in plate 3 and only amounted to 9.2%.

In tank AW-106, RPP-RPT-41840, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-106 – FY 2009,* notes no reportable results. Indeed the measured wall thicknesses were greater in 2009 than in 2002.

Overall the tank farm is in acceptable condition.

**AN Tank Farm**

The data taken in 2002 show three small areas of thinning, no pitting or crack indications. Additional work in 2006 showed no thinning or pitting. The examination of 2011 reported one area, less than about 2 in. × 2 in. × 63 mil, of reported thinning with no pitting or crack indications. It is likely the reported thinning was actually non-reportable pitting (RPP-RPT-49494, *Ultrasonic Inspection Results for Double-Shell Tank 241-AN-101 – FY 2011*).

Tank AN-105 data taken in FY 1999 and re-evaluated in FY 2002 were found to be in error (RPP-RPT-27467, *Supplemental Ultrasonic Inspection Results for Double-Shell Tank 241-AN-105 – FY 2005*). Data taken in FY 2005 showed no reportable thinning, pitting, or crack-like indications.

PNNL-15415 provides the 2005 wall thickness loss for tank AN-107. According to the report, no metal loss occurred.

**AP Tank Farm**

The examination of tank AP-101 reported no thinning, pitting, or linear indications in 2003. Further, in 2013 there was no thinning observed, plate 1 had one non-reportable pit, and no linear indications. There were no reportable data in the HAZ or the knuckle (RPP-RPT-55259, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-101 – FY 2013*).

Based on the 2003 report (RPP-RPT-11581), tank AP-102 had a loss (maximum) of 40 mil. Most of the loss was in plate 1 and may have been due to thin plate. The 2015 inspection revealed no areas of reportable wall thinning, 11 non-reportable pits, no reportable indications of pitting, and no reportable linear indications (RPP-RPT-58301).

Tank AP-103 (RPP-13802, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-103 – FY 2003*) had no reportable indications. There was one small gouge (1.42 in. long in plate 4 near plate 5) that was deemed of no concern.

During the 2004 and 2005 inspections of tank AP-104, nothing reportable was noted on the walls or upper and lower knuckles. The 2014 examination (RPP-RPT-56230, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-104 – FY 2014*) revealed no thinning or linear indications

but two non-reportable pits. Nothing reportable was noted in the HAZ (including vertical welds and the knuckle weld).

Tank AP-105 had no reportable thinning, pitting, or linear indications in 2003. In the 2012 examination (RPP-RPT-51735, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-105 – FY 2012*), no thinning or linear indications were noted in the vertical scan. One non-reportable pit indication was seen. Nothing reportable was observed in along the HAZ and the LAI showed nothing reportable.

Tank AP-106 was first examined in 2005. This documents the second inspection (RPP-RPT-57127). No reportable wall thinning, no reportable pitting, and no reportable linear indications are present. No other defects or anomalies were found that indicated additional areas of concern for the integrity of the tank.

The summary of the error of the results showed the following:

- Wall thinning: 0.012 in. rms
- Pit: 0.014 in. rms
- Crack depth, primary wall: 0.058 in. rms
- Crack depth, HAZ: 0.051 in. rms.

In the 2014 inspection of tank AP-106, there was nothing reportable on the primary wall, the HAZ (including the vertical weld and horizontal knuckle/plate 5 weld). No thinning, pitting, or linear indications were noted for the secondary floor (RPP-RPT-57127). On pg. 8-5 it is stated that he respective wall thicknesses for plate 1, as measured in 2005 and 2014, are 104.6 and 105.0% of nominal. Quote from pg. 64: "The greatest estimated Weibul extreme value, non-pit, metal loss for the entire tank was 0.070" based on the estimated nominal thickness (based on UT measurements), not the nominal wall thickness." As noted earlier, Weibul estimates are not reliable at this time because of the lack of a baseline and/or reliable comparisons of data between UT cycles.

Tank AP-107 inspections revealed no reportable conditions (RPP-RPT-35741, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-107 – FY 2008*).

The report of FY 2008 (RPP-RPT-36722, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-108 – FY 2008*) for tank AP-108 notes that a linear indication (crack-like indication) had not grown in the FY 2008 inspection and is therefore not likely a crack. No corrosion or pitting was noted in 2008 that requires new operational limits.

As with other tank farms, no significant concerns are present in AP Tank Farm relating to the primary tank. Extrapolating and analysis of data remains difficult due to the lack of baseline information and measurement error.

### 11.3.3 Dome and Vapor Phase Considerations

There are three components to the examination of corrosion of the dome interiors: visual inspections, corrosion probes located in the vapor phase, and laboratory tests. No work has been done nor needs to be considered for the exterior surface overlain by concrete. Corrosion examinations of the exterior dome surface in the annular space have been limited to visual examinations.

Work at Savannah River National Laboratory (SRNL-STI-2013-00739) has shown that if the waste contains 550 ppm ammonia there will be a sufficient amount in the vapor to inhibit vapor phase corrosion. Pitting will be inhibited if the molar nitrite to nitrate ratio (R) is >0.15 while an R-value of 0.6 to 0.8 will significantly reduce the degree of pitting (SRNL-STI-2013-00743). At least in the laboratory, pitting did not progress past about 4 months. Table 9-1 shows the nitrite/nitrate ratios for the various tanks, and no ratio is <0.15.

### 11.3.4 Results of Corrosion Testing Program

As noted in the 2006 DSTAR, a major test program was performed by Battelle in 1980-1984 to examine corrosion of ASTM A516 and A537 carbon steels in a wide range of simulated waste compositions (PNL-5488) at temperatures ranging from ambient, about 25 °C to the DST design temperature of 180 °C. Over 3,000 pre-oxidized weight loss coupons and more than 1,000 U-bend specimens in 154 different simulant compositions were used. Uniform corrosion rates were less than 1.0 mil/yr and frequently much less. Cracking only occurred on the stressed coupons at high temperature and hydroxide concentration or at conditions more dilute than the lower limit specified by (OSD-T-151-00007) which is based on those tests as well as numerous results from Savannah River National Laboratory.

Typical procedures for laboratory testing using DST waste samples are described in RPP-PLAN-36109; this plan is specific for tanks AW-103 and AW-105 but is valid in general.

The following sections summarize laboratory and probe data. Both the laboratory tests and the probes dealt with actual tank waste. More critical is the observation that the laboratory data and the in-tank probes show corrosion rates are much less than 1 mil/yr, frequently near 0 mil/yr.

#### 11.3.4.1 Electrochemical Laboratory Tests of DST Waste

Laboratory tests on supernate from tanks AN-102, AP-107, and AP-108 yielded corrosion rates of <0.09 mil/yr (RPP-RPT-39224). Additional testing in the supernate of tanks AW-103, AZ-102, AN-106, AN-107, AY-101, and AY-102 all measured <0.14 mil/yr. In the settled solids of tanks AW-103, AZ-102, AN-107, AY-101, and AY-102, the corrosion rates were all <0.09 mil/yr. In other tests on tank AP-108 core samples (RPP-RPT-39396), corrosion rates of less than about 0.09 mil/yr were observed. It was noted the tank had averaged about 24 °Cover a 4-year period. In this test, no tendency towards pitting was noted.

Additional tests (RPP-RPT-41335) on core samples from tanks AW-103 and AW-105 that contained high fluoride (up to 0.18 M) and chloride (up to 0.13 M) contents were conducted at about 27 °C; the tanks operated at 16 to 18 °C. The maximum corrosion rates were 0.03 mil/yr. Based on the potentials, no pitting is expected; the fluoride does not contribute to pitting.

Core samples from tank AN-107 were examined (RPP-RPT-30824, *Electrochemical Corrosion Studies for Tank 241-AN-107, Core 309 Segments 21R1, 21R2*). Maximum corrosion rates of 0.004 mil/yr were reported in the interstitial fluid; there was no indication of a tendency to pit.

An evaluation of core samples from tank AY-101 (RPP-RPT-35554) showed no propensity for pitting. A maximum corrosion rate of 0.03 mil/yr was measured.

In summary, all laboratory tests with waste samples have resulted in corrosion rates <0.15 mil/yr and generally much less than 0.1 mil/yr. These observations suggest that corrosion is not a concern with proper operation.

#### 11.3.4.2 In-Tank Corrosion Probes and Coupons

Based on recommendations of the Expert Panel Oversight Committee (Terry 2006, "Expert Panel Oversight Committee Assessment of the 241-AN-107 and 241-AN-102 Waste Chemistry Corrosion Testing for Double-Shell Tank Waste Chemistry Optimization"), electrochemical noise probes were phased out in 2007; too little information that was of use was obtained. Probes containing ER sensors plus racks of coupons were installed in six tanks beginning in 2008 (RPP-RPT-51766, Rev. 9):

- AN-102 05/01/2008 ER sensors, coupons, and reference electrodes
- AY-102 03/26/2009 ER sensors, coupons, and reference electrodes
- AY-101 04/30/2009 ER sensors, coupons, and reference electrodes
- AN-107 06/18/2010 ER sensors, coupons, and reference electrodes
- AW-104 07/21/2010 ER sensors, coupons, and reference electrodes
- AW-105 08/28/2013 Reference electrodes only, no sensors
- SY-101 05/15/2014 Reference electrodes only, no sensors.

Factors to keep in mind about corrosion rates:

- The values are averages over the exposure time period for coupons and, to a lesser extent, ER probes
- The 1 mil/yr design value is only for uniform corrosion because it affects structural integrity
- Though pits may affect containment, they do not significantly affect the structural strength
- Pitting generally slows with time
- An average pitting rate of 5 mil/yr would take 100 years to penetrate a 0.500 in. thick plate.

**AY Tank Farm**

A coupon assembly in tank AY-101 was removed in 2012 after about 3.1 years (RPP-RPT-53488). Vapor phase corrosion rates were less than about 0.2 mil/yr with pits up to roughly 8 mil (≈2.5 mil/yr), suggesting a humid environment. The uniform rate in the waste was ≈0.004 mil/yr with pits 5 to 7 mil deep (≈1.6-2.3 mil/yr). There was no obvious LAI effect though approximately 8 mil pits were present in that region. There was no suggestion of SCC.

In the 2014 review of the tank AY-101 probes (RPP-RPT-53427), it was noted that the electrochemical potentials were closer to -100 mV (saturated calomel electrode [SCE]), more positive than noted elsewhere. Further, it was stated that SCC was unlikely at potentials more negative than 0 mV (SCE) which is slightly more positive than the usually reported -100 mV. The vapor phase uniform corrosion rate was given as 0.3 mil/yr, slightly higher than the 2012 value of 0.2 mil/yr. In the supernate it was measured at ≈0 mil/yr while the sludge value was 0.01 mil/yr – nominally higher than in 2012 but all within the normal measurement error.

The first quarterly report of 2014 (RPP-RPT-51766, Rev. 8) notes the potentials in tank AY-101 waste were all satisfactorily negative and the corrosion rate was much less than 1 mil/yr. The

second quarterly report of 2014 (RPP-RPT-51766, Rev. 9), notes the potential in the sludge is now in the region of possible SCC though the stress relieved metal should be immune.

Corrosion probes note no SCC in tanks AY-101 or in AY-102 in the third quarterly report of 2013 (RPP-RPT-51766, Rev. 6). Corrosion rates were much less than 1 mil/yr.

The first of the tank AY-102 coupon racks removed in 2013 showed no indication of SCC, only minor pitting, and no LAI effect (RPP-RPT-56410). After an exposure time of about 4.5 years, the maximum corrosion rate in the vapor space was 0.2 mil/yr with pitting of about 2.8 mil (≈0.6 mil/yr). In the supernate/sludge region, the average corrosion rate was about 0.01 mil/yr and the typical pit was about 0.6 mil (≈0.1 mil/yr) with the deepest about 2 mil (≈0.5 mil/yr). An interesting fact was the presence of silver deposits (similarly found on pipe), blamed on deposition at local anodes (which is novel electrochemistry because silver usually deposits at the cathode).

The first quarterly report of 2014 (RPP-RPT-51766, Rev. 8) notes the potentials in tank AY-102 were all satisfactorily negative and the corrosion rate was much less than 1 mil/yr.

**AZ Tank Farm**
There are no probes and no coupons.

**SY Tank Farm**
The probe installation planned for 2011 (RPP-7574) for tank SY-102 does not appear to have occurred to this time; however, a retractable probe with reference electrodes was installed in tank SY-101.

**AW Tank Farm**
Corrosion probes suffered no SCC in tank AW-104 or in tank AW-105 in the third quarter report of 2013 (RPP-RPT-51766, Rev. 6). Corrosion rates were much less than 1 mil/yr.

The first quarterly report of 2014 (RPP-RPT-51766, Rev. 8) notes the potentials in tanks AW-104 and AW-105 were all satisfactorily negative. The corrosion rate of tank AW-104 was much less than 1 mil/yr; the tank AW-105 probe was too new and corrosion rates were not available.

**AN Tank Farm**
A 2008 report (RPP-RPT-36722) noted that coupons in tank AN-107 showed corrosion rates less than 0.01 mil/yr over an 8-year period.

In the second quarterly report of 2011 (RPP-RPT-46806, Rev. 16), ER probes in tank AN-107 noted the following corrosion rates:

- Vapor space: -0.002 mil/yr
- Supernate: -0.002 mil/yr
- Solids/saltcake: +0.000 mil/yr.

The negative rates are considered a fluctuation around 0.000.

The immersed probes all had potentials more negative than -296 mV (SCE); laboratory work (RPP-RPT-31680, *Hanford Tanks 241-AN-107 and 241-AN-102: Effect of Chemistry and Other Variables on Corrosion and Stress Corrosion Cracking*) suggests SCC is unlikely at potentials

more negative than -100 mV (SCE). At potentials more positive than -100 mV, SCC was induced and accelerated.

In 2012, after about 4.2 years, one of the coupon assemblies associated with the corrosion probe was removed (RPP-RPT-54241). All coupons were in excellent condition, still polished even in the vapor phase. There was no suggestion of SCC and the uniform corrosion rate was estimated at less than 0.003 mil/yr.

The 2014 probe data (RPP-RPT-53428) reported a measured corrosion rate of 0.000 mil/yr. The first quarterly report of 2014 (RPP-RPT-51766, Rev. 8) noted the potentials in tank AN-107 were all satisfactorily negative and the corrosion rate was much less than 1 mil/yr.

**AP Tank Farm**

There are no probes and no coupons.

For the tanks with coupons and probes, all results, vapor and waste, indicated uniform corrosion rates much less than 1 mil/yr; one coupon in the tank AY-101 vapor space that had a 2- to 3-mil/yr pitting rate. Hence, the conclusion, based on the various in-tank probes/coupons is that corrosion is not a concern in the present environment.

## 11.4 TANKS SECONDARY CONTAINMENT

Very little information was found about tanks secondary containment, but the bottom (in the annulus) of tank AY-102 does show some thinning. As with the primary tank, it is currently not known how much thinning actually exists.

Estimates based on the review of waste chemistry, specifically of tank AY-102, show that the secondary tank is not expected to be affected by the waste. This is true for all tanks in which the waste meets specification in OSD-T-151-00007.

Two areas of thinning were noted in tank AN-103 (RPP-RPT-58776).

The tank AN-105 inspection showed no reportable thinning or pitting; the equipment was not able to look for cracking (RPP-RPT-27467) though none is anticipated.

The tank AN-107 secondary tank showed no reportable thinning or pitting; the equipment was unable to look for cracks.

In 2015 the tank AP-102 floor was inspected and several areas of thinning were noted, the most serious being measured as 0.156 in. or about a 70% loss from the nominal 0.500 in. thickness. No areas of reportable thinning were discovered above the thinned floor regions on the secondary liner sidewall. No through-wall penetration of the secondary liner was discovered. Based on a review of construction drawings, these areas of thinning are noted to be located approximately above the concrete foundation drain slot locations. Continued visual examination is planned with a UT rescan in 5 years.

Little corrosion of the secondary shell is expected but as noted for tank AP-102, special circumstances can arise. Evaluation of the secondary bottom is clearly one situation where UT can be valuable.

The 2014 examination of tank AP-104 (RPP-RPT-56230) indicated no reportable data for the secondary knuckle.

Though some thinning was noted in the secondary shell of tank AN-103, the most significant annulus side corrosion, to the extent examined was observed in tank AP-102.

## 11.5 RESULTS OF PIPELINE CORROSION EXAMINATIONS AND TESTS

The development of a corrosion/erosion analysis methodology led to four principles. In summary, these utilize UT methods and, potentially, forensic analyses in the laboratory. Essentially, if UT said there was wear and the laboratory agreed, a corrosion rate was calculated. If the laboratory found no evidence of wear, the conclusion was that no wear occurred. On the other hand, if UT detected wear and no laboratory analysis was done, the default position was that wear occurred and a rate was calculated based on UT alone.

Corrosion evaluations of the interior of the primary pipe (in contact with waste) and the annular space between the exterior of the primary pipe and the interior of the encasement pipe are discussed in the following sections. Discussions of the exterior of the primary pipe, in the absence of and encasement or the exterior of the encasement pipe are discussed in Section 6.5 on cathodic protection.

### 11.5.1 Transfer Line, Primary Pipe Interior

**Lines SN-285, SN-286, and SN-278**

These lines are located in the SY Tank Farm. Lines SN-285 and SN-286 were estimated to have transferred 15.5 and 28 Mgal respectively. Though no specific records were found, line SN-278 was estimated to have transferred 0.2 Mgal (RPP-RPT-50397) based on tank SY-101 fill records.

Inspection of carbon steel piping is probably indicative of waste effects and suggests very low corrosion rates. For example, specific examinations performed in the laboratory include sections of the 3 in. carbon steel from lines SN-285, SN-286, and SN-278 that were removed and examined in the laboratory (LAB-RPT-12-00007). UT observed no noticeable thinning on any of the pipes. Small, 2 mil deep, pits were noted in lines SN-285 and SN-286 while SN-278 had an 8 mil deep pit – if the lines were in use for about 35 years, the pit depths are insignificant. An indication of the uncertainty involved is that UT measured the wall thickness of the line SN-285 coupon at about 213 to 232 mil while the nominal was 216 mil. As noted in one of the jumpers from AW Tank Farm discussed below, a silver deposit was noted on the interior surface of one of the lines and was attributed to the cathodic protection on the exterior of the encasement line which is clearly not a practicable electrochemical process; the metals were probably deposited on a cleaned patch of steel by an exchange reaction. Interestingly, one patch of oxide was observed on the line SN-285 coupon that was about 88.6 μm thick. This is equivalent to about 58 μm (≈2 mil) of iron. If the line was in use for about 35 years, this yields a corrosion rate of less than or about 0.07 mil/yr, consistent with laboratory tests.

**242-A Jumpers**

The 242-A Evaporator feeds several tank farms. RPP-PLAN-55015, *242-A Evaporator Jumper Ultrasonic Test Plan*, was prepared to evaluate corrosion/erosion in five jumpers using UT methods. In one jumper, jumper 18-4, a 2 in. stainless steel line had not been used and was defined as a baseline. Another 2 in. stainless steel jumper, jumper 19-5, the oldest jumper in service and destined for reuse, had processed 42 Mgal of slurry. In addition to the two jumpers listed, the other stainless steel jumpers C-4&5 (2 in.) (11 Mgal slurry), 13-K (3 in.) (86 Mgal supernate), and J-13A (3 in.) (29 Mgal supernate) were examined. In no case was there a

suggestion of significant erosion or corrosion (RPP-RPT-55941, *242-A Evaporator Jumper Ultrasonic Test Report*).

Jumper B-2 is from the AW-02E feed pump pit (LAB-RPT-14-00005, *Final Report for the Erosion-Corrosion Analysis of Tank 241-AW-02E Feed Pump Pit Jumpers B-2 and 1-4 Removed from Service in 2013*): This carbon steel jumper was in operation for over 30 years and had approximately 161 Mgal of waste passed through it. UT measurements yielded results of 0.211 to 0.286 in. (the nominal wall thickness is 0.216 in.).

Microscopic examination of the interior surface showed no sign of erosion, and the degree of corrosion was minor. Some pitting was observed with an average pitting rate of 0.1 to 0.2 mil/yr; however, without baseline data it is impossible to determine whether the pits were present in the new pipe.

The stainless steel connector showed no sign of erosion or corrosion.

Jumper 1-4 from the same pit similarly showed little corrosion and no indication of erosion.

After cleaning, deposits of silver, bismuth, and lead were observed. It is unknown whether they were present prior to cleaning or deposited on the clean metal surface during the cleaning process; the latter is physically more likely.

**Valve Box POR104**

A limited amount of work has been done with the installation of UT sensors on piping in valve box POR104. The UT sensors were mounted in silicone rubber and clamped to the 2 in. Schedule 40 stainless steel pipe in the extrados (outside of the bend) and at 90° abeam (RPP-RPT-49197, *Determination of Erosion/Corrosion Sensor Placement Locations for Valve Box POR104*). The sections were removed from service in 2011 and examined in the laboratory in 2014 (RPP-RPT-52791). Baseline data for the pipe (the report says the nominal thickness was 0.156 in. though ASTM standards list it as 0.154 in.) ranged from 0.126 to 0.234 in. though the latter value is suspect (RPP-RPT-51005, *Ultrasonic Thickness Testing of POR104 Valve Pit Piping in C-Farm*). Similar data were obtained for a repeat measurement. After using the valve box, little effect of erosion was noted. The estimated metal loss per 1 Mgal of waste was -0.53 mil for the slurry and +0.46 mil for the supernate. The worst case estimate was 3 mil, but since the standard deviation of the wall thickness measurements was 111.41 mil distinguishing 3 mil is difficult.

The overall conclusion was there was no statistical significant evidence of erosion per 1 Mgal of waste; though the results only pertain to C Tank Farm (which contained garnet abrasive) after processing 2 Mgal of waste (RPP-RPT-56223, *Valve Box POR104 Mounted Dry Array Ultrasonic Test Report*), the results seem conservative.

**Line SL-164**

Testing of this line in 2014 failed (TFC-WO-14-1905). Subsequent tests showed the primary line had failed. No corrosion data are available.

### 11.5.2 Annular Region of the Primary/Encasement Pipes

**Line SL-167**

This primary line is 2 in. Schedule 40 carbon steel encased in a 4 in. Schedule 40 carbon steel line. Residual water was found in the annulus in 2005 after tests performed earlier in 2005. In 2012 the annulus was dried, examined visually and with UT, and tested for Fitness-for-Service (RPP-RPT-55204).

Corrosion was determined to be minimal and the line fit for use. The line has been moved to a 5-year test schedule rather than the standard 10-year period.

## 11.6 DISCUSSION OF RESOLUTIONS OF THE 2006 DSTAR RECOMMENDATIONS

The following list the 2006 DSTAR observations and recommendations with current 2016 comments:

- 2006 DSTAR Item R10: TSAFT or equivalent examinations should be made on the secondary liner lower knuckle to provide gross indication of cracking.
    - 2016 DSTAR Assessment: As noted in the 2006 DSTAR, examination of the secondary liner lower knuckle has been completed, but notes this is actually an on-going process per R16-8.
- 2006 DSTAR Item R13: Secondary Liner analysis for ability to contain waste.
    - 2016 DSTAR: As noted in the 2006 DSTAR, examination of the secondary liner lower knuckle has been completed.
- 2006 DSTAR Item R15: Any DST piping (especially carbon steel primary piping) and other ancillary equipment that is removed from service for the next several years should be examined for erosion and/or corrosion. The history of the transfers through that piping should be reviewed so that an actual, average corrosion/erosion rate for Hanford Site DST piping can be determined.
    - 2016 DSTAR Assessment: Results to date suggest that from the waste side of the pipe, there is no problem; failures have occurred on the external/encasement pipe, which are not discussed in this section because they are not waste caused.
- 2006 DSTAR Item R16: Comparison of historical to current DST visual inspections should be performed, looking for growth and changes to the corrosion patches and discoloration. Similarly, coordination between the visual and ultrasonic examinations should occur to provide quantification for better understanding. The periodic ultrasonic examinations of the DSTs are to be performed in the same location to determine how fast the tank wall is corroding.
    - 2016 DSTAR Assessment: Comparisons based on visual inspection can provide suggestions on where to inspect and affect interpretations of other measurements but do not provide quantitative data. Based on the results of the first two UT inspections, it appears that at the minimum one more round of inspection and, probably, several more will be required to define a definitive corrosion rate assuming the same or compatible technology is used.

- 2006 DSTAR Item R18: Some sizeable fraction of the threaded fittings of the ancillary equipment should be inspected for leakage, if possible. Any removed ancillary equipment with a threaded fitting should be disassembled for evidence of increased corrosion from radiolysis of the thread sealant.
    - 2016 DSTAR Assessment: To date, no evidence has been presented that this is a worthwhile procedure.
- 2006 DSTAR Item R54: 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.

    - 2016 DSTAR Assessment: This recommendation has been completed. Paragraph 11.3.3 of RPP-RPT-31129, Rev. 0, *Expert Panel Workshop of Double-Shell Tank Vapor Space Corrosion Testing* notes the vapor phase of the DSTs meet the criteria noted by SRNL. Paragraph 11.3.4.2 notes only minor pitting has been observed in the vapor phase and has no failure significance.
- 2006 DSTAR Item R67: 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).
    - 2016 DSTAR Assessment: A review of the examination methodology has been completed and increased visual surveillance is in progress, per R16-8.
- 2006 DSTAR Item R68: 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.
    - 2016 DSTAR Assessment: This recommendation has been completed.
- 2006 DSTAR Item R76: 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.
    - 2016 DSTAR Assessment: This recommendation is effectively complete. In actuality, it is an on-going process.

- 2006 DSTAR Item R78: The recommendations from the expert panel report on RPP-RPT-22126 recommendation III results should be revised to require:

    1. Specific frequencies for forensic examination of the passive probes at once per year.
    2. Installation and use of a multi-probe in AN-102 in addition to the passive probe.

  It must also be pointed out that, while the testing focused on SCC and pitting corrosion, these are localized phenomena.
  UT at Hanford is primarily – and correctly – tasked to monitor the effects of general corrosion with only a small possibility of picking up problematic pitting or SCC since the exams do not cover 100% of the tank surface area.

    3. Unless the endpoint chemical composition is expected to exacerbate general corrosion, the UT examinations should remain at the current 10 year frequency.
    4. Alternately, the UT examinations could be increased to include significantly more surface area at 5 to 7 year intervals, such that the possibility of detecting problematic SCC and pitting is increased.

  - 2016 DSTAR Assessment: This recommendation is effectively complete. It should be noted that item 3 in R78 is correct in a general sense only. UT data at this time can only provide crude approximations of corrosion; the current usage of probes, electrochemical testings, and visual examinations is more indicative of the extent and rate of corrosion.

## 11.7 IQRPE SUMMARY DISCUSSION OF 2016 DST CORROSION INSPECTION AND EXISTING CORROSION ASSESSMENT

In this 2016 DSTAR corrosion report, despite the recent failure of tank AY-102, nothing has been found to contradict the above points. In addition to the above, several observations have been made:

- Pits were found in the three inspected DSTs after completion of hydrotesting. The pits were typically much less than 50 mil deep but some were in the 50 to 60 mil range. Estimates made at the time suggested a limited number of pits >1/16 in. (≈63 mil) could be present in tank AW-104.
- None of the pits reported by UT measurement significantly exceed the post hydrotest range, that is, within about a factor of 2 which is reasonable for corrosion.
- Much of the 'small' spot thinning reported is probably pitting (pits in carbon steel tend to be large diameter).
- It seems reasonable to assume much of the 'pitting' occurred during the (up to) 10-month hold up of hydrotest water or even prior to construction.
- Nominally all UT measurements provide results to the nearest 1 mil (0.001 in.). However, in demonstration tests on clean unused steel plate the reproducibility was about 12 mil due to location, operator, software, and equipment errors (RPP-RPT-57127).

A review of 13 DSTs that were examined twice suggests the error can be reduced to about 5 mil for average thicknesses while the minima have an error of 8 mil (RPP-RPT-46309; PNNL-19242). A review of recent UT summary document RPP-RPT-58301 suggests an error of 10 to 15 mil is not unreasonable.

- For various reasons, including interpretive procedures, the measured wall thicknesses in the 2006 to 2013 period are frequently greater than in the pre-2006 data. Hence, interpretation of UT data for determining corrosion rates is still in the future.
- Based on recommendations of the Expert Panel Oversight Committee (Terry 2006), electrochemical noise probes were phased out in 2007; too little information that was of use was obtained. However, the ER probes are proving to be useful sources of data.
- Interpreting the PNNL-15415 data suggests that, lacking original thicknesses, we cannot (yet) determine whether the 'losses' are due to corrosion or to ignorance about the baseline conditions. The lack of a baseline will become less important with the availability of further UT data.
- Tank/couplant temperature change data are critical; if the couplant is too cool, thickness is underestimated (PNNL-15415, pg. iv).
- Conclusions on corrosion rate are risky due to current methods of analysis – new methods under study may eliminate errors (PNNL-15415, pg. iii).

The UT data for the primary tank walls through 2014 show the tanks are in good condition (RPP-RPT-58301). There is no consistent trend in the primary tank wall data and nothing to suggest the remaining useful life of the tanks is compromised. Average values that are lower over the 8- to 10-year period between measurements are typically 10 to 20 mil lower but usually still above nominal plate thickness values.

Expected corrosion rates for carbon steel in contact with the waste are about 0.1 mil/yr based on coupon data. The accuracy of current UT scans under ideal conditions is ±6 mil/yr. The results in the field are closer to ±10 to15 mil with environmental factors and differences in taking and translating the data between certified UT technicians. Seven of the tanks actually show increases in thickness from the first scan to the second, indicating variability in the scanning conditions.

Primary tank walls (RPP-RPT-58301): *Of the 27 tanks, 17 tanks show no areas of wall thinning >10%. As shown in Table 4-2, 10 tanks show reportable areas of thinning >10% but less than 20%. Four tanks have pit-like findings that are below the reportable level. Two tanks were found to have linear indications."*

Selected weld seams are scanned in the vicinity of the riser chosen for each tank. These data show the welds are in good condition.

Nothing in any of the documentation defines what is thinning or what is pitting. Pitting is usually defined as localized corrosion confined to a point or to a 'small' area. In stainless steel, the area is usually quite small, on the order of a few tenths of a square inch or less, but in carbon steel the 'small' area can easily be on the order of square inches. A critical difference between pitting and thinning, however, is that pitting is of no real consequence structurally. While a pit may effect a leak, it is not likely to cause a tank to fail catastrophically. Thinning, on the other

hand, if wide spread can weaken the structure. It is proposed that any thinning of less than 1 or 2 in.$^2$ be considered pitting. The definition of thinning is a structural concern.

Specifics include the following:

- In as much as the reported pitting has tended to be of a similar depth as that after hydrotest, there does not appear to be any proof, at this time, that new pitting is occurring below the LAI. At or above the LAI there is a potential for out-of-specification conditions and therefore a potential for pitting though no significant concern exists at this time. To date, ER probes in the vapor phase suggest pitting is not a concern.
- None of the tank farms have significant concerns:
    - Despite the EOC report recommendation for enhanced inspection of AZ Tank Farm, no reason for such action is apparent.
    - The DSTs were all acceptably heat treated. Therefore, even if the tank chemistry should ever be out of specification, nitrate induced SCC is not expected.
    - According to the EOC report, AP Tank Farm inhibited water was to be used for hydrotests but this may not have occurred; therefore, there is a possibility of hydrotest water induced pitting. Pitting, as noted in the text, has been observed after hydrotesting in the tanks that were inspected and probably occurred to some degree in all tanks.
    - Tank AP-102 may have external corrosion on the secondary tank. At this time there is no significant concern and could be patched if it does.
- Extrapolating and analysis of data remains difficult due to the lack of baseline information, measurement error, and sufficient data.
- In summary, all laboratory tests with waste samples have resulted in corrosion rates <0.14 mil/yr and generally much less than 0.1 mil/yr.
- UT methods on piping also are open to question. UT data appear to give a ±10 to 15 mil error while laboratory inspections suggest little corrosion or erosion over 20+ year periods.

The discovery of 70% through-floor corrosion in the tank AP-102 secondary has many aspects. Inasmuch as the drain pits have not been reported as being flooded, it is difficult to determine the source of water to effect corrosion. Hanford is an arid site with a water table roughly 200 ft below ground level or about 150 ft below the bottom of the tank. Carbon steel could corrode to the extent noted in 28 years in Hanford Site soil; unfortunately, the steel was not in contact with soil so the mechanism is uncertain. It is possible, though not likely, for conditions present during construction to have affected the corrosion during and shortly after construction. The best approach is to check this site again in 5 to 10 years and see if the corrosion is continuing; alternatively, a core sample could be taken to see if corrosion has actually occurred.

### 11.7.1 Findings

There are no findings.

### 11.7.2 Observations

- An obvious question is: what was the extent of corrosion on the primary bottom base due to water/steam from the 'refractory' during heat up? High temperature alkaline solutions can be very corrosive toward carbon steel. Whether the time involved would allow for serious attack is unknown as is the corrosion rate under those conditions.
- There are no data on how much of the UT detected pitting occurred before or during construction and little data for that occurring during hydrotest operations.
- For those tanks with probes or coupons data to date show corrosion rates are <0.14 mil/yr and often less.
- None of the nitrite/nitrate ratios listed in Table 9-1 suggest there is a major pitting problem in the vapor phase.

### 11.7.3 Recommendations

- From a corrosion assessment of the DST system, the next overall DSTAR integrity assessment should follow the current 10-year schedule. (Summarized in recommendation R16-1 in Section 3.3.3.)
- Development of a primary tank bottom inspection tool should be done to reduce concerns about the DST bottoms. It must be determined whether it is more feasible to access the bottom through the refractory or to develop a robot that can access the bottom of the primary from the waste side. In any case, inspections should include non-destructive examination (NDE) techniques, such as UT. However, because no obviously applicable techniques currently exist, emphasis should be placed on tracking investigative techniques as they develop in the industry and with continued communications with developers. It is also recommended to DOE that they promote a Small Business Innovation Research (SBIR) program for this subject. (Summarized in recommendation R16-4 in Section 3.3.3.)
- As UT measurement processes evolve, both old and new methods should be compared on the same systems to assist in interpreting results. (Summarized in recommendation R16-6 in Section 3.3.3.)
- Laboratory testing of corrosion probes in waste samples along with the electrochemical tests to better understand the potential for error in the corrosion readings obtained in the DSTs should be completed. (Summarized in recommendation R16-11 in Section 3.3.3.)
- An improved temperature more closely representing the wall temperature is needed for the UT measurements of the DSTs. As noted in Section 11.3.2, inaccurate temperatures can lead to large measurement errors. The UT experts should explain/clarify their needs for reliable data. (Summarized in recommendation R16-12 in Section 3.3.3.)
- UT calibration tests should be tried on corroded 'waste' filled 'tanks.' UT instrumentation should be able to differentiate between metal and waste but this has not been confirmed and may be a source of error. (Summarized in recommendation R16-13 in Section 3.3.3.)

- When future treatment options are exercised, instrumented (e.g., UT, coupons, ER probes) spool pieces should be considered to monitor input lines to critical tanks in accordance with requirement WTI-3 in the tank farms WTS Fitness-for-Service requirements and recommendations (RPP-RPT-52206). This would provide a more rapid indication of the potential for corrosion when practicable and consistent with ALARA principles. Alternatively, evaluate the possibility of remote monitoring of the LAI to detect unwanted changes. An obvious but often neglected point is the collection of baseline data for any new WTS component prior to use especially if only one set of measurements is available. Once two or more sets of reliable data sets are available, the use of baseline data is not needed. (Summarized in recommendation R16-14 in Section 3.3.3.)

### 11.7.4 Conclusions

In regards to the DST corrosion assessment, the DST System is fit for use as listed in Appendix D.

## 11.8 SUMMARY AND BEST PRACTICES FOR IMPROVING CORROSION MONITORING PRACTICES

The status and the best practices for improving Hanford Site corrosion monitoring practices in the 2006 DSTAR were divided into two categories, one for DSTs and one for the transfer lines. This information has been condensed in one category in the 2016 DSTAR.

**Corrosion Monitoring Program**

The corrosion monitoring program for the DSTs used for waste storage at the Hanford Site has been based on collecting and analyzing samples of waste from within the DSTs. The results from these chemical analyses would then be compared to laboratory tests results, which matched chemical compositions of synthetic waste and the associated corrosion rates, as measured in laboratory studies. Because it is an expensive and time-consuming process to collect and analyze samples from multiple layers at all the DSTs, there can be a significant period of time between samples. If system conditions change for whatever reason, it is possible that the corrosion processes could accelerate. Though the corrosion rate is not likely to be a short-term (months or less) concern, it is desirable to have a corrosion monitoring system that is independent of the fluid sampling program and can detect the presence of conditions that can lead to corrosion rates in excess of 1 mil/yr.

The early efforts to implement a corrosion monitoring program started with corrosion coupons in the 1950s but then the effort died around 1965. Later efforts used coupons and ER probes. However, the results were not found to be satisfactory, in part because the corrosion was apparently not being detected (i.e., corrosion rates were approximately zero as is to be expected for waste within the stated OSDs). Because localized pitting was determined to be the most likely type of corrosion within the DSTs, the Hanford Site focused its efforts on trying to develop and implement the relatively new electrochemical noise corrosion monitoring technique. In actuality electrochemical noise was known to be a laboratory oriented process and difficult to use in the field. It was discontinued in 2007 (Terry 2006).

It is best practice that the corrosion monitoring systems within the (all) DSTs at the Hanford Site employ multiple, independent monitoring techniques. Thus the results from the different, independent monitoring techniques would be used to mutually confirm the results from the other techniques. As such, it is best practice to supplement the present fluid sampling/analysis with corrosion probes, corrosion coupons, or potential measurements. It is recognized that in-tank probes are also expensive and require periodic replacement. A similar situation exists with coupon racks.

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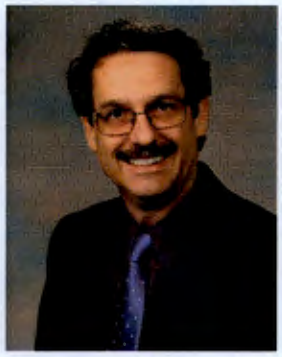
# APPENDIX A
# PERSONNEL QUALIFICATIONS



**Paul Giever, PE, SE**
**Independent Qualified Registered Professional Engineer**

Mr. Giever has more than 25 years of civil/structural engineering related experience and currently serves as Structural Technical Manager. As a Lead Engineer, he is responsible for the structural design of steel, concrete, masonry, and wood structures. His extensive experience includes nuclear, industrial, medical facilities, laboratories and commercial facilities. Other areas of expertise include the structural design of nuclear facilities, commercial tanks, pressure vessels, multi-level buildings, rehabilitation of trusses, and foundation designs for pre-engineered metal buildings. He has also been involved in designing normal and seismic loads of nuclear, industrial, public commercial buildings, schools, and hospitals and plan checking of steel, concrete, masonry, timber, and highway bridge structures.

**Education**

Master of Science, Civil Engineering, University of Idaho, 1988
Bachelor of Science, Civil Engineering, University of Idaho, 1986

**Registrations/Licenses/Certifications**

Professional Civil Engineer (PE): Washington (As well as 28 additional states)
Professional Structural Engineer (SE): Washington (As well as 19 additional states)

**Project Experience**

100D Septic Tank, Hanford, WA
100H Expansion, Hanford, WA
105 Construction Assistance, Hanford, WA
105 KE ISS SSE Design, Hanford, WA
109 N Demolition Support, Hanford, WA
116-C-3 Tank Remediation, Hanford, WA
200 W Pump & Treat Injection Building 2, Hanford, WA
200W Lime Treatment Project, Hanford, WA
291S Control House, Hanford, WA
308-A Reactor, 309 Reactor & 340 Building, Hanford, WA
309 PRTP and 340 Vault, Hanford, WA
B-Reactor RAWP Support, Hanford, WA
B12 Structural Evaluation, Hanford, WA
B75 Analysis on Flex Building, Hanford, WA
Conditioned Storage Building, 200 East Area, Hanford, WA
Diesel Generator Building, Hanford, WA
Double Shell Tank System Assessment, Hanford, W

Excavation Sluice Pit at Tank 241-C102, Hanford, WA
K-Basin Filter Mockup Skid, Hanford, WA
KW Annex Modification, Hanford, WA
L-691, 200W Sewer Lagoon Building, Hanford, WA
LAW Annex - Structural/Plumbing, Hanford, WA
Leak Check Tank Analysis, Richland, WA
N-Reactor Overbuild, Hanford, WA
Remedial Action for 100-N Area Waste Sit, Hanford, WA
VIT Plant Duct Calculations - Analytical, Hanford, WA

**STATE OF WASHINGTON**

DEPARTMENT OF LICENSING – BUSINESS AND PROFESSIONS DIVISION

**THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AS A**

**PROFESSIONAL ENGINEER**
**CIVIL, STRUCTURAL**

**MEIER ENTERPRISES INC**
**PAUL MICHAEL GIEVER**

[redacted]

| Cert/Lic No. | Issued Date | Expiration Date |
|---|---|---|
| 38084 | 08/23/1991 | 08/20/2016 |

Pat Kohler

PL-630-159 (R/6/13)

**Jill Shuttleworth, PE, SE**
**Subject Matter Expert – Structural Engineer**
Mrs. Shuttleworth has over 30 years of experience in structural engineering related experience. She is responsible for the design of steel, concrete, masonry and wood structure. Her extensive experience includes commercial, agricultural, religious, schools, and residential structural design. She has been involved with the design of new structures and rehabilitation of existing structures.

Meier
ARCHITECTURE • ENGINEERING

**Education**
Professional Civil Engineer (PE): Washington (As well as Oregon and Idaho)
Professional Structural Engineer (SE): Washington (As well as Oregon and Idaho)

**Registrations/Licenses/Certifications**
Professional Engineer: Washington (#25811)

**Professional Affiliations**
American Society of Civil Engineers
National Council of Engineering Exam Services, Structural Exam Committee
National Council of Structural Engineering Associations
Structural Engineers Association of Washington, Paste State President

**Project Experience**
Ammonia Receiver Foundation, Burbank, WA
B75 Analysis on Flex Building, Hanford Area, Richland, WA
DG HVAC Enclosure, Hanford, WA
ELO Building - Raffinate Tanks Support Analysis, Hanford, WA
Existing Gasoline Storage Tank Structural Analysis, Richland, WA
Fukushima Center of Gravity Calculations, Richland, WA
Grimmway Farms Condenser Platform Design, Pasco, WA
Kodiak Carbonics CO2 Plant, Boardman, OR
KW Basin Annex Modification, Richland, WA
Limerick Generating Station, Pottstown, PA
Richland Areva NP Site Seismic Documentation Support, Richland, WA
Standby Service Water Connector, Hanford, WA

# STATE OF WASHINGTON

DEPARTMENT OF LICENSING – BUSINESS AND PROFESSIONS DIVISION

**THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AS A**

**PROFESSIONAL ENGINEER**
**CIVIL, STRUCTURAL**

**JILL T SHUTTLEWORTH**

[redacted]

| Cert/Lic No. | Issued Date | Expiration Date |
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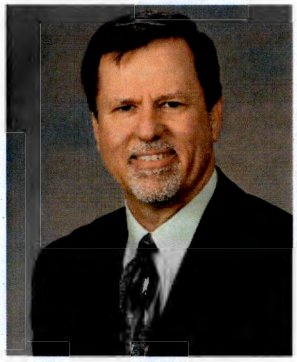
| 25811 | 01/27/1989 | 03/17/2016 |

Pat Kohler
Pat Kohler, Director

PL-630-159 (R/6/13)



**Dale Green, PE, LEED® AP**

Subject Matter Expert - Mechanical Engineer

Mr. Green is a licensed Professional Engineer with more than 19 years of engineering experience in the design of HVAC and plumbing systems. He currently serves as a Project Manager and is responsible for HVAC and plumbing systems design for commercial and industrial facilities. His background includes work on DOE facilities, commercial, and light industrial buildings. His engineering responsibilities include HVAC, plumbing, hydronic system design and layout, preparation of construction documents and specifications, cost estimates, engineering calculations, and construction management. Other areas of experience include educational facilities, office buildings, community centers, libraries, veterinary clinics, and containment ventilation systems.

**Education**

Bachelor of Science, Mechanical Engineering, New Mexico State University, 1994

**Registrations/Licenses/Certifications**

Professional Mechanical Engineer: Washington (#42240)
LEED Accredited Professional

**Professional Affiliations**

American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), Past President, Mid-Columbia Chapter

**Project Experience**

105 KE ISS SSE Design, Hanford Area, WA
B-Reactor RAWP Support, Hanford, WA
IQRPE/QII Support for AP, AN Jumpers R 30
LAW Annex - HVAC, Hanford, WA
LAW Annex - Structural/Plumbing, Hanford, WA
Liquid Nitrogen Delivery, Hanford, WA
MOX AR/H2 Skid, Aiken, SC
SWPF Shop Drawings - NQA-1, Aiken, SC
UN Tank Storage Building, Richland, WA
WTP Civil Materials Testing Facility, Richland, WA

**STATE OF WASHINGTON**

DEPARTMENT OF LICENSING – BUSINESS AND PROFESSIONS DIVISION

**THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AS A**

**PROFESSIONAL ENGINEER**
**MECHANICAL**

**DALE E GREEN**

[redacted]

| Cert/Lic No. | Issued Date | Expiration Date |
|---|---|---|
| 42240 | 01/19/2006 | 10/17/2016 |

Pat Kohler
Pat Kohler, Director

PL-630-159 (R/6/13)

Northwest Corrosion Engineering
10995 Warfield Road, Sedro-Woolley, WA 98284
Phone: (360) 826-4570 Fax: (360) 826-6321

# CURRICULUM VITEA

# JEREMY A. HAILEY, P.E.

## EDUCATION

Bachelor of Science, Agricultural Engineering - Washington State University, 1994

Professional Licenses/Certifications

Registered Professional Civil Engineer: Washington, Oregon, Alaska, Idaho, Colorado
Licensed Electrical Administrator, Washington State
Certified by the National Association of Corrosion Engineers in the following categories:

- NACE International Corrosion Specialist, P #5401
- NACE International Material Selection/Design Specialist, #5401
- NACE International Cathodic Protection Specialist, #5401
- NACE International Corrosion Technician, #5401
- NACE International Certified Coating Inspector, #5672

Washington State Department of Ecology
ICC Underground Tank – Cathodic Protection Certification - 1037949
ICC Underground Tank – Installation/Retrofitting - 1037949

## EXPERIENCE

Mr. Hailey is the President and Owner of Northwest Corrosion Engineering, a consulting firm providing specialized engineering services in the field of corrosion control. Mr. Hailey has over twenty years experience providing Professional Corrosion Engineering services. Specific areas of expertise include: corrosion control engineering, cathodic protection system design, specification development, design review, corrosion surveys, soil and water analysis, coating evaluation/inspection, material selection, failure analysis, data interpretation, installation supervision, system troubleshooting, and expert witness testimony.

Mr. Hailey has been involved with the development of comprehensive corrosion control programs for several clients including petroleum refineries, natural gas companies, and sewer

and water districts. Additional clients include consulting engineering firms, local, state, and federal agencies, department of defense, and municipal utilities.

Mr. Hailey has several years of experience providing corrosion engineering services to operators and owners of Underground Storage Tanks (USTs). Northwest Corrosion Engineering provides corrosion control system checkouts, impressed current cathodic protection system commissioning, detailed cathodic protection system design, and system installation support/inspection.

Prior to establishing Northwest Corrosion Engineering, Mr. Hailey provided corrosion engineering consulting services to Alyeska, stewards of the trans-Alaska pipeline system. His responsibilities included providing corrosion engineering design for both impressed current and galvanic anode cathodic protection systems for the buried portions of the pipeline from the north slope of Alaska to the Valdez Marine Terminal. Additional responsibilities included corrosion control system design and design oversight for numerous other Alyeska facilities including aboveground/belowground petroleum storage tanks, natural gas piping, and marine berth loading structures.

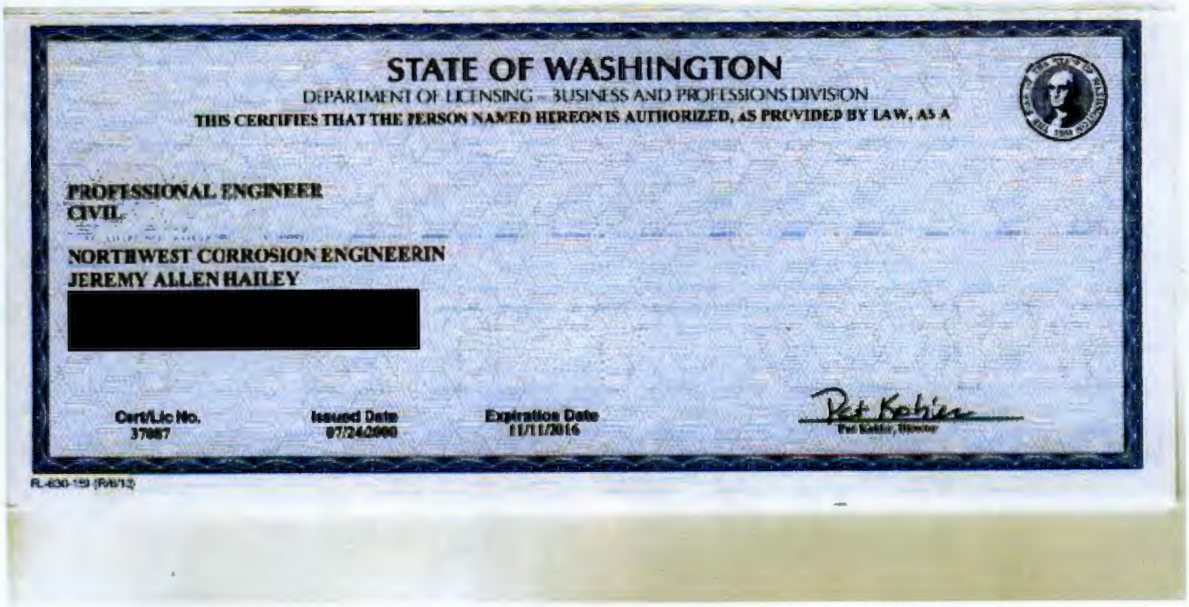
Mr. Hailey currently serves as a lead instructor for the National Association of Corrosion Engineers Cathodic Protection Certification and Training Program, providing instruction for the associations Cathodic Protection Tester (CP Level 1), Cathodic Protection Technician (CP Level 2), Cathodic Protection Technician - Marine, and Coatings in Conjunction With Cathodic Protection certification programs. In addition, Mr. Hailey is an instructor for the Steel Tank Institute's 2 and 3 day underground storage tank corrosion control tester certification classes.

Mr. Hailey serves as the Past-Chairman for the Puget Sound Section of the National Association of Corrosion Engineers, is the Past-Chairman of the American Water Works Association Pacific Northwest Engineering Committee, and is a past director of the American Water Works Association Northwest subsection.

Mr. Hailey has served as an expert witness providing expertise in coatings and corrosion related failures to buried and submerged metallic structures.

## PROFESSIONAL AFFILIATIONS

NACE – National Association of Corrosion Engineers
SSPC – Society for Protective Coatings
AWWA – American Water Works Association



STATE OF WASHINGTON
DEPARTMENT OF LICENSING – BUSINESS AND PROFESSIONS DIVISION
THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AS A

PROFESSIONAL ENGINEER
CIVIL

NORTHWEST CORROSION ENGINEERIN
JEREMY ALLEN HAILEY
[redacted]

Cert/Lic No. 37087
Issued Date 07/24/2000
Expiration Date 11/11/2016

Pat Kohler, Director

FL-630-159 (Rev/12)

NACE INTERNATIONAL INSTITUTE
CORROSION SPECIALIST
Jeremy Hailey
Cert No. 5401 Expires: February 28, 2017
The person to whom this has been issued has fulfilled the examination and experience requirements of the NACE Institute in order to attain the status of *Corrosion Specialist* certification.
Helena Seelinger - Executive Director

NACE INTERNATIONAL INSTITUTE
CATHODIC PROTECTION SPECIALIST
Jeremy Hailey
Cert No. 5401 Expires: February 28, 2017
The person to whom this has been issued has fulfilled the examination and experience requirements of the NACE Institute in order to attain the status of *Cathodic Protection Specialist* certification.
Helena Seelinger - Executive Director

NACE INTERNATIONAL INSTITUTE
MATERIALS SELECTION/ DESIGN SPECIALIST
Jeremy Hailey
Cert No. 5401 Expires: February 28, 2017
The person to whom this has been issued has fulfilled the examination and experience requirements of the NACE Institute in order to attain the status of *Materials Selection/Design Specialist* certification.
Helena Seelinger - Executive Director

NACE INTERNATIONAL INSTITUTE
NACE CERTIFIED COATING INSPECTOR—LEVEL 3
Jeremy Hailey
Cert No. 5672 Expires: October 31, 2018
The person to whom this has been issued has fulfilled the examination and experience requirements of the NACE Institute in order to attain the status of *NACE Certified Coating Inspector—Level 3* certification.
Helena Seelinger - Executive Director

**Kevin Miller, PE**

Subject Matter Expert - Electrical Engineer

Mr. Miller has 40 years of experience in leadership roles with responsibilities including: site surveys, electrical design, equipment commissioning, trouble shooting, construction management, maintenance management, and project management. Additional areas of expertise include project scope development, power quality analysis, estimating, team building, engineering management, scheduling, and cost control.

Meier
ARCHITECTURE • ENGINEERING

**Education**

Bachelor of Science, Electrical Engineering Technology, Milwaukee School of Engineering, 1974

**Registrations/Licenses/Certifications**

Professional Engineer: Washington (#20228)

**Professional Affiliations:**

Lighting Protection Institute

**Project Experience**

105 KE ISS SSE Design, Hanford Area, Richland, WA
200 East Area Conditioned Storage Building, Hanford Area, Richland, WA
308-A & 309 Reactor & 340 Building Disposition, Richland, WA
Energy Northwest Power Study, Richland, WA
Energy Northwest Tower Review, Richland, WA
MOX AR/H2 Skid, Hanford Area, Richland, WA
N-Reactor Overbuild, Hanford Area, Richland, WA
WTP Site Heat Trace, Hanford Area, Richland, WA

**STATE OF WASHINGTON**

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**THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AS A**

**PROFESSIONAL ENGINEER**
**ELECTRICAL**

**KEVIN D MILLER**

[redacted]

| Cert/Lic No. | Issued Date | Expiration Date |
|---|---|---|
| 20228 | 02/19/1982 | 05/05/2017 |

Pat Kohler
Pat Kohler, Director

**Andrew Klein, PE**
Senior Engineer/Chemical

**EXPERIENCE**

**Consulting Engineer**, May 2006 to Present
*Self-Employed - Founded **A S Klein Engineering, PLLC** in January 2013, Pasco, WA*
*Prior to its founding, consulted for Marshall A. Klein & Associates, Inc., based in Eldersburg, MD*

- Acted as the independent waste compatibility subject matter expert (SME) for Hanford Tank Farms to assess the likelihood and severity of consequences of both reactions within the waste and corrosion/degradation caused by waste properties on containment materials. Waste-contacting materials were thoroughly investigated including stainless steels, carbon steels, bronze, compressed asbestos, PTFE (Teflon), PVDF (Kynar), and PEEK. Polymer films in pump and valve pits including Amercoat, Amerlock 400FC epoxy and polyuria were confirmed to be compatible with tank wastes in the event of primary containment failure.
- Performed third-party reviews/inspections on the selection and installation of gaskets in bolted flange connections throughout an entire semiconductor fabrication campus. Selection of adequate gaskets, including gasket-specific certificates for tightness coefficients (gasket factors), was verified. Inspection was performed after installation to ensure compliance with ASME & EN standards including: verification of proper torqueing and re-torqueing, spring washer locations, washer/flange material combinations, gasket material compatibility with process fluids, etc.
- Assessed the overall Tank Farms Contractor corrosion mitigation program that specified maintaining tank waste properties within specifications, assessing the resultant waste combinations before transfer or mixing, waste sampling, confirmation of annulus tank ventilation, and annulus video inspections.
- Reviewed the chemical compatibility of gases and chemicals upon mixing and with duct, pipe, flange, and gasket materials for a semiconductor fabrication campus. Chemicals included acids, bases, solvents, and fabrication waste.
- Consulted on the proper storage of chemicals, separation based on incompatibilities, secondary containment measures, and fire protection and life safety adequacy for chemical storage warehouses to ensure compliance with the International Fire Code, OSHA regulations, and governing standards.

- Performed design reviews and inspections on chemical storage systems, chemical processing systems, tools and machinery to confirm whether design theories would work as intended, that materials were compatible, and that operations were code-compliant.
- Performed design review, inspections, and fire hazard analyses for high-hazard occupancies and special use buildings (e.g., semiconductor, gas/chemical storage, heavy mechanical, coating/dipping operations, refrigerated storage warehouses, Hanford infrastructure, specialty gas processes).
- Performed building and system plan review for compliance with the International Codes (e.g., IBC, IFC, IMC, etc.), legacy codes (Uniform, BOCA, and Standard), NFPA codes & standards, ASME standards, SEMI standards, and a variety of other referenced standards.
- Technical code & standard committee representation for a variety of client interests.
- Investigated the compatibility of antifreeze solutions with piping and sealing components in residential sprinkler systems.
- Created spreadsheet programs for hydraulic calculations ranging from pressure losses in waste water treatment piping systems to sizing programs for automatic fire sprinkler systems. Transformed the Plumbing Engineering and Design Handbook of Tables into a standalone program for the American Society of Plumbing Engineers (ASPE).

**Process Flowsheet Engineer**, July 2007 to January 2013
*URS Corporation, River Protection Project – Hanford Waste Treatment Plant (WTP): Richland, WA*

- Process Engineer responsible for the validation of the design for a $12 billion nuclear waste treatment plant.
- Analyzed the predicted composition of waste, close to 200 compounds, within all systems throughout the WTP.
- Verified the material compatibility of ultrafilters with Hanford waste and that the erosion corrosion was below specified limits based on process demand and throughput requirements.
- Reviewed the effects of chemical and radiological degradation on ion exchange resins to determine the estimated number of regeneration cycles that can be realized before resin replacement. Determined the estimated total cesium loading for each cycle based on the resin degradation calculations.
- Analyzed exhaust compositions from the WTP for compliance with Washington State Department of Ecology and Environmental Protection Agency (EPA) standards.
- Performed design review of the following systems: exhaust and scrubbers; ion exchange; ultrafiltration; evaporators; melters; transfer and mixing pumps.
- Managed the calculation and implementation of RAMI data within an Operations Research model.
- Composed reports ranging from in-house technical documentation to US Department of Energy (DOE) contract-deliverable assessments.

**Evaporation and Distillation Products Specialist**, October 2006 to June 2007
*Buchi Corporation, New Castle, DE*

- Provided on-site bench-scale evaporation and distillation technical support for the U.S. customer base.

- Advised customers on appropriate consumable material selections for their bench-scale products based on the proposed equipment and chemical use.
- Drafted technical documents and presentations to help the U.S. sales team and customers understand governing scientific principles of evaporation and vapor recovery.

## PROFESSIONAL LICENSES

**Licensed Professional Chemical Engineer (WA Lic. #47831)**
**Licensed Professional Fire Protection Engineer (WA Lic. #47831)**

### EDUCATION

Master's of **Engineering & Technology Management**, *2010*
*Washington State University, Tri-Cities, WA*
**Graduate Certificates** in Engineering Management & Project Management

Bachelor of Science in **Chemical Engineering**, *2006*
*University of Delaware, Newark, DE*
**Minors** in Chemistry & Mathematics

### PROFESSIONAL SOCIETY MEMBERSHIPS & COMMITTEE APPOINTMENTS

**American Institute of Chemical Engineers (AIChE)**
**Member**
2006 – Present

**Association of Energy Engineers (AEE)**
**Member**
2010 – Present

**Benton-Franklin Council of Governments (BFCG)**
**Board Member**
***Benton-Franklin Economic Development Council***
2014 – Present
**Committee Member**
***Comprehensive Economic Development Strategies (CEDS) Strategy Committee***
2014 – Present

**International Association of Plumbing & Mechanical Officials (IAPMO)**
**Technical Committee Member**
***Uniform Solar Energy & Hydronics Code (USEHC)***
2013 – Present

**International Code Council (ICC)**
**Member**
2012 – Present
**Code Development Committee Member**
***International Energy Conservation Code (IECC) – Commercial Code***
2015 – 2017 Code Development Cycle

**National Fire Protection Association (NFPA)**
**Technical Committee Member**
**NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages***
2012 – Present
**NFPA 101/5000, Life Safety Code: *Industrial, Storage & Misc. Occupancies***
2012 – Present

**Society of Fire Protection Engineers (SFPE)**
**Member**
2014 – Present

**STATE OF WASHINGTON**

DEPARTMENT OF LICENSING – BUSINESS AND PROFESSIONS DIVISION

**THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AS A**

**PROFESSIONAL ENGINEER**
**CHEMICAL, FIRE PROTECTION**

**ANDREW SCOTT KLEIN**
[redacted]

| Cert/Lic No. | Issued Date | Expiration Date |
|---|---|---|
| 47831 | 01/03/2011 | 01/12/2018 |

Pat Kohler
Pat Kohler, Director

**JAMES R. DIVINE**

CHEMMET, LTD., PC
POB 4068
West Richland, WA 99353

(509) 967-2309 or (800) 570-2309 Fax (509) 967-2459

**Chief Engineer**

## EXPERTISE

- Evaluation of the safe and proper use of engineering materials including the investigation of corrosion and degradation of metals and polymers in waste management, nuclear, construction, and industrial operations
- Independent oversight of hazardous waste system designs and construction
- Chemical behavior of high level wastes.
- Mitigation of buried materials degradation including cathodic protection and materials selection.
- Application of chemical and electrochemical engineering principles to industrial processes.
- Decontamination using chemical methods (chemical cleaning).
- Inter-disciplinary information exchange with emphasis on chemistry and engineering.

## EDUCATION

UNIVERSITY

| | | |
|---|---|---|
| **BS**. (with honors) | Chemical Engineering<br>University of California, Berkeley | 1961 |
| **PhD** | Chemical Engineering (minors: Chemistry & Mathematics)<br>Oregon State University, Corvallis | 1965 |

INDUSTRY (Selected Courses)
Arctic Engineering, Univ. of British Columbia
Principles of Safety Evaluation for Managers
Hazardous Waste Operator 24 hour Training for Supervisors with 8 hour Refreshers

## PROFESSIONAL CERTIFICATIONS

Registered/licensed professional engineer in Washington (#12231), Alaska (#EC 5925), Idaho (#10292), Oregon (#17,054), Maryland (#21365), Arizona (#29767), New Mexico (#13190), and Montana (15030 PE)

Corrosion Specialist (#867) certified by the NACE International

Registered with the **National Council of Examiners for Engineering and Surveying** (#13634)
Registered with the **USCIEP International Registry of Professional Engineers** (#137)

## EXPERIENCE

— Current Responsibilities

In 1991, Dr. Divine was instrumental in organizing ChemMet, Ltd., PC, a licensed professional services engineering corporation for which he serves as Chief Engineer. He is in charge of the management of chemical and corrosion engineering tasks including environmental assessment efforts, evaluation of operational safety in industrial and nuclear facilities, and the development of programs which combine the principles of chemistry and materials. He is also responsible for assisting in the transfer of technology between governmental agencies and private industry.

Some of his recent projects involve:

- ◊ Providing services as an independent qualified registered professional engineer (IQRPE) for several Hanford tank farm piping systems during design and construction;
- ◊ selection of materials for a proposed nuclear-waste treatment plant;
- ◊ evaluation of the failure of bolts on valves on potable water lines
- ◊ studies on and evaluation of aqueous corrosion in piping;
- ◊ evaluation of welded water treatment skids for West Valley Nuclear;
- ◊ participation in a corrosion study of welds, conducted at Columbia Basin College;
- ◊ participation in the oversight committee for the USDOE Rapid Commercialization Initiative (RCI);
- ◊ interfacing with Hanford and other Washington state personnel on three of the RCI technologies aimed for use in the state;
- ◊ participation in a technical review of international waste storage at Idaho Falls National Engineering Laboratory as one of three nationally selected NACE corrosion experts;
- ◊ oversight of corrosion design evaluations for the US Army Corps of Engineers;
- ◊ evaluation and testing of water treatment processes;
- ◊ corrosion monitoring and evaluation of the safety of Hanford nuclear waste storage tanks and underground waste sites;
- ◊ the corrosion evaluation of waste and chemical processing operations;
- ◊ review of corrosion failures and probable causes for legal action;
- ◊ the evaluation of polymers for use at waste treatment and disposal sites;
- ◊ evaluation of coated systems used at national waste treatment site; and
- ◊ the cathodic protection of fuel storage sites.

He has been an Adjunct Faculty Member of the Chemical Engineering Department at the Tri-Cities Campus of Washington State University. He has taught courses in fluid flow, thermodynamics, and corrosion as well as review courses in mathematics.

— Prior to 1991

Dr. Divine joined Battelle-Northwest in 1965 and was primarily concerned with studying corrosion mechanisms and kinetics in high-temperature water. He participated in programs aimed at establishing the effects of process parameters, including fluid hydraulics, heat flux, and radiation, on corrosion processes, corrosion product transport and deposition. Dr. Divine was also associated with studies on the dissolution of uranium and plutonium oxides, corrosion processes in nonaqueous solvent systems, and the electrodeposition of coatings on thin wires. During this period, he contributed to three invention reports and was a co-author of a US patent. He also developed, from a basic concept, a research program on corrosion of grinding steel in the mining industry that included international participants.

In 1974, he joined Westinghouse Hanford Company as a Senior Process Chemical Engineer for the development of the Acid Digestion Process for the reduction of combustible transuranic waste volumes. During this period, he conceived of a novel method of processing acidic off-gasses to reduce their effective corrosiveness which was prepared as an invention report, collaborated on the development of methods of waste volume reduction, and assisted in the preparation of Safety Analysis Reports.

He returned to Battelle-Northwest in 1978 as a Senior Research Engineer where he conducted studies on corrosion and the mass transport of corrosion products in aqueous systems as well as studies on chemical decontamination of nuclear reactor systems. He also consulted on refinery corrosion. As Technical Leader of the Electrochemical and Corrosion Processes Group, he had the added responsibility of monitoring the technical performance of a group of eight professionals while serving as project manager for his own programs. He participated in and guided activities to promote and market the capabilities of the group and section.

In 1983 - 1985, while serving as Technical Leader, he was promoted Staff Engineer. During this period, he was in charge of several technical programs as well as simultaneously serving in an administrative position. Typical programs included:

> A corrosion evaluation program on storage tank construction materials in simulated Hanford caustic waste mixtures which included developing and evaluating methods for in-tank corrosion monitoring.
>
> Development of inert anodes and cathodes for aluminum production by chemical and metallurgical engineering methods and by electrode reaction mechanisms studies using ac/dc methods.
>
> Evaluation of atmospheric corrosion in Alaska for the purpose of extending the database of the contiguous United States into the Cold Regions.

He served as Manager, Corrosion and Metallurgy Section, 1985-1989. During this period, he was in charge of an average of 30 (maximum of 55) Exempt and Non-exempt staff, an average annual section funding of about $5,000,000, a capital equipment inventory with a value of over $6,000,000, and over 35,000 $ft^2$ of facility space.

He provided technical oversight on programs in the areas of: Corrosion Testing; High-temperature and High-pressure pH and Conductivity Sensor Development; Chemical Cleaning (Nuclear and Chemical Systems); Geothermal System Materials Monitoring; Hazardous Waste Barrier Development; DOE/Industry Technology Transfer; Operation of a 100-Unit Autoclave Facility; Basic Electrochemical Processes of Stress Corrosion Cracking; and Natural Gas Pipeline Corrosion.

Administratively he promoted the expansion of program development into new technical areas with the participation of all professional members of the section staff. He worked towards the simplification of the preparation of proposals, and instigated centralized control of Section Quality Assurance records to provide expeditious management oversight, increase staff acceptance to new regulations, and hold down costs. He developed and implemented a safety plan and training records system for the section that was copied for use at higher administrative levels. He also had developed and implemented an equipment inspection procedure for high temperature/pressure test equipment.

While Section Manager, Dr. Divine maintained his own technical activities where he consulted with corporate, national, and local groups, primarily in the area of corrosion and environmental effects on materials including the testing of improved clothing materials exposed to surety agents. He conducted studies as the principal investigator in these areas. A 15-20% level of effort was allocated to these technical efforts; during this period, he conceived of a method for analyzing impurities in motor oil for which an invention report was filed.

Following his tenure as Section Manager, he served as Principal Investigator and Project Manager for corrosion and materials test programs. Typical programs included studies on the corrosion of Hanford waste tanks and processing operations, the corrosion of steel in Hanford soil, and the testing and evaluation of polymeric liners for waste storage sites. He was also involved in technology transfer and the novel application of chemical engineering processes, as for example, when he conceived of, and was project manager, for a "novel" space suit glove developed by Battelle for NASA.

## SELECTED COURSES TAUGHT

Corrosion Short Course, with Dr. R. S. Johnson, at Idaho National Engineering Laboratory, July, 1994
Sessions on Toxicology and Confined Space Entry for Hazardous Waste Operator Courses, 1996 through 2005
Session on Stoichiometry for the ChemEng PE Refresher course on Aug, 1996, WSU-Tri-Cities
Session on Materials for MechEng PE Refresher course in September, 2002, Bechtel National
Session on BWR Corrosion to staff of the Bilibino Nuc. Pwr. Sta., Russia, in Anchorage, AK, October, 1997

## PROFESSIONAL AFFILIATIONS

| | | |
|---|---|---|
| — | American Institute of Chemical Engineers, AIChE | Sr Member |
| — | American Water Works Association, AWWA | Member |
| — | American Society for Testing & Materials, ASTM | Member |
| — | ASM International | Member |
| — | Association of Consulting Chemists & Chemical Engineers | Member |
| — | NACE International (The Corrosion Society) | Fellow |
| — | National Society of Professional Engineers, NSPE | Lic. Member |
| — | Society of Plastics Engineers, SPE | Sr Member |

**STATE OF WASHINGTON**

DEPARTMENT OF LICENSING – BUSINESS AND PROFESSIONS DIVISION

THIS CERTIFIES THAT THE PERSON NAMED HEREON IS AUTHORIZED, AS PROVIDED BY LAW, AN A

**PROFESSIONAL ENGINEER**
**CHEMICAL**

**JAMES R. DIVINE**

[redacted]

| Cert/Lic No. | Issued Date | Expiration Date |
|---|---|---|
| 12331 | 08/13/1979 | 03/11/2016 |

Pat Kohler
Pat Kohler, Director

NACE
CORROSION SPECIALIST
James R Divine FNACE
Cert No. 867
Expires: May 31, 2016
The person to whom this has been issued has fulfilled the examination and experience requirements of NACE in order to attain the status of Corrosion Specialist certification.

## Scott W. Seiler – Base Point, Inc.
## Subject Matter Expert – Regulatory Compliance

### CAPABILITIES

**Management Leadership.** Thirty years of results oriented leadership, with a substantial record of successfully managing diverse activities in challenging environments. Experienced in corporate team projects and government-international contracting.

**Organization and Process Improvement.** Developed and implemented significant improvements in a wide range of organizations and systems. Special skills in the disciplines of strategic planning, regulatory compliance, land, infrastructure, facilities and asset management.

**Program and Project Management.** Successful planning and execution of multiple complex projects involving business planning, systems engineering, risk analysis, design, configuration management, construction, operations, demolition, and remediation.

**Capital Planning.** Developing and implementing strategic capital asset plans that have significantly reduced operations and overhead costs, while improving the general condition and value of assets held by commercial and government organizations.

### EXPERIENCE

**1999-current Base Point, Inc. – President**
Provide direct support for accelerated closure, environmental compliance, and land use projects. Including: IQRPE independent assessments of Hanford Tank Waste System installations, Baseline development for Hanford Tank Waste Project, and Rocky Flats Site Closure Planning.

**2006-current Federal Engineers & Constructors, Inc. – Vice President, US – President, UK**
Physical performance of Nuclear and Hazardous Waste Project Delivery in the United States, Canada, and the United Kingdom.

**1996-1999 ICF Kaiser International, Inc. – Program Manager, Consulting Group**
Provided infrastructure and environmental management services to federal, state, local, and industrial clients throughout the U.S. Specific focus on strategic planning that lead to improved operations and services that ensured maximum impact for invested funds.

**1989-1996 ICF Kaiser Hanford – Manager, Land and Infrastructure Division**
Responsible for life cycle planning of general support facilities, extensive infrastructure networks, and a 580+ square mile land base. Included strategic asset planning, land use, management of facility and maintenance upgrades, and the development and execution of a facilities demolition program.

**1987-1989 Boeing Advanced Systems Division – Administrator, Capital Assets Program**
Coordinated capital and strategic facility planning for this division of Boeing and integrated these plans with other divisions within the company. Included the justification of complex and highly technical projects to meet client needs, while maintaining and improving Boeing's strategic capabilities within the aerospace industry.

**1985-1987 City of Bellevue, Washington – Manager, Design and Development Dept.**
Responsible for the permit review and issuance process within a progressive urban jurisdiction located directly east of Seattle. Included extensive interface and integration with the development community, business community, city council, and city staff and management.

**1982-1985 Rockwell Hanford Operations – Project Manager, Facilities Department**
Responsible for specific facility and infrastructure upgrade and utilization projects. Included projection of facility needs, definition and justification of projects, management of construction projects, and direction for life cycle maintenance.

**1980-1982 Benton County Planning Department, Washington – Associate Planner**
Defined and implemented both short and long range land use plans, codes, and standards. Required extensive public and political contact, while ensuring compliance with state and local laws and requirements for development within the County.

**1979-1980 Washington State University, Facilities Department – Design / Draftsman**
Responsible for the design and implementation of grounds and facilities improvement projects. Included transportation upgrades, campus-wide signs program, land use assessment, and an athletic complex re-development project.

## EDUCATION

BS, Land Architecture, Washington State University, 1980
Supplemental Tracks: Civil Engineering
Urban and Regional Planning

## TRAINING

Activity Based Planning and Management
NEPA / CERCLA / RCRA Requirements and Processes
WA ST Certified Water Treatment Plant Operator
Real Property Management Practices
Uniform Building Code Plans Review

## AWARDS

DOE Office of River Protection Recognition Award, 2001
Westinghouse Quality Achievement Award, 1991
Washington State Planning Achievement Award, 1983

## CLEARANCES

Department of Energy 'Q' – Inactive
Department of Defense 'Secret' – Inactive

In addition to the Subject Matter Experts, Meier would like to thank the assistance of:

Alex Butterfield, Meier, P.E.
Anthony Cockbain, Meier, P.E. and Project Manager
Donna Williams, Meier, Administrative Assistant
Leiloni Mahoney, AEM Consulting, Technical Editor
Shari Matthews, Meier, Technical Editor

# APPENDIX B
# 40 CFR 265.191 AND WAC 173-303-640 CODE COMPLIANCE MATRIX

# APPENDIX B 40 CFR 265.191 AND WAC 173-303-640 CODE COMPLIANCE MATRIX

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**Table B-1: Compliance Matrix for DST Structural Adequacy Assessment**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| DST Structural Adequacy Assessment | 265.191 assessment of existing tank system's integrity.<br>(a) For each existing tank system that does not have secondary containment meeting the requirements of 265.193, the owner or operator must determine that the tank system is not leaking or is unfit for use. Except as provided in paragraph (c) of this section, the owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that attests to the tank system's integrity by January 12, 1988.<br>(b) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (1) design standard(s), if available, according to which the tank and ancillary equipment were constructed. | (2) (c) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (i) design standard(s), if available, according to which the tank system was constructed. | Tanks:<br>1. Review existing assessments of existing double-shell tank construction.<br>2. Determine Key operating parameter limits for double-shell tanks.<br>3. Review operating records to determine if operating parameters are maintained.<br>Pits:<br>1. Review Pit structural assessments that have been performed.<br>2. Coordinate with NACE Coatings SME to assess if any structurally significant cracks may be present. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5<br>2. RPP-RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br>3. Volume 6: IQRPE DST System Integrity Assessment - Evaluation and Documentation of DST Secondary Liner Issues, RPP-22604, Rev. 1<br>4. Volume 7: IQRPE DST System Integrity Assessment - Evaluation of the Dome Load Program for Double-shell Tanks, RPP-20556, Rev. 1<br>5. Independent Qualified Registered Professional Engineer (IQRPE) Reports since 2006 DSTAR<br>6. OSD-T-151-00007 (Operating Specifications Document)<br>7. PC SACS (Surveillance Analysis Computer Systems)<br>8. RPP-RPT-28968, 2009, Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br>9. Tank Farm Construction Extent of Condition Review for Tank Integrity Reports (EOCs) | • The DST Tanks and Pits are adequately designed and have sufficient structural strength that they will not collapse, rupture, or fail.<br>• Tank designs provide structural adequacy until 60 year tank life with respect to design adequacy and structural strength.<br>• Operating parameter limits are properly maintained.<br>• DST Dome Loading Program is adequate and proper controls are implemented. The Dome Loading Program is now under control of one authority.<br>• Pits for DST Tank Farms meet or exceed pit design requirements for the AY Tank Farm. Therefore, all pits are structurally adequate since no structurally significant cracks were noted during the coating replacements.<br>• Determine current life expectancy of the Tanks to be completed before 2025. At that time, AY-101will be 53 years old, which is 7 years from current life expectancy. |
| DST Structural Adequacy Assessment | (4) Documented age of the tank system, if available (otherwise, an estimate of the age) | (iv) Documented age of the tank system, if available (otherwise, an estimate of the age) | Verify that age information exists for each tank system. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5 | • Age of tanks and pits verified. |
| DST Structural Adequacy Assessment | -- | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. | Based on the assessment outlined above, recommendations regarding scheduled integrity assessments will be made, as required. | -- | • Based on current structural adequacy and no evidence of significant corrosion, a 10 year interval for the next DSTAR is appropriate.<br>• Visual inspections should be conducted at least every 8 to 10 years preceding UT and can help direct where UT measurements are taken.<br>• UT measurements should be conducted at least every 8 to 10 years.<br>• Determine the temperature of the steel plate at time and location of UT measurements. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended, U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

**Table B-2: Compliance Matrix for DST Waste Compatibility**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| DST Waste Compatibility | (b) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (1) design standard(s), if available, according to which the tank and ancillary equipment were constructed. | (2) (c) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (i) design standard(s), if available, according to which the tank system was constructed. | 1. Review prior corrosion assessment.<br><br>2. Review new corrosion reports after 2006 DSTAR. | 1. Volume 3: IQRPE DST System Integrity Assessment - Waste Compatibility, RPP-25153, Rev. 1<br><br>2. RPP-RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br><br>3. Independent Qualified Registered Professional Engineer (IQRPE) Reports since 2006 DSTAR<br><br>4. OSD-T-151-00007 (Operating Specifications Document)<br><br>5. Laboratory Reports | • The chemical compositions of the wastes stored within the DSTs have been kept within acceptable limits so as to limit corrosion of DST materials.<br><br>• No new corrosion mechanisms have been identified since the 2006 DSTAR, and modifications to the DST, as documented in IQRPE reports, have utilized acceptable materials for waste compatibility with respect to DST corrosion and longevity.<br><br>• Recommendations from the 2006 DSTAR affecting DST material compatibility with the waste have been closed.<br><br>• Operating specifications ensure that the waste will continue to be stored, transferred, and monitored to limit effects on DST integrity. |
| DST Waste Compatibility | (2) Hazardous characteristics of the waste(s) that have been or will be handled. | (ii) Hazardous characteristics of the waste(s) that have been and will be handled. | 1. Review the estimated concentrations for all chemicals of concern as a baseline for future assessments. This may include toxic and organic constituents and those that contribute to corrosion mechanisms.<br><br>2. Review the Transfer Compatibility Program to determine how chemical inventories are being managed in order to avoid combinations that create concerns. | 1. IQRPE DST System Integrity Assessment - Waste Compatibility, RPP-25153, Rev. 1<br><br>2. RPP-RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br><br>3. OSD-T-151-00007 (Operating Specifications Document)<br><br>4. Best Basis Inventory (BBI) Summary Tables<br><br>5. Waste Compatibility Assessment Reports | • Estimated tank inventories by constituent obtained from the Best Basis Inventory (BBI) indicate that tank waste characteristics pose no physical hazards to the DSTS integrity.<br><br>• Aging waste will not pose addition concerns, as operating specifications adequately ensure the management of waste characteristics within the tank and also during/after transfers.<br><br>• Recommendations from the 2006 DSTAR affecting waste characteristics have been closed. |
| DST Waste Compatibility | -- | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. | 1. Recommend an assessment schedule based upon current tank system materials and associated chemistries, proposed future tank chemistries, and proposed operations. | -- | • The characteristics of the tank waste, as currently managed, are not a driver of the schedule for conducting the next integrity assessment.<br><br>• Independent confirmation that waste is managed within current operating specifications should occur on a period not to exceed 10 years. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended, U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

**Table B-3: Compliance Matrix for DST WTS (2 sheets)**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| DST WTS | 265.191 assessment of existing tank system's integrity.<br><br>(a) For each existing tank system that does not have secondary containment meeting the requirements of 265.193, the owner or operator must determine that the tank system is not leaking or is unfit for use. Except as provided in paragraph (c) of this section, the owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that attests to the tank system's integrity by January 12, 1988. | (2) Assessment of existing tank system's integrity.<br><br>(a) For each existing tank system, the owner or operator must determine that the tank system is not leaking or is unfit for use. Except as provided in (b) of this subsection, the owner or operator must obtain and keep on file at the facility a written assessment reviewed and certified by an independent, qualified registered professional engineer, in accordance with WAC 173-303-810(13)(a),[c] that attests to the tank system's integrity by January 12, 1988, for underground tanks that do not meet the requirements of subsection (4) of this section and that cannot be entered for inspection, or by January 12, 1990, for all other tank systems. | 1. Review tank system leak tightness.<br><br>2. Review Fitness For Use Program and Active Line List to assure that each component of the WTS is still Fit For Use. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5<br><br>2. RPP RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br><br>3. Volume 2: IQRPE DST System Integrity Assessment - Pipeline Integrity, RPP-27591, Rev. 1<br><br>4. Volume 5: IQRPE DST System Integrity Assessment - Waste Transfer Line Encasement Integrity Technology Study, RPP-27097, Rev. 1<br><br>5. Independent Qualified Registered Professional Engineer (IQRPE) Reports associated with WTSs since 2006 DSTAR.<br><br>6. Fit-for-Service (FFS) Program - Active Lines List | • The DST WTS has been demonstrated to be leak tight and fit for use.<br><br>• There is a "Fit-for-Service" (FFS) program in place to ensure the WTS remains operational and leak tight. The FFS program includes the requirement of IQRPE review and reporting for all new piping, jumper, and ancillary equipment installations. The reviews required from the IQRPE include design, fabrication, and installation. An IQRPE or Qualified Independent Inspector (QII) is required to do independent reviews and verifications of all new installations. |
| DST WTS | (b) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (1) design standard(s), if available, according to which the tank and ancillary equipment were constructed. | (2) (c) This assessment must determine that the tank system is adequately designed and has sufficient structural strength and compatibility with the waste(s) to be stored or treated, to ensure that it will not collapse, rupture, or fail. At a minimum, this assessment must consider the following: (i) design standard(s), if available, according to which the tank system was constructed. | 1. Review prior design assessment.<br><br>2. Review new design reports after 2006. | 1. Volume 2: IQRPE DST System Integrity Assessment - Pipeline Integrity, RPP-27591, Rev. 1<br><br>2. RPP-RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br><br>3. Volume 5: IQRPE DST System Integrity Assessment - Waste Transfer Line Encasement Integrity Technology Study, RPP-27097, Rev. 1<br><br>4. Independent Qualified Registered Professional Engineer (IQRPE) Reports associated with WTSs.<br><br>5. RPP-RPT-28500.<br><br>6. TFC-ENG-STD-22. | • The DST WTS has been demonstrated to be designed to meet appropriate industry standards.<br><br>• The design of new equipment and piping systems in the DST WTS is guided by Engineering Standard TFC-ENG-STD-22. The technical basis for this standard is found in RPP-RPT-28500.<br><br>• Appropriate industry standards are used in the design, fabrication, installation, and testing of components and systems associated with the DST WTS.<br><br>• Independent design reviews are conducted by an IRQPE and design review reports are provided. |
| DST WTS | (4) Documented age of the tank system, if available (otherwise, an estimate of the age) | (iv) Documented age of the tank system, if available (otherwise, an estimate of the age) | Verify that WTS component age information exists. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5 | • The age of the DST WTS is documented. |

**Table B-3: Compliance Matrix for DST WTS (2 sheets)**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| DST WTS | (5) Results of a leak test, internal inspection, or other tank integrity examination such that: (i) For non-enterable underground tanks, this assessment must consist of a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects,(ii) For other than non-enterable underground tanks and for ancillary equipment, this assessment must be either a leak test, as described above, or an internal inspection and/or other tank integrity examination certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that addresses cracks, leaks, corrosion, and erosion | (v) Results of a leak test, internal inspection, or other tank system integrity examination such that:(A) For nonenterable underground tanks, the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects; and(B) For other than nonenterable underground tanks and for ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an independent, qualified registered professional engineer, in accordance with WAC 173-303-810 (13)(a), that addresses cracks, leaks, corrosion, and erosion. | Determine if WTS components comply. | 1. Independent Qualified Registered Professional Engineer (IQRPE) Reports since 2006 DSTAR. (Jumper Component Assessments)<br>2. Test Reports<br>3. RPP-PLAN-52788 Rev 0 | • The DST WTS has been demonstrated to be leak tight.<br>• The "Fit-for-Service" (FFS) program recommends pneumatic leak tests be performed on the encasement of all transfer lines in the FFS scope (excluding HIHTLs).<br>• The reviews required from the IQRPE include design, fabrication, and installation. An IQRPE or Qualified Independent Inspector (QII) is required to do independent reviews and verifications of all new installations.<br>• RPP-PLAN-52788 Rev 0 recommends the encasements be re-tested on a 10-year schedule or prior to next use, whichever is greater.<br>• Leak testing has been conducted and the program is working. Line SL-164 failed a leak test and was subsequently removed from the fit-for-service list. |
| DST WTS | -- | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. | Based on the assessments performed above, recommendations regarding inspection schedules will be made, if required. | -- | • IQRPE concurs that the encasements should be re-tested on a 10-year schedule or prior to next use, whichever is greater.<br>• For existing pipeline and encasements, the next overall DSTAR integrity assessment should follow the current 10 year schedule. There is no evidence of significant corrosion, erosion or structural degradation for the waste transfer components. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended, U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems." *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions." *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

**Table B-4: Compliance Matrix for DST Leak Detection Instrumentation**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| DST Leak Detection Instrumentation | N/A | (2) (a) For each existing tank system, the owner or operator must determine that the tank system is not leaking or is unfit for use. | 1. Review existing leak detection components lists by tank and WTS to determine physical leak detection methods currently in place.<br><br>2. Review existing maintenance program and schedules to determine that administrative controls are in place.<br><br>3. Review existing maintenance on the leak detection system and scheduled PM are in compliance with requirements.<br><br>4. Review known leak reports / data to assess leak detection system performance. | 1. Tank Farm daily round sheets/logs<br>2. Tank systems transfer plan and round sheets/logs<br>3. AY-102 Leak Inspection Report<br>4. Leak Detection Problem Evaluation Requests (PERs)<br>5. Washington Pollution Control Hearings Board (PCHB) 98-429 and 98-250 (SY Settlement Agreement, SY tank leak detection system settlement decision)<br>6. System Design Descriptions for each of the DST tank storage systems | • The existing DST leak detection devices meet the requirement to determine that the tank systems are not leaking or unfit for use.<br><br>• The Tank Farm Daily Rounds logs demonstrate continued surveillance of all leak detectors and level detectors as well as the associated alarm systems.<br><br>• Although Tank AY-102 is not within the scope of this report, the extra emphasis placed on it has heightened the awareness and importance of early leak detection.<br><br>• The leak detection related Problem Evaluation Requests (PERs) have led to refinements in the maintenance and calibration procedures for the leak detection devices.<br><br>• The DSTs each have at least three (3) annulus leak detectors and one (1) level detector (all Enraf devices) that satisfy the SY Settlement Agreement (Washington Pollution Control Hearings Board (PCHB) 98-249 and 98-250) requirements.<br><br>• Information regarding leak detection devices is not managed in a single database. Thus, information should be collected and managed in a single database such that any issues with a particular device or location can be tracked as well as an aid to identifying reoccurring issues and maintenance done on the devices. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended, U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

**Table B-5: Compliance Matrix for DST System Cathodic Protection**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| DST System Cathodic Protection | (3) Existing corrosion protection measures | (iii) Existing corrosion protection measures | 1. Review cathodic protection system design background.<br>2. Review design modifications to the cathodic protection system.<br>3. Review monitoring protocol.<br>4. System operation within NACE Requirements | 1. Volume 4: IQRPE DST System Integrity Assessment - Cathodic Protection for DST Transfer Lines, RPP-25299, Rev. 1<br>2. RPP- RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br>3. SY cathodic protection modifications<br>4. PM schedules and PM listings<br>5. Cathodic Protection Annual Reports.<br>6. 2014 overall system assessment report.<br>7. RPT-PLAN-55857, Rev. 0 Cathodic Protection Program Improvement Plan | • The cathodic protection equipment installed to protect the regulated piping along with testing and reporting procedures is consistent with industry standards. Therefore, the DST cathodic protection system meets fit for use requirements.<br>• The addition of supplemental inspection techniques that have been implemented since 2006 DSTAR, specifically coupons, ER probes, and the use of synchronizable current interrupters are an enhancement to the monitoring of the overall cathodic protection system.<br>• Direct assessment methodologies should be implemented for the ACT 100 piping in the next 5 years in order to validate current cathodic protection system operation for this type of piping.<br>• The monitoring protocol and system operations are performed in accordance with industry standards and comply with NACE requirements. |
| DST System Cathodic Protection | (4) Documented age of the tank system, if available (otherwise, an estimate of the age) | (iv) Documented age of the tank system, if available (otherwise, an estimate of the age) | Verify that age information exists for each cathodic protection system. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5 | • The age of the DST cathodic protection system is documented. |
| DST System Cathodic Protection | -- | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. | Based on the assessment outlined above, recommendations regarding scheduled DST System cathodic protection assessments will be made, as required. | -- | • Testing intervals for the cathodic protection system are outlined in WAC 173-303-640 (6)(c) and require annual monitoring of the cathodic protection test stations and bimonthly inspection of all impressed current sources (rectifiers). These regulatory requirements are being met.<br>• For existing cathodic protection system, the next overall DSTAR integrity assessment should follow the current 10 year schedule. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended, U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

**Table B-6: Compliance Matrix for Pit Coatings**

| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| Pit Coatings | (4) Documented age of the tank system, if available (otherwise, an estimate of the age) | (iv) Documented age of the tank system, if available (otherwise, an estimate of the age) | Verify that age information exists for each pit. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5 | • The age of the DST pit coatings is documented. |
| Pit Coatings | (5) Results of a leak test, internal inspection, or other tank integrity examination such that:<br><br>(i) For non-enterable underground tanks, this assessment must consist of a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects,<br><br>(ii) For other than non-enterable underground tanks and for ancillary equipment, this assessment must be either a leak test, as described above, or an internal inspection and/or other tank integrity examination certified by a qualified Professional Engineer in accordance with 270.11(d) of this chapter that addresses cracks, leaks, corrosion, and erosion | (v) Results of a leak test, internal inspection, or other tank system integrity examination such that:<br><br>(A) For nonenterable underground tanks, the assessment must include a leak test that is capable of taking into account the effects of temperature variations, tank end deflection, vapor pockets, and high water table effects; and<br><br>(B) For other than nonenterable underground tanks and for ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an independent, qualified registered professional engineer, in accordance with WAC 173-303-810 (13)(a), that addresses cracks, leaks, corrosion, and erosion. | 1. Review design documents for pit coatings.<br><br>2. Review inspection and repair of coatings.<br><br>3. Review Inspection and Repair Reports to include certification of individuals performing upgrades / repair and certification of inspection personnel.<br><br>4. Develop and evaluate a matrix of pit coating inspection history and planned inspections. | 1. Volume 1: IQRPE Double-Shell Tank Integrity Assessment Report HFFACO M-48-14, RPP-28538, Rev. 5<br><br>2. RPP-RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington.<br><br>3. Independent Qualified Registered Professional Engineer (IQRPE) Reports since 2006 DSTAR.<br><br>4. TO-040-050, Perform Inspections of Pit Coatings, Tank Operating Procedure. | • Given known pit coating conditions and operational requirements, the DST pit coatings are in compliance with fit for use requirements.<br><br>• The 2006 DSTAR recommended pit coating inspection cycles. These recommended inspection cycles are not being met for pits that are not being used. In these instances, the pit coatings must be inspected prior to use.<br><br>• The implementation of current inspection and repair procedures are providing adequate evidence of pit coatings conditions in order to assess compliance. |
| Pit Coatings | – | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. | Based on the assessment outlined above, recommendations regarding scheduled pit secondary liners/coatings assessments will be made, as required. | -- | • For pit coatings, the next overall DSTAR integrity assessment should follow the current 10 year schedule. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended, U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

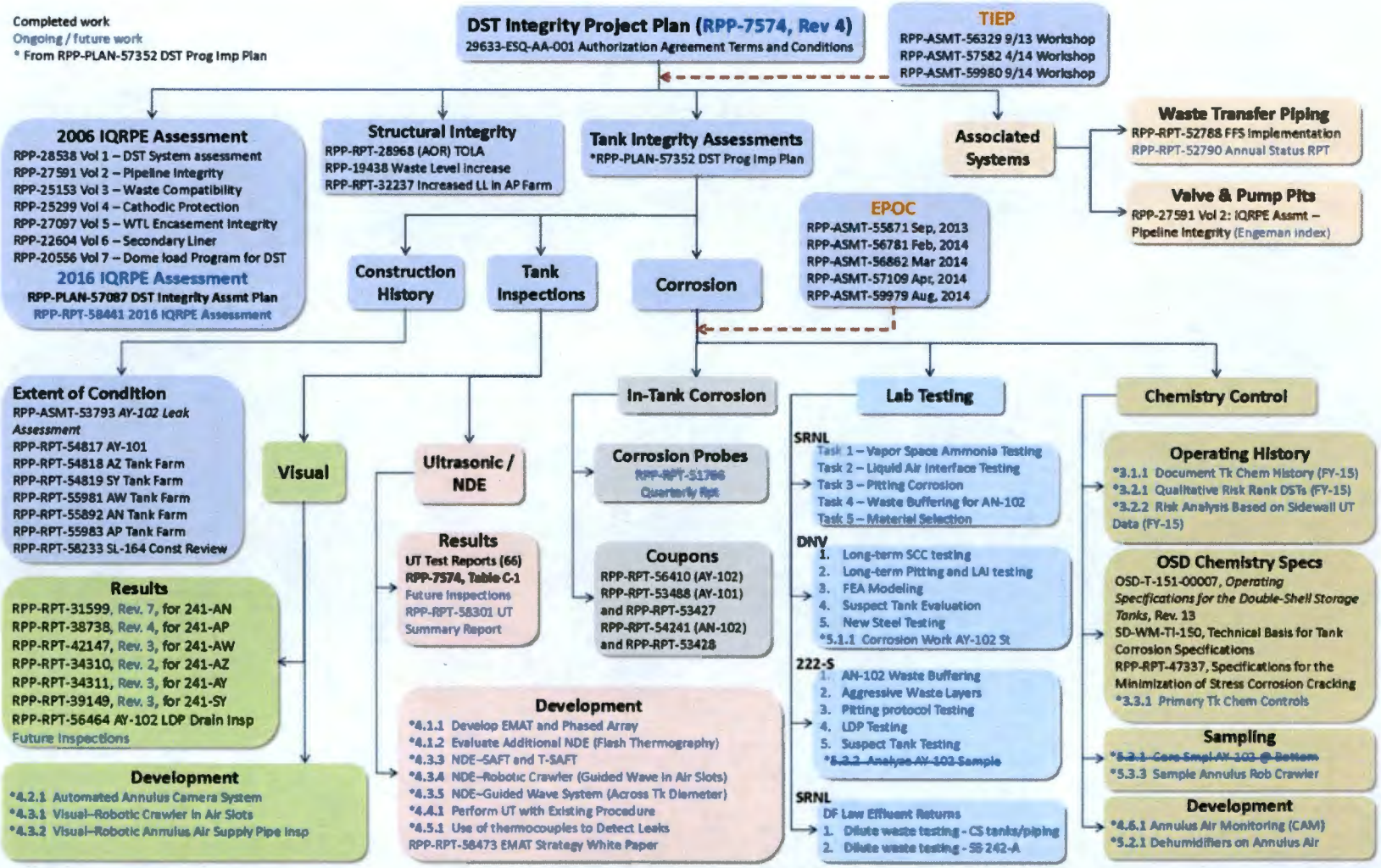
**Table B-7: Compliance Matrix for Corrosion of DST WTS**

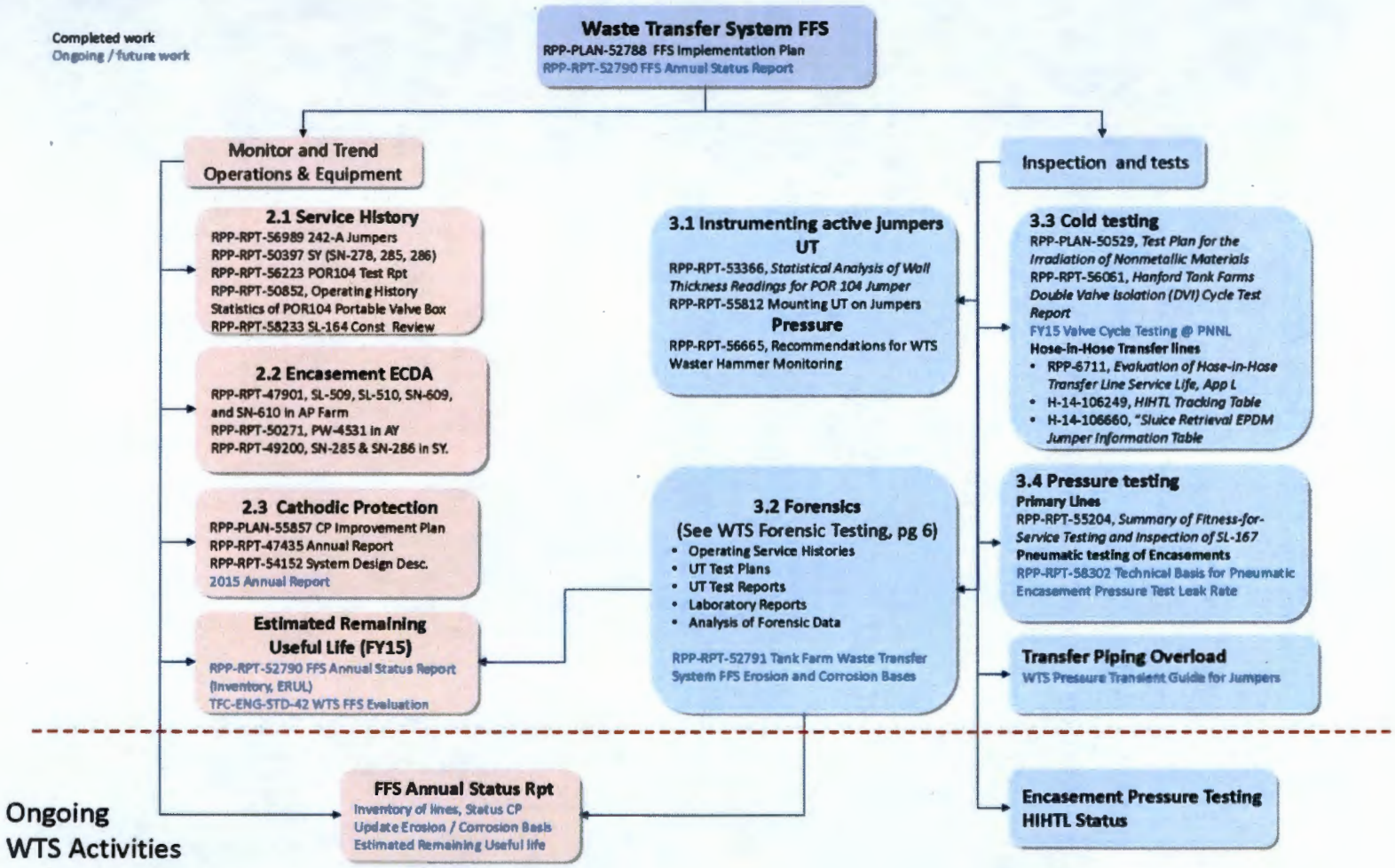
| Scope | 40CFR 265[a], Subpart J | WAC 173-303-640[b] | Assessment Activities | Primary Items Assessed | Conclusions |
|---|---|---|---|---|---|
| Corrosion of DST WTS | (3) Existing corrosion protection measures | (iii) Existing corrosion protection measures | Confirm that adequate corrosion protection measures are in place. | 1. OSD-T-151-00007 (Operating Specifications Document).<br><br>2. RPP-RPT 50440, 2013, 2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | • The DST System has adequate corrosion protection measures in place.<br><br>• The RPP-RPT 50440 recommendations remain valid for corrosion. |
| Corrosion of DST WTS | (5) Results of a leak test, internal inspection, or other tank integrity examination such that:<br><br>(ii) For other than nonenterable underground tanks and for ancillary equipment, this assessment must be either a leak test, as described above, or an internal inspection and/or other tank integrity examination certified by a qualified PE in accordance with 270.11(d) of this chapter that addresses cracks, leaks, corrosion, and erosion. | (v) Results of a leak test, internal inspection, or other tank system integrity examination such that:<br><br>(B) For other than nonenterable underground tanks and for ancillary equipment, this assessment must include either a leak test, as described above, or other integrity examination, that is certified by an IQRPE, in accordance with WAC 173-303-810 (13)(a), that addresses cracks, leaks, corrosion, and erosion. | Determine:<br><br>1. If any DST tank walls are thinner than 90% of the nominal wall thickness.<br><br>2. If any DST tank walls have pits deeper than 25% of the nominal wall thickness.<br><br>3. If any DST walls have linear indications of 6 in. or more and a depth of more than 1/10 of wall thickness. | 1. UT Reports<br>2. In-tank probes and coupons Reports<br>3. Laboratory Testing Reports<br>4. Visual Inspection Reports | • There is no evidence that DST tank walls are not thinner than 90% of the nominal wall thickness.<br><br>• There is no evidence that DST tank walls have pits deeper than 25% of the nominal wall thickness.<br><br>• There is no evidence that DST tank walls have linear indications of 6 in. or more and a depth of more than 1/10 of wall thickness.<br><br>• There is no evidence of significant observable corrosion of DST System. |
| Corrosion of DST WTS | -- | (2) (e) The owner or operator must develop a schedule for conducting integrity assessments over the life of the tank to ensure that the tank retains its structural integrity and will not collapse, rupture, or fail. The schedule must be based on the results of past integrity assessments, age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. | Based upon the reports and attachments, make recommendations regarding future corrosion assessments. | 1. UT Reports<br>2. In-tank probes and coupons Reports<br>3. Laboratory Testing Reports<br>4. Visual Inspection Reports | • UT measurements on a 15 to 20 year schedule appears to be reasonable based on maintaining DST operations within specifications.<br><br>• Visual inspections remain useful and should be continued on a regular basis while maintaining DST operations within specifications.<br><br>• For corrosion, the next overall DSTAR integrity assessment should follow the current 10 year schedule. There is no evidence of significant corrosion, erosion or structural degradation for the DST System. |

[a] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart J, "Tank Systems," *Code of Federal Regulations*, as amended. U.S. Government Printing Office, Washington, D.C.
[b] WAC-173-303-640, "Dangerous Waste Regulations," Section 640, "Tank Systems," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.
[c] WAC 173-303-810, "Dangerous Waste Regulations," Section 810, "General Permit Conditions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

# APPENDIX C
# DOUBLE-SHELL TANK INTEGRITY PROJECT PLAN

# APPENDIX C DOUBLE-SHELL TANK INTEGRITY PROJECT PLAN




Completed work
Ongoing / future work
Waste Transfer System FFS
RPP-PLAN-52788 FFS Implementation Plan
RPP-RPT-52790 FFS Annual Status Report
Monitor and Trend Operations & Equipment
2.1 Service History
RPP-RPT-56989 242-A Jumpers
RPP-RPT-50397 SY (SN-278, 285, 286)
RPP-RPT-56223 POR104 Test Rpt
RPP-RPT-50852, Operating History Statistics of POR104 Portable Valve Box
RPP-RPT-58233 SL-164 Const Review
2.2 Encasement ECDA
RPP-RPT-47901, SL-509, SL-510, SN-609, and SN-610 in AP Farm
RPP-RPT-50271, PW-4531 in AY
RPP-RPT-49200, SN-285 & SN-286 in SY.
2.3 Cathodic Protection
RPP-PLAN-55857 CP Improvement Plan
RPP-RPT-47435 Annual Report
RPP-RPT-54152 System Design Desc.
2015 Annual Report
Estimated Remaining Useful Life (FY15)
RPP-RPT-52790 FFS Annual Status Report (Inventory, ERUL)
TFC-ENG-STD-42 WTS FFS Evaluation
3.1 Instrumenting active jumpers UT
RPP-RPT-53366, Statistical Analysis of Wall Thickness Readings for POR 104 Jumper
RPP-RPT-55812 Mounting UT on Jumpers
Pressure
RPP-RPT-56665, Recommendations for WTS Waster Hammer Monitoring
3.2 Forensics
(See WTS Forensic Testing, pg 6)
• Operating Service Histories
• UT Test Plans
• UT Test Reports
• Laboratory Reports
• Analysis of Forensic Data
RPP-RPT-52791 Tank Farm Waste Transfer System FFS Erosion and Corrosion Bases
Inspection and tests
3.3 Cold testing
RPP-PLAN-50529, Test Plan for the Irradiation of Nonmetallic Materials
RPP-RPT-56061, Hanford Tank Farms Double Valve Isolation (DVI) Cycle Test Report
FY15 Valve Cycle Testing @ PNNL
Hose-in-Hose Transfer lines
• RPP-6711, Evaluation of Hose-in-Hose Transfer Line Service Life, App L
• H-14-106249, HIHTL Tracking Table
• H-14-106660, "Sluice Retrieval EPDM Jumper Information Table
3.4 Pressure testing
Primary Lines
RPP-RPT-55204, Summary of Fitness-for-Service Testing and Inspection of SL-167
Pneumatic testing of Encasements
RPP-RPT-58302 Technical Basis for Pneumatic Encasement Pressure Test Leak Rate
Transfer Piping Overload
WTS Pressure Transient Guide for Jumpers
Encasement Pressure Testing HIHTL Status
Ongoing WTS Activities
FFS Annual Status Rpt
Inventory of lines, Status CP
Update Erosion / Corrosion Basis
Estimated Remaining Useful life

# APPENDIX D
# LIST OF COMPONENTS REVIEWED AS FIT FOR USE

# APPENDIX D LIST OF COMPONENTS REVIEWED AS FIT FOR USE

## LIST OF TABLES

TABLE D-1: LIST OF COMPONENTS REVIEWED AS FIT FOR USE..... D-3

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| 241-AN-01A | Central Pump Pit | AN | H-2-71991 | RPP-39121 | FFU |
| 241-AN-02A | Central Pump Pit | AN | H-2-71992 | RPP-18678 | FFU |
| 241-AN-03A | Central Pump Pit | AN | H-2-71993 | RPP-18679 | FFU |
| 241-AN-04A | Central Pump Pit | AN | H-2-71994 | TFC-WO-11-4676 | FFU |
| 241-AN-05A | Central Pump Pit | AN | H-2-71995 | RPP-12552 | FFU |
| 241-AN-06A | Central Pump Pit | AN | H-2-71996 | TFC-WO-11-1252 | FFU |
| 241-AN-07A | Central Pump Pit | AN | H-2-72039 | RPP-18680 | FFU |
| 241-AN-101 | 1,200,000 Gallon Waste Tank | AN | H-2-71991 | RPP-28538 | FFU |
| 241-AN-102 | 1,200,000 Gallon Waste Tank | AN | H-2-71992 | RPP-28538 | FFU |
| 241-AN-103 | 1,200,000 Gallon Waste Tank | AN | H-2-71993 | RPP-28538 | FFU |
| 241-AN-104 | 1,200,000 Gallon Waste Tank | AN | H-2-71994 | RPP-28538 | FFU |
| 241-AN-105 | 1,200,000 Gallon Waste Tank | AN | H-2-71995 | RPP-28538 | FFU |
| 241-AN-106 | 1,200,000 Gallon Waste Tank | AN | H-2-71996 | RPP-28538 | FFU |
| 241-AN-107 | 1,200,000 Gallon Waste Tank | AN | H-2-72039 | RPP-28538 | FFU |
| 241-AN-A | Valve Pit | AN | H-2-71989 | RPP-34475<br>TFC-WO-10-4562 | FFU |
| 241-AN-B | Valve Pit | AN | H-2-71989 | RPP-16375<br>TFC-WO-10-4563 | FFU |
| DR-368 | Drain Line | AN | H-2-71991 | RPP-27591 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| DR-369 | Drain Line | AN | H-2-71989 | RPP-27591 | FFU |
| SL-161 | Slurry Transfer Line | AN | H-2-71991 | RPP-27591 | FFU |
| SL-166 | Slurry Transfer Line | AN | H-2-71996 | RPP-27591 | FFU |
| SL-168 | Slurry Transfer Line | AN | H-2-72038 | RPP-27591<br>WFO-WO-06-002151 | FFU |
| SN-261 | Supernate Transfer Line | AN | H-2-71991 | RPP-27591 | FFU |
| SN-266 | Supernate Transfer Line | AN | H-2-71996 | RPP-27591 | FFU |
| SN-268 | Supernate Transfer Line | AN | H-2-71989 | RPP-27591 | FFU |
| SN-636 | Supernate Transfer Line | AN/AP | H-14-103271 | RPP-10535<br>RPP-15831<br>RPP-27591 | FFU |
| 241-AP-01A | Central Pump Pit | AP | H-2-90553 | RPP-RPT-26809 | FFU |
| 241-AP-02A | Central Pump Pit | AP | H-2-90554 | RPP-RPT-26808<br>TFC-WO-09-2387 | FFU |
| 241-AP-02D | Valve Pit | AP | H-2-90554 | RPP-RPT-29199<br>WFO-WO-06-000440 | FFU |
| 241-AP-03A | Central Pump Pit | AP | H-2-90555 | RPP-RPT-26810 | FFU |
| 241-AP-03D | Drain Pit | AP | H-2-90555 | RPP-RPT-26866 | FFU |
| 241-AP-04A | Central Pump Pit | AP | H-2-90556 | RPP-RPT-26811 | FFU |
| 241-AP-05A | Central Pump Pit | AP | H-2-90557 | RPP-RPT-27145 | FFU |
| 241-AP-06A | Central Pump Pit | AP | H-2-90558 | RPP-RPT-29426 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| 241-AP-07A | Central Pump Pit | AP | H-2-90559 | RPP-RPT-26807 | FFU |
| 241-AP-08A | Central Pump Pit | AP | H-2-90560 | RPP-RPT-27146 | FFU |
| 241-AP-101 | 1,200,000 Gallon Waste Tank | AP | H-2-90553 | RPP-28538 | FFU |
| 241-AP-102 | 1,200,000 Gallon Waste Tank | AP | H-2-90554 | RPP-28538 | FFU |
| 241-AP-103 | 1,200,000 Gallon Waste Tank | AP | H-2-90555 | RPP-28538 | FFU |
| 241-AP-104 | 1,200,000 Gallon Waste Tank | AP | H-2-90556 | RPP-28538 | FFU |
| 241-AP-105 | 1,200,000 Gallon Waste Tank | AP | H-2-90557 | RPP-28538 | FFU |
| 241-AP-106 | 1,200,000 Gallon Waste Tank | AP | H-2-90558 | RPP-28538 | FFU |
| 241-AP-107 | 1,200,000 Gallon Waste Tank | AP | H-2-90559 | RPP-28538 | FFU |
| 241-AP-108 | 1,200,000 Gallon Waste Tank | AP | H-2-90560 | RPP-28538 | FFU |
| 241-AP-VP | Valve Pit | AP | H-2-90547 | RPP-RPT-29052 | FFU |
| DR-712 | Drain Line | AP | H-2-90555 | RPP-27591 | FFU |
| DR-713 | Drain Line | AP | H-2-90555 | RPP-27591 | FFU |
| DR-716 | Drain Line | AP | H-2-90547 | RPP-27591 | FFU |
| SL-509 | Slurry Transfer Line | AP/ AW | H-2-90544 | RPP-27591 | FFU |
| SL-510 | Slurry Transfer Line | AP/ AW | H-2-90544 | RPP-27591 | FFU |
| SL-511 | Slurry Transfer Line | AP | H-2-90553 | RPP-27591 | FFU |
| SL-512 | Slurry Transfer Line | AP | H-2-90554 | RPP-27591 | FFU |
| SL-513 | Slurry Transfer Line | AP | H-2-90555 | RPP-27591 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| SL-514 | Slurry Transfer Line | AP | H-2-90556 | RPP-27591 | FFU |
| SL-515 | Slurry Transfer Line | AP | H-2-90557 | RPP-27591 | FFU |
| SL-516 | Slurry Transfer Line | AP | H-2-90558 | RPP-27591<br>WO 2E-03-01441 | FFU |
| SL-517 | Slurry Transfer Line | AP | H-2-90559 | RPP-27591 | FFU |
| SL-518 | Slurry Transfer Line | AP | H-2-90560 | RPP-27591 | FFU |
| SN-611 | Supernate Transfer Line | AP | H-2-90553 | RPP-27591 | FFU |
| SN-612 | Supernate Transfer Line | AP | H-2-90554 | RPP-27591 | FFU |
| SN-613 | Supernate Transfer Line | AP | H-2-90555 | RPP-27591 | FFU |
| SN-614 | Supernate Transfer Line | AP | H-2-90556 | RPP-27591 | FFU |
| SN-615 | Supernate Transfer Line | AP | H-2-90557 | RPP-27591 | FFU |
| SN-616 | Supernate Transfer Line | AP | H-2-90558 | RPP-27591<br>WO 2E-03-01441 | FFU |
| SN-617 | Supernate Transfer Line | AP | H-2-90559 | RPP-27591 | FFU |
| SN-618 | Supernate Transfer Line | AP | H-2-90560 | RPP-27591 | FFU |
| SN-622 | Supernate Transfer Line | AP | H-2-90554 | RPP-10535<br>RPP-27591 | FFU |
| SN-634 | Supernate Transfer Line | AP/AZ | H-14-103270 | RPP-10535<br>RPP-27591 | FFU |
| 241-AW-01A | Central Pump Pit | AW | H-2-70403 | RPP-RPT-25855 | FFU |
| 241-AW-02A | Central Pump Pit | AW | H-2-70404 | RPP-RPT-40011 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| | | | | TFC-WO-08-1012 | |
| 241-AW-02D | Drain Pit | AW | H-2-70404 | RPP-RPT-25162 | FFU |
| 241-AW-02E | Pump Pit | AW | H-2-70404 | RPP-27147<br>TFC-WO-10-760 | FFU |
| 241-AW-03A | Central Pump Pit | AW | H-2-70405 | RPP-19430 | FFU |
| 241-AW-05A | Central Pump Pit | AW | H-2-70407 | RPP-19431 | FFU |
| 241-AW-06A | Central Pump Pit | AW | H-2-70408 | RPP-RPT-25979 | FFU |
| 241-AW-101 | 1,200,000 Gallon Waste Tank | AW | H-2-70403 | RPP-28538 | FFU |
| 241-AW-102 | 1,200,000 Gallon Waste Tank | AW | H-2-70404 | RPP-28538 | FFU |
| 241-AW-103 | 1,200,000 Gallon Waste Tank | AW | H-2-70405 | RPP-28538 | FFU |
| 241-AW-104 | 1,200,000 Gallon Waste Tank | AW | H-2-70406 | RPP-28538 | FFU |
| 241-AW-105 | 1,200,000 Gallon Waste Tank | AW | H-2-70407 | RPP-28538 | FFU |
| 241-AW-106 | 1,200,000 Gallon Waste Tank | AW | H-2-70408 | RPP-28538 | FFU |
| 241-AW-A | Valve Pit | AW | H-2-70401 | RPP-13624 | FFU |
| 241-AW-B | Valve Pit | AW | H-2-70401 | RPP-11060 | FFU |
| DR-334 | Drain Line | AW | H-2-70404 | RPP-27591 | FFU |
| DR-335 | Drain Line | AW | H-2-70404 | RPP-27591 | FFU |
| DR-338 | Drain Line | AW | H-2-69354 | RPP-27591 | FFU |
| DR-339 | Drain Line | AW | H-2-69183 | RPP-27591 | FFU |
| DR-343 | Drain Line | AW | H-2-70404 | RPP-27591 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| DR-361 | Drain Line | AW | H-2-70401 | RPP-27591 | FFU |
| DR-369 | Drain Line | AW | H-2-70401 | RPP-27591 | FFU |
| SL-162 | Slurry Transfer Line | AW | H-2-70404 | RPP-27591<br>WFO-WO-06-001482 | FFU |
| SL-166 | Slurry Transfer Line | AW | H-2-70406 | RPP-27591 | FFU |
| SL-167 | Slurry Transfer Line | AW | H-2-70398 | RPP-27591 | FFU |
| SL-169 | Slurry Transfer Line | AW | H-2-70401 | RPP-27591 | FFU |
| SN-261 | Supernate Transfer Line | AW | H-2-70403 | WFO-WO-06-000766 | FFU |
| SN-264 | Supernate Transfer Line | AW | H-14-107346 | RPP-58049<br>TFC-WO-14-1905 | FFU |
| SN-265 | Supernate Transfer Line | AW | H-2-70401<br>H-2-70404 | RPP-RPT-56412 | FFU |
| SN-266 | Supernate Transfer Line | AW | H-2-70406 | RPP-27591 | FFU |
| SN-267 | Supernate Transfer Line | AW | H-14-107346 | WFO-WO-05-000867 | FFU |
| SN-268 | Supernate Transfer Line | AW | H-2-70404 | RPP-27591<br>WFO-WO-06-001482 | FFU |
| SN-269 | Supernate Transfer Line | AW | H-2-70404 | RPP-27591 | FFU |
| SN-270 | Supernate Transfer Line | AW | H-2-70404 | RPP-27591 | FFU |
| SN-271 | Supernate Transfer Line | AW | H-2-70401 | RPP-27591 | FFU |
| SN-272 | Supernate Transfer Line | AW | H-2-70404 | RPP-27591 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| SN-274 | Supernate Transfer Line | AW | H-2-70406 | RPP-58049<br>TFC-WO-14-1905 | FFU |
| SN-609 | Supernate Transfer Line | AW | H-2-70404 | RPP-27591 | FFU |
| SN-610 | Supernate Transfer Line | AW | H-2-70399 | RPP-27591 | FFU |
| 241-AY-01A | Central Pump Pit | AY | H-2-64405 | RPP-11217 | FFU |
| 241-AY-101 | 1,000,000 Gallon Waste Tank | AY | H-2-64405 | RPP-28538 | FFU |
| SN-633 | Supernate Transfer Line | AY | H-14-102620 | RPP-11217<br>RPP-27591 | FFU |
| SN-635 | Supernate Transfer Line | AY | H-14-102620 | RPP-11217<br>RPP-27591 | FFU |
| 241-AZ-01A | Central Pump Pit | AZ | H-2-68353 | RPP-11218<br>TFC-WO-07-1730 | FFU |
| 241-AZ-02A | Central Pump Pit | AZ | H-2-68413 | RPP-11218<br>TFC-WO-4297 | FFU |
| 241-AZ-101 | 1,000,000 Gallon Waste Tank | AZ | H-2-68413 | RPP-28538 | FFU |
| 241-AZ-102 | 1,000,000 Gallon Waste Tank | AZ | H-2-68353 | RPP-28538 | FFU |
| 241-AZ-VP | Valve Pit | AZ | H-14-103263 | RPP-16278 | FFU |
| DR-100 | Drain Line | AZ | H-14-103263 | RPP-11218<br>RPP-27591 | FFU |
| SN-630 | Supernate Transfer Line | AZ/ AN | H-14-101110 | RPP-15831<br>RPP-27591 | FFU |
| SN-631 | Supernate Transfer Line | AZ | H-2-68413 | RPP-11218 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| | | | | RPP-27591 | |
| SN-632 | Supernate Transfer Line | AZ | H-2-68413 | RPP-11218<br>RPP-27591 | FFU |
| 241-SY-02A | Central Pump Pit | SY | H-2-37802 | RPP-RPT-25980 | FFU |
| 241-SY-02D | Drain Pit | SY | H-2-37802 | RPP-RPT-25978 | FFU |
| 241-SY-03A | Central Pump Pit | SY | H-2-37803`` | RPP-RPT-25853 | FFU |
| 241-SY-101 | 1,200,000 Gallon Waste Tank | SY | H-2-37801 | RPP-28538 | FFU |
| 241-SY-102 | 1,200,000 Gallon Waste Tank | SY | H-2-37802 | RPP-28538 | FFU |
| 241-SY-103 | 1,200,000 Gallon Waste Tank | SY | H-2-37803 | RPP-28538 | FFU |
| 241-SY-A | Valve Pit | SY | H-2-37780 | RPP-RPT-25163 | FFU |
| 241-SY-B | Valve Pit | SY | H-2-37780 | RPP-RPT-29962 | FFU |
| DR-376 | Drain Line | SY | H-2-37778 | RPP-27591 | FFU |
| DR-379 | Drain Line | SY | H-2-37778 | RPP-27591 | FFU |
| SL-177 | Slurry Transfer Line | SY | H-2-37802 | RPP-RPT-50752 | FFU |
| SL-180 | Slurry Transfer Line | SY | H-2-37778 | RPP-RPT-50752 | FFU |
| SN-277 | Supernate Transfer Line | SY | H-2-37802 | RPP-RPT-50752 | FFU |
| SN-278 | Supernate Transfer Line | SY | H-2-37801 | RPP-RPT-50752 | FFU |
| SN-279 | Supernate Transfer Line | SY | H-2-37803 | RPP-RPT-50752 | FFU |
| SN-280 | Supernate Transfer Line | SY | H-2-37778 | RPP-RPT-50752 | FFU |
| SN-285 | Supernate Transfer Line | SY | H-2-37802 | RPP-RPT-50752 | FFU |

**Table D-1: List of Components Reviewed as Fit For Use (9 sheets)**

| Component ID | Description | Farm | Drawing | Assessment Reference | Comments |
|---|---|---|---|---|---|
| SN-286 | Supernate Transfer Line | SY | H-2-37802 | RPP-RPT-50752 | FFU |
| SNL-3150 | Supernate Transfer Line 6241-V to AN-101 | SY | H-2-822210 | RPP-16278<br>RPP-27591 | FFU |
| SNL-3150 | Supernate Transfer Line 6241-V to 6241-A | SY | H-2-822210 | RPP-16278<br>RPP-27591 | FFU |
| SNL-3150 | Supernate Transfer Line 6241-A to SY-A | SY | H-2-822210 | RPP-16278<br>RPP-27591 | FFU |
| SNL-5350 | Supernate Transfer Line | SY | H-14-105612 | RPP-20512<br>RPP-27591<br>HNF-4737 | FFU |
| SNL-5351 | Supernate Transfer Line | SY | H-14-105612 | RPP-20512<br>RPP-27591<br>HNF-4737 | FFU |

Note: Appendix D does not list other ancillary equipment such as cathodic protection, leak detection, etc. associated with the tanks, pipelines, and pits listed above.

# APPENDIX E
# TANK WASTE CHARACTERIZATION DATA

# APPENDIX E TANK WASTE CHARACTERIZATION DATA

## LIST OF TABLES

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Table E-2: BBI Estimated Saltcake Interstitial Liquid Waste Chemistry Applicable to Corrosion per OSD-T-151-00007 ..... E-4

Table E-3: BBI Estimated Sludge Interstitial Liquid Waste Chemistry Applicable to Corrosion per OSD-T-151-00007 ..... E-4

**Table E-1: BBI Estimated Supernate Waste Chemistry Applicable to Corrosion per OSD-T-151-00007**

| Tank Name | Average Temperature from Appendix R (°F) | Supernate Free (OH-) (M) | | Supernate (NO2-) (M) | | Supernate (NO3-) (M) | |
|---|---|---|---|---|---|---|---|
| | | Tank Estimate | Requirement | Tank Estimate | Requirement | Tank Estimate | Requirement |
| 241-AN-101 | 115 | 1.628 | 0.010M < (OH-) < 8.0M | 0.565 | 0.011M < (NO2-) < 5.5M | 0.705 | (NO3-) / [(OH-) + (NO2-)] < 2.5 |
| 241-AN-102 | 85 | 0.617 | 0.3M < (OH-) < 10M | 2.017 | (OH-) + (NO2-) > 1.2M | 3.283 | (NO3-) < 5.5M |
| 241-AN-103 | 100 | 3.956 | 0.1(NO3-) < (OH-) < 10M | 2.825 | (OH-) + (NO3-) > 0.4(NO3-) | 2.133 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AN-104 | 95 | 3.839 | 0.3M < (OH-) < 10M | 2.586 | (OH-) + (NO2-) > 1.2M | 3.149 | (NO3-) < 5.5M |
| 241-AN-105 | 95 | 3.516 | 0.1(NO3-) < (OH-) < 10M | 2.586 | (OH-) + (NO3-) > 0.4(NO3-) | 2.600 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AN-106 | 75 | 1.393 | 0.010M < (OH-) < 8.0M | 0.324 | 0.011M < (NO2-) < 5.5M | 0.393 | (NO3-) / [(OH-) + (NO2-)] < 2.5 |
| 241-AN-107 | 90 | 0.752 | 0.3M < (OH-) < 10M | 1.287 | (OH-) + (NO2-) > 1.2M | 3.333 | (NO3-) < 5.5M |
| 241-AP-101 | 75 | 1.299 | 0.3M < (OH-) < 10M | 1.717 | (OH-) + (NO2-) > 1.2M | 3.933 | (NO3-) < 5.5M |
| 241-AP-102 | 70 | 2.005 | 0.1(NO3-) < (OH-) < 10M | 2.054 | (OH-) + (NO3-) > 0.4(NO3-) | 2.850 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AP-103 | 70 | 1.111 | 0.3M < (OH-) < 10M | 1.860 | (OH-) + (NO2-) > 1.2M | 3.033 | (NO3-) < 5.5M |
| 241-AP-104 | 70 | 0.676 | 0.1(NO3-) < (OH-) < 10M | 0.635 | (OH-) + (NO3-) > 0.4(NO3-) | 1.211 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AP-105 | 75 | 1.734 | 0.3M < (OH-) < 10M | 1.982 | (OH-) + (NO2-) > 1.2M | 3.049 | (NO3-) < 5.5M |
| 241-AP-106 | 75 | 0.372 | 0.1(NO3-) < (OH-) < 10M | 1.019 | (OH-) + (NO3-) > 0.4(NO3-) | 1.296 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AP-107 | 75 | 1.282 | 0.3M < (OH-) < 10M | 1.732 | (OH-) + (NO2-) > 1.2M | 3.849 | (NO3-) < 5.5M |
| 241-AP-108 | 75 | 2.246 | 0.3M < (OH-) < 10M | 1.891 | (OH-) + (NO2-) > 1.2M | 3.249 | (NO3-) < 5.5M |
| 241-AW-101 | 95 | 5.850 | 0.1(NO3-) < (OH-) < 10M | 2.282 | (OH-) + (NO3-) > 0.4(NO3-) | 2.850 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AW-102 | 70 | 0.664 | 0.1(NO3-) < (OH-) < 10M | 0.939 | (OH-) + (NO3-) > 0.4(NO3-) | 1.558 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AW-103 | 100 | 0.782 | 0.1(NO3-) < (OH-) < 10M | 0.741 | (OH-) + (NO3-) > 0.4(NO3-) | 1.636 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AW-104 | 80 | 1.534 | 0.1(NO3-) < (OH-) < 10M | 1.667 | (OH-) + (NO3-) > 0.4(NO3-) | 1.933 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AW-105 | 65 | 0.308 | 0.010M < (OH- )< 8.0M | 0.072 | 0.011M < (NO2-) < 5.5M | 0.495 | (NO3-) / [(OH-) + (NO2-)] < 2.5 |
| 241-AW-106 | 90 | 0.954 | 0.1(NO3-) < (OH-) < 10M | 1.042 | (OH-) + (NO3-) > 0.4(NO3-) | 2.836 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AY-101 | 112 | 0.258 | 0.010M < (OH- )< 8.0M | 0.196 | 0.011M < (NO2-) < 5.5M | 0.553 | (NO3-) / [(OH-) + (NO2-)] < 2.5 |
| 241-AY-102 | 130 | 2.998 | 0.1(NO3-) < (OH-) < 10M | 1.193 | (OH-) + (NO3-) > 0.4(NO3-) | 2.483 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AZ-101 | 155 | 0.617 | 0.1(NO3-) < (OH-) < 10M | 1.919 | (OH-) + (NO3-) > 0.4(NO3-) | 1.060 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AZ-102 | 140 | 1.035 | 0.1(NO3-) < (OH-) < 10M | 1.713 | (OH-) + (NO3-) > 0.4(NO3-) | 2.783 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-SY-101 | 70 | 0.647 | 0.010M < (OH-) < 8.0M | 0.201 | 0.011M < (NO2-) < 5.5M | 0.953 | (NO3-) / [(OH-) + (NO2-)] < 2.5 |
| 241-SY-102 | 70 | 0.882 | 0.1(NO3-) < (OH-) < 10M | 0.250 | (OH-) + (NO3-) > 0.4(NO3-) | 1.133 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-SY-103 | 90 | 2.199 | 0.1(NO3-) < (OH-) < 10M | 3.304 | (OH-) + (NO3-) > 0.4(NO3-) | 2.800 | (OH-) + (NO3-) > 0.4(NO3-) |

Reference: OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks*, Washington River Protection Solutions, LLC, Richland, Washington.

**Table E-2: BBI Estimated Saltcake Interstitial Liquid Waste Chemistry Applicable to Corrosion per OSD-T-151-00007**

| Tank Name | Average Temperature from Appendix R (°F) | Saltcake Interstitial Liquid Free (OH-) (M) | | Saltcake Interstitial Liquid (NO2-) (M) | | Saltcake Interstitial Liquid (NO3-) (M) | |
|---|---|---|---|---|---|---|---|
| | | Tank Estimate | Requirement | Tank Estimate | Requirement | Tank Estimate | Requirement |
| 241-AN-101 | 115 | 2.834 | 0.3M < (OH-) < 10M | 2.655 | (OH-) + (NO2-) > 1.2M | 3.166 | (NO3-) < 5.5M |
| 241-AW-103 | 100 | 1.599 | 0.3M < (OH-) < 10M | 2.019 | (OH-) + (NO2-) > 1.2M | 4.116 | (NO3-) < 5.5M |
| 241-AW-104 | 80 | 2.887 | 0.1(NO3-) < (OH-) < 10M | 2.110 | (OH-) + (NO3-) > 0.4(NO3-) | 2.316 | (OH-) + (NO3-) > 0.4(NO3-) |

Reference: OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks*, Washington River Protection Solutions, LLC, Richland, Washington.

**Table E-3: BBI Estimated Sludge Interstitial Liquid Waste Chemistry Applicable to Corrosion per OSD-T-151-00007**

| Tank Name | Average Temperature from Appendix R (°F) | Sludge Interstitial Liquid Free (OH-) (M) | | Sludge Interstitial Liquid (NO2-) (M) | | Sludge Interstitial Liquid (NO3-) (M) | |
|---|---|---|---|---|---|---|---|
| | | Tank Estimate | Requirement | Tank Estimate | Requirement | Tank Estimate | Requirement |
| 241-AN-101 | 115 | 1.425 | 0.1(NO3-) < (OH-) < 10M | 2.454 | (OH-) + (NO3-) > 0.4(NO3-) | 2.720 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AW-104 | 80 | 1.199 | 0.1(NO3-) < (OH-) < 10M | 0.954 | (OH-) + (NO3-) > 0.4(NO3-) | 1.176 | (OH-) + (NO3-) > 0.4(NO3-) |
| 241-AY-101 | 112 | 0.022 | pH ≥ 10 | 0.856 | (NO2-) / (NO3-) ≥ 0.32 | 0.063 | (NO2-) / (NO3-) ≥ 0.32 |
| 241-AY-102 | 130 | 0.032 | 0.010M < (OH-) < 8.0M | 0.158 | 0.011M < (NO2-) < 5.5M | 0.006 | (NO3-) / [(OH-) + (NO2-)] < 2.5 |
| 241-SY-102 | 70 | 1.214 | 0.1(NO3-) < (OH-) < 10M | 1.219 | (OH-) + (NO3-) > 0.4(NO3-) | 2.117 | (OH-) + (NO3-) > 0.4(NO3-) |

Reference: OSD-T-151-00007, *Operating Specifications for the Double-Shell Storage Tanks*, Washington River Protection Solutions, LLC, Richland, Washington.

# APPENDIX F
# DOUBLE-SHELL TANK CONTENTS

# APPENDIX F DOUBLE-SHELL TANK CONTENTS

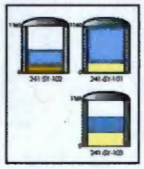
## Double-Shell Tank Waste Contents

**AZ-Tank Farm**

| Tank | Sludge | Saltcake | Supernatant |
|---|---|---|---|
| 241-AZ-101 | 62 | 0 | 737 |
| 241-AZ-102 | 105 | 0 | 79 |

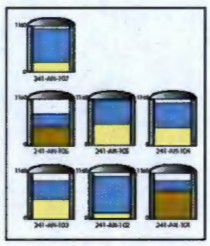
**SY-Tank Farm**

| Tank | Sludge | Saltcake | Supernatant |
|---|---|---|---|
| 241-SY-101 | 0 | 255 | 885 |
| 241-SY-102 | 188 | 0 | 355 |
| 241-SY-103 | 0 | 357 | 377 |



**AN-Tank Farm**

| Tank | Sludge | Saltcake | Supernatant |
|---|---|---|---|
| 241-AN-101 | 701 | 31 | 224 |
| 241-AN-102 | 0 | 154 | 806 |
| 241-AN-103 | 0 | 491 | 470 |
| 241-AN-104 | 0 | 445 | 804 |
| 241-AN-105 | 0 | 539 | 585 |
| 241-AN-106 | 448 | 17 | 321 |
| 241-AN-107 | 0 | 241 | 832 |

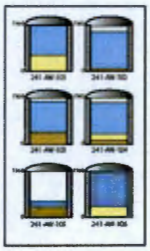


**AP-Tank Farm**

| Tank | Sludge | Saltcake | Supernatant |
|---|---|---|---|
| 241-AP-101 | 0 | 33 | 1199 |
| 241-AP-102 | 28 | 0 | 1109 |
| 241-AP-103 | 0 | 17 | 988 |
| 241-AP-104 | 0 | 100 | 268 |
| 241-AP-105 | 0 | 105 | 1139 |
| 241-AP-106 | 0 | 0 | 1129 |
| 241-AP-107 | 0 | 11 | 1078 |
| 241-AP-108 | 0 | 112 | 1127 |

**AW-Tank Farm**

| Tank | Sludge | Saltcake | Supernatant |
|---|---|---|---|
| 241-AW-101 | 0 | 398 | 739 |
| 241-AW-102 | 52 | 0 | 823 |
| 241-AW-103 | 280 | 40 | 759 |
| 241-AW-104 | 97 | 157 | 799 |
| 241-AW-105 | 248 | 0 | 152 |
| 241-AW-106 | 0 | 264 | 867 |



**AY-Tank Farm**

| Tank | Sludge | Saltcake | Supernatant |
|---|---|---|---|
| 241-AY-101 | 105 | 0 | 801 |
| 241-AY-102 | 151 | 0 | 814 |

Note: AY-102 is not in DSTAR scope.

9/6

LEGEND Sludge Saltcake Supernatant Available Space Assumed/Confirmed Leaker

Data Derived From Waste Tank Summary Report Dated 6/30/2013

HNF-EP-0182, Rev. 330

Reference: HNF-EP-0182, *Waste Tank Summary Report*, Rev. 330.

# APPENDIX G
# FINDINGS, OBSERVATIONS, AND RECOMMENDATIONS

# APPENDIX G FINDINGS, RECOMMENDATIONS, AND OBSERVATIONS

## CONTENTS

G.1 Findings ..... G-3

G.2 Observations ..... G-4

G.3 Recommendations ..... G-8

## G.1 FINDINGS

Findings are covered in Section 3.3.1 of the body of this report. To avoid any discrepancies, the Findings are not duplicated here.

## G.2 OBSERVATIONS

This is a compilation of the observations from each of the sections of the report. For additional information, please refer to the respective section.

General:

- At times it has been very difficult to find references and documents for this IQRPE report. WRPS staff have been very helpful, but even with those resources it has sometimes been hard to get information. For example, the list of IQRPE assessments done on the DST System listed in Table 3-1 took several weeks to compile. A method to facilitate future DSTARs with relevant references and documents would be very helpful.

From Section 4.0, DST Structural Adequacy:

- Evaluations performed for the 2006 DSTAR meet the current design requirement for the structural adequacy of the DST System.
- No new structural analyses of the DSTs are required for this 2016 DSTAR.
- The review of Extent of Condition reports of the tank farms indicate that, in general the construction of the remaining fit for use DSTs was better than that of tank AY-102. The weld rejection rates on the primary and secondary tank bases are a concern. These welds were all deemed acceptable at the time of construction.
- The refractories were deemed compatible with the waste in the DSTs at the time of construction.
- The secondary lower haunch is the only portion of the secondary tank that needs to be considered in the structural adequacy of the tanks, once the exterior concrete shell was poured.
- All tanks were accepted as meeting the stress relief of the primary tanks prior to completion of the DSTs.
- The anchorage of the primary dome to the concrete dome meets the current 2006 anchorage requirements for cracked concrete sections.
- The primary and secondary tanks are structurally adequate.
- The pits are structurally adequate.
- Continue existing Dome Loading Monitoring Program.
- The procedures for structural assessments after a seismic event are outlined in TF ERP 008 and TFC ENG DESIGN C-30.

From Section 5.0, DST Waste Transfer System Integrity:

- Operation of the DST Waste Transfer System limits the pressure and velocity in the piping system to well within the limits of the piping materials. All piping examined to date has shown no corrosion or erosion that is above expected values.
- Although there have been failures in the piping system and components in the DST Waste Transfer System, the failed components were found during testing processes prior

to the transfer of waste and replaced or repaired. The system and process in place are ensuring the safe operation of the Waste Transfer System.

- Several instances of duplicate pipe numbers exist within the DST WTS. As an example, there is a line numbered SL-167 in the AN Tank Farm and another line numbered SL-167 in the AW Tank Farm. These are completely separate lines and are in no way related to each other. The line in the AN Tank Farm is listed as not approved for use while the AW Tank Farm line is fit for service. The line numbers are unique if the entire line number is used. However, it is the practice to use shortened line numbers. To avoid confusion when using shortened line numbers, a reference to the tank farm where the line is located should be used along with the line number.

From Section 6.0, Cathodic Protection for DST Transfer Lines:

- Cathodic protection system testing is in accordance with regulatory and industry standards.
- The addition of coupons and electrical resistance probes will provide additional important corrosion related information for the tank farms piping.
- Certifying individuals to NACE CP-1 and CP-2 will provide for a more knowledgeable team that will be able to more readily recognize and respond to noted areas of concern.
- The cathodic protection equipment installed to protect the regulated piping meets industry standards for fit for use requirements. It is understood that not all locations met criteria for corrosion control; however, system adjustments are made after testing is completed to address these locations.
- Monitoring protocol and system operations are performed in accordance with industry standards and comply with NACE requirements.
- Discussions with Hanford Site personnel indicate that evaluation of long-range guided wave inspection methodology continues to be evaluated as a means to determine locations of defects on the pipe and/or casing walls. It is understood that at this time pipe diameters, elbows, and the number of required access points do not allow for a reasonable use of this inspection tool. However, the rate at which this inspection methodology is advancing suggests that it will become a viable manner to evaluate the existing condition of the pipe/casing.

From Section 7.0, Pit Secondary Liners/Coatings for DST System:

- Pit coating inspection intervals based upon the type of secondary containment protection (epoxy, polyurea, and stainless steel) are reasonable and prudent.
- Conducting a visual inspection using photographs is reasonable considering the potentially hazardous conditions. However, the inspector must continue to be given the authority to require additional photographs of suspect areas as required.
- The protective coatings and liners were determined to be compatible with the waste being transferred and will provide protection to the concrete in the event of a leak or spill.

- Table 7-1 lists multiple pits that have not had their coatings inspected within their recommended cycle. So long as these pits continue to not be used, inspection of the pit coatings is not warranted. However, prior to their use, the pits must have their coatings evaluated as outlined in the inspection documents.

From Section 8.0, Leak Detection Systems:

- Each DST has a level detector and three annulus leak detectors meeting the requirements of the WAC 173 303 610(2)(a). The logs show any issue with a level/leak detector and any out of limit reading as well as an instrument malfunction. The repair history of any individual instrument maintained in the CHAMPS and EAM. Performance issues of the leak detection system are addressed in the Corrective Action database, and compliance with regulatory requirements are identified in the Environmental Notification database.

From Section 9.0, Waste Characterization for DSTs:

- The Tank Farm Waste Transfer Compatibility Program (HNF-SD-WM-OCD-015) is comprehensive and being properly implemented.
- Waste compatibility assessments prior to transfers and chemical additions are being properly completed. Future waste additions will likely be of similar properties and present no concerns assuming continued management per HNF-SD-WM-OCD-015.
- Physical and chemical properties have been kept almost entirely within specification with the possible exception of solids pockets in tank AZ-102.
- The knowledge of waste constituents is sufficient for compatibility purposes. Additions to and transfers between DSTs, adjustments to volume due to sampling, and chemical additions have been documented in the Tank Waste Information Network System database.
- Tanks that have been known to have or that have the waste chemistry and rheological properties that make buoyant-displacement gas release events possible are continuously monitored to ensure flammable gas concentrations remain below 25% of the lower flammability limit.
- Criticality is prevented by form and distribution. OSD-T-151-0007, the Waste Compatibility Program HNF-SD-WM-OCD-015, Interface Control Document for [WTP] Waste Feed ICD-19, and TSR Administrative Control Key Element 5.9.5, Nuclear Criticality Safety, HNF-SD-WM-TSR-006, all protect the nuclear criticality safety assumptions. Controls that are in place are sufficient.

From Section 10.0, Waste Compatibility with DST System Materials of Construction:

- The conclusions of the 2006 DSTAR regarding the tank system's adequate design, material selection, and operation are still valid. Operation of the DSTs has continued to be within their design limits; therefore, the corrosion allowances and imposed stresses are within the design values and the DST design lifetimes should be attained or even exceeded.

- No new corrosion mechanisms have been identified since the 2006 DSTAR, and no previously-identified mechanisms present any additional concerns than at that time.
- The waste contents are not believed to have had any contributory effect on the leak in tank AY-102.

From Section 11.0, Corrosion Assessment and Status:

- An obvious question is what was extent of corrosion on the primary bottom base due to water/steam from the 'refractory' during heat up? High temperature alkaline solutions can be very corrosive toward carbon steel. Whether the time involved would allow for serious attack is unknown as is the corrosion rate under those conditions.
- There are no data on how much of the ultrasonic testing detected pitting occurred before or during construction and little data for that occurring during hydrotest operations.
- For those tanks with probes or coupons data to date show corrosion rates are less than 0.14 mil/yr and often less.
- None of the nitrite/nitrate ratios listed in Table 9-1 suggest there is a major pitting problem in the vapor phase.

## G.3 RECOMMENDATIONS

Recommendations are covered in Section 3.3.2 of the body of this report. To avoid any discrepancies, the Recommendations are not duplicated here.

# APPENDIX H
# DISPOSITION SUMMARIES OF 2006 DSTAR RECOMMENDATIONS

## APPENDIX H DISPOSITION SUMMARIES OF 2006 DSTAR RECOMMENDATIONS

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| R1 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | Basis for recommendations was concern over shallowness of some pipe burials.<br>It is recommended that the potentially shallow burial depths of some transfer lines mentioned in this document (RPP-18652, Rev. 1) be reviewed and inspected to ensure compliance with applicable safety requirements, but it is not within the scope of this analysis to determine the adequacy of the present soil cover to comply with current shielding requirements. PER-2004-1039 has been written to address the above recommendation. | Completed | Shallow burial pipelines are subject to damage from overhead traffic, and from frost heave, and may create a radiation hazard due to lack of sufficient soil cover.<br>RPP-21726, Rev. 0, *Vehicle and Equipment Access over Buried Utilities in and Around Tank Farms*, addresses the concerns identified by PER-2004-1039. The PER was written to highlight concerns for waste transfer lines having soil cover less than 3-ft – 0-in. or even as shallow as 2-ft – 0 in. The results developed in the analysis show that vehicular and equipment loads are acceptable for buried utility lines, including transfer encasement lines, as shown in Table 6 and Table 7, with shallow soil cover as low as 19-in. RPP-18652, Rev. 1, *Buried Pipe Analysis for DST System Integrity Assessment*, indicates that the transfer lines have a minimum of 24-inches of soil cover.<br>RPP-13033 Rev. 4-H, *Tank Farm Documented Safety Analysis*, Section 2, "Facility Description," is intended to provide descriptions of the facility and processes to support assumptions used in the hazard and accident analysis. Information in Chapter 2 is not intended to establish requirements. For buried pipeline depth, the DSA states in Section 2.4.2.1, "Transfer Lines": "Waste transfer lines are buried or bermed primarily to provide shielding that generally requires approximately 3-ft of soil but may vary depending on the specific piping system."<br>Per procedure TFC-ESHQ-RP-ADM-P-01, *Radiological Monitoring During Waste Transfers and Waste Pump Maintenance Activities*, projects must develop a comprehensive radiological monitoring plan for each specific waste transfer prior to initiating the transfer. Procedure requirements include determining worst-case and anticipated radiation levels during the transfer, applying access controls, and establishing survey frequencies.<br>Potential damage from frost heave is addressed in Recommendation R2 below. |
| R2 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | In addition, due to the shallowness of some of the transfer lines mentioned in this document (RPP-18652, Rev. 1), it is recommended that an analysis or evaluation of frost heave and its effects is in order to determine the corrective action needed. Inspections and/or testing of identified pipes might also be in order, if it is determined that frost heave is a concern and that its damaging effects could have occurred in the past. | Completed | RPP-RPT-39400, Rev. 0, *Evaluation of Frost Heave on Waste Transfer Lines with Shallow Depths in DST Farms*, May 12, 2009, concluded that the waste transfer lines with one foot of soil cover are not expected to undergo frost heave damaging effects because of the well-compacted sandy material around waste transfer lines, the type of sand and gravel soil, the relatively low precipitation at the Hanford Site, and the level of insulation applied to the pipelines.<br>No documented instance of frost heave damage to buried waste pipelines was found in the Tank Integrity occurrence report database, which covers the period beginning in 1972 with the implementation of the Occurrence Reporting system at Hanford. |
| R3 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | PER No. 2004-5678, which was written against this document (RPP-18652, Rev. 1), indicated that the soil cover for SN-631 of Tank Farm AZ should be much greater as indicated by drawing H-I4-102671 Sht. 1. The increase in soil cover was credited to a berm. Upon further investigation, the height of the berm was still not conclusive. Berms on other transfer lines, in other tank farms, called out on numerous related drawings are simply stated as "as required." This is not definite enough to be included in this | Completed | PER-2004-5678 was generated as a result of information pertaining to the discrepant minimal burial depth requirements and numerically documented pipe elevations and grade elevations for pipe SN-631 in the 241-AZ Tank Farm. The PER evaluation notes, "... Drawing H-14-102671 Sht. 1 does indeed show a berm over SN-631. Drawing H-14-102671 Sht. 4 shows a detail that has a minimum depth from top of berm to top of pipe to be 3-ft – 0-in. Drawing H-14-102671 Sht.1 also indicates that there are breaks in the berm where shield blocks have been placed in-lieu of placing the berm. The areas where the shield blocks are placed would appear to have burial depths consistent with the original evaluation of SN-631 since the top of the block is at grade. Within Drawing H-14-102671 Sheets 1 and 4, a definite numerical value for the top of berm elevation or grade elevation is not provided..."<br>PER-2004-5678 indicates that drawing H-14-102671, sheet 1, shows a berm over SN-631 and suggests that the issue of discrepant burial depths is explained within the drawing. |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| | | evaluation. Thus, as previously recommended, inspections on suspected shallow transfer lines are in order. This should provide a more accurate assessment of the soil cover above the suspect transfer line. | | Although drawing H-14-102671, sheets 1 and 4, provide traceable documentation that there is a berm over SN-631, there is no elevation information for the berm. Drawing H-14-102671, sheet 1, indicates that the berm does not extend to the area of deepest burial location (the face of Pump Pit 241-AZ-01A) and that the maximum depth already calculated is greater than the minimum specified on sheet 4.<br>According to PER-2004-5678, "ECN 722447 Rev. 0 is being written to revise RPP-18652 Rev. 1, for highlighting information of berm related to the soil cover for SN-631 piping. As part of RPP-18652 Rev. 1, a statement was added in the Recommendations Section, pg. 52, which explains the use of Drawing H-14-102671." The accompanying ESTARS action CH2M-PER-2004-5681 was closed April 21, 2005.<br>Review of the issue indicates that no changes to the document in question are required. Discussion with the preparer of this PER and the document originator verify no action required.<br>Per procedure TFC-ESHQ-RP_ADM-P-01, *Radiological Monitoring During Waste Transfers and Waste Pump Maintenance Activities*, projects must develop a comprehensive radiological monitoring plan for each specific waste transfer prior to initiating the transfer. Procedure requirements include determining worst-case and anticipated radiation levels during the transfer, applying access controls, and establishing survey frequencies. |
| R4 | Not Used | Not Used | Not Applicable | As noted by the IQRPE, this comment was resolved in Recommendations: Section 8 of RPP-20556, Rev. 1, *Volume 7: IQRPE DST System Integrity Assessment - Evaluation of the Dome Load Program for Double-Shell Tanks*. |
| R5 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | An effort is currently underway to model DST loading. This effort should be carried through to include dome deflection studies such that a basis can be provided for dome deflection survey allowable dome deflections which would then be translated into allowable riser deflections. The effort should also be carried through to determine failure loads for the DSTs, including both uniform and concentrated. This recommendation was accepted and completed by the TFC. See Volume 1, Section 4.10 for more information. | Completed | RPP-RPT-25608, *Hanford Double-Shell Tank Thermal and Seismic Project – Increased Concentrated Load Analysis*, June 27, 2005, documents an analysis of increased concentrated loading on the double-shell tanks.<br>The Executive Summary states, "The structural evaluations indicate that current restrictions on concentrated live load are conservative. The results reveal 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 the American Concrete Institute (ACI) for demand-to-capacity ratios per ACI 349. The maximum allowable concentrated load limit based on the ACI evaluation is identified as 1,575,000 lbf."<br>Section 7.1, "Summary of Results," states, "The concrete dome experiences essentially a linear deflection in response to increasing concentrated load until 3,800,000 lbf. The corresponding dome displacement is slightly in excess of 1-in. At that point, additional cracking in the dome begins, resulting in an increased rate of deflection. Crushing of the dome concrete begins at a load of 6,100,000 lbf and corresponding centerline deflection of 2.5-in. The analysis is unable to predict the complete failure response of the DST, so it is not known if the collapse would be limited to a local region underneath the concentrated load or result in full dome collapse." |
| R6 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | The calculation procedure, TFC-ENG-DESIGN-C-10, should be revised to clarify which type of dome load calculations may be considered computations. Table 2 of that procedure lists "Dome Loads" as<br>computations or as formal calculations. In general, dome load calculations are complex. | Completed | The WRPS Administrative Engineering Facility Support Procedure TFC-ENG-FACSUP-C-10, Rev 20, *Control of Dome Loading*, December 20, 2012, states the following:<br>Section 4.1, "Generation and Control of Analysis of Record Document," states that the Responsible Engineer is required to prepare an Analysis of Record calculation in accordance with TFC-ENG-DESIGN-C-10.<br>Section 4.2, "Generation of the Dome Load Record and Dome Load Record Summary Sheet (DLRSS)," states that the Responsible Engineer is required to perform the following actions:<br>"Generate Dome Load Record Summary Sheets (DLRSS) by using a calculation in accordance with TFC-ENG-DESIGN-C-10. Each tank shall have a Dome Load Record Summary Sheet (DLRSS) (A-6003-834). Estimate equipment weight through the use of drawings, |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| | | | | VI (Vendor Information) data, manufacturer's data or other technical information. Do not use visual methods of estimating."<br>The WRPS Administrative Engineering Design Procedure, TFC-ENG-DESIGN-C-10, Rev. B-4, *Engineering Calculations*, October 1, 2012, Section 5.0, "Definitions," states that dome load calculations are computations if they meet the following criteria:<br>• "There are no assumptions.<br>• A permanent record is not needed (i.e., it does not need to be referenced and can easily be reconstructed).<br>• Special engineering expertise is not needed.<br>• Engineering expertise is used to evaluate the problem, and a formal calculation is not required." |
| R7 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | 1. The Tank Farm Contractor should perform periodic self-assessments on the dome load monitoring program to track compliance with the dome load procedures and errors, if any, with the DLL. The fact that responsibility for dome load tracking and monitoring is spread across multiple organizations increases the possibility of non-compliance.<br>2. It is further recommended that the periodicity of these self-assessments be a minimum of once per year. | Completed | The annual self-assessment recommendation will not be adopted.<br>Management assessments of the Dome Load Program have been conducted to determine whether the WRPS dome loading controls are adequately implemented and to identify areas in need of improvement:<br>• RPP-ASMT-27757, Rev. 0, *Engineering Management Assessment of the Dome Load Program*, November 30, 2005.<br>• RPP-ASMT-36127, Rev. 0, *Dome Loading Controls Safety Management Program Management Assessment (FY2008-ENG-M-0103)*, December 20, 2007.<br>• RPP-ASMT-44988, Rev. 0, *Dome Loading Controls Safety Management Program Management Assessment (FY2010--ENG-M-0111)*, February 18, 2010.<br>These reviews were deemed as no longer necessary per the Management Assessment Postponement or Cancelation Form FY2012-ENG-M-0111, Dome Load Controls Safety Management Program and as such canceled. Procedure TFC-ENG-FACSUP-C-10, *Control of Dome Loading*, contains the elements of the dome load program and provides roles and responsibilities associated with them.<br>The dome load program will be described in the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*. |
| R8 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-7<br>See discussion in Section 4.5 | The Tank Farm Contractor should consider centralizing dome load and dome deflection responsibility under one engineer. This engineer would track and maintain an independent database of dome deflections, correlated with loads, and serve as a central point of contact (POC) for operations resolution of DLL and DLRSS issues. | Completed | TFC-ENG-FACSUP-C-10, *Control of Dome Loading*, also provides direction for DST dome elevation surveys. Dome elevation surveys are performed according to RPP-25782, *DST Dome Survey Program*. RPP-25782, which is approved by the civil/structural EDL, provides frequency for dome elevation surveys and deflection criteria. DST-specific dome elevation surveys are documented for each DST farm in its respective RPP-Dome Load Record document (see below). The dome elevation survey process involves a review of the results of dome elevation surveys by the civil/structural EDL. If necessary, the civil/structural EDL may impose limited tank access if there is a deflection greater than that specified in RPP-25782 as 0.5-in.<br>The civil/structural EDL owns the TFC-ENG-FACSUP-C-10 procedure. Operations and Project personnel must evaluate and record dome loads according to the procedure. Involvement of the civil/structural EDL is on an as-needed basis. Essentially, the civil/structural EDL is responsible for approval of allowable dome loads, which are then tracked in accordance with TFC-ENG-FACSUP-C-10. Issues regarding the dome loads for DSTs procedurally require notification of the civil/structural EDL. The civil/structural EDL also has approval authority on all crane route maps. In summary, aside from tracking individual loads as they are added and removed according to the established Dome Load Log procedure, the civil/structural EDL is solely responsible for the dome load program. The dome elevation surveys are also reviewed by the civil/structural EDL, which may result in imposed constraints. |
| R9 | IQRPE Concurs with Completion | Each tank farm has received a varying degree of inspection on the secondary tanks. None have received a hydrostatic leak check (for justifiable | Completed | RPP-28538, Rev. 2, *Volume I: IQRPE Double-Shell Tank System Integrity Assessment, HFFCO M-48-14*, was released September 21, 2006. Section 4.10.5, "Secondary Liners," states that a number of the secondary liners of tanks in the tank farms were not given enhanced weld inspection (EWI) to the upper knuckle weld. The report concludes that, because of this, the secondary liners were not designed to hold tank waste above the EWI level. |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
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| | See discussion in Section 4.5 | reasons). Nonetheless, a primary recommendation of this evaluation is to document the limit on the level of leaked product permitted in the secondary containment on the SY, AY and AZ tanks. These tank farms received the least amount of inspection on the secondary liners. This evaluation must consider reasonable leak scenarios and develop a model for the most likely leak condition. If the estimated leak height is above the respective tank's radiographic inspection level, operational and engineering measures should be taken to limit a leak in those tanks to that height in the secondary tank. | | The report states:<br>"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 enhanced weld inspection (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."<br>RPP-ASMT-27062, Rev. 0, *Stress Corrosion Cracking Evaluation for the Secondary Liner Exposed to In-Specification Waste in a Double-Shell Tank Annulus*, evaluates the consequences of in-specification waste leaking through the primary carbon steel tank liner of a DST and coming into contact with the carbon steel secondary liner. The evaluation assesses the possibility of stress corrosion cracking (SCC) in the secondary liner and concludes from SCC testing of similar steels at the Savannah River Site that:<br>"... an accidental leak of waste into a DST annulus will not lead to a breach of the secondary liner in the foreseeable future, even if it is assumed that cracks are already present in the secondary liner. It should be noted that it is not likely that cracks are present given that the secondary liners have never been exposed to out-of-specification waste or an aggressive environment."<br>The evaluation goes on to state:<br>"However, the caustic deficiency created by a reaction of the hydroxide with carbon dioxide in the annulus air could lead to SCC of the secondary liner over a relatively short period of time (depending on waste volume leaked to the annulus, about eight to 44 weeks for caustic deficiency and crack initiation plus three to five weeks for crack growth)."<br>Actions to mitigate the impact of a waste leak into the annulus are described in HNF-SD-WM-TSR-006, Rev. 7, *Tank Farms Technical Safety Requirement*, and in HNF-3484, *Double-Shell Tank Emergency Pumping Guide*. Limiting Condition of Operation LCO 3.5, "DST Annulus Flammable Gas Control," requires that the DST annulus waste level shall be equal to or less than 15-in., applicable to all DSTs at all times. If the DST annulus waste level is greater than 15-in., the following actions are required:<br>• Stop all activities in the affected DST annulus and directly above the affected DST, except for flammable gas sampling/monitoring, de-energizing or removing equipment that does not meet ignition controls, and actions to reduce the flammable gas concentration. These actions must be completed within 8 hours. AND<br>• Stop all activities in enclosed spaces connected to the affected DST annulus headspace, except for flammable gas sampling/monitoring and actions to reduce the flammable gas concentration. This action must be completed in 10 days without flammable gas monitoring OR prior to the concentration of flammable gas exceeding 60% of the lower flammability limit (LFL). AND<br>• De-energize or remove equipment that does not meet ignition controls in the affected DST annulus headspace and connected enclosed spaces. This action must be completed within 10 days without flammable gas monitoring OR prior to the concentration of flammable gas exceeding 60% of the LFL.<br>If the DST annulus waste level is greater than 15-in. AND there is no flammable gas monitoring of the DST annulus head space the following actions are required:<br>• Submit a RECOVERY PLAN to the ORP within 20 days. AND<br>• Reduce the DST annulus headspace flammable gas concentration to less than or equal to 25% of the LFL in accordance with the approved RECOVERY PLAN.<br>The following is a list of the Emergency Annulus Pumping Procedures for their respective tank farms. Although these procedures are not |

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| | | | | approved for use, they are accessible from the procedures web page at the request of the Washington Department of Ecology and the DOE. These procedures are only meant as an emergency starting point, in case a leak was to occur from a primary tank into the annulus. A 72-hour window has been provided by the Washington Department of Ecology and the DOE to have approved procedures in place, if a leak were to occur.<br>• TO-001-281, *Emergency Annulus Pumping Procedure for AN-Farm*<br>• TO-001-282, *Emergency Annulus Pumping Procedure for AP-Farm*<br>• TO-001-283, *Emergency Annulus Pumping Procedure for AW-Farm*<br>• TO-001-284, *Emergency Annulus Pumping Procedure for SY-Farm*<br>• TO-001-288, *Emergency Annulus Pumping Procedure for AY-Farm*<br>• TO-001-289, *Emergency Annulus Pumping Procedure for AZ-Farm.* |
| R10 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-8<br>See discussion in Section 11.6 | TSAFT or equivalent examinations should be made on the secondary liner lower knuckle to provide gross indication of cracking. This recommendation was resolved per section 4.10.5 (Secondary Liners) of this document (RPP-28538, Rev. 2). | Resolved | As noted by the IQRPE, this comment was resolved per section 4.10.5, "Secondary Liners," of RPP-28538, *Volume 1: IQRPE Double-Shell Tank System Integrity Assessment, HFFACO M-48-14.* |
| R11 | IQRPE Concurs with Completion<br>See discussion in Section 10.4 | Emergency pumping procedures currently estimate that the pumping of a secondary tank will begin on the tenth day from discovery of the leak. According to stated functional requirements for the secondary tanks, pumping needs to be completed on the seventh day. The Tank Farm Contractor needs to perform one of the following actions:<br>1. Reexamine and streamline the emergency pumping process to remove liquid by the seventh day as required in the design specifications.<br>2. Perform structural and corrosion analyses or implement real time corrosion monitoring in the annulus with the intent to provide some technical basis for removing waste solutions beyond the seven-day requirement<br>3. Ratify the TSIP guidelines and use them to | Completed | This recommendation fails to consider that the most likely source of waste entering the DST annulus will be a leak from the primary tank. The immediate action upon discovery will be to lower the waste level in the primary tank below the elevation of the leak site, if the leak site can be identified. Emergency pumping of a leaking DST is described in HNF-3484, *Double-Shell Tank Emergency Pumping Guide*. The removal of waste from the annulus is likely to be a secondary concern. The disposition of Recommendation R9 describes the time limits and actions needed to stabilize the annulus.<br>Although not recognized as having either tertiary leak detection or mitigation functions by the DST RCRA Part B Permit application, any leakage from the annulus would be collected in a leaking DST's concrete foundation channels and drained into the leak detection pit where it could be removed. |

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| | | document a basis for a secondary liner design life that is greater than or equal to the time to pump the annulus. A graded approach could also be documented which accounts for the varying liner thicknesses and leak depth. | | |
| R12 | Not in scope. | The short design life for the secondary tanks, coupled with the current age of the tanks suggests it is vitally important to ensure operability of the tertiary leak detection pits. The TFC needs to maintain tertiary leak detection capability throughout the life of the tanks. | Completed | The tertiary leak detection pit monitoring system includes the following features:<br>• Dip tubes are used to monitor the liquid level in the leak detection pit; a manual liquid level tape/zip cord reading may be taken at each tank as a backup to the dip tube instrumentation.<br>• Normal Operating Ranges (Alarm Set Points) verify equipment operation and provide indication that the liquid level is within the Maximum Authorized Limit. The levels are checked and recorded on a weekly basis by operator rounds<br>• The data are then reviewed per TFC-ENG-CHEM-D-21, *Process Engineering Waste Surveillance Data Review*.<br>The tertiary leak detection pits are no longer listed as a Leak Detection Monitoring and Mitigation (LDMM) feature because they are not recognized by the Washington State Department of Ecology as necessary features. Currently, there is no discussion of tertiary leak detection pits in the Resource Conservation and Recovery Act of 1976 (RCRA) Part B Dangerous Waste Permit application, nor in the draft permit conditions that are available.<br>While tertiary leak detection pits may not be recognized by the State as necessary LDMM features, they play a significant role in maintaining integrity of the secondary liners. Operability of the LDPs is important and maintained for three reasons:<br>• Water accumulation from precipitation can fill the pits and cause corrosion of the secondary tank liners.<br>• If the pits fill with water, uplifting/floating of the tanks could occur.<br>• Postulating that the LDPs have been allowed to fill with water and a waste leak through the secondary liner occurs, the waste would not be able to drain into the leak detection pits. |
| R13 | IQRPE Concurs with Completion<br>See discussion in Sections 4.5 and 11.6 | The secondary liner needs to be analyzed for its ability to contain waste solutions accounting for appropriate design input loads, the fact that the lower knuckle is not supported, and the fact that the liner was not stress relieved. The results of this recommendation may provide input for Recommendation 3 (R11 in this Table).<br>RPP-ASTM-27936, *Evaluation of Secondary Liner Under Postulated Waste Leakage Scenario in a Double-Shell Tank Annulus*, fulfills the intent of this recommendation. This recommendation has been accepted and completed by the TFC. See Volume 1, Section 4.10.3 for additional information. | Completed | This work was completed using:<br>• RPP-CALC-28703, *Annulus Fill Calculation*, February 23, 2006.<br>• RPP-ASMT-27936, *Evaluation of Secondary Liner Under Postulated Waste Leakage Scenario in a Double-Shell Tank Annulus*, February 23, 2006.<br>• RPP-ASMT-27062, *Stress Corrosion Cracking Evaluation for the Secondary Liner Exposed to In-Specification Waste in a Double Shell Tank Annulus*, February 7, 2006.<br>RPP-CALC-28703, *Annulus Fill Calculation*, February 23, 2006, showed that the failures weren't catastrophic and would be detected and mitigated before the welds, which didn't receive enhanced inspections, are reached.<br>RPP-ASMT-27936, *Evaluation of Secondary Liner Under Postulated Waste Leakage Scenario in a Double-Shell Tank Annulus*, February 23, 2006, evaluated the structural integrity of the secondary steel liners of DSTs for a primary tank leak scenario. The analysis of the secondary steel liner with contained leaked waste was performed for 241-AP and 241-AW tanks, but the original analysis-of-record (AOR) for the remaining four DST farms (241-AN, 241-AY, 241-AZ, and 241-SY) did not evaluate the secondary steel liner for primary tank leak scenario. The 241-AY tank steel liner, which has the least plate thickness among these four tank farms, has been evaluated in this report by comparing its structural properties and design conditions with those for the 241-AW tank liner, using the original AOR of the 241-AW tank farm as a guide. Based on the evaluation, the report concludes that the secondary liners of all six sets of DSTs will maintain their structural integrity, accounting for appropriate design input loads, in the event of a |

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| | | | | leakage from primary tank to secondary steel liner shell.<br>RPP-ASMT-27062, *Stress Corrosion Cracking Evaluation for the Secondary Liner Exposed to In-Specification Waste in a Double Shell Tank Annulus*, February 7, 2006, showed that, following a leak of compliant waste, it would take at least 12 weeks using worst case assumptions before SCC could occur, allowing a sufficient period of time to allow pumping of the primary tank and annulus. |
| R14 | IQRPE Concurs with Completion<br>See discussion in Section 10.4 | Waste streams sent to the DSTs should continue to be managed using the methodology of RPP-10006 to not create convective and non-convective layers that are required for episodic gas release events as given in PNNL-13337. | Completed | RPP-10006, Rev. 9, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*, states that Waste Group A tanks are defined as, "Tanks with a potential spontaneous buoyant displacement gas release event (BDGRE) flammable gas hazard in addition to a potential induced gas release event (GRE) flammable gas hazard. That is, tanks that are conservatively estimated to achieve a flammable gas concentration of 100% of the lower flammability limit (LFL) in the tank headspace if all of the retained gas is released from a spontaneous BDGRE."<br>HNF-SD-WM-OCD-015, Rev. 23, *Tank Farms Waste Transfer Compatibility Program*, Section 3.1.1.1, "Waste Group Prohibitions," prohibits waste transfers into Waste Group A tanks, or operations that would result in re-designation of a Waste Group B or C tank as a Waste Group A tank without prior written approval from the U.S. Department of Energy, ORP manager as governed by 29633-ESQ-AA-0001, *River Protection Project Authorization Agreement between the U. S. Department of Energy, Office of River Protection and Washington River Protection Solutions LLC*, dated February 22, 2011. |
| R15 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-20<br>See discussion in Section 11.6 | Any DST piping (especially carbon steel primary piping) and other ancillary equipment that is removed from service for the next several years should be examined for erosion and/or corrosion. The history of the transfers through that piping should be reviewed so that the average corrosion/erosion rate for Hanford DST piping can be determined | Completed | Portions of this recommendation overlap with those presented for Recommendation R40.<br>Prior to this recommendation, two sections of the cross-site transfer lines near catch tank 244-A, SNL-3150 and SLL-3160, were removed and samples were analyzed at the 222-S Analytical Laboratory. The SNL-3150 pipe sections consisted of two 3-in. diameter primary pipe stainless steel sections with 6-in carbon steel encasements. The SLL-3160 pipe sections were control pieces from a line that was not used for waste transfers and consisted of two 3-in. diameter primary pipe stainless steel sections with 6-in. carbon steel encasements. The analysis results cited in Interoffice Memorandum 7S110-GAC-05-035, "Final Analytical Results from the Examination of Corrosion on Sections of 244AR Cross-Site Transfer Pipe," indicated the following:<br>"Both the SNL-3150 and SLL-3160 6-in. pipe sections had a surface corrosion layer that was easily removed. Removal of the corrosion layer revealed sparse shallow pitting as a result of this corrosion. The thickness loss on cleaning for the 6-in. pipes was about 50 to 60 µin. This was also the approximate depth of the deepest pits on these specimens."<br>RPP-RPT-47901, Rev. 0, *Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610*, was released November 5, 2010. The assessment of the supernatant and slurry lines focused on corrosion of the encasements to determine the effectiveness of the cathodic protection program. The assessment identified no significant areas of corrosion damage. However, the inspection noted that the coating system used on these lines (non-bonded coating consisting of "dryer-ducting" to create an air gap between the encasement pipe and sprayed-in-place foam insulation) was incompatible with traditional cathodic protection survey techniques and corrosion protection via the Site's cathodic protection system. The report concluded that alternative means of evaluating the extent of cathodic protection should be utilized to assess the protection of these lines. Electrical resistance sensors and permanently-installed reference electrodes were installed on and around these lines. The report states that corrosion rate data from these sensors can be used to track corrosion conditions on these lines and, by inference, other similarly-coated lines that have not been directly inspected.<br>SN-285 and SN-286, two 241-SY tank farm out-of-service supernatant lines, were sampled in FY 2010 and the samples were transferred to the 222-S Analytical Laboratory for examination. The encasement pipe samples were examined for corrosion with observations documented in ATS-LAB-RPT-11-00006, Rev. 0, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, released in May 2011. ARES Corporation generated an evaluation, RPP-RPT-49200, Rev. 0, *Direct Assessment of 241-SY Pipelines SN-285 and SN-286*, |

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| | | | | which concluded that the assessments performed in-situ and in the lab identified no significant areas of corrosion damage at the inspection site.<br>The evaluation stated:<br>"For both pipe sections, the highest level of corrosion and pitting was located on the bottom outside surface of the encasement, and this level of corrosion decreased while traversing up the side and onto the top of the pipe. Corrosion removal treatments showed that the SN-285 pipe section was more corroded, having a corrosion level of 2.2% by mass for the bottom section, compared to SN-286 which had a 1.3% corrosion level for its bottom section. However, the corrosion on both pipe sections did not erode through the pipe as all sampled areas had at least 6 mm of pipe wall thickness that was not corroded. The reported nominal wall thickness of schedule-40 pipe is 7.1 mm, resulting in a rough calculation of maximum corrosion on these two pipe sections to be no greater than 15% with a majority of the other sections of the pipe investigated falling well below this number."<br>These lines were installed in the early 1970s; the wall thickness loss reflects nearly three decades in service.<br>The primary pipe sections from the SN-285 and SN-286 samples, as well as a sample from SN-278, will be examined for erosion and corrosion in FY 2012. It is unlikely that a quantitative volume and composition history of these, or other typical waste transfer lines that have been taken out of service, can be developed. Recreation of the SN-285 and SN-286 process histories relies on recovery of records for individual waste transfers and knowledge of the waste compositions transferred through the pipelines. The lines were placed into operation in 1977. Recoverable transfer records for SN-285 and SN-286 are discontinuous, with the longest complete transfer history covering about 400 days of the 30-year period.<br>The process envisioned by the IQRPE recommendation relies on exhumation of out-of-service waste transfer lines and removal of sections of the radioactive piping. Since 2006, when the recommendation was first made, only three samples have been collected – all in 2010 when the lines were excavated for replacements. The opportunistic quality of this effort and the low probability of recreating the process history suggest an alternative is needed, as described below.<br>The first quantitative estimate of waste transfer line erosion and corrosion will be made by installing ultrasonic test (UT) instrumentation on Retrieval and Closure piping in portable valve box POR104. Flexible dry-coupled UT arrays will be located on and downstream of supernatant- and slurry-side pipe bends to measure wall erosion over time. The selected locations are based on Letter Report, "Washington River Protection Solutions, LLC, Subcontract 30519, Release 103 – Transmittal of Draft Corrosion Sensor Placement Letter Report – Ares Task No. 09054403.03." Four UT sensor arrays will be used on each pipe bend, and a "cal-block" UT thickness control will be employed. The total volume transferred through the lines will be metered, and the volume percent of solids carried on the slurry side will be calculated from sludge volume changes. An estimated 283 kgal of sludge from single-shell tanks (SSTs) C-103, C-108, C-109, and C-110 will be retrieved through POR104. Assuming the slurry was a nominal 5% by volume, the equivalent transfer volume will be about 5.7 Mgal.<br>The supernatant- and slurry-side floor nozzle bends removed from POR104 to make way for the replacement piping have been packaged and stored for erosion/corrosion analysis planned in FY 2012. About 342 kgal of sludge was retrieved through the floor nozzles – a nominal 6.9 Mgal of slurry. Testing is described in LAB-PLN-11-0005, Rev. 0, *Test Plan and Procedure for the Erosion Analysis of POR104 Valve Box Pipe from C-Tank Farm*. Records of total volume pumped through the bends and the volume percent of solids in the slurry are available.<br>The UT-instrumented POR104 lines and the floor nozzles recovered from POR104 are 2-in. diameter stainless steel, similar to DST jumpers. Jumpers are the only type of readily accessible piping that is routinely changed out, and thus available for testing.<br>A description of the opportunistic sampling and erosion monitoring will be incorporated into the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan.* |

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| R16 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-3, R16-5 and R16-8<br>See discussion on Sections 4.5 and 11.6 | 1. Comparison of historical to current visual inspections should be performed, looking for growth and changes to the corrosion patches and discoloration. Currently, the inspection cycle is to be every five years and the first cycle is essentially complete.<br>2. Similarly, coordination between the visual and UT examinations should occur to provide quantification for better understanding. The periodic UT examinations of the DSTs are to be performed in the same location at a minimum to determine how fast the tank wall is corroding. | Completed | The methodology of comparing current inspections with results from past inspections is described in RPP-PLAN-46847, Rev. 0, *Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks*. Section 3.2, "Double-Shell Tank Visual Inspections," states that the present approach for conducting visual examinations of DSTs is to perform a video examination of each tank's interior and annulus regions in conjunction with the tank's ultrasonic examination inspection, or approximately every 5 years (not to exceed 7 years between inspections), whichever occurs first.<br>The DST visual examinations completed in 2006 established a baseline that will be used for comparison for future planned re-examinations. The visual baseline information is documented in the Tank Integrity Inspection Guides (TIIGs). Each TIIG contains photographic information of notable indications (areas of interest) and specifies their location on each DST, as well as showing the tank regions examined by UT in order to provide the historical trends comparison recommended by the IQRPE. Each location on the TIIG overlay is hyperlinked to a photograph to allow for visual comparison. Each DST has a unique TIIG.<br>The following is a list of the most recent inspection reports:<br>• RPP-RPT-31599, *Double-Shell Tank Integrity Inspection Report for 241-AN Tank Farm*<br>• RPP-RPT-34310 , *Double-Shell Tank Integrity Inspection Report for 241-AZ Tank Farm*<br>• RPP-RPT-34311, *Double-Shell Tank Integrity Inspection Report for 241-AY Tank Farm*<br>• RPP-RPT-38738, *Double-Shell Tank Integrity Inspection Report for 241-AP Tank Farm*<br>• RPP-RPT-39149, *Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm*<br>• RPP-RPT-42147, *Double-Shell Tank Integrity Inspection Report for 241-AW Tank Farm*<br>The generation and use of TIIGs are described in RPP-7574, *Double-Shell Tank Integrity Program Plan*. The areas of interest identified in previous inspections and documented in the TIIG will be revisited in future inspections. |
| R17 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-5<br>See discussion in Section 4.5 | UT examination of the DST walls above the waste (i.e., the vapor space) should continue to be performed, if possible, and also coordinated with the visual records. | Completed | RPP-7574, Rev. 3, *Double-Shell Tank Integrity Program Plan*, describes the process by which ultrasonic examinations of the 28 DSTs are performed in section 3.4.2.1, "Ultrasonic Testing Inspection Performance." Limited examination above historical liquid-air interfaces is included in the inspections. The UT examinations of the 28 DSTs are carried out as follows:<br>• Two thirty-inch wide vertical scan of the primary tank wall for all DSTs.<br>• Twenty-foot long scan of circumferential weld joining the primary tank vertical wall to the lower knuckle and adjacent heat-affected zone for all DSTs.<br>• Twenty-foot long scan of vertical weld joining shell plate courses of the primary tank, extended as necessary to include at least one foot of vertical weld in the nominally thinnest wall plate and adjacent heat-affected zones for all DSTs.<br>• Twenty-foot long circumferential scan at a location in the vertical portion of the primary tank wall corresponding to a static liquid/vapor interface level that existed for any 5-year period, extending at least 1 foot above that liquid/vapor interface for six DSTs.<br>• Twenty-foot long circumferential scan of the predicted maximum stress region of the primary tank lower knuckle for six DSTs. |
| R18 | IQRPE Concurs with Completion<br>See discussion in Section 11.6 | Some sizeable fraction of the threaded fittings of the ancillary equipment should be inspected for leakage, if possible. Any removed ancillary equipment with a threaded fitting should be disassembled for evidence of increased corrosion from radiolysis of the Teflon thread sealant | Completed | This recommendation has not been adopted.<br>According to industry references, Teflon is highly susceptible to radiation damage. Tank Farm experience conflicts with that widely-held belief.<br>The principal use of Teflon in Tank Farms is PUREX connector head gaskets in stainless steel jumpers. Teflon performs satisfactorily in this application. Field experience indicates that the only leakage through Teflon connector head gaskets occurs when the connectors are loosened and re-impacted – most likely from mechanical abrasion of the gasket by the stainless steel surfaces. Once a connector with a Teflon gasket is |

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| | | | | made up leak-tight, it is highly unlikely to develop a leak. It is unlikely that Teflon thread sealant behaves differently in contact with threaded stainless steel piping.<br>Because they become highly contaminated during operation, it is impractical to meaningfully examine either used connector head gaskets or waste-wetted threaded Teflon parts. Packaging, transporting, and testing these materials requires handling that is inconsistent with ALARA practice. Since the 222-S Analytical Laboratory is not equipped to perform materials properties analysis, inspection would be limited to visual interpretation of conditions – in isolation from other measurements, a problematic evaluation at best.<br>The acceptable performance of in-service Teflon head gaskets indicates further testing is not required or justifiable. If it became necessary to understand why Teflon performs satisfactorily in Tank Farm service, then it would be appropriate to test the most commonly used configurations at a gamma irradiation test facility. Here known radiation fluxes and instrumentation would yield quantitative integrated doses for the tests. The post-irradiation materials would be contamination- and radiation-free, making visual examination and materials properties tests relatively straightforward.<br>Guidance for selection of non-metallic materials in contact with tank waste is provided by TFC-ENG-STD-34, Rev. A, *Standard for the Selection of Non-Metallic Materials in Contact with Tank Waste*, March 10, 2011. |
| R19 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | Review the design lifetime documents for both 241-AZ and 241-AY tank farms and determine why there is a 10-year difference. | Completed | RPP-RPT-28968, Rev. 0A, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis*, based structural evaluations of all Hanford Site DSTs on analysis at the design waste temperature of 350°F and the full 60-year corrosion allowance on the tank wall of 0.060-in. (using the allowable 1 mil (0.001-in.) per year assumed corrosion rate). The evaluation concluded that upon analysis of the reinforced concrete, primary tank, stress corrosion cracking, primary tank buckling, concrete-backed liner, and J-bolts, the DSTs met their demands and were approved for use through the end of the evaluated 60-year design life.<br>The 60-year design life began at the completion of the 241-AY tank farm. The DSTs will be re-evaluated for structural integrity before the end of their service life in 2028. Project management will determine when the re-evaluation for structural integrity will occur.<br>ARH-205, *Design Criteria PUREX AY Tank Farm*, and ARH-1437, *Design Criteria PUREX AZ Tank Farm*, do not specify design lifetimes. The stated design lifetimes were quoted from a secondary reference, WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks*, which does not cite a primary reference for the design lives. |
| R20 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Inspect excavated pipelines and specified abandoned pipelines<br>If the surface of a pipeline is accessible or is exposed for repairs or alterations, a visual inspection should be used to evaluate the effectiveness of cathodic protection applied to the pipe. Signs of corrosion such as the presence of corrosion products, pitting,<br>cracking, reduction in physical size, or other evidence of deterioration should be noted.<br>Additionally, with the consolidation efforts by WFO to reduce the number of rectifiers needed to support the post-2005 pipelines, an | Completed | This recommendation is essentially a continuation of Recommendation R15, but emphasizes encasement protection provided by the impressed current cathodic protection system. Therefore, this disposition is limited to the description of the encasement forensic line examinations that have been made to evaluate cathodic protection. The encasement examinations were based on sites selected by ARES Corporation. ARES Corporation was the area engineer (A/E) responsible for interpreting the IQRPE's cathodic protection recommendations in terms of conducting the necessary field testing and evaluation to determine the cathodic protection system's health, for recovery of configuration control of the cathodic protection system, and for system design modification. The following documentation is the product of the A/E's work to evaluate the performance of the system.<br>RPP-RPT-42487, Rev. 0, *Evaluation of Buried Transfer Lines with Cathodic Protection*, released in November 2009, listed seven different buried transfer pipelines and a total of 14 different locations to be considered for excavation for external corrosion direct assessment (ECDA). From the recommended lines, the PW-4531 pipeline, located in 241-AY farm, was selected for ECDA because it has several sections with varying levels of protection and because of its accessibility for excavation.<br>RPP-RPT-42489, *Evaluation of Heat-Traced Buried Transfer Lines with Cathodic Protection*, released in November 2009, listed 11 heat-traced and buried transfer pipelines at 24 different locations recommended for excavation and ECDA. Six were selected for ECDA:<br>• 241-AP Farm: SL-509 and SL-510 were selected because the protection data for these lines were missing. Lines SN-609 and SN-610 |

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| | | opportunity is presented to inspect lines (non-post-2005) which had been cathodically protected. The selection of pipes to be inspected should include as many different pipeline configurations (e.g., coatings, covering, insulation, jacketing) as possible, including corrosion conditions surmised as simple to complex, and should include piping from limited to extended years of service. The investigations should be done as soon as possible to observe those pipes no longer receiving cathodic current due to isolated (shutdown) cathodic rectifier systems. IQRPE is aware of several DST pipelines in the 241-SY tank farm that will be replaced by Project E-525. These lines should be evaluated for corrosion data at the time of replacement.<br><br>IQRPE considers this empirical methodology to be the most effective and proactive means of determining the effectiveness of the corrosion control program. The investigation should include a person whose professional activities include suitable experience in external corrosion control of buried or submerged metallic piping systems and is either a registered professional engineer, a person recognized as a corrosion specialist or a NACE cathodic protection specialist. A database of evaluations/reports for trending and analysis should be maintained. | | were selected because they were considered to be under-protected (i.e. they did not meet any of the NACE criteria for adequate cathodic protection), and the pipes are located within close proximity of each other with multiple excavation locations to choose from and minimal interference.<br>• 241-SY Farm: SN-285 and SN-286 were selected because they were considered to be under-protected, and were located within close proximity of each other with minimized interference. These lines were also being replaced, and replacement required their excavation.<br><br>RPP-RPT-47901, Rev. 0, *Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610*, November 2010, identified no significant areas of corrosion damage at the inspection site. The inspection noted that the coating system used on these lines (non-bonded coating consisting of "dryer-ducting" to create an air gap between the encasement pipe and sprayed-in-place foam insulation) was incompatible with traditional cathodic protection survey techniques and corrosion protection. The report concluded that alternative means of corrosion monitoring should be utilized to assess the condition of these lines. Electrical resistance sensors and permanently-installed reference electrodes were installed on and around these lines. The corrosion rate data from these sensors can be used to track corrosion conditions on these lines at the electrode sites and, by inference, other similarly-coated lines that have not been directly inspected.<br><br>RPP-RPT-50271, Rev. 0. *Direct Assessment of 241-AY Farm Line PW-4531, released on October 13, 2011*, documents the results of a direct assessment of transfer line PW-4531 in 241-AY Farm. The assessment identified no significant areas of corrosion damage at the inspection site. Electrical resistance sensors and permanently-installed reference electrodes were installed on and around this line. Corrosion rate data from the sensors can be used to track corrosion conditions on the line and, by interference, other similarly-coated lines that have been directly inspected.<br><br>SN-285 and SN-286, two 241-SY tank farm out-of-service supernatant lines, were sampled in FY 2010 and the samples were transferred to the 222-S Analytical Laboratory for examination. The encasement samples were examined for corrosion and observations were documented in ATS-LAB-RPT-11-00006, Rev. 0, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, released in May 2011. ARES Corporation's evaluation, RPP-RPT-49200, Rev. 0, *Direct Assessment of 241-SY Pipelines SN-285 and SN-286*, concluded that the assessments performed in-situ and in the lab identified no significant areas of corrosion damage at the inspection site. Additional discussion of the results is provided in the Recommendation R15 disposition.<br><br>Line SN-278 from 241-SY farm has also been sampled. Evaluation will occur in FY 2012. |
| R21 | IQRPE Concurs with Completion<br><br>See discussion in Section 6.7 | Obtain native potentials at test stations<br><br>It is recommended that present-day native potentials be taken at the post-June 2005 test stations. At least four native potentials should be taken around the test stations in the effort to establish the most anodic native potential around the test stations. The most anodic native potential can be used to establish conservative NACE Criterion 2 calculations. It is also recommended to access the native | Completed | The term *native potential* has been used incorrectly in this recommendation. The native potential of the soil at test stations would be the potential of the soil prior to the initial operation of the cathodic protection system. *Depolarized potential* is the correct term, and refers to the potential of the soil after the cathodic protection system has been powered off for a period of no less than one week.<br><br>Depolarized potentials were collected between April and May, 2007, following the work instructions provided in work order WFO-WO-07-1110, *Cathodic Protection Native Potential Data*. Depolarized potential data recorded from the test stations are included in the completed work package. The depolarized potential data are used to evaluate cathodic protection system compliance with NACE Criterion 3.<br><br>Procedure 3-CATH-690, Rev. D-0, *Cathodic Protection System Testing*, contains guidance for completing depolarized potential measurements at the test stations associated with the post-June 30, 2005 DST piping system |

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| | | potential readings located in the ATPs of the project files. | | |
| R22 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Troubleshoot aberrant readings of last annual survey<br>1. It is recommended that re-work and additional work be performed at the following test stations, (i.e. those test stations accessed during the last annual survey from December 2004 to February 2005):<br>a. Polarization testing re-work: (78-T2), (82-T12)<br>b. Proper configuration verified, and if verified, then polarization re-work: T(41-2), east of 702-AZ<br>c. Anode output current measurements for anodes around test station: T(33-45 A and B).<br>2. With respect to the first bullet of Step 5.10.2 of 3-CATH-690, it is recommended to remove this bullet from this Step since the first bullet is impossible to perform. The test station readings cannot be 'ENSURED' to comply with Section 5.9 NACE criterion.<br>3. As an alternative, a list of native potentials for each test station in 3-CATH-690 should be provided or listed in a referenced document. It is recommended a different step be established to verify whether or not NACE Criterions 2 and 3 are being met. | Completed | 1. Integration of QA/QC spot checks and retests of suspect readings were recommended to reduce the likelihood of the collection of errant data following the December 2004 to February 2005 annual survey.<br>The March 2006 annual survey indicated the following for each of the test stations listed by the recommendation:<br>a. The terminals measured in test stations (78-T2) and (82-T12) met NACE Criterion 2.<br>b. The terminals measured in test station T(41-2), east of 702-AZ, met NACE Criterion 2.<br>c. Procedure 3-CATH-782, Rev. A-1, *Cathodic Protection System Individual Anode Output Measurement*, was released October 11, 2010. Anode output data were scheduled to be collected in late FY 2010, but postponed to allow for completion of higher priority field operations. Sheets 2 and 3 of drawing H-14-011502, *Cathodic Protection Partial Plan 241-AW Farm*, do not indicate anodes in close proximity to test station T(33-45 A and B).<br>2. Section 5.10.2 of procedure 3-CATH-690, Rev. D-0, *Cathodic Protection System Testing*, does not include a bullet directing the field work supervisor to "ENSURE" compliance with the Section 5.9 NACE criterion.<br>3. Data have been trended and analyzed since 2006; analysis includes evaluation against the NACE criteria. Depolarized potential readings have been obtained at the test stations and documented in work order WFO-WO-07-1110, *Cathodic Protection Native Potential Data*. The depolarized potential data are also available in the Hanford Site Cathodic Protection Geographic Interface System (GIS) database, as well as in the Tank Farm Cathodic Protection Data Evaluation Tool (DET). The Tank Farm Cathodic Protection DET was developed to archive, trend, and analyze cathodic protection data. The GIS is used to manage the Hanford Site Cathodic Protection system and includes the ability to evaluate NACE Criteria 2 and 3 individually.<br>Future depolarized potential measurements will be taken following the guidance in procedure 3-CATH-690, with measurements recorded in the work package directing the activity. A five year periodicity has been recommended for collection of depolarized potential data, unless significant earthwork has occurred. |
| R23 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Document, Trend, and Analyze Data from Bi-monthly Rectifier Inspection and Annual Polarization Surveys<br>It is recommended that time-dependent parameters (i.e., rectifier tap settings, rectifier | Completed | Washington Administrative Code (WAC) 173-303-640 requires that proper operation of a cathodic protection system be confirmed within six months after initial installation and annually after the initial confirmation. Additionally, the sources of impressed current must be inspected and/or tested at least bimonthly.<br>The annual survey and the bi-monthly rectifier inspections have been occurring as required since March 31, 2006. Completion of the annual survey and the bi-monthly rectifier inspections is documented in the applicable work package with the data entered into the Hanford Site |

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| | | DC output voltages and amperages, test station native potentials, polarization potentials, and cathodic potentials) be inputted into spread sheets soon after the data is collected and analyzed for trends and abnormalities.<br>It is recommended that the data analysis methods include verifying the 'ON' and 'OFF' measurements of 3-CATH-690 by employing a voltage balance for the following readings:<br>• Voltage between portable reference electrode and first listed pipe in terminal numbers column<br>• Voltage between each applicable permanent reference electrode and the first listed pipe in terminal numbers column<br>• Voltage between portable reference electrode and each applicable permanent reference electrode.<br>Each voltage loop should add to a near zero value. The voltage loop calculation verifies the measurement method and provides high confidence in the readings. | | Cathodic Protection GIS for trending and analyses.<br>The voltage loop method of analysis identified in the IQRPE's recommendation was not completed, since the permanent reference electrodes are no longer used to perform any measurements.<br>A description of the annual surveys and the bi-monthly rectifier inspections will be incorporated into the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*. |
| R24 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Clarify need for resistance testing in annual test procedure<br>1. Data collection for continuity between individual pipelines, represented by test leads in test stations, should be completed for the remaining test stations whose terminal number rows are un-shaded and devoid of terminal numbers.<br>2. The procedural steps for resistance measurement need to be revisited to make clear the intent of the resistance measurements.<br>3. Alternatively, an analysis should be made for those test stations (i.e., those test stations without terminal numbers in the | Completed | 1. Resistance testing to establish continuity between individual pipelines was determined to be redundant as discussed in RPP-RPT-33664, *Independent Assessment of Cathodic Protection-Related Findings in the 2006 Double-Shell Tank Integrity Assessment Report*. Pipe-to-soil potentials must be measured to allow evaluation of the cathodic protection system. Additionally, the data allow review of electrical continuity between test station terminals. The measurement of equivalent (±0.001 V) pipe-to-soil potentials between each test station terminal and the reference cell, which remains in a single location during data collection at each test station, is sufficient to establish electrical continuity.<br>2. The resistance measurement requirement has been removed from procedure 3-CATH-690, *Cathodic Protection System Testing*.<br>3. Resistance testing has been superseded by the pipe-to soil measurements. The requirement for resistance measurements has been removed from procedure 3-CATH-690. |

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| | | annual testing procedure) to determine if resistance testing is required. | | |
| R25 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Analyzed 'waterproof' assumptions and methods of jacketed pipelines<br>The IQRPE recommends that the TFC obtain industry and/or design documentation asserting that the construction methods and materials for the 26 waterproof post-2005 pipelines (Figures 12 to 17) are adequate to maintain a corrosion-free environment. WHC-SD-W058-SOIL-001, *Cross-Site Pipeline Evaluation Corrosion Project W058*, recommends against the use of cathodic protection on the cross-site transfer line. However, the basis invokes "recent statements" by Ecology, which are not referenced. The document also does not appear to account for possible fabrication flaws and that the lines cannot be inspected. IQRPE recommends obtaining physical evidence at selected test sites confirming the efficacy of the waterproof jacketing. | Completed | Section 15493, "Chemical Process Piping Systems," of W-058-C2, *Pipeline Tie-Ins for Replacement of The Cross Site Transfer System*, the construction specification for cross-site waste transfer pipelines SNL-3150 and SLL-3160 states that once the installation of the transfer pipelines is complete, then the lines having factory-applied exterior protective coatings (all buried sections of lines) should have their coatings examined for damage with an electrical holiday detector. The field joints, fittings, and short lengths of pipe having field-applied exterior protective coatings should also be examined for damage. The specifications require repair of any damage to the coating in accordance with the manufacturer's instructions. Insulation, including foam and fiberglass reinforced plastic jackets (FRP), are then installed at all bends, field welds, and increased potential corrosion points, consistent with the remainder of the lines. Similar requirements are incorporated in specification W-314-C5, Rev. 1, *Tank Waste Remediation System AN-Farm to 200 East Waste Transfer System*, (see, for example, section 2.2.4, "Protective coating for buried piping and anchor plates," and section 3.1.6, "Exterior Protective Coating").<br>J.R. Divine, the IQRPE of record at the time of line installation, assessed the waterproof coatings of cross-site waste transfer pipelines SNL-3150 and SLL-3160 in WHC-SD-W058-SOIL-001, *Cross-Site Pipeline Evaluation Corrosion Project W058, A Report to Shannon & Wilson, Inc.* As a reference for the EPA statements, Divine listed the Code of Federal Regulation, 40-CFR-280.20 Performance standards for new UST systems, section (a)(3), which states:<br>"In order to prevent releases due to structural failure, corrosion, or spills and overfills for as long as the UST system is used to store regulated substances, all owners and operators of new UST systems must meet the following requirements.<br>(a) *Tanks.* Each tank must be properly designed and constructed, and any portion underground that routinely contains product must be protected from corrosion, in accordance with a code of practice developed by a nationally recognized association or independent testing laboratory as specified below:<br>(3) The tank is constructed of a steel fiberglass-reinforced-plastic composite; or<br>NOTE: The following industry codes may be used to comply with paragraph (a)(3) of this section: Underwriters Laboratories Standard 1746, "Corrosion Protection Systems for Underground Storage Tanks," or the Association for Composite Tanks ACT-100, "Specification for the Fabrication of FRP Clad Underground Storage Tanks."<br>The statements referenced by J.R. Divine were reiterated in an USEPA Memorandum from Anna Hopkins Virbick, Director of Office of Underground Storage Tanks to State UST Program Managers and EPA Regional Program Managers, dated February 23, 1999. The memo states:<br>"Pursuant to a request from the Steel Tank Institute (STI), the Environmental Protection Agency (EPA) is providing guidance regarding the cathodic protection (CP) monitoring of two underground storage tank (UST) technologies. The ACT-100 and, where accepted by implementing agencies according to EPA guidance dated June 25, 1998, ACT-100-U tank technologies meet new tank standards at § 208.20 without the addition of cathodic protection. These tanks are corrosion protected by an external cladding which provides a dielectric barrier between the steel tank and the environment. As long as the integrity of the cladding is maintained, the addition of anodes to these types of tanks at installation provides an additional level of corrosion protection that is beyond minimum requirements described in the federal regulations."<br>Through conversations with J.R. Divine via telephone and email, it was determined that he believes the cross-site transfer lines, and therefore all transfer lines with similar FRP jacketing, meet the design standards of ACT-100 tanks, and therefore meet minimum criterion for corrosion protection required by 40-CFR-280.20. |

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| | | | | A copy of the Anna Hopkins Virbick memorandum is included as an attachment to this report. |
| R26.1 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Establish the 0.03 amp/anode output limit near the tanks as a temporary measure (see Appendix E of Volume 4)<br>1. Establish a 0.03 amp/anode limit within the radius of the distance between the centerline of a DST to a distance where the voltage projection superimposition by three anodes to the side of the DSTs is less than 1.7 volts as soon as possible by measuring current outputs from each individual anode lead over the tanks and to the sides of the tanks (See Appendix E for guidance in superimposition calculation).<br>2. Measure all anode outputs in the DST areas to establish the baseline for modeling the cathodic protection systems for future medication to meet as close to 100% as possible the minimum NACE criterion, NACE Criterion 2 for the important Post-2005 piping.<br>3. During the measurements of anode outputs, record rectifier voltage and install variable resistors into the series circuit circuits formed by the installation of the anode current measurement box (ECN 633212).<br>4. Obtain compaction and resistivity samples when modification to anode circuits near and above the tank are required to ensure projected voltage at the tank rebar is less than 1.7 volt superimposition by three anodes. | Completed | An extensive review of the application of the 0.03 A/anode output criteria was conducted as part of the preparation of RPP-RPT-33664, *Independent Assessment of Cathodic Protection-Related Findings in the 2006 Double-Shell Tank Integrity Assessment Report*. Through the review of CP system design data, as-built construction details, laboratory test data, and discussions with Dodd Ezzard (original CP system designer), a detailed understanding of the development and intended application of the 0.03 A/anode criteria was developed. Details are available in RPP-RPT-33664, but it was generally determined that this anode output limit (applied to minimize the risk of stray current damage to the rebar in the DST concrete) was intended as a guideline, not a strict operational limit.<br>As noted in the Recommendation R22 disposition, measurement of the individual anode outputs has not been completed. The action to complete the anode measurements will be incorporated in the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*. |
| R27 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Incorporate design, testing, and operating parameters<br>1. In future cathodic protection calculations, it is recommended that steady-state | Completed | This recommendation applies to future cathodic protection designs, and therefore may not correctly anticipate the performance requirements. The IQRPE recommendations addressing continued system functionality, especially the annual surveys and the bi-monthly rectifier checks and adjustments, have been completed, and are being performed. |

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| | | resistance gain, due to anodic polarization at the impressed current anode, be accounted in current or voltage calculations.<br>2. In future ATPs, it is recommended to perform the test over a month's time span to compensate for increase in system resistance due to polarization at the anodes.<br>3. In future cathodic protection calculations, it is recommended to conduct resistivity tests for the area of interest, rather than assuming resistivity values.<br>4. It is recommended to determine if there is any 'non-waterproof-covered', stainless steel piping receiving cathodic current, but at a rate where less than 100mV of polarization gain is occurring. If such conditions are determined, it is recommended to ensure at least 100mV of polarization gain is realized on the piping.<br>5. Unless it is definitely proven that the rebar in the concrete surrounding the DST is bonded to the tank, it is recommended to continue designing future CPSs with an anode amperage output limit of 0.03 amps around and above DSTs.<br>6. It is recommended to incorporate the testing of each anode output in any future DST cathodic protection ATP. | | |
| R28 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Measure and Document Anode Current Outputs<br>1. It is recommended to measure the amperage output for each anode with a lead connected to a stud in a DST distribution box.<br>2. ECN 644214, *Supplemental ECN to Change Drawing to Add Detail 8 and Add* | Completed | As noted in the Recommendation R22 disposition, measurement of the individual anode outputs has not been completed. The action to complete the anode measurements will be incorporated in the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*.<br>Procedure 3-CATH-782, Rev. A-1, *Cathodic Protection System Individual Anode Output Measurement*, was released October 11, 2010. Anode output measurements are to be made using a calibrated 30A Clamp-On DC Ammeter and do not require use of the anode current measurement box. The Clamp-On Ammeter is used to measure the anode feeder and loop cables in the anode junction boxes, the anode feeder, loop, and individual anode lead cables in the anode distribution boxes, and the positive rectifier anode lead cables to facilitate determination of the individual anode outputs.<br>The DST distribution box design will be updated via ECN-10-000637 and ECN-10-000638 to enlarge the boxes to ensure electrical access. |

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| | | *Materials List to Drawing and Add Note for Anode Current Box,* shows the anode current measurement box constructed by Fluor Daniel Northwest. The box is located on the Hanford Site in the 200 East Area. This box provides a fast and accurate method of anode current measurement. The box provides the facility to measure the current (i.e., voltage drop across a precision shunt) to 32 anode leads in one step. | | These ECNs are currently in draft form and are awaiting approval. |
| R29 | Not in Scope | Perform Internal Inspections of the Secondary Liner of catch tank AZ-301 Every 10 Years<br>Attachment 2 of Volume 4 contains a letter report from a NACE certified Cathodic Protection Specialist who evaluated the need for cathodic protection and corrosion protection measures on the secondary liner of catch tank AZ-301. The specialist recommended the application of certain exterior coatings in lieu of cathodic protection. However, the recommendation was based on the assumption that damage from the soil side of the secondary containment tank would eventually be detected visually from the inside of the tank and could be repaired. It is therefore recommended to invoke a visual inspection program for the internal side of the secondary liner. Visual inspections on the internal side of the secondary liner should be performed every ten years from the time the tank was installed. The first inspection will be due to be performed in 2015. | Completed | RPP-PLAN-37138, *Work Plan for Assessing the Need for Cathodic Protection on the 241-AZ-301 Condensate Receiver Tank Secondary Containment Vessel*, January 2010.<br>The visual inspection will occur in FY 2014. The action to complete the inspection will be incorporated in the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan.* |
| R30 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Analyze pipelines of Figures 1 through 11 for the applicability for receiving new or additional cathodic protection features.<br>1. With respect to those post-2005 pipelines of Figures 1 through 11 (i.e., those pipelines without stated Waterproof jacketing and without cathodic protection | Completed | RPP-RPT-45264, Rev. 1, *Pipeline Configuration Analysis for Applicability of Cathodic Protection,* released in July 2010, concluded that only bare and conventionally coated lines are compatible with corrosion protection via cathodic protection.<br>According to report RPP-RPT-47435, *Annual Select List Line CP Status Report Based on 2010 Annual Survey Data,* the only Post-2005 pipelines without stated waterproof jacketing and without cathodic protection features are as follows:<br>• PW-471 in 241-AN<br>• PW-472 in 241-AN |

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| | | features), the IQRPE recommends an analysis of these piping configurations to determine whether the risk to those pipes not receiving cathodic protection or not receiving at least 100 mV of polarization gain is acceptable.<br>2. IQRPE does not recommend applying cathodic protection to those raw water post-2005 pipelines (Table 1) that are not located directly above a DST. | | • PW-473 in 241-AN<br>• PW-474 in 241-AN<br>• PW-475 in 241-AN<br>• PW-476 in 241-AN<br>• PW-477 in 241-AN<br>• PW-472 in 241-AW<br>• PW-475 in 241-SY<br>• PW-476 in 241-SY<br>• PW-477 in 241-SY<br>• PW-478 in 241-SY<br>• PW-479 in 241-SY<br>• PW-480 in 241-SY<br>• DR-339 in 241-AW<br>These process waste (PW) lines have no coatings, have a void space created by a parting agent, and are insulated. The coatings of these process waste lines correspond to Cases 3 through 5 in the IQRPE's report RPP-25299.<br>Report RPP-RPT-45264 states that for pipelines within Case 3, cathodic protection is not necessary because the coating system is intact and providing adequate corrosion protection. The report says that for pipelines within Cases 4 and 5, assume that water exists under the insulation regardless of local defects in the insulation or not. If the insulation on the pipe allows water and oxygen from the soil to permeate to the surface, then Corrosion Under the Insulation (CUI) is possible. Because of the shielding effects of the insulation and the tortuous path between the soil and the pipe surface, CP would likely be ineffective.<br>The DR-339 drain line is coated with coal tar enamel and double wrapped with felt wrap and Kraft paper cover wrap. Assuming that there are defects in the coating, the pipeline corresponds to Case 2 in RPP-25299. Report RPP-RPT-45264 states that cathodic protection will be effective in mitigating corrosion at breaks and defects in the coating. There are no plans to excavate and cathodically protect this line: it is unpressurized and exposed to material on an infrequent basis. |
| R31 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Improve documentation accessibility<br>It is recommended to implement and/or evaluate the following documentation suggestions:<br>1. Document cathodic protection test station deliverable sketches as a separate document in RMIS.<br>2. Document an evaluation regarding the need to document the piping leads terminating on test station studs*<br>Obtain from Project files all ATPs and ATRs that were not readily available to the IQRPE and scan into RMIS. | Completed | The Records Management Information System (RMIS) is an obsolete database and has been replaced with the Site's Integrated Document Management System (IDMS). Data that were submitted for inclusion in RMIS have been rolled over to IDMS, thus all the information that was previously submitted to RMIS is available in IDMS.<br>1. Cathodic protection test station deliverable sketches have not been issued as separate documents in the Hanford Site's document management system. However, test station wiring and details are provided by the cathodic protection system as-built drawings completed in 2009.<br>2. Test station terminal information is presented in the as-built drawing set completed in 2009<br>All available acceptance test procedures (ATPs) and acceptance test reports (ATRs) that could be located have been submitted for incorporation into the Hanford Site's document management system. |

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| R32 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Determine whether inaccessible test stations are Post-2005 test stations<br>It is recommended to make a list of the test stations marked as 'N/A' on the data sheets of 3-CATH-690 during the last annual survey of December 2004 to February 2005. That list should be compared against Table 2 of this assessment (RPP-25299, Rev. 1) to determine if any of the piping located underneath the test stations is categorized as a post-2005 pipeline. Those 'N/A' test stations which contain leads to post-2005 piping should be investigated for the nature of their inaccessibility. If feasible, the inaccessibility of post-2005 test stations should be remediated. | Completed | Report RPP-RPT-41570, *Locating Missing Test Stations on Select List Lines*, was released in July 2009. The report identified only one missing test station, (T(77-3)), which is associated with the Select List Lines SL-509 and SL-510. The report notes that these two lines are currently monitored by nine additional test stations. Data from these nine stations indicate the lines are adequately protected. The report concludes that test station (T(77-3)) need not be replaced since the associated lines can be adequately monitored using the nine additional test stations. |
| R33<br>&<br>R33.1 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Performance of bimonthly rectifier inspections and annual polarization surveys<br>1. It is recommended to perform the bi-monthly rectifier survey every two months and to perform the annual polarization survey every year.<br>Pare down annual survey test stations<br>2. Evaluate if the 100 plus test stations representing neither Post-2005 pipelines, 702-AZ ventilation piping, AY-Farm annulus ventilating piping, and raw water piping for the AZ-farm mixer pumps should require annual polarization testing, and if not, determine if it is economically justifiable to de-terminate the electrical leads to the anodes feeding the pipelines represented at these test stations. | Completed | 1. Washington Administrative Code (WAC) 173-303-640 requires that proper operation of a cathodic protection system be confirmed within six months after initial installation and annually after the initial confirmation. Additionally, the sources of impressed current must be inspected and/or tested at least bimonthly. The annual survey and the bi-monthly rectifier inspections have been occurring as required since March 31, 2006. Completion of the annual survey and the bi-monthly rectifier inspections is documented in the applicable work package with the data entered into the Hanford Site Cathodic Protection GIS for trending and analyses.<br>2. The test stations included in 3-CATH-690, Rev. D-0, *Cathodic Protection System Testing* are the test stations associated with the Select List lines, a subset of 128 of the Post-2005 pipelines. The Select List lines are primarily waste transfer, process, drain, and flush lines that cannot easily be repaired or replaced in the event of a corrosion-related failure. A procedure revision was completed to remove all test stations from 3-CATH-690 that were not associated with the 128 Select List lines. However, de-termination of the electrical leads to the anodes feeding the non-Post-2005 and the Post-2005 non Select List lines has not been evaluated. |
| R34 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Perform a detailed cost benefits analysis for performance of a close-interval potential survey (CIPS) to evaluate the effectiveness of the cathodic protection system. The initial CIPS survey may be performed in addition to, | Completed | Report RPP-46762, *Cost Benefit Analysis: One-Time Close Interval Potential Survey of the Hanford Site Select List Pipelines*, September 2010, concluded that the cost of performing the Close Interval Potential (CIP) survey would be substantially higher than the cost of the annual pipe-to-soil potential survey, and would only be effective for the conventionally-coated and bare lines on the Select Lines list. RPP-47175, *Cost Benefit Analysis: Selection of Alternative Direct Inspection Technology for Future Encasement Pipeline Integrity Assessments*, notes that the conventionally-coated and bare lines represent only 4% by length of the Select Lines list. |

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| | | or in lieu of, the annual cathodic protection system survey as required by WAC-173-303-640. | | |
| R35 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Perform a detailed cost benefits analysis for performance of a direct current voltage gradient (DCVG) survey, following the CIPS survey, for Types I through III in CIPS anomalies, to evaluate the integrity of encasement exterior protective coatings. | Completed | Report RPP-46979, *Cost Benefit Analysis: One-Time Direct Current Voltage Gradient Survey of the Hanford Site Select List Pipelines*, September 2010, concluded that the cost of performing the Direct Current Voltage Gradient (DCVG) survey would be substantially higher than the cost of the annual pipe-to-soil potential survey, and would only be effective for the conventionally-coated and bare lines on the Select Lines list. RPP-47175, *Cost Benefit Analysis: Selection of Alternative Direct Inspection Technology for Future Encasement Pipeline Integrity Assessments*, notes that the conventionally-coated and bare lines represent only 4% by length of the Select Lines list.<br>Application of the CIP and DCVG inspection techniques proved to be ineffective and they were dismissed as ineffective in 2010. Justification for dismissing the CIP/DCVG inspections was documented in RPP-RPT-47180, 2010, *"Waterproof" Pipeline Assessment Report*, Rev. 0. |
| R36 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Perform a detailed cost benefits analysis for the selection of a feasible direct inspection technology for future encasement integrity assessments, as required, as a result of CIPS and DCVG survey findings. | Completed | Report RPP-47175, *Cost Benefit Analysis: Selection of Alternative Direct Inspection Technology for Future Encasement Pipeline Integrity Assessments*, November 2010, examined the use of the long range ultrasonic and electromagnetic wave technologies as a means of replacing the use of pressure tests to verify the integrity of buried encasement lines. The estimated inspection costs ranged from $31M to $117M, and the report concluded that there was no viable alternative to encasement pressure testing for evaluating the integrity of buried encasement lines. |
| R37 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Perform a detailed cost benefits analysis for consideration for either supplementing or replacing the annual cathodic protection system survey method (traditional pipe-to-soil potential at the test stations) with the CIPS method for all future annual cathodic protection system surveys in an effort to provide a more accurate and complete determination of the cathodic protection system effectiveness. | Completed | This recommendation extends the one-time Close Interval Potential measurements, as suggested in Recommendation R34, to all future cathodic protection surveys. The possible change was evaluated in RPP-46982, *Cost Benefit Analysis: Supplement or Replace the Annual Cathodic Protection System Pipe-to-Soil Potential Survey with Close Interval Potential Survey on Hanford Site Select List Pipelines*, released in November 2010.<br>The report concluded that it was not cost-effective to replace the annual pipe-to-soil potential survey of the Select List lines with an annual close interval potential survey. Additionally the report noted that the majority of the Select Lines list utilizes non-bonded coating systems. These systems are incompatible with the close interval potential survey method. |
| R38 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Consider for adoption: Develop and adopt a DST system waste transfer line encasement future integrity assessment inspection schedule for implementation, similar to the example provided in Appendix B (RPP-27097, Rev. 1). | Completed | Appendix B, RPP-27097, 2008, *Volume 5: IQRPE DST System Integrity Assessment - Waste Transfer Line Encasement Integrity Technology Study*, Rev. 1, Table B-1 presents an example inspection schedule. The column titled, "Pneumatic Leak Test" lists either "No," or "Optional." The column titled, "Future Indirect Inspection Interval," gives "Close Interval Potential Survey" (CIP) or "Direct Current Voltage Gradient" (DCVG) inspection intervals ranging from one year to 8 – 10 years depending on whether or not a coating fault had been detected during a previous inspection. When RPP-27097 was written in 2008, CIP/DCVG was the recommended indirect integrity inspection technique. However, application of this technique proved to be ineffective, as documented in RPP-RPT-47180, 2010, *"Waterproof" Pipeline Assessment Report*, Rev. 0.<br>The referenced table was constructed and recommended with the purpose of scheduling CIP/DCVG inspections. In lieu of the ineffective CIP/DCVG inspection method, pneumatic pressure testing of the pipeline encasements on a 10 year interval has been implemented. Documentation of the purposeful decision to switch from CIP/DCVG testing to pneumatic pressure testing cannot be located. It is possible that the 10 year requirement was based on empirical field evidence of the number of pneumatic encasement tests that could be completed in |

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| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
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| | | | | one year – about seven or eight. When staggered year to year, a complete test cycle of the 75 active transfer lines works out to about 10 years. It is with this reasoning that the IQRPE recommended interval of 10 years has been adopted for pneumatic pressure testing of the 75 active transfer pipeline encasements.<br>Pneumatic pressure testing of the pipeline encasements is performed using procedure TO-140-170, *Pressure Testing of Pipe-In-Pipe Encasement*. Early revisions of RPP-7574, *Double-Shell Integrity Program Plan*, contained the schedule for pressure testing the transfer pipeline encasements. Updating the program plan for the frequent schedule changes proved impractical and was discontinued in subsequent revisions.<br>A description of encasement pressure testing will be incorporated into the next revision of RPP-7574. The encasement pressure testing will be part of the Fitness-for-Service program. |
| R39 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Consider for adoption: Continue to investigate and assess advancements in long-range UT, specifically EMW technologies. Future development of these and other technologies may provide a more viable method of direct inspection for application to future encasement integrity assessments. | Completed | RPP-RPT-48540, Rev. 0, *Alternatives Generation and Analysis of Methods for Nondestructive Integrity Assessments of Buried Transfer Pipelines and Encasements*, was released in January 2011 as a complementary report to RPP-47175, *Cost Benefit Analysis: Selection of Alternative Direct Inspection Technology for Future Encasement Pipeline Integrity Assessments*. RPP-RPT-48540 evaluated the use of Long Range Ultrasonic Testing (LRUT) for the encasements and concluded that LRUT was not feasible because of the extent of excavation needed to attach UT transmitters and receivers, and because it's high detection threshold would limit it to detecting only major flaws and thinning. |
| R40 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-20<br>See discussion in Section 5.6 | Consider for adoption: Performance of a detailed laboratory examination of any DST system waste transfer line encasements that are removed permanently from service for coating defects, and internal and external corrosion. | Completed | This recommendation is the same as Recommendations R15 and R20. For consistency, the disposition of Recommendation R15 is repeated here:<br>Prior to this recommendation, two sections of the cross-site transfer lines near catch tank 244-A, SNL-3150 and SLL-3160, were removed and samples were analyzed at the 222-S Analytical Laboratory. The SNL-3150 pipe sections consisted of two 3-in. diameter primary pipe stainless steel sections with 6-in. carbon steel encasements. The SLL-3160 pipe sections were control pieces from a line that was not used for waste transfers and consisted of two 3-in. diameter primary pipe stainless steel sections with 6-in. carbon steel encasements. The analysis results cited in Interoffice Memorandum 7S110-GAC-05-035, "Final Analytical Results from the Examination of Corrosion on Sections of 244AR Cross-Site Transfer Pipe," indicated the following:<br>"Both the SNL-3150 and SLL-3160 6-in. pipe sections had a surface corrosion layer that was easily removed. Removal of the corrosion layer revealed sparse shallow pitting as a result of this corrosion. The thickness loss on cleaning for the 6-in. pipes was about 50 to 60μ. This was also the approximate depth of the deepest pits on these specimens."<br>RPP-RPT-47901, Rev. 0, *Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610*, was released November 5, 2010. The assessment of the supernatant and slurry lines focused on corrosion of the encasements to determine the effectiveness of the cathodic protection program. The assessment identified no significant areas of corrosion damage. However, the inspection noted that the coating system used on these lines (non-bonded coating consisting of "dryer-ducting" to create an air gap between the encasement pipe and sprayed-in-place foam insulation) was incompatible with traditional cathodic protection survey techniques and corrosion protection via the Site's cathodic protection system. The report concluded that alternative means of evaluating the extent of cathodic protection should be utilized to assess the protection of these lines. Electrical resistance sensors and permanently-installed reference electrodes were installed on and around these lines. The report states that corrosion rate data from these sensors can be used to track corrosion conditions on these lines and, by inference, other similarly-coated lines that have not been directly inspected.<br>SN-285 and SN-286, two 241-SY tank farm out-of-service supernatant lines, were sampled in FY 2010 and the samples were transferred to the 222-S Analytical Laboratory for examination. The encasement pipe samples were examined for corrosion with observations documented in |

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| | | | | ATS-LAB-RPT-11-00006, Rev. 0, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, released in May 2011. ARES Corporation generated an evaluation, RPP-RPT-49200, Rev. 0, *Direct Assessment of 241-SY Pipelines SN-285 and SN-286*, which concluded that the assessments performed in-situ and in the lab identified no significant areas of corrosion damage at the inspection site.<br><br>The examinations found that:<br><br>"For both pipe sections, the highest level of corrosion and pitting was located on the bottom outside surface of the encasement, and this level of corrosion decreased while traversing up the side and onto the top of the pipe. Corrosion removal treatments showed that the SN-285 pipe section was more corroded, having a corrosion level of 2.2% by mass for the bottom section, compared to SN-286 which had a 1.3% corrosion level for its bottom section. However, the corrosion on both pipe sections did not erode through the pipe as all sampled areas had at least 6 mm of pipe wall thickness that was not corroded. The reported nominal wall thickness of schedule-40 pipe is 7.1 mm, resulting in a rough calculation of maximum corrosion on these two pipe sections to be no greater than 15% with a majority of the other sections of the pipe investigated falling well below this number."<br><br>These lines were installed in the early 1970s; the wall thickness loss reflects nearly three decades in service.<br><br>The primary pipe sections from the SN-285 and SN-286 samples, as well as a sample from SN-278, were examined for erosion and corrosion LAB-RPT-007-12-00007, *Final Report for Corrosion and Erosion Analysis of Waste Transfer Primary Pipe Line*. It is unlikely that a quantitative volume and composition history of these, or other typical waste transfer lines that have been taken out of service can be developed. Recreation of the SN-285 and SN-286 process histories relies on recovery of records for individual waste transfers, and knowledge of the waste compositions transferred through the pipelines. The lines were placed into operation in 1977. Recoverable transfer records for SN-285 and SN-286 are discontinuous, with the longest complete transfer history covering about 400 days of the 30-year period.<br><br>The process envisioned by the IQRPE recommendation relies on exhumation of out-of-service waste transfer lines, and removal of sections of the radioactive piping. Since 2006, when the recommendation was first made, only three samples have been collected – all in 2010 when the lines were excavated for replacements. The opportunistic quality of this effort and the low probability of recreating the process history suggest an alternative is needed, as described below.<br><br>The first quantitative estimate of waste transfer line erosion and corrosion will be made by installing ultrasonic test (UT) instrumentation on Retrieval and Closure piping in portable valve box POR104. Flexible dry-coupled UT arrays will be located on and downstream of supernatant- and slurry-side pipe bends to measure wall erosion over time. The selected locations are based on (Draft) Letter Report, "Washington River Protection Solutions, LLC, Subcontract 30519, Release 103 – Transmittal of Draft Corrosion Sensor Placement Letter Report – Ares Task No. 09054403.03." Four UT sensor arrays will be used on each pipe bend, and a "cal-block" UT thickness control will be employed. The total volume transferred through the lines will be metered, and the volume percent of solids carried on the slurry side will be calculated from sludge volume changes. An estimated 283 kgal of sludge from single-shell tanks (SSTs) C-103, C-108, C-109, and C-110 will be retrieved through POR104. Assuming the slurry was a nominal 5% by volume, the equivalent transfer volume will be about 5.7 Mgal.<br><br>The supernatant- and slurry-side floor nozzle bends removed from POR104 to make way for the replacement piping have been packaged and stored for erosion/corrosion analysis planned in FY 2012. About 342 kgal of sludge was retrieved through the floor nozzles – a nominal 6.9 Mgal of slurry. Testing is described in LAB-PLN-11-0005, Rev. 0, *Test Plan and Procedure for the Erosion Analysis of POR104 Valve Box Pipe from C-Tank Farm*. Records of total volume pumped through the bends and the volume percent of solids in the slurry are available.<br><br>The UT-instrumented POR104 lines and the floor nozzles recovered from POR104 are 2-in. stainless steel, similar to DST jumpers. Jumpers are the only type of readily accessible piping that is routinely changed out, and thus available for testing. |

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| | | | | A description of the opportunistic sampling and erosion monitoring will be incorporated into the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*. |
| R41 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | Consider for adoption:<br>1. Ensure that all heat-traced encasements within the scope of this document are connected to a properly functioning cathodic protection system.<br>2. Consideration for either supplementing or replacing the annual cathodic protection system survey method (traditional pipe-to-soil potential at the test stations) with the CIPS method for all future annual cathodic protection system surveys. | Completed | 1. RPP-RPT-42489, Evaluation of Heat-Traced Buried Transfer Lines with Cathodic Protection, was released in November 2009. This report cites RPP-RPT-40634, Rev. 1, Status of Cathodic Protection on Heat-Traced Select-List Lines, as basis for recommending approximately 5% (or at a minimum, 4) of the 63 lines identified in RPP-RPT-40634 for excavation and examination. The selection criteria used to identify the lines are detailed in RPP-RPT-42487, Evaluation of Buried Transfer Lines with *Cathodic Protection*. Based on these criteria, 241-AP tank farm lines SL-509, SL-510, SN-609, and SN-610 were selected for inspection.<br>RPP-RPT-47901, *Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610*, issued in November 2010, documents the results of the inspections in 241-AP Farm. The inspections revealed no indication of significant encasement corrosion damage. Following the inspections, electrical resistance (ER) sensors and permanent reference electrodes were installed on and near the lines to track corrosion conditions on these and, by inference, other similarly-coated lines.<br>2. Part 2 of Recommendation R41 repeats Recommendations R34 and R37. For consistency, the disposition of Recommendation R34 is repeated here:<br>Report RPP-46762, *Cost Benefit Analysis: One-Time Close Interval Potential Survey of the Hanford Site Select List Pipelines*, was released in September 2010. The report concluded that the cost of performing the Close Interval Potential (CIP) survey would be substantially higher than the cost of the annual pipe-to-soil potential survey, and would only be effective for the conventionally-coated and bare lines on the Select Lines list. RPP-47175, *Cost Benefit Analysis: Selection of Alternative Direct Inspection Technology for Future Encasement Pipeline Integrity Assessments*, notes that the conventionally-coated and bare lines represent only 4% by length of the Select Lines list. |
| R42 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | Flush all DST system waste transfer lines following waste transfer with hot inhibited water (see TFC-ENG-STD-26 for inhibited flush water composition and temperature). Any non-process transfers should also be performed using inhibited water. | Completed | This recommendation results from misinterpretation of a recommendation in SD-RE-TI-044, *Analysis of Pipeline Failure, SL-176*. In the Recommendation section of this report, on page 10, the author states:<br>"Of the possible alternates, using a heated flush solution containing low concentrations of caustic and nitrite offer the best alternates to prevent future pipeline failures."<br>This recommendation was misinterpreted as a requirement to flush waste transfer lines with inhibited water in order to prevent failures similar to SL-176. The document includes a letter from G.D. Aden and R.A. Palmer to L.H. Rodgers. In the letter, Aden and Palmer discuss the failure cause of SL-176 in greater detail. The letter states:<br>"The evidence suggests that the pipe was under significant stress and failed at the point of a small oxide inclusion in the metal. This initial fracture went completely through the pipe at the point of the notch and produced a small leak there. The pipe relieved the stress by developing a crack on the outer surface which initially did not go completely through the pipe."<br>Because the crack occurred on the outer surface of the pipe, flushing the pipe with hot inhibited water following waste transfers would not have prevented its failure.<br>Flushing requirements are described in TFC-ENG-STD-26, *Waste Transfer, Dilution, and Flushing Requirements*, **3.7.3, Corrosion**:<br>2. "The piping system for the DSTs is sloped to minimize the pooling liquids that could cause corrosion to occur. The transfer of compliant waste further reduces the propensity for corrosion in a piping system and as such, raw water flushes are sufficiently protective of the piping system. To ensure the protection of the piping, each transfer of non-compliant waste shall be evaluated for the need of a |

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| | | | | chemical flush. If a flush is required, the following compositions should be used:<br>a. For carbon steel piping, the flushes shall consist of inhibited water, which contains at least 0.01 M hydroxide and 0.011 M nitrite.<br>b. For stainless steel piping flushes shall consist of raw water, de-ionized water, or ionic species that promote the formation of an oxide layer on the pipe surface (e.g., nitrate, phosphate, aluminate, etc.). If an ionic solution is used the species should have a concentration of 0.1M."<br>Due to the misinterpretation of the recommendation in SD-RE-TI-044 as a requirement to flush all pipelines with hot inhibited water, this recommendation is closed without action. |
| R43 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | This document, in conjunction with e-mail Anantatmula 2005-09-16 and internal memo 7G110-05-003 (both included in Appendix E), finds that the following actions are necessary to reduce the possibility of continued corrosion in 241-AW tank farm slurry line SL-167:<br>3. Evaluate the use of a biocide to the exposed portions of the line encasement and exterior surface of the 2-in. primary pipe and 1-in. pipes at cleanout box 241-AW-COB-6 as soon as possible.<br>4. Evaluate the performance of an inhibited water flush of the line to fill the low spot with inhibited water. An inhibited water flush should also follow any transfers in this line as recommended in paragraph 5.4.3(3) above. Evaluate the using inhibited water flush of the line for all verification activities that introduce water into the line or its encasement. | Completed | 1. Interoffice Memorandum 7S110-JBD-07-095, *Letter Report for Microbially Influenced Corrosion, SL-167*, issued by J.B. Duncan to T.M. Blaak on January 18, 2007, evaluates the material on the pipes inside the clean-out box (COB) 241-AW-COB-6 and concludes that it is microbially influenced corrosion (MIC), based on visual inspection. Table 1 in the memorandum provides information on a variety of biocide compounds that can be used to prevent further damage to the carbon steel or other materials of construction from MIC. The report concludes:<br>"As to the control of MIC, it would appear from the literature that there are non-oxidizing biocides available to mitigate MIC in the tank farms without deleterious effects on carbon steel. However, to maximize the effectiveness of the biocide, the protective tubercles should be compromised."<br>Subsequent to the IQRPE's report and the interoffice memorandum, cleanout box 241-AW-COB-6 was removed from SL-167.<br>2. Line SL-167 originates at the 242-A Evaporator. There is no simple way of introducing inhibited water (0.01 M $OH^-$ and 0.011 M $NO_2^-$ for carbon steel lines) to the system, so a workaround is used. At the completion of each campaign, the 242-A Evaporator vessel C-A-1 is deep flushed to remove residual supernatant. A portion of the deep flush is drained through SL-167.<br>If raw water is used in the line instead of residual supernatant, then the line must be used for a waste transfer, or flushed with inhibited water or a portion of the deep flush from the 242-A Evaporator. This must take place within 12 months after the line's last usage. These requirements are described in TFC-ENG-STD-26, *Waste Transfer, Dilution, and Flushing Requirements*, Section 3.7.3.4. |
| R44 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-20<br>See discussion in Section 6.7 | Based on the lack of evidence of the effective operation of the DST system pipeline cathodic protection system specific to any individual line, and the inability to verify the integrity of exterior protective coatings or insulation once buried in the earth, it is recommended that 5% of the buried carbon steel DST system waste transfer line (slurry, supernate, process waste) encasements, and raw water flush lines listed in Appendix A, should be inspected for evidence of corrosion five years following this integrity | Completed | This recommendation is similar to the first part of Recommendations R40 and R41. For consistency, brief portions of those dispositions are repeated here:<br>RPP-RPT-42489, *Evaluation of Heat – Traced Buried Transfer Lines with Cathodic Protection*, was released in November 2009. This report cites RPP-RPT-40634, Rev. 1, *Status of Cathodic Protection on Heat-Traced Select-List Lines*, as basis for recommending approximately 5% (or at a minimum, 4) of the 63 lines identified in RPP-RPT-40634 for excavation and examination. The selection criteria used to identify the lines are detailed in RPP-RPT-42487, *Evaluation of Buried Transfer Lines with Cathodic Protection*. Based on these criteria, 241-AP tank farm lines SL-509, SL-510, SN-609, and SN-610 were selected for inspection.<br>RPP-RPT-47901, *Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610*, issued in November 2010, documents the results of the inspections. The inspections revealed no indication of significant encasement corrosion damage. Following the inspections, electrical resistance (ER) sensors and permanent reference electrodes were installed on and near the lines to track corrosion conditions on these |

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| | | assessment and every five years thereafter, based on the recommended frequency presented in ANSIB 31.1, Appendix V, paragraph V-7.5.<br>At a minimum, two sprayed polyurethane insulated lines and two un-insulated lines with exterior protective coatings should be inspected. Examination for evidence of corrosion should be made by UT. The examinations should focus specifically on pipeline low points and, if possible, areas of the pipe where it is known that field welds were made (e.g., where bends were joined to straight lengths of pipe). The inspection should obtain data points for pipe wall thickness for use in conjunction with a history of transfer duration and frequency through the pipeline for establishment of a representative corrosion rate. The inspection should also examine the exterior protective coatings and insulation for defects and any evidence of water infiltration. The coating or insulation shall be removed nominally 12-in. from either side of the selected inspection point or coating/insulation defect location to expose the pipe for examination.<br>Following the examination, the coating or insulation shall be repaired and or replaced in accordance with the original construction specification. A formal report of findings, whether significant or not, should be documented. That report should include any recommendations for future DST system pipeline integrity assessments seen necessary as a result of the inspection results. This recommendation may be waived if, within five years, buried carbon steel DST pipelines are inspected or examined as a result of recommendation 9 within RPP-27591, Rev. 1. | | and, by inference, other similarly-coated lines.<br>SN-285 and SN-286, two 241-SY tank farm out-of-service supernatant lines, were sampled in FY 2010 and the samples were transferred to the 222-S Analytical Laboratory for examination. The encasement pipe samples were examined for corrosion with observations documented in ATS-LAB-RPT-11-00006, Rev. 0, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, released in May 2011. ARES Corporation generated an evaluation, RPP-RPT-49200, Rev. 0, *Direct Assessment of 241-SY Pipelines SN-285 and SN-286*, which concluded that the assessments performed in-situ and in the lab identified no significant areas of corrosion damage at the inspection site.<br>Determining the process history of transfer lines is highly problematic. For example, the two 241-SY process lines were placed in service in 1977. The earliest recoverable records begin in 1984; these are lists of active transfer routes, not the transfers or the transfer volumes. An approximation could be made using month-end liquid level changes in tank SY-102, where both of these lines terminate, but its value would be suspect.<br>A coated, non-insulated process line in the 241-AY tank farm, PW-4531, was examined in FY 2011. There was no significant corrosion found during the inspection. |
| R45 | IQRPE Concurs with Completion | A formal integrity assessment should be performed on all DST system waste transfer, drain, and process waste lines eight years after | Completed | This recommendation is a variation of Recommendation R38. For consistency, part of the Recommendation R38 disposition is referenced in this disposition.<br>The inclusion of waste transfer lines in this recommendation implies the inclusion of the pipeline encasements. In lieu of a ten year life of the |

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| | See discussion in Section 5.6 | the issuance of this integrity assessment | | IQRPE integrity assessment, as indicated in RPP-28538, *Volume 1: IQRPE Double-Shell Tank System Integrity Assessment, HFFACO M-48-14*, this recommendation can be interpreted to imply that the waste transfer lines should be governed by an eight year assessment interval.<br><br>There are numerous encasement test interval contradictions that exist in RPP-28538, *Volume 1: IQRPE Double-Shell Tank System Integrity Assessment, HFFACO M-48-14*, and its supporting documents. Some conflicts arise because the integrity assessment assumed an alternate method of encasement testing; others have resulted from mid-stream changes that were not back-checked for consistency against previous iterations. The following are three key conflicts:<br><br>1. RPP-27591, 2006, *DST System Pipeline Integrity Assessment*, Rev. 0, states, "…A formal integrity assessment should be performed on all DST system waste transfer, drain, and process waste lines eight years after issuance of this integrity assessment. …" (Page 73). Encasement testing is not specifically identified in this statement.<br>2. RPP-27591, 2007, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*, Rev. 1, states "…A formal integrity assessment should be performed on all DST system waste transfer, drain, and process waste lines no later than ten years after issuance of this integrity assessment …" (Page 73). Between 2006 and 2008, the inspection interval had been extended two years. As noted in item 1 above, encasement testing is not specifically identified in this statement.<br>3. Encasement pressure testing is likely not specifically identified due to the decision to utilize alternate assessment methods, "Close Interval Potential Survey" (CIP) or "Direct Current Voltage Gradient" (DCVG). RPP-27097, 2008, *Volume 5: IQRPE DST System Integrity Assessment – Waste Transfer Line Encasement Integrity Technology Study*, Rev. 1, said the following about encasement pressure testing:<br><br>"Per the IQRPE's recommendation, all encasements within the scope of this document will be pneumatically leak tested. Leak testing is under way, and is scheduled for completion this year… considering the historical record of waste transfer line encasement failures, future leak testing may not be necessary if proper indirect DCVG and CIPs surveys reveal an encasement as no coating faults…" (page iii).<br><br>From the disposition of Recommendation R38:<br><br>Close Interval Potential Survey (CIP) or Direct Current Voltage Gradient (DCVG) inspections were to be substituted for pneumatic encasement pressure tests after the first round was complete and be performed on an 8-10 year interval per IQRPE recommendation. Detail of these inspection methods can be found in RPP-27097, 2008, *Volume 5: IQRPE DST System Integrity Assessment – Waste Transfer Line Encasement Integrity Technology Study*, Rev. 1. Application of the CIP and DCVG inspection techniques proved to be ineffective and they were later dismissed as ineffective in 2010. Justification for dismissing the CIP/DCVG inspections was documented in RPP-RPT-47180, 2010, *"Waterproof" Pipeline Assessment Report*, Rev. 0.<br><br>Combining the ten year interval from RPP-27591, 2007, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*, Rev. 1, with the recommendation of RPP-27097, 2008, *Volume 5: IQRPE DST System Integrity Assessment – Waste Transfer Line Encasement Integrity Technology Study*, Rev. 1, and knowing the ineffectiveness of the CIP/DCVG inspection methods, there was a logical path that led to a fixed encasement pneumatic pressure testing interval. Intention of an eight or ten year interval is subject to contradictory remarks in the various IQRPE- prepared documents.<br><br>• RPP-28538, 2006, *Volume 1: IQRPE Double Shell Tank System Integrity Assessment, HFFACO M-48-14*, Rev. 0, states that the DST system should be re-assessed every ten years (page 114). Table G-2, Recommendation R45, states, "…A formal integrity assessment should be performed on all DST system waste, transfer, drain, and process waste lines eight years after issuance of this integrity assessment" (page G-46). This recommendation is extracted from RPP-27591, 2006, *DST System Pipeline Integrity Assessment*, Rev. 0, that states, "…A formal integrity assessment should be performed on all DST system waste transfer, drain, and process waste lines eight years after issuance of this integrity assessment." This pipeline integrity supporting documentation is generally consistent with |

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| | | | | the Table G-2 recommendations, even if inconsistent with the overall 10 year assessment requirement.<br>• RPP-28538, 2008, *Volume 1: IQRPE Double Shell Tank System Integrity Assessment, HFFACO M-48-14*, Rev. 5, states that the DST system should be re-assessed every ten years (page 10-1), which is consistent with RPP-28538, Rev. 0, as discussed in the preceding paragraph. Table G-2, Recommendation R45, states, "…A formal integrity assessment should be performed on all DST system waste, transfer, drain, and process waste lines eight years after issuance of this integrity assessment" (page G-52). The wording is identical to RPP-28538, Rev. 0, except that the recommendation's source is not cited as RPP-27591, 2007, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*, Rev. 1, the updated and retitled version of RPP-27591, Rev. 0. The text in RPP-27591, Rev. 1 specifies, not an eight year interval, but a ten year interval as follows:<br>"…A formal integrity assessment should be performed on all DST system waste transfer, drain, and process waste lines not later than ten years after issuance of this integrity assessment, and each subsequent ten-year period" (page 73).<br>This interval change was not propagated through to RPP-28538, Rev. 5, Table G-2.<br>In lieu of the ineffective CIP/DCVG inspection methods, pneumatic pressure testing of the pipeline encasements on a 10 year interval has been implemented. Documentation of the purposeful decision to switch from CIP/DCVG testing to pneumatic pressure testing cannot be located. It is possible that the 10 year interval was based on empirical field evidence of the number of pneumatic encasement tests that could be completed in one year – about seven or eight. When staggered year to year, a complete test cycle of the 75 active transfer lines works out to about 10 years. It is with this reasoning that the IQRPE recommended interval of 10 years has been adopted for pneumatic pressure testing of the 75 active transfer pipeline encasements.<br>Drain lines cannot be assessed by traditional means of pneumatic pressure testing because they are open at each end (i.e., at the pump pits and where they drain waste back into the tanks). There is no need to pressure test drain lines because they are never pressurized during operations. Therefore, integrity assessments of the drain lines are not performed.<br>Early revisions of RPP-7574, *Double-Shell Integrity Program Plan*, contained the schedule for pressure testing the transfer pipeline encasements. Updating the program plan for frequent schedule changes proved impractical and was discontinued in subsequent revisions.<br>A description of encasement pressure testing will be incorporated into the next revision of RPP-7574, *Double-Shell Tank Program Plan*, to comply with RPP-RPT-52206, 2012, *Tank Farms Waste Transfer System Fitness-for-Service Requirements and Recommendations*, Rev. 0. |
| R46 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | There is no indication, via either the documented video inspections, pneumatic encasement leak test results, observed material loss and resulting corrosion rate for line SL-167 or Estimated Remaining Useful Life (ERUL) calculation results that provides evidence that the encasements are susceptible to failure due to a common failure mechanism. Thus, these systems do not warrant periodic encasement leak testing, other than testing as required in the future DST system pipeline integrity assessment recommended above, or as required for deferred use, emergency use only, or approved variance | Completed | This recommendation to discontinue periodic encasement leak testing is inconsistent with IQRPE Recommendations R38 and R45:<br>R38: Consider for adoption: Develop and adopt a DST system waste transfer line encasement future integrity assessment inspection schedule for implementation, similar to the example provided in Appendix B (RPP-27097, Rev. 1).<br>R45: A formal integrity assessment should be performed on all DST system waste transfer, drain, and process waste lines eight years after the issuance of this integrity assessment.<br>This recommendation statement was incomplete in RPP-27591, 2006, *DST System Pipeline Integrity Assessment*, Rev. 0, and was copied verbatim into RPP-27591, 2007, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*, Rev. 1. The phrase, "…these systems do not warrant periodic encasement leak testing…," was used because an alternate method of evaluating encasement integrity had been selected.<br>As was described in the disposition of Recommendations R38 and R45, "Close Interval Potential Survey" (CIP) or "Direct Current Voltage Gradient" (DCVG) inspections were to be substituted for pneumatic encasement pressure tests after the first round was complete and be performed on an 8-10 year interval per IQRPE recommendation. Detail of these inspection methods can be found in RPP-27097, 2008, |

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| | | pipelines within one year or prior to use. | | *Volume 5: IQRPE DST System Integrity Assessment – Waste Transfer Line Encasement Integrity Technology Study*, Rev. 1. Application of the CIP and DCVG inspection techniques proved to be ineffective and they were later dismissed as ineffective in 2010. Justification for dismissing the CIP/DCVG inspections was documented in RPP-RPT-47180, 2010, *"Waterproof" Pipeline Assessment Report*, Rev. 0.<br>Pneumatic pressure testing of pipeline encasements on an 8-10 year interval has evolved to be the chosen indirect inspection technique to evaluate active transfer pipeline encasement integrity. This evolution was detailed in Recommendations R38 and R45 and is repeated below in this disposition for clarity.<br>In lieu of the ineffective CIP/DCVG inspection methods, pneumatic pressure testing of the pipeline encasements on a 10 year interval has been implemented. Documentation of the purposeful decision to switch from CIP/DCVG testing to pneumatic pressure testing cannot be located. It is possible that the 10 year interval was based on empirical field evidence of the number of pneumatic encasement tests that could be completed in one year – about seven or eight. When staggered year to year, a complete test cycle of the 75 active transfer lines works out to about 10 years. It is with this reasoning that the IQRPE recommended interval of 10 years has been adopted for pneumatic pressure testing of the 75 active transfer pipeline encasements.<br>No action is taken on this recommendation. |
| R47 | IQRPE Concurs with Completion<br>See discussion in Section 5.6 | A formal Estimated Remaining Useful Life (ERUL) calculation should be performed to assess the structural impact of corrosion/erosion on the DST system pipelines. Although video inspections, pneumatic encasement leak testing, operational and failure history, and ERUL calculations seem to indicate that relatively few, if any, waste transfer lines would fail during the 2028 mission, formal testing to establish a valid corrosion rate is necessary to assure this conclusion. That analysis should incorporate data resulting from tests performed to establish a relevant corrosion/erosion allowance and/or rate for DST waste simulant flowing through ASTM A53 or ASTM A106 carbon steel pipe at maximum velocities expected during DST system waste transfers, or 10-ft/sec, whichever is greater. The time basis for the rate should be associated with a maximum estimated transfer frequency and duration for the DST system waste transfer pipelines. | Completed | ERUL calculations will be based on empirical data gathered from field samples. Lines SN-285 and SN-286, two 241-SY tank farm out-of-service supernatant lines, were sampled in FY 2010 and the samples transferred to the 222-S Analytical Laboratory for examination. The encasement pipe samples were examined for corrosion and observations were documented in ATS-LAB-RPT-11-00006, Rev. 0, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, released in May 2011. ARES Corporation generated an evaluation, RPP-RPT-49200, Rev. 0, *Direct Assessment of 241-SY Pipelines SN-285 and SN-286*, which concluded that the assessments performed in-situ and in the laboratory identified no significant areas of corrosion damage at the inspection site. The primary pipe samples will be analyzed in FY 2012.<br>In order to use the laboratory data to develop an ERUL, the total flow through the primary pipe and the flow composition are both required. Lines SN-285 and SN-286 were first used in 1977. Recoverable transfer records for SN-285 and SN-286 are discontinuous, with the longest complete transfer history covering about 400 days of the 30-year period.<br>A rough approximation of total flow can be made by summing the monthly liquid level changes reported for tank SY-102, the termination point for both of the lines, but the liquid level changes include material entering the tank that did not pass through the two lines. For example, 222-S Analytical Laboratory waste discharged into the tank from a dedicated line for part of the tank's history. The composition of the waste transferred through the lines is more problematic than the volume, since most transfers were made using a calculated composition; similarly, the solids content of the transfers was rarely determined.<br>A workaround may be to monitor pipeline jumpers for the evidence of erosion/corrosion. The workaround is described in the Recommendation R15 disposition, and is repeated here for consistency:<br>The process envisioned by the IQRPE recommendation relies on exhumation of out-of-service waste transfer lines and removal of sections of the radioactive piping. Since 2006, when the recommendation was first made, only three samples have been collected – all in 2010 when the lines were excavated for replacements. The opportunistic quality of this effort and the low probability of recreating the process history suggest an alternative is needed, as described below.<br>The first quantitative estimate of waste transfer line erosion and corrosion will be made by installing ultrasonic test (UT) instrumentation on Retrieval and Closure piping in portable valve box POR104. Flexible dry-coupled UT arrays will be located on and downstream of supernatant- and slurry-side pipe bends to measure wall erosion over time. The selected locations are based on (Draft) Letter Report, "Washington River Protection Solutions, LLC, Subcontract 30519, Release 103 – Transmittal of Draft Corrosion Sensor Placement Letter |

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| | | | | Report – Ares Task No. 09054403.03." Four UT sensor arrays will be used on each pipe bend, and a "cal-block" UT thickness control will be employed. The total volume transferred through the lines will be metered, and the volume percent of solids carried on the slurry side will be calculated from sludge volume changes. An estimated 283 kgal of sludge from single-shell tanks (SSTs) C-103, C-108, C-109, and C-110 will be retrieved through POR104. Assuming the slurry was a nominal 5% by volume, the equivalent transfer volume will be about 5.7 Mgal.<br><br>The supernatant- and slurry-side floor nozzle bends removed from POR104 to make way for the replacement piping have been packaged and stored for erosion/corrosion analysis planned in FY 2012. About 342 kgal of sludge was retrieved through the floor nozzles – a nominal 6.9 Mgal of slurry. Testing is described in LAB-PLN-11-0005, Rev. 0, *Test Plan and Procedure for the Erosion Analysis of POR104 Valve Box Pipe from C-Tank Farm*. Records of total volume pumped through the bends and the volume percent of solids in the slurry are available.<br><br>The UT-instrumented POR104 lines and the floor nozzles recovered from POR104 are 2-in. stainless steel, similar to DST jumpers. Jumpers are the only type of readily accessible piping that is routinely changed out, and thus available for testing. |
| R48 | IQRPE Concurs with Completion<br><br>See discussion in Section 5.6 | An ECN should be written to update the hose information table on H-14-103596 (via ECN-720301-R0) to reflect the June 1, 2006 HOSE-SY101-PPP/SYA expiration date. | Completed | The hose-in-hose transfer line (HIHTL), HOSE-SY101-PPP/SYA, was replaced in January 2007. Engineering Change Notice ECN-720301-R2 reflects the installation and new service date.<br><br>Drawing H-14-106249, *HIHTL Tracking Table*, was created to describe and monitor all in-service HIHTLs and to ensure the lines are not used after they have reached the end of their service life. The table documents the in-service date, service life expiration date, mission description, mission completion date, required removal date, and the actual removal date, among other pertinent information. |
| R49 | IQRPE Concurs with Completion<br><br>See new 2016 DSTAR IQRPE Recommendation R16-20<br><br>See discussion in Section 5.6 | a.) Any statistically representative samples of DST pipelines removed from service (via failure, end of life, or other cause for removal from service) should be unearthed and examined in a laboratory for corrosion/erosion, and failure mode as necessary. Examination for evidence of corrosion should be made by UT. The examinations should focus specifically on pipeline low points and if possible areas of the pipe where it is known that field welds were made (e.g., where bends were joined to straight lengths of pipe). The inspection should obtain data points for pipe wall thickness for use in conjunction with a history of transfer duration and frequency through the pipeline for establishment of a representative corrosion rate. The inspection should also examine the exterior protective coatings and insulation for defects and any evidence of water infiltration.<br><br>b.) Please provide copies of the associated reports, if available, that describe the actions that have been taken, or are | Completed | This recommendation reiterates Recommendations R15, R40, R41, R44 and R47 For consistency, brief portions of those dispositions are repeated here:<br><br>a.) Lines SN-285 and SN-286, two 241-SY tank farm out-of-service supernatant lines, were sampled in FY 2010 and the samples were transferred to the 222-S Analytical Laboratory for examination. The encasement pipe samples were examined for corrosion and observations documented in ATS-LAB-RPT-11-00006, Rev. 0, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline from SY Tank Farm*, released in May 2011. ARES Corporation generated an evaluation, RPP-RPT-49200, Rev. 0, *Direct Assessment of 241-SY Pipelines SN-285 and SN-286*, which concluded that the assessments performed in-situ and in the laboratory identified no significant areas of corrosion damage at the inspection site. The primary pipe samples will be analyzed in FY 2012.<br><br>Four lines in 241-AP tank farm (SL-509, SL-510, SN-609, and SN-610) were exhumed and inspected. The inspection identified no significant areas of corrosion damage at the inspection site. Electrical resistance sensors and permanently-installed reference electrodes were installed on and around these lines. The corrosion rate data from these sensors can be used to track corrosion conditions on these lines at the electrode sites and, by inference, other similarly-coated lines that have not been directly inspected.<br><br>Line PW-4531, located in 241-AY farm, was selected for excavation and inspection in FY 2011 because it has several sections with varying levels of protection and because of its accessibility for excavation. RPP-RPT-50271, Rev. 0. *Direct Assessment of 241-AY Farm Line PW-4531, October 13, 2011, provides details of this excavation and inspection.*<br><br>b.) The next revision of existing program plan RPP-7574, *Double-Shell Tank Integrity Program Plan*, will incorporate the remaining incomplete activities from the IQRPE's recommendations. The items intended for incorporation have been noted in these dispositions.<br><br>c.) A separate plan for primary piping recommendations that mirrors RPP-PLAN-45268, Rev. 0, *Hanford Site Cathodic Protection Monitoring Program Plan*, has not been developed. A significant number of the recommendations that could be classified as primary piping system recommendations are being addressed in the context of cathodic protection. See, for example, Table 2-1, *Status of Activities Described in RPP-PLAN-35917*, in RPP-PLAN-45268. RPP-RPT-52066, 2012, *Tank Farms Waste Transfer System Fitness-for-Service Requirements and Recommendations*, Rev. 0, provides a basis for the Fitness-for-Service program. This program will also address primary piping |

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| | | currently planned to address the IQRPE recommendations, cited above, for the primary piping system?<br>c.) Has a program plan to address the IQRPE recommendations for the primary piping system been developed similar the plan developed for the cathodic protection system (RPP-PLAN-45268)? | | recommendations. |
| R50 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-3<br>See discussion in Section 4.5 | 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. | Completed | RPP-PLAN-46847, Rev. 0, *Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks*, Table 3-2, *Criteria for Double Shell Annulus Inspections*, includes inspection criteria for the concrete refractory.<br>Section 3.2, "Double-Shell Tank Visual Inspections," references operating procedure TO-020-142, *Visual Examination of DST Annuli and Interior*, which explains how the inspection of the insulating concrete is performed.<br>Visual inspection reports, which refer to the inspection of the refractory concrete as part of the Annulus Visual Inspections, are generated after a visual inspection is performed. The inspection reports emphasize trends in the condition of the tank over time. If cracks are noted during the inspection, these are tracked to monitor additional deterioration.<br>The following is a list of the most recent inspection reports:<br>• RPP-RPT-31599, *Double-Shell Tank Integrity Inspection Report for 241-AN Tank Farm*<br>• RPP-RPT-34310 , *Double-Shell Tank Integrity Inspection Report for 241-AZ Tank Farm*<br>• RPP-RPT-34311, *Double-Shell Tank Integrity Inspection Report for 241-AY Tank Farm*<br>• RPP-RPT-38738, *Double-Shell Tank Integrity Inspection Report for 241-AP Tank Farm*<br>• RPP-RPT-39149, *Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm*<br>• RPP-RPT-42147, *Double-Shell Tank Integrity Inspection Report for 241-AW Tank Farm*. |
| R51 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-5. Note: AY-102 is not in scope.<br>See discussion in Section 4.5 | UT examinations should continue on the current frequency and schedule, except for tanks AY-101 and AY-102. UT examination frequencies for those tanks should be increased to every 1-2 years until such time that it can be shown the corrosion is not progressing at rates greater than 1 mil/year. The UT examinations on AY-101 should include the riser 89 areas of the LAI previously examined in 2001 and 2002. | Completed | Ultrasonic examinations of the primary tanks are being performed on an 8- to 10-year cycle in accordance with the schedule provided in Appendix B, "Double-Shell Tank Integrity Project Baseline Schedule," published in RPP-7574, Rev. 2, *Double-Shell Tank Integrity Program Plan*. In the past, the schedule was modified when necessary to meet field limitations such as accessibility, and to take advantage of equipment and resource opportunities; however, the schedule was removed from RPP-7574, Rev. 3. A description of the schedule for ultrasonic examinations of the primary tanks will be incorporated into the next revision of RPP-7574.<br>Based on the lack of progression of wall thinning shown by the UT measurements, the general results from the AY-102 corrosion probe which shows that the waste is not aggressive to the primary tank, and the corrosion chemistry results from the Det Norske Veritas (DNV) laboratory, it has been determined that corrosion rates have never exceeded 0.001-in. per year. Therefore, UT examination frequencies do not need to be increased to every 1 to 2 years.<br>RPP-RPT-32137, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AY-102 – FY 2007*, issued June 4, 2007, documents the required the required ultrasonic examination of DST 241-AY-102 performed during FY 2007. This examination included specified primary tank and secondary tank wall areas, welds, and lower knuckle region. There was no indication of cracking or pitting in any of the plate areas examined. There were four areas of wall thinning that met the threshold for reporting that did not exceed the minimum acceptance criteria of 80 percent of nominal plate thickness. |

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| | | | | RPP-RPT-47563, Rev. 0, *Ultrasonic Inspection Results for Liquid/Air Interface Region of Double-Shell Tank 241-AY-101 – FY 2010*, issued September 24, 2010, documents the third examination of the liquid/air interface region of the DST 241-AY-101. This inspection found 14 areas of wall thinning, no reportable pitting, and no crack-like indications. |
| R52 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-5<br>See discussion in Section 4.5 | 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. | Completed | The recommendation is an extension of Recommendation R10. For consistency, the disposition is repeated here:<br>Ultrasonic testing inspection of the secondary liner lower knuckle was attempted on tank AY-101 in FY 2003. Concrete debris prevented the crawler from accessing the inspection points. RPP-15763, Rev. 0, *Supplement 2 to Inspection Results for Double-Shell Tank 241-AY-101 – FY 2003*, released in March 2004, described the inspection difficulties in section 10.0, "Inspection Results," under the paragraph entitled "Secondary tank bottom." Upon deployment of P-scan crawlers, both the traditional and the smaller modified crawler encountered debris which could not be removed and interfered with and prevented examination of the secondary tank bottom and lower knuckle.<br>Ultrasonic testing inspections of secondary liner lower knuckles were performed on two DSTs with reports generated to document the results of the UT inspections:<br>• RPP-18447, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-104 – FY 2004*, was released in September, 2004. The report concluded that no reportable wall thinning was detected in any of the plate areas examined. This includes the secondary liner bottom and lower knuckle.<br>• RPP-RPT-27467, Rev. 0, *Supplemental Ultrasonic Inspection Results for Double-Shell Tank 241-AN-105 – FY 2005*, was released in March 2006. The report concluded that examination of the secondary tank floor (which includes the knuckle, as can be seen in Figure 10-2) revealed no areas of reportable thinning or pitting. |
| R53 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-5<br>See discussion in Section 4.5 | 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. | Completed | Tank SY-101 received an ultrasonic inspection during FY 2004 and FY 2006. The initial P-scan inspection was completed in the second quarter of FY 2004, and the final inspection was completed in the first quarter of FY 2006. The results are summarized in RPP-RPT-39149, Rev. 0, *Double-Shell Tank Inspection Report for 241-SY Tank Farm*, and reported in detail in RPP-18444, Rev. 1, *Ultrasonic Inspection Results for Double –Shell Tank 241-SY-101 – FY 2004 and FY 2006*.<br>The tank SY-101 second round UT inspection was originally scheduled for FY 2011. However, construction in the 241-SY tank farm prevented inspection access to the tank.<br>The tank was rescheduled for its UT inspection in FY 2012, six years after RPP-18444 was issued. The interval between the first round and second round UT inspections is consistent with the RPP-7574, Rev. 2, *Double-Shell Tank Integrity Program Plan* 7 to 10 year inspection interval requirement. The tank waste composition is compliant with the corrosion chemistry limits in operating specification OSD-T-151-00007, *Operating Specifications for the Double-Shell Tanks;* no further wall thinning is expected.<br>Tank SY-101 was inspected during FY 2012. This inspection has been documented in the report RPP-RPT-52572, 2012, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-101 – FY 2012, Rev. 0.* Figure 7-1, "UT Scan Paths on West Side of Tank 241-SY-101 Primary Wall (via Riser-026)," on page 14 shows that this inspection was conducted in Riser 26. Plate #1 was included in this inspection and no reportable wall thinning was discovered. Table ES-2, "FY 2004 and 2012 Average Wall Thickness," and Table ES-3, "FY 2004 and 2012 Average Minimum Wall Thickness," on page vii provide evidence of this. As such, no additional evaluation will be performed. |
| R54 | IQRPE Concurs with Completion<br>See discussion in | A workshop of experts should be held to determine a path-forward on vapor space corrosion for the Hanford DSTs. The workshop should: | Completed | This recommendation is an extension of Recommendation R17.<br>The vapor space corrosion workshop was held in Richland, WA, July 10 – 12, 2006; the proceedings are published as RPP-RPT-31129, Rev. 0, *Expert Panel Workshop of Double-Shell Tank Vapor Space Corrosion Testing*. The workshop concluded that: |

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| | Section 11.6 | • 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.<br>• Review the consequences of through-wall pitting in the tank dome.<br>• Propose techniques for mitigation of vapor space corrosion and recommend methods for implementation and use, if required.<br>• Evaluate and explore techniques for accelerated laboratory corrosion testing of vapor space conditions. | | "...there is not yet sufficient technical information for a comprehensive evaluation of the propensity for vapor space corrosion, for the design of simulants for corrosion testing, and for the desired determination of the relationship between changes in waste chemistry and corrosion in the vapor space."<br>The expert panel offered eight recommendations needed to establish a meaningful vapor space corrosion testing program and a means to evaluate the effects of waste chemistry changes on vapor space corrosion.<br>In FY 2007, Pacific Northwest National Laboratory (PNNL) began a literature review that became the basis for thermodynamic modeling of the chemical species in the tank vapor space; subsequently, PNNL performed experiments to confirm the modeling results, and Savannah River National Laboratory performed tank steel corrosion studies supporting the vapor space research. PNNL-19767, *Chemical Species in the Vapor Phase of Hanford Double-Shell Tanks: Potential Impacts on Waste Tank Corrosion Processes*, was published by the Pacific Northwest National Laboratory in September, 2010. The report states:<br>"The overall objective of this research program was to determine the changes in supernatant or condensate chemistry that could occur on the surface of waste tank steels as the solutions dried and exchanged gases with the vapor phase, and to determine what potential impacts such changes could have on the corrosion of DST steels in the tank headspace."<br>The vapor space work through FY 2010 is summarized in PNNL-19767, *Chemical Species in the Vapor Phase of Hanford Double-Shell Tanks: Potential Impacts on Waste Tank Corrosion Processes.* PNNL-19767 summarizes the research to date:<br>"...although a wide range of vapor species have been identified in the DST's, the principal gas phase species likely to impact waste tank corrosion were $CO_2$ and $NH_3$ since these gases were present at much higher concentration than any other gases in the system and can act as either acids ($CO_2$) or bases ($NH_3$) as they exchange with tank condensates or supernatants....the use of chemical models to predict the near surface chemical composition of evaporating supernatants appears justified if the results are interpreted as the worst possible case in terms of the solution pH value. Although very preliminary, the initial studies of tank steel corrosion, using the equilibrated waste tank simulant composition, appear (sic) to follow the expected trends of greater corrosion rates at high nitrate concentration and lower pH."<br>The tank steel corrosion work is reported in SRNL-STI-2010-00509, *Corrosion Testing in Simulated Tank Solutions*.<br>Section 3.5.6, "Vapor Space Corrosion," of RPP-7574, *Double-Shell Tank Integrity Program Plan*, Rev. 4, discusses the vapor space corrosion work completed by PNNL and a Vapor Space Corrosion Expert Panel. |
| R55 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-1<br>See discussion in Section 4.5 | 1. All DSTs, except for AY-101 and AY-102, should be assessed for integrity by an IQRPE in 10 years (the year 2017). As a precautionary measure, tanks AY -101 and AY-102 should be assessed for integrity by an IQRPE in 5 years (the year 2012). These assessments 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.<br>2. Assessment frequencies for DST components (e.g., ancillary equipment) are | Completed | This recommendation proposes a shortened interval between inspections for tanks AY-101 and AY-102 based on the tanks' history as of 2006. Subsequent evaluations and real-time monitoring demonstrate that mitigation activities have reduced the measured corrosion rates in the tanks to near zero. As a result of these changes, the recommended increase in UT monitoring was not adopted.<br>1. According to RPP-7574, Rev. 2, *Double-Shell Tank Integrity Program Plan*, the double-shell primary tanks and annuli will receive visual examinations every 5 to 7 years; the primary tanks will receive ultrasonic examinations every 8 to 10 years. Tanks AY-101 and AY-102 are scheduled for second round UT examination in FY 2012. Both the lower knuckle and liquid-air interface of each tank will be inspected. It should be recognized that in some cases, schedule changes are required due to accessibility limitations, as occurred for tank SY-102 in FY 2011, or opportunistic testing presented by a different DST.<br>Concerns about tank AY-101 liner integrity arose in FY 2002 after the first UT examination detected a corrosion band at an elevation of 321-in. – 343-in, corresponding to long-term waterlines. In one small area near the 343-in. water line, 20 percent of the wall thickness had been lost. A review of the tank is summarized in RPP-13361, Rev. 0, *Tank 241-AY-101 Fitness for Service*. The review concluded that |

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| | | provided in the appropriate sections of this document. | | the tank was fit for waste storage with no operational restrictions.<br><br>During FY 2007, the 222-S Analytical Laboratory evaluated the corrosion potential for the tank AY-101 and AY-102 supernatants and sludges. The conclusion, reported in RPP-RPT-34697, Rev. 0, *Electrochemical Corrosion Report for Tanks 241-AW-103, 241-AZ-102, 241-AN-106, 241-AN-107, 241-AY-101 and 241-AY-102*, was that, "...the corrosion rates were found to be less than 1 mpy (mil per year) for both supernatant and solids samples..." The corrosion rate is less than the allowable 1 mil per year allowable rate.<br><br>A Multi-Probe Corrosion Monitoring System was installed in tank AY-101 on April 30, 2009 to provide continuous feedback on the corrosion potential of the waste. Initially, weekly corrosion potential summaries were published; later, the summaries were reported quarterly. The latest available report (as of May 2011), RPP-RPT-41206, Rev. 19, *241-AY-101 Multi-Probe Corrosion Monitoring System: May, June, July 2010 Quarterly Report*, concludes:<br><br>"...the immersed ER sensors on the MPCMS have indicated corrosion rates of near 0 mpy (mils per year) during the current reporting period. This is consistent with what would be expected for carbon steel in a passive, high-pH environment."<br><br>Tank AY-101 is on a shortened, three-year liquid-air interface UT interval until FY 2013. After FY 2013 the interval is extended to five years, anticipating that no further corrosion will be detected at the liquid-air interface.<br><br>The UT interval for tank AY-102 has remained unchanged at 8 to 10 years. Laboratory work in FY 2007, reported in RPP-RPT-34697, confirmed that the supernatant and solids have a low propensity for pitting and stress corrosion cracking. The laboratory work has been confirmed by installation of an MPCMS corrosion monitoring probe in the tank on May 1, 2009. During fabrication, and following installation, the MPMCS experienced a significant number of wiring errors and electrode failures. The latest available report, RPP-RPT-40661, Rev. 22, *241-AY-102 Multi-Probe Corrosion Monitoring System: February 2009* (sic – February 2010) *Monthly Report*, concludes that, "...Over the current reporting period, the operational ER sensors on the MPCMS have indicated corrosion rates well under 1 mils per year (mpy)."<br><br>In August, 2012, unexplained material was discovered on the Tank AY-102 annulus floor during a trouble-shooting visual inspection of the Riser 90 annulus leak detection probe. Subsequently, a ≥ 95% visual inspection of the annulus floor was performed and additional materials discovered near Riser 83. Samples from both sites confirmed that the material was tank waste. A formal leak assessment, published as RPP-ASMT-53793, *"Tank 241-AY-102 Leak Assessment Report,"* concluded that the origin of the material was a leak from the primary tank. Subsequent to this determination, an Extent of Condition evaluation identified six other "at risk" DSTs, AY-101, AZ-101, AZ-102, SY-1010, SY-102, and SY-103. Annulus visual inspections encompassing ≥ 95% of the viewable area will be completed during FY 2013.<br><br>The Extent of Condition evaluation, WRPS-1204931, *"Double-Shell Tank 241-AY-102 Primary Tank Leak Extent of Condition Evaluation and Recommended Annulus Visual Inspection Intervals,"* recommended increased annulus visual inspection frequencies for all twenty-eight DSTs, varying from annually to once every three years, following completion of a ≥ 95% inspection of the viewable area in the annulus. The frequency depends on the extent of similarity between the tanks construction and operating histories and those of tank AY-102. The increase in inspection frequencies has been provided to the Tank AY-102 Integrated Project Team that is determining if, and when, to commence emergency pumping of tank AY-102. If the Integrated Project Team determines a change in frequency is required then the change will be incorporated into the next revision of RPP-7574, *Double-Shell Tank Integrity Project Plan* and will be implemented in FY 2014.<br><br>2. The RPP-7574, Rev. 2, program plan specifies the inspection frequencies for ancillary DST components, as follows:<br><br>"The piping system requires an inspection of five percent of the transfer piping every five years and pressure testing of the encasements either annually or before transfers occur, whichever is less. The Valve pits must be cleaned and have their coatings re-inspected by a |

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| | | | | qualified NACE coating inspector at the following periodicities for the pits. Pits/vaults with poly urea coatings: every 10 to 12 years. Valve pits with epoxy paint coatings: every 5 to 7 years or after every two jumper installation or disconnect activities, whichever is shorter. Vaults with epoxy paint coatings: every 10 to 12 years. Pits/vaults with stainless steel liners: every 12 to 15 years."<br><br>The "External Direct Corrosion Assessment – (ECDA) technique, defining that 5% of the waste transfer piping be exhumed every five years and examined for corrosion, is intended as an independent verification of cathodic protection system performance. It is unrelated to encasement pneumatic pressure testing for indirect inspection of pipeline encasement integrity on the IQRPE recommended 8-10 year frequency, the origin of which has been detailed in Recommendations R38, R45, and R46 and is repeated below for clarity.<br><br>As was described in the disposition of Recommendation R38, R45, and R46, "Close Interval Potential Survey" (CIP) or "Direct Current Voltage Gradient" (DCVG) inspections were to be substituted for pneumatic encasement pressure tests after the first round was complete (RPP-27097, Rev 1, Page iii) and be performed on an 8-10 year interval per IQRPE recommendation. Application of the CIP and DCVG inspection techniques proved to be ineffective and they were dismissed as ineffective in 2010. Justification for dismissing the CIP/DCVG inspections as ineffective was documented in RPP-RPT-47180, 2010, *"Waterproof" Pipeline Assessment Report*, Rev. 0.<br><br>In lieu of the ineffective CIP/DCVG inspection methods, pneumatic pressure testing of the pipeline encasements on a 10 year interval has been implemented. Documentation of the purposeful decision to switch from CIP/DCVG testing to pneumatic pressure testing cannot be located. It is possible that the 10 year interval was based on empirical field evidence of the number of pneumatic encasement tests that could be completed in one year – about seven or eight. When staggered year to year, a complete test cycle of the 75 active transfer lines works out to about 10 years. It is with this reasoning that the IQRPE recommended interval of 10 years has been adopted for pneumatic pressure testing of the 75 active transfer pipeline encasements.<br><br>This inspection frequency for ancillary equipment was removed from the program plan when Revision 3 was published. It will be reinstated in the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*, clarifying the information presented herein. |
| R56 | IQRPE Concurs with Completion<br><br>See new 2016 DSTAR IQRPE Recommendation R16-5<br><br>See discussion in Section 4.5 | A. 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 RPP-RPT-32238 released in early 2007, or on the established minimum wall determinations from the PNNL analyses due this year.<br><br>B. 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. | Completed | This recommendation, in part, proposes a change in the DST primary tank corrosion allowance. Structural evaluations completed subsequent to the recommendation show that the primary tank corrosion allowances depend on the primary tank wall design and the wall location. Corrosion allowances based on the structural analyses have been adopted rather than the IQRPE's proposed change, as described below.<br><br>A. The minimum DST wall corrosion allowances are stated in RPP-RPT-32238, Rev. 0, *Hanford Double-Shell Tank Thermal and Seismic Project – Primary Tank Minimum Wall Thickness Analysis*. The allowances are different than the 0.060-in. value cited by the recommendation, as described here:<br><br>"The limiting structural criterion for the primary tank wall thickness for all of the families of DSTs was observed to be the buckling criterion. The buckling criterion is a function of waste temperature, depth, specific gravity, and the vacuum limit. The buckling criterion applies to the upper knuckle region of the tank. Under current operating conditions, the maximum corrosion allowance for the AP tanks is 0.025 inch (25 mils). The maximum corrosion allowance for all other tanks is 0.12 inch (120 mils)."<br><br>"The limiting criterion for the main wall of the primary tank is the membrane stress. The maximum corrosion allowance is 0.144 inch (144 mils), which occurs in the 1/2-inch plate on Course 2 near the transition from the thicker Course 3. The remainder of the tank surface can withstand corrosion of up to 0.25 inch (250 mils) or more, depending on location."<br><br>B. Fifteen of the 28 DSTs have completed second cycle UT wall thickness tests as of May 2011. Evaluation of the data for each individual cycle receives an independent third party review, currently performed by Pacific Northwest National Laboratory statisticians; cross-cycle comparisons of the data are made to highlight trends. |

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| | | | | The report RPP-RPT-48427, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AN-107 – FY2011*, is typical content of the UT reports now being issued. Section 8, "Evaluation of Inspection Results," presents the results of the UT tests. Figures 8-1, 8-2, and 8-3 illustrate the FY 2011 average wall thickness; tables 8-1 and 8-2 present the minimum vs. nominal and average vs. nominal wall thickness, respectively. Other tables and figures in Section 8 compare the data to the FY 1998 and FY 2006 UT analyses.<br><br>Attachment 2 of the inspection report, PNNL-20344, Rev. 0, *Ultrasonic Examination of Double-Shell Tank 241-AN-107 Examination Completed March 2011*, provides the statistical analysis of the data and a comparison between the FY 2011 data and data collected during FY 1998 and FY 2006. The comparison uses a statistical methodology denoted as "extreme value statistics" to predict the apparent worst case wall thinning present anywhere in the tank using the set of measured data. The methodology was developed to evaluate severe thinning detected in the tank AY-101 Course 1 plate occurring at a chronic liquid-air interface level (see R55 disposition for tank AY-101 description), and is described in PNNL-14106, *Statistical Analysis of AY-101 Ultrasonic Measurements of Wall Thickness*. The methodology has been adopted for statistical analysis of UT data from all of the DSTs.<br><br>The PNNL-14106 report describes the statistical method:<br><br>"Tank AY-101 wall thicknesses have been measured using ultrasonic (UT) images. Interest is in using the available data to estimate a worst-case minimum wall thickness for regions of the tank that remain unexamined with the UT approach. Each UT image can provide the wall thickness at a very large number of pixels, but only the minimum value of each image is used in this work. Since the data arise in this manner, one of several candidate statistical extreme value distributions should successfully fit these reported minimum values."<br><br>"Given a set of multiple UT images and the resulting minimum measured wall thicknesses, extreme value distributions are fit to the data with subsequent extrapolations made to estimate the "minimum measured wall thickness" expected for the entire tank. Such a minimum estimate incorporates both the variability in wall thicknesses and the uncertainty associated with the measurement method. Uncertainties of the estimated parameters are also derived and used in propagation of variance methods to obtain confidence bounds on the estimated minimum measured wall thickness as well." |
| R57 | IQRPE Concurs with Completion<br><br>See discussion in Section 4.5 | An evaluation of the tank 241-SY-101overall 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 the minimum wall thickness structural analysis, RPP-RPT-32238. 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 | Completed | This recommendation is an expansion of Recommendation R53. For consistency, the disposition is repeated here:<br><br>Tank SY-101 received an ultrasonic inspection during FY 2004 and FY 2006. The initial P-scan inspection was completed in the second quarter of FY 2004, and the final inspection was completed in the first quarter of FY 2006. The results are summarized in RPP-RPT-39149, Rev. 0, *Double-Shell Tank Inspection Report for 241-SY Tank Farm*, and reported in detail in RPP-18444, Rev. 1, *Ultrasonic Inspection Results for Double –Shell Tank 241-SY-101 – FY 2004 and FY 2006*.<br><br>The tank SY-101 second round UT inspection was originally scheduled for FY 2011. However, construction in the 241-SY tank farm prevented inspection access to the tank.<br><br>The tank was rescheduled for its UT inspection in FY 2012, six years after RPP-18 444 was issued. The interval between the first round and second round UT inspections is consistent with the RPP-7574, Rev. 2, *Double-Shell Tank Integrity Program Plan* 7- to 10-year inspection interval requirement. The tank waste composition is compliant with the corrosion chemistry limits in operating specification OSD-T-151-00007, *Operating Specifications for the Double-Shell Tanks*; no further wall thinning is expected.<br><br>Tank SY-101 was inspected during FY 2012. This inspection has been documented in the report RPP-RPT-52572, 2012, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-101 – FY 2012, Rev. 0*. Figure 7-1, "UT Scan Paths on West Side of Tank 241-SY-101 Primary Wall (via Riser-026)," on page 14 shows that this inspection was conducted in Riser 26. Figure 8-8, "Riser-026 Average Wall Thickness (FY 2004 and FY 2012)," on page 50 compares the wall thickness measurement in Riser 26 between 2004 and 2012. The 2012 measurements were |

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| | | 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. | | greater than the 2004 measurements. As such, no additional evaluation will be performed. |
| R58 | IQRPE Concurs with Completion<br>See discussion in Section 10.4 | AP Tanks certified to operate at a maximum of 460 in. of tank waste should not be permitted to receive evaporator discharges. | Not Applicable | Not Applicable |
| R59 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-7<br>See discussion in Section 4.5 | 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. | Completed | This recommendation is similar to Recommendation R4, Part 4. For consistency, a portion of the disposition is repeated here:<br>RPP-25782, Rev. 0A, *DST Dome Survey Program*, was released June 13, 2007. This establishes the basis and protocol for the DST Dome Survey Program. The goal of this program is to monitor the elevation of the tank and tank dome deflection to determine if settlement or excess deflection of the tank dome is occurring. The surveys should be performed as requested by engineering or in accordance with this document, whichever is more restrictive.<br>DST dome surveys for determining elevation/deflection are performed every 20 to 28 months, as required by the Survey Program. Historical dome load record data obtained from riser and pit benchmark elevation surveys are compiled by tank, and the surveys for all of the tanks in a DST farm are compiled into a single document. The document is updated when data from a new survey are received.<br>The following are the most recent inspection reports:<br>• RPP-20257, Rev. 0, *241-AN Tank Farm Historic Dome Load Record Data*<br>• RPP-20258, Rev. 0, *241-AP Tank Farm Historic Dome Load Record Data*<br>• RPP-20259, Rev. 0, *241-AW Tank Farm Historic Dome Load Record Data*<br>• RPP-20260, Rev. 0, *241-AY Tank Farm Historic Dome Load Record Data*<br>• RPP-20261, Rev. 0, *241-AZ Tank Farm Historic Dome Load Record Data*<br>• RPP-20262, Rev. 0, *241-SY Tank Farm Historic Dome Load Record Data.* |
| R60 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-3 and R16-8<br>See discussion in Section 4.5 | Primary tank inspection videos for tanks 241-AZ-101 and 241-AZ-102 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 of the AZ-102 inspection. The 241-AZ-101 video was of poor quality and the AZ-102 video was not available. | Completed | The recommendation has been completed.<br>RPP-RPT-34310, *Double-Shell Tank Integrity Inspection Report for 241-AZ Tank*, was released August 27, 2007.<br>Section 4.3.1, "241-AZ-101 Video Inspections," states:<br>"The third generation visual inspection for AZ-101 included four annulus risers and one primary in-tank riser. The annulus inspections were conducted in Risers 78, 82, 83, and 86 on June 6, 2007. The primary in-tank inspection was performed in Riser 66 on July 25, 2007."<br>Section 4.3.2, "241-AZ-102 Video Inspections," states:<br>"The third generation visual inspections for AZ-102 included four annulus risers and one primary in-tank riser. The annulus inspections |

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| | | | | were conducted in Risers 80, 82, 85, and 87 on July 30, 2007. The primary in-tank inspection was performed in Riser 57 on July 25, 2007."<br>Both sections concluded that during the examinations, minimal new areas of interest were identified; none showed significant changes from the appearance of the tank wall seen during the second generation inspections. |
| R60.1 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-9<br>See discussion in Section 4.5 | The TOLA should be revisited based on more realistic design inputs. At a minimum, the 350°F design temperature should be reduced to 250°F or some other technically and historically justifiable temperature. This is intended to verify engineering judgment with respect to DST structural concrete slab adequacy. | Completed | This recommendation was generated during preparation of Revision 4 of the IQRPE's DST Integrity Assessment. RPP-28538, Rev. 5, *Volume 1: IQRPE Double-Shell Tank System Integrity Assessment, HFFCO M-48-14*, was issued as a general update to Revision 4. The new revision incorporated the results of structural analyses from RPP-RPT-28968, Rev. 0A, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads with Seismic Analysis*, as described in section 4.10.2.3, "Seismic Load Analysis":<br>"Subsequent to the initial publication of this report, and independent review of ( (sic) DSTs TOLA combined with the seismic analysis was conducted by Dr. Robert P. Kennedy of RPK Structural Mechanics Consulting and Dr. Anestis S. Veletsos of Rice University. RPP-RPT-28968, Revision 0A, was issued to document their review and address their comments. The results of these clarifications and additional analyses do not affect the conclusions of the original (RPP-RPT-28968 Rev. 0) report."<br>"...This determination was based on analysis at the design waste temperature of 350°F and the full 60-year corrosion allowance on the tank wall of 0.060-in. However, analysis at a more realistic temperature of 250°F or corrosion allowance of 0.025-in. results in an acceptable demand/capacity ratio according to the ASME code criteria. Thus, buckling of the primary tank is judged to be unlikely for the current lack of corrosion in the tanks, and the expectation that the maximum waste temperature will not exceed 210°F. " (Page 4-58)<br>Recommendation R60 was removed from Table G-2 in RPP-28538, Rev. 5. |
| R61 | IQRPE Concurs with Completion<br>See new 2016 DSTAR Recommendation R16-15<br>See discussion in Section 7.5 | 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.<br>• Pits/vaults with polyurea coatings: every 10 to 12 years.<br>• Pits with epoxy paint coatings: every 5 to 7 years or after every two jumper installation or disconnect activities, whichever is shorter.<br>• Vaults with epoxy paint coatings: every 10 to 12 years.<br>• Pits/vaults with stainless steel liners: every 12 to 15 years.<br>2. 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 | Completed | This recommendation is a restatement of Recommendation R55. For consistency, a portion of the disposition is repeated here.<br>1. The RPP-7574, Rev. 2 program plan specifies the inspection frequencies for ancillary DST components, as follows:<br>"The piping system requires an inspection of five percent of the transfer piping every five years and pressure testing of the encasements either annually or before transfers occur, whichever is less. The Valve pits must be cleaned and have their coatings re-inspected by a qualified NACE coating inspector at the following periodicities for the pits. Pits/vaults with poly urea coatings: every 10 to 12 years. Valve pits with epoxy paint coatings: every 5 to 7 years or after every two jumper installation or disconnect activities, whichever is shorter. Vaults with epoxy paint coatings: every 10 to 12 years. Pits/vaults with stainless steel liners: every 12 to 15 years."<br>2. Pit coating inspections are performed in accordance with Tank Farms procedure TO-040-050, *Perform Inspections of Pit Coatings*. Inspection is performed by a minimum of the System Engineer and a National Association of Corrosion Engineers (NACE) Coating Level 2 inspector. |

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| | | 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. | | |
| R62 | IQRPE Concurs with Completion<br>See discussion in Section 7.5 | 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.<br><br>Table in Recommendation is not included for brevity. | Completed | Since this recommendation was made, there have been housekeeping improvements in the active tank farm pits. As a part of the W-314 project upgrades for pits and coatings, abandoned equipment, including legacy rigid jumpers, was removed. There are currently no abandoned jumpers resting on the floor in active waste transfer pits with epoxy coatings.<br>The only known jumper resting on the pit floor in an active pit is the K-C Jumper in the stainless steel lined 241-AZ valve pit. This jumper will be utilized for feed transfer to the Waste Treatment Plant. There will be cases where PUREX process blanks may rest on the pit floor for future use.<br>The use of flex jumpers in the DST system is limited. Most long-length flex jumpers, such as those installed for a Retrieval and Closure WTS, utilize a wrap such as heat trace which minimizes the exposure of the pit floor to the braided surface.<br>Currently the only known flex jumpers which are of sufficient length to touch the pit floor and that are not wrapped are in the 241-AY-02A, 241-AN-02A, 241-AN-07A, 241-AW-03A, and 241-AW-04A pits. Confirmation has been made, by review of the most current available pit photos, that except for the 241-AW-04A flex jumper, none of the jumpers is in contact with the pit floor. Available photos of the 241-AW-04A flex jumper indicate that the braided surface may be in contact with the pit floor. |
| R63 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | 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 an IQRPE.<br><br>The IQRPE should prepare a stamped report documenting the review with observations and recommendations if applicable. | Completed | RPP-CALC-41333, Rev. 0, *241-AP Valve Pit Wall Analysis*, evaluates the structural integrity of the reinforced concrete 241-AP valve pit. A minimum 2-ft distance from the AP valve pit is recommended for a 44 kip wheel load accompanying a 40 psf live load applied at the ground surface.<br>RPP-CALC-41282, Rev. 0, *241-SY Valve Pits A/B Wall Analysis*, evaluates the integrity of the reinforced concrete 241-SY-A and 241-SY-B valve pits. A minimum 2-ft distance from the 241-SY-A and 241-SY-B pits is recommended for a 44 kip wheel load accompanying a 40 psf live load applied at the ground surface.<br>Both calculations evaluate the reinforced concrete pits according to ACI-318, *Building Requirements for Structural Concrete*. |
| R64 | Not in scope | This tank (Catch Tank 241-AZ-301) should be assessed again by an IQRPE in 10 years (the year 2017). The assessment should include visual inspection and UT examination of both the primary and secondary tank. | Completed | This recommendation is a restatement of Recommendation R29. For consistency, the disposition is repeated here.<br>RPP-PLAN-37138, *Work Plan for Assessing the Need for Cathodic Protection on the 241-AZ-301 Condensate Receiver Tank Secondary Containment Vessel*, January 2010.<br>The visual inspection will occur in FY 2014. The action to complete the inspection will be incorporated in the next revision of RPP-7574, *Double-Shell Tank Integrity Program Plan*. |
| R65 | Not in scope | If actual plate thickness measurements were obtained during construction (Catch Tank 241-AZ-301), those values should be captured and retained by the DST Integrity Project before | Completed | Records for plate thickness measurements that may have been made during construction of tank 241-AZ-301 could not be found. Drawing H-14-105905, *Structural AZ-PC-SP-1 Cond Dist Sys Receiver Tank Details*, sheets 1 through 4, are the documented as-built drawings of tank AZ-301. Detail 7 of sheet 3 shows the primary tank wall thickness to be 1/4-in. UT wall thickness measurements will be recorded during the |

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| | | project files are archived. These measurements will be needed as a baseline for the next integrity assessment. | | FY 2012 integrity assessment (see disposition of Recommendation R65). These measurements will become the baseline for future integrity assessments. |
| R66 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-5<br>See discussion in Section 4.5 | 1. 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).<br>2. 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. | Completed | 1. PNNL-15415, *Estimation of Maximum Wall Thickness Loss of Five DSTs (AN-107, AP-102, AW-101, AZ-102, and SY-101)*, does not make a recommendation about progressive quadrant inspections.<br>2. To understand the variation between quadrants, two riser ultrasonic wall inspections have been completed on 13 tanks. The two riser inspections showed less variability between the risers than the plates measured at each riser, as reported in RPP-RPT-46309, *Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks*. The report recommended collecting data from a number of plates as opposed to a number of risers.<br>The design of the Multi-Probe Corrosion Monitoring System probes has evolved past the fifth generation probe discussed at the time of the assessment (see Recommendation R55 disposition for Multi-Probe Corrosion Monitoring System results from the 241-AY tanks). Monitoring systems are implemented following judgment and recommendation by an Expert Panel Oversight Committee (EPOC).<br>Descriptions of the statistical review of the PNNL work and possible reversion to single-riser tank ultrasonic wall thickness inspections, as well as the scoping work for an improved, low cost corrosion probe, will be incorporated into the next update to RPP-7574, *Double-Shell Tank Integrity Program Plan*. |
| R67 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-8<br>See discussion in Section 11.6 | Due to the crack measurement limitations of the Tandem Synthetic Aperture Focusing Technique (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 | Completed | Current techniques for dimensioning cracks in the lower knuckle are limited. The DST Integrity Project (DSTIP) has performed the six required inspections in demonstrating SAFT prior to 2006. PNNL provided an evaluation of the feasibility of SAFT in PNNL-15136, *Feasibility Test Report SAFT/T-SAFT Scanning on the Curved Knuckle of Hanford's Double Shell Tanks*. The T-SAFT performance demonstration test, reported in PNNL-14072, *Annual Report: Remotely Operated NDE System for Inspection of Hanford's Waste Tank Knuckle Regions and Development of a Small Roving Annulus Inspection Vehicle T-SAFT Scanning Bridge for Savannah River Site Applications*, showed that Level II non-destructive examination (NDE) technician could dimension a linear indication in the knuckle region with a high confidence level to a depth of 180 mils. This depth is essentially the same value required by BNL-52527, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, of 20% wall thickness (175 mils) for the 7/8-in. plate in the lower knuckle. WRPS plans to use the T-SAFT to dimension linear indications in the lower knuckle. |

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| | | 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. | | |
| R68 | IQRPE Concurs with Completion<br>See discussion in Section 11.6 | 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. | Completed | The results from RPP-RPT-28968, Rev. 0A, *Hanford Double-Shell Tank Thermal and Seismic Project – Summary of Combined Thermal and Operating Loads*, showed that the highest demand to capacity ratio in the tank occurs not in the lower knuckle, but in the transition between Course 1 (3/4-in.) and Course 2 (1/2-in.) plates. The highest stresses still occur in the lower knuckle, but the increased thickness of the knuckle reduces this key ratio. As indicated in R67, WRPS shall continue to examine the lower knuckle and use T-SAFT to dimension any linear indications. |
| R69 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | 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. | Completed | The recommendation assumes that an alternative inspection technique is required to satisfactorily demonstrate primary tank leak integrity, as an alternative to ultrasonic wall thickness measurements. The recommendation is a variation of Recommendation R66 for progressive quadrant ultrasonic wall thickness measurements. From the Recommendation R66 disposition:<br>To understand the variation between quadrants, two riser ultrasonic wall inspections have been completed on 13 tanks. The two riser inspections showed less variability between the risers than the plates measured at each riser, as reported in RPP-RPT-46309, *Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks*. The report recommended collecting data from a number of plates as opposed to a number of risers.<br>Three-dimensional visual inspections only provide an understanding of the surface of the inspected plates. Ultrasonic wall thickness inspections provide an understanding of the volume of the inspected locations of tank plates, and therefore provide much more valuable data. |
| R70 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | A. 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 | Completed | This recommendation is a restatement of Recommendations R16 and R58. For consistency, part of the Recommendation R58 disposition is repeated here:<br>The mechanism for ensuring that comparisons can be made between future and past visual and UT inspections is described in RPP-7574, Rev. 3, *Double-Shell Tank Integrity Program Plan*. Per section 3.4.1, "Visual Examination," the visual baseline data and the location of previous UT scans are documented in the Tank Integrity Inspection Guide (TIIG) that is specific for each DST.<br>The TIIG is initially prepared by locating the results of past visual and UT inspections geographically on an unwrapped graphic rendering of the DST surface. For visual inspection data, each location is assigned a unique identifier and is hyperlinked via the identifier to a photograph and description that is maintained in a separate database. The TIIGs for all tanks in a DST farm are compiled into a single document.<br>RPP-PLAN-46847, Rev. 0, *Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks*, specifies the visual inspection criteria for the primary and secondary tanks in Table 3-1, "Criteria for Double Shell Primary In-Tank Inspections," and Table 3-2, "Criteria for Double Shell Annulus Inspections." The plan includes example photographs of surface corrosion, cracks, and latence deposits to use for visual guidance during the inspections.<br>The engineer responsible for creating the TIIG format and for populating it is the prime cognizant technical authority for visual inspections. |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| | | corrosion.<br>B. A video inspection program, integrated with the UT inspection program, is needed to ensure quality video data is obtained and reported<br>C. 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. | | He is responsible for visual inspection input to the planning packages, and for interpreting the results of the visual inspection. Other, less experienced engineers are assigned to work under his supervision.<br>The lead technical authority for visual inspections is knowledgeable on the construction of the different DSTs as well as the indications of corrosion/areas of interest based on training through National Association of Corrosion Engineers (NACE) programs. |
| R71 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | A. Inspectors tending to the video inspections should have already viewed previous videos for areas of interest that need to be revisited.<br>B. Tracking specific areas of corrosion in subsequent inspections will provide an indication of how the corrosion is progressing. | Completed | This recommendation is a restatement of Recommendation R16. For consistency, the disposition of Recommendation R16 is repeated here:<br>The methodology of comparing current inspections with results from past inspections is described in RPP-PLAN-46847, Rev. 0, *Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks*. Section 3.2, "Double-Shell Tank Visual Inspections," states that the present approach for conducting visual examinations of DSTs is to perform a video examination of each tank's interior and annulus regions in conjunction with the tank's ultrasonic examination inspection, or approximately every 5 years (not to exceed 7 years between inspections), whichever occurs first.<br>The DST visual examinations completed in 2006 established a baseline that will be used for comparison for future planned re-examinations. The visual baseline information is documented in the Tank Integrity Inspection Guides (TIIGs). Each TIIG contains photographic information of notable indications (areas of interest) and specifies their location on each DST, as well as showing the tank regions examined by UT in order to provide the historical trends comparison recommended by the IQRPE. Each location on the TIIG overlay is hyperlinked to a photograph to allow for visual comparison. Each DST has a unique TIIG.<br>The areas of interest identified in previous inspections and documented in the TIIG are revisited in future inspections. |
| R72 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-8<br>See discussion in Section 4.5 | 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. | Completed | This recommendation is an expansion of Recommendations R16, R70, R71, and R72. For consistency, part of the Recommendation R16 disposition is repeated here:<br>The DST visual examinations completed in 2006 established a baseline that will be used for comparison for future planned re-examinations. The visual baseline information is documented in the Tank Integrity Inspection Guides (TIIGs). Each TIIG contains photographic information of notable indications (areas of interest) and specifies their location on each DST, as well as showing the tank regions examined by UT in order to provide the historical trends comparison recommended by the IQRPE. Each location on the TIIG overlay is hyperlinked to a photograph to allow for visual comparison. Each DST has a unique TIIG.<br>Since the TIIGs contain the historical summary and location of all past visual inspections, they represent the most viable planning tool for locating ultrasonic wall thickness testing. In addition, the value of the repeating ultrasonic wall thickness testing every 8 to 10 years lies in the thinning trends that can be detected by comparing new and historical data. Video inspections cannot identify locations of wall thinning to perform ultrasonic testing upon.<br>There is no plan to perform a new visual inspection prior to making a tank entry for ultrasonic wall thickness inspection. The historical information collected in the TIIG is used to guide the UT inspections. |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| R73 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | 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.<br>1. 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.<br>2. 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.<br>3. A qualified engineer with knowledge or training in corrosion and tank construction could fulfill the role of the video examination director. | Completed | This recommendation is a restatement of Recommendations R16, R58, and R70. For consistency, parts of the dispositions of those recommendations are repeated here:<br>The mechanism for ensuring that comparisons can be made between future and past visual and UT inspections is described in RPP-7574, Rev. 3, *Double-Shell Tank Integrity Program Plan*. Per Section 3.4.1, "Visual Examination," the visual baseline data and the location of previous UT scans are documented in the Tank Integrity Inspection Guide (TIIG) that is specific for each DST.<br>The TIIG is initially prepared by locating the results of past visual and UT inspections geographically on an unwrapped graphic rendering of the DST surface. For visual inspection data, each location is assigned a unique identifier and is hyperlinked via the identifier to a photograph and description that is maintained in a separate database. The TIIGs for all tanks in a DST farm are compiled into a single document.<br>RPP-PLAN-46847, Rev. 0, *Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks*, specifies the visual inspection criteria for the primary and secondary tanks in Table 3-1, "Criteria for Double Shell Primary In-Tank Inspections," and Table 3-2, "Criteria for Double Shell Annulus Inspections." The plan includes example photographs of surface corrosion, cracks, and latence deposits to use for visual guidance during the inspections.<br>The engineer responsible for creating the TIIG format and for populating it is the prime cognizant technical authority for visual inspections. He is responsible for visual inspection input to the planning packages, and for interpreting the results of the visual inspection. Other, less experienced engineers are assigned to work under his supervision.<br>The lead technical authority for visual inspections is knowledgeable on the construction of the different DSTs as well as the indications of corrosion/areas of interest based on training through National Association of Corrosion Engineers (NACE) programs. |
| R74 | IQRPE Concurs with Completion<br>See discussion in Section 4.5 | 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.<br>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 | Completed | When a video is submitted for entry into the Video Library and archiving, Lockheed Martin Records & Information Management Procedure *Checklist 26* requires that the video be assigned a VID/DVD ID number, which can be obtained from the Hanford Document Numbering system (HDNS), and then entered into the Video Library database. The video is then processed and transferred to DVD, if submitted in video tape format. The video information is then entered into IDMS. DVDs or videos that are created must be checked for playability and repaired/cleaned as needed. The video is then labeled and ready to be packed for shipping to the Records Storage Area (RSA).<br>The video is packed and transferred following the procedures of Lockheed Martin Records & Information Management Procedure *Checklist 27*. Once the video is ready for shipping, the Manager of Records & Information Management (RIM) Services – Document Management, assigns a file custodian to collect, receive, process, protect, control access to, maintain, retrieve, and disposition the file material.<br>The File Custodian follows Lockheed Martin Records & Information Management Procedure *Checklist 28*, Rev. 1, to set up an RSA. Once the video file (DVD or video tape) is received, the File Custodian sets up the RSA, using the Site Form A-6004-360, *TOC Records Storage Area (RSA) Approval Form*, and procedure TFC-BSM-IRM-DC-C-02, *Records Management*, as guides. Per Lockheed Martin Records & Information Management Procedure *Checklist 28*, the File Custodian must be sure to "appropriately protect the media to minimize risk of |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| | | guaranteed life) be made for each of the inspections and stored in a separate location. | | damage or destruction from winds, fire, flood, high/low temperatures, humidity, and infestation of insects, mold, or rodents using a graded approach considering the value of the media as a record." |
| R75 | Not in Scope | 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, and the consequences of failure are negligible compared to the DSTs, which do not receive annual leak tests. It is therefore recommended that catch tank 241-AZ-301 not receive annual leak testing. | Rejected | The leak tightness of 241-AZ-301 is verified annually as required by RPP-16922, Rev. 21d, *Environmental Specifications Requirements*, which states that the observable parts of the 241-AZ-301AZ high tank level detector and secondary tank leak detector alarm systems shall be visually inspected and monitored as required by TF-OR-ER1-01-D, for routine surveillance, and during transfers. Therefore, because RPP-16922 requires annual leak tightness verification of the tank, the recommendation to eliminate annual leak testing of 241-AZ-301 has been rejected.<br>This recommendation is a variation of Recommendation R29. For consistency, the disposition of Recommendation R29 is repeated here:<br>RPP-PLAN-37138, *Work Plan for Assessing the Need for Cathodic Protection on the 241-AZ-301 Condensate Receiver Tank Secondary Containment Vessel*, January 2010, outlines activities to assess the corrosion resistance of the secondary containment vessel (AZ301-COND-TANK-002) surrounding the 241-AZ-301 condensate receiver tank. The Work Plan includes activities to assess the condition of the exterior coating on the secondary containment vessel and to assess the effects of a bond with AZ241-CATH-RECT-041.<br>The visual inspection will occur in FY 2012 as part of Baseline Change Request BCR-11-162. |
| R76 | IQRPE Concurs with Completion<br>See new 2016 DSTAR IQRPE Recommendation R16-11<br>See discussion in Section 11.6 | 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.<br>Obtaining baseline data is of highest priority once testing is complete.<br>1. The probes should be configured to include monitoring of vapor space corrosion in addition to the liquid and condensed solids regions of the waste.<br>2. It is recommended that a program and funding he provided for immediate deployment of corrosion probes in each waste type representative DST at a minimum.<br>3. 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. | Completed | This recommendation is a restatement and variation of a number of earlier recommendations, including Recommendations R66.<br>The design of the Multi-Probe Corrosion Monitoring System has evolved past the fifth generation probe. A new corrosion probe design is being discussed for possible implementation in FY 2012, which will reduce cost and improve data collection.<br>Three knowledgeable senior technical staff members are responsible for monitoring probe performance: K. D. Boomer, K.G. Corrothers, and G. Edgemon (ARES). These staff members have participated in probe design, data interpretation, and routine probe data monitoring. |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| R77 | IQRPE Concurs with Completion<br>See discussion in Section 6.7 | 1. Document RPP-27591 provides further recommendations regarding corrosion monitoring and control on buried waste transfer lines. These are summarized in the tables of Appendix G (in RPP-28538, Rev 4.)<br>2. Section 5.4.3, "Existing Corrosion Protection Measures," in RPP-27591, Rev. 1, recommends flushing all DST system waste transfer lines following waste transfer with hot inhibited water (see TFC-ENG-STD-26 for inhibited flush water composition and temperature). Any non-process transfers should also be performed using inhibited water. | Completed | 1. This recommendation is a summary restatement of cathodic protection Recommendations R20 through R37. The reader is referred to the dispositions of those individual recommendations for additional information.<br>2. This recommendation is a restatement of Recommendation R42. For consistency, the disposition of Recommendation R42 is provided here:<br>This recommendation results from misinterpretation of a recommendation in SD-RE-TI-044, *Analysis of Pipeline Failure, SL-176*. In the Recommendation section of this report, on page 10, the author states, "Of the possible alternates, using a heated flush solution containing low concentrations of caustic and nitrite offer the best alternates to prevent future pipeline failures."<br>This recommendation was misinterpreted as a requirement to flush waste transfer lines with inhibited water in order to prevent failures similar to SL-176. The document includes a letter from G.D. Aden and R.A. Palmer to L.H. Rodgers. In the letter, Aden and Palmer discuss the failure cause of SL-176 in greater detail. The letter states:<br>"The evidence suggests that the pipe was under significant stress and failed at the point of a small oxide inclusion in the metal. This initial fracture went completely through the pipe at the point of the notch and produced a small leak there. The pipe relieved the stress by developing a crack on the outer surface which initially did not go completely through the pipe."<br>Because the crack occurred on the outer surface of the pipe, flushing the pipe with hot inhibited water following waste transfers would not have prevented its failure.<br>Flushing requirements are described into TFC-ENG-STD-26, *Waste Transfer, Dilution, and Flushing Requirements*, 3.7.3 Corrosion:<br>2. *"The piping system for the DSTs is sloped to minimize the pooling liquids that could cause corrosion to occur. The transfer of compliant waste further reduces the propensity for corrosion in a piping system and as such, raw water flushes are sufficiently protective of the piping system. To ensure the protection of the piping, each transfer of non-compliant waste shall be evaluated for the need of a chemical flush. If a flush is required, the following compositions should be used:*<br>a. *For carbon steel piping, the flushes shall consist of inhibited water, which contains at least 0.01 M hydroxide and 0.011 M nitrite.*<br>b. *For stainless steel piping flushes shall consist of raw water, de-ionized water, or ionic species that promote the formation of an oxide layer on the pipe surface (e.g., nitrate, phosphate, aluminate, etc.). If an ionic solution is used the species should have a concentration of 0.1M."* |
| R78 | IQRPE Concurs with Completion<br>See discussion in Section 11.6 | The recommendations from the expert panel report on RPP-RPT-22126 Recommendation III results should be revised to require:<br>1. Specific frequencies for forensic examination of the passive probes at once per year.<br>2. Installation and use of a multi-probe in AN-102 in addition to the passive probe.<br>It must also be pointed out that, while the testing focused on stress corrosion cracking (SCC) and pitting corrosion, these are localized phenomena.<br>UT at Hanford is primarily – and correctly – tasked to monitor the effects of general corrosion | Completed | This recommendation is a summary restatement of Recommendations R17, R54, R55, R66, and R76. The reader is referred to the dispositions of those individual recommendations for additional information. DST Integrity Project changes resulting from Recommendations R55 and R66 are described in those dispositions. |

**Table H-1: Disposition Summaries of 2006 DSTAR Recommendations (45 sheets)**

| Item | 2016 IQRPE DSTAR Recommendation Disposition | 2006 DSTAR Recommendation | WRPS Status | WRPS Disposition |
|---|---|---|---|---|
| | | with only a small possibility of picking up problematic pitting or SCC since the exams do not cover 100% of the tank surface area.<br>3. Unless the endpoint chemical composition is expected to exacerbate general corrosion, the UT examinations should remain at the current 10 year frequency.<br>4. Alternately, the UT examinations could be increased to include significantly more surface area at 5 to 7 year intervals, such that the possibility of detecting problematic SCC and pitting is increased. | | |

# APPENDIX I
# DESCRIPTION AND CONFIGURATION OF DOUBLE-SHELL TANKS

# APPENDIX I DESCRIPTION AND CONFIGURATION OF DOUBLE-SHELL TANKS

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## I.1 INTRODUCTION

This appendix provides descriptions and detailed lists of the Hanford Site Double-Shell Tank (DST) System tanks, pipelines, and ancillary equipment to be assessed as part of the Independent Qualified Registered Professional Engineer (IQRPE) DST integrity assessment. The system design descriptions include the following:

- RPP-15131, *System Design Description for AW Tank Farm Double-shell Tank Waste Storage System (DSA Based)*
- RPP-15132, *System Design Description for AN Tank Farm Double-shell Tank Waste Storage System (DSA Based)*
- RPP-15135, *System Design Description for AY/AZ Tank Farm Double-shell Tank Waste Storage System (DSA Based)*
- RPP-15137, *System Design Description for the 200 Area Double-Shell Tank Waste Transfer System.*

## I.2 DOUBLE-SHELL TANK COMPONENTS

The DSTs consist of a primary steel tank inside of a secondary steel liner. The secondary steel liner is encased by a reinforced concrete shell. The primary tank rests on a refractory concrete slab, used to thermally insulate it from the secondary liner and concrete foundation. This refractory slab also provides air circulation/leak detection channels under the primary tank bottom plate. An annular space of 2.5 ft exists between the secondary liners and primary tanks, allowing for visual examination of the tank wall and secondary liner annulus surfaces. The annular space also allows for ultrasonic volumetric inspections of the primary tank walls and secondary liners.

Both the primary tank and secondary liner are built of the same specification carbon steel. In each DST, the primary tank was post-weld heat-treated to reduce residual stresses from fabrication and the propensity for stress corrosion cracking failures.

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

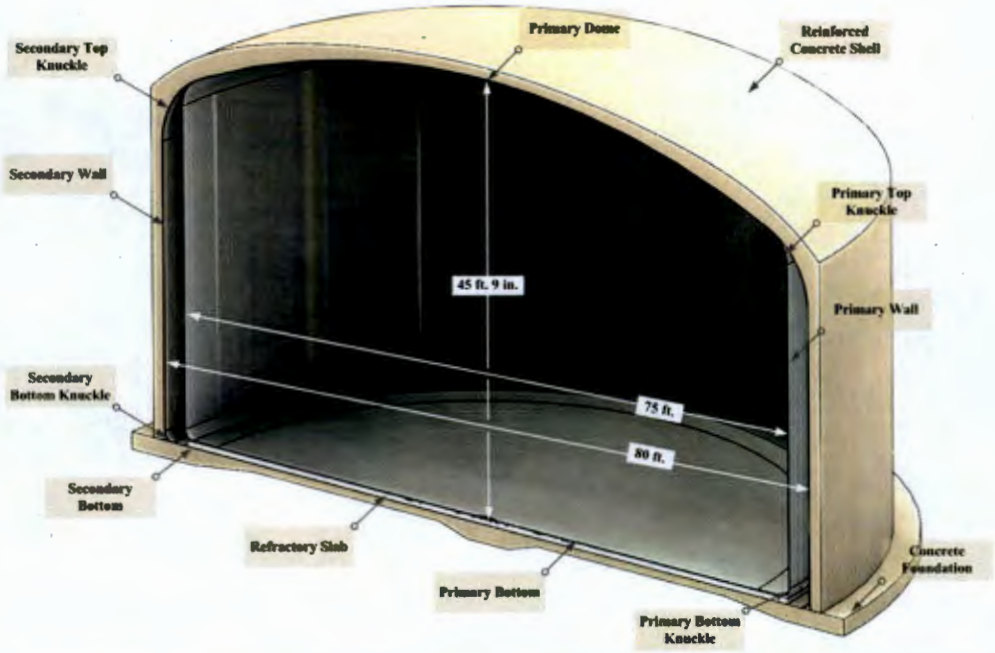
The DST matrix of 27 sound DSTs to be assessed is provided in Table I-1.

**Table I-1: Matrix of DSTs to be Assessed**

| No. | Component ID | Description | Tank Farm |
|---|---|---|---|
| 1 | 241-AY-101 | 1 Mgal waste tank | AY |
| 2 | 241-AZ-101 | 1 Mgal waste tank | AZ |
| 3 | 241-AZ-102 | 1 Mgal waste tank | AZ |
| 4 | 241-SY-101 | 1 Mgal waste tank | SY |
| 5 | 241-SY-102 | 1 Mgal waste tank | SY |
| 6 | 241-SY-103 | 1 Mgal waste tank | SY |
| 7 | 241-AW-101 | 1 Mgal waste tank | AW |
| 8 | 241-AW-102 | 1 Mgal waste tank | AW |
| 9 | 241-AW-103 | 1 Mgal waste tank | AW |
| 10 | 241-AW-104 | 1 Mgal waste tank | AW |
| 11 | 241-AW-105 | 1 Mgal waste tank | AW |
| 12 | 241-AW-106 | 1 Mgal waste tank | AW |
| 13 | 241-AN-101 | 1 Mgal waste tank | AN |
| 14 | 241-AN-102 | 1 Mgal waste tank | AN |
| 15 | 241-AN-103 | 1 Mgal waste tank | AN |
| 16 | 241-AN-104 | 1 Mgal waste tank | AN |
| 17 | 241-AN-105 | 1 Mgal waste tank | AN |
| 18 | 241-AN-106 | 1 Mgal waste tank | AN |
| 19 | 241-AN-107 | 1 Mgal waste tank | AN |
| 20 | 241-AP-101 | 1 Mgal waste tank | AP |
| 21 | 241-AP-102 | 1 Mgal waste tank | AP |
| 22 | 241-AP-103 | 1 Mgal waste tank | AP |
| 23 | 241-AP-104 | 1 Mgal waste tank | AP |
| 24 | 241-AP-105 | 1 Mgal waste tank | AP |
| 25 | 241-AP-106 | 1 Mgal waste tank | AP |
| 26 | 241-AP-107 | 1 Mgal waste tank | AP |
| 27 | 241-AP-108 | 1 Mgal waste tank | AP |

## I.3 SECONDARY LINER

The secondary liner of a DST is 80 ft in diameter and measures approximately 40 ft in height. The secondary liner consists of a bottom, bottom knuckle, wall, and top knuckle. The liner bottom rests on a concrete pad and is joined to a bottom knuckle. The bottom knuckle of the secondary liner includes a bottom transition plate, which connects to the vertical wall plates. Four vertical plates form the wall of the secondary liner of the DST, which is topped by an inwardly curved secondary top knuckle. Dimensions of these components are provided in Figure I-1 for the six DST farms.




| Secondary Liner Top Knuckle | Plate Material | Primary Tank Bottom Knuckle |
|---|---|---|
| AY – ⅜ in. | AY –ASTM A515-65 | AY – ⅞ in. |
| AZ – ⅜ in. | AZ –ASTM A515-69 | AZ – ⅞ in. |
| SY – ⅜ in. | SY –ASTM A516-72 | SY – ⅞ in. |
| AW – ⅜ in. | AW –ASTM A537-74a | AW – ⅞ in. |
| AN – ⅜ in. | AN –ASTM A537-75 | AN – ⅞ in. |
| AP – ⅜ in. | AP –ASTM A537-80 or 79 | AP – 15/16 in. |
| **Secondary Liner Wall** | **Primary Tank Dome** | **Primary Tank Bottom** |
| AY – ¼ in. | AY – ⅜ in. and ½ in. | AY – ⅜ in. and 1 in. |
| AZ – ⅜ in. | AZ – ⅜ in. and ½ in. | AZ – ½ in. and 1 in. |
| SY – ⅜ in. | SY – ⅜ in. and ½ in. | SY – ½ in. and 1 in. |
| AW – ⅜ in. | AW – ⅜ in. and ½ in. | AW – ½ in. and 1 in. |
| AN – ⅜ in. | AN – ⅜ in. and ½ in. | AN – ½ in. and 1 in. |
| AP – ⅜ in. and ½ in. | AP – ⅜ in. and ½ in. | AP – ⅞ in., ½ in., and 1 in. |
| **Secondary Liner Bottom Knuckle** | **Primary Tank Top Knuckle** | |
| AY – ¼ in. | AY – ⅜ in. | |
| AZ – ½ in. | AZ – ⅜ in. | |
| SY – ½ in. | SY – ⅜ in. | |
| AW – ½ in. | AW – ⅜ in. | |
| AN – ½ in. | AN – ⅜ in. | |
| AP – 9/16 in. | AP – ½ in. | |
| **Secondary Liner Bottom** | **Primary Tank Wall** | |
| AY – ¼ in. | AY – ¾ in. and ½ in. | |
| AZ – ⅜ in. | AZ – ¾ in. and ½ in. | |
| SY – ⅜ in. | SY – ¾ in. and ½ in. | |
| AW – ⅜ in. | AW – ¾ in. and ½ in. | |
| AN – ⅜ in. | AN – ¾ in. and ½ in. | |
| AP – ⅜ in. | AP – ½ in., ¾ in., 9/16 in., ⅞ in. | |

**Figure I-1: DST Detail by Tank Farm**

The secondary top knuckle approaches the top knuckle of the primary tank where a small gap (from 0.5 to 1 in. in width in AY Tank Farm and from 0 to 1 in. in width in all of the other tank farms) exists between the two. This gap is overlapped by a series of 14-in. wide, 18-gauge flashing strips. These strips are tack-welded to the primary tank and extend approximately 4 in. past the secondary liner gap. An example of this primary tank and secondary liner top knuckle interface is shown in Figure I-2.

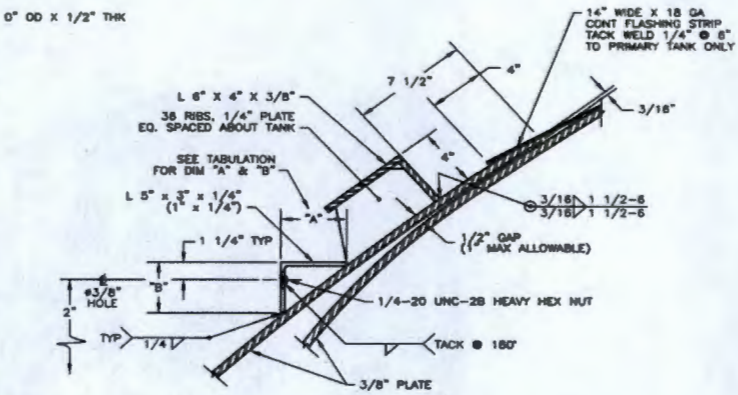



**Figure I-2: .Representative AY Tank Farm Tank Primary and Secondary Top Knuckle Interface**

## I.4 REFRACTORY

An insulating refractory pad is placed on top of the secondary liner bottom. The primary purpose of the refractory is to act as an insulating barrier between the primary tank and the concrete foundation during post-weld stress relieving, where temperatures of up to 1,100°F were required in the primary tank. The refractory prevents the structural concrete foundation temperature from rising above 500°F. The refractory pad houses air ventilation piping, thermocouple conduit, and air distribution slots. The air distribution slots allow airflow to cool the primary tank bottom and direct potential leaks to the tank annulus where leak detectors are installed. Several refractory materials were used during DST construction. Table I-2 provides an overview of the refractory materials used in each DST farm.

**Table I-2: Tank Farms Refractory Materials**

| Tank Farm | Refractory Material |
|---|---|
| AY | Kaolite 2200-LI |
| AZ | Kaolite 2000 |
| SY | Lite Wate 50 |
| AW | Lite Wate 50 and 70 |
| AN | Lite Wate 70 |
| AP | Litecrete 60M |

Refractory air distribution slot design was similar for the majority of the tank farms, with the exception of the AY Tank Farm. Figure I-3 shows the difference in the designs.

## I.5 PRIMARY TANK

The primary tank of a DST is 75 ft in diameter and measures approximately 46 ft, 9 in. in height at the dome center.

The primary tank consists of a bottom, bottom knuckle, wall, top knuckle, and dome. The primary tank bottom rests on the refractory slab and joins to the bottom knuckle. The bottom knuckle is an inwardly curved section of plate that transitions up to the tank wall.

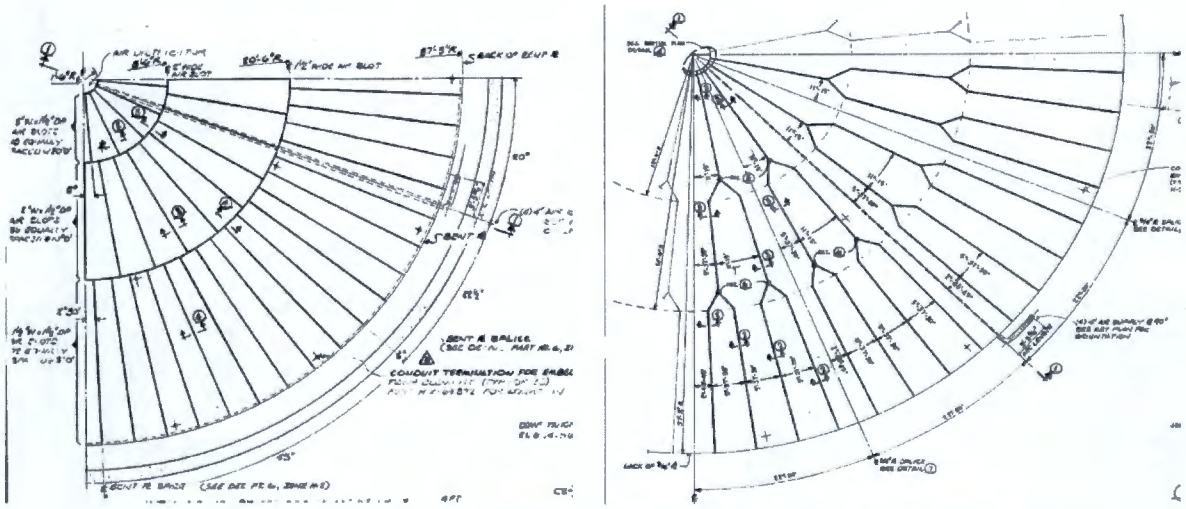


**Figure I-3: Refractory Air Slot Design: AY Tank Farm on the Left; AZ, SY, AW, AN, and AP Tank Farms on the Right**

In the AY, AZ, and SY Tank Farms, the wall consists of three plates that are approximately 10 ft in height, followed by a "top transition plate" that is approximately 3 ft in height. In the AW, AN, and AP Tank Farms, there are four plates that are approximately 8 ft in height. An inwardly curved section, referred to as the top knuckle, joins the vertical wall with the roof section of the tank.

Dimensions of these components are provided in Figure I-1 for the six DST farms.

## I.6 CONCRETE STRUCTURE

The concrete foundation of the DSTs is 88.5 ft in diameter for AY Tank Farm, or 89.5 ft in diameter for the remaining farms. The foundation is designed to uniformly distribute all structural loads.

For the farms other than AP Tank Farm, the center portion of the foundation is 2 ft thick and 3 ft in diameter. From the center, the bottom side of the foundation tapers to a thickness of about 1 ft, which then returns to 2 ft thick at the outer edge. The AP Tank Farm has no taper, and the entire foundation is 2 ft thick. The foundations contain slots and drain lines to collect any leakage from the secondary tank. Any leakage from the bottom of the secondary liner is directed to a leak-detection well.

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

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

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

## I.7 LEAK DETECTION SYSTEMS

The DST leak detection pits (LDP) are tertiary containment systems designed to collect any liquid draining from beneath the secondary liner, and are not discussed in the *Resource Conservation and Recovery Act of 1976* (RCRA) Part B permit application. Therefore, the DST LDPs are not part of the DST system treatment, storage, and/or disposal (TSD) unit designation. The DST LDPs were patterned after the last single-shell tank (SST) farm constructed, AX Tank Farm, which was the first design to incorporate LDPs.

Each tank in the AY, AZ, SY, AW, and AN Tank Farms is equipped with a separate LDP and drain system. In AP Tank Farm, four tanks share a common LDP via an interconnected drain manifold. The leak detection well in AP Tank Farm does not have an enlarged bottom section and is 24 in. in diameter for the entire depth.

The concrete foundation beneath the secondary liner is slotted. In the AY, AZ, and SY Tank Farms, tank foundations are fitted with drain pipe connections at the center, mid-point, and edge of the slab, as shown in Figure I-5. The AW, AN, and AP Tank Farms tank foundations use a drain slot cut from the center of the foundation to the outer edge. The slot then drains into a drain pipe that is connected at the perimeter and to a LDP.

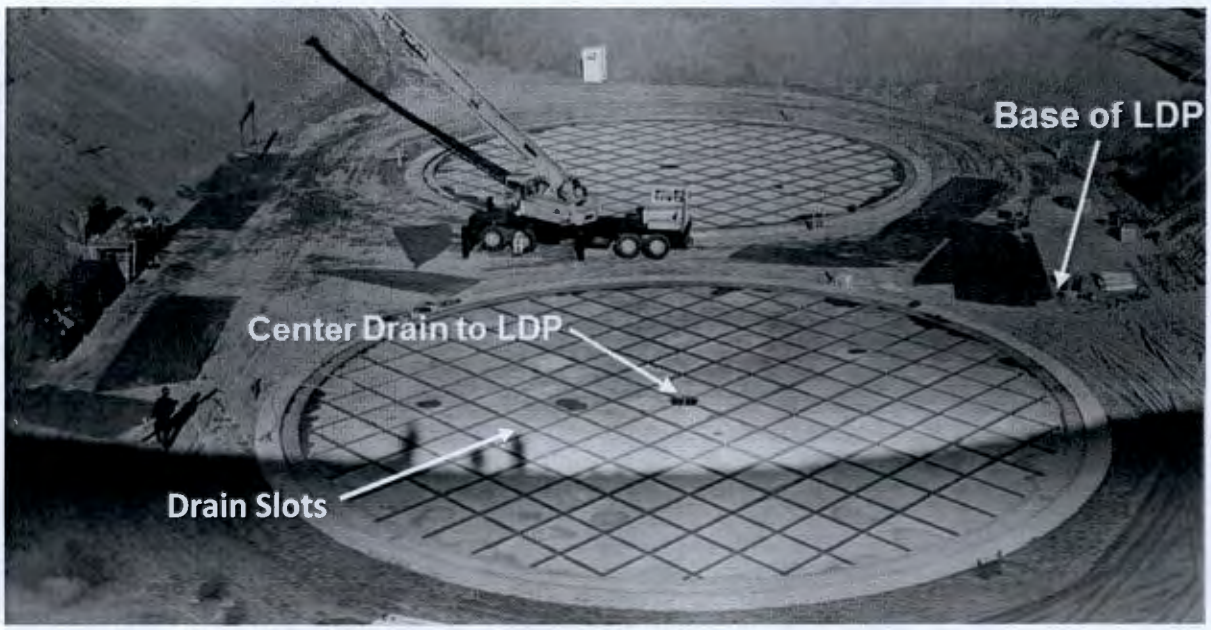



**Figure I-4: Concrete Base Slabs for AY Tank Farm Showing Drain Slots (8041-1) (Tank AY-102 in foreground)**

The LDPs are ventilated via a 2-in. line connected to the DST annulus ventilation exhaust. The leak detection pump pits are equipped with floor drains. In the AY and AZ Tank Farms, these floor drains are connected to a drop leg in the primary tank. In all other DST farms, these pump pit drains are routed back to the LDP riser.

In the event of a secondary liner breach, tank waste would accumulate in drain slots (shown in Figure I-5), cut or cast into the tank foundation, and drain into a LDP. The leak would be indicated by an increase in the LDP liquid level.

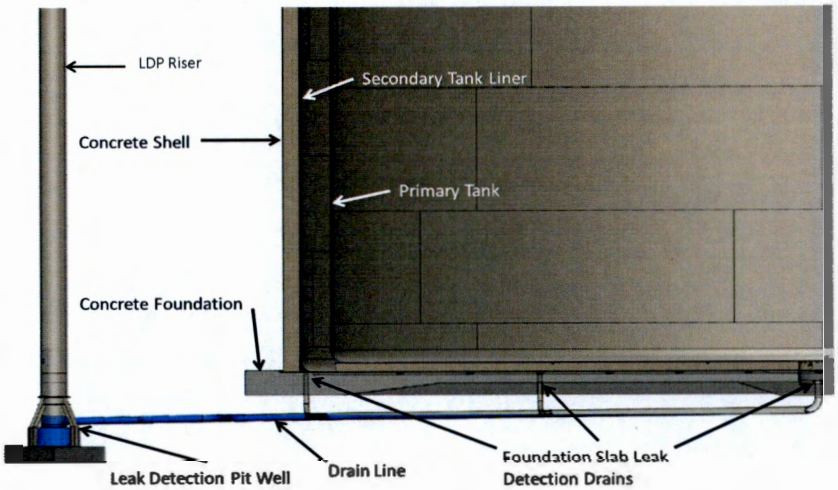



**Figure I-5: Diagram of AY, AZ, and SY Tank Farms Leak Detection Pit Drain System**

## I.8 REFERENCES

*Resource Conservation and Recovery Act of 1976*, as amended, 42 USC 6901, et seq.

RPP-15131, 2013, *System Design Description for AW Tank Farm Double-Shell Tank Waste Storage System (DSA Based),* Rev. 3, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-15132, 2013, *System Design Description for AN Tank Farm Double-Shell Tank Waste Storage System (DSA Based),* Rev. 3, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-15135, 2013, *System Design Description for AY/AZ Tank Farm Double-Shell Tank Waste Storage System (DSA Based),* Rev. 3, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-15137, *System Design Description for the 200 Area Double-Shell Tank Waste Transfer System*, Washington River Protection Solutions, LLC, Richland, Washington.

# APPENDIX J
# DOUBLE-SHELL TANK CROSS-SECTIONS

# APPENDIX J DOUBLE-SHELL TANK CROSS-SECTIONS

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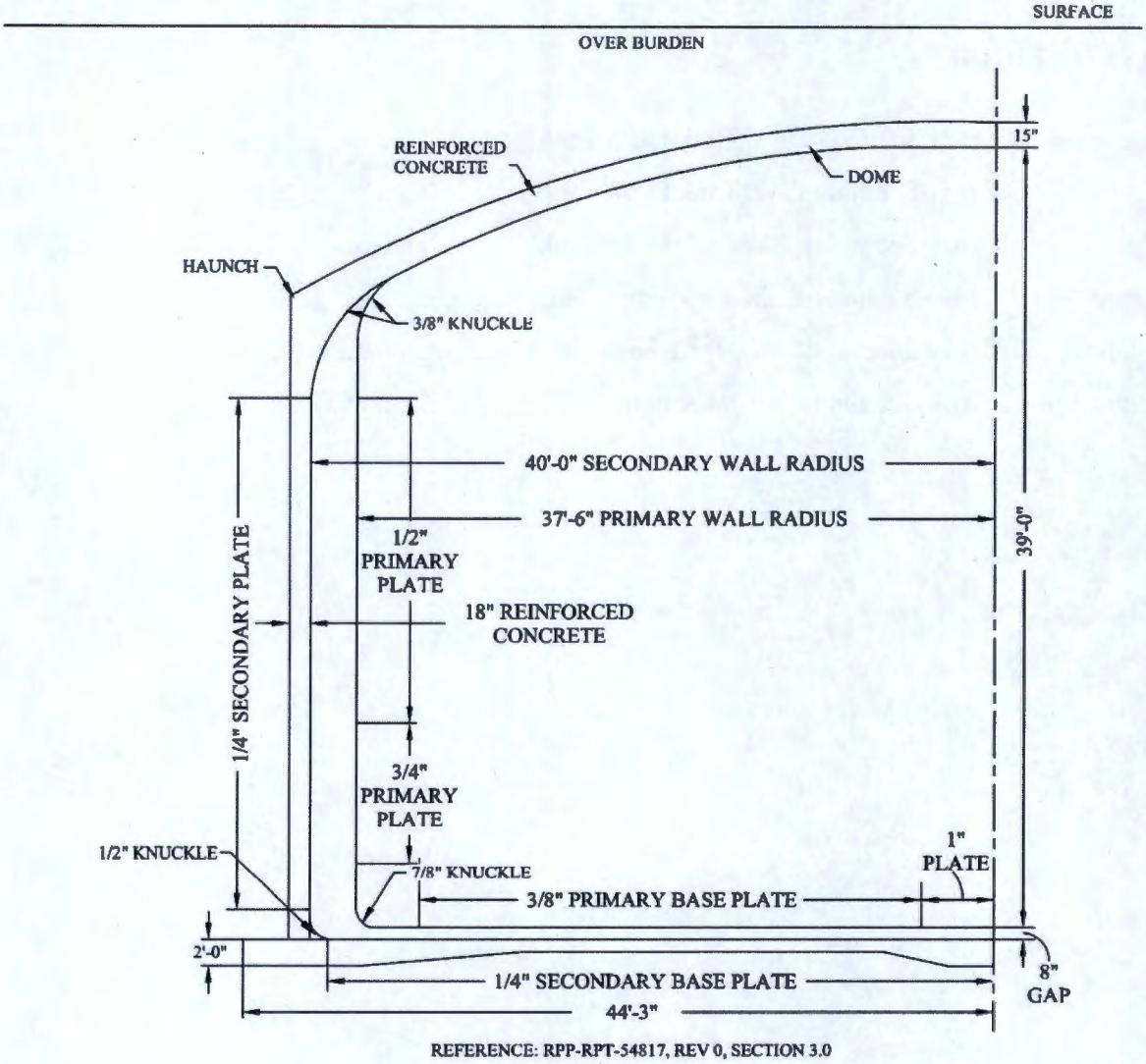



**Figure J-1: Cross Section of AY Tank Farm Tank**

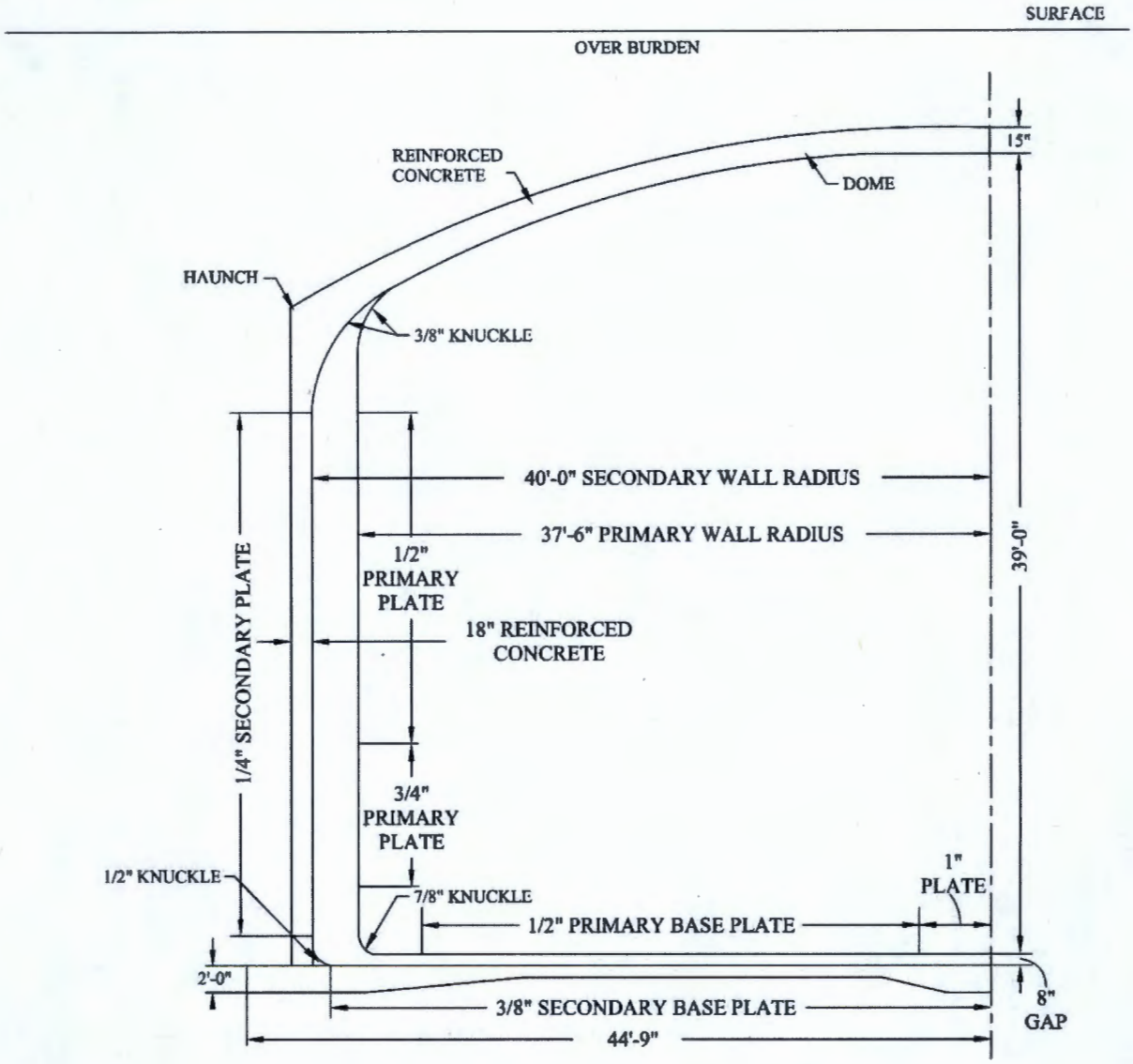



**Figure J-2: Cross-Section of AZ Tank Farm Tank**

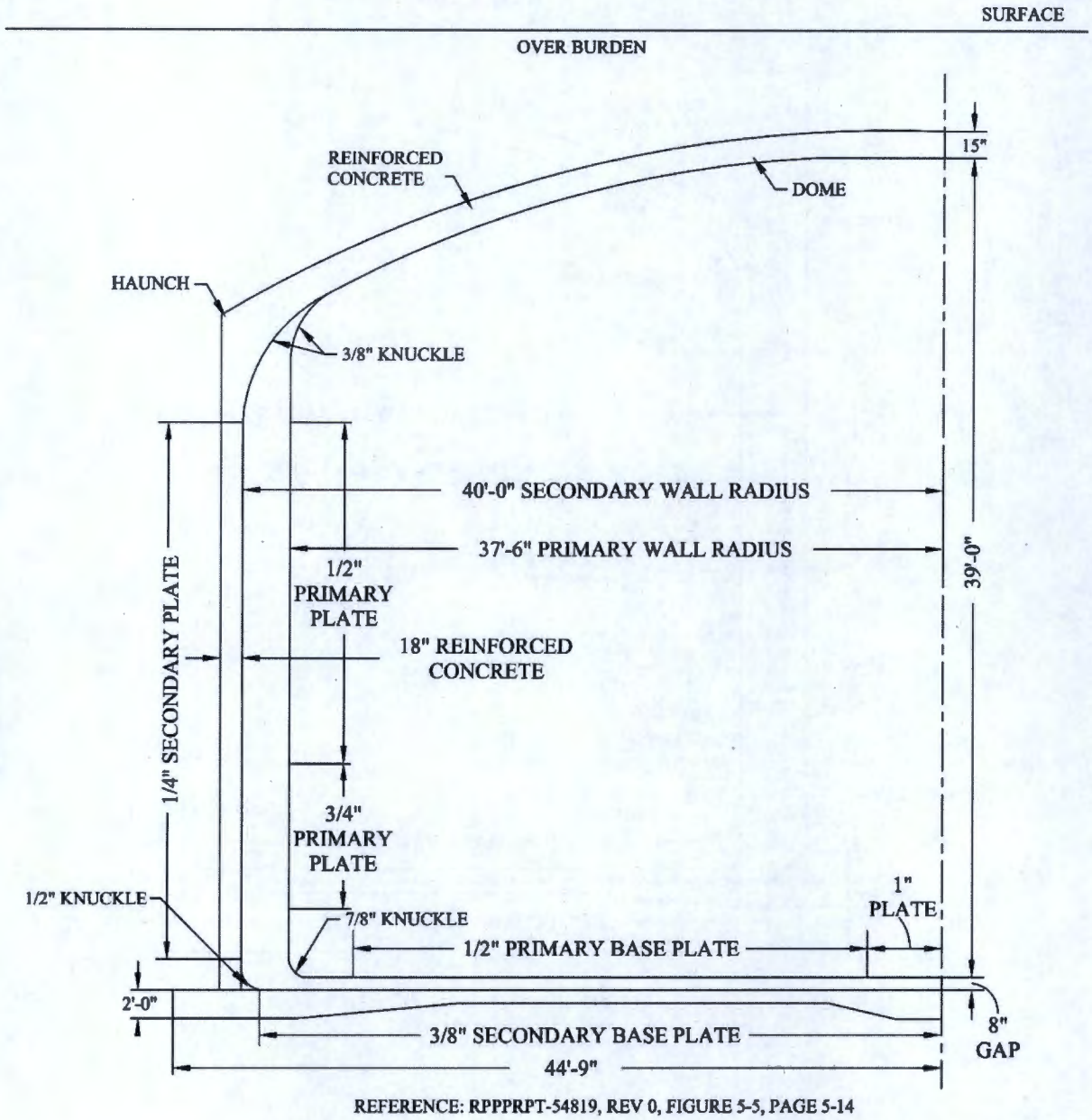
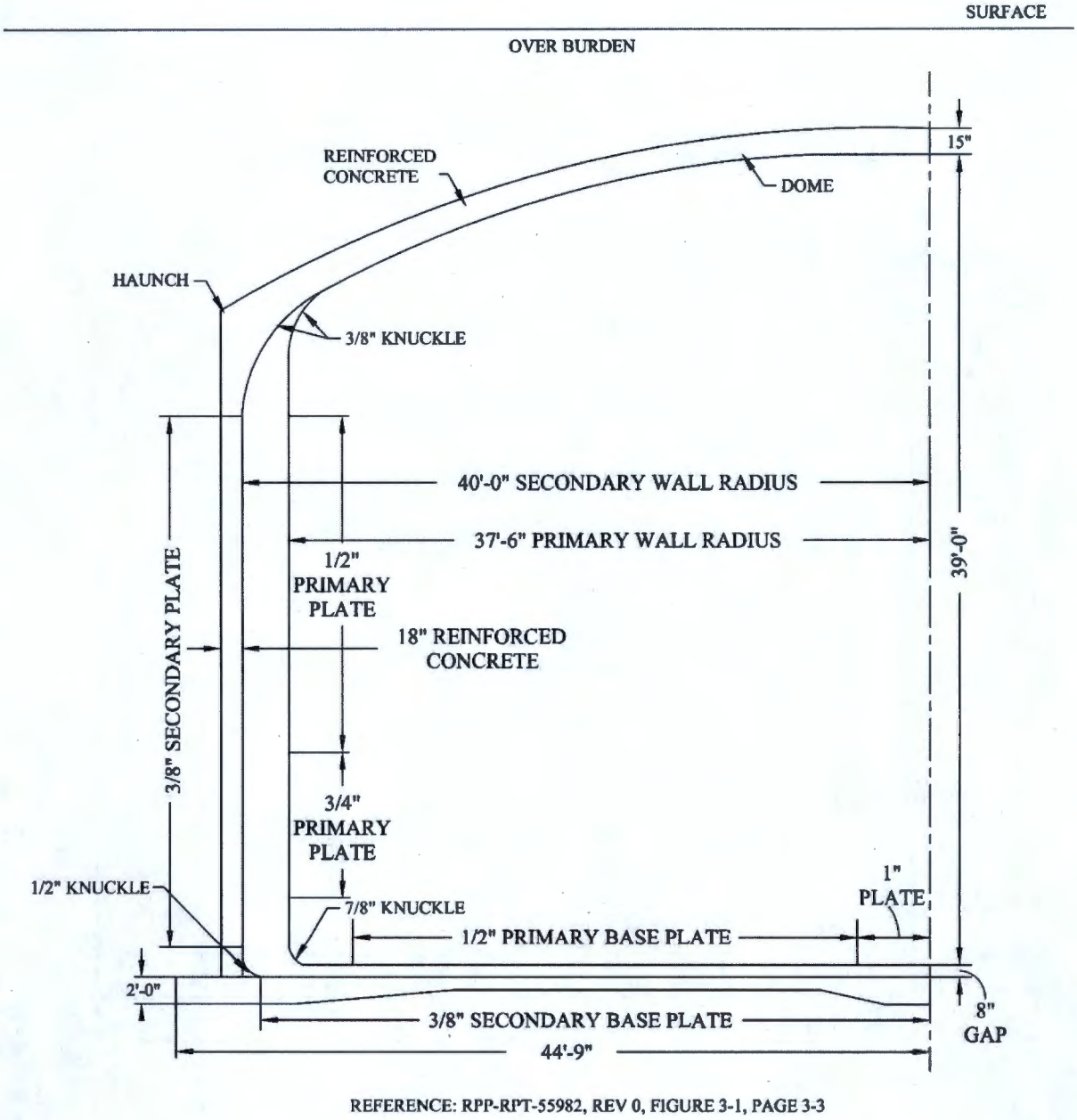
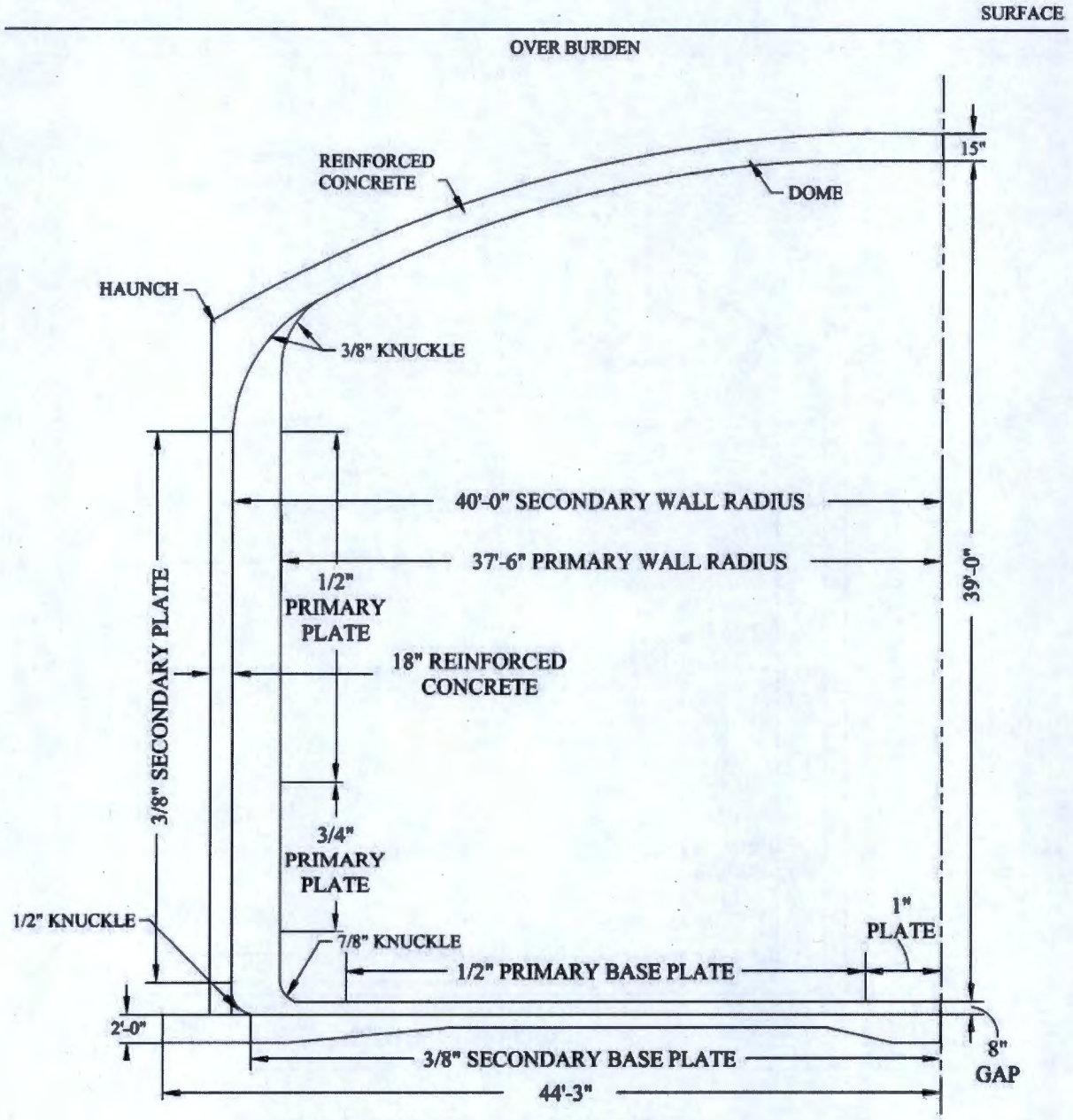



**Figure J-3: Cross-Section of SY Tank Farm Tank**



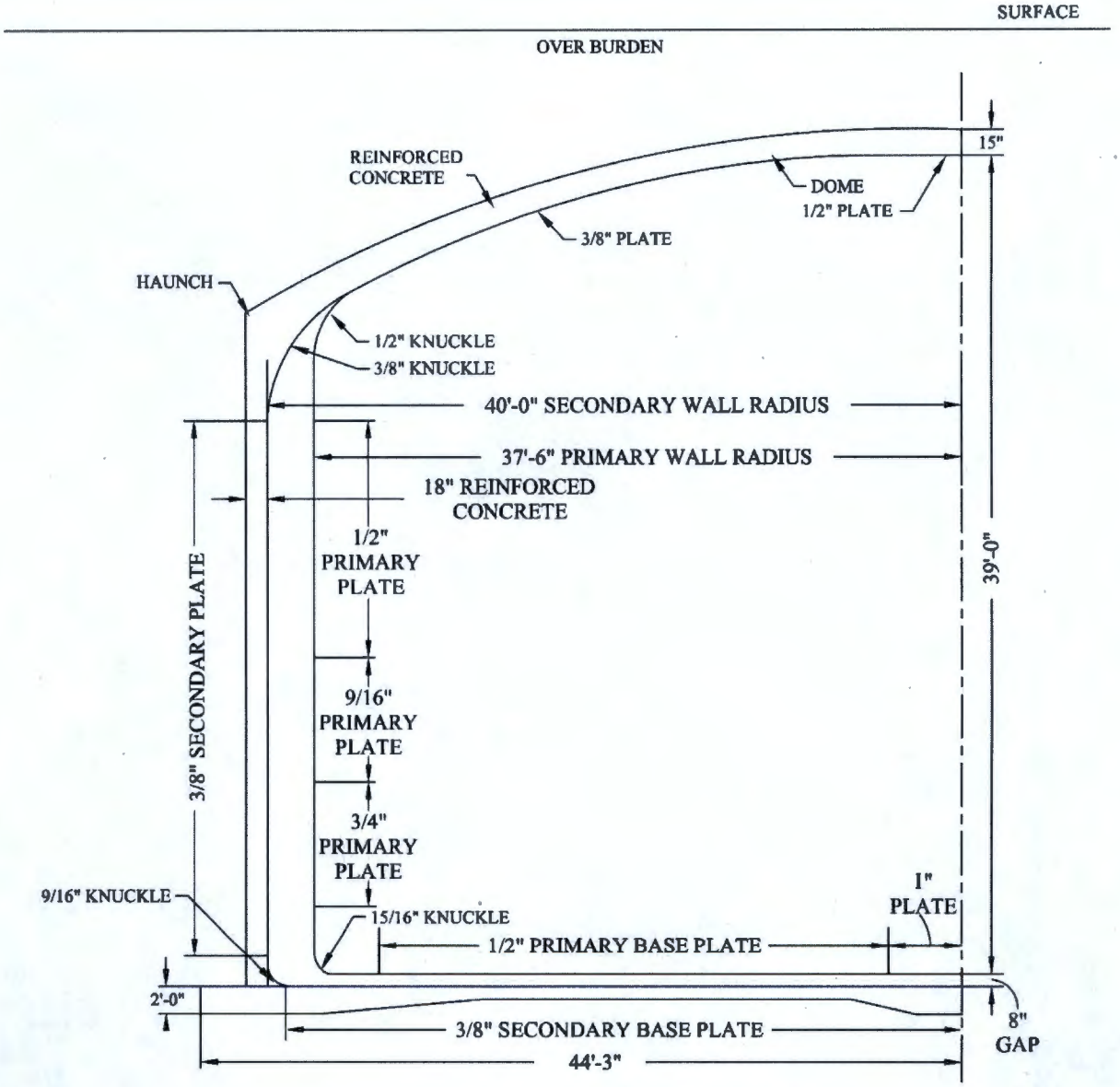

REFERENCE: RPP-RPT-55982, REV 0, FIGURE 3-1, PAGE 3-3

**Figure J-4: Cross-Section of AN Tank Farm Tank**




REFERENCE: RPP-RPT-55981, REV 0, FIGURE 3-1, PAGE 3-3

**Figure J-5: Cross-Section of AW Tank Farm Tank**




REFERENCE: RPP-RPT-55983, REV 0, FIGURE 3-1, PAGE 3-3

**Figure J-6: Cross-Section of AP Tank Farm Tank**

# APPENDIX K
# DOUBLE-SHELL TANK FABRICATION WELD REJECTION RATES

# APPENDIX K DOUBLE-SHELL TANK FABRICATION WELD REJECTION RATES

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**Table K-1: Tank AY-101 and Tank AY-102 Primary Bottom Welding Success Comparison**

| | Tank AY-101 | | | Tank AY-102 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 672 | N/A | N/A | 673 | N/A | N/A |
| Weld rejected after original weld | 67 | 10% | 10% | 229 | 34% | 34% |
| Weld rejected after first repair | 7 | 10% | 10% | 86 | 38% | 35% |
| Weld rejected after second repair | 1 | 14% | 10% | 27 | 31% | 35% |
| Weld rejected after third repair | 1 | 100% | 10% | 1 | 4% | 34% |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 76 | | | 343 | | |
| Total welds | 748 | | | 1016 | | |
| Overall weld rejection rate | 10% | | | 34% | | |

(Reference: RPP-RPT-55982, Rev 0, Page 5-4)

**Table K-2: Tank AZ-101 and Tank AZ-102 Primary Bottom Welding Success Comparison**

| | Tank AZ-101 | | | Tank AZ-102 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 582 | N/A | N/A | 582 | N/A | N/A |
| Weld rejected after original weld | 68 | 11.7% | 11.7% | 31 | 5.3% | 5.3% |
| Weld rejected after first repair | 20 | 29.4% | 13.5% | 7 | 22.6% | 6.2% |
| Weld rejected after second repair | 8 | 40.0% | 14.3% | 1 | 14.3% | 6.3% |
| Weld rejected after third repair | 2 | 25.0% | 14.5% | 0 | N/A | N/A |
| Weld rejected after forth repair | 1 | 50.0% | 14.5% | 0 | N/A | N/A |
| Weld rejected after fifth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 99 | | | 39 | | |
| Total welds | 681 | | | 621 | | |
| Overall weld rejection rate | 14.5% | | | 6.3% | | |

(Reference: RPP-RPT-54818, Rev 0, Page 5-2)

## Table K-3: Tank SY-101, SY-102, and SY-103 Primary Bottom Welding Success Comparison

| | Tank SY-101 | | | Tank SY-102 | | | Tank SY-103 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 655 | N/A | N/A | 625 | N/A | N/A | 647 | N/A | N/A |
| Weld rejected after original weld | 189 | 28.9% | 28.9% | 130 | 20.8% | 20.8% | 184 | 28.4% | 28.4% |
| Weld rejected after first repair | 71 | 37.6% | 30.8% | 30 | 23.1% | 21.2% | 29 | 15.8% | 25.6% |
| Weld rejected after second repair | 21 | 29.6% | 30.7% | 11 | 36.7% | 21.8% | 8 | 27.6% | 25.7% |
| Weld rejected after third repair | 1 | 4.8% | 30.1% | 4 | 36.4% | 22.0% | 1 | 12.5% | 25.6% |
| Weld rejected after forth repair | 0 | 0.0% | 30.1% | 0 | 0.0% | 22.0% | 1 | 100.0% | 25.7% |
| Weld rejected after fifth repair | 0 | N/A | N/A | 0 | N/A | N/A | 1 | 100.0% | 25.7% |
| Weld rejected after Sixth repair | 0 | N/A | N/A | 0 | N/A | N/A | 0 | 0% | 25.7% |
| Total weld rejections | 282 | | | 175 | | | 224 | | |
| Total welds | 937 | | | 800 | | | 871 | | |
| Overall weld rejection rate | 30.1% | | | 22.0% | | | 25.7% | | |

(Reference: RPP-RPT-54819, Rev 0, Page 5-2)

## Table K-4: Tank AW-101 and Tank AW-102 Primary Bottom Welding Success Comparison

| | Tank AW-101 | | | Tank AW-102 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 214 | 29% | 29% | 212 | 29% | 29% |
| Weld rejected after first repair | 69 | 32% | 30% | 87 | 41% | 32% |
| Weld rejected after second repair | 21 | 30% | 30% | 22 | 25% | 31% |
| Weld rejected after third repair | 6 | 29% | 30% | 6 | 27% | 31% |
| Weld rejected after forth repair | 2 | 33% | 30% | 1 | 17% | 31% |
| Weld rejected after fifth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 312 | | | 328 | | |
| Total welds | 1047 | | | 1063 | | |
| Overall weld rejection rate | 30% | | | 31% | | |

(Reference: RPP-RPT-55981, Rev 0, Page 5-1)

**Table K-5: Tank AW-103 and Tank AW-104 Primary Bottom Welding Success Comparison**

| | Tank AW-103 | | | Tank AW-104 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 738 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 225 | 31% | 31% | 274 | 37% | 37% |
| Weld rejected after first repair | 48 | 21% | 28% | 82 | 30% | 35% |
| Weld rejected after second repair | 5 | 10% | 28% | 18 | 22% | 34% |
| Weld rejected after third repair | 0 | 0% | 27% | 1 | 6% | 34% |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 278 | | | 375 | | |
| Total welds | 1013 | | | 1110 | | |
| Overall weld rejection rate | 27% | | | 34% | | |

(Reference: RPP-RPT-55981, Rev 0, Page 5-2)

**Table K-6: Tank AW-105 and Tank AW-106 Primary Bottom Welding Success Comparison**

| | Tank AW-105 | | | Tank AW-106 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 252 | 34% | 34% | 200 | 27% | 27% |
| Weld rejected after first repair | 61 | 24% | 32% | 29 | 15% | 24% |
| Weld rejected after second repair | 10 | 16% | 31% | 3 | 10% | 24% |
| Weld rejected after third repair | 0 | 0% | 31% | 0 | 0% | 24% |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 323 | | | 232 | | |
| Total welds | 1058 | | | 967 | | |
| Overall weld rejection rate | 31% | | | 24% | | |

(Reference: RPP-RPT-55981, Rev 0, Page 5-2)

## Table K-7: Tank AN-101 and Tank AN-102 Primary Bottom Welding Success Comparison

| | Tank AN-101 | | | Tank AN-102 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 99 | 13% | 13% | 96 | 13% | 13% |
| Weld rejected after first repair | 12 | 12% | 13% | 7 | 7% | 12% |
| Weld rejected after second repair | 1 | 8% | 13% | 3 | 43% | 13% |
| Weld rejected after third repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 112 | | | 106 | | |
| Total welds | 847 | | | 841 | | |
| Overall weld rejection rate | 13% | | | 13% | | |

(Reference: RPP-RPT-55982, Rev 0, Page 5-2)

## Table K-8: Tank AN-103 and Tank AN-104 Primary Bottom Welding Success Comparison

| | Tank AN-103 | | | Tank AN-104 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 64 | 9% | 9% | 63 | 9% | 9% |
| Weld rejected after first repair | 7 | 11% | 9% | 4 | 6% | 8% |
| Weld rejected after second repair | 1 | 14% | 9% | 1 | 25% | 8% |
| Weld rejected after third repair | 1 | 100% | 9% | 0 | N/A | N/A |
| Weld rejected after forth repair | 1 | 100% | 9% | 0 | N/A | N/A |
| Weld rejected after fifth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 74 | | | 68 | | |
| Total welds | 809 | | | 803 | | |
| Overall weld rejection rate | 9% | | | 8% | | |

(Reference: RPP-RPT-55982, Rev 0, Page 5-3)

## Table K-9: Tank AN-105 and Tank AN-106 Primary Bottom Welding Success Comparison

| | Tank AN-105 | | | Tank AN-106 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 111 | 15% | 15% | 78 | 11% | 11% |
| Weld rejected after first repair | 21 | 19% | 16% | 5 | 6% | 10% |
| Weld rejected after second repair | 1 | 5% | 15% | 1 | 20% | 10% |
| Weld rejected after third repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 133 | | | 84 | | |
| Total welds | 868 | | | 819 | | |
| Overall weld rejection rate | 15% | | | 10% | | |

(Reference: RPP-RPT-55982, Rev 0, Page 5-3)

## Table K-10: Tank AN-107 Primary Bottom Welding Success Comparison

| | Tank AN-107 | | |
|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 734 | N/A | N/A |
| Weld rejected after original weld | 155 | 21% | 21% |
| Weld rejected after first repair | 25 | 16% | 20% |
| Weld rejected after second repair | 1 | 4% | 20% |
| Weld rejected after third repair | 0 | N/A | N/A |
| Total weld rejections | 181 | | |
| Total welds | 915 | | |
| Overall weld rejection rate | 20% | | |

(Reference: RPP-RPT-55982, Rev 0, Page 5-4)

## Table K-11: Tank AP-101 and Tank AP-102 Primary Bottom Welding Success Comparison

| | Tank AP-101 | | | Tank AP-102 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 47 | 6% | 6% | 65 | 9% | 9% |
| Weld rejected after first repair | 2 | 4% | 6% | 8 | 12% | 9% |
| Weld rejected after second repair | 1 | 50% | 6% | 0 | 0% | 9% |
| Weld rejected after third repair | 0 | 0% | 6% | 0 | N/A | N/A |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 50 | | | 73 | | |
| Total welds | 785 | | | 808 | | |
| Overall weld rejection rate | 6% | | | 9% | | |

(Reference: RPP-RPT-55983, Rev 0, Page 5-3)

## Table K-12: Tank AP-103 and Tank AP-104 Primary Bottom Welding Success Comparison

| | Tank AP-103 | | | Tank AP-104 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 81 | 11% | 11% | 63 | 9% | 9% |
| Weld rejected after first repair | 3 | 4% | 10% | 5 | 8% | 9% |
| Weld rejected after second repair | 0 | 0% | 10% | 1 | 20% | 9% |
| Weld rejected after third repair | 0 | N/A | N/A | 0 | 0% | 9% |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 84 | | | 69 | | |
| Total welds | 819 | | | 804 | | |
| Overall weld rejection rate | 10% | | | 9% | | |

(Reference: RPP-RPT-55983, Rev 0, Page 5-3)

## Table K-13: Tank AP-105 and Tank AP-106 Primary Bottom Welding Success Comparison

| | Tank AP-105 | | | Tank AP-106 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 90 | 12% | 12% | 44 | 6% | 6% |
| Weld rejected after first repair | 9 | 10% | 12% | 2 | 5% | 6% |
| Weld rejected after second repair | 0 | 0% | 12% | 0 | 0% | 6% |
| Weld rejected after third repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 99 | | | 46 | | |
| Total welds | 834 | | | 781 | | |
| Overall weld rejection rate | 12% | | | 6% | | |

(Reference: RPP-RPT-55983, Rev 0, Page 5-4)

## Table K-14: Tank AP-105 and Tank A6-106 Primary Bottom Welding Success Comparison

| | Tank AP-107 | | | Tank AP-108 | | |
|---|---|---|---|---|---|---|
| | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) | Length of Weld (ft) | Reject Rate per Repair Cycle (%) | Total Reject Rate (%) |
| Weld prior to inspection | 735 | N/A | N/A | 735 | N/A | N/A |
| Weld rejected after original weld | 50 | 7% | 7% | 38 | 5% | 5% |
| Weld rejected after first repair | 3 | 6% | 7% | 1 | 3% | 5% |
| Weld rejected after second repair | 0 | 0% | 7% | 0 | 0% | 5% |
| Weld rejected after third repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Weld rejected after forth repair | 0 | N/A | N/A | 0 | N/A | N/A |
| Total weld rejections | 53 | | | 39 | | |
| Total welds | 788 | | | 773 | | |
| Overall weld rejection rate | 7% | | | 5% | | |

(Reference: RPP-RPT-55983, Rev 0, Page 5-4)

# APPENDIX L
# DOUBLE-SHELL TANK PRIMARY WALL THICKNESS

# APPENDIX L DOUBLE-SHELL TANK PRIMARY WALL THICKNESS

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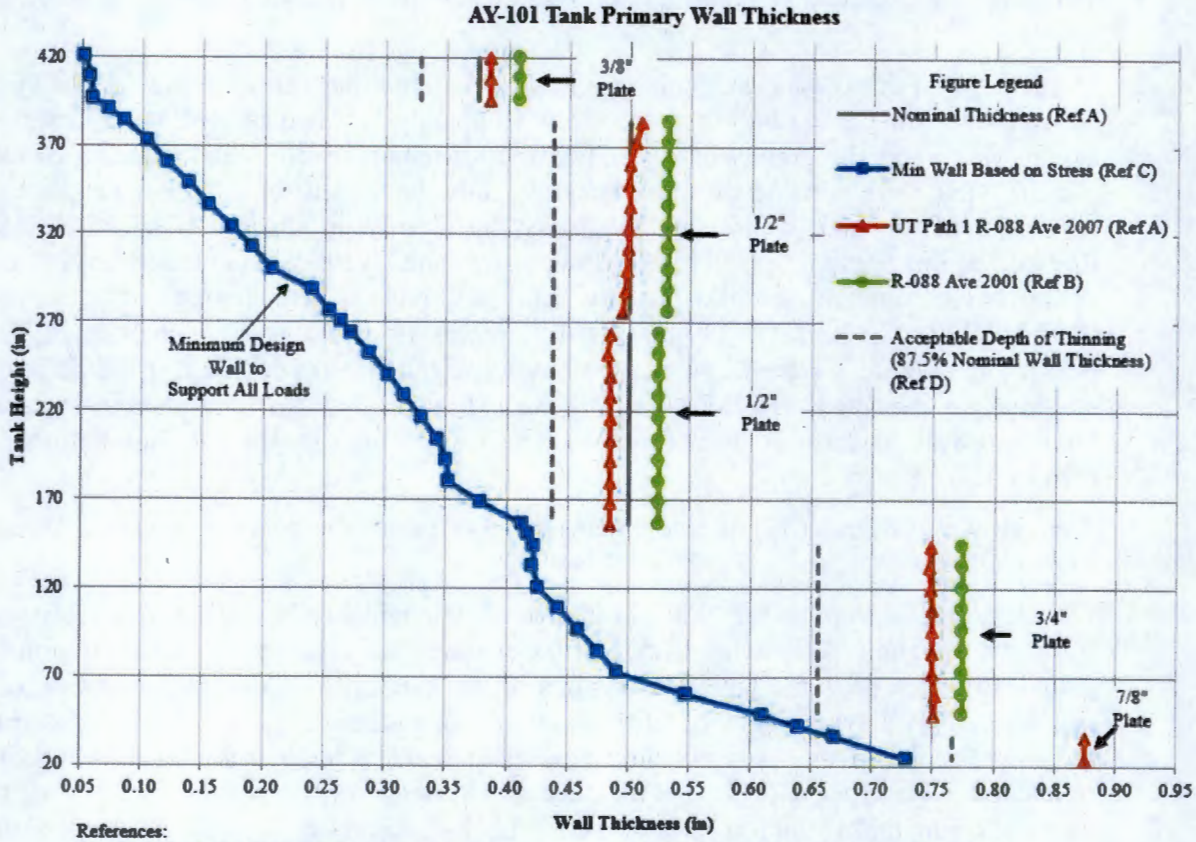
The figures in this appendix show primary wall thicknesses for each tank. Noted on the graphs are the following:

1. Nominal wall thickness is the design thickness of the walls per the original construction document.
2. Minimum wall thickness based on stress is shown. This wall thickness was established by using the worst case of all the tanks. The tank analysis was made with 422 in. waste height with a specific gravity of 1.7 and 350 °F. Membrane stress and buckling of the primary tank were considered. The buckling only controlled on the top knuckle, the remainder of the tank walls were controlled by membrane stress. (RPP-RPT-32238, Rev. 0, Section 5.0, pg. 5.1) The AP Tank Farm tanks were re-rated based on 460 in. waste height and a specific gravity of 1.83 and a temperature of 210 °F. (RPP-RPT-32237, Rev. 1) "Primary tank stresses from the revised analysis of the BES-BEC case are compared the original analysis, and it was verified that the changes are small as expected" (RPP-RPT-32239, Rev. 1, pg. 1.2). No revised primary tank minimum wall thickness analysis for the 460 in. waste height for the AP Tank Farm was reviewed.
3. Average wall thickness UT measurements are plotted for the years that measurements were available.
4. The Acceptable Depths for Wall Thinning 12.5% table (RPP-RPT-32238, Rev. 0, Appendix A, Table A-3) is the 87.5% of the nominal wall thickness. This criterion is graphically shown on the table and applies to the sidewall of the tank and the lower knuckle. This flaw acceptance criterion was recommended by the Tank Structural Integrity Panel. In the main portion of this document, a larger acceptance criteria is concluded. The upper knuckle (not included graph) has a corrosion allowance of 0.12 in for most of the tanks which is 32% of the 3/8 in. wall thickness. For the AP Tank Farm tanks with 12 in. wg vacuum, the corrosion allowance is 0.025 in., which is 6.67 % of the nominal knuckle thickness of the top knuckle. In conjunction with these criteria, the corrosion allowance of 0.144 in. is allowed in the tank sidewalls. This is 28.8% of the ½ in. side wall plates (RPP-RPT-32238, Rev. 0, Section 5.0, pg. 5.1). The reason this line was drawn was to show that the tank wall thickness is not close to the capacity of the wall.




References:
A) RPP-RPT-46309 (PNNL-19242), Appendix A, pg 25
B) RPP-RPT-58301 Rev 0, Table A-2, pg A-2
C) RPP-RPT-32238, Rev 0, Figure 4-1, pg 4.2
D) RPP-RPT-32238, Rev 0, Table A-3, pg A-7

**Figure L-1: Tank AY-101 Primary Wall Thickness**

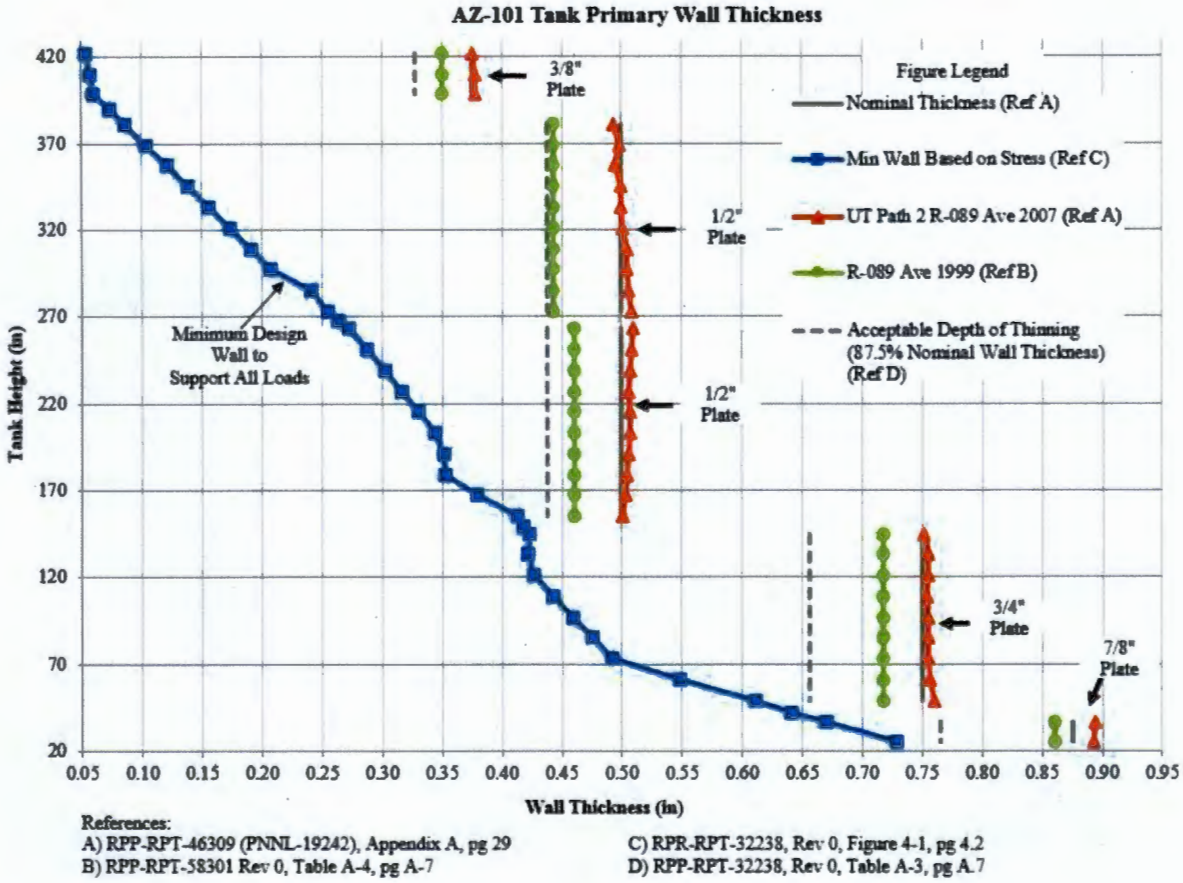



**Figure L-2: Tank AZ-101 Primary Wall Thickness**

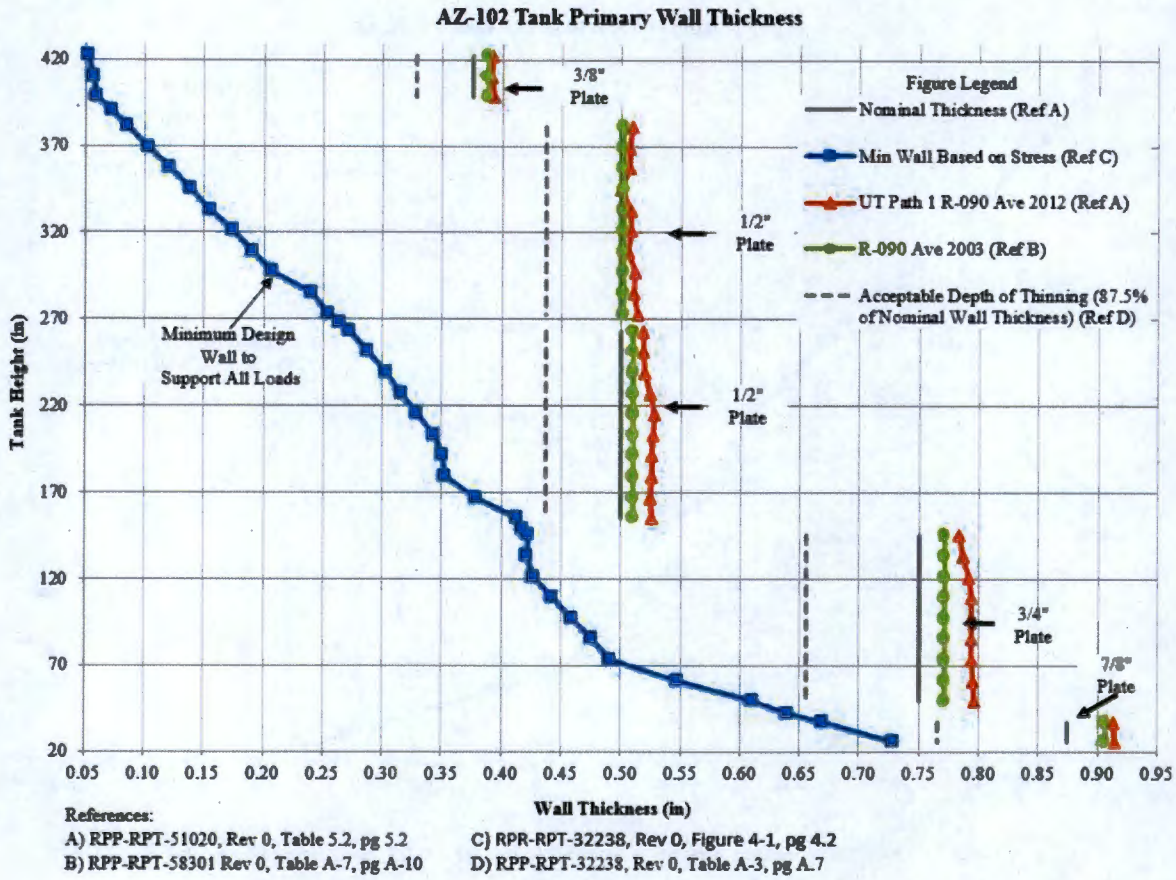



**Figure L-3: Tank AZ-102 Primary Wall Thickness**

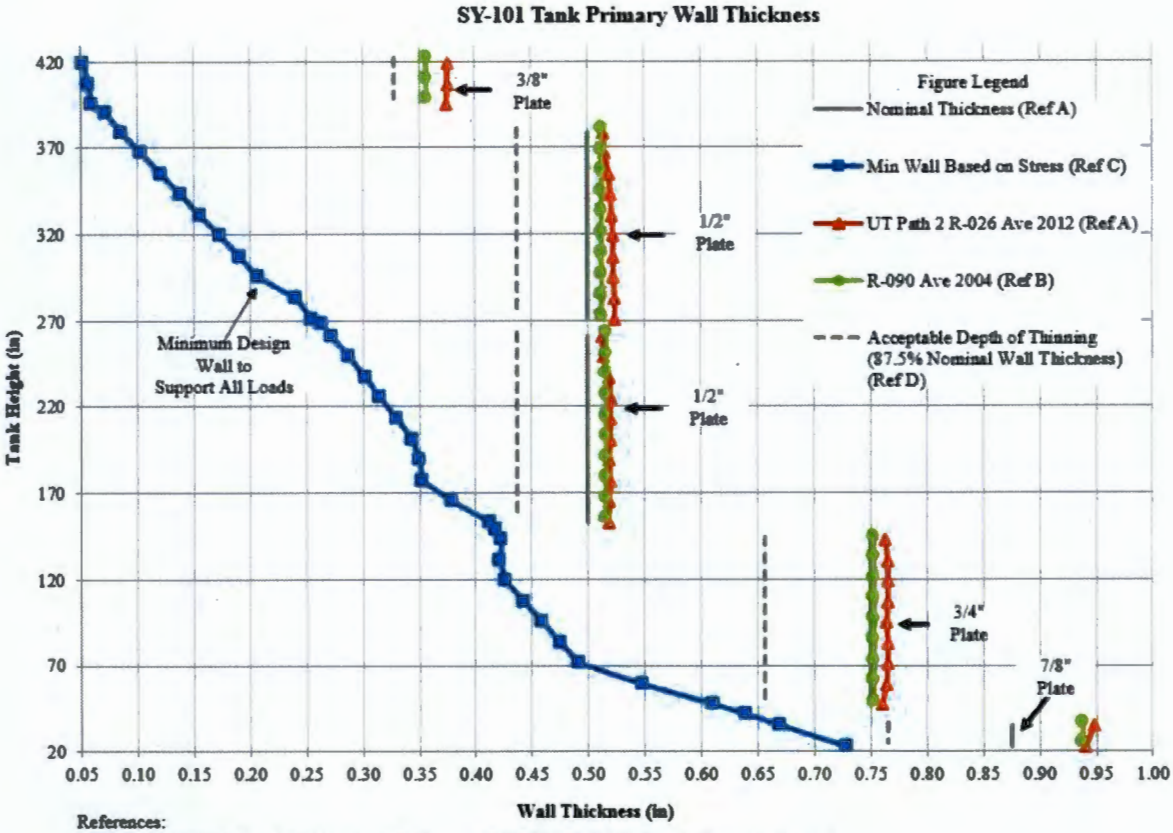



**Figure L-4: Tank SY-101 Primary Wall Thickness**

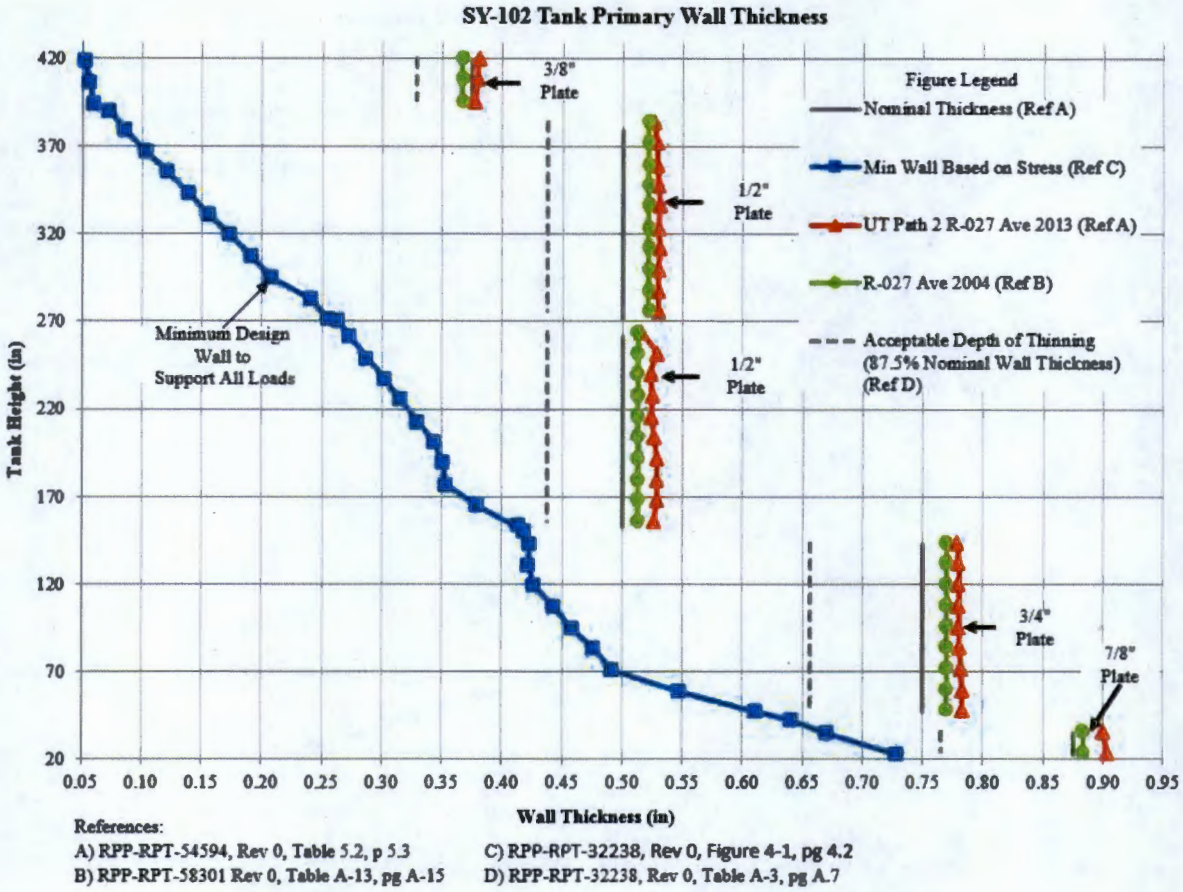



**Figure L-5: Tank SY-102 Primary Wall Thickness**

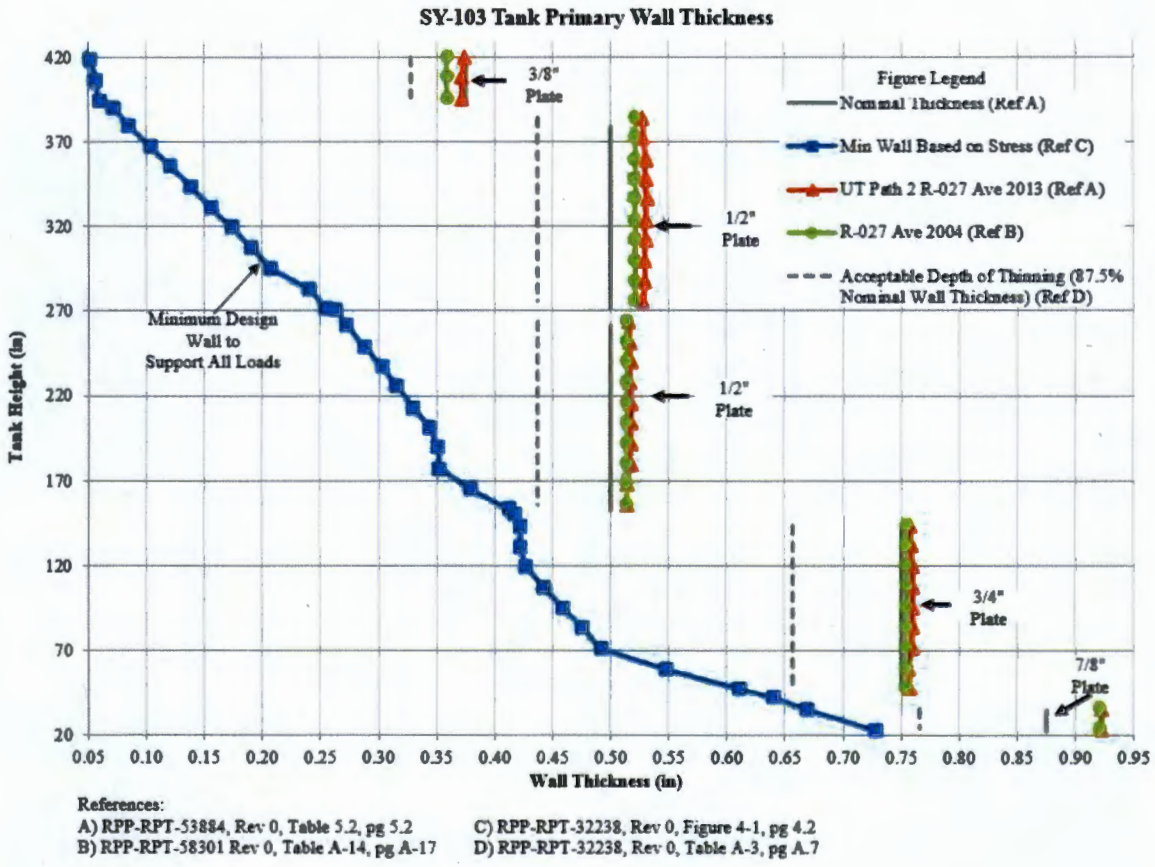



**Figure L-6: Tank SY-103 Primary Wall Thickness**

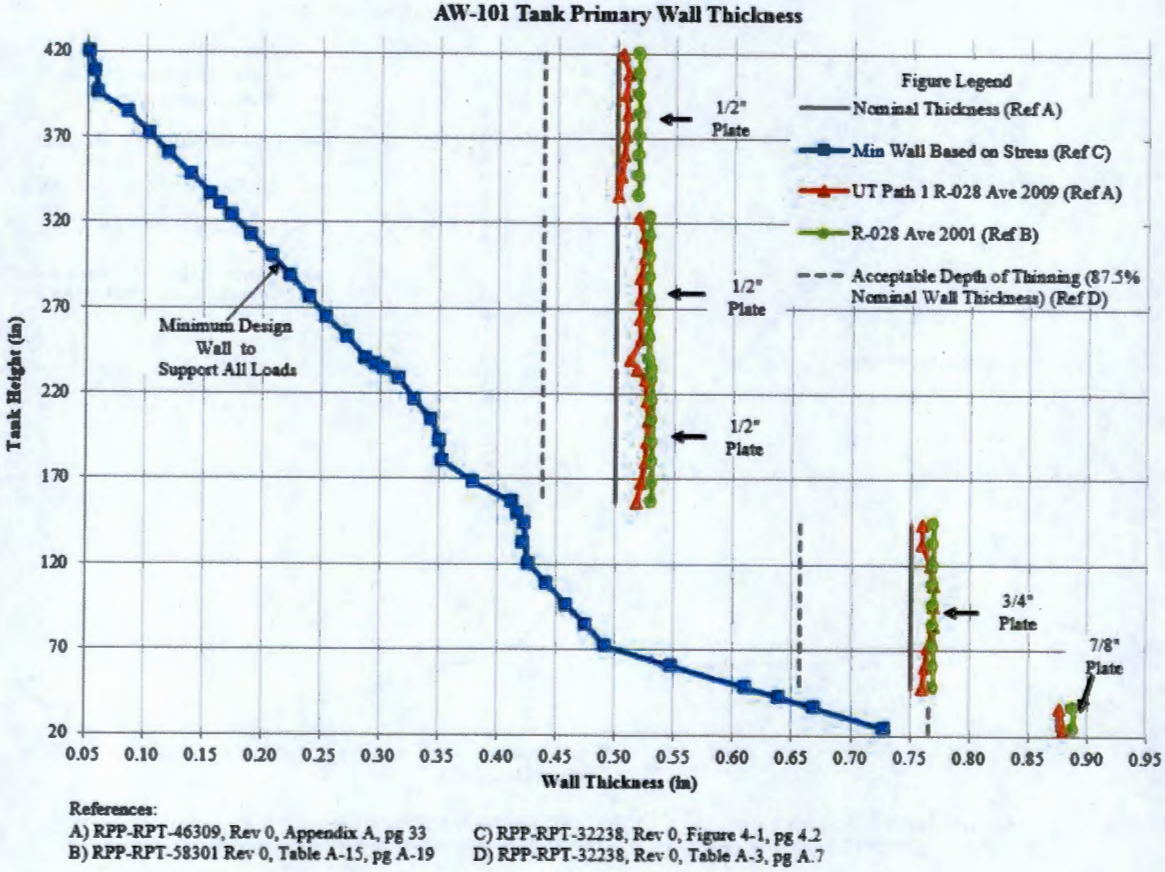



**Figure L-7: Tank AW-101 Primary Wall Thickness**

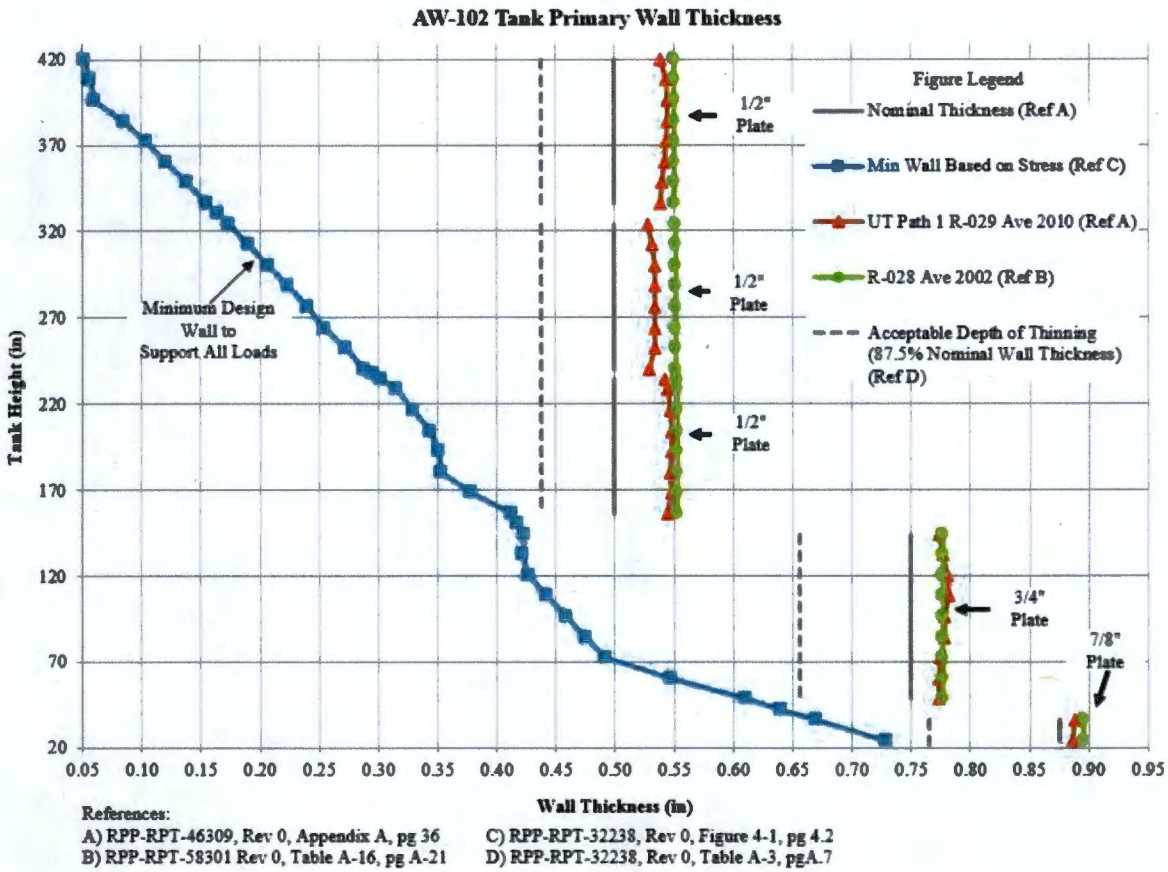



**Figure L-8: Tank AW-102 Primary Wall Thickness**

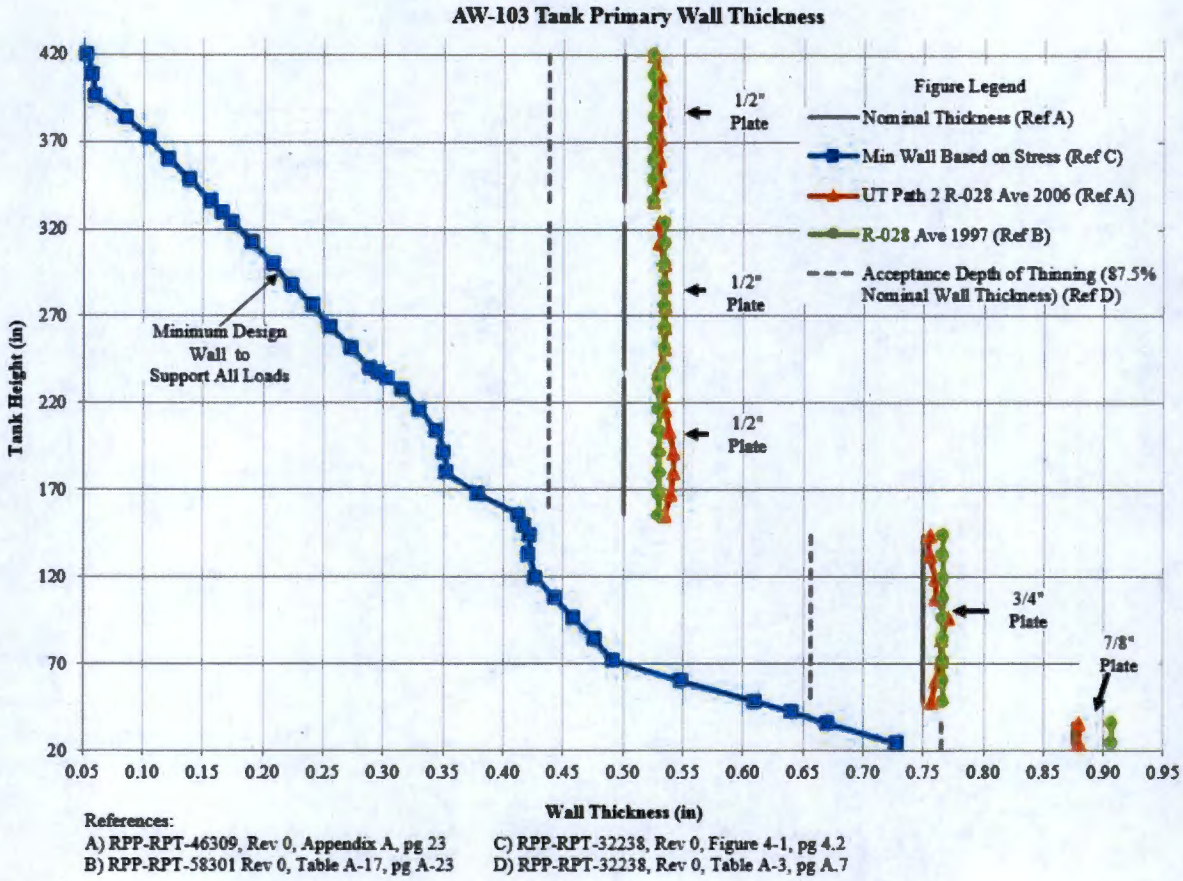



**Figure L-9: Tank AW-103 Primary Wall Thickness**

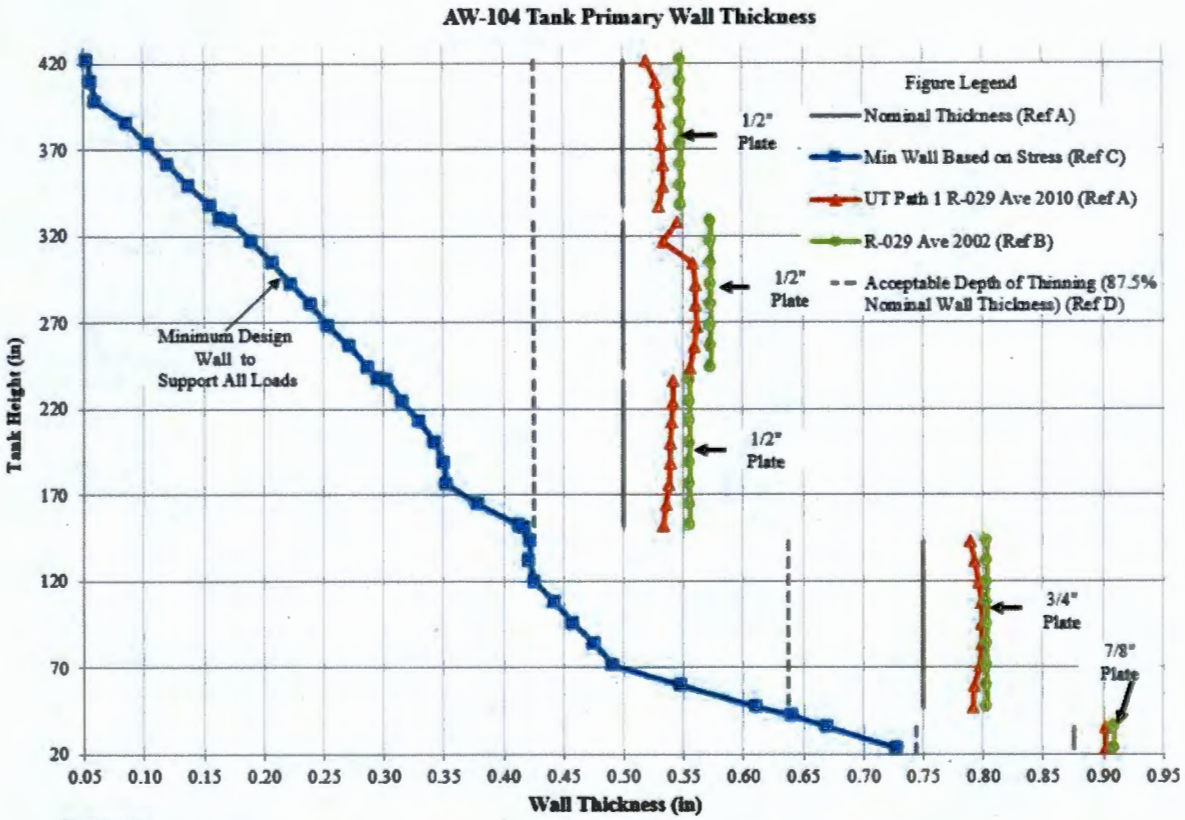



**Figure L-10: Tank AW-104 Primary Wall Thickness**

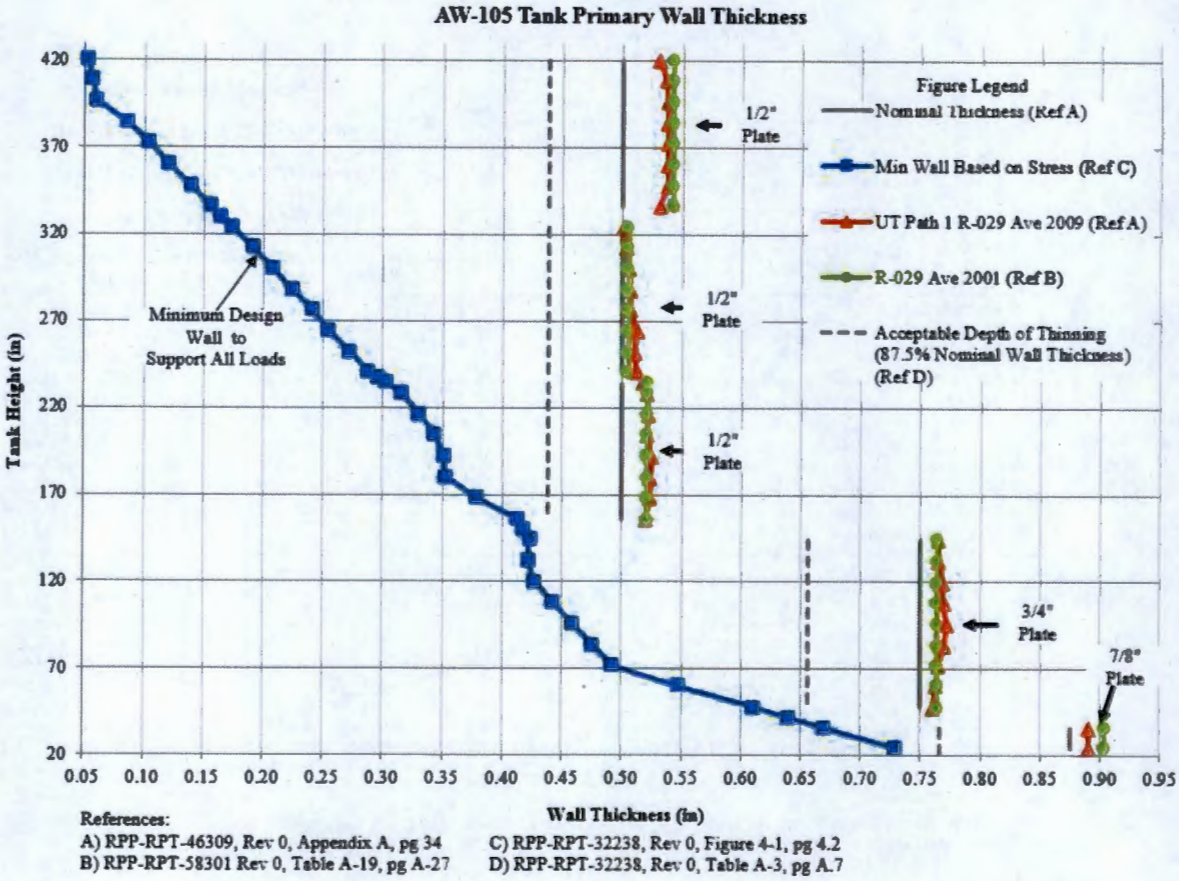



**Figure L-11: Tank AW-105 Primary Wall Thickness**

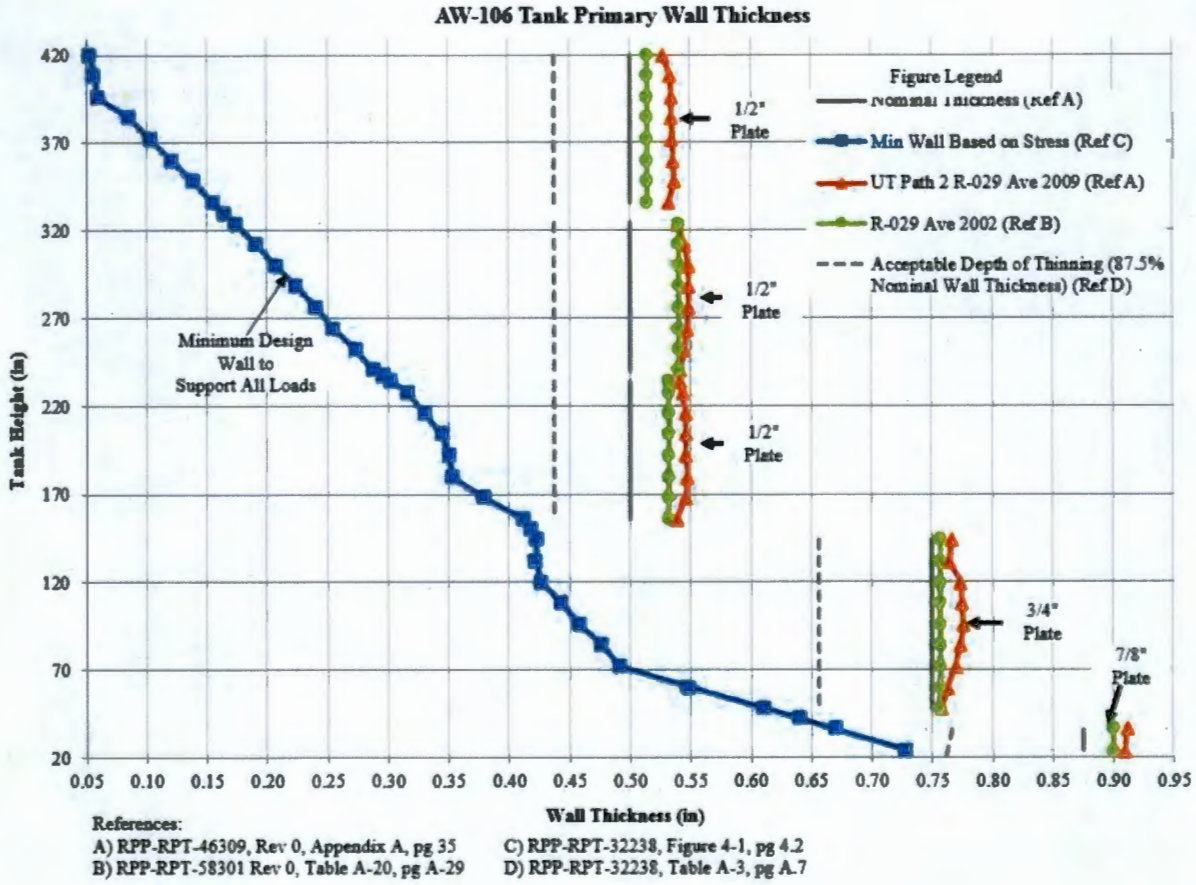
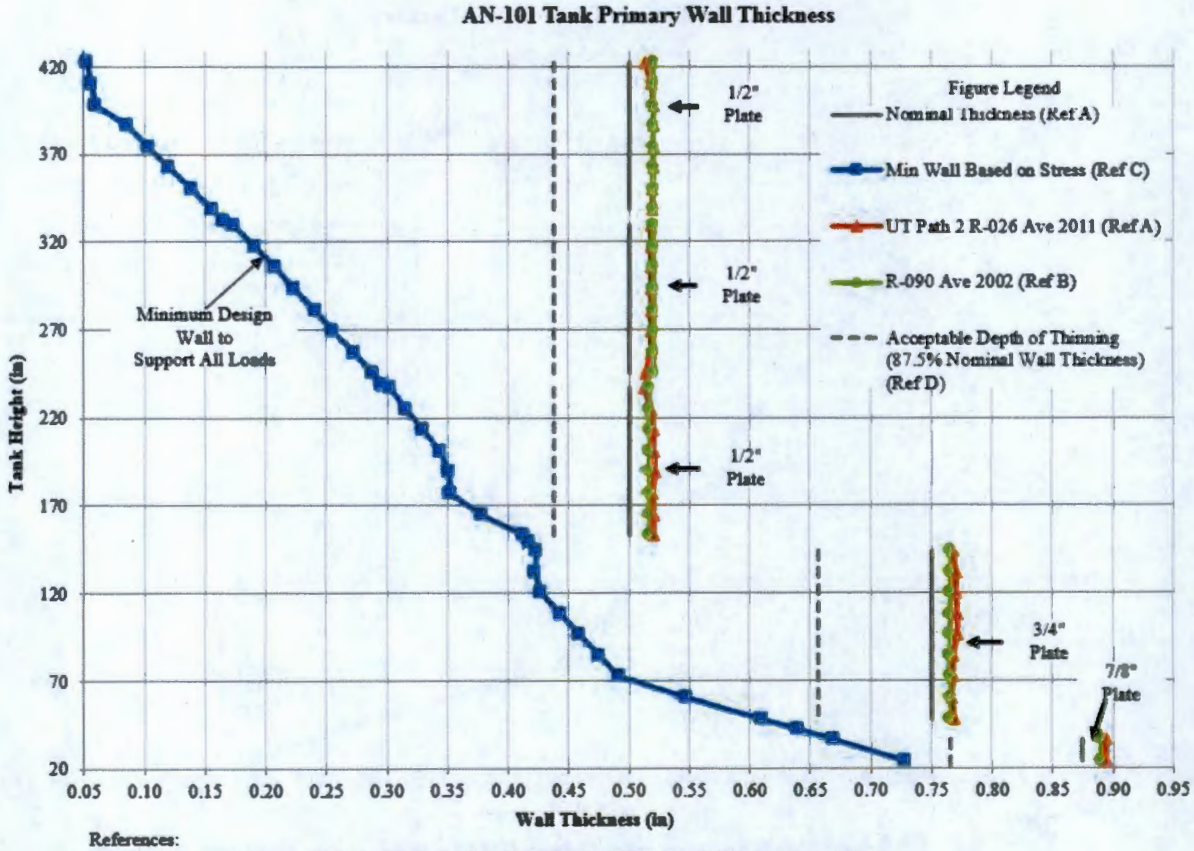



**Figure L-12: Tank AW-106 Primary Wall Thickness**




References:
A) RPP-RPT-49494, Rev 0, Table 5.2, pg Att 2-28
B) RPP-RPT-58301 Rev 0, Table A-21, pg A-31
C) RPT-RPP-32238, Rev 0, Figure 4-1, pg 4.2
D) RPT-RPP-32238, Rev 0, Table A-3, pg A.7

**Figure L-13: Tank AN-101 Primary Wall Thickness**

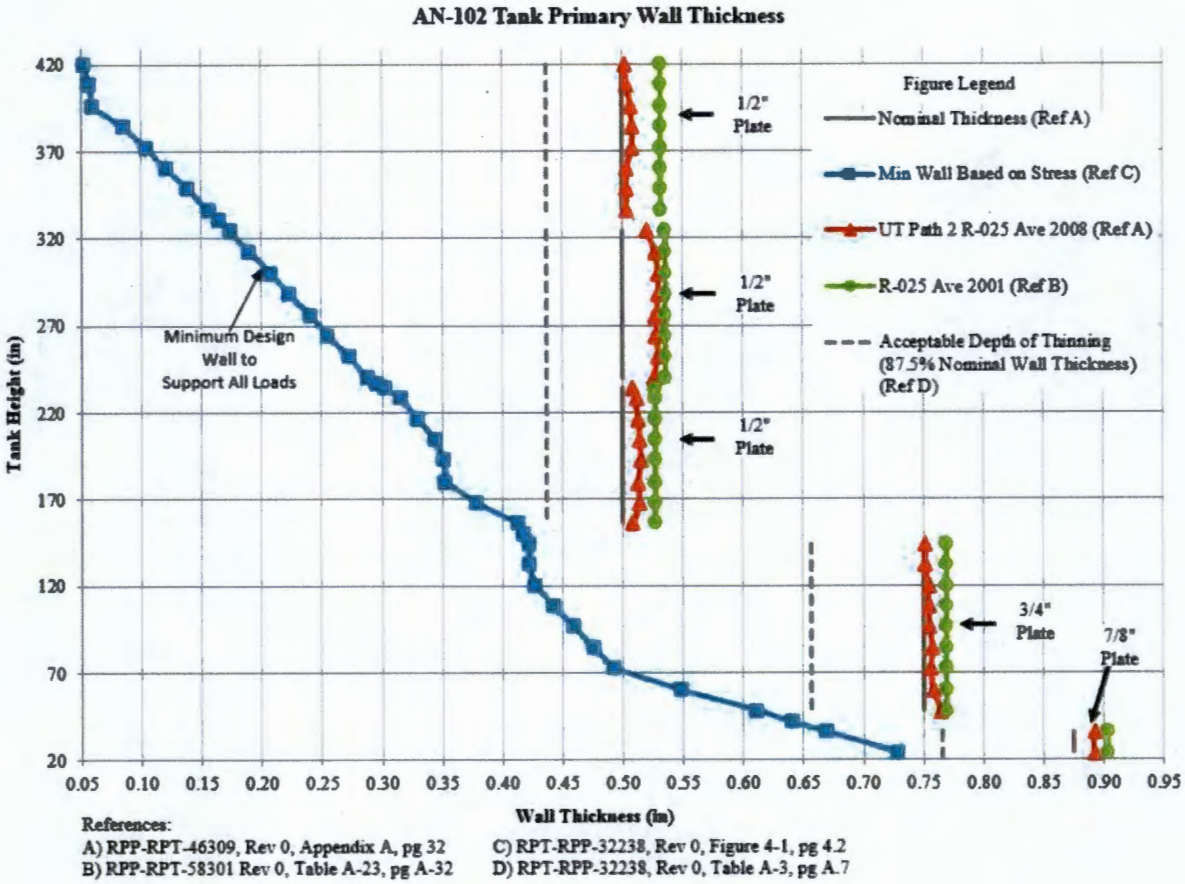



**Figure L-14: Tank AN-102 Primary Wall Thickness**

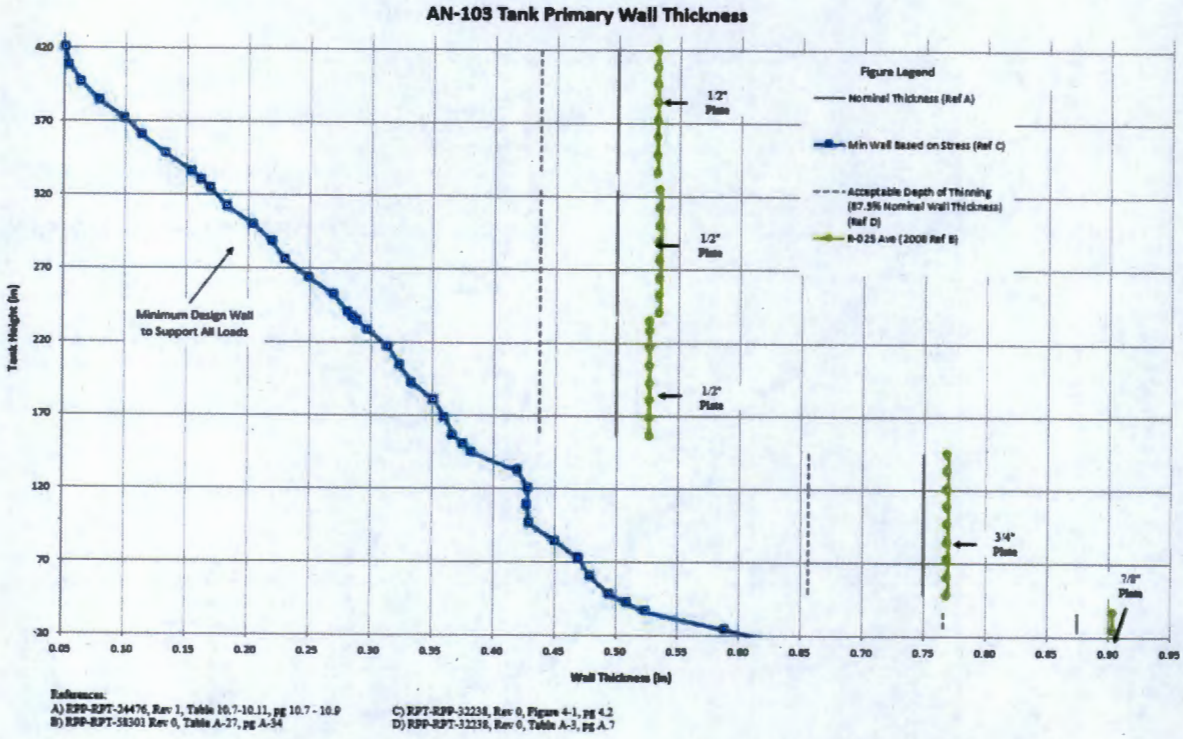



**Figure L-15: Tank AN-103 Primary Wall Thickness**

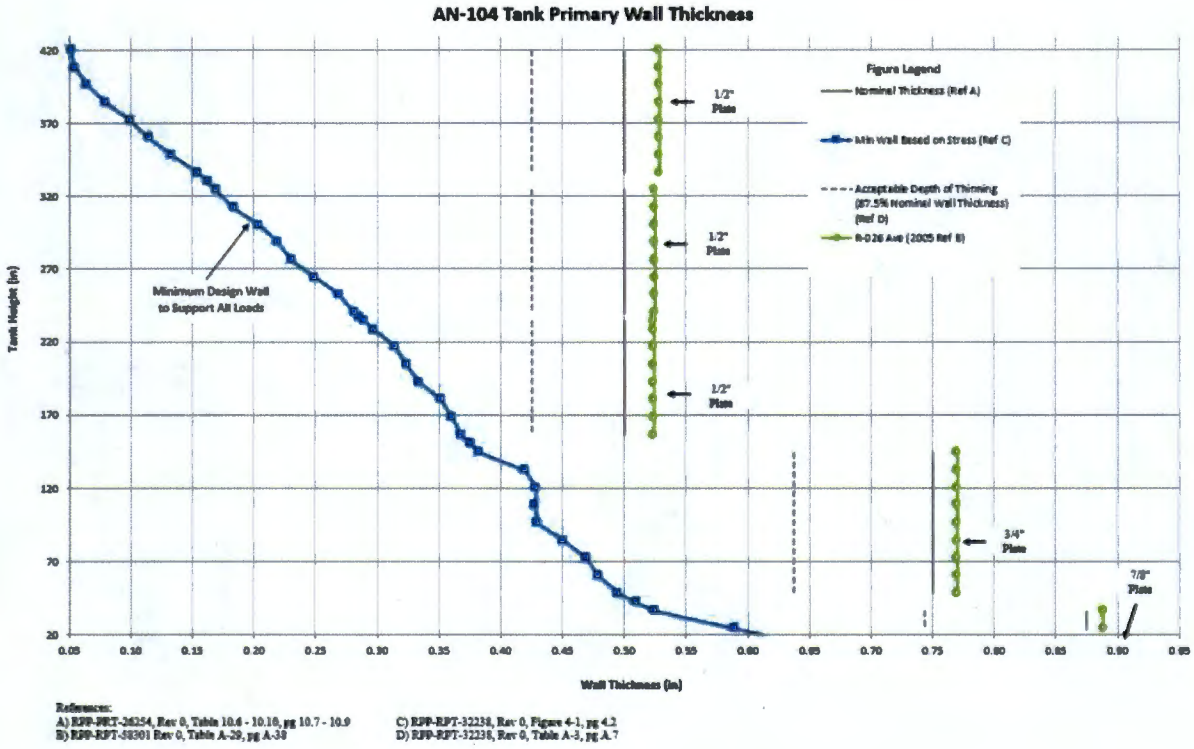



**Figure L-16: Tank AN-104 Primary Wall Thickness**

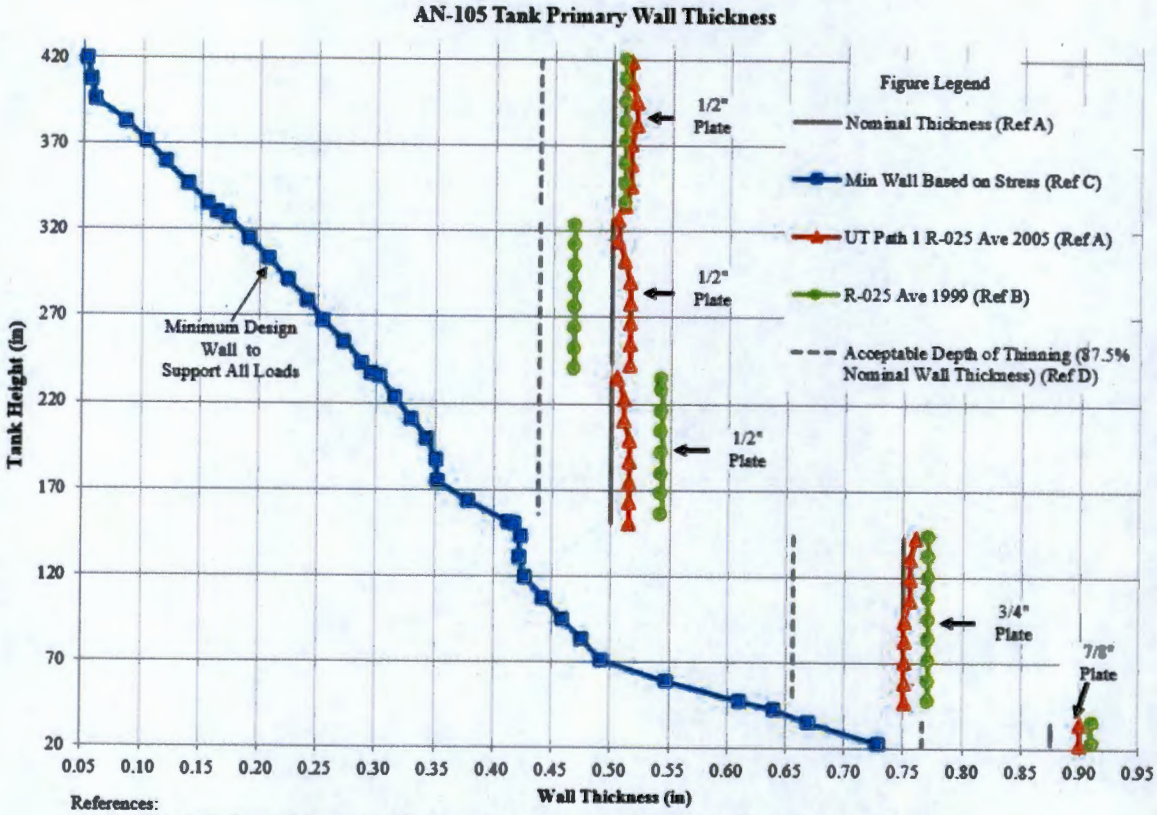



**Figure L-17: Tank AN-105 Primary Wall Thickness**

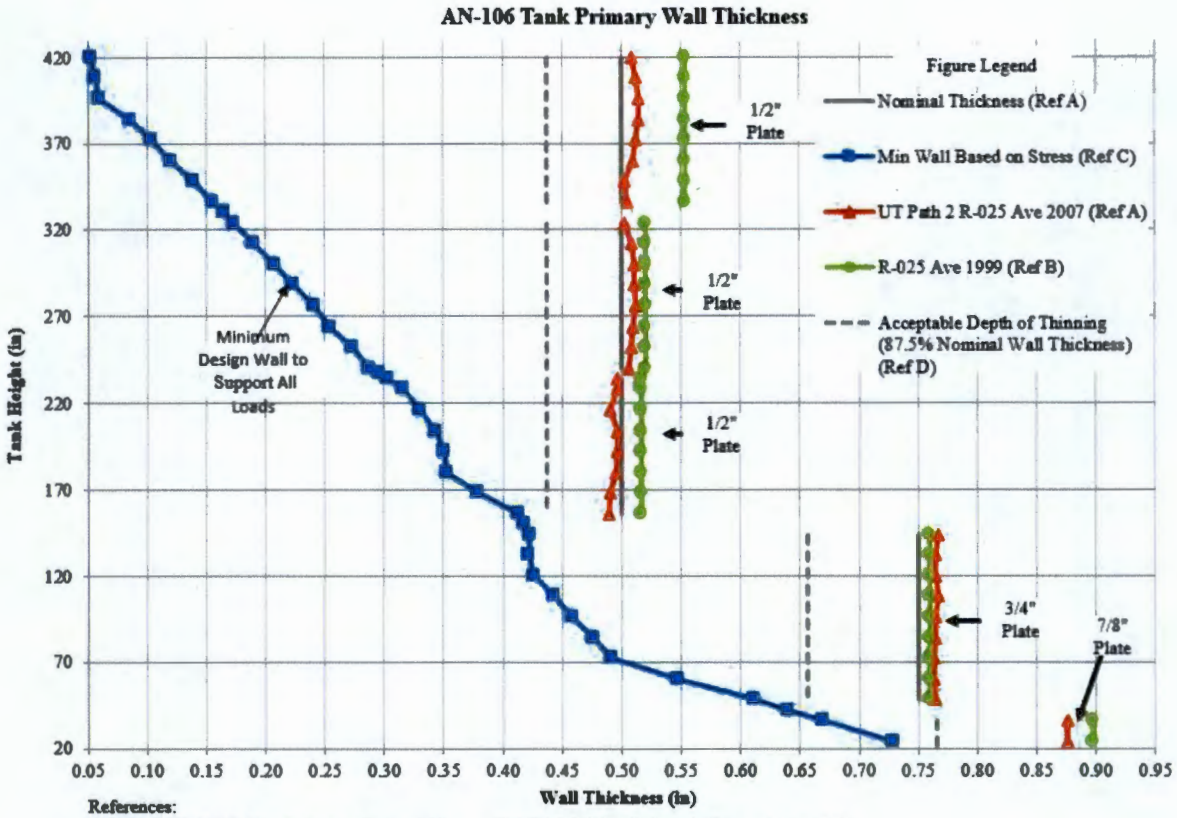



**Figure L-18: Tank AN-106 Primary Wall Thickness**

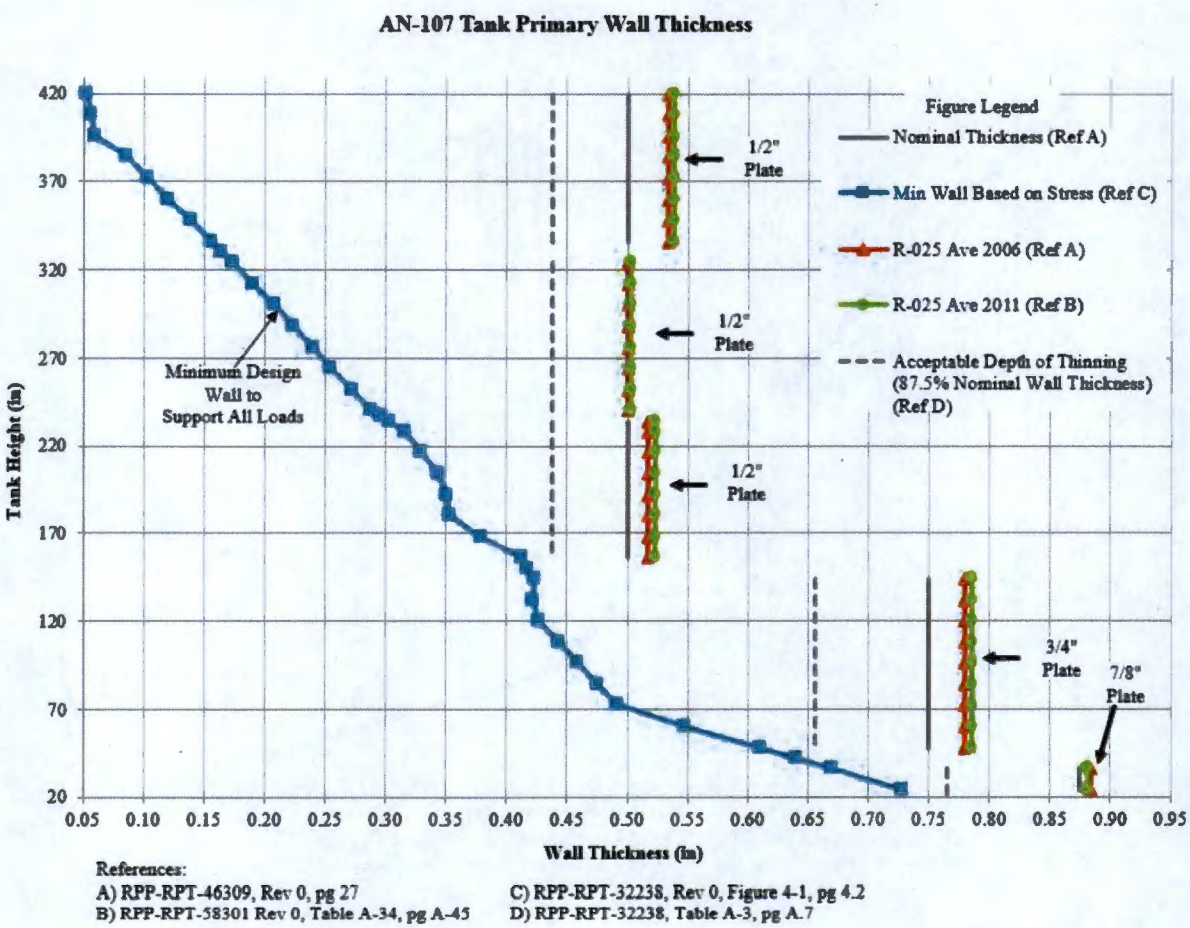



**Figure L-19: Tank AN-107 Primary Wall Thickness**

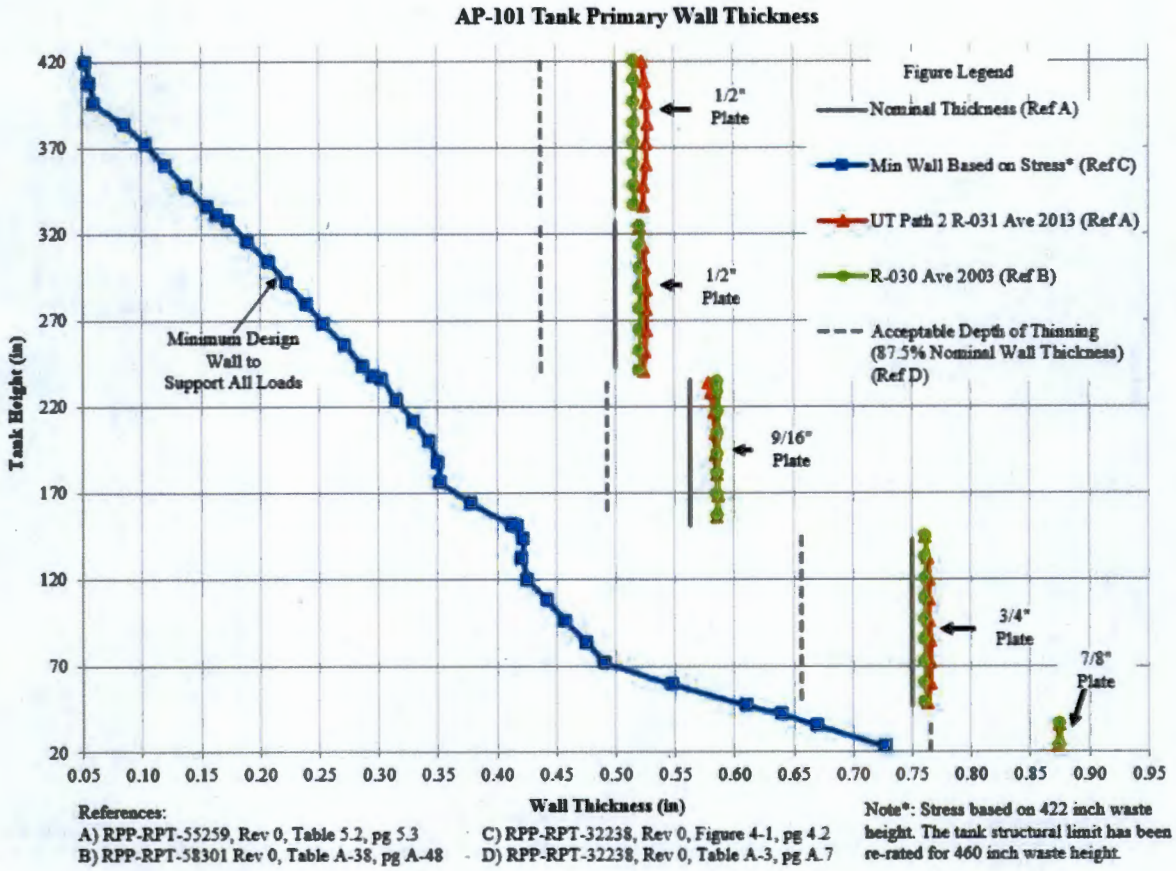



**Figure L-20: Tank AP-101 Primary Wall Thickness**

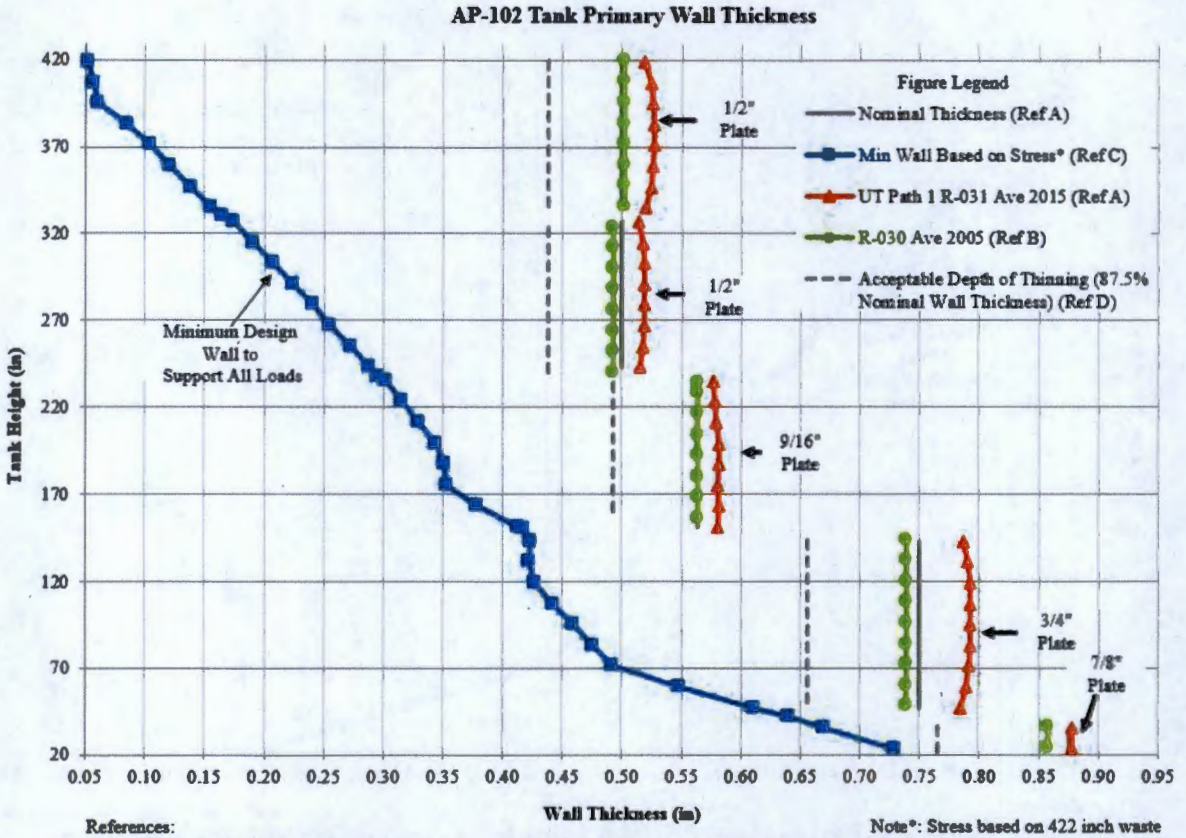



**Figure L-21: Tank AP-102 Primary Wall Thickness**

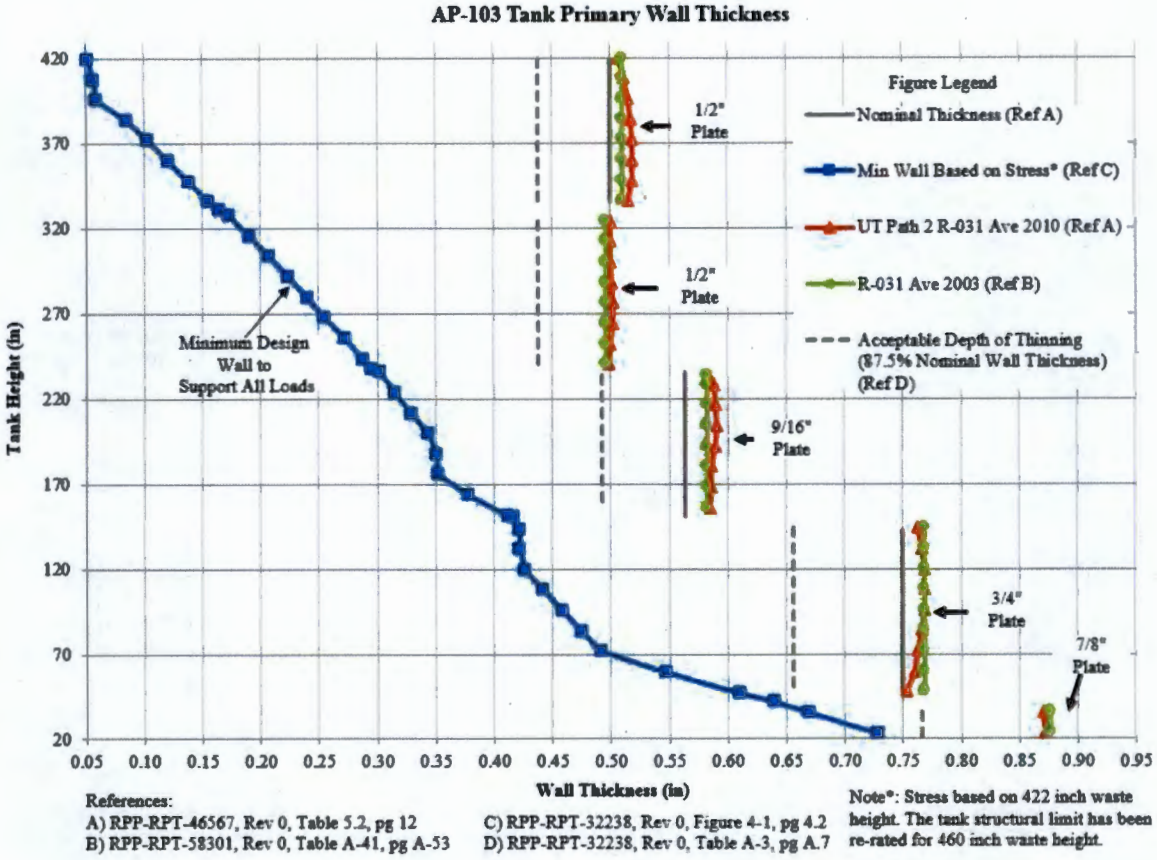



**Figure L-22: Tank AP-103 Primary Wall Thickness**

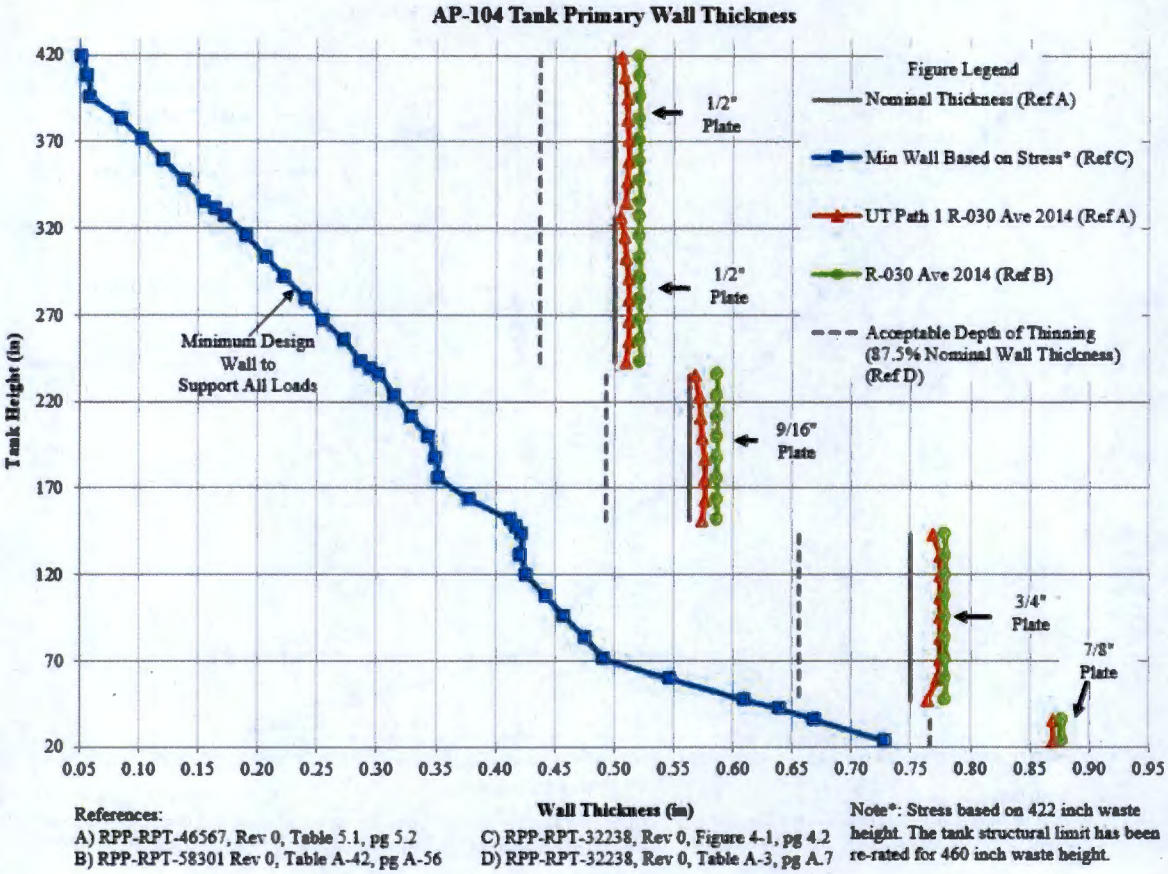



**Figure L-23: Tank AP-104 Primary Wall Thickness**

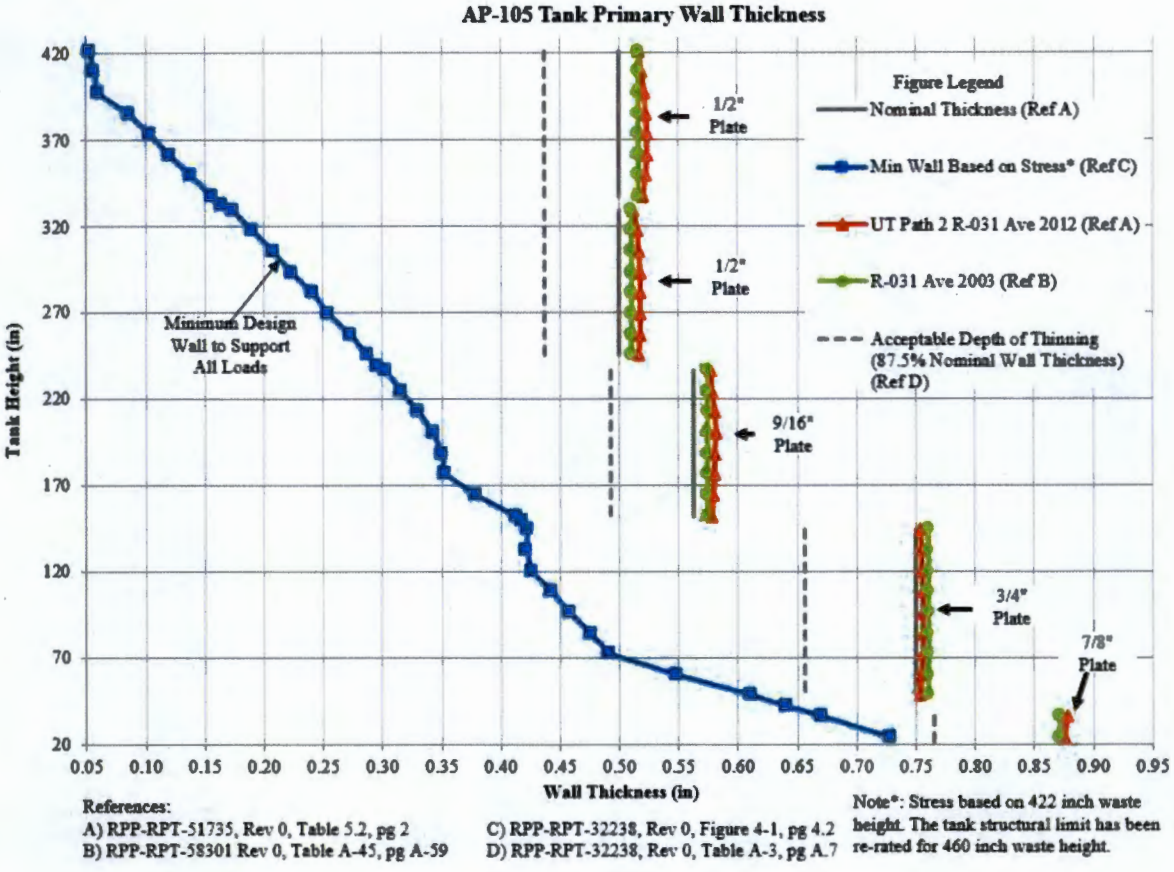



**Figure L-24: Tank AP-105 Primary Wall Thickness**

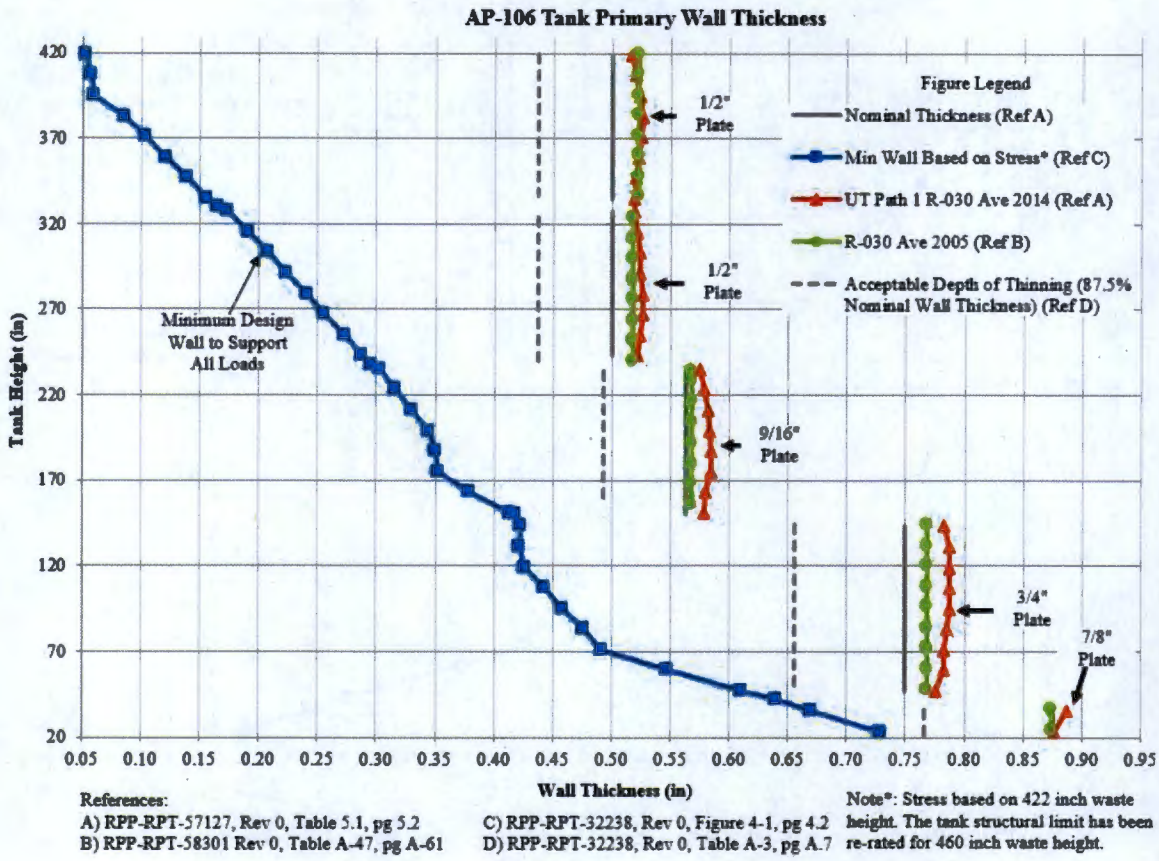



**Figure L-25: Tank AP-106 Primary Wall Thickness**

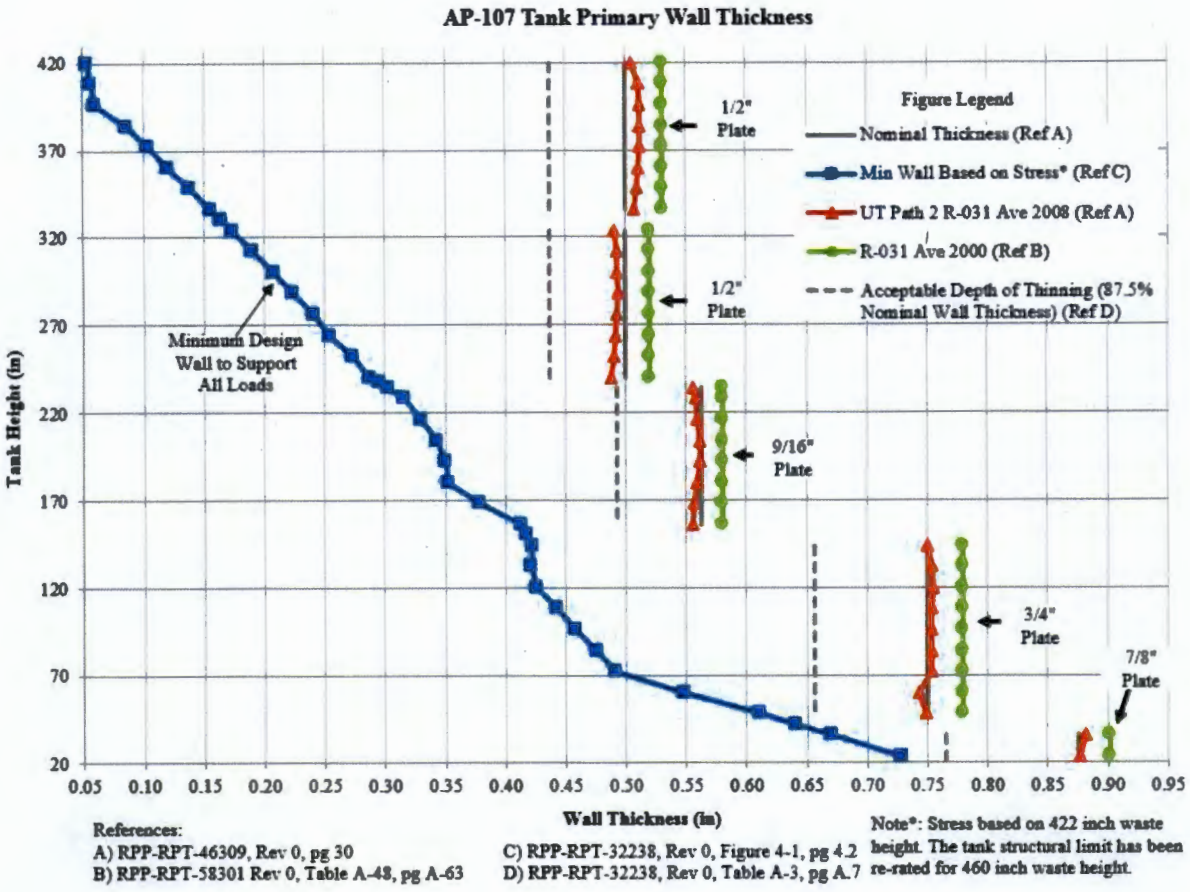



**Figure L-26: Tank AP-107 Primary Wall Thickness**

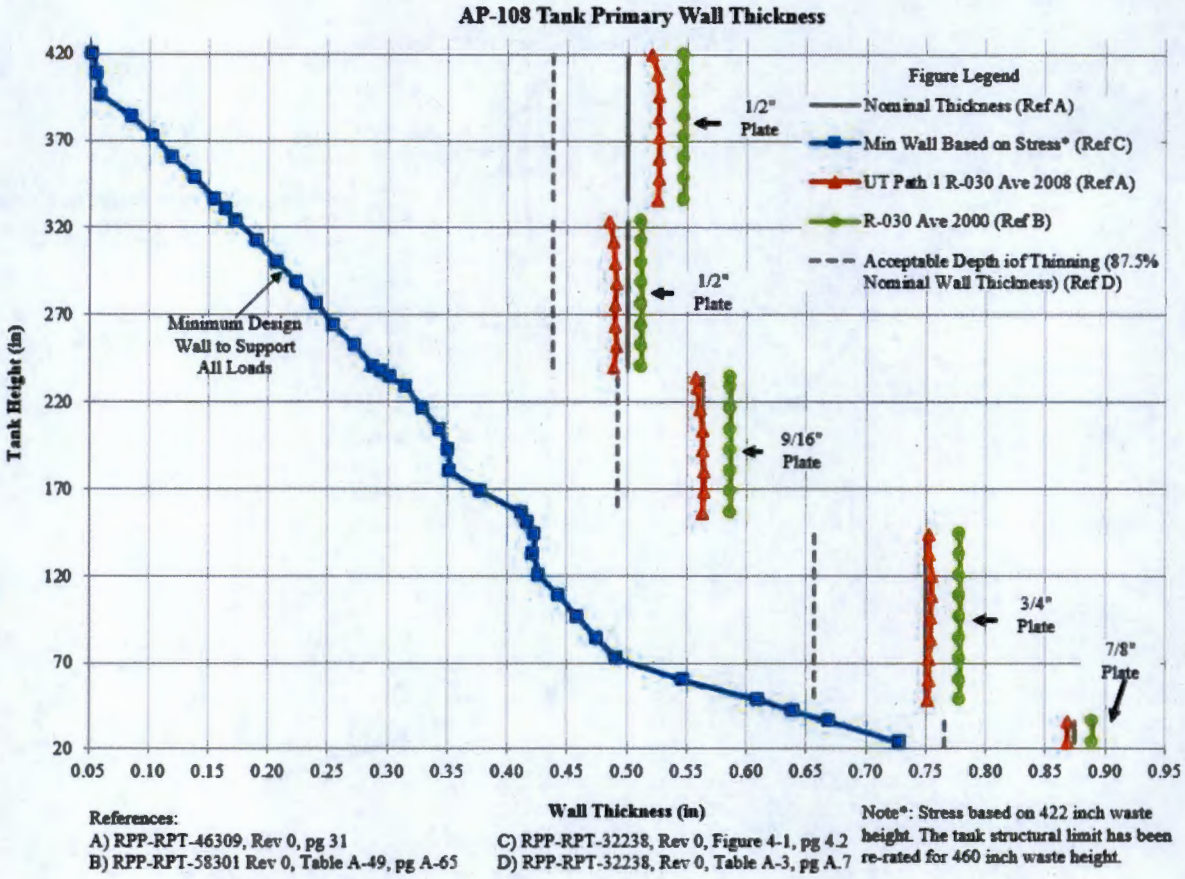



**Figure L-27: Tank AP-108 Primary Wall Thickness**

# APPENDIX M
# DOUBLE-SHELL TANK WASTE LEVELS

# APPENDIX M DOUBLE-SHELL TANK WASTE LEVELS

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Table M-2: Primary Tank Minimum Waste Liquid Level ..... M-4

**Table M-1: Primary Tank Maximum Waste Liquid Level**

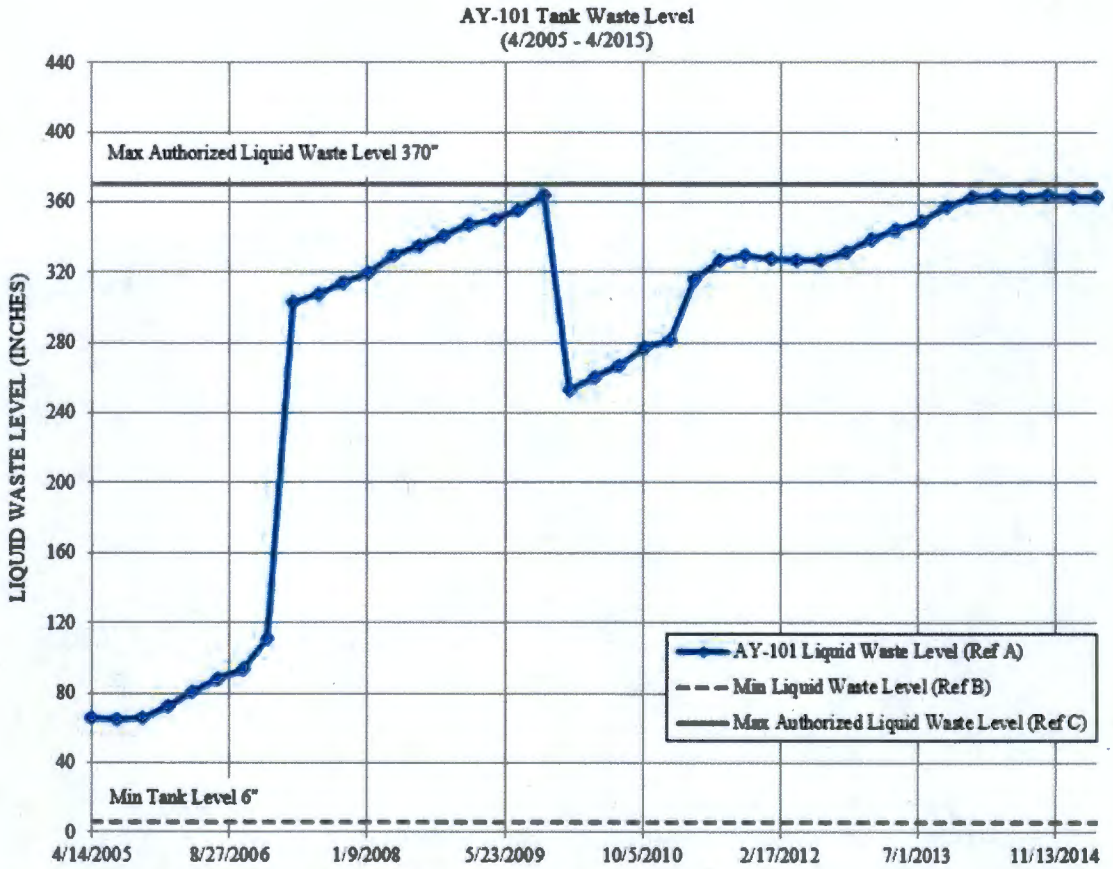
| Tanks | Normal Operating Limit (inch) | Maximum Authorized Limit (inch) | Structural Limit (inch) |
|---|---|---|---|
| 241-AY | 364 | 370 | 370 |
| 241-AZ | 364 | 370 | 370 |
| 241-SY | 416 | 422 | 422 |
| 241-AW-101, 103-106 | 416 | 422 | 422 |
| 241-AW-102 | 409 | 422 | 422 |
| 241-AN | 416 | 422 | 422 |
| 241-AP-101, 103, 104, 105, 107, 108 | 416 | 422 | 460 |
| 241-AP-102, 106 | 454 | 458 | 460 |

Reference: Table 1.1.1, Page 1 of OSD-T-151-00007, 2015, *Operating Specifications for the Double-Shell Storage Tanks*, Rev. 14, Washington River Protection Solutions, LLC, Richland, Washington.

**Table M-2: Primary Tank Minimum Waste Liquid Level**

| Tanks | When Annulus Ventilation in Operation (inch) | When Primary Tank Ventilation in Operation (inch) |
|---|---|---|
| 241-AY, AZ | 64 | 6 |
| 241-AN, SY, AW | N/A | 6 |
| 241-AP | N/A | 12 |

Reference: Table 1.1.2, Page 4 of OSD-T-151-00007, 2015, *Operating Specifications for the Double-Shell Storage Tanks*, Rev. 14, Washington River Protection Solutions, LLC, Richland, Washington.




Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-1: Tank AY-101 Waste Level**

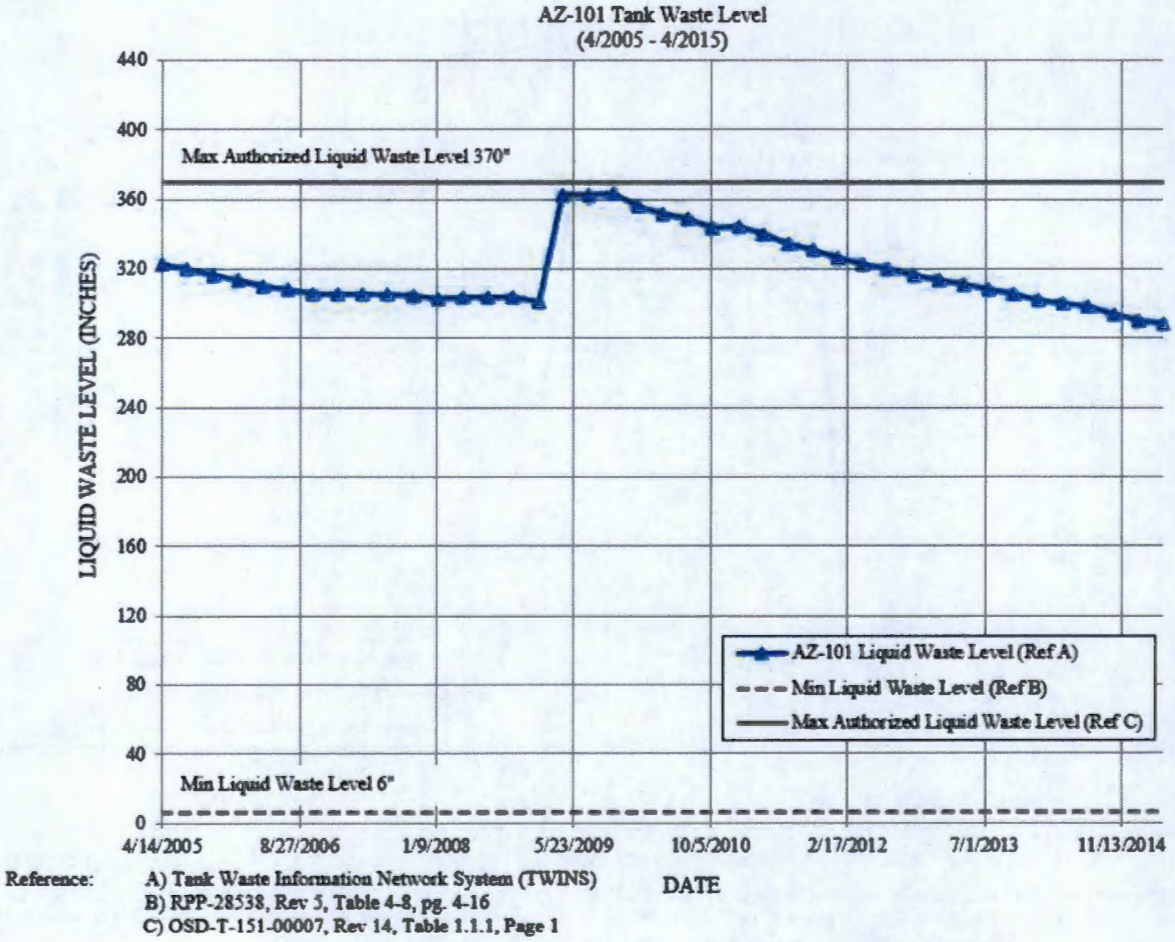
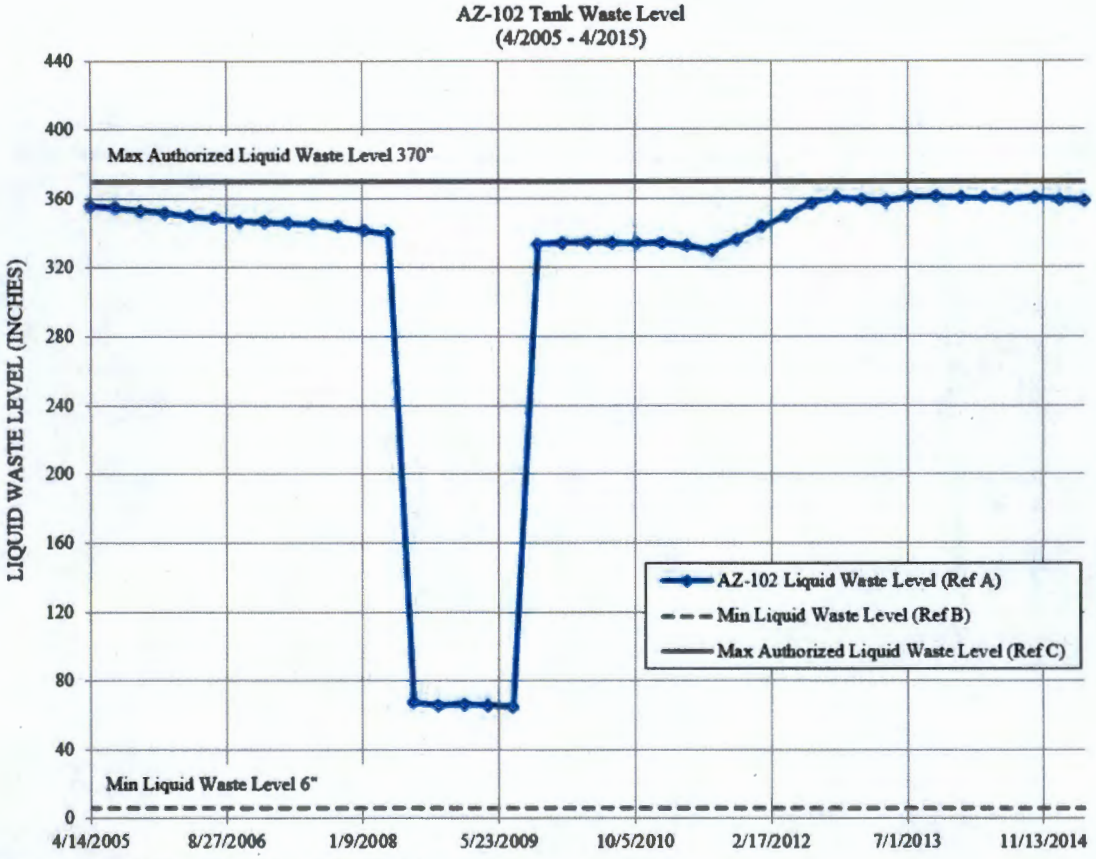
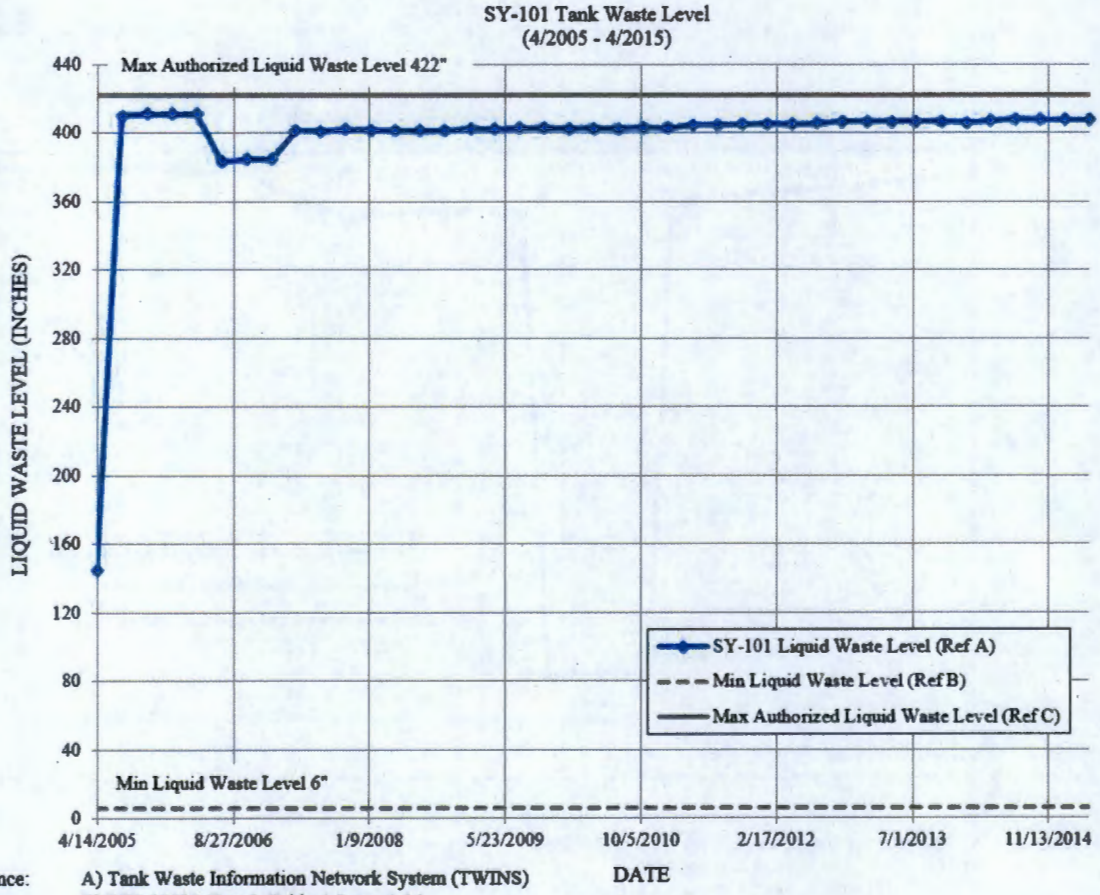



**Figure M-2: Tank AZ-101 Waste Level**



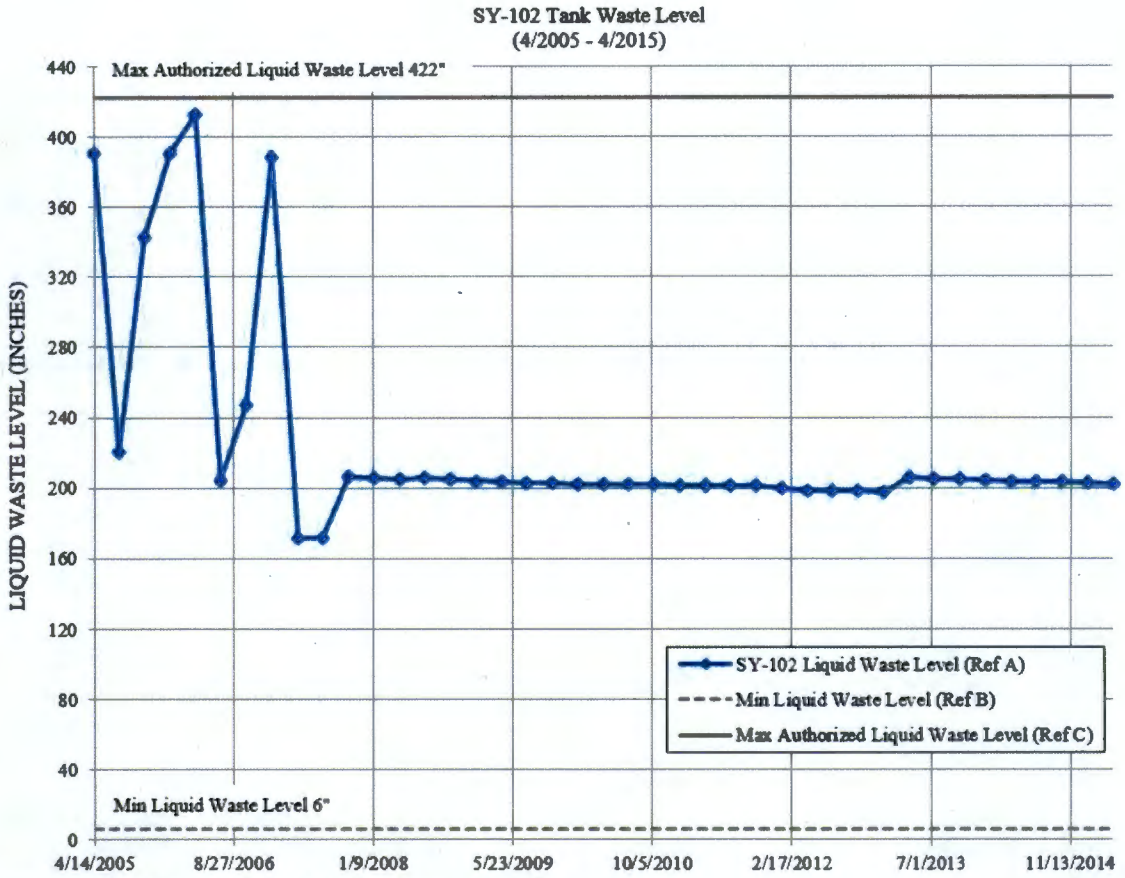

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-3: Tank AZ-102 Waste Level**



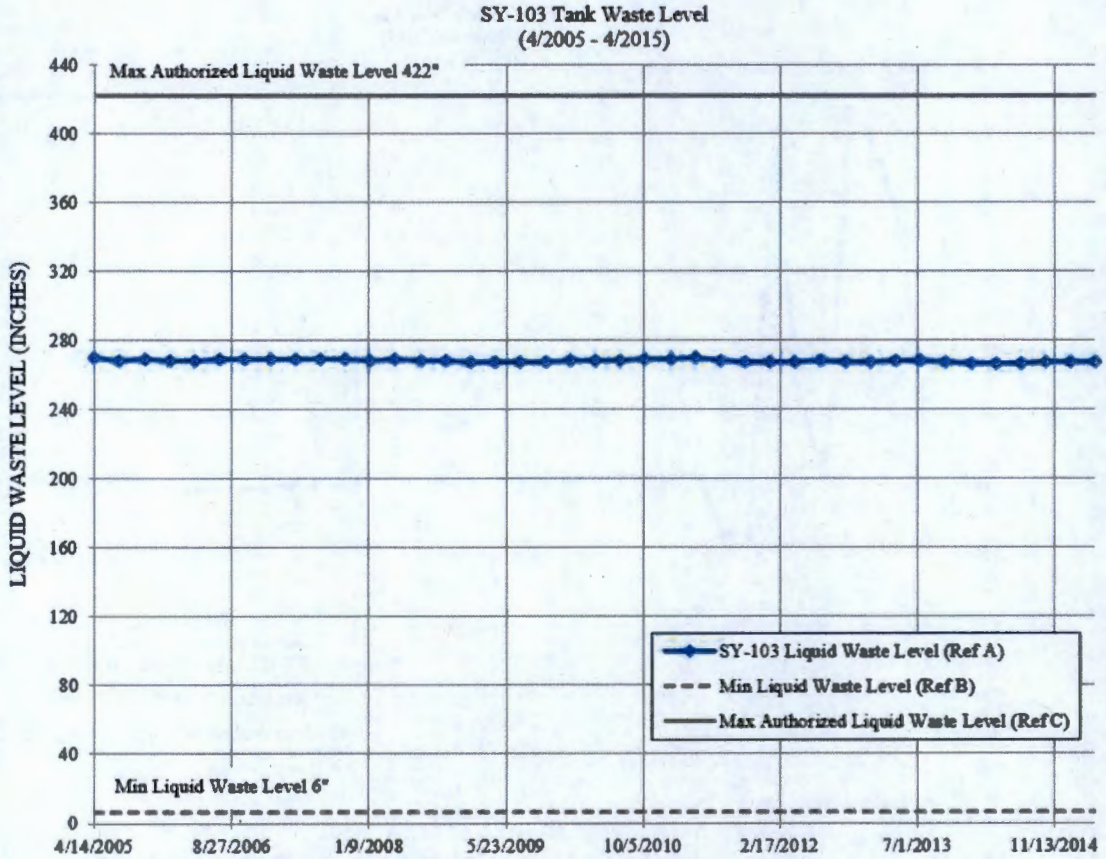

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 2

**Figure M-4: Tank SY-101 Waste Level**



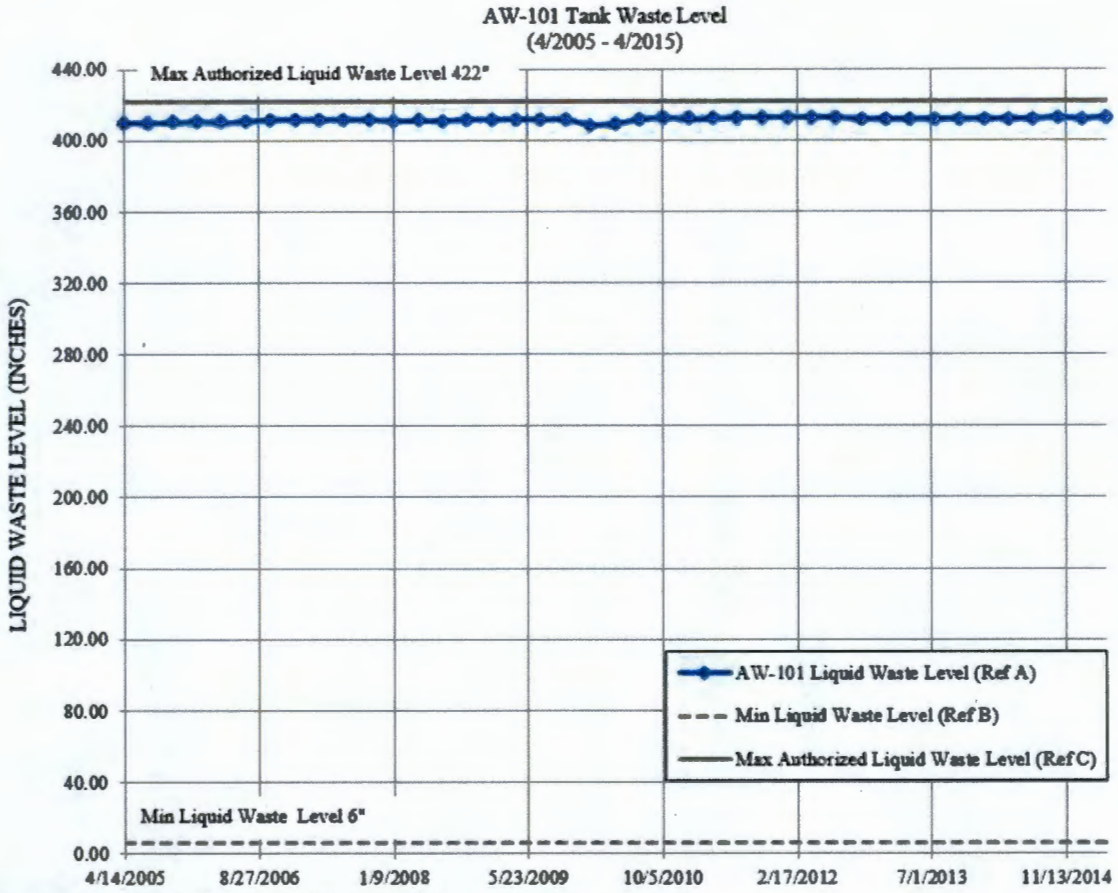

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 2

**Figure M-5: Tank SY-102 Waste Level**



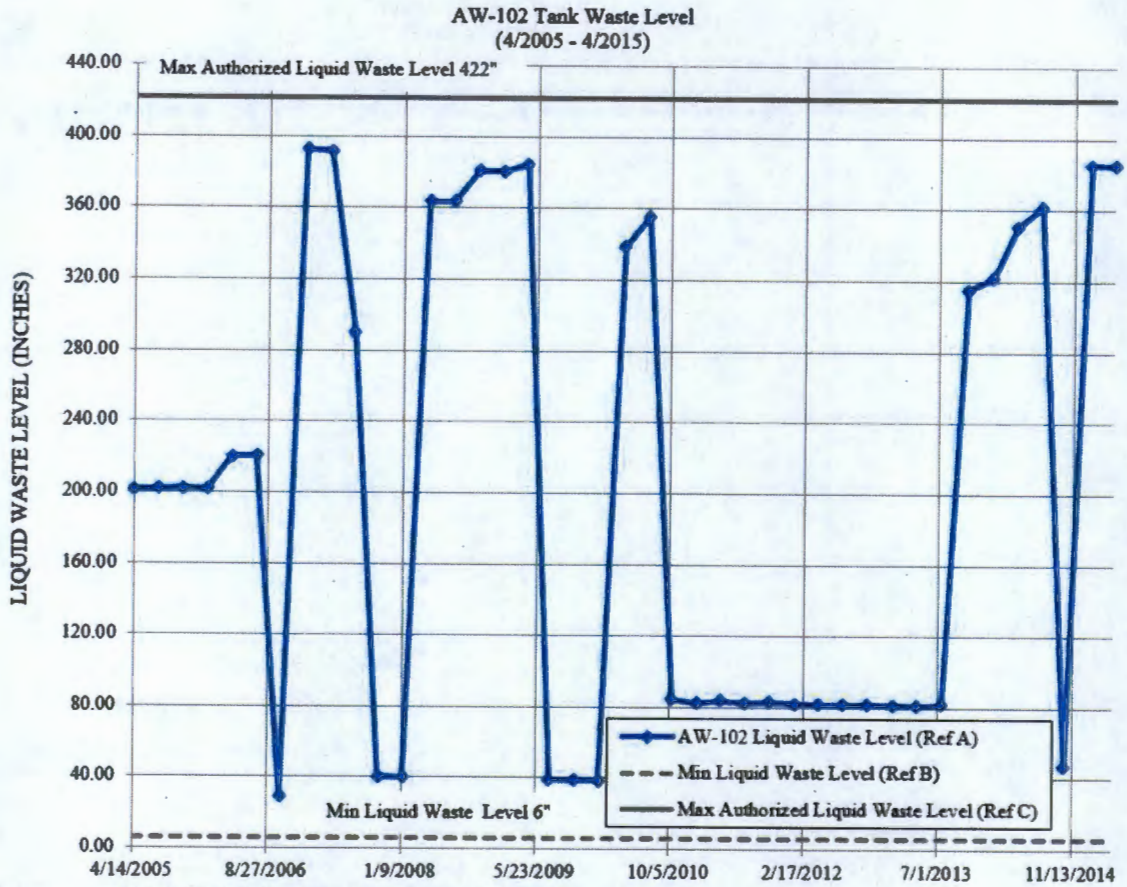

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 2

**Figure M-6: Tank SY-103 Waste Level**



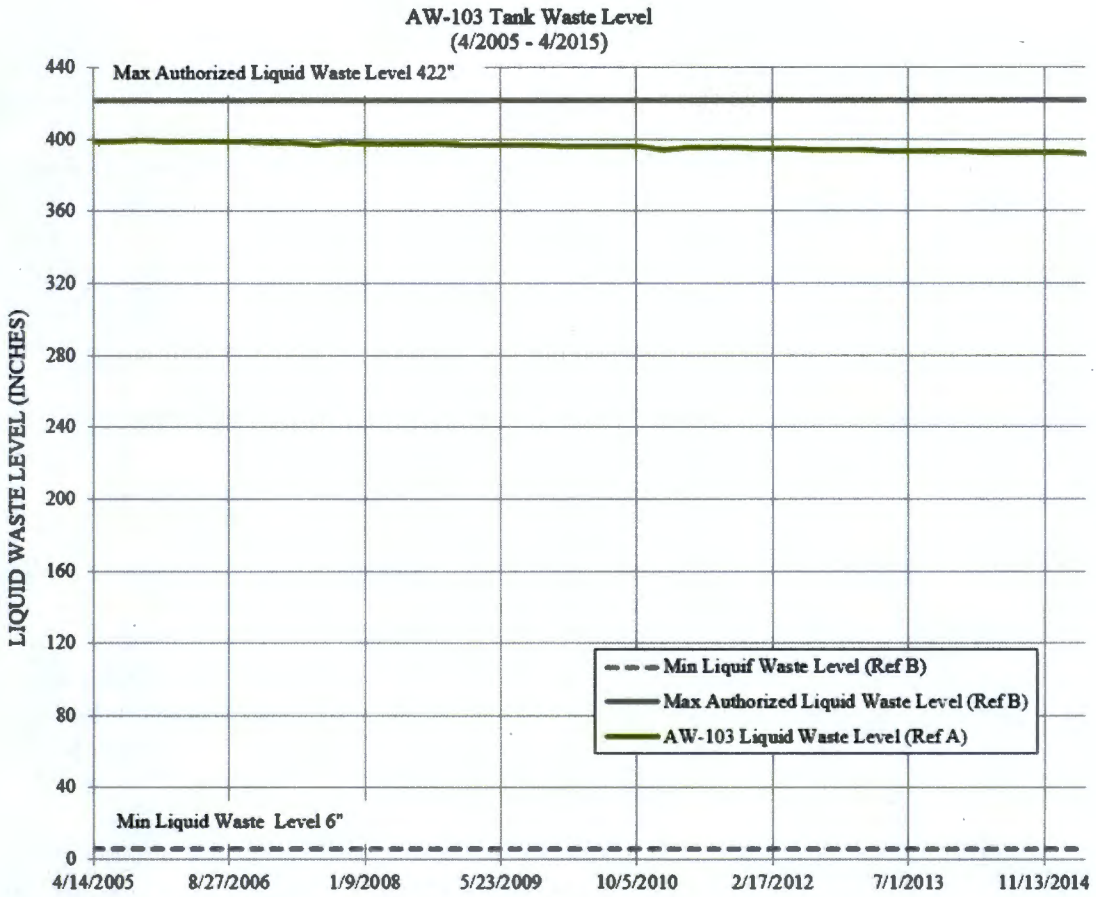

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-7: Tank AW-101 Waste Level**



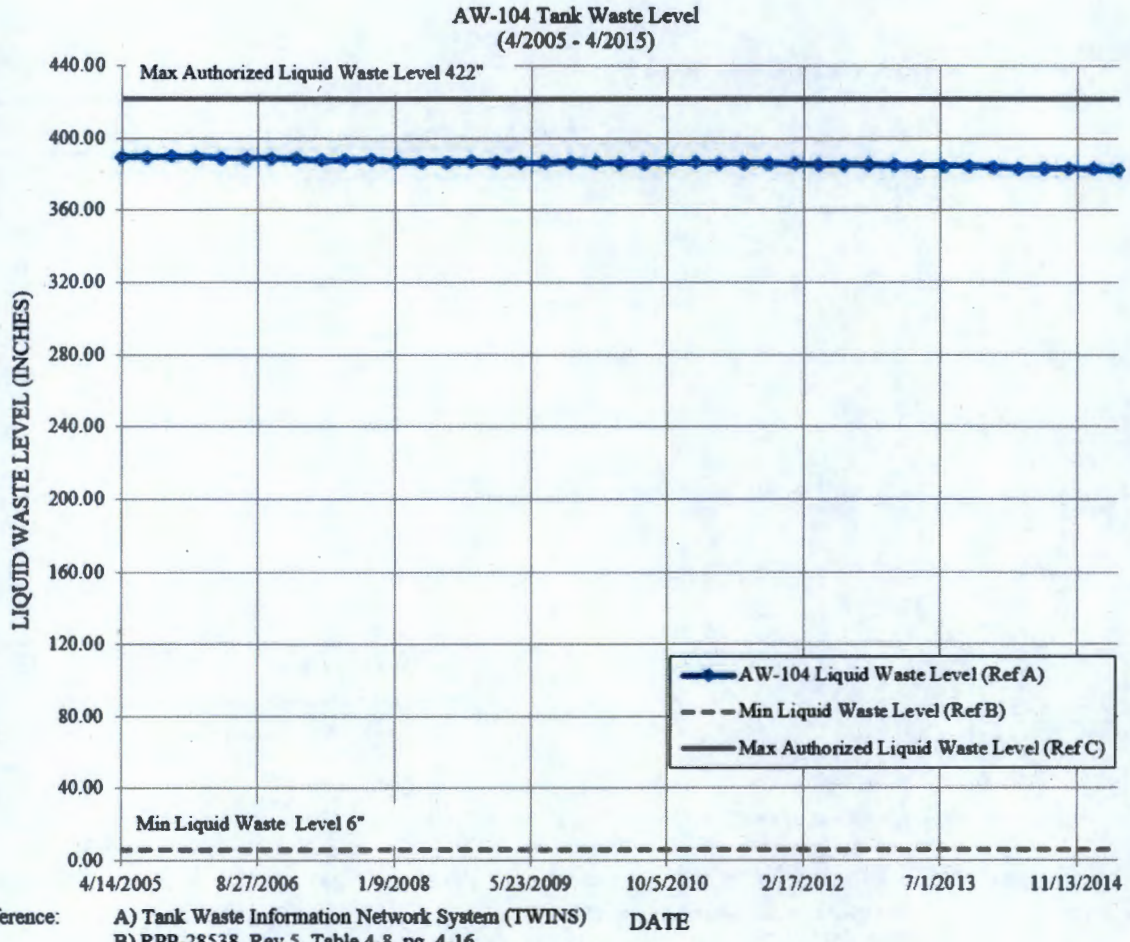

Reference:
A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-8: Tank AW-102 Waste Level**



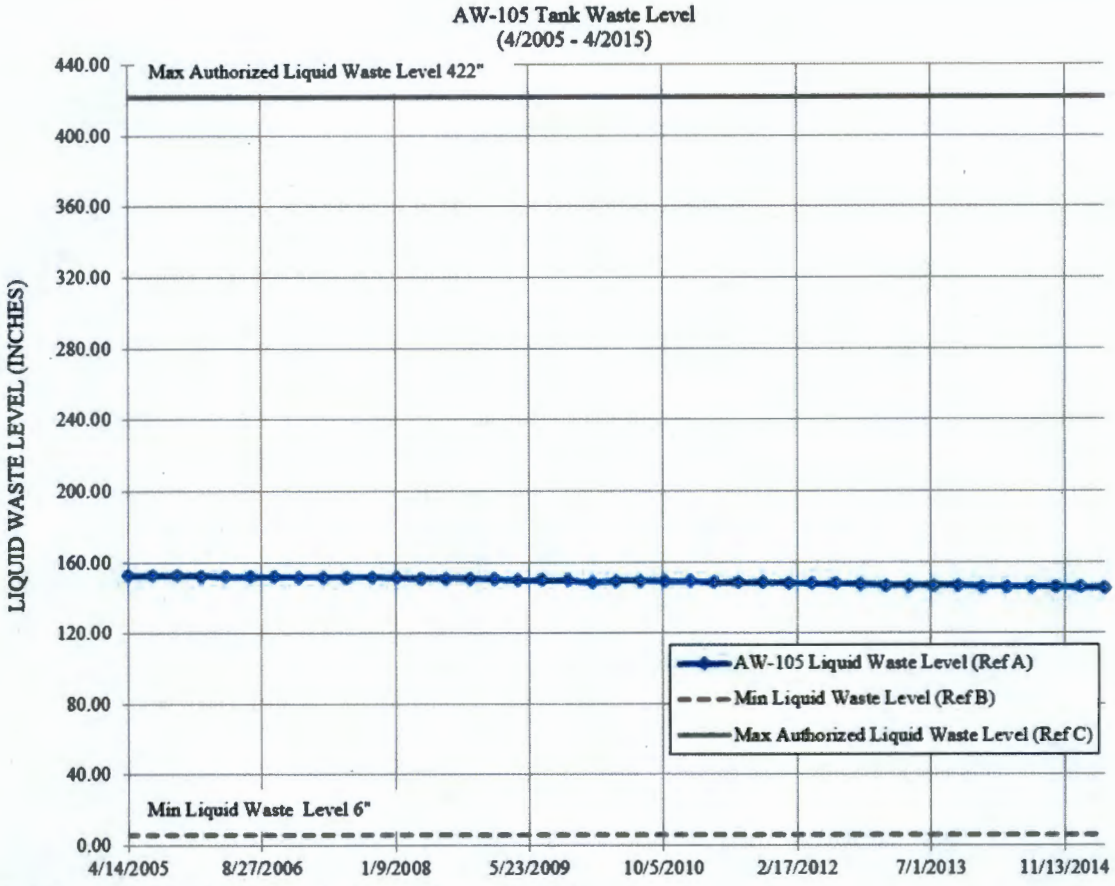

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-9: Tank AW-103 Waste Level**



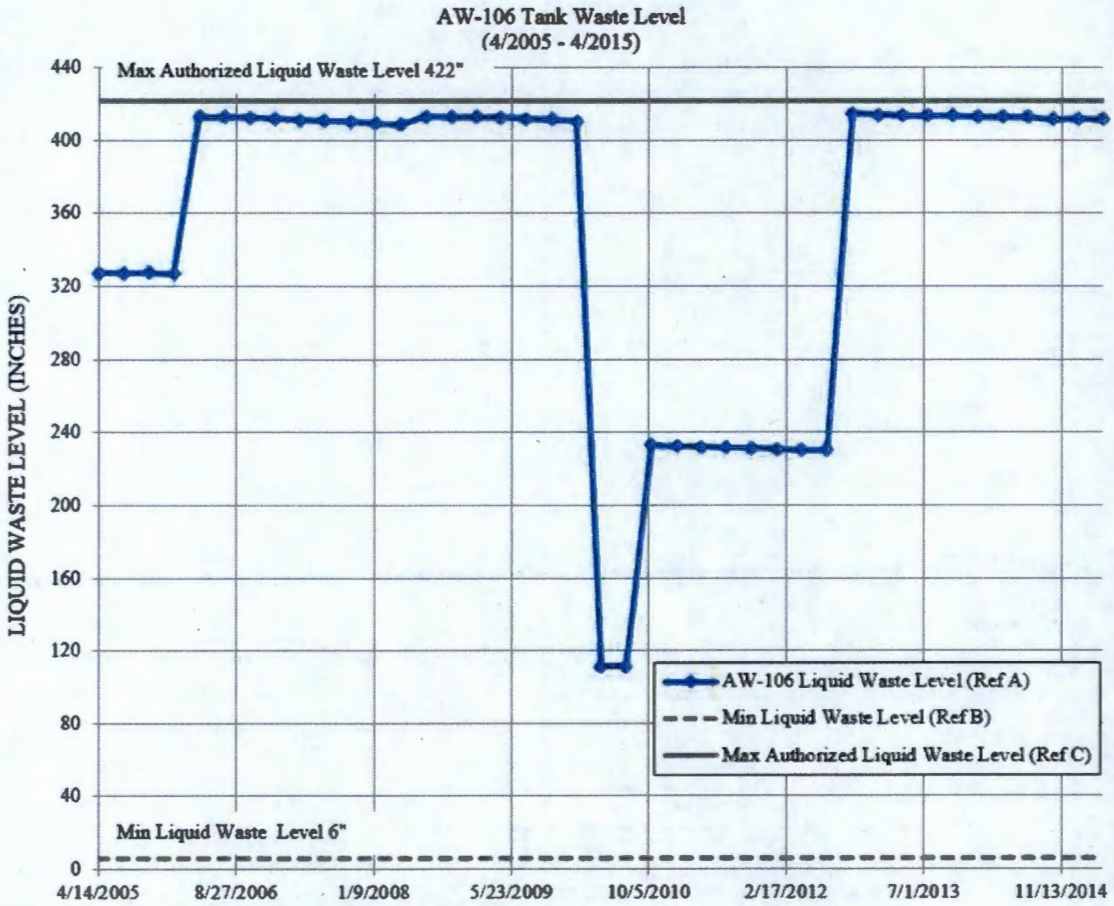

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-10: Tank AW-104 Waste Level**



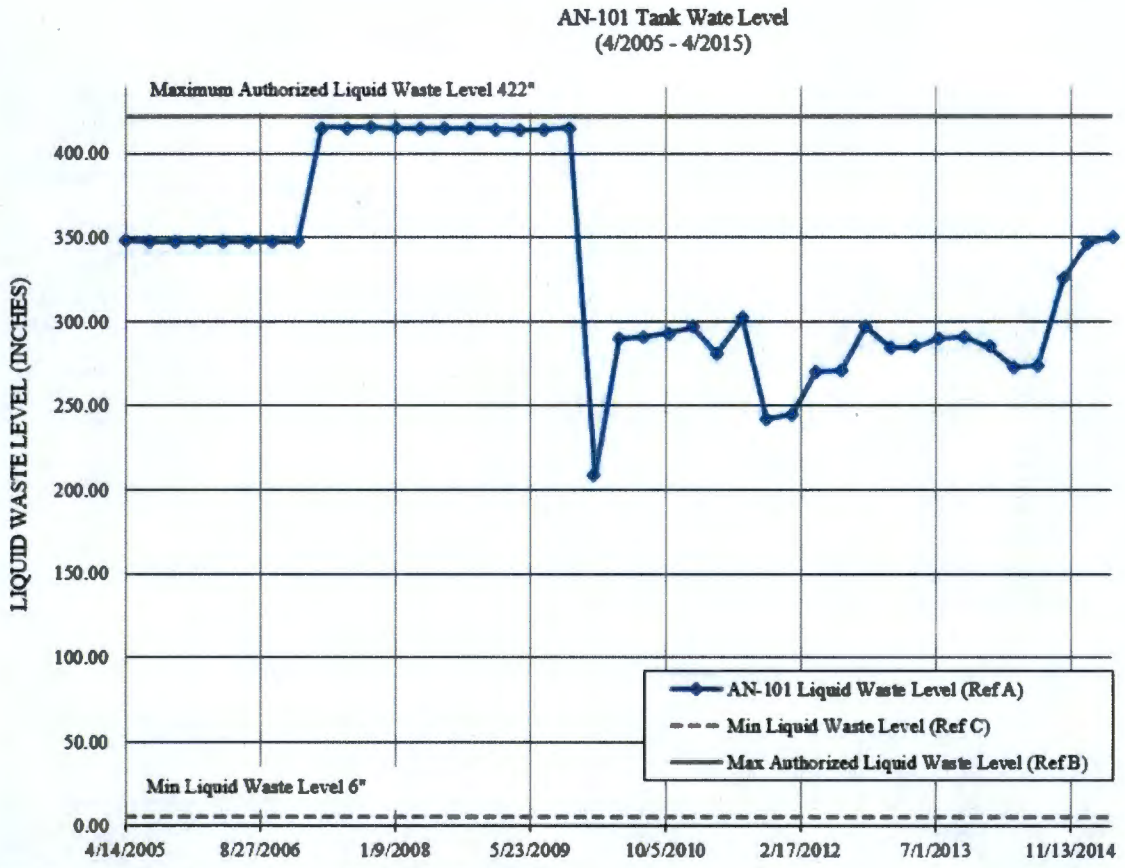

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-11: Tank AW-105 Waste Level**



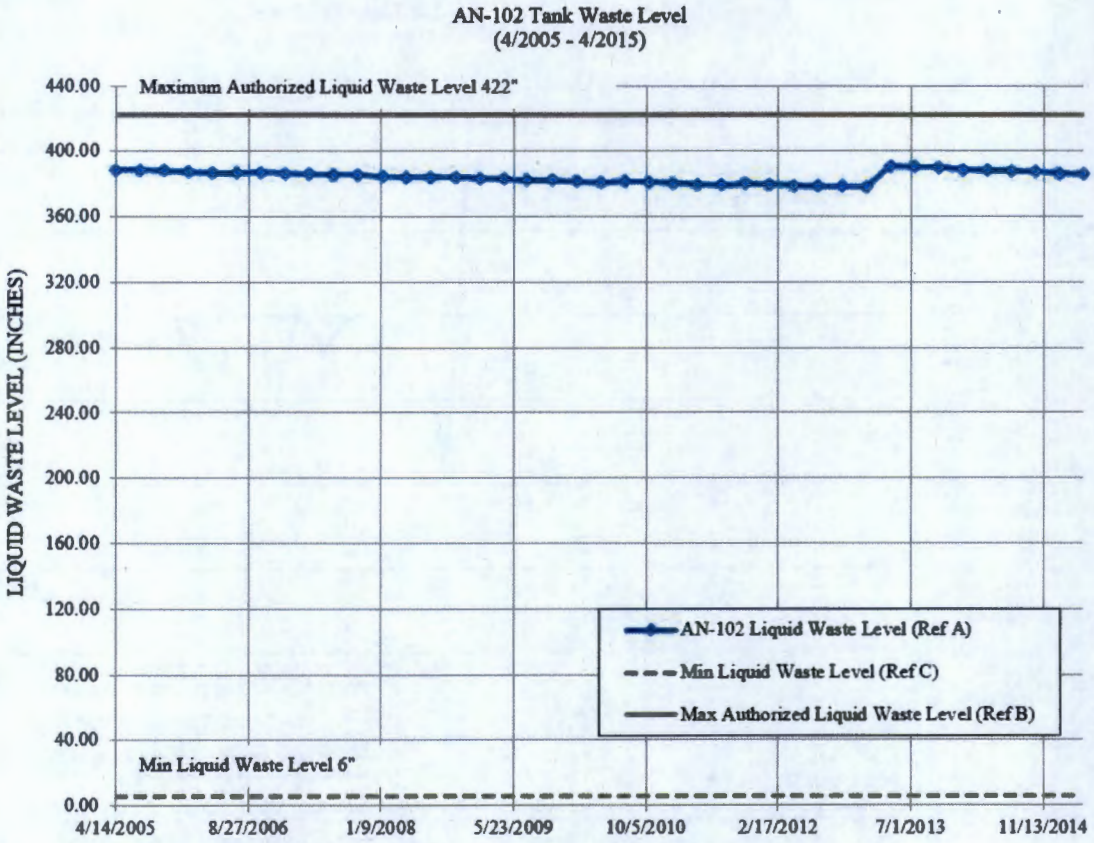

Reference: A) Tank Waste Information Network System (TWINS)
B) RPP-28538, Rev 5, Table 4-8, pg. 4-16
C) OSD-T-151-00007, Rev 14, Table 1.1.1, Page 1

**Figure M-12: Tank AW-106 Waste Level**



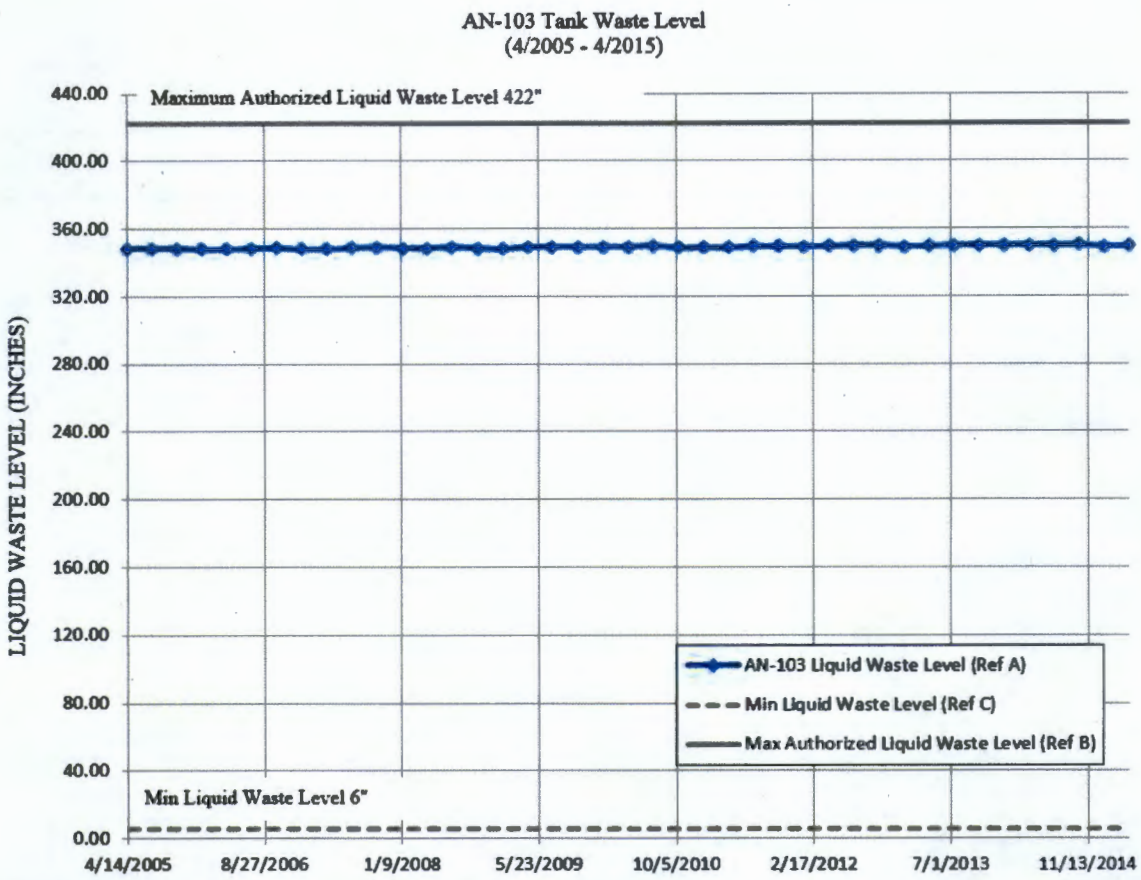

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-13: Tank AN-101 Waste Level**



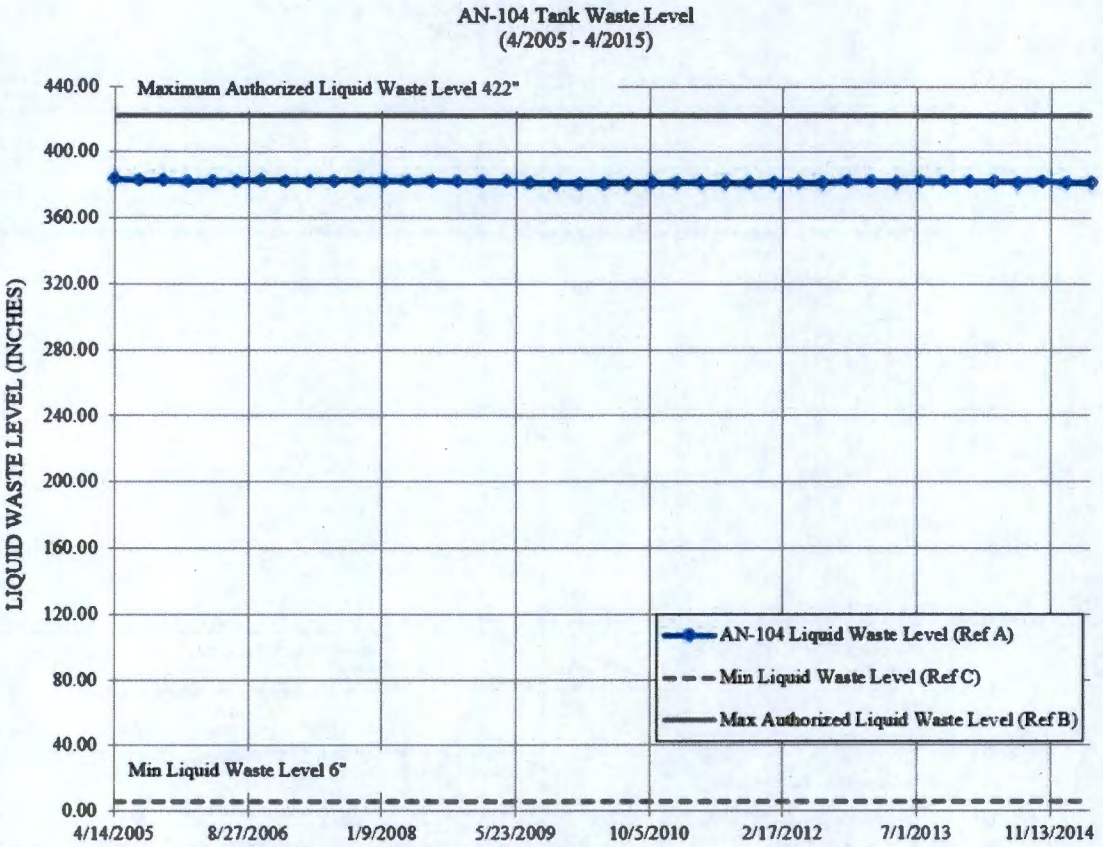

Reference: A) Tank Waste Information Network System (TWINS) DATE
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-14: Tank AN-102 Waste Level**



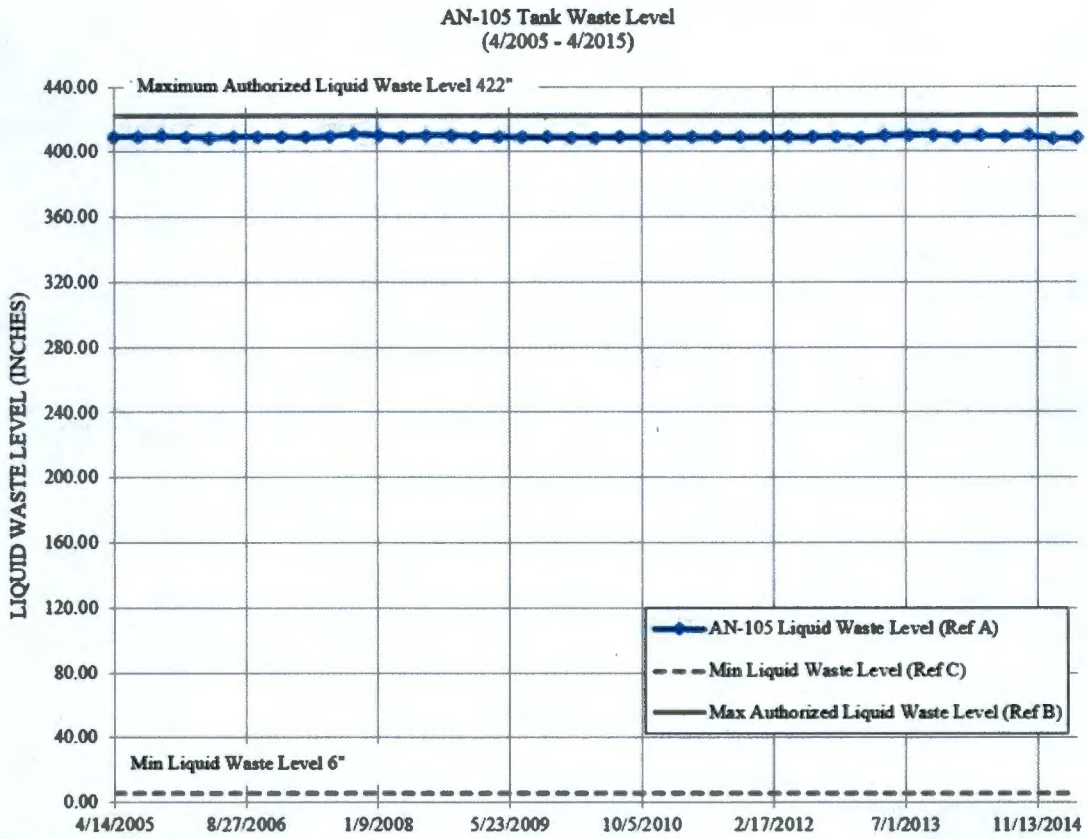

Reference: A) Tank Waste Information Network System (TWINS) DATE
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-15: Tank AN-103 Waste Level**



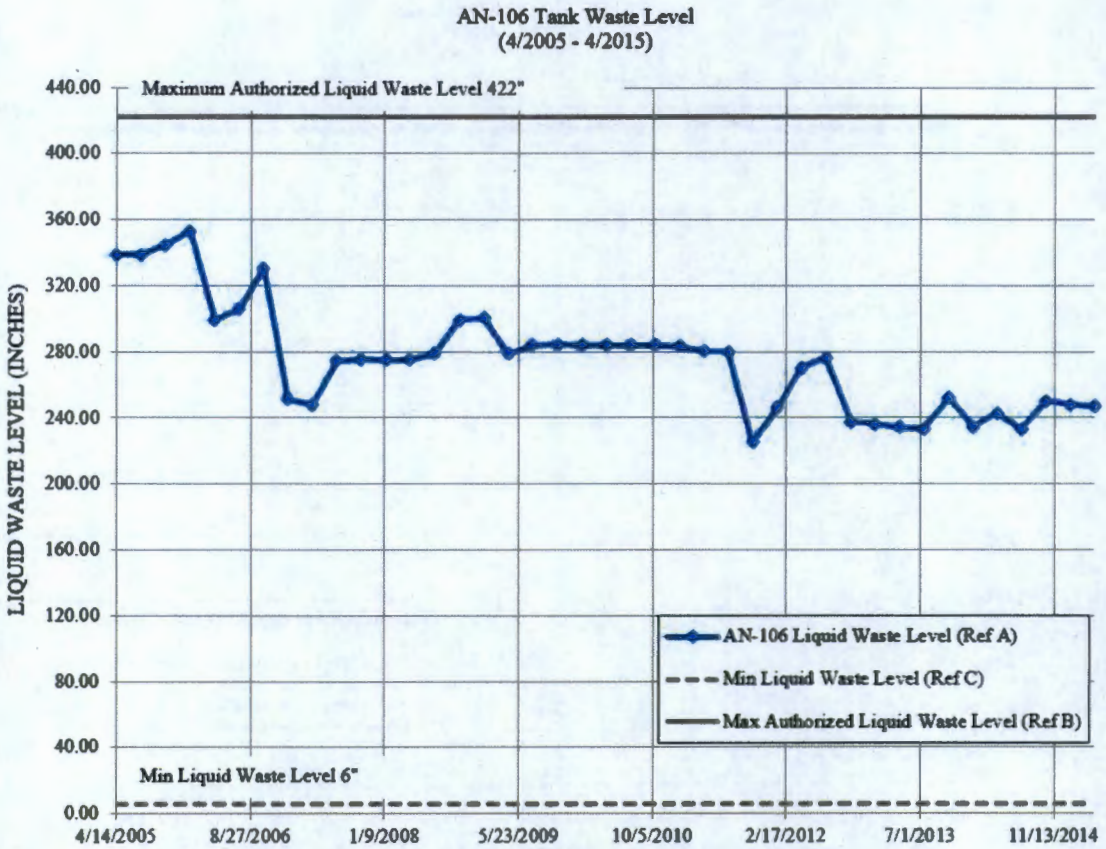

Reference: A) Tank Waste Information Network System (TWINS) DATE
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-16: Tank AN-104 Waste Level**



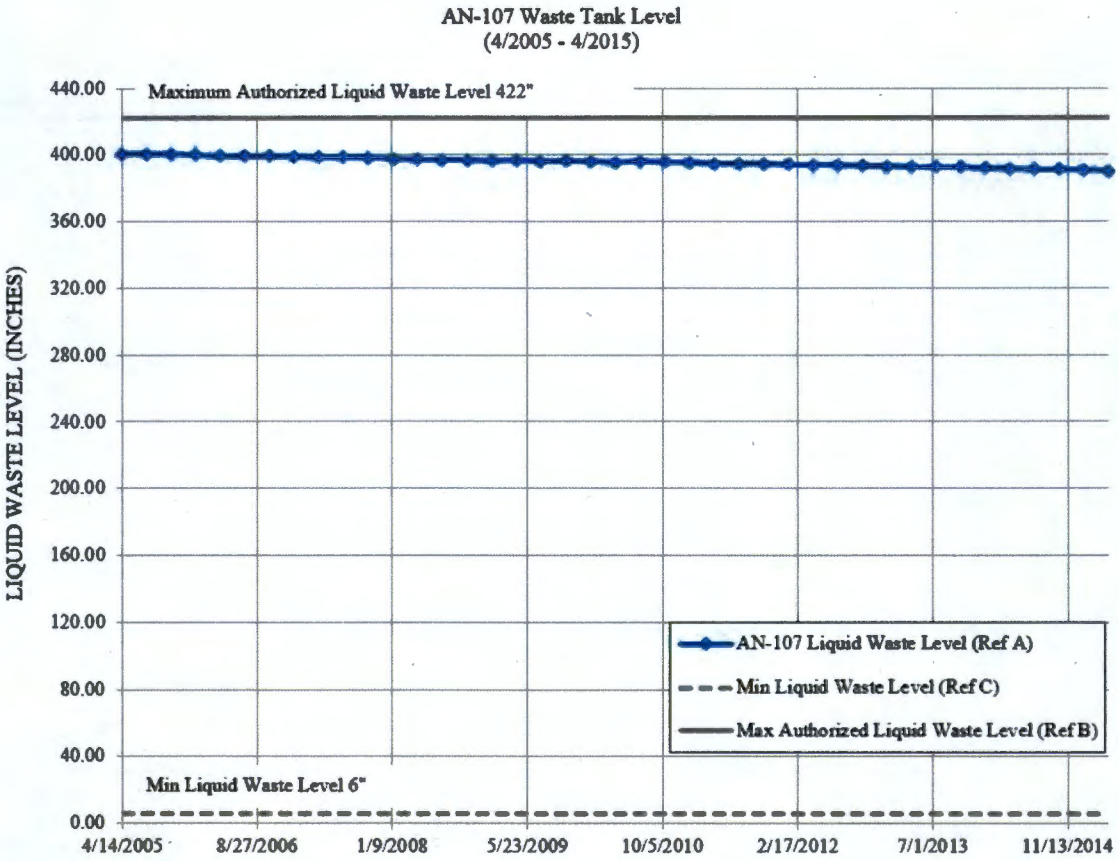

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-17: Tank AN-105 Waste Level**



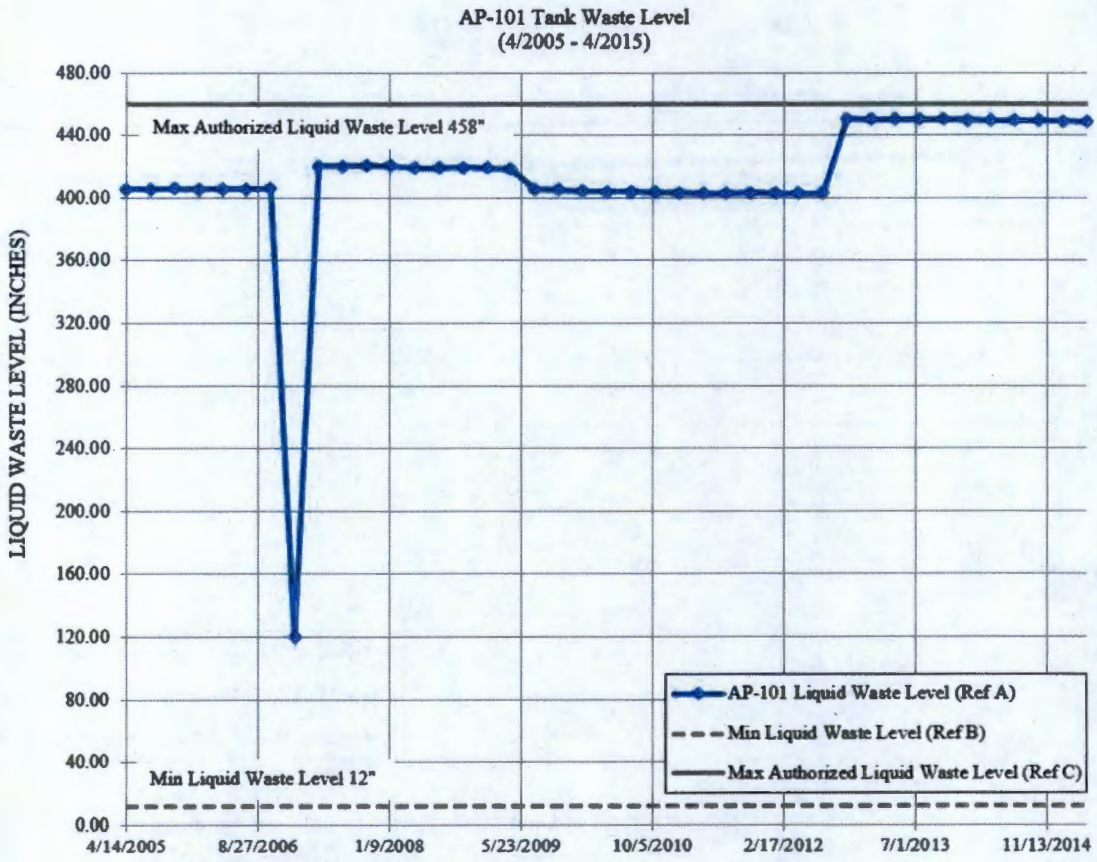

Reference: A) Tank Waste Information Network System (TWINS) DATE
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-18: Tank AN-106 Waste Level**



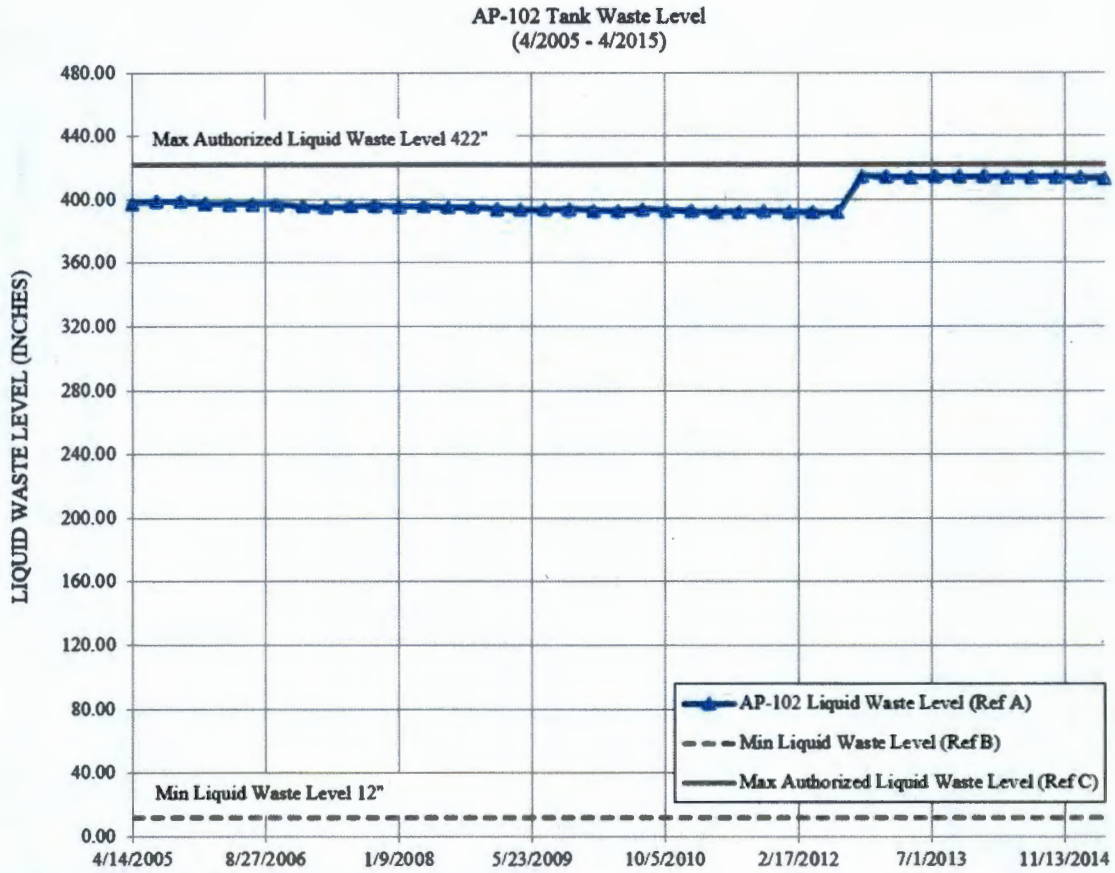

Reference: A) Tank Waste Information Network System (TWINS) DATE
B) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1
C) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4

**Figure M-19: Tank AN-107 Waste Level**



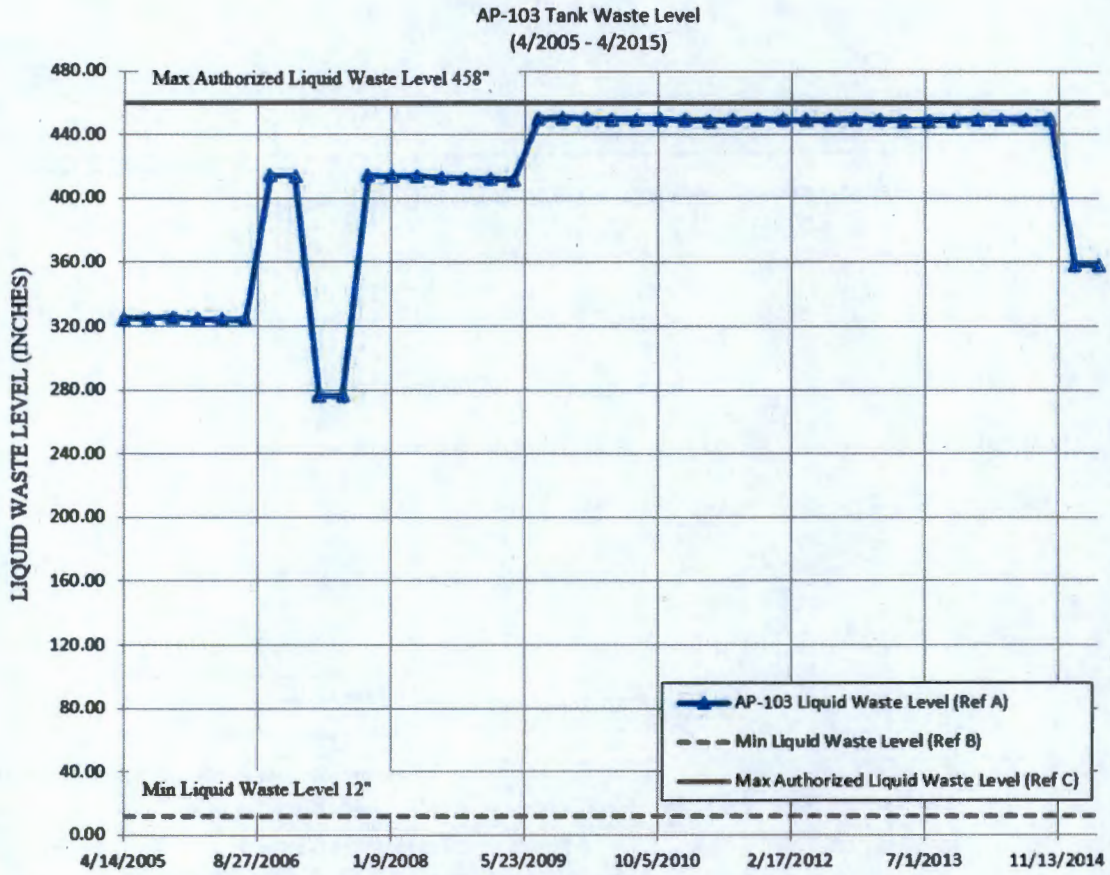

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-20: Tank AP-101 Waste Level**



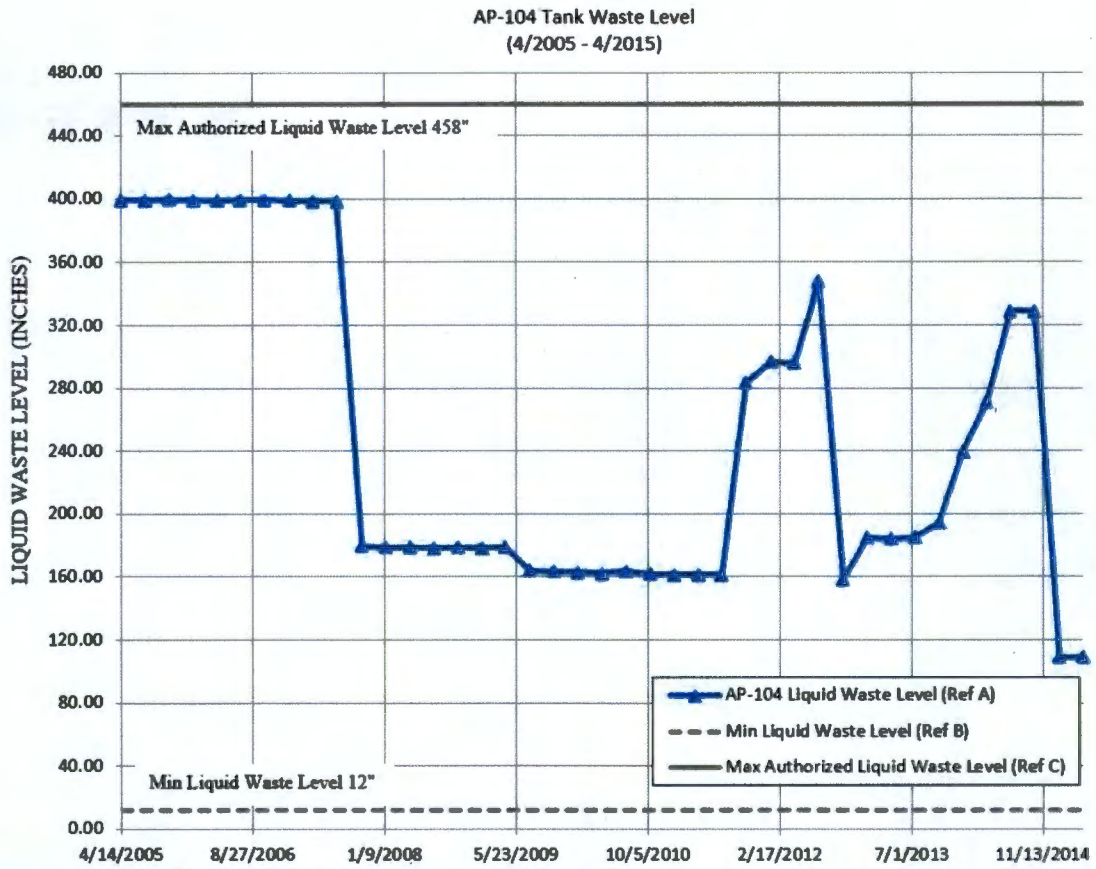

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-21: Tank AP-102 Waste Level**



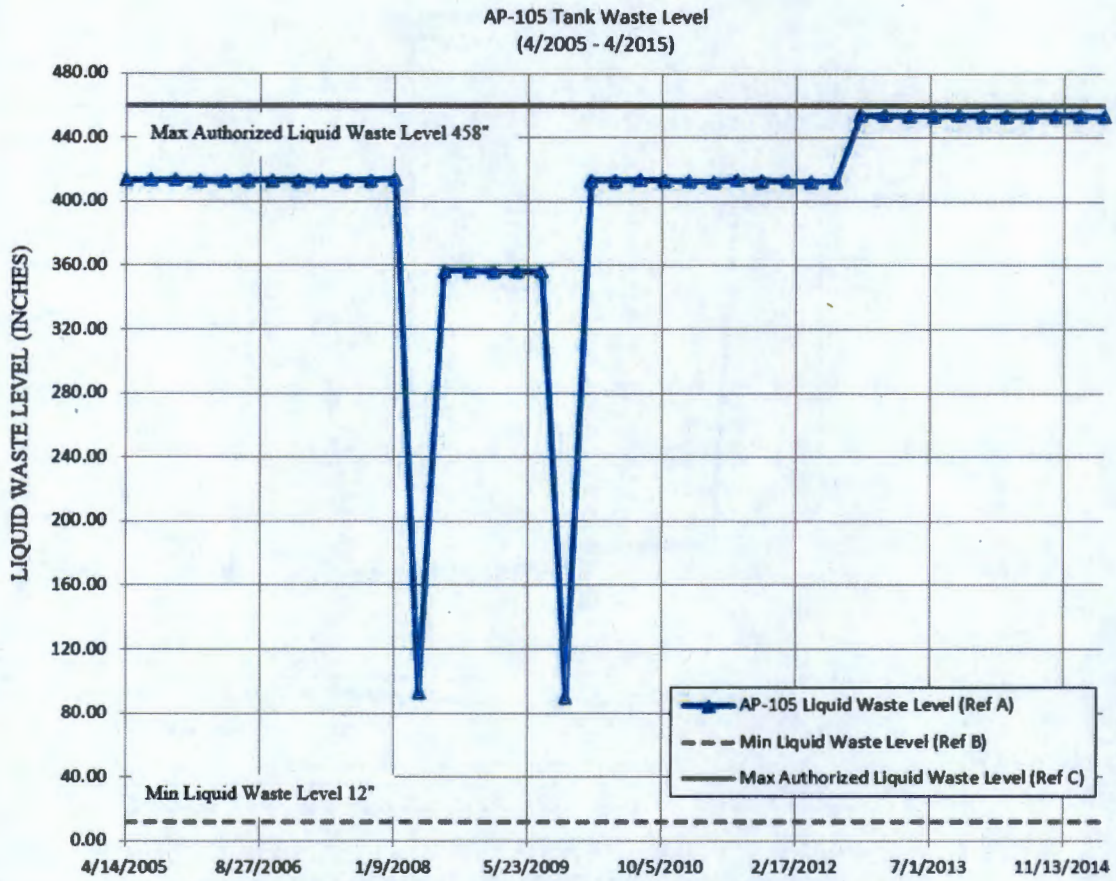

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-22: Tank AP-103 Waste Level**



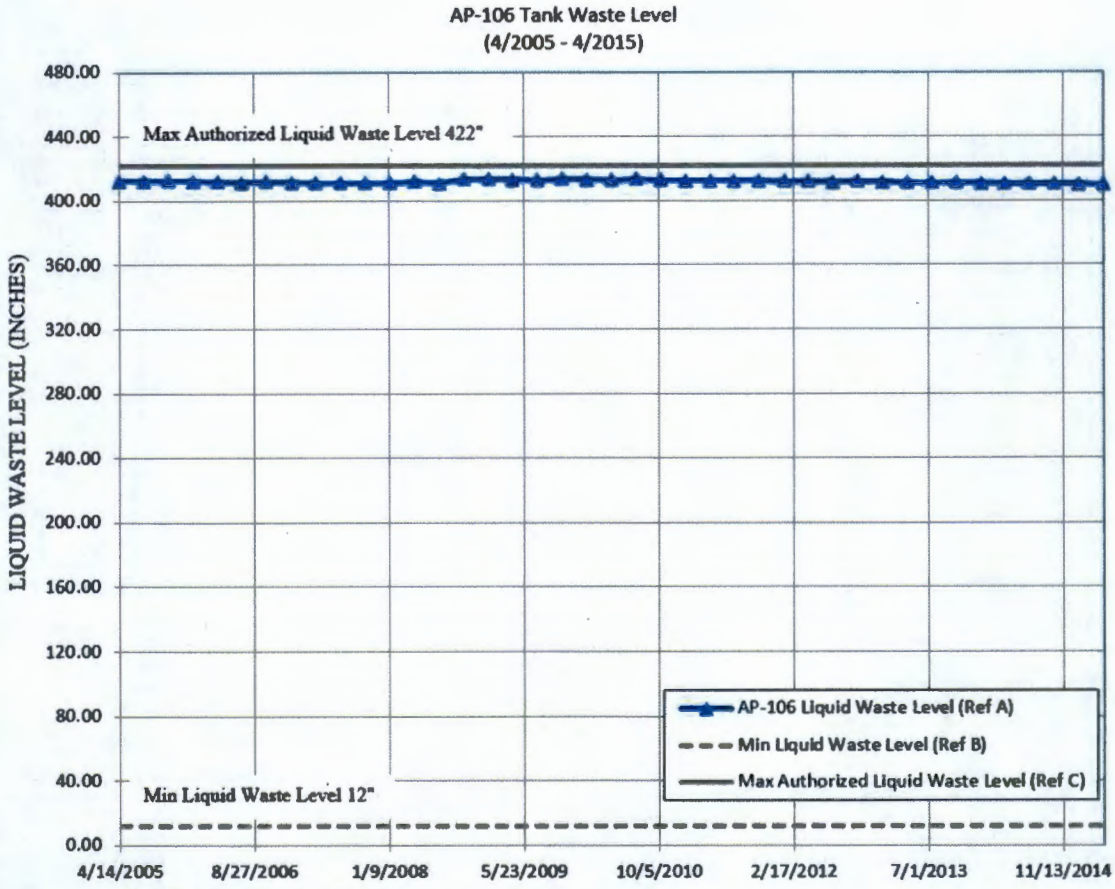

Reference:
A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-23: Tank AP-104 Waste Level**



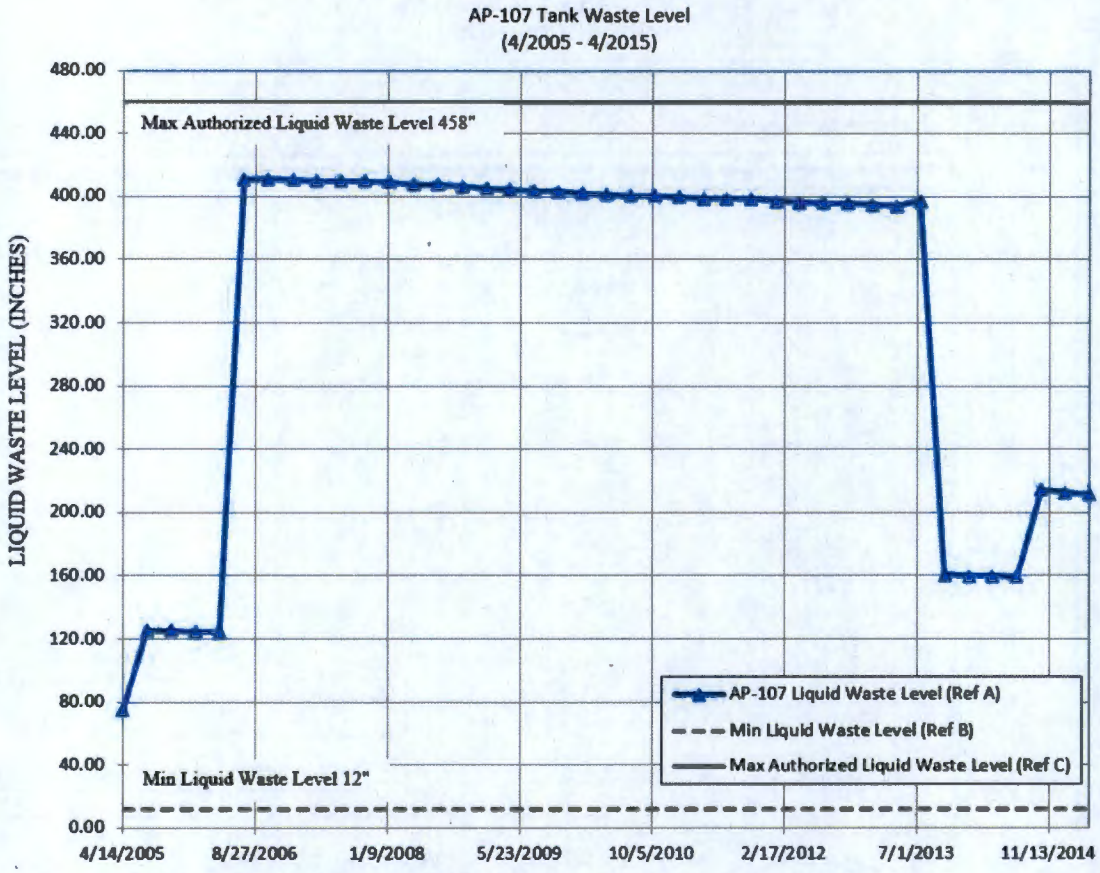

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-24: Tank AP-105 Waste Level**



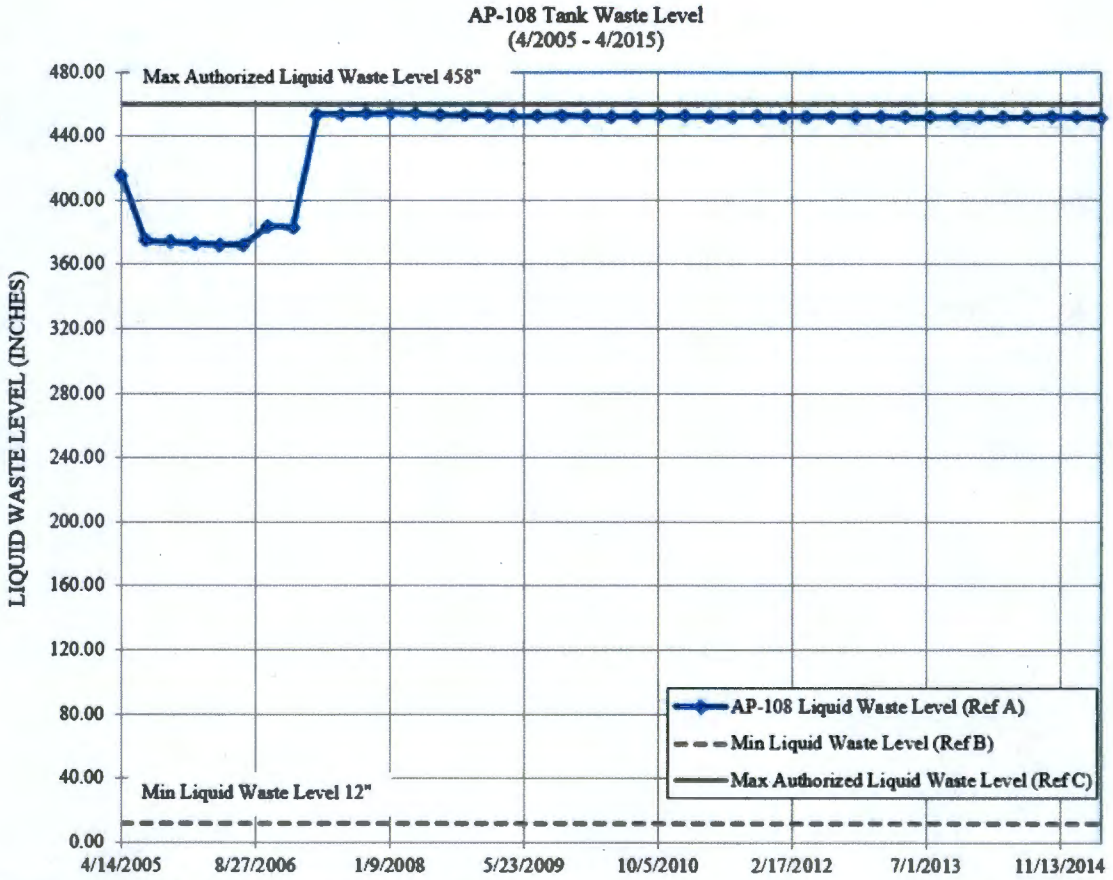

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-25: Tank AP-106 Waste Level**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-26: Tank AP-107 Waste Level**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 14, Table 1.1.2, pg. 4
C) OSD-T-151-00007, Rev 14, Table 1.1.1, pg. 1

**Figure M-27: Tank AP-108 Waste Level**

# APPENDIX N
# DOUBLE-SHELL TANK DOME PENETRATIONS, TANK RISER CONFIGURATIONS, AND PIT LOCATIONS

# APPENDIX N DOUBLE-SHELL TANK DOME PENETRATIONS, TANK RISER CONFIGURATIONS, AND PIT LOCATIONS

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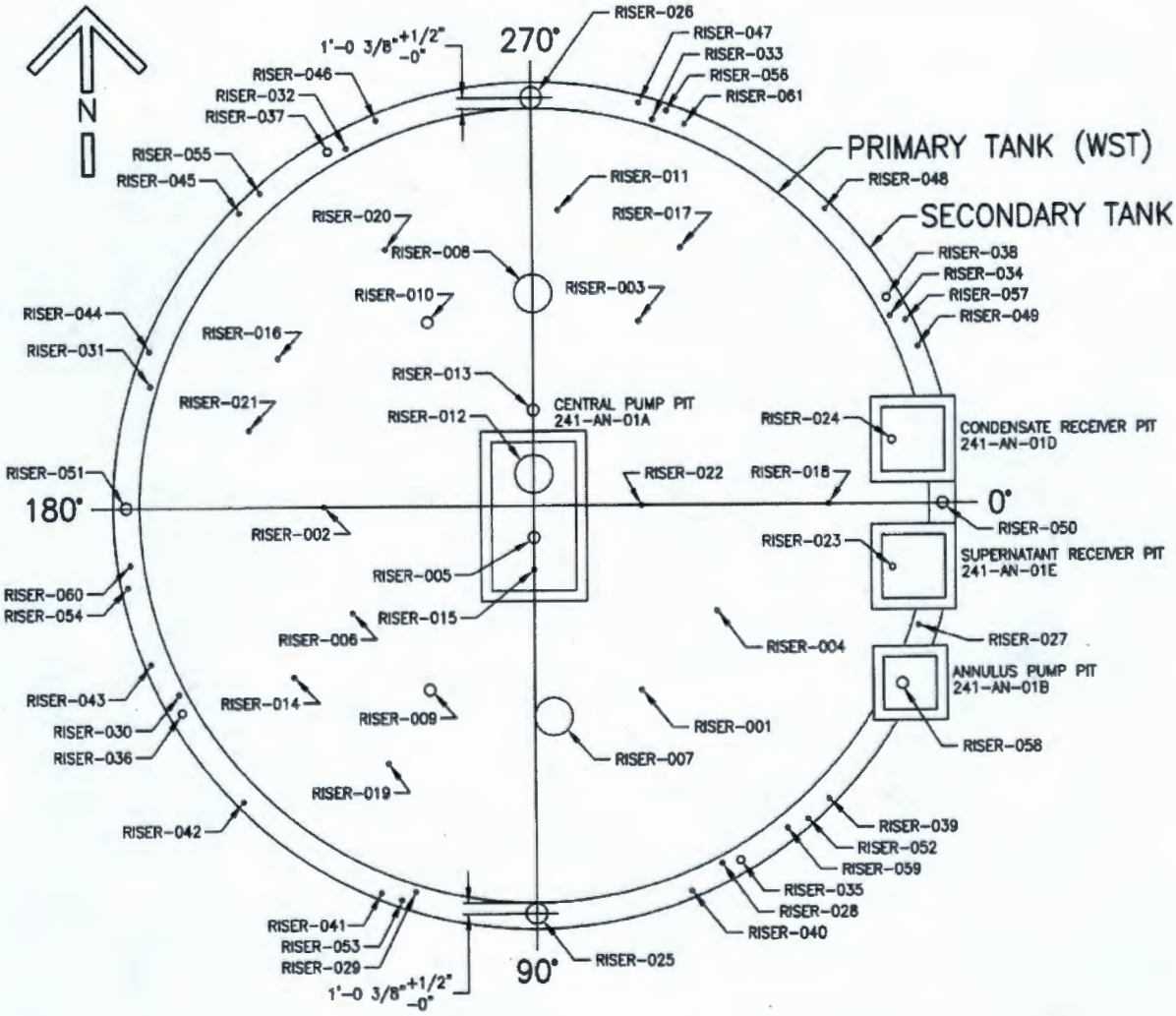


**Figure N-1: Dome Penetrations for Tank 241-AN-101 (H-14-010501, Sheet 1)**

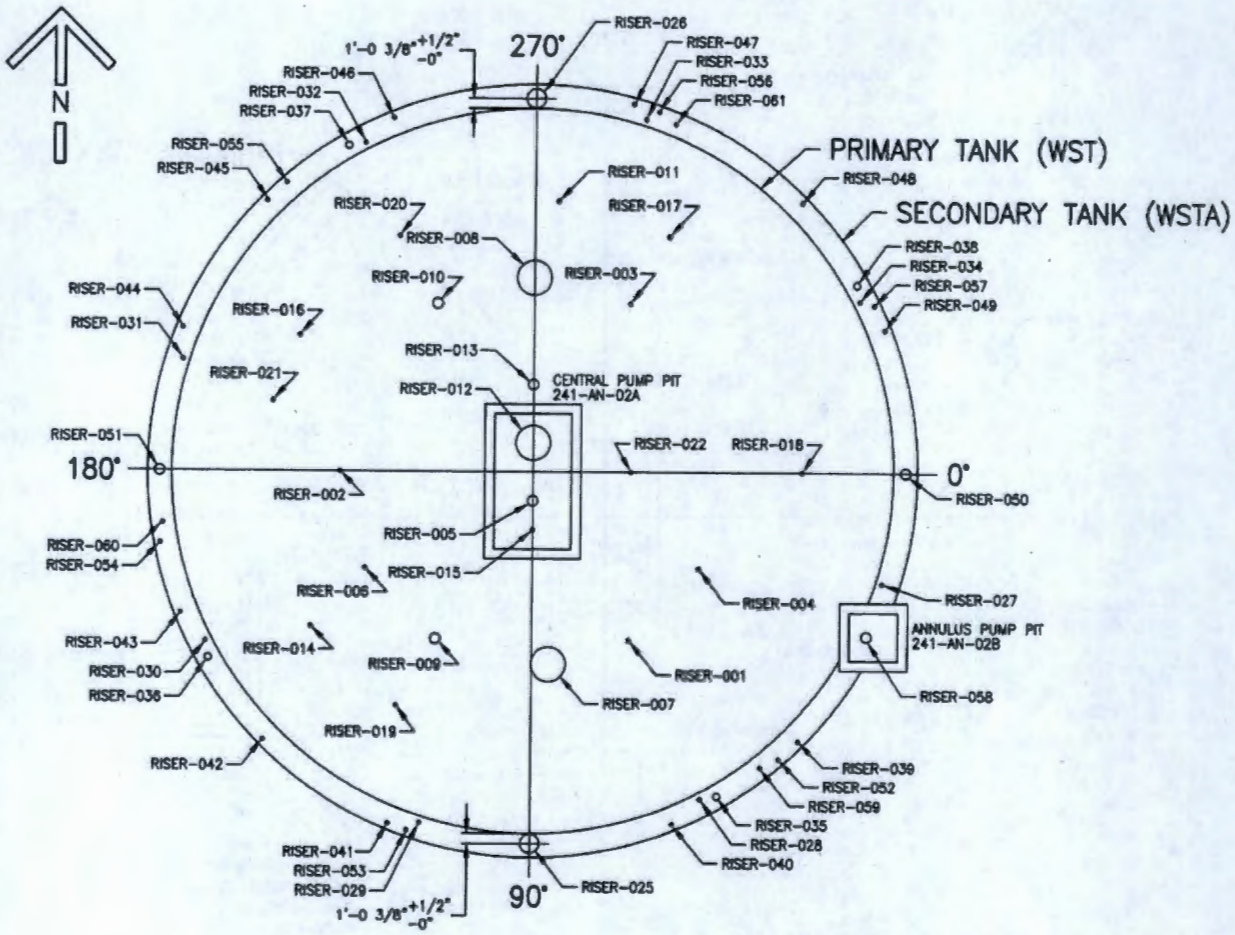


**Figure N-2: Dome Penetrations for Tank 241-AN-102 (H-14-010501, Sheet 2)**

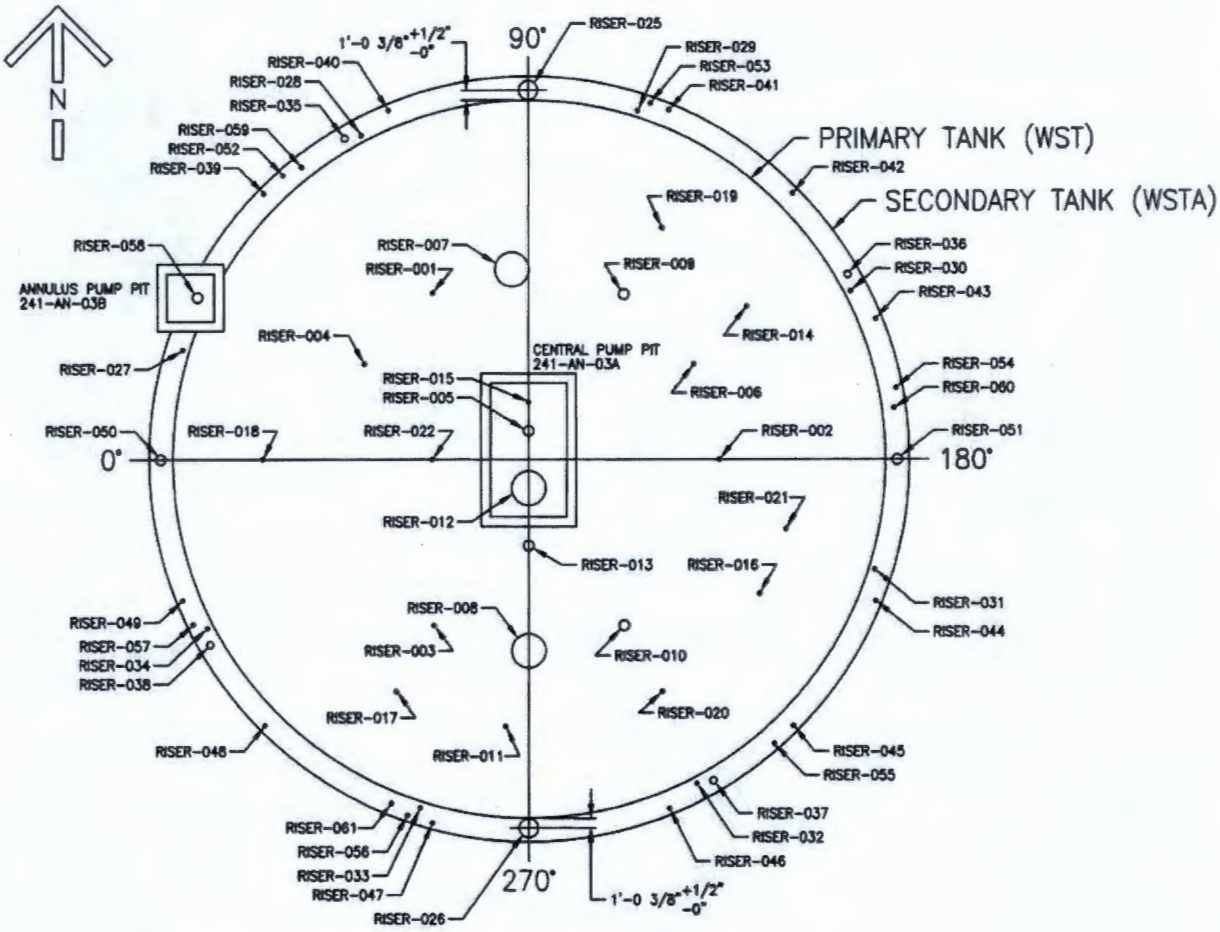


**Figure N-3: Dome Penetrations for Tank 241-AN-103 (H-14-010501, Sheet 3)**

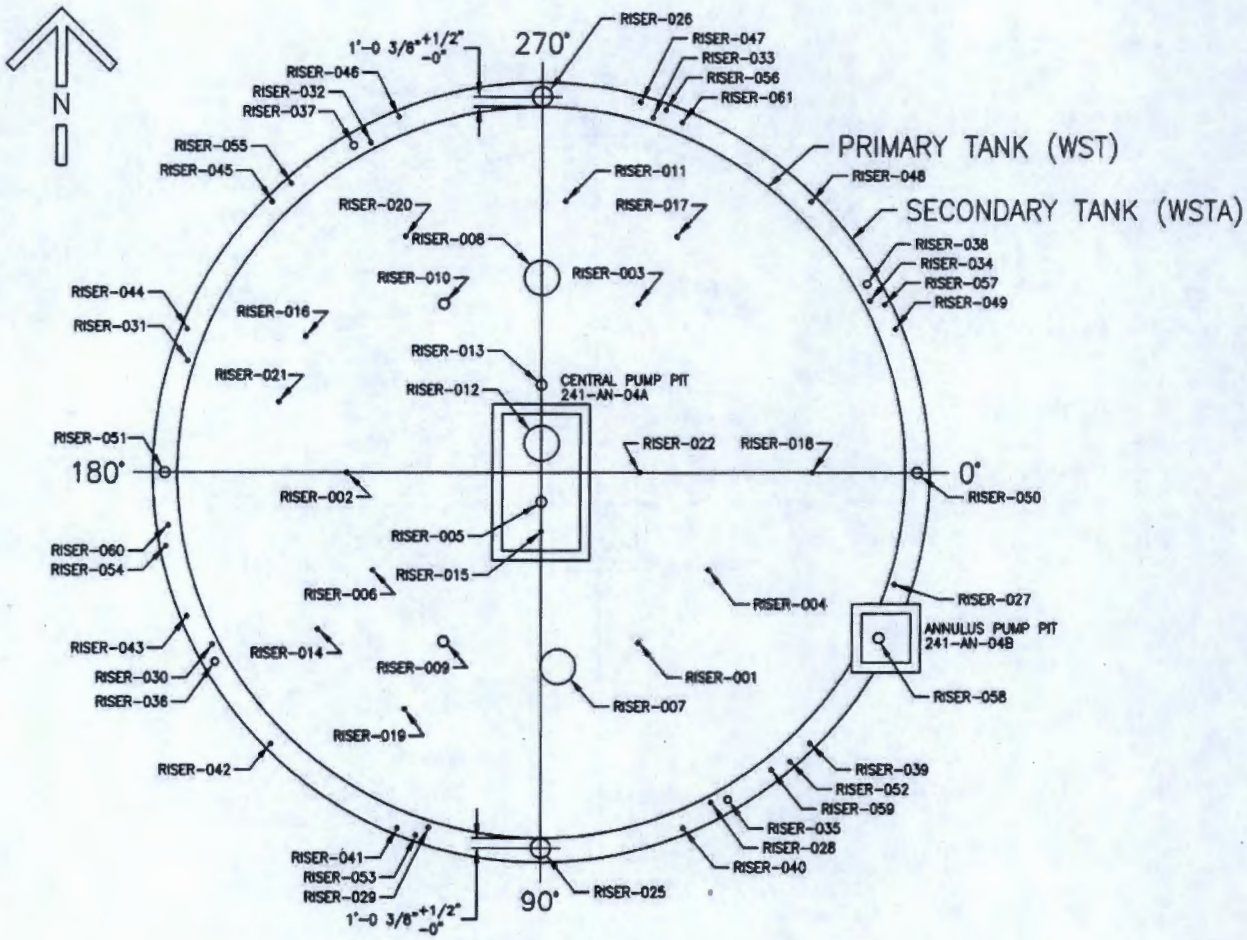


**Figure N-4: Dome Penetrations for Tank 241-AN-104 (H-14-010501, Sheet 4)**

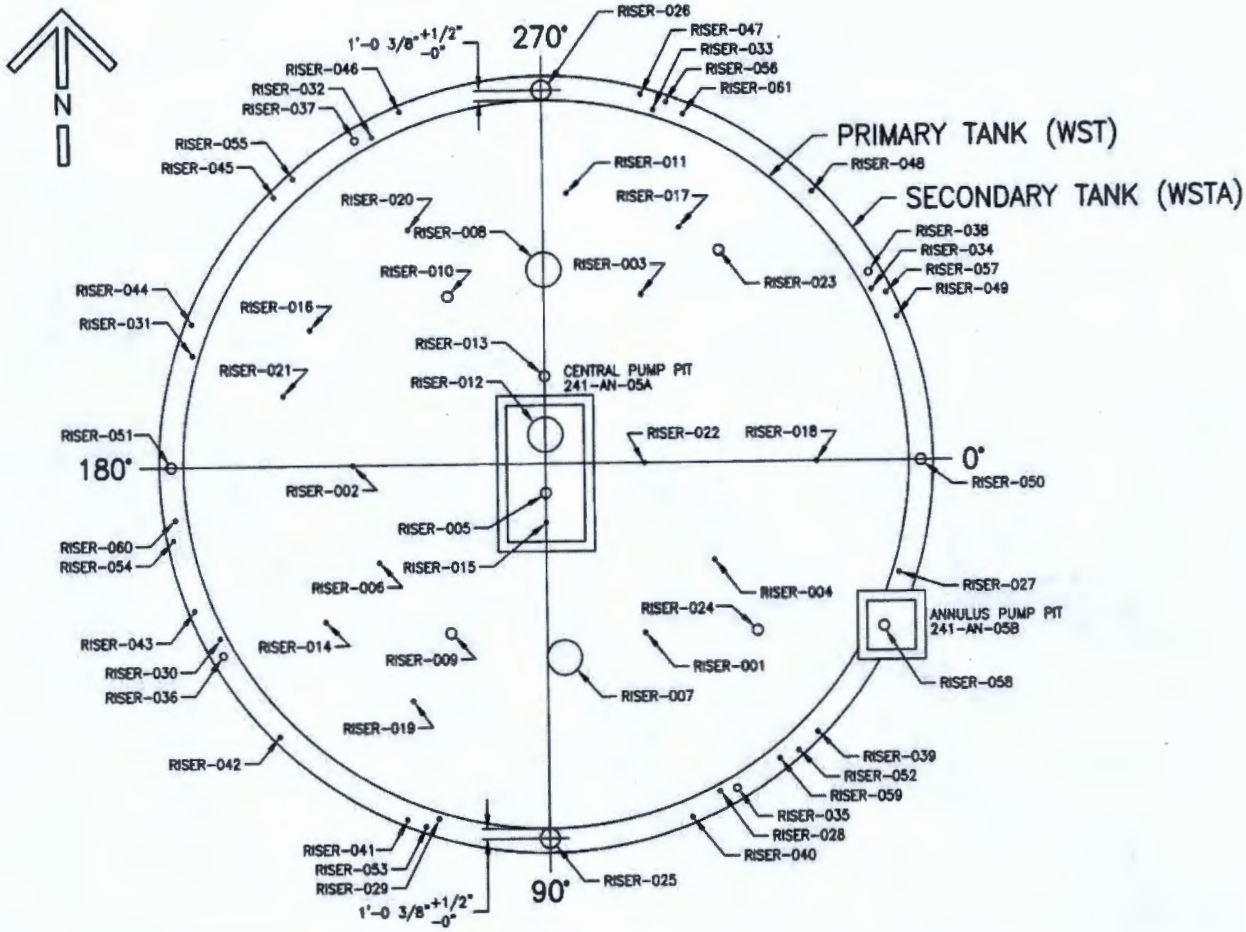


**Figure N-5: Dome Penetrations for Tank 241-AN-105 (H-14-010501, Sheet 5)**

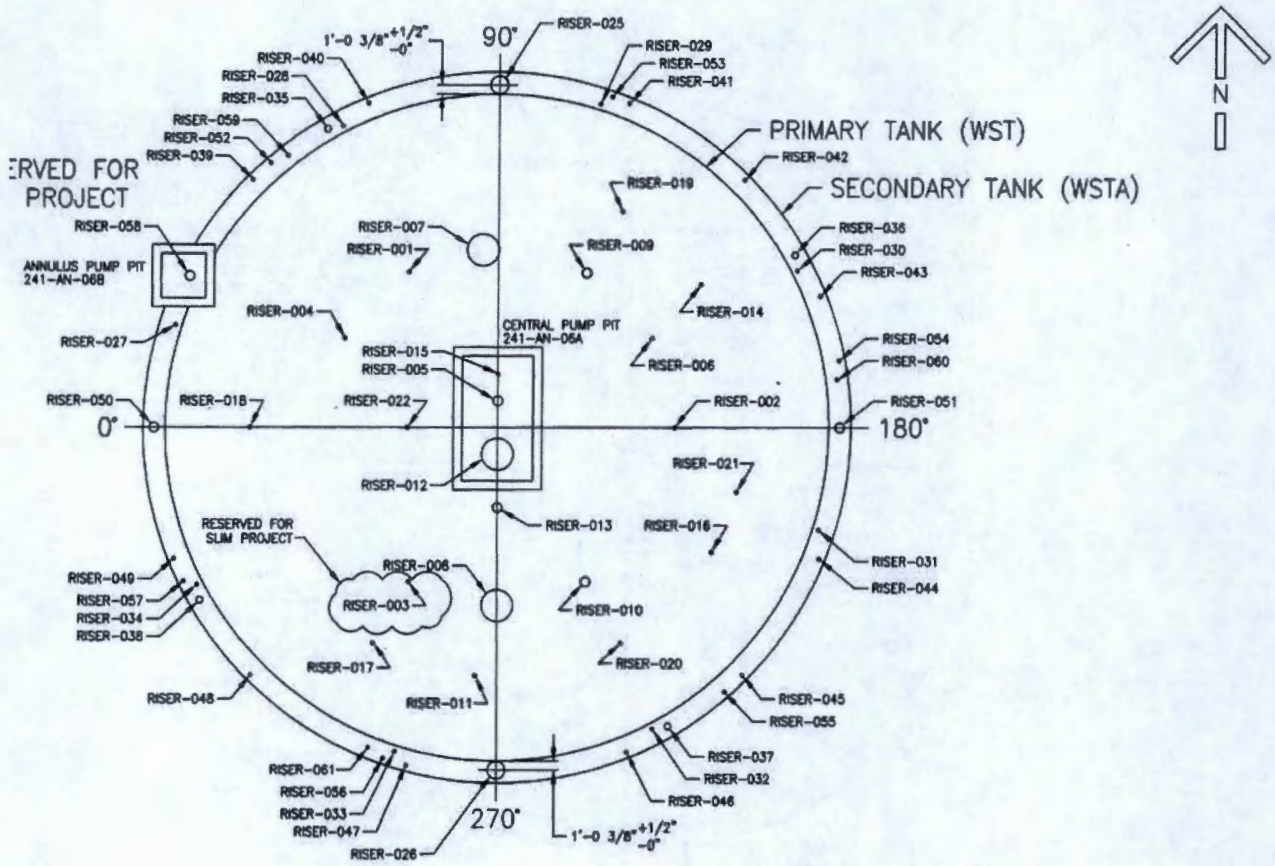


**Figure N-6: Dome Penetrations for Tank 241-AN-106 (H-14-010501, Sheet 6)**

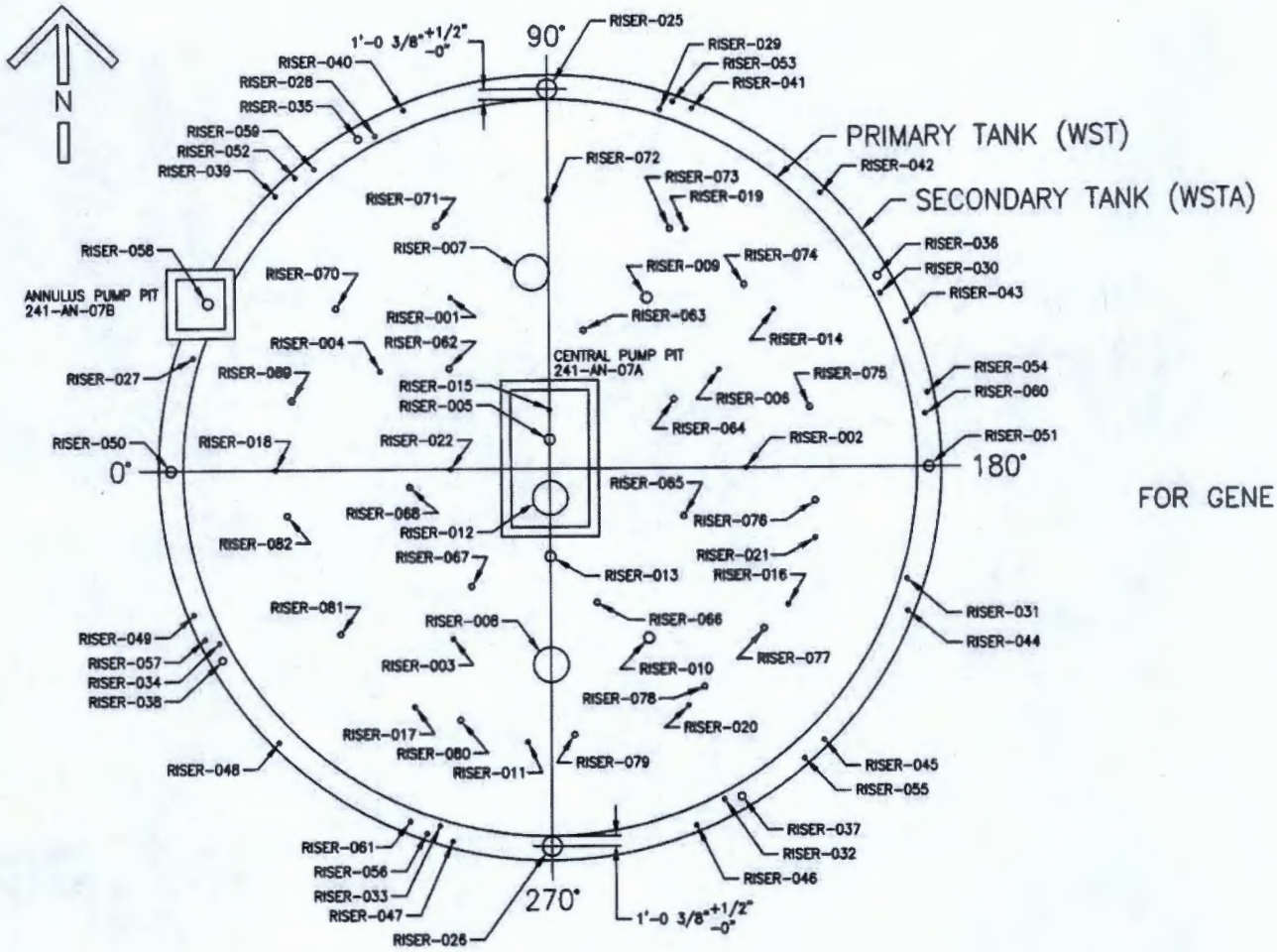


**Figure N-7: Dome Penetrations for Tank 241-AN-107 (H-14-010501, Sheet 7)**

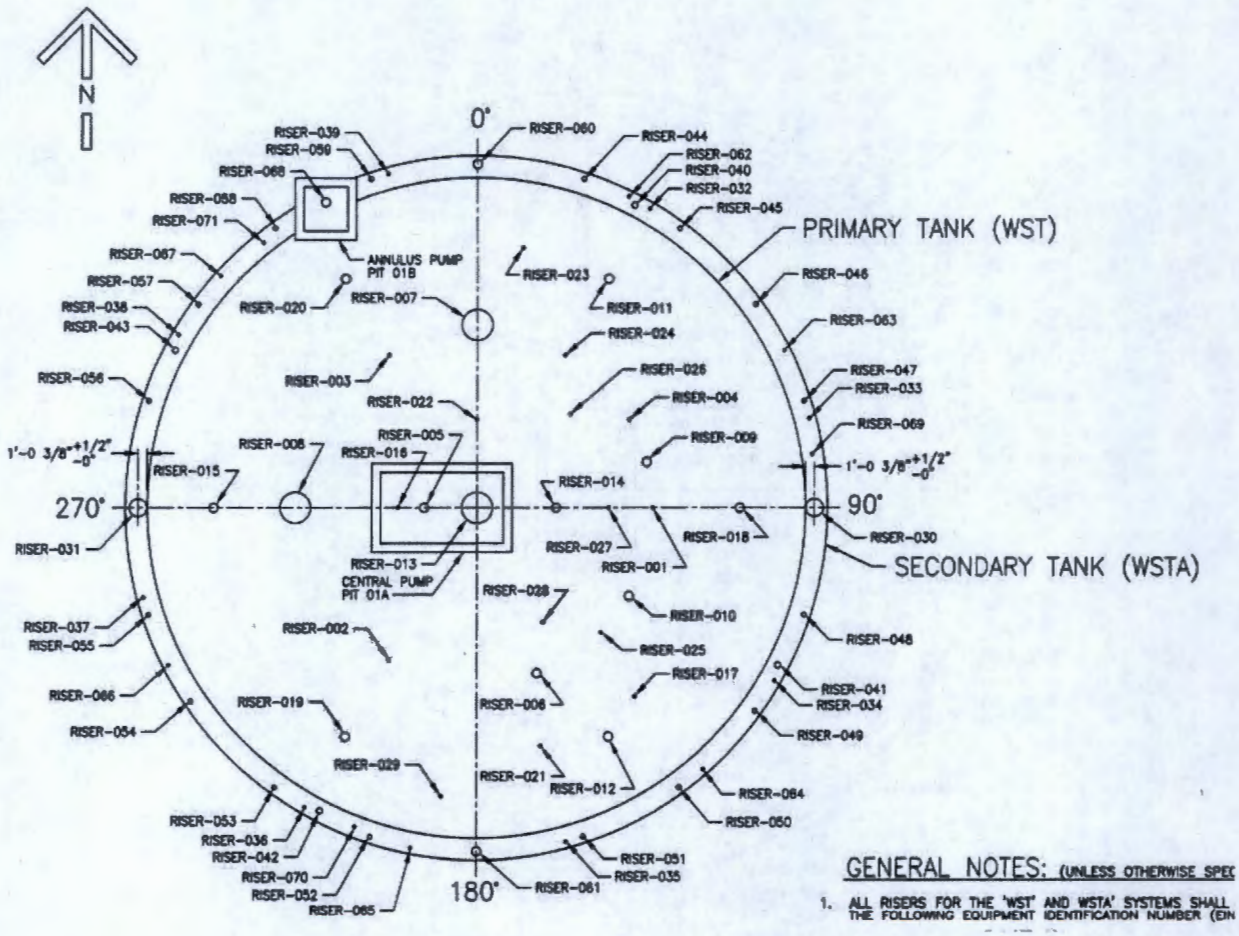


**Figure N-8: Dome Penetrations for Tank 241-AP-101 (H-14-010503, Sheet 1)**

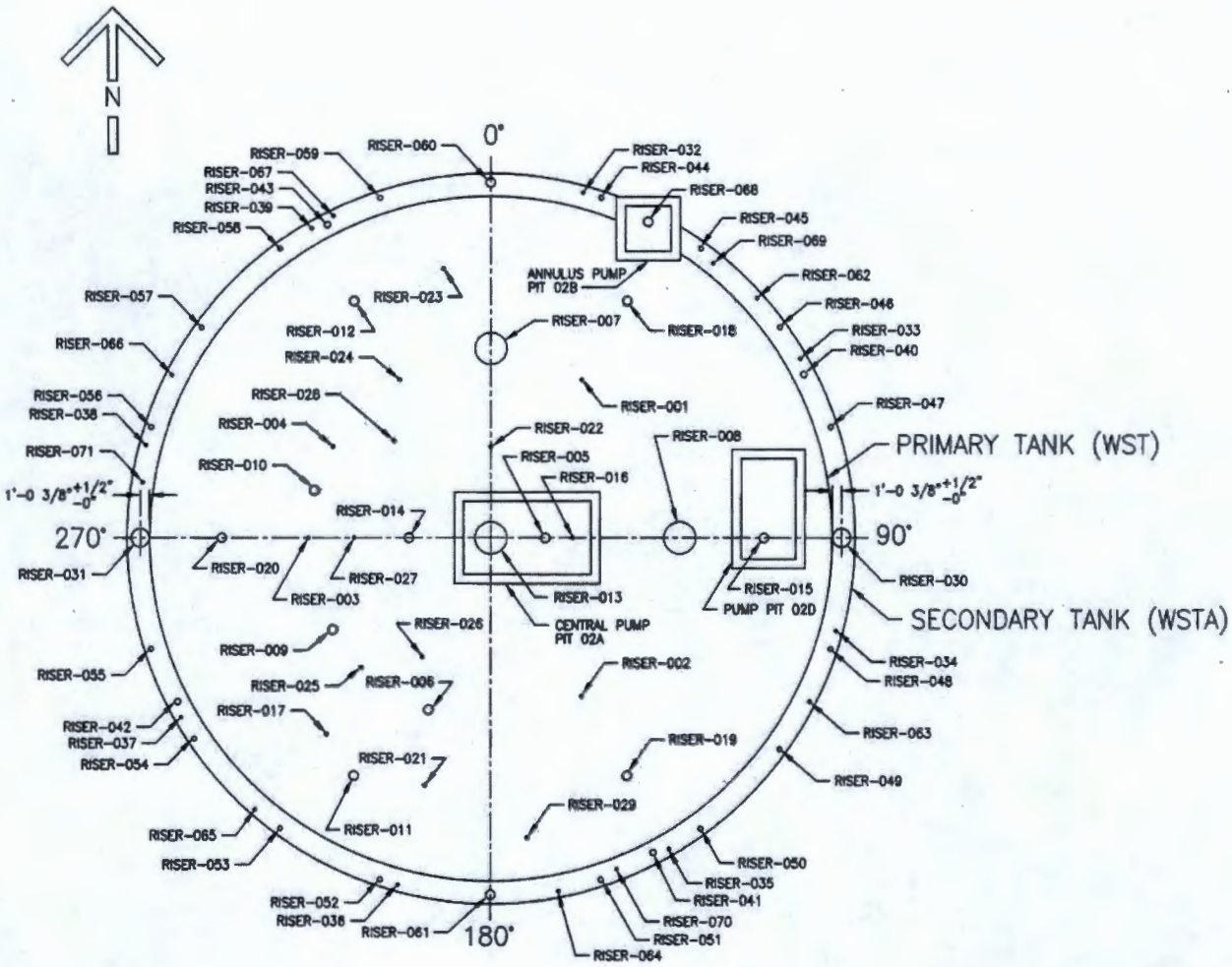


**Figure N-9: Dome Penetrations for Tank 241-AP-102 (H-14-010503, Sheet 2)**

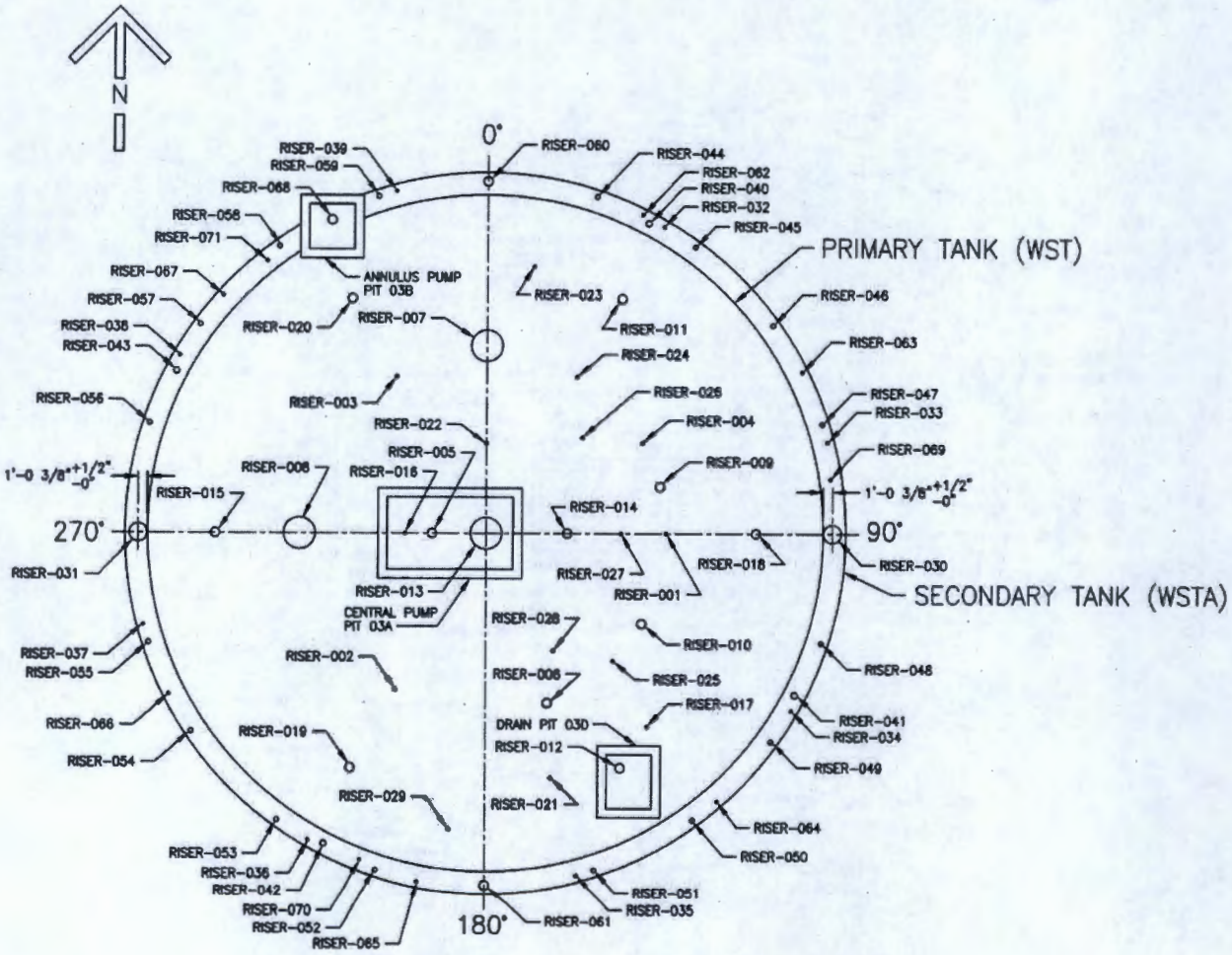


**Figure N-10: Dome Penetrations for Tank 241-AP-103 (H-14-010503, Sheet 3)**

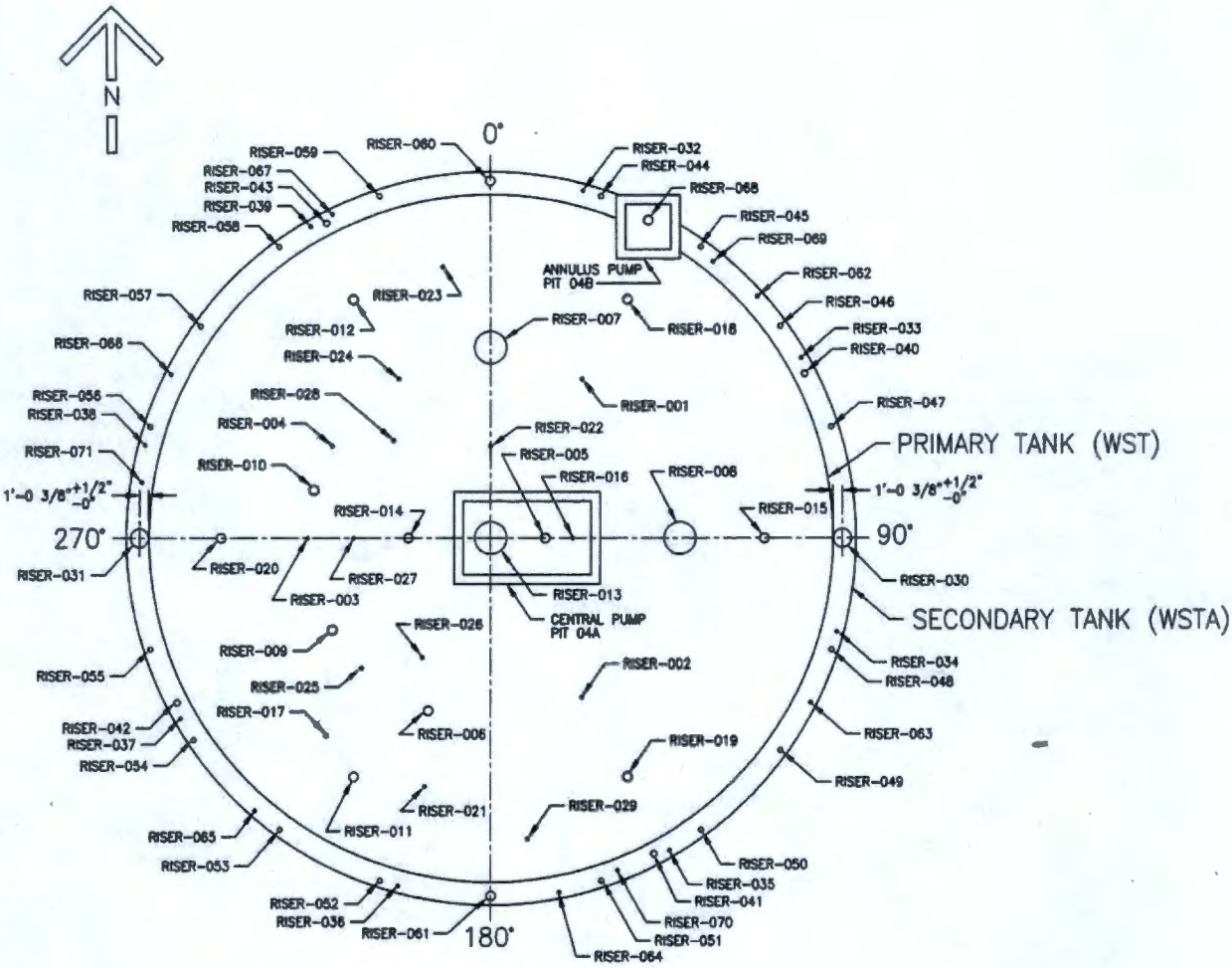


**Figure N-11: Dome Penetrations for Tank 241-AP-104 (H-14-010503, Sheet 4)**

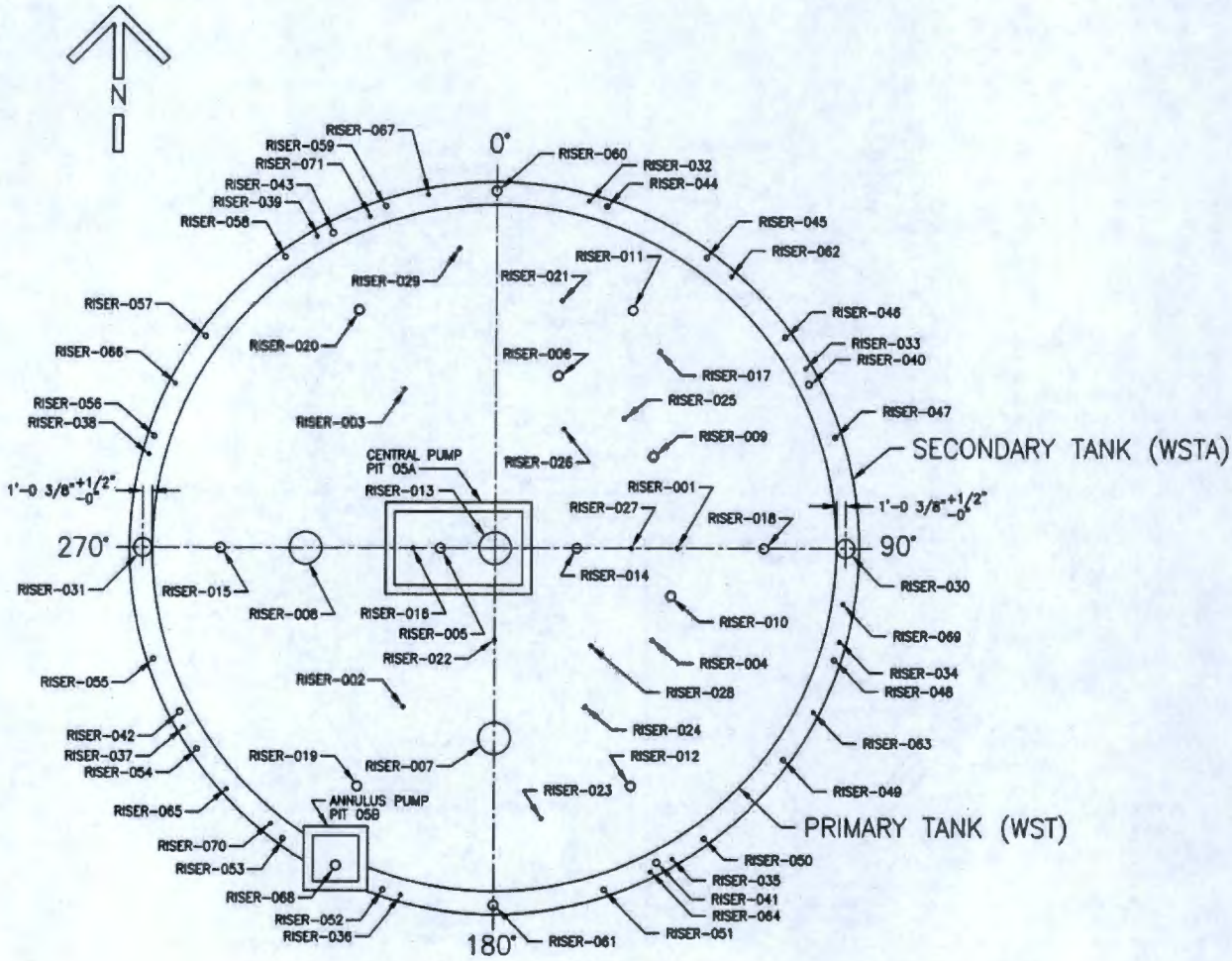


**Figure N-12: Dome Penetrations for Tank 241-AP-105 (H-14-010503, Sheet 5)**

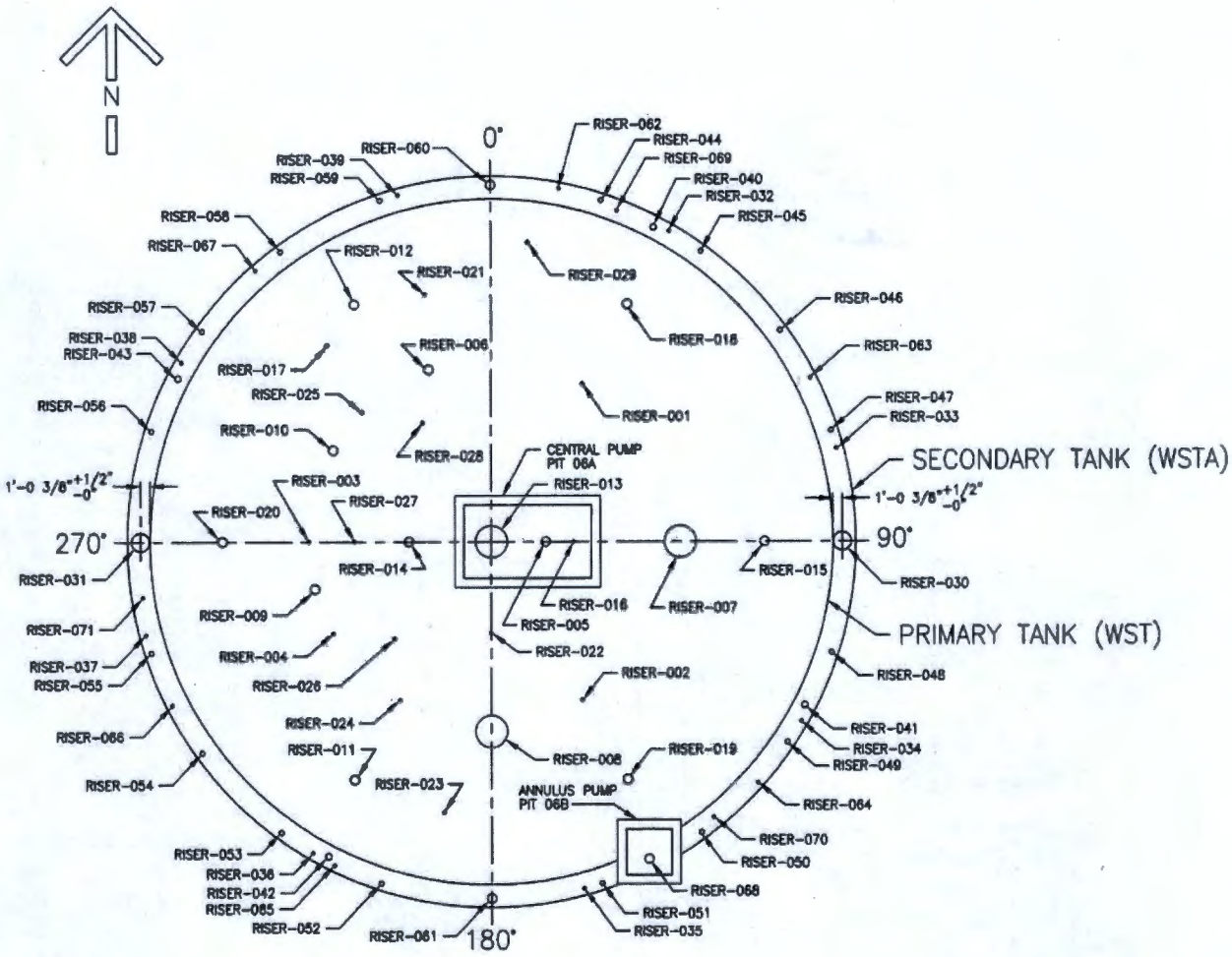


**Figure N-13: Dome Penetrations for Tank 241-AP-106 (H-14-010503, Sheet 6)**

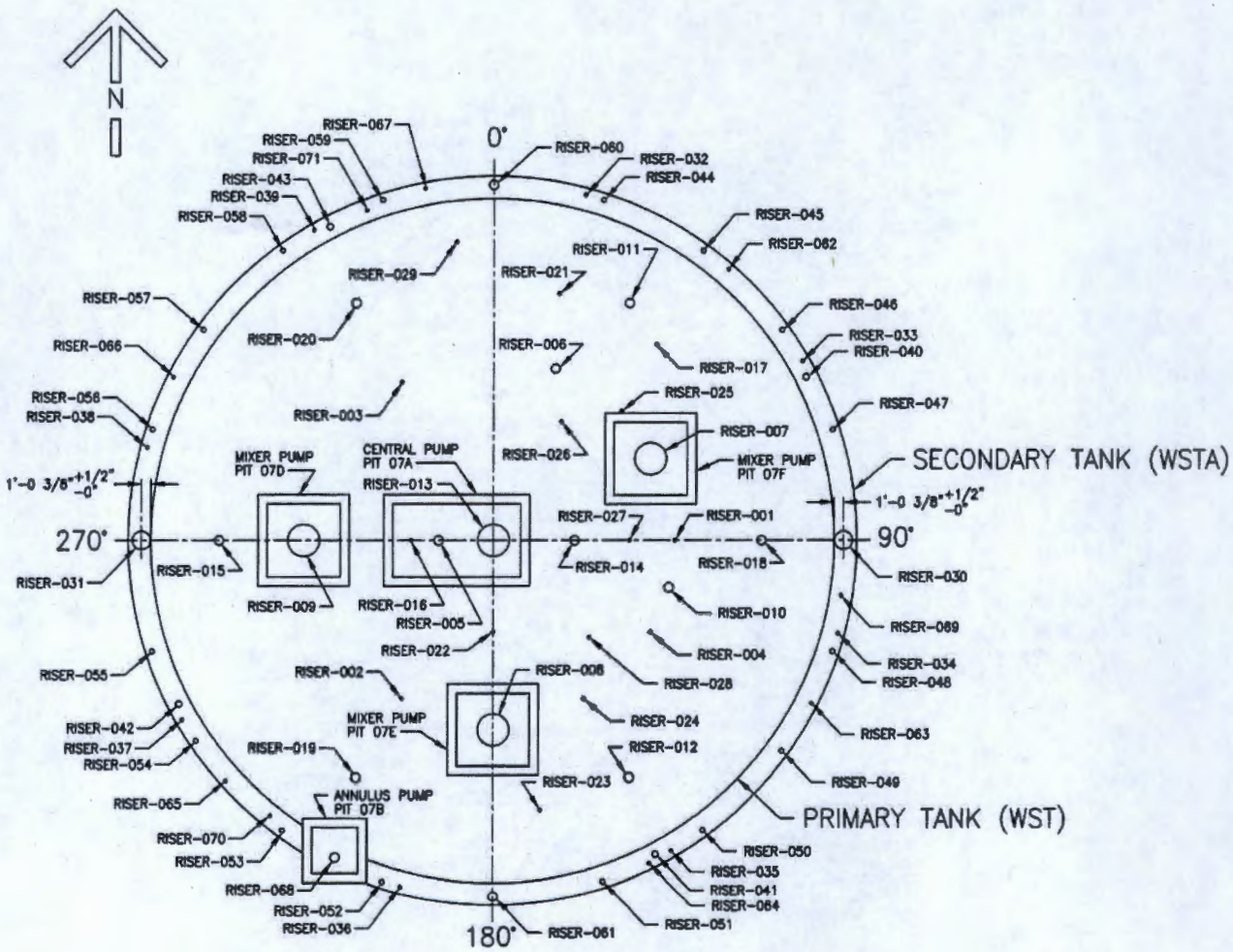


**Figure N-14: Dome Penetrations for Tank 241-AP-107 (H-14-010503, Sheet 7)**

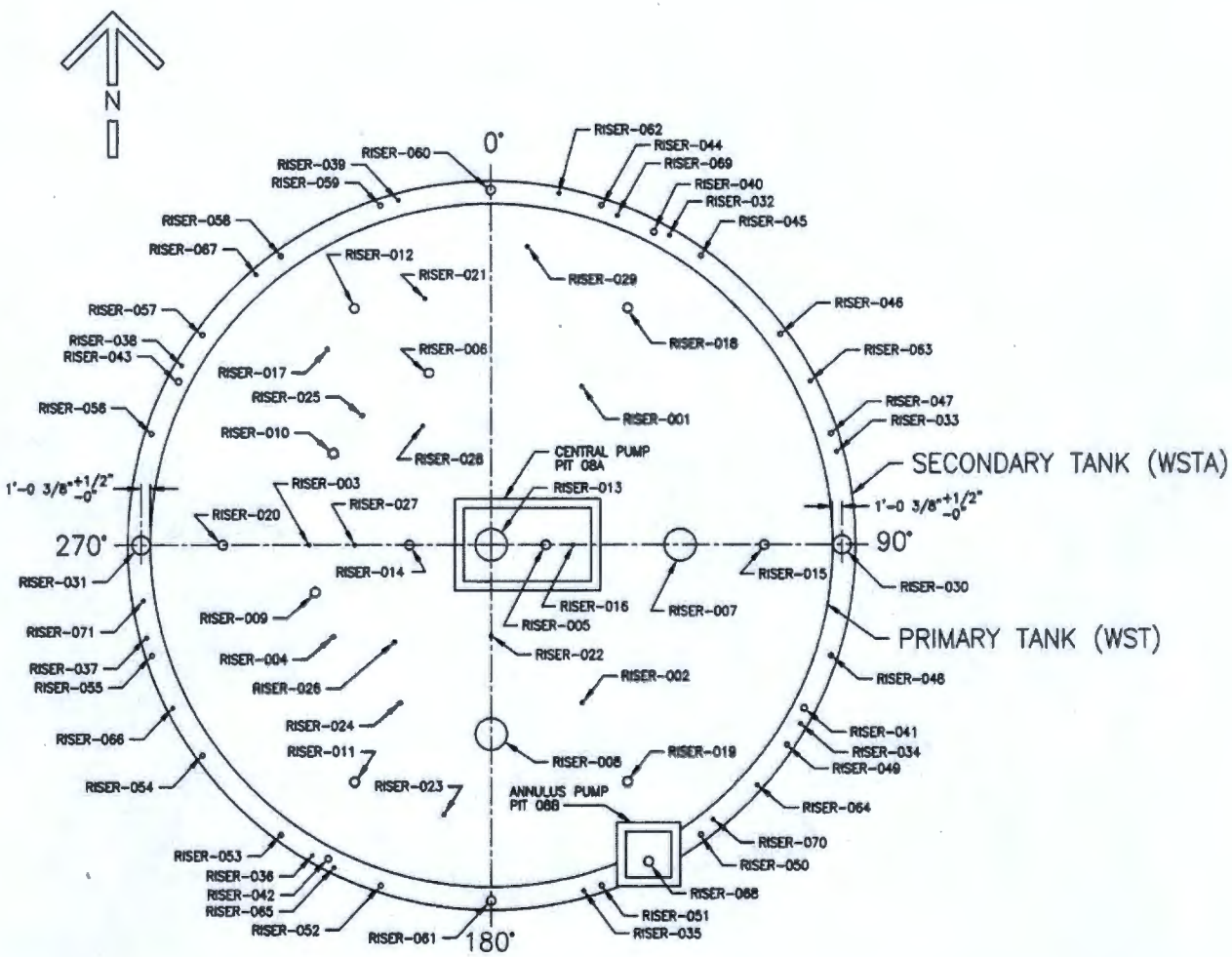


**Figure N-15: Dome Penetrations for Tank 241-AP-108 (H-14-010503, Sheet 8)**

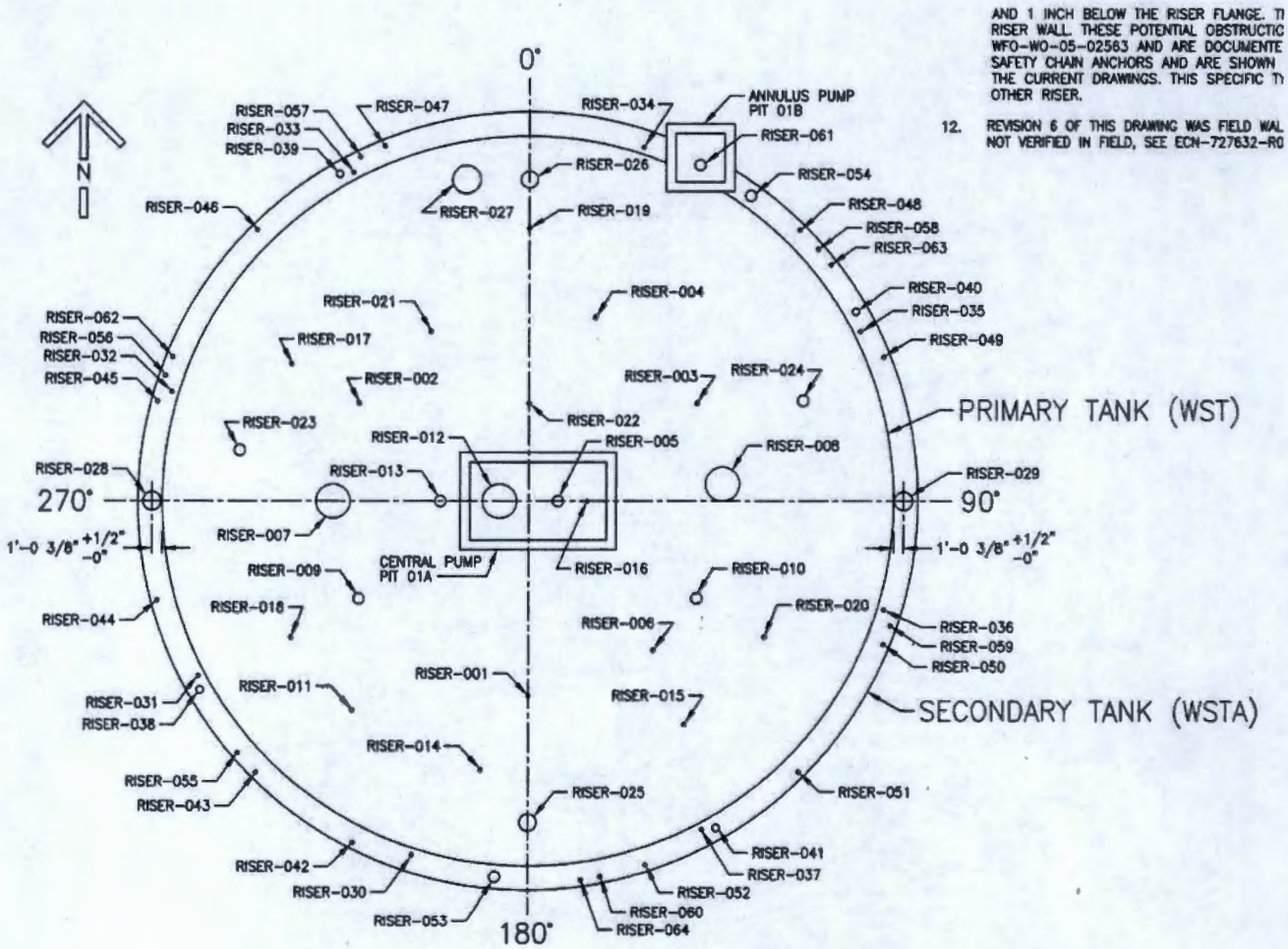


**Figure N-16: Dome Penetrations for Tank 241-AW-101 (H-14-010502, Sheet 1)**

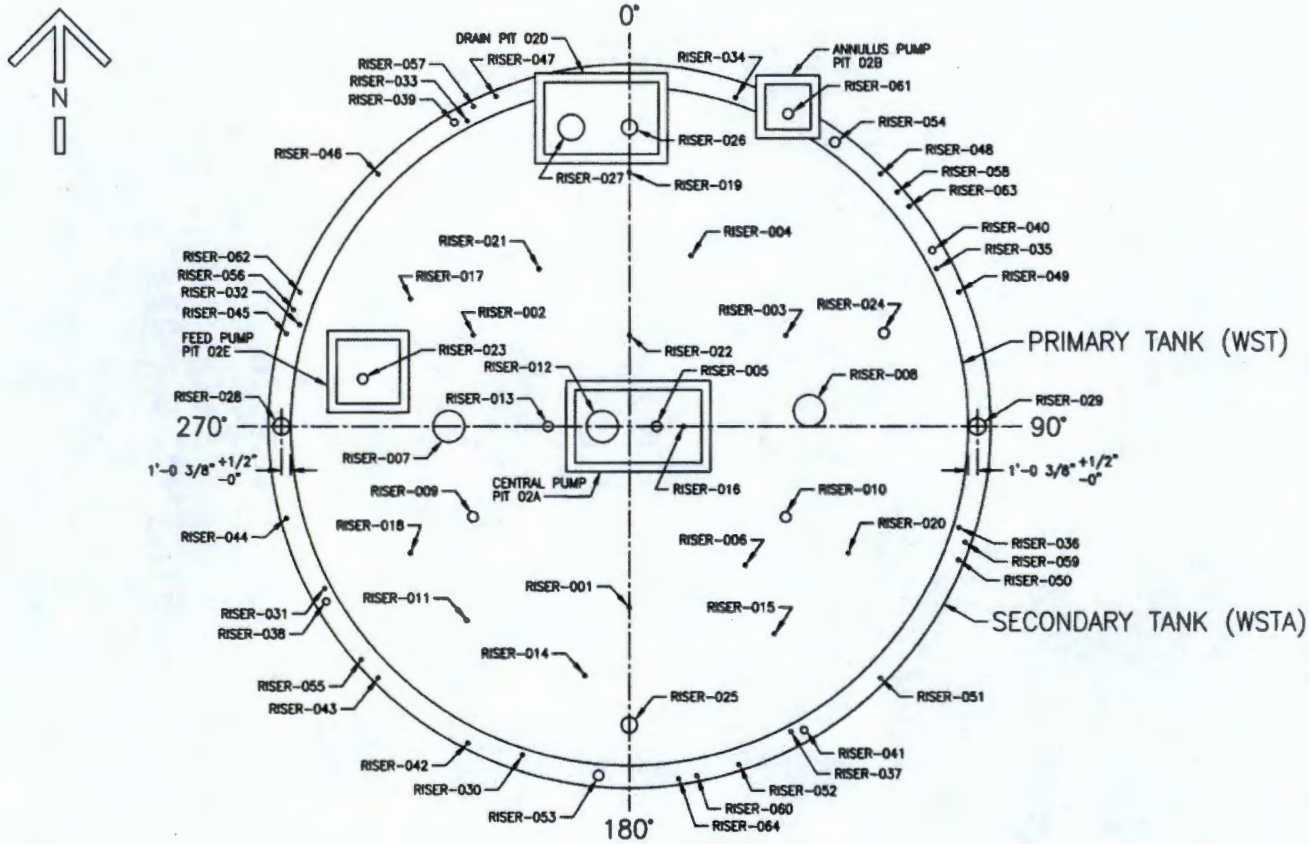


**Figure N-17: Dome Penetrations for Tank 241-AW-102 (H-14-010502, Sheet 2)**

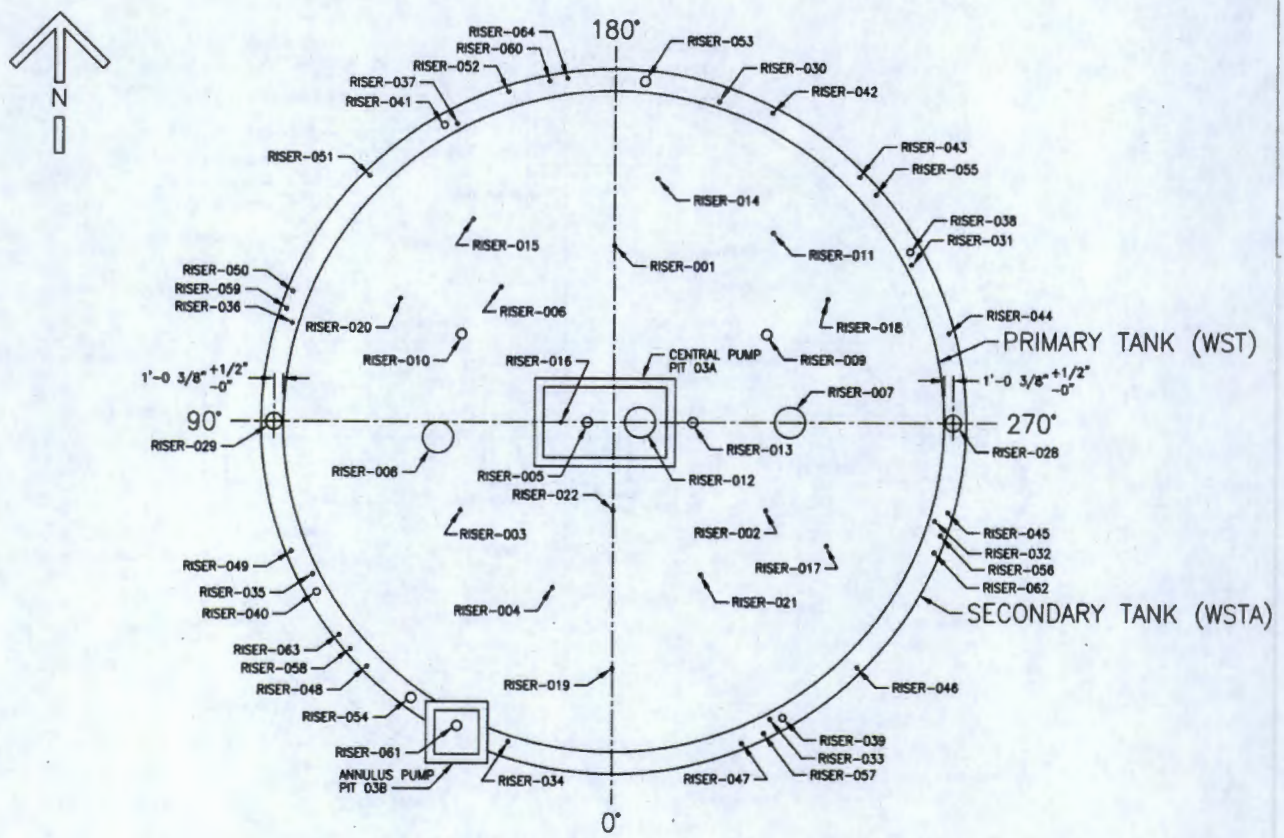


**Figure N-18: Dome Penetrations for Tank 241-AW-103 (H-14-010502, Sheet 3)**

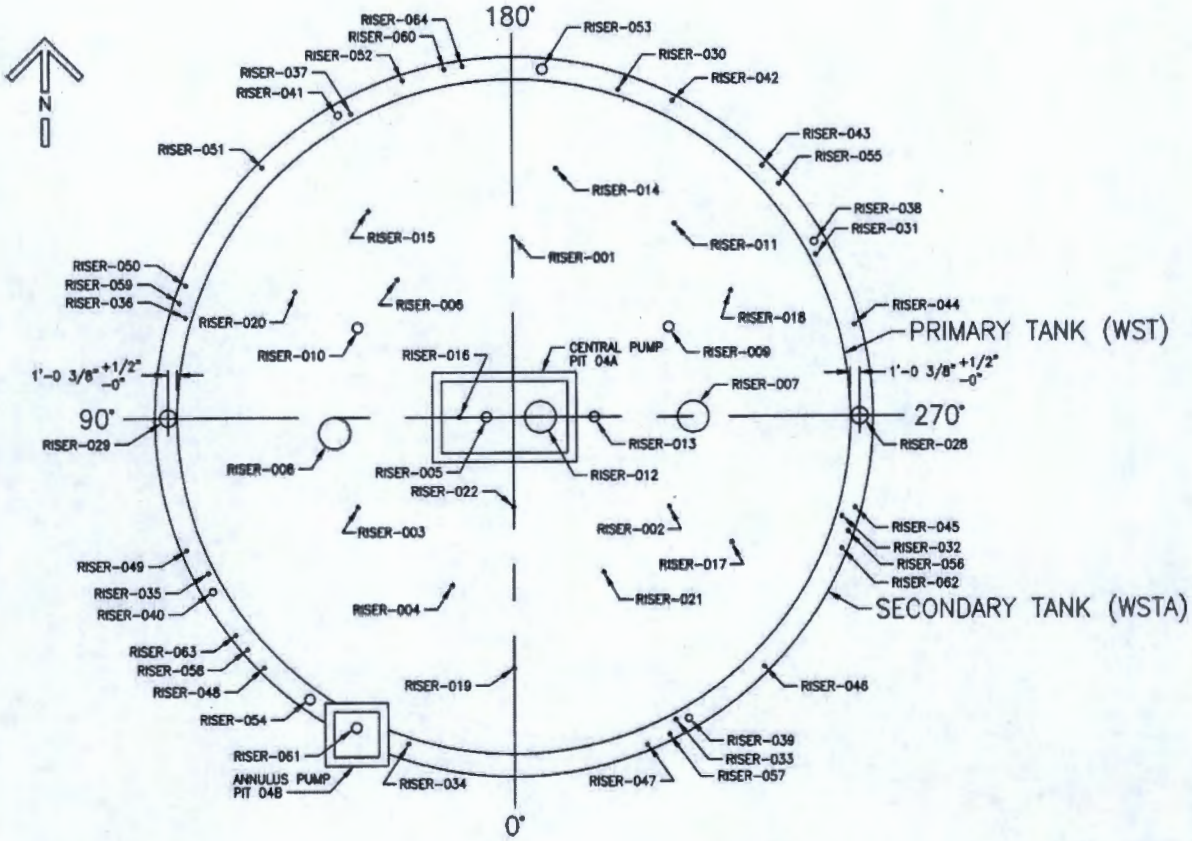


**Figure N-19: Dome Penetrations for Tank 241-AW-104 (H-14-010502, Sheet 4)**

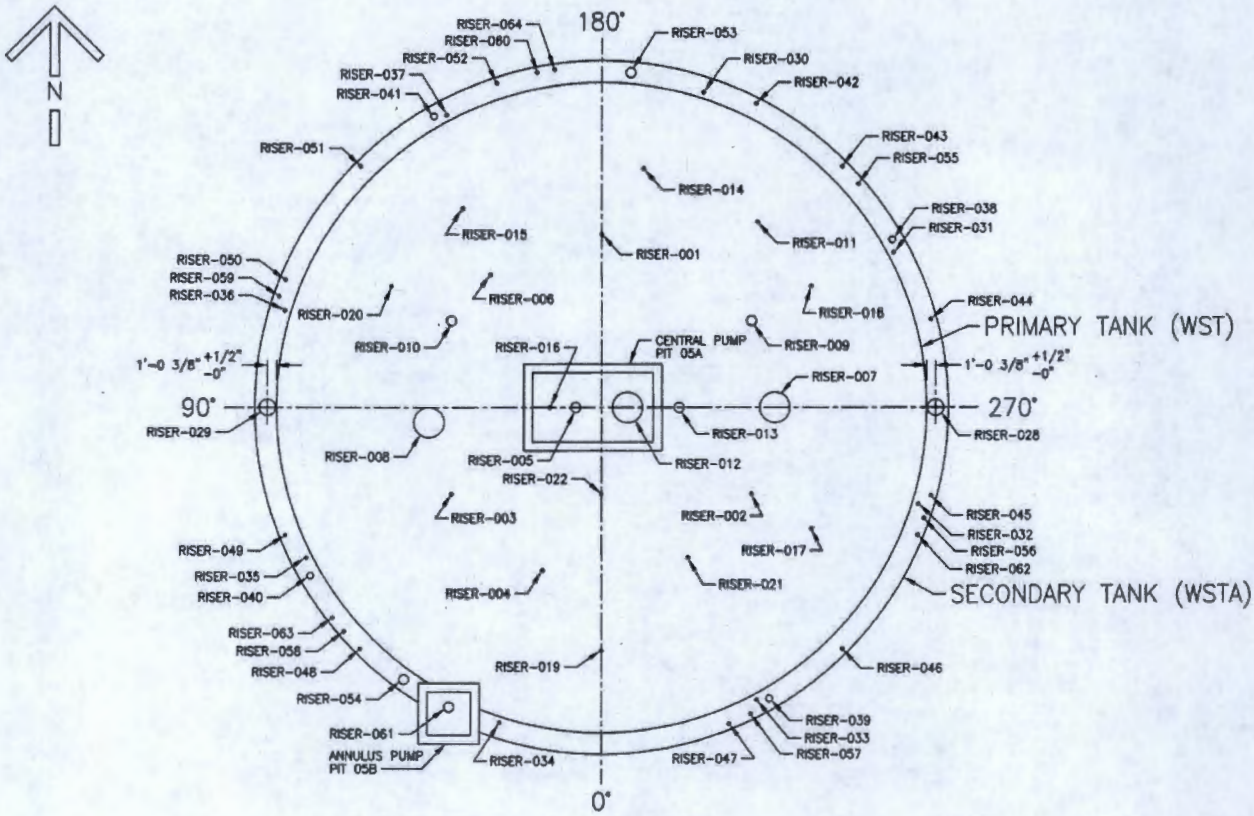


**Figure N-20: Dome Penetrations for Tank 241-AW-105 (H-14-010502, Sheet 5)**

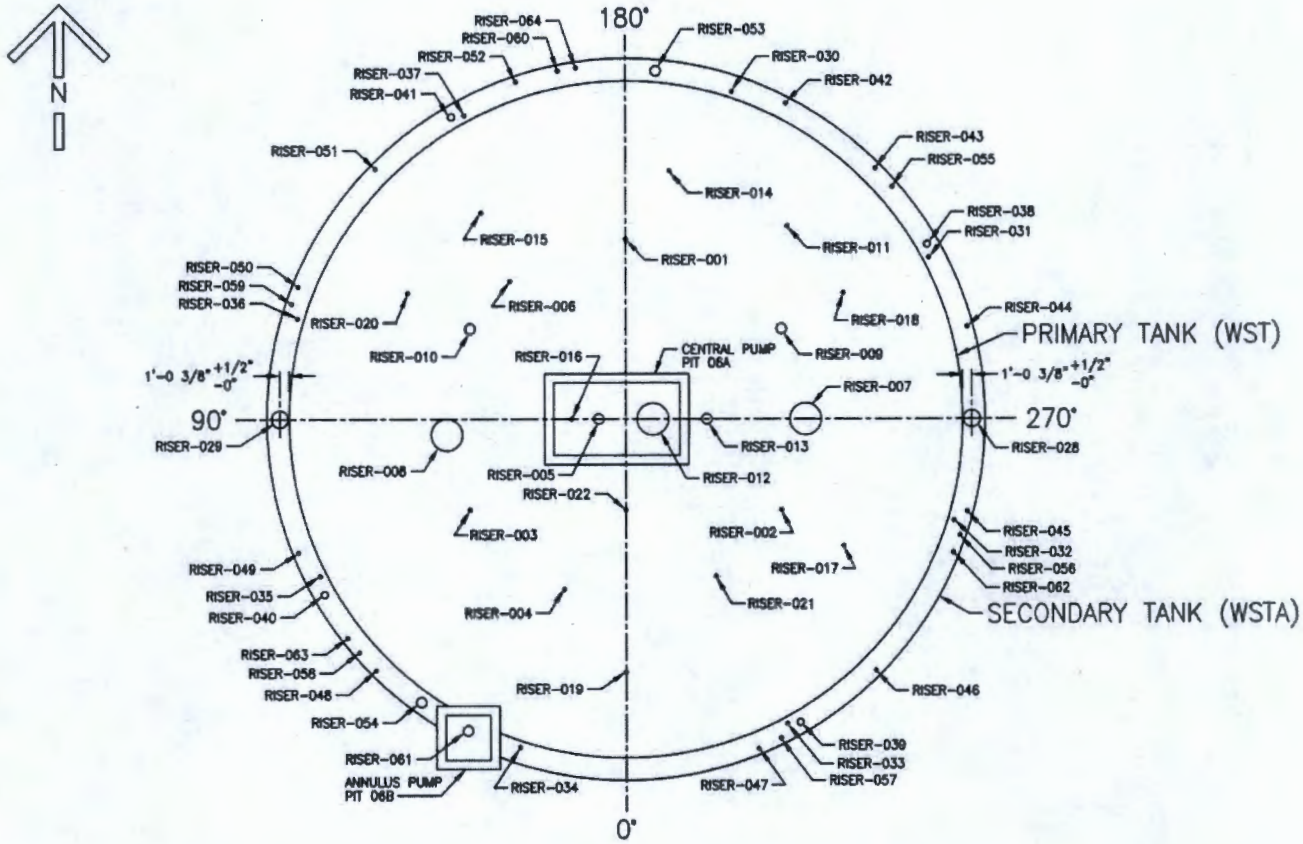


**Figure N-21: Dome Penetrations for Tank 241-AW-106 (H-14-010502, Sheet 6)**

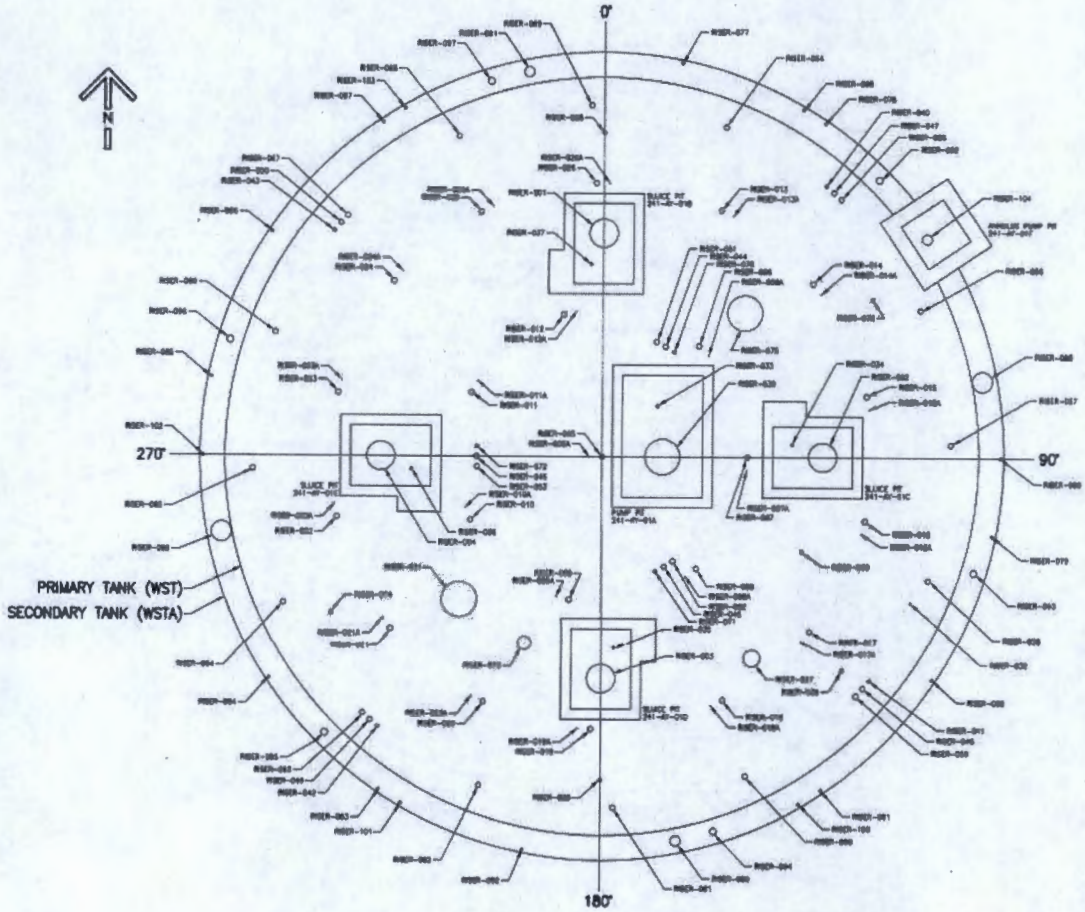


**Figure N-22: Dome Penetrations for Tank 241-AY-101 (H-14-010506, Sheet 2)**

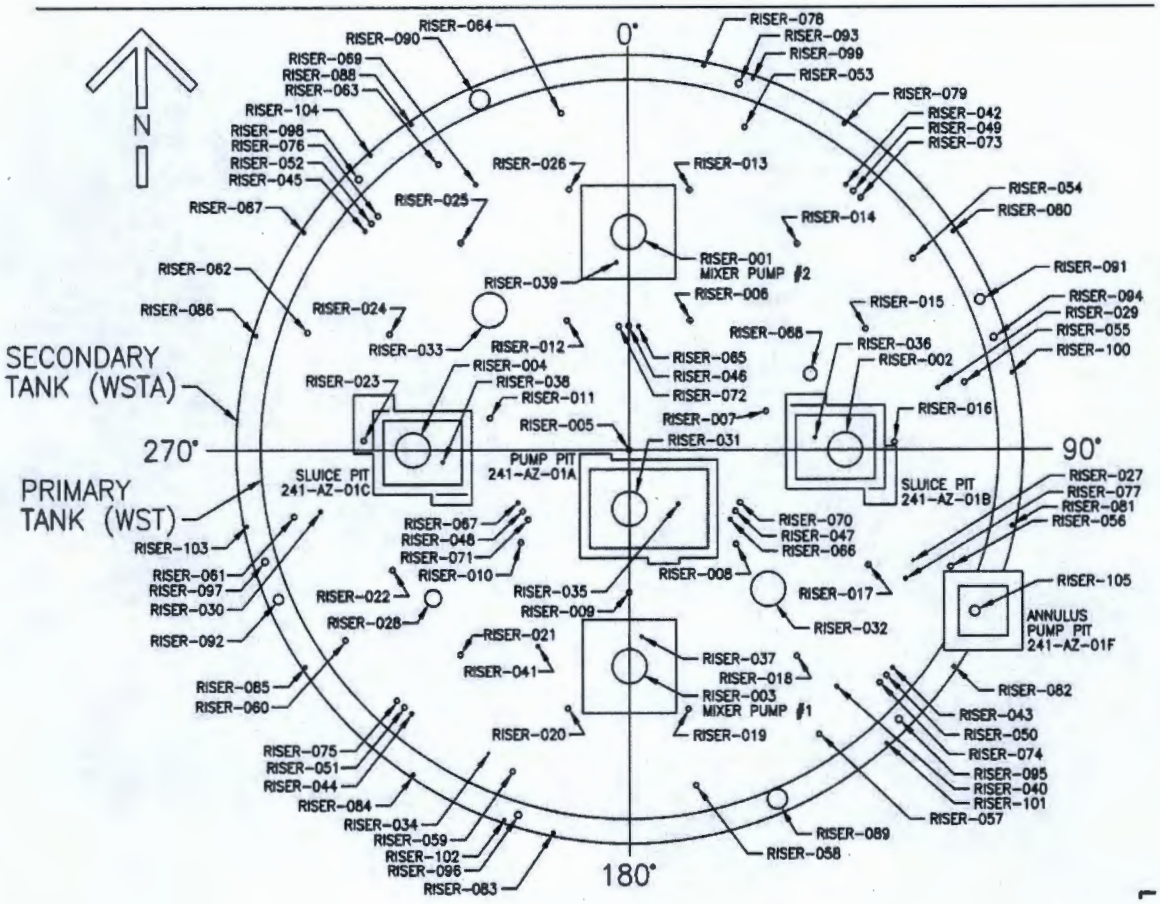


**Figure N-23: Dome Penetrations for Tank 241-AZ-101 (H-14-010507, Sheet 1)**

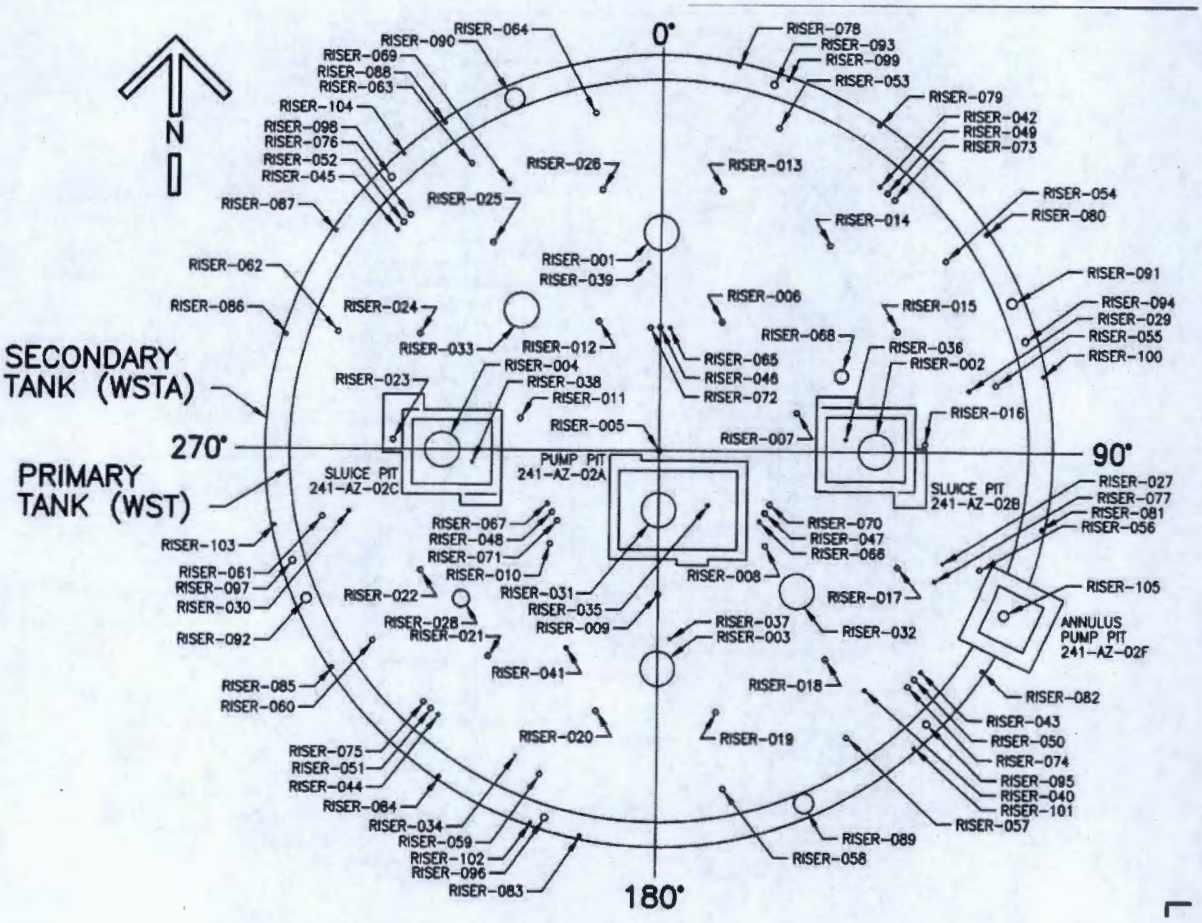


**Figure N-24: Dome Penetrations for Tank 241-AZ-102 (H-14-010507, Sheet 2)**

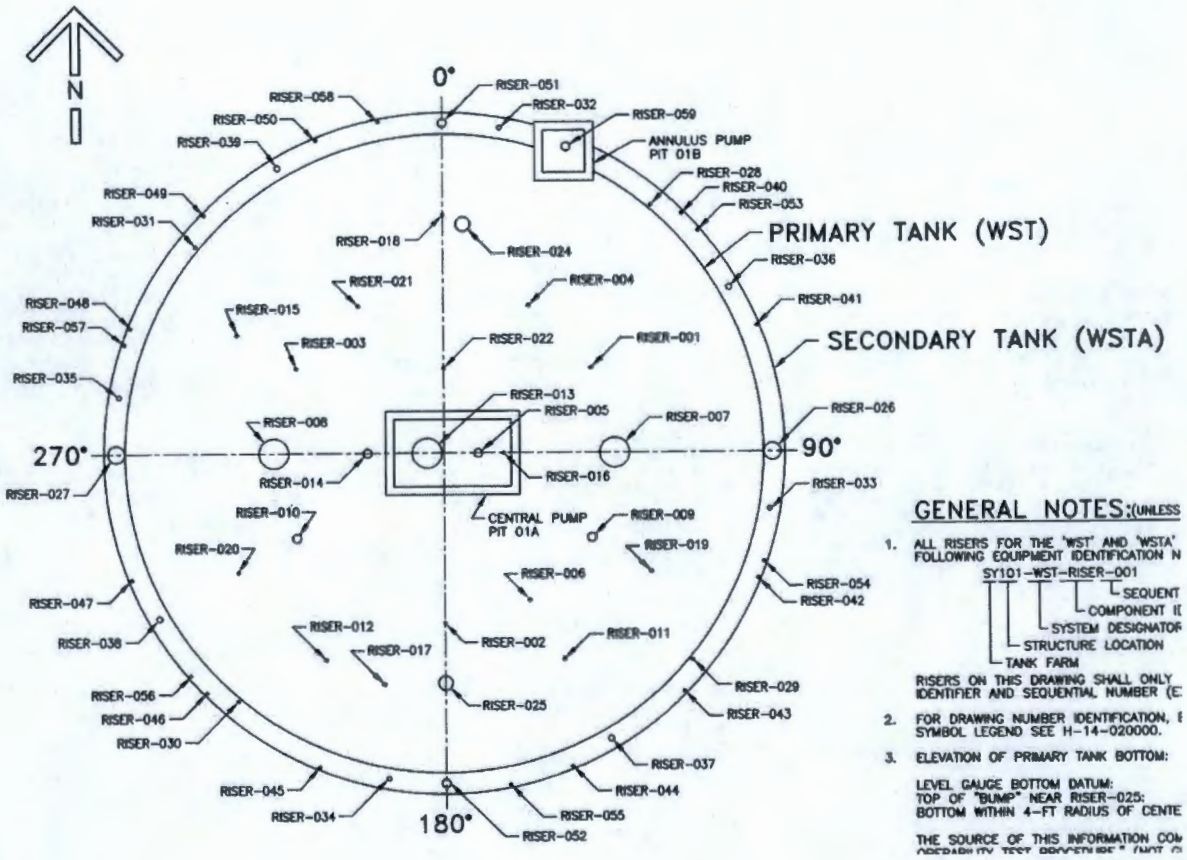


**Figure N-25: Dome Penetrations for Tank 241-SY-101 (H-14-010531, Sheet 1)**

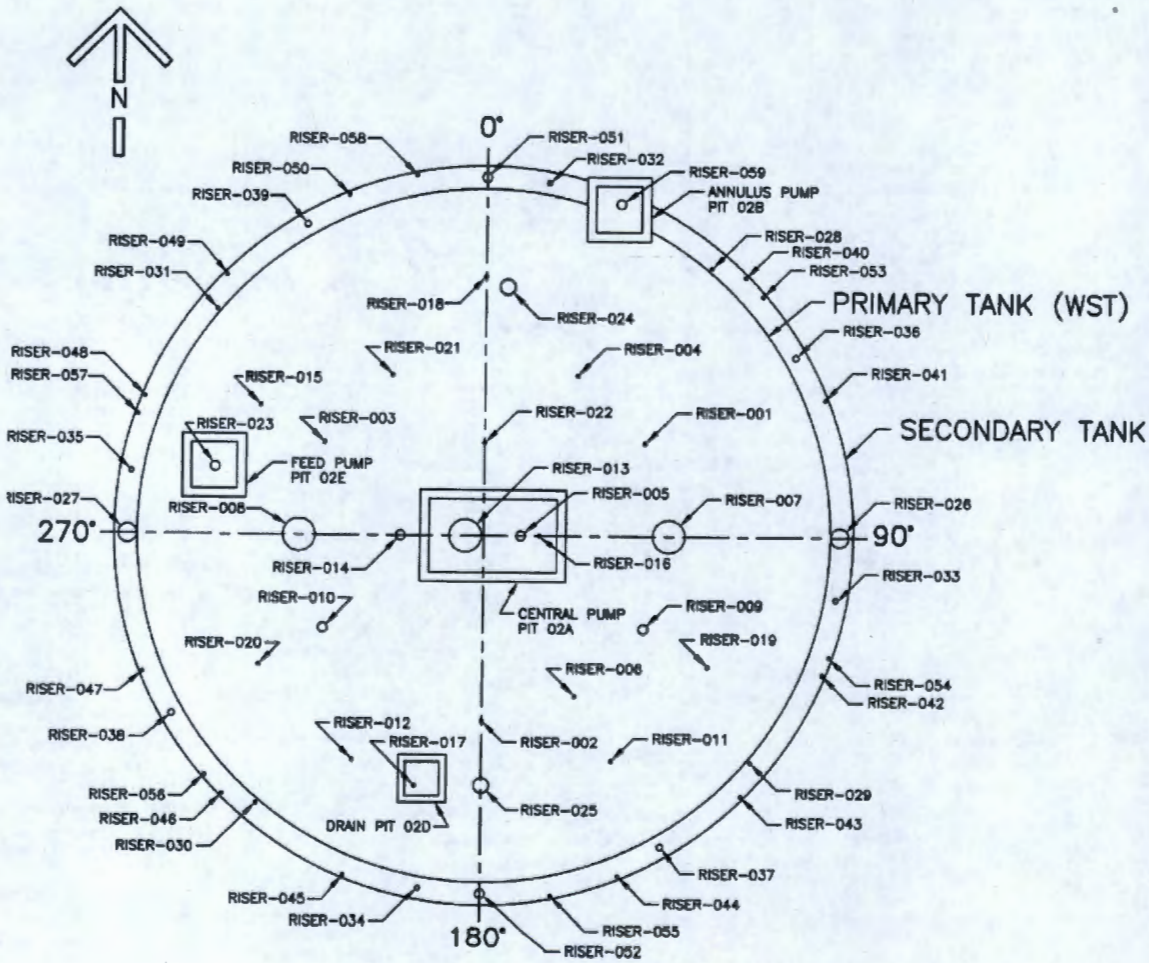


**Figure N-26: Dome Penetrations for Tank 241-SY-102 (H-14-010531, Sheet 2)**

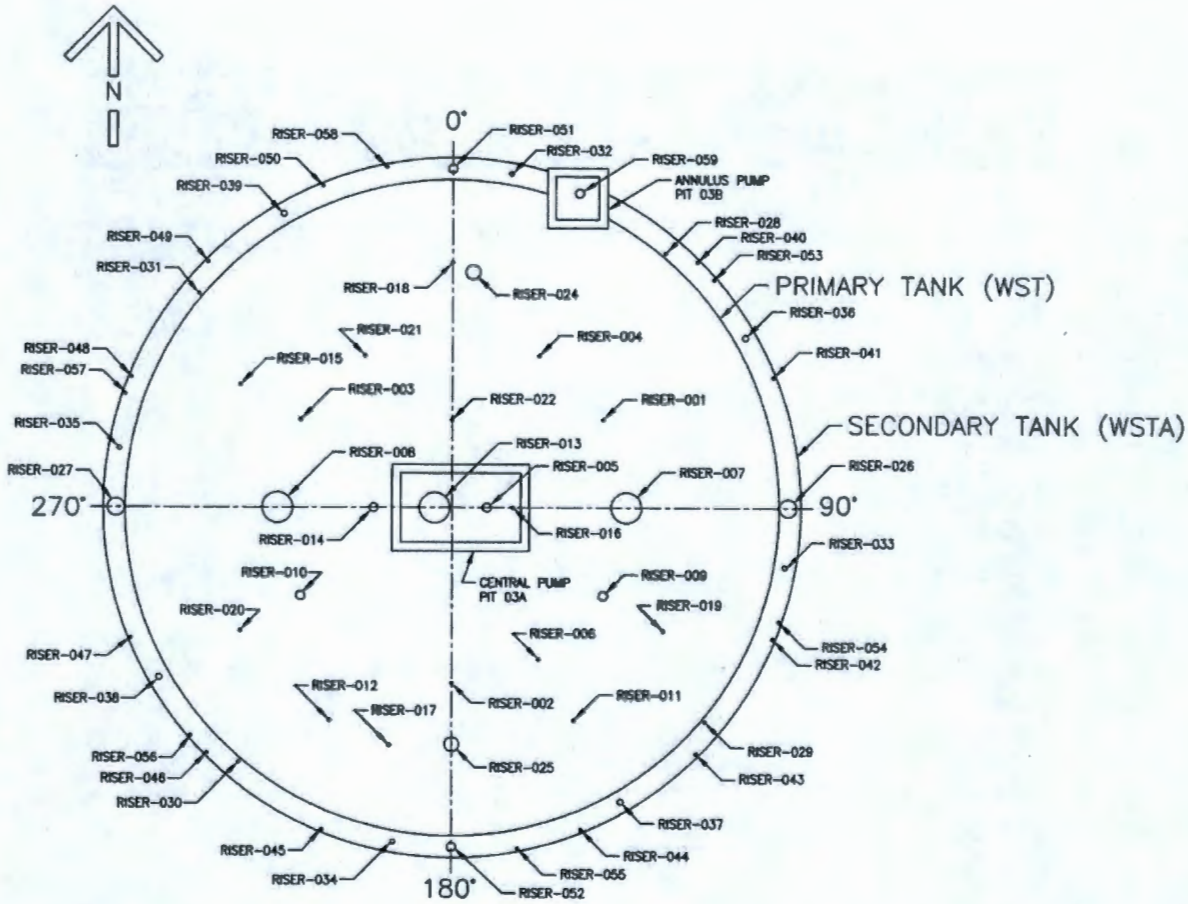


**Figure N-27: Dome Penetrations for Tank 241-SY-103 (H-14-010531, Sheet 3)**

**Table N-1: Double-Shell Tank Equipment Details**

| Tank | Volume kgal | Construct Date | Air Lift Circulators | Sidefill lines | Sluice Pits |
|---|---|---|---|---|---|
| AY-101 | 1,018 | 1971 | X | X | X |
| AZ-101 | 1,018 | 1975 | X | X | X |
| AZ-102 | 1,018 | 1976 | X | X | X |
| SY-101 | 1,160 | 1977 | | | |
| SY-102 | 1,160 | 1977 | X | | |
| SY-103 | 1,160 | 1977 | | | |
| AW-101 | 1,160 | 1980 | | | |
| AW-102 | 1,160 | 1980 | X | | |
| AW-103 | 1,160 | 1980 | | | |
| AW-104 | 1,160 | 1980 | | | |
| AW-105 | 1,160 | 1980 | | | |
| AW-106 | 1,160 | 1980 | | | |
| AN-101 | 1,160 | 1981 | | | |
| AN-102 | 1,160 | 1981 | | | |
| AN-103 | 1,160 | 1981 | | | |
| AN-104 | 1,160 | 1981 | | | |
| AN-105 | 1,160 | 1981 | | | |
| AN-106 | 1,160 | 1981 | | | |
| AN-107 | 1,160 | 1981 | X | | |
| AP-101 | 1,160 | 1986 | | | |
| AP-102 | 1,160 | 1986 | | | |
| AP-103 | 1,257 | 1986 | | | |
| AP-104 | 1,160 | 1986 | | | |
| AP-105 | 1,160 | 1986 | | | |
| AP-106 | 1,160 | 1986 | | | |
| AP-107 | 1,160 | 1986 | | | |
| AP-108 | 1,257 | 1986 | | | |

# APPENDIX O
# DOUBLE-SHELL TANK HEAT TREATMENT TIMES AND TEMPERATURES

# APPENDIX O DOUBLE-SHELL TANK HEAT TREATMENT TIMES AND TEMPERATURES

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Table O-2: AZ Tank Farm Heat Treatment Times and Temperatures ..... O-3
Table O-3: SY Tank Farm Heat Treatment Times and Temperatures ..... O-3
Table O-4: AW Tank Farm Heat Treatment Times and Temperatures ..... O-4
Table O-5: AN Tank Farm Heat Treatment Times and Temperatures ..... O-4
Table O-6: AP Tank Farm Heat Treatment Times and Temperatures ..... O-5

## Table O-1: AY Tank Farm Heat Treatment Times and Temperatures

| Tank | Burners Turned On | Completed Initial Hold Time to Cure Refractory | Completed Final Hold Time for Post-Weld Stress Relief | All Thermocouples Reading Below 600°F, Recorders Turned Off. |
|---|---|---|---|---|
| AY-101 | 4:30 PM October 31, 1969 | November 1, 1969 | 1:20 AM November 3, 1969 Four Hour Hold at 1000°F | November 3, 1969 |
| AY-102 | 4:30 PM September 26, 1969 | Unknown | 7:30 AM October 1, 1969 Three Hour Hold at 1000°F | 4:15 PM October 1, 1969 |

Reference: RPP-RPT-54817, Table 4-1, Page 4-10

## Table O-2: AZ Tank Farm Heat Treatment Times and Temperatures

| Tank | Burners Turned On | Completed Initial Hold Time to Cure Refractory | Completed Final Hold Time for Post-Weld Stress Relief | All Thermocouples Reading Below 600°F, Recorders Turned Off. |
|---|---|---|---|---|
| AZ-101 | 3:30 PM April 19, 1972 | Unknown | 1:40 PM April 20, 1972 Two Hour Hold at 1000°F | Unknown |
| AZ-102 | 5:08 PM May 24, 1972 | Unknown | 12:10 AM May 26, 1972 Three Hour Hold at 1000°F | Unknown |

Reference: RPP-RPT-54818, Table 4-1, Page 4-10

## Table O-3: SY Tank Farm Heat Treatment Times and Temperatures

| Tank | Burners Turned On | Completed Initial Hold Time to Cure Refractory | Completed Final Hold Time for Post-Weld Stress Relief | All Thermocouples Reading Below 600°F, Recorders Turned Off. |
|---|---|---|---|---|
| SY-101 | 2:00 PM July 10, 1975 | 5:30 AM July 11, 1975 | 12:10 AM July 12, 1975 Three Hour Hold as 1000°F | 8:10 AM July 12, 1975 |
| SY-102 | 5:00 PM June 21, 1975 | 3:30 AM June 22, 1975 | 11:42 AM June 23, 1975 One Hour Hold at 1100°F | 7:30 AM June 24, 1974 |
| SY-103 | 10:00 AM August 1, 1975 | 10:00 PM August 1, 1975 | 3:00 PM August 2, 1975 One Hour Hold at 1100°F | 11:20 PM August 2, 1974 |

Reference: RPP-RPT-54819, Table 4-1, Page 4-9

## Table O-4: AW Tank Farm Heat Treatment Times and Temperatures

| Tank | Burners Turned On | Completed Final Hold Time for Post-Weld Stress Relief | All Thermocouples Reading Below 600°F, Recorders Turned Off. |
|---|---|---|---|
| AW-101 | 4:35 PM March 3, 1978 | 8:30 PM March 8, 1978 One Hour Hold at 1100°F | 4:00 PM March 5, 1978 |
| AW-102 | 6:30 PM March 22, 1978 | 9:30 PM March 23, 1978 Three Hour Hold at 1000°F | 4:30 PM March 24, 1978 |
| AW-103 | 6:30 PM April 13, 1978 | 12:00 AM April 15, 1978 Three Hour Hold at 1000°F | 7:00 AM April 15, 1978 |
| AW-104 | 8:45 AM April 26, 1978 | 2:30 PM April 27, 1978 Three Hour Hold at 1000°F | 8:30 PM April 27, 1978 |
| AW-105 | 11:00 AM June 7, 1978 | 9:00 AM June 8, 1978 Three Hour Hold at 1000°F | 3:00 PM June 8, 1978 |
| AW-106 | 5:00 PM June 15, 1978 | 12:30 PM June 16, 1978 Three Hour Hold at 1000°F | 5:30 PM June 16, 1978 |

Reference: RPP-RPT-55981, Table 4-3/4-4, Page 4-10

## Table O-5: AN Tank Farm Heat Treatment Times and Temperatures

| Tank | Burners Turned On | Completed Final 3-hr Hold Time at 1000°F | All Thermocouples Reading below 600°F, Recorders Turned Off |
|---|---|---|---|
| AN-101 | 8:30 AM October 10, 1978 | 10:30 PM October 10, 1978 | 6:00 AM October 11, 1978 |
| AN-102 | 9:00 AM October 27, 1978 | 10:00 PM October 27, 1978 | 3:00 AM October 28, 1978 |
| AN-103 | 12:00 PM November 15, 1978 | 2:00 AM November 16, 1978 | 8:20 AM November 16, 1978 |
| AN-104 | 2:00 PM September 21, 1978 | 11:15 AM September 22, 1978 | 5:30 PM September 22, 1978 |
| AN-105 | 12:00 PM December 7, 1978 | 8:00 AM December 8, 1978 | 4:00 PM December 8, 1978 |
| AN-106 | 11:00 AM January 4, 1979 | 10:00 AM January 5, 1979 | 5:00 PM January 5, 1979 |
| AN-107 | 12:00 PM February 7, 1979 | 5:00 AM February 15, 1979 | 12:15 PM February 15, 1979 |

Reference: RPP-RPT-55982, Table 4-3, Page 4-12

## Table O-6: AP Tank Farm Heat Treatment Times and Temperatures

| Tank | Burners Turned On | Completed 6-hr Hold Time at 220°F | Completed Final 3-hr Hold Time at 1000°F | All Thermocouples Reading below 800°F, Recorders Turned Off |
|---|---|---|---|---|
| AP-101 | 6:30 AM August 16, 1984 | 2:00 PM[B] August 16, 1984 | 10:45 AM August 17, 1984 | 1:00 PM[A] August 17, 1984 |
| AP-102 | 6:30 AM August 2, 1984 | 3:30 PM[B] August 2, 1984 | 7:30 AM August 3, 1984 | 10:30 AM[A] August 3, 1984 |
| AP-103 | 7:00 AM[B] September 18, 1984 | 4:00 PM September 18, 1984 | 2:00 PM[B] September 19, 1984 | 7:00 PM[B] September 19, 1984 |
| AP-104 | 7:00 AM September 12, 1984 | 4:00 PM[B] September 12, 1984 | 1:00 PM[B] September 13, 1984 | 4:00 PM[A] September 13, 1984 |
| AP-105 | 9:30 AM October 2, 1984 | 6:30 PM October 2, 1984 | 2:00 PM October 3, 1984 | 3:30 PM[A] October 3, 1984 |
| AP-106 | 6:30 AM August 28, 1984 | 3:30 PM[B] August 28, 1984 | 1:00 PM[B] August 29, 1984 | 5:30 PM August 29, 1984 |
| AP-107 | 8:00 AM July 19, 1984 | 5:15 PM July 19, 1984 | 1:00 PM July 20, 1984 | 5:00 PM July 20, 1984 |
| AP-108 | 9:00 AM July 6, 1984 | 6:00 PM[B] July 6, 1984 | 7:00 PM[C] July 7, 1984 | 11:00 PM July 7, 1984 |

Reference: RPP-RPT-55983, Table 4-1, Page 4-9

# APPENDIX P
# DOUBLE-SHELL TANK TEMPERATURE HISTORY

# APPENDIX P DOUBLE-SHELL TANK TEMPERATURE HISTORY

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Figure P-2: Tank AZ-101 Temperature ..... P-6
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Figure P-5: Tank SY-102 Temperature ..... P-9
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Figure P-8: Tank AW-102 Temperature ..... P-12
Figure P-9: Tank AW-103 Temperature ..... P-13
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Figure P-11: Tank AW-105 Temperature ..... P-15
Figure P-12: Tank AW-106 Temperature ..... P-16
Figure P-13: Tank AN-101 Temperature ..... P-17
Figure P-14: Tank AN-102 Temperature ..... P-18
Figure P-15: Tank AN-103 Temperature ..... P-19
Figure P-16: Tank AN-104 Temperature ..... P-20
Figure P-17: Tank AN-105 Temperature ..... P-21
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Figure P-20: Tank AP-101 Temperature ..... P-24
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Figure P-22: Tank AP-103 Temperature ..... P-26
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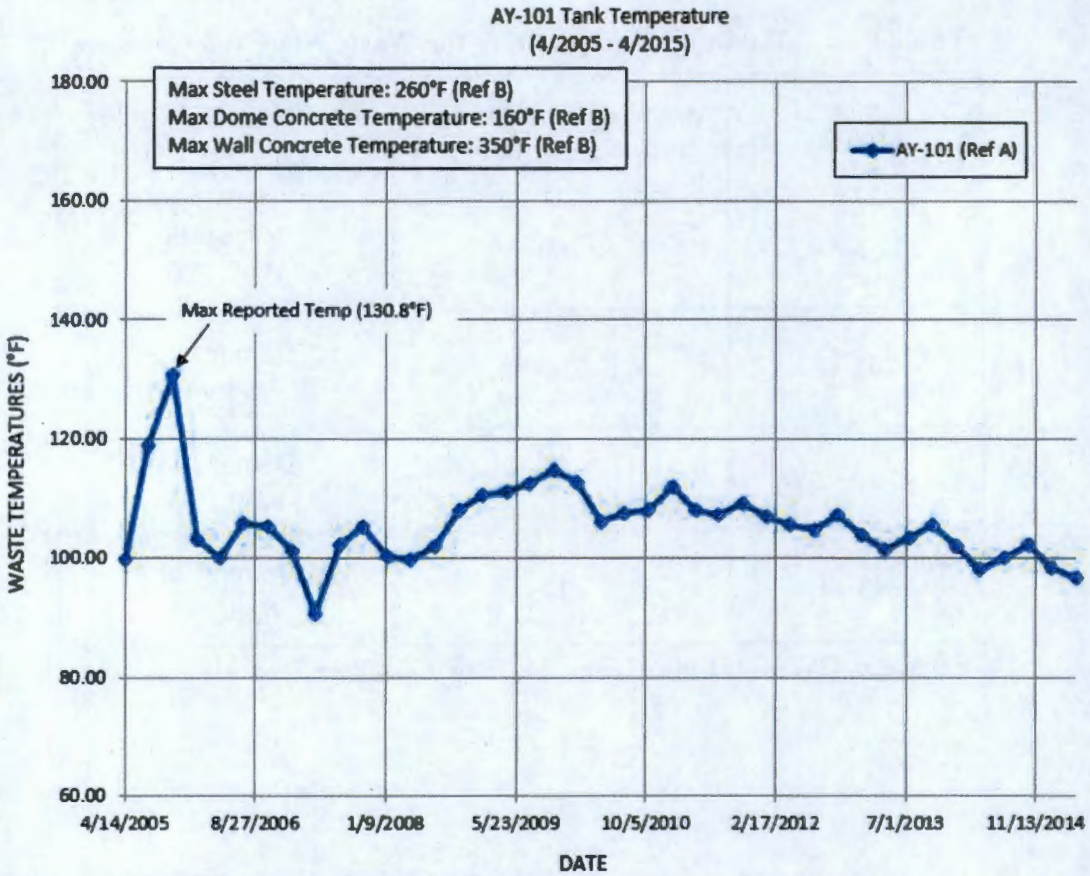
## LIST OF TABLES

Table P-1: Maximum Temperature for Waste, Steel and Concrete.....P-4

**Table P-1: Maximum Temperature for Waste, Steel and Concrete**

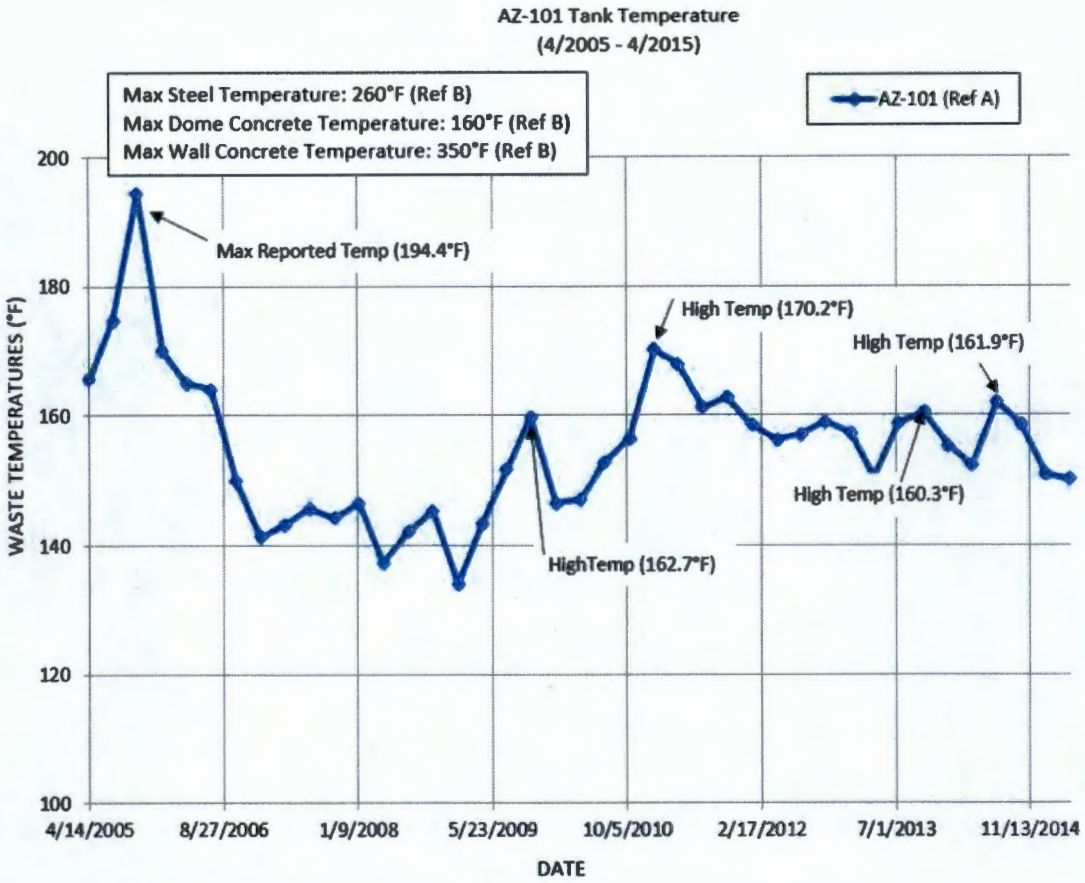
| Tanks | Max Temperature for Waste and Steel (°F) | Max Temperature for Concrete (°F) |
|---|---|---|
| 241-AY, AZ | 260 | Dome: 160<br>Wall: 350 |
| 241-SY | 250 | Dome: 160<br>Wall: 250 |
| 241-AN, AW | 350 | Dome: 160<br>Wall: 236 |
| 241-AP | 210 | Dome: 135<br>Wall: 236 |

Reference: OSD-T-151-00007, Rev. 14, Table 1.4.1, Page 11



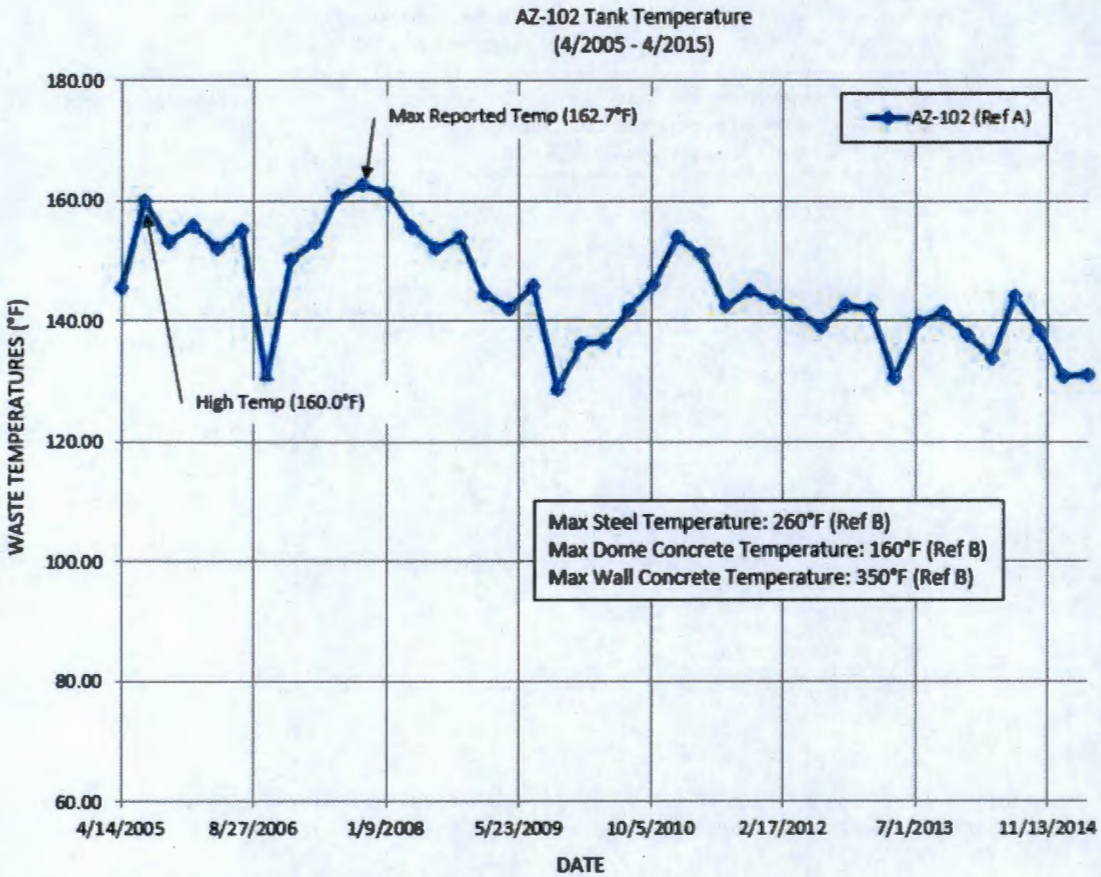

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-1: Tank AY-101 Temperature**



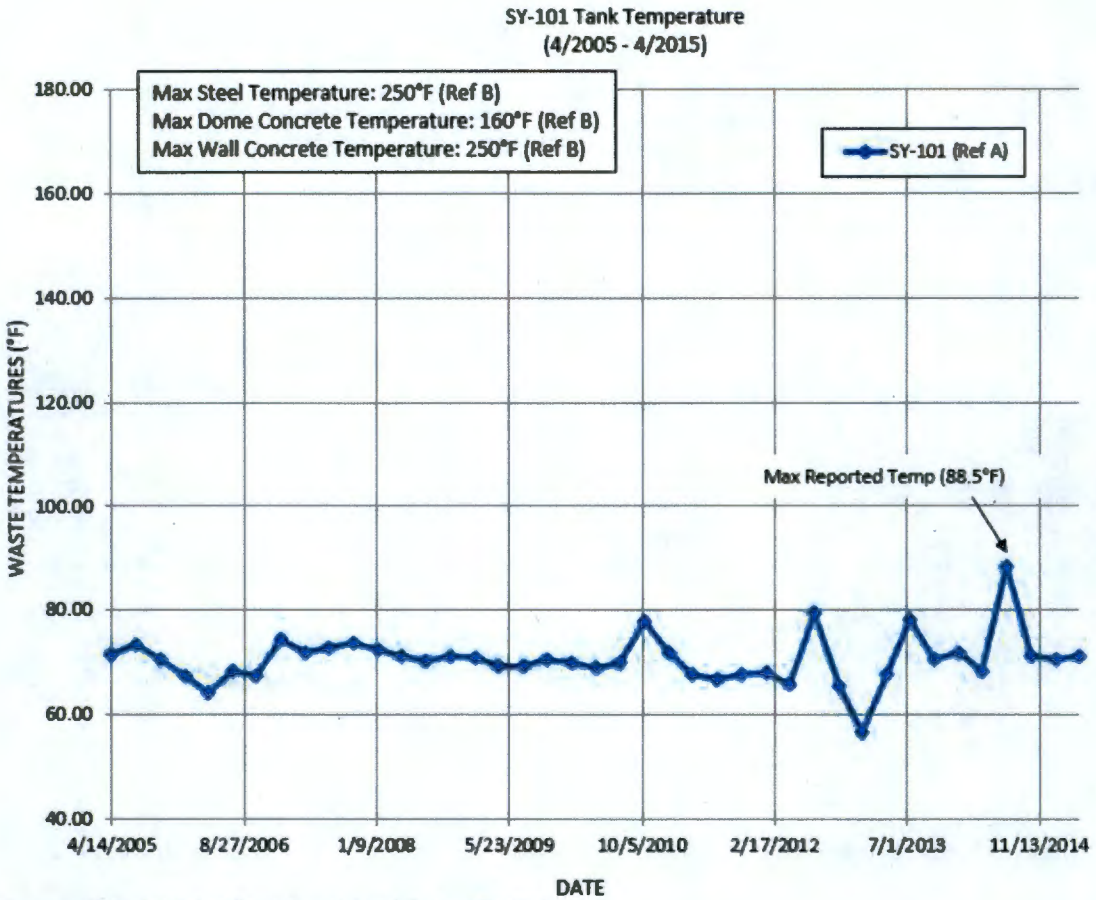

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-2: Tank AZ-101 Temperature**



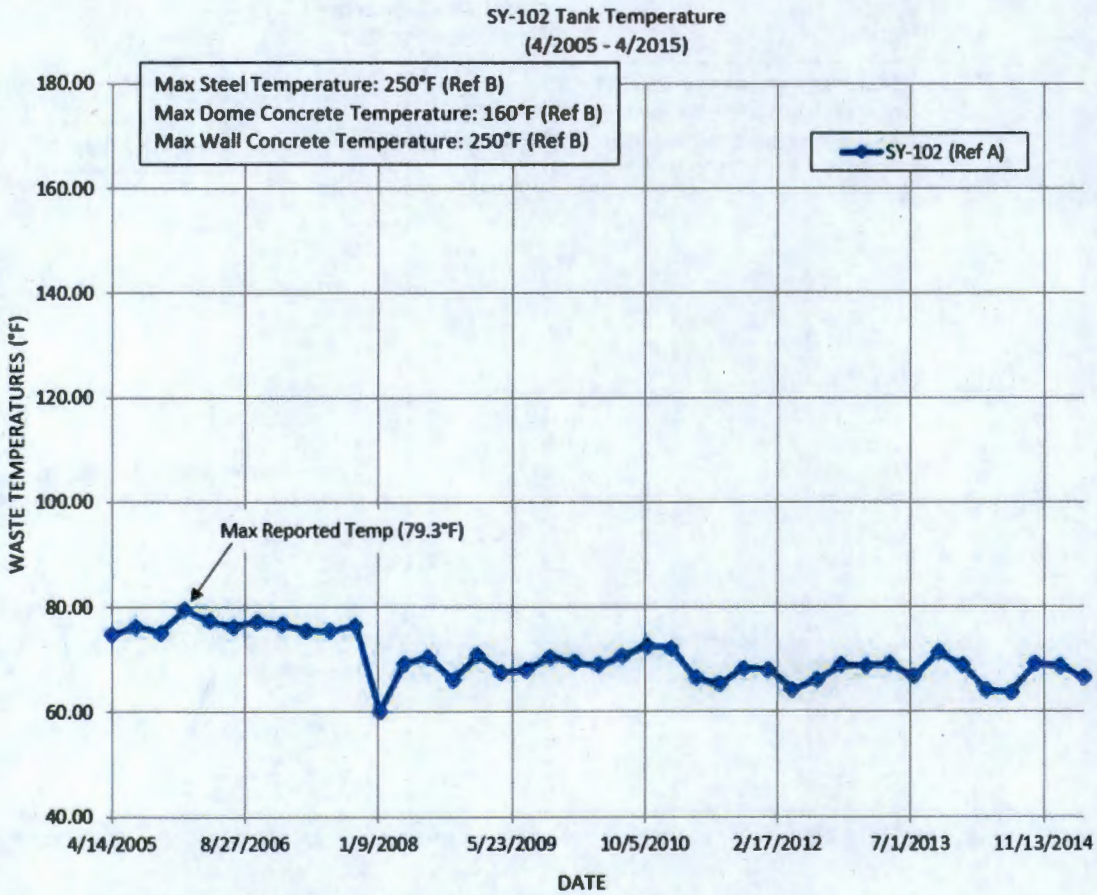

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-3: Tank AZ-102 Temperature**



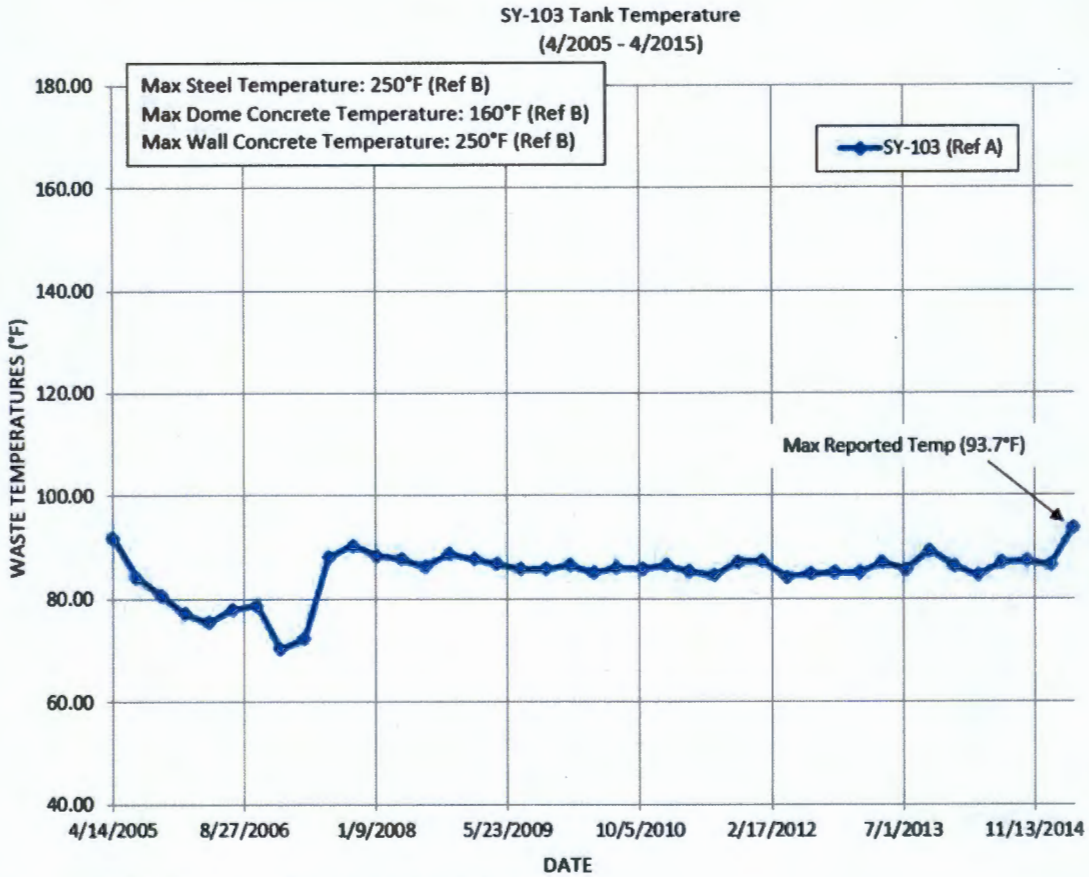

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-4: Tank SY-101 Temperature**



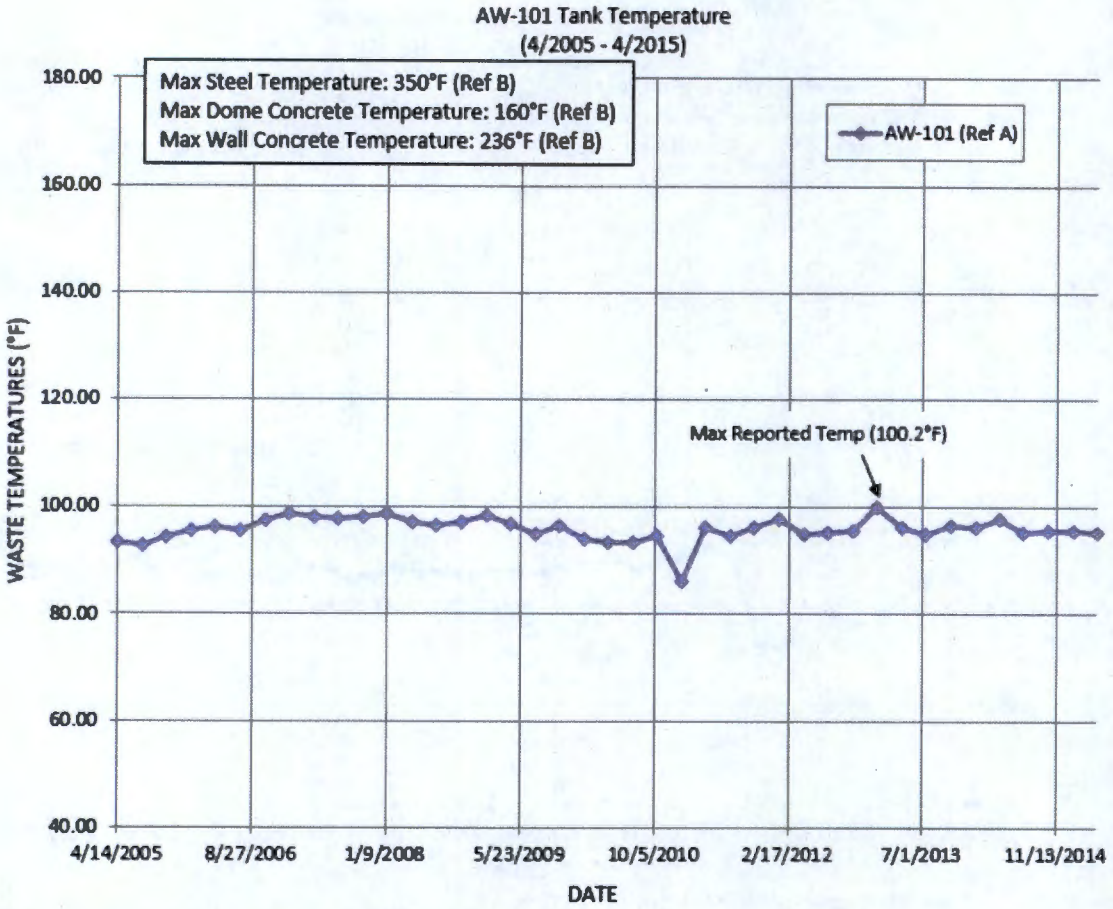

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-5: Tank SY-102 Temperature**



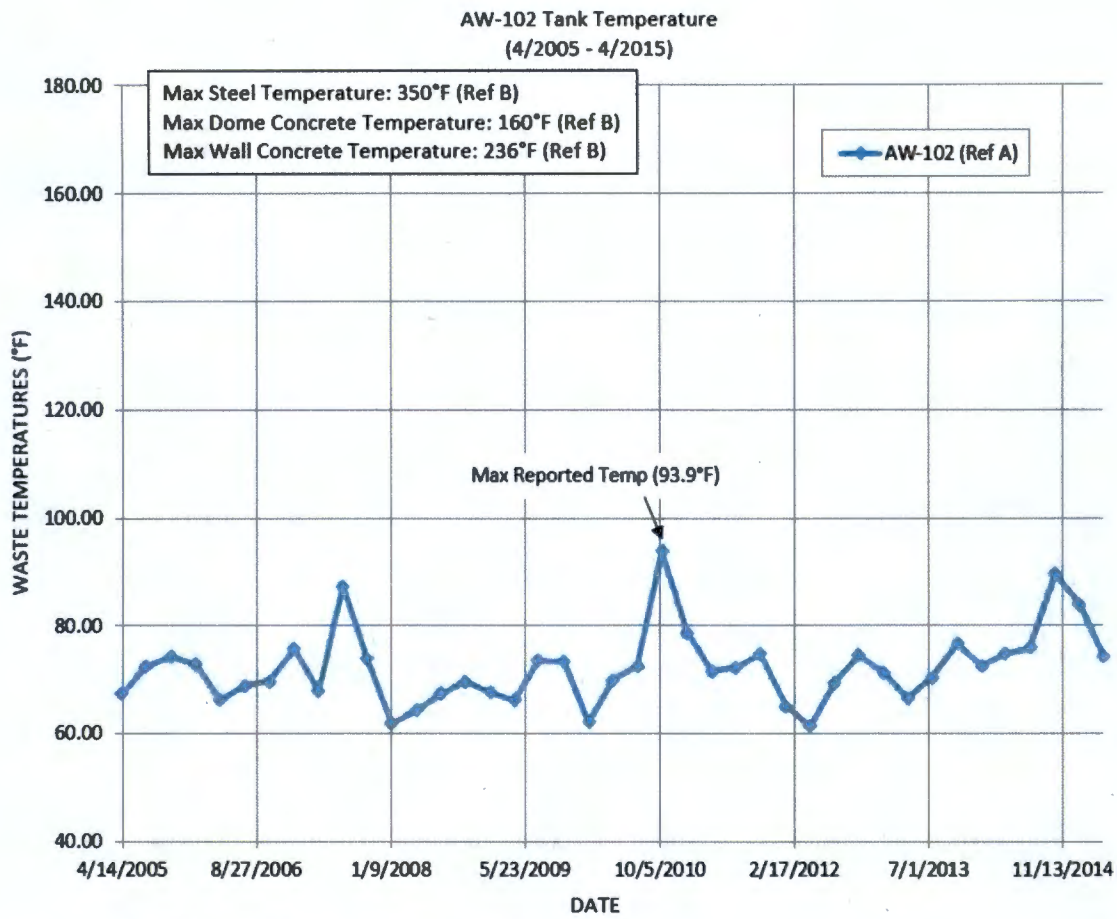

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-6: Tank SY-103 Temperature**



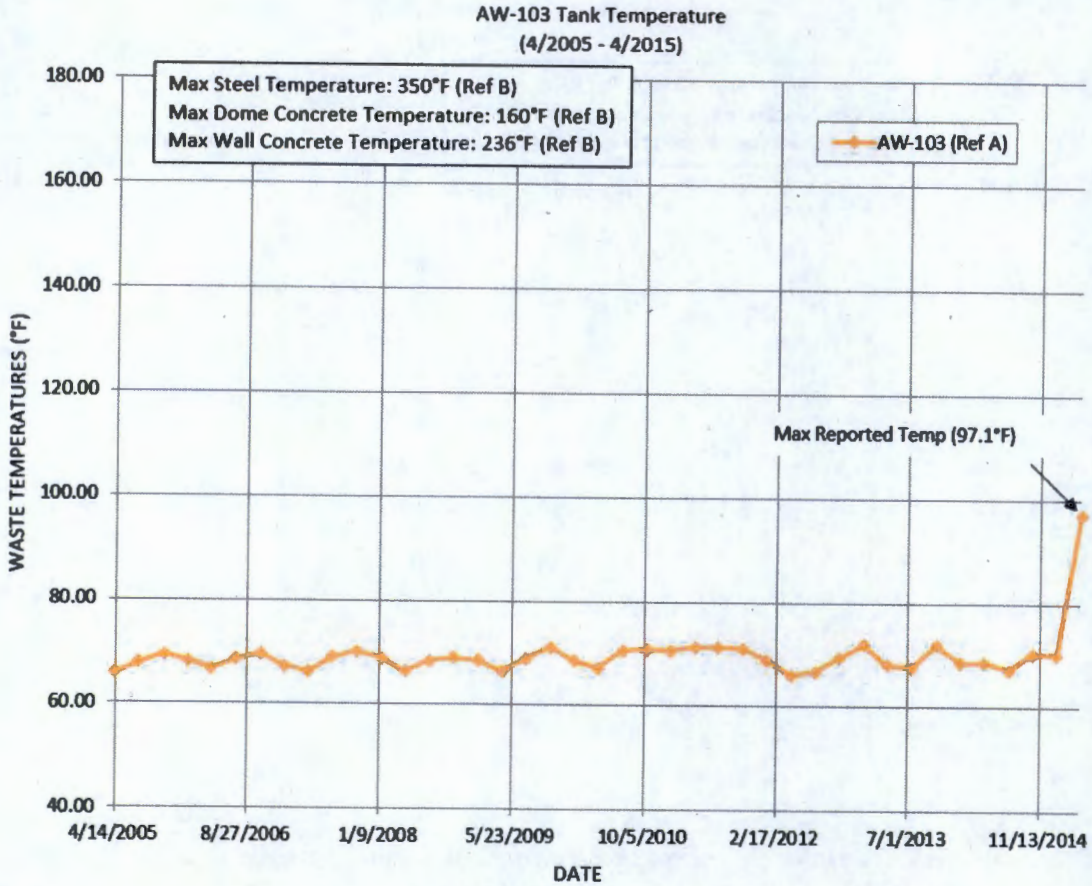

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-7: Tank AW-101 Temperature**



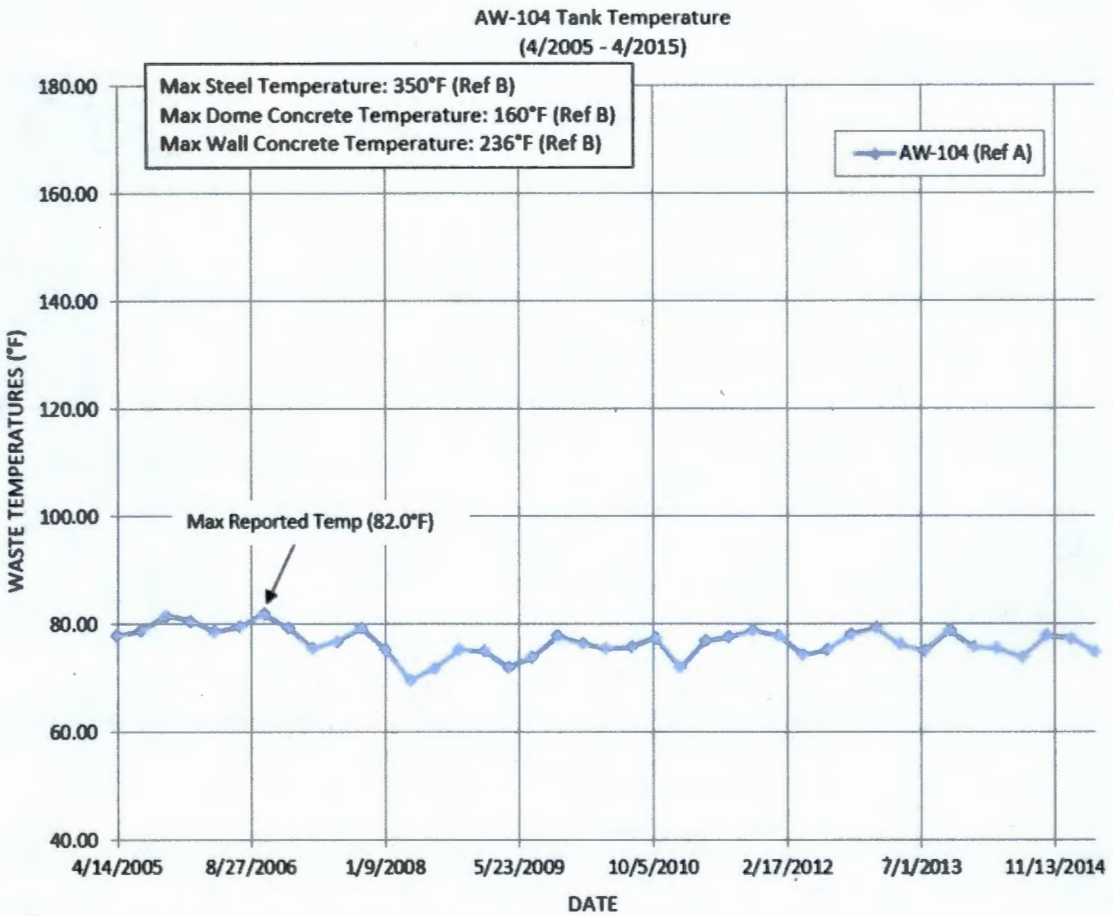

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-8: Tank AW-102 Temperature**



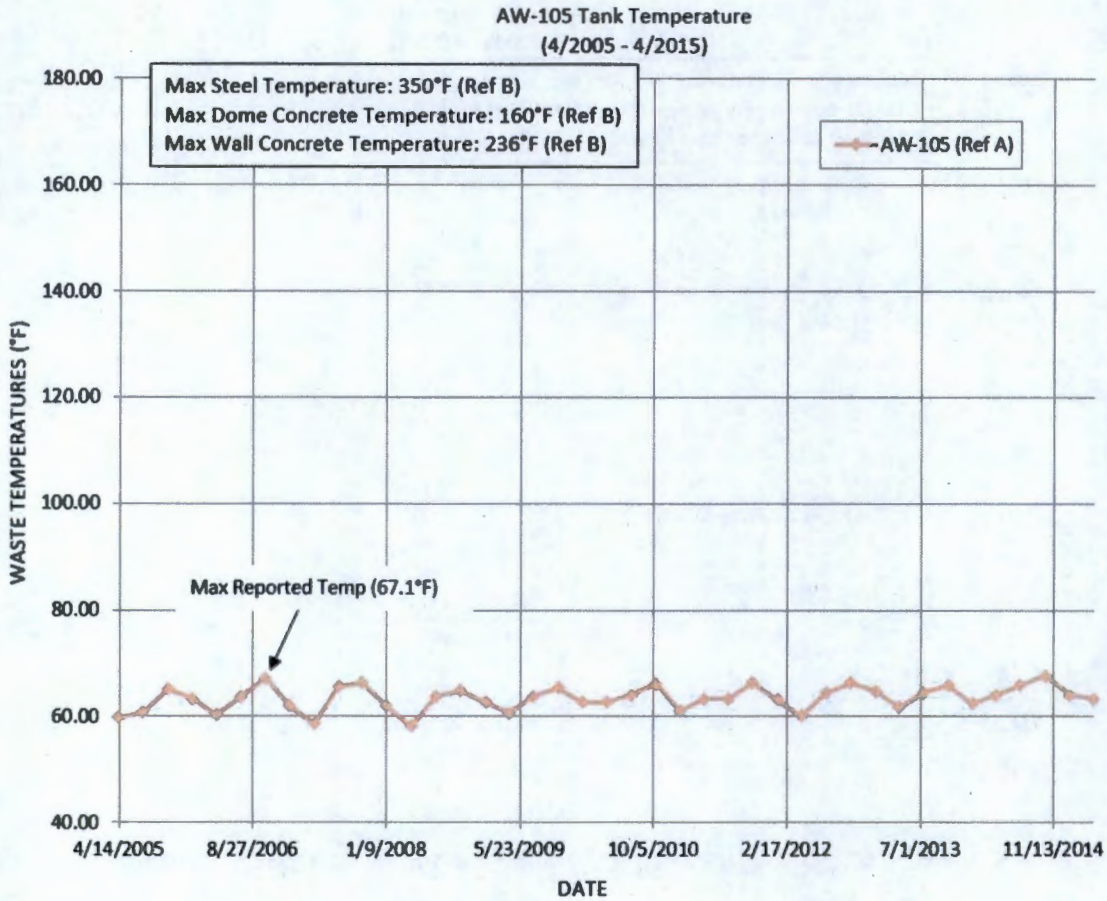

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-9: Tank AW-103 Temperature**



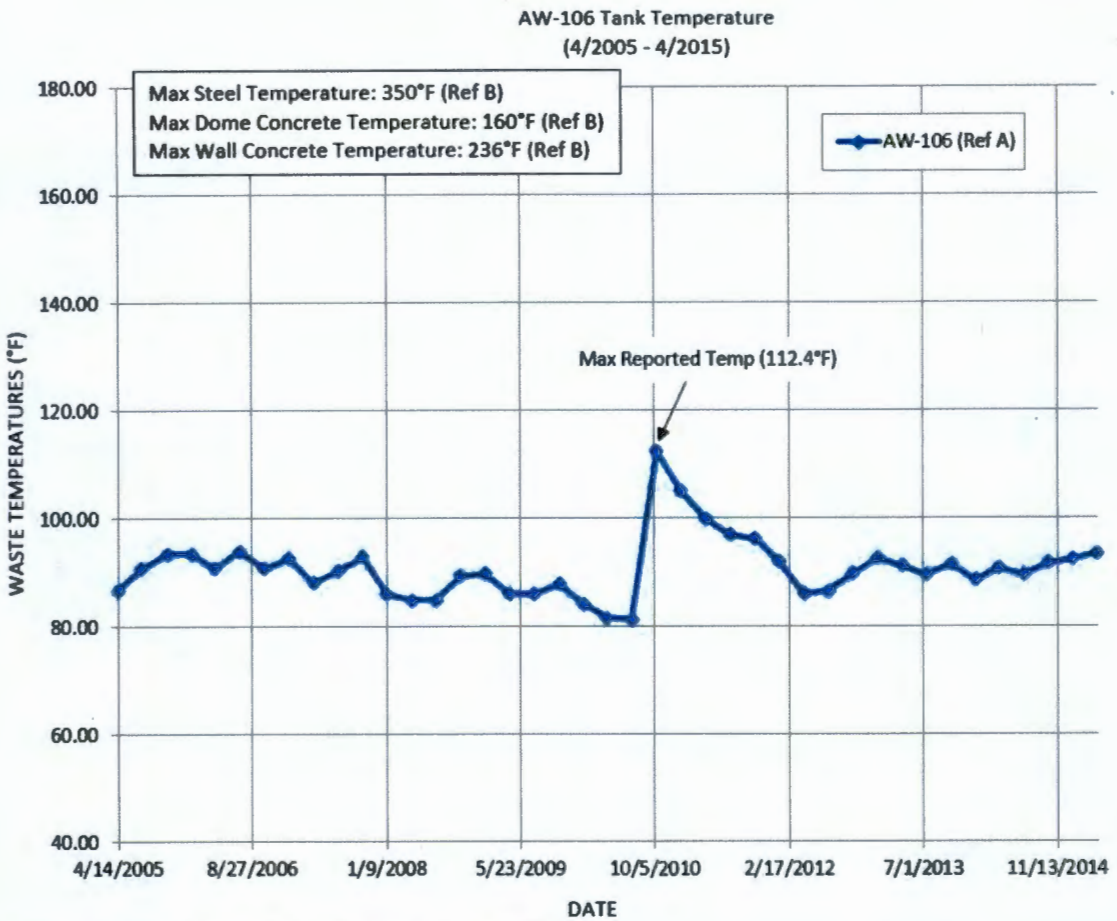

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-10: Tank AW-104 Temperature**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-11: Tank AW-105 Temperature**

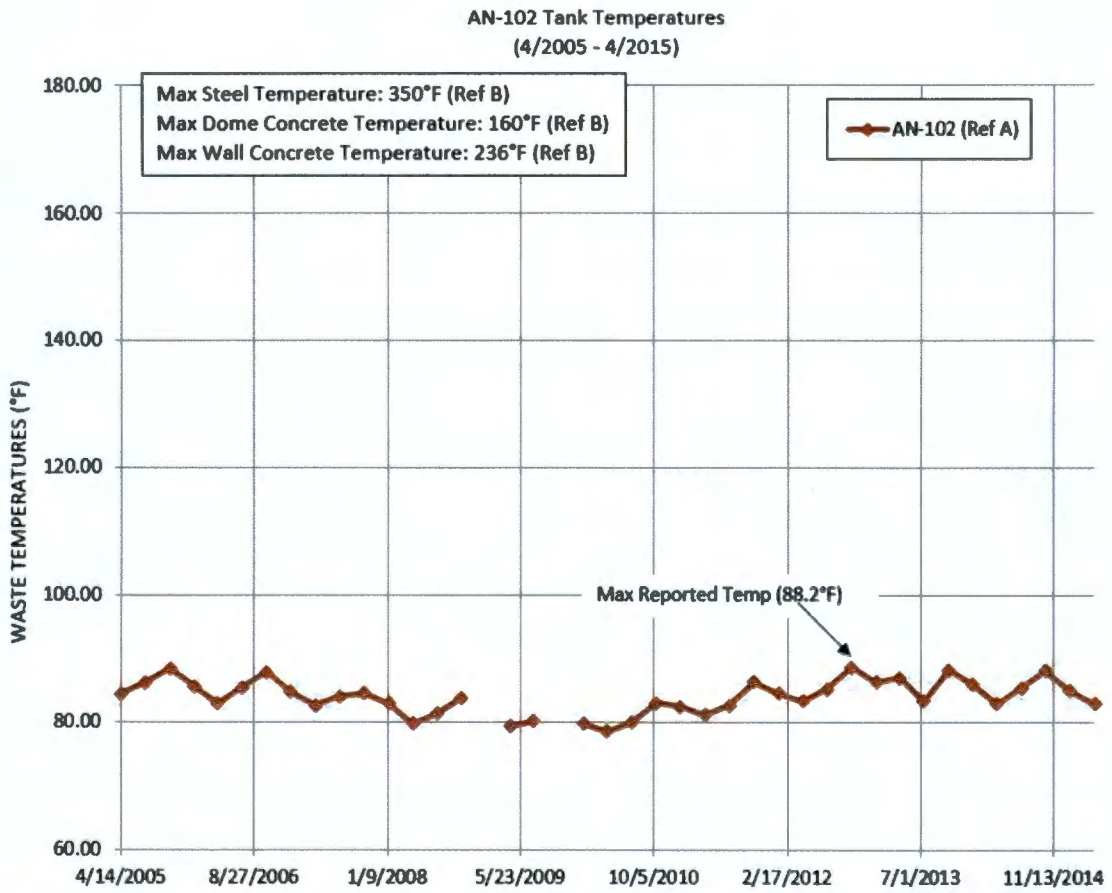



Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-12: Tank AW-106 Temperature**

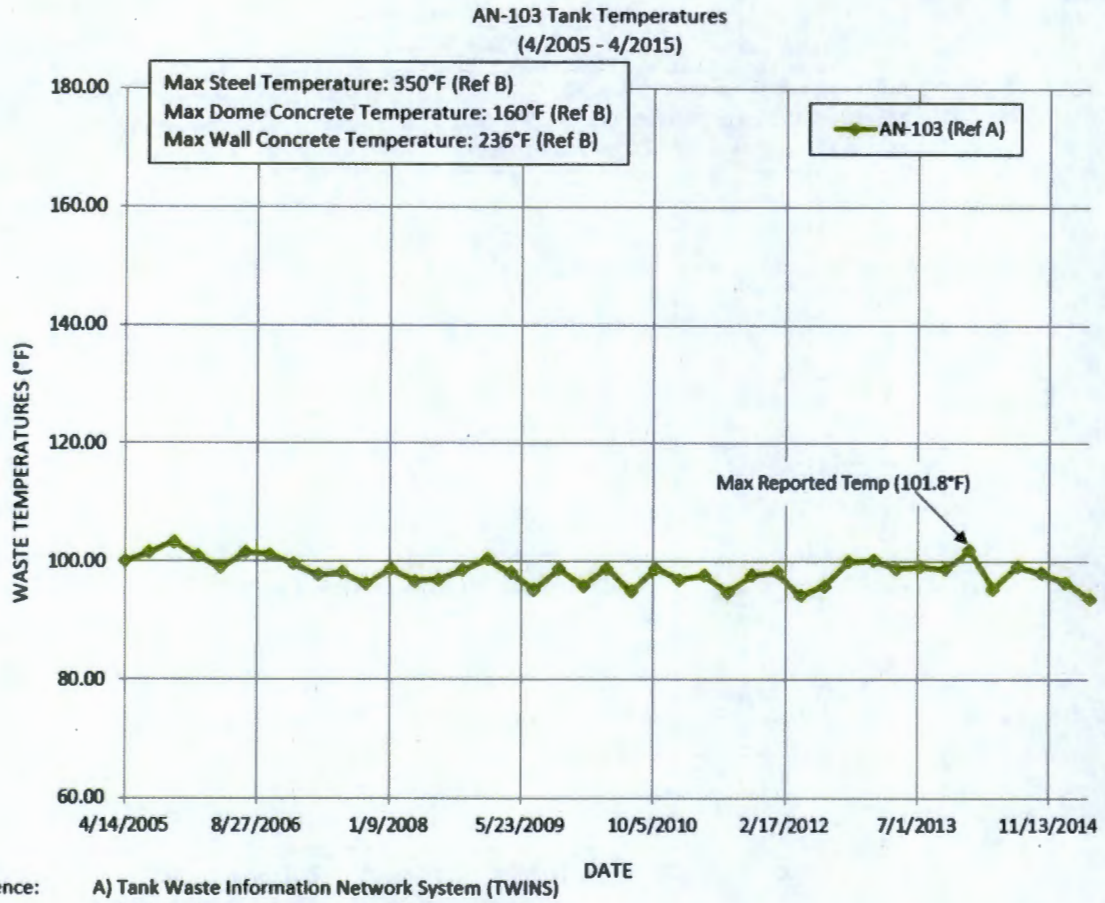
Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-13: Tank AN-101 Temperature**



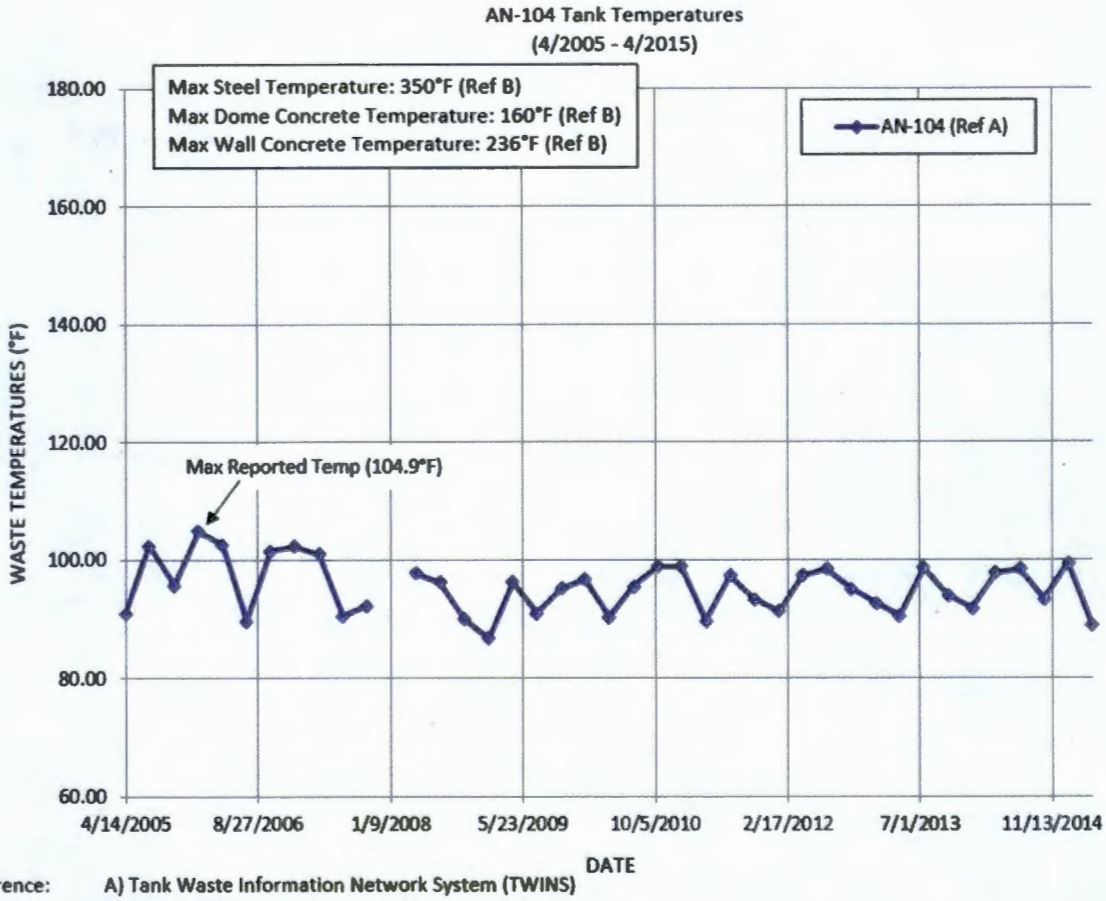

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-14: Tank AN-102 Temperature**



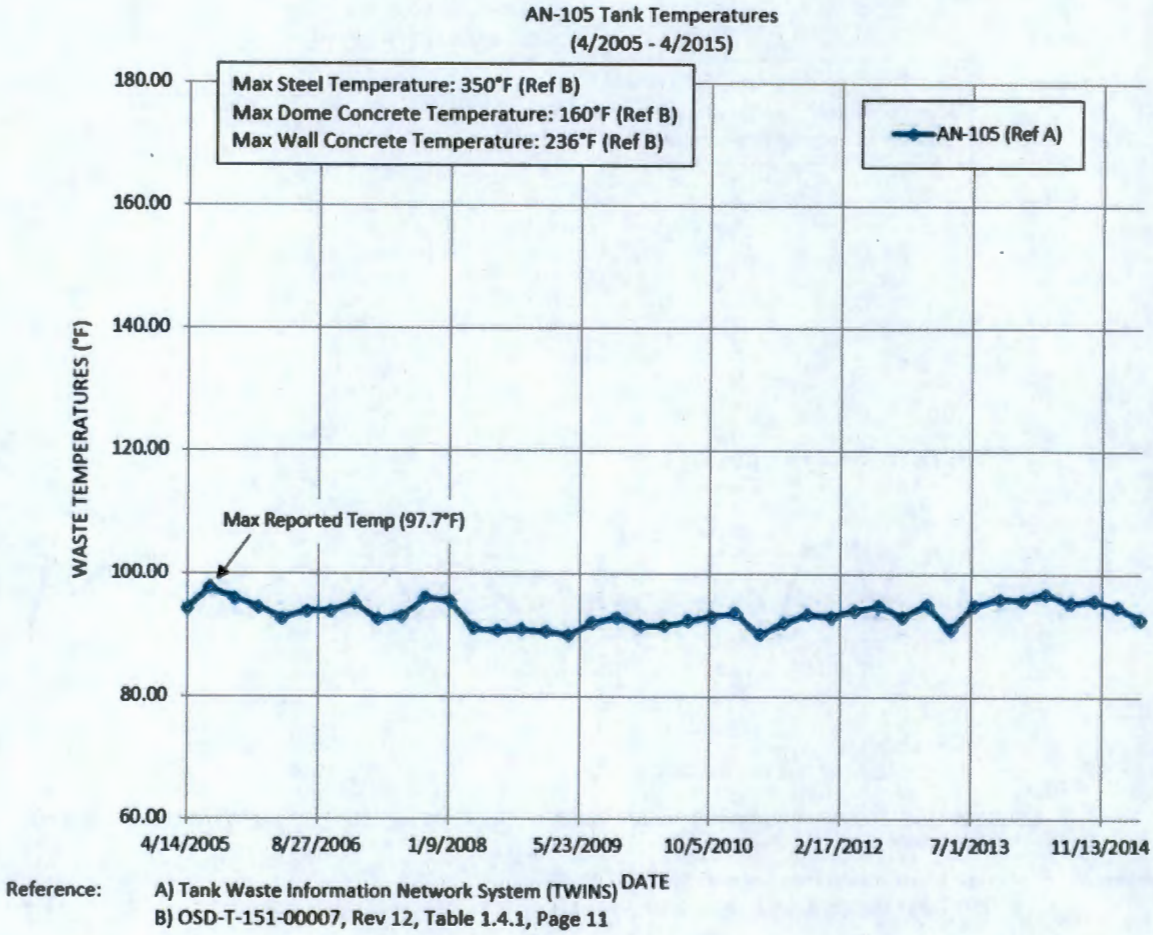

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-15: Tank AN-103 Temperature**



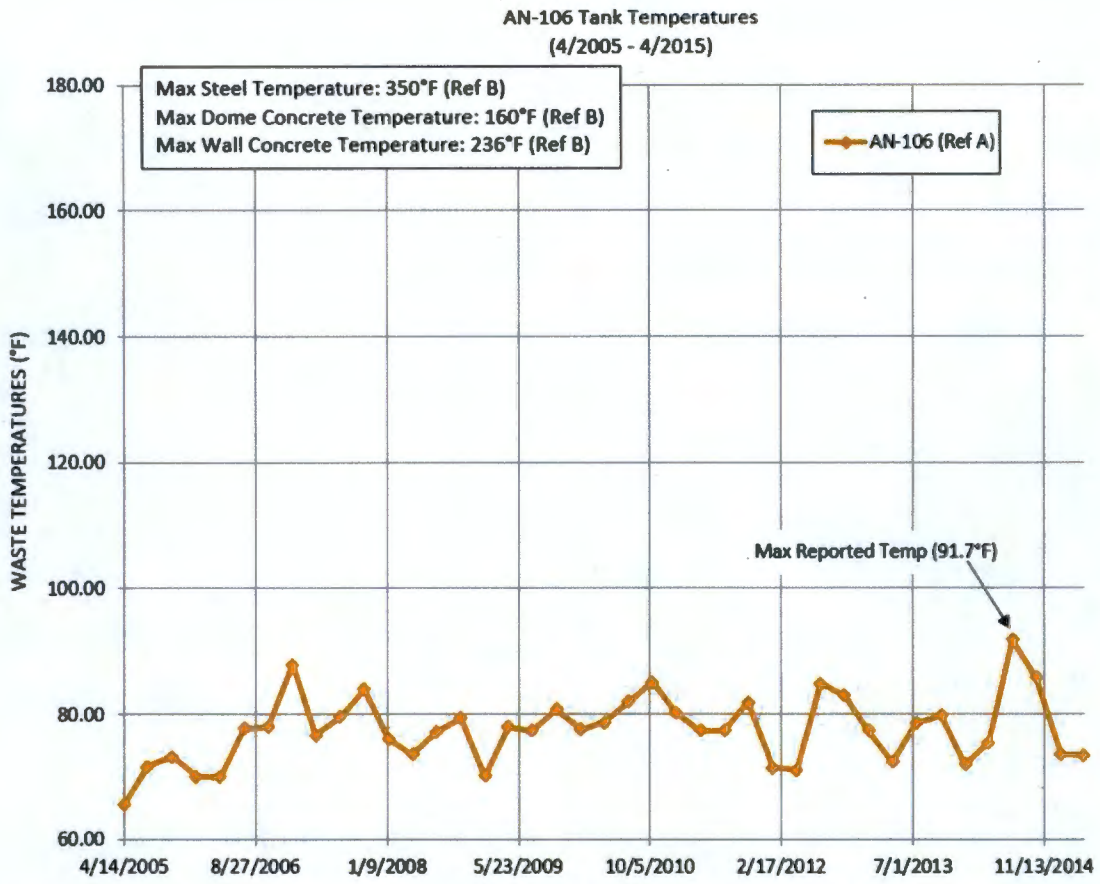

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-16: Tank AN-104 Temperature**



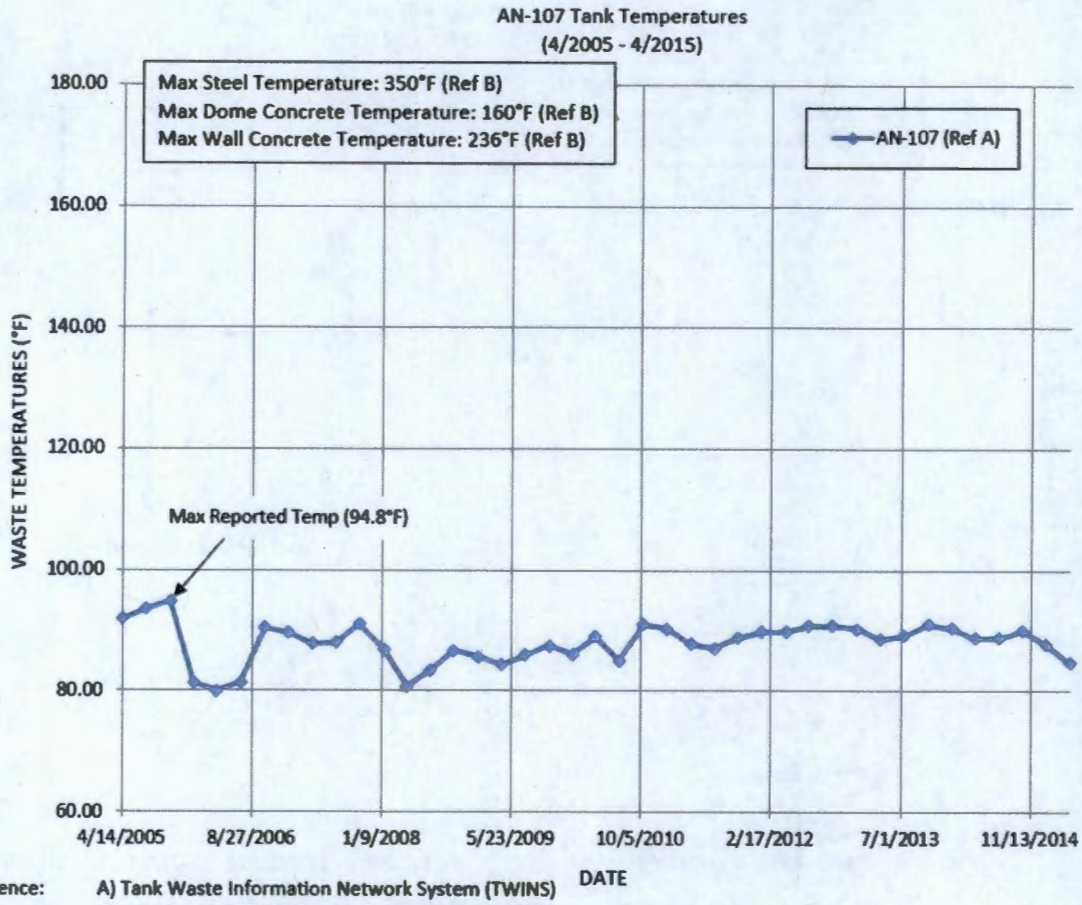

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-17: Tank AN-105 Temperature**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-18: Tank AN-106 Temperature**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-19: Tank AN-107 Temperature**

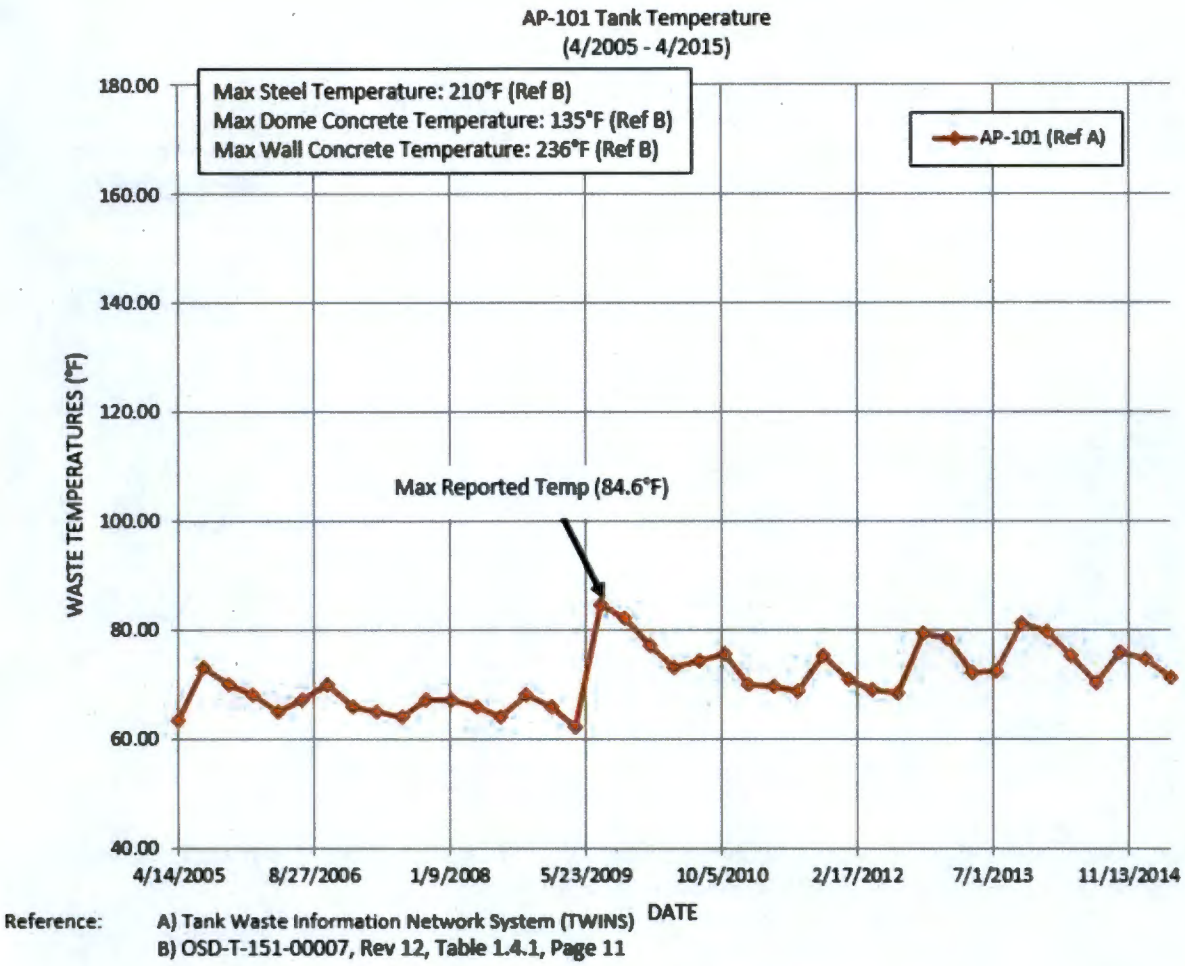
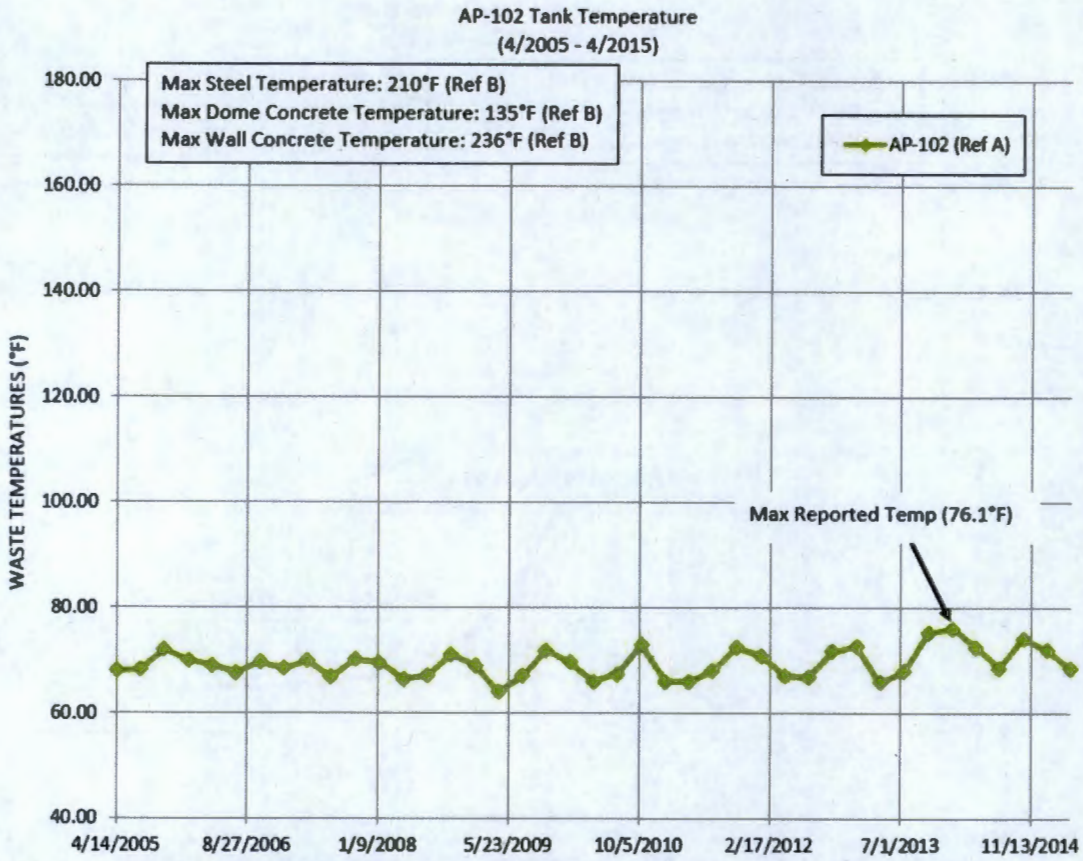
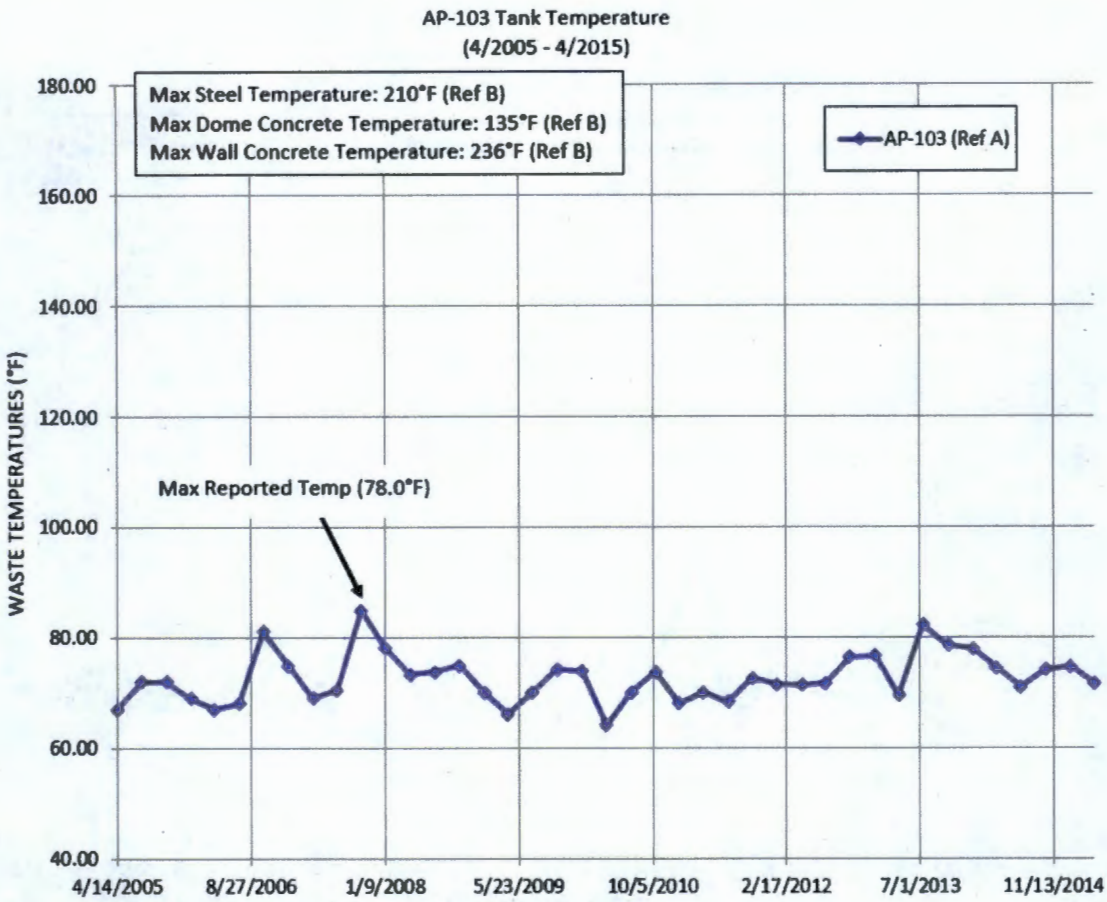



**Figure P-20: Tank AP-101 Temperature**



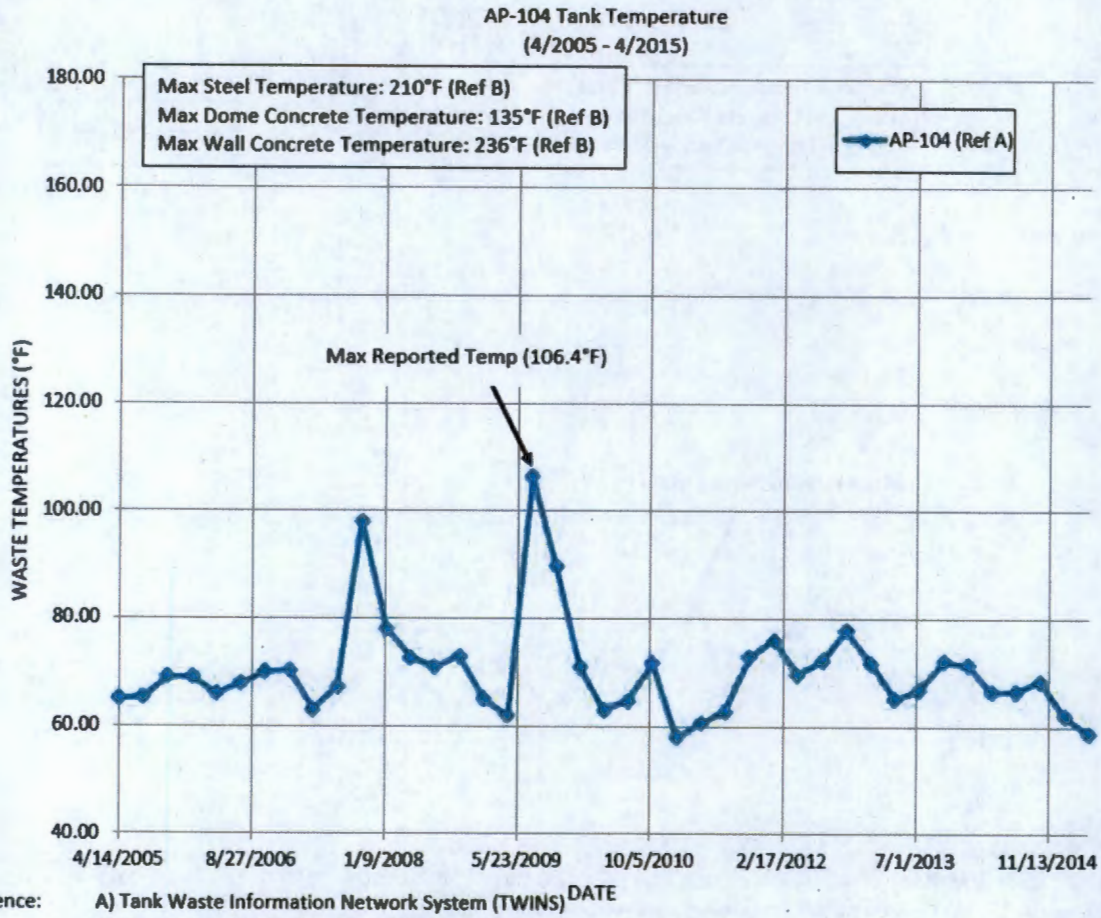

Reference: A) Tank Waste Information Network System (TWINS) DATE
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-21: Tank AP-102 Temperature**



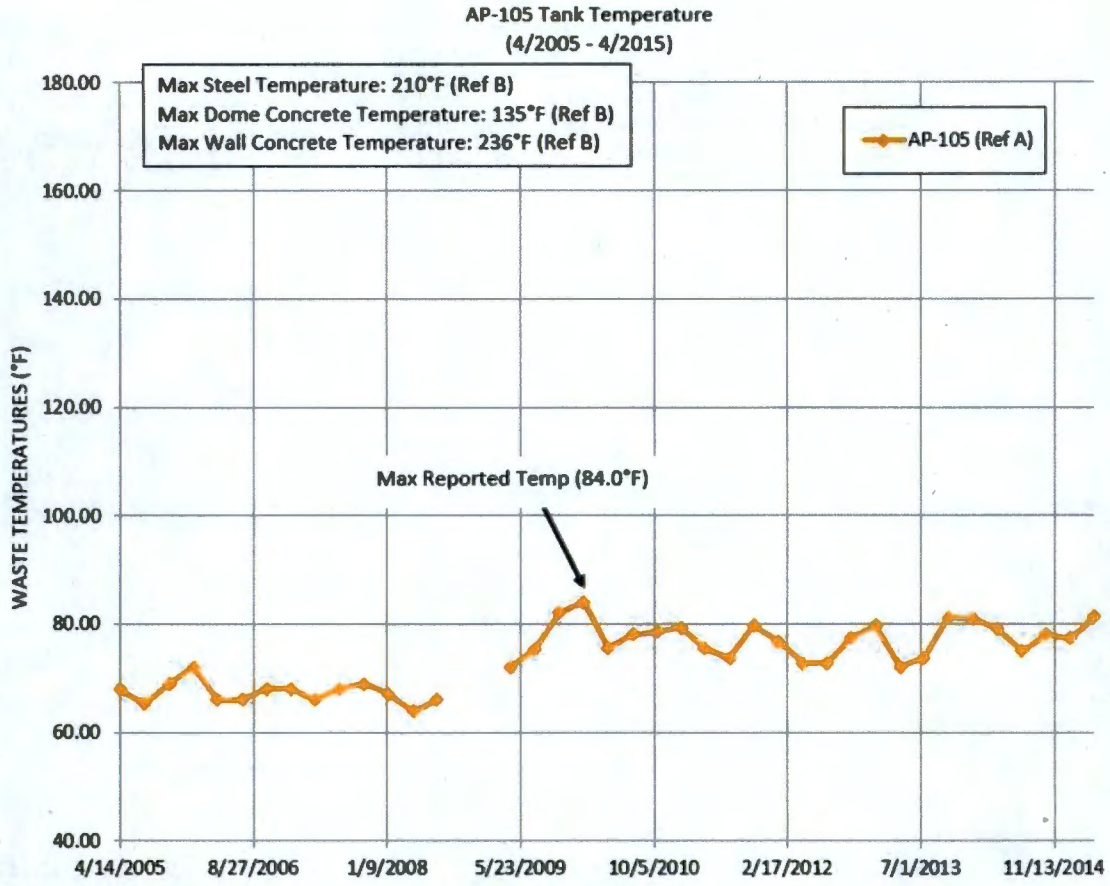

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-22: Tank AP-103 Temperature**



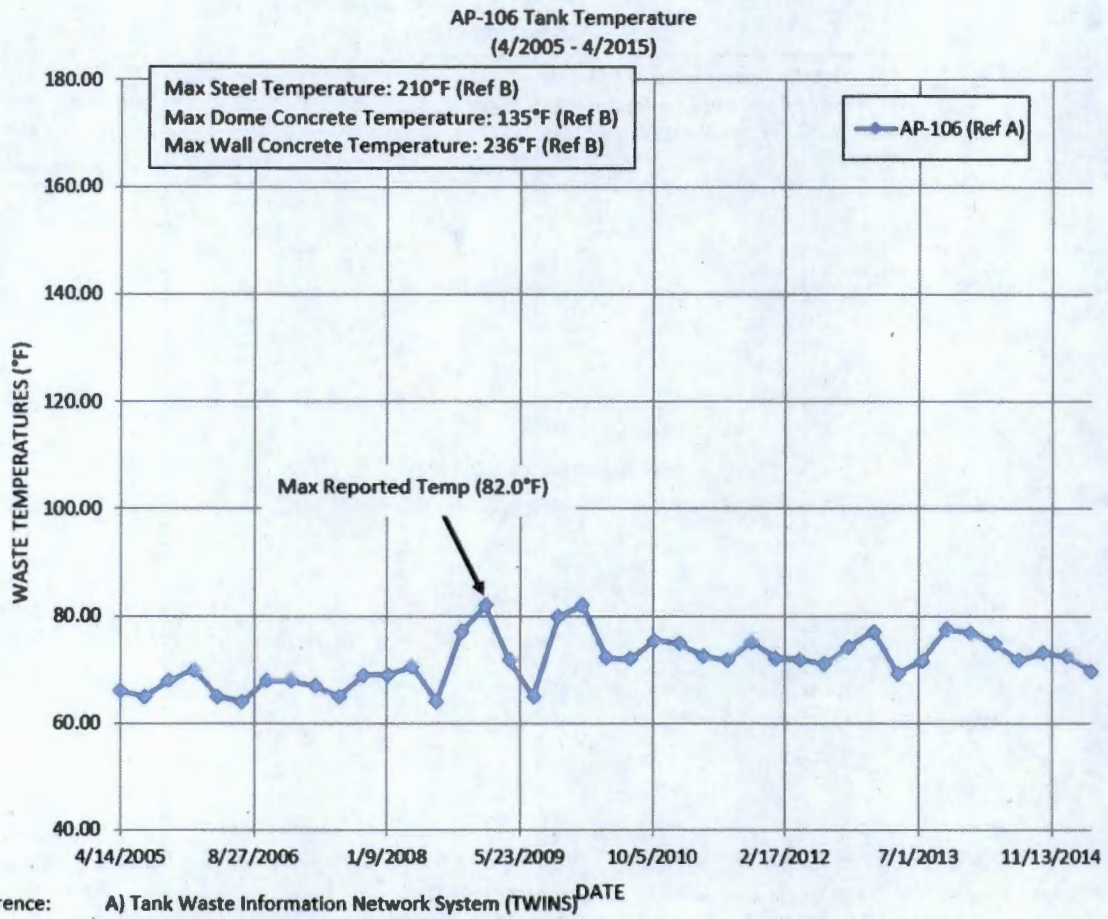

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-23: Tank AP-104 Temperature**



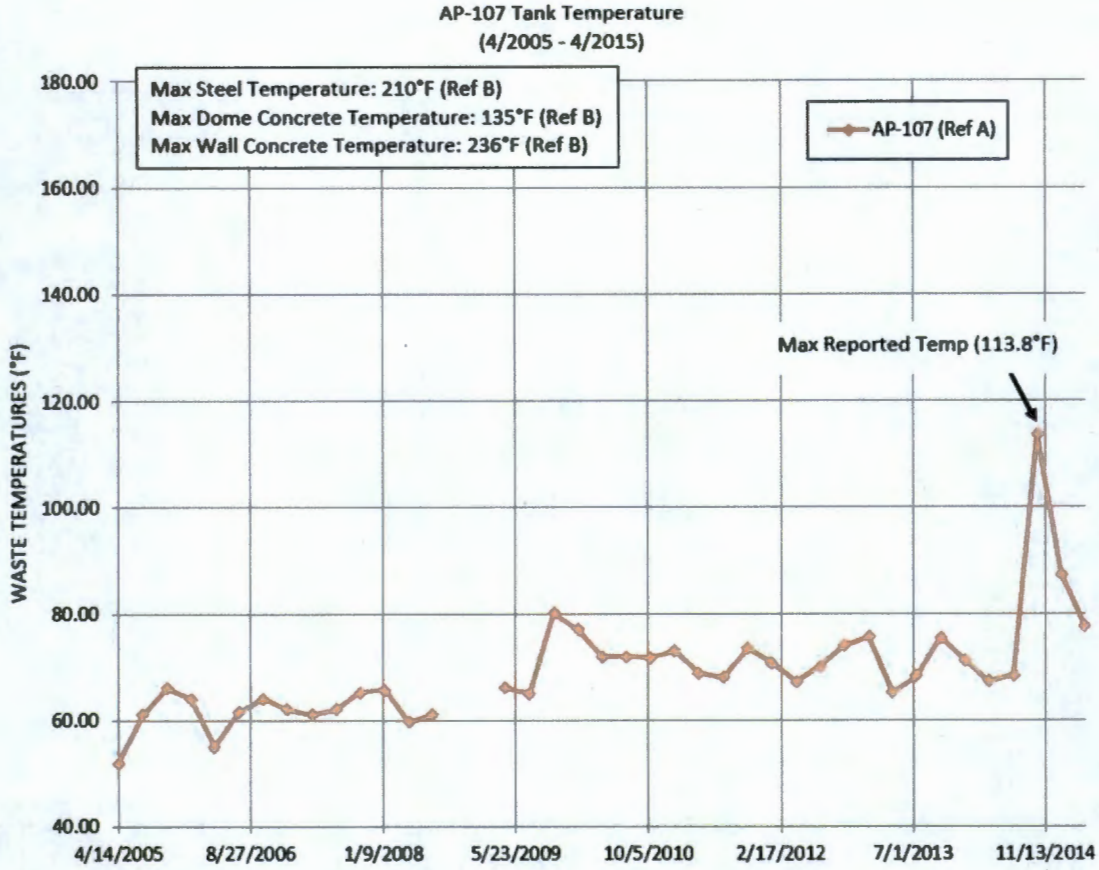

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-24: Tank AP-105 Temperature**



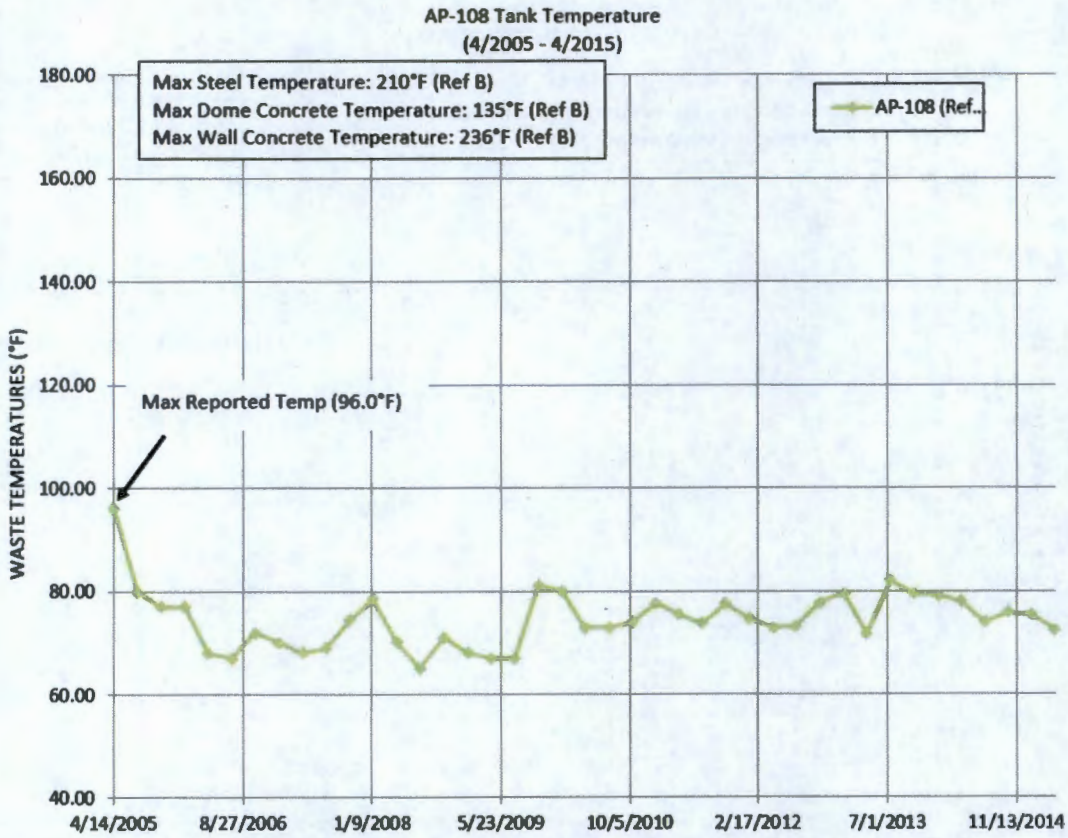

Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-25: Tank AP-106 Temperature**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-26: Tank AP-107 Temperature**




Reference: A) Tank Waste Information Network System (TWINS)
B) OSD-T-151-00007, Rev 12, Table 1.4.1, Page 11

**Figure P-27: Tank AP-108 Temperature**

# APPENDIX Q
# PIT CONSTRUCTION

# APPENDIX Q PIT CONSTRUCTION

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**Table Q-1: Construction Codes for Pits (5 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<br>241-AZ | AASHO T180-731 | Moisture-Density Relations of Soils Using a 10 lb ramer and 18 Inch Drop | B-101-C3,<br>B-109-C1 |
| 241-SY<br>241-AZ | AASHO T191-61 | Density of Soil In-Place by the Sand-Cone Method | B-101-C3,<br>B-109-C1 |
| 241-AW<br>241-AN<br>241-AP | ASTM D422-63 (1972) | Particle Size Analysis of Soils | B-120-C7,<br>B-130-C7,<br>B-340-C7 |
| 241-AW<br>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,<br>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 |
| 241-AW<br>241-AN | ASTM D1556-64 (1974) | Density of Soil In-Place by the Sand-Cone Method | B-120-C7,<br>B-130-C7 |
| 241-AW<br>241-AN | ASTM D2167-66 (1972) | Density of Soil In-Place by the Rubber Ballon Method | B-120-C7,<br>B-130-C7 |
| 241-AN<br>241-AP | ASTM D2049-69 | Relative Density of Cohesionless Soils | B-130-C7,<br>B-340-C7 |
| 241-AW<br>241-AN | ASTM D2922-71 (1976) | Density of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth) | B-120-C7,<br>B-130-C7 |
| 241-AP | ASTM D2922-81 | Density of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth) | B-340-C7 |
| 241-AW<br>241-AN | ASTM D3017-72 | Moisture Content of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth) | B-120-C7,<br>B-130-C7 |
| 241-AP | ASTM D3017-78 | Moisture Content of Soil and Soil Aggregate in Place by Nuclear Method (Shallow Depth) | B-340-C7 |
| 241-AW<br>241-AN | Title 29 CFR Part 1926 | Safety and Health Regulations for Construction | B-120-C7,<br>B-130-C7 |
| 241-AW<br>241-AN | Title 29 CFR Part 1926<br>Subpart P | Excavation, Trenching and Shoring | B-120-C7,<br>B-130-C7 |
| Cast-in-Place Concrete | | | |

## Table Q-1: Construction Codes for Pits (5 sheets)

| Farm/Pit | Code | Title | Specification |
|---|---|---|---|
| 241-AP | ACI 117-81 | Standard Tolerances for Concrete Construction and Materials | B-340-C7 |
| 241-SY<br>241-AZ | ACI 301-72 | Structural Concrete for Buildings | B-101-C3,<br>B-109-C1 |
| 241-AW<br>241-AN | ACI 301-72 (Revised 1975) | Structural Concrete for Buildings | B-120-C7,<br>B-130-C7 |
| 241-AP | ACI 301-72 (Revised 1981) | Structural Concrete for Buildings | B-340-C7 |
| 241-AW<br>241-AN<br>241-SY<br>241-AZ | ACI 305-72 | Recommended Practice for Hot Weather Concreting | B-120-C7,<br>B-130-C7,<br>B-101-C3,<br>B-109-C1 |
| 241-AW<br>241-AN | ACI 306-66 (Reaffirmed 1975) | Recommended Practice for Cold Weather Concreting | B-120-C7,<br>B-130-C7 |
| 241-AY<br>241-SY<br>241-AZ | ACI 306-66 | Recommended Practice for Cold Weather Concreting | HWS-7792,<br>B-101-C3,<br>B-109-C1 |
| 241-AY | ACI 315-65 | Manual of Standard Practice for Detailing Reinforced Concrete Structures | HWS-7792 |
| 241-AW<br>241-AN<br>241-SY<br>241-AZ | ACI 315-74 | Manual of Standard Practice for Detailing Reinforced Concrete Structures | B-120-C7,<br>B-130-C7,<br>B-101-C3,<br>B-109-C1 |
| 241-AY | ACI 318-65 | Building Code Requirements For Reinforced Concrete | HWS-7792 |
| 241-AW<br>241-AN | ACI 318-71 | Building Code Requirements For Reinforced Concrete | B-120-C7,<br>B-130-C7 |
| 241-AP | ACI 318-77 | Building Code Requirements For Reinforced Concrete | B-340-C7 |
| 241-AY | ACI 605-59 | Recommended Practice for Hot Weather Concreting | HWS-7792 |
| 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 |
| 241-AY | ASTM A305-65 | Minimum Requirements for Deformations of Deformed Steel Bars for Concrete Reinforcement | HWS-7792 |
| 241-AY | ASTM A432-66 | Deformed Billet-Steel Bars for Concrete Reinforcement with 60,000 PSI Minimum | HWS-7792 |

**Table Q-1: Construction Codes for Pits (5 sheets)**

| Farm/Pit | Code | Title | Specification |
|---|---|---|---|
| | | Yield Strength | |
| 241-AY | ASTM D41-41 | Primer for Use With Asphalt in Dampproofing and Waterproofing | HWS-7792 |
| 241-AY | ASTM D449-49 | Asphalt in 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<br>241-AN | ASTM A615-76a | Deformed and Plain Billet-Steel Bars for Concrete Reinforcement | B-102-C7,<br>B-130-C7 |
| 241-AP | ASTM A615-82 | Deformed and Plain Billet-Steel Bars for Concrete Reinforcement | B-340-C7 |
| 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 |
| 241-AP | ASTM C94-73a | Ready-Mixed Concrete | B-101-C3 |
| 241-AZ | ASTM C94-74 | Ready-Mixed Concrete | B-109-C1 |
| 241-AW<br>241-AN | ASTM C94-74a | Ready-Mixed Concrete | B-120-C7 |
| 241-AP | ASTM C94-83 | Ready-Mixed Concrete | B-340-C7 |
| 241-AZ | ASTM C150-74 | Portland Cement | B-109-C1 |
| 241-AW | ASTM 150-76a | 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 |
| 241-AP | ASTM C156-71 | Water Retention by Concrete Curing Materials | B-101-C3 |
| 241-AW<br>241-AN<br>241-AZ | ASTM C156-74 | Water Retention by Concrete Curing Materials | B-120-C7,<br>B-130-C7,<br>B-101-C1 |

## Table Q-1: Construction Codes for Pits (5 sheets)

| Farm/Pit | Code | Title | Specification |
|---|---|---|---|
| 241-AP<br>241-AZ | ASTM C260-73 | Air-Entraining Admixtures for Concrete | B-101-C3,<br>B-109-C1 |
| 241-AW<br>241-AN | ASTM C260-74 | Air-Entraining Admixtures for Concrete | B-120-C7,<br>B-130-C7 |
| 241-AP | ASTM C260-77 | Air-Entraining Admixtures for Concrete | B-340-C7 |
| 241-AZ | ASTM C494-71 | Chemical Admixtures For Concrete | B-109-C1 |
| 241-AP | ASTM C476-80 | Grout for Reinforced and Nonreinforced Masonry | B-340-C7 |
| 241-AW<br>241-AN | CRSI 1976 | Manual of Standard Practice Placing Reinforcing Bars | B-120-C7,<br>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<br>241-AN<br>241-AP<br>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,<br>B-130-C7,<br>B-340-C7,<br>B-101-C3 |
| 241-AW<br>241-AN | NRMCA 1976 | Certificate of Conformance for Concrete Production Facilities | B-120-C7,<br>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<br><br>Section II<br>Section IX | ASME Boiler and Pressure Vessel Code<br><br>Materials 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 Q-1: Construction Codes for Pits (5 sheets)**

| Farm/Pit | Code | Title | Specification |
|---|---|---|---|
| 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 | Specifications 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 Bar 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 |
| 241-AP | AWS D9.1-81 | Specification for Welding of Sheet Metal | B-340-C7 |
| 241-AP | AWS QC1-83 | Standard for Qualification and Certification of Welding Inspectors | B-340-C7 |

Reference: From 2006 DSTAR Volume 1, Table 6-2, rearranged.

**Table Q-2: Pit Calculation Parameters (2 sheets)**

| Calculation | Title | Design Inputs | Assessment |
|---|---|---|---|
| W314-C-020 | W-314 AY Pump Pit Upgrades - Pump Pit Structural Evaluation | $W_{concrete}$ = 150 lbf/ft$^3$<br>$E_s$ = 29E06 psi<br>$S_{yrebar}$ = 40,000 psi<br>$S_{c\ conc.\ Exist}$ = 3,000 psi<br>$W_{snow}$ = 20 psf<br>$W_{live}$ = 200 psf<br>$D_{soil}$ = 125 lb/ft$^3$<br>$W_{surcharge}$ = 100 psf<br>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 | W-314 AZ Pump Pit Upgrades - Pump Pit Structural Evaluation | $W_{concrete}$ = 150 lbf/ft$^3$<br>$E_s$ = 29E06 psi<br>$S_{yrebar}$ = 40,000 psi<br>$S_{c\ conc.\ Exist}$ = 3,000 psi<br>$W_{snow}$ = 20 psf<br>$W_{live}$ = 200 psf<br>$D_{soil}$ = 125 lb/ft3<br>$W_{surcharge}$ = 100 psf<br>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. |
| W314-C-054 | AW Valve Pit Structural Evaluation | $W_{concrete}$ = 150 lbf/ft$^3$<br>$E_s$ = 29E06 psi<br>$S_{ysteel}$ = 36,000 psi<br>$S_{usteel}$ = 58,000 psi<br>$S_{yrebar}$ = 60,000 psi<br>$S_{c\ conc.\ Exist}$ = 3,000 psi<br>$S_{c\ conc.\ New}$ = 4,000 psi<br>$W_{snow}$ = 20 psf<br>$W_{live}$ = 200 psf<br>$D_{soil}$ = 125 lb/ft3<br>$W_{surcharge}$ = 100 psf<br>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. |
| W314-C-001 | W-314 AN Valve Pit Upgrades - Valve Pit Structural Evaluation | $W_{concrete}$ = 150 lbf/ft$^3$<br>$E_s$ = 29E06 psi<br>$S_{ysteel}$ = 36,000 psi<br>$S_{usteel}$ = 58,000 psi<br>$S_{yrebar}$ = 60,000 psi<br>$S_{c\ conc.\ Wall}$ = 3,000 psi<br>$S_{c\ cvrblock}$ = 5,000 psi<br>$W_{snow}$ = 20 psf<br>$W_{live}$ = 200 psf<br>$D_{soil}$ = 125 lb/ft$^3$<br>$W_{surcharge}$ = 100 psf<br>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 | Pump Pits 01A & 04A Structural Evaluation | $W_{concrete}$ = 150 lbf/ft$^3$<br>$E_s$ = 29E06 psi<br>$S_{ysteel}$ = 36,000 psi<br>$S_{usteel}$ = 58,000 psi | Utilizes a 1.5 factor on peak horizontal and vertical acceleration at 5% damping as obtained from GC- |

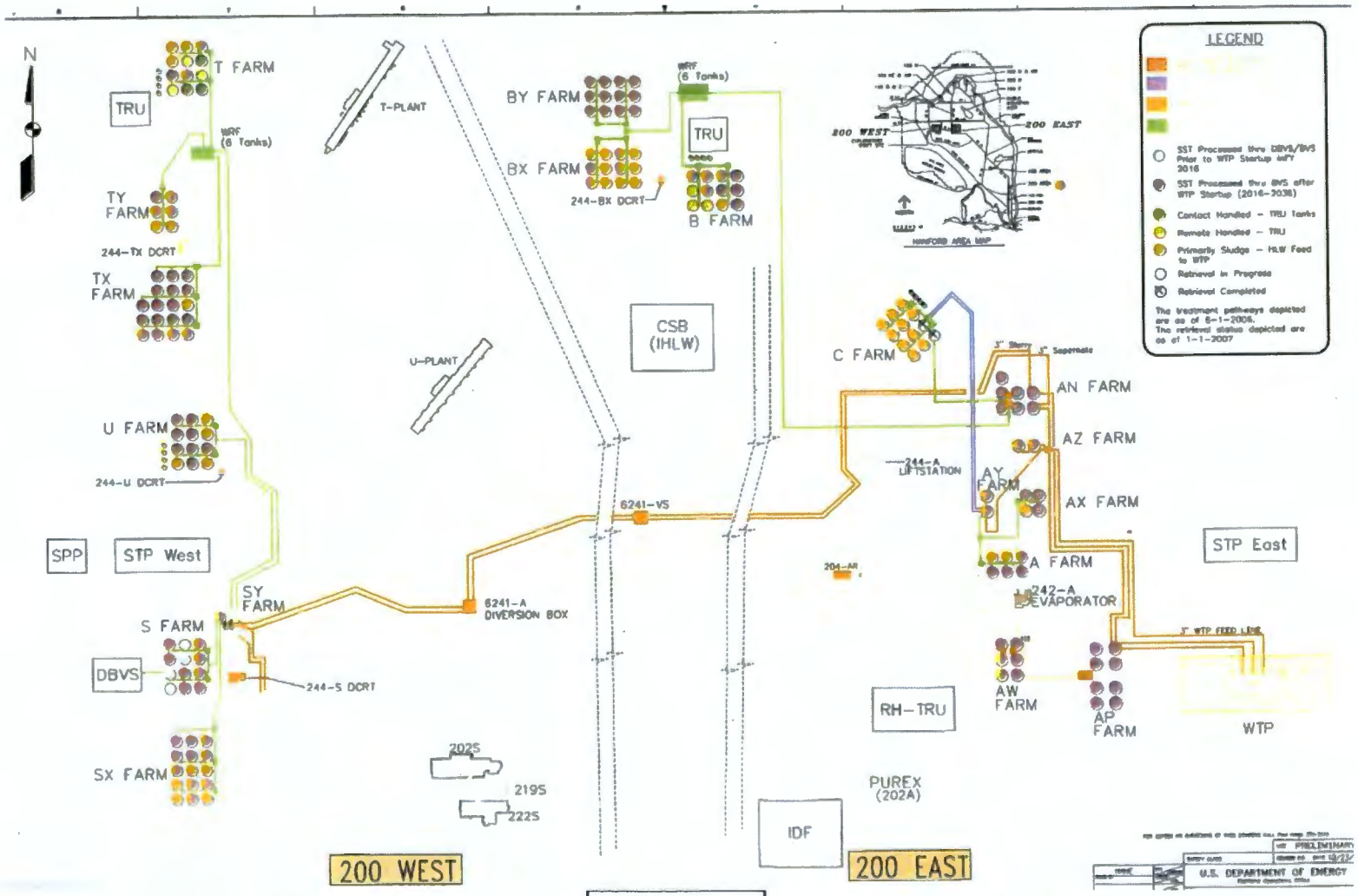
**Table Q-2: Pit Calculation Parameters (2 sheets)**

| Calculation | Title | Design Inputs | Assessment |
|---|---|---|---|
| | | $S_{yrebar}$ = 60,000 psi<br>$S_{c\ conc.\ exist}$ = 3,000 psi<br>$S_{c\ conc.\ new}$ = 5,000 psi<br>$W_{snow}$ = 20 psf<br>$W_{live}$ = 200 psf<br>$D_{soil}$ = 125 lb/ft3<br>$W_{surcharge}$ = 100 psf<br>Seismic Importance factor = 1.5 | LOAD-01 and UCRL-15910. |

Reference: From 2006 DSTAR Volume 1, Table 6-4, rearranged.

# APPENDIX R
# DOUBLE-SHELL TANK FARM MAPS

# APPENDIX R DOUBLE-SHELL TANK FARM MAPS




Note: This figure is diagrammatic and is presented for information only.

The Double-Shell Tank Interface Diagram, plotter size 36 × 103 in., is provided as a separate file to facilitate printing:
'Page R-3 DST Interface Diagram.pdf'

# APPENDIX S
# DOUBLE-SHELL TANK WASTE TRANSFER EQUIPMENT

# APPENDIX S DOUBLE-SHELL TANK WASTE TRANSFER EQUIPMENT

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## S.1 INTRODUCTION

The Double-Shell Tank (DST) Waste Transfer System (WTS) consists of a number of double-encased pipelines, pump and valve pits, pumps, jumpers, and valves. The WTS was reviewed in the 2008 IQRPE assessment and is described in RPP-27591, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*. All of the DST active system pipelines were constructed beginning in the late 1970s, and continuing through 2011, with the replacement of lines in the SY Farm.

The DST WTS is used intermittently and provides a means to convey waste between the tanks and process facilities. All waste transfer lines are designed with a secondary containment system capable of detecting and collecting releases and accumulated liquids in the event of a primary line failure. Included in the WTS are pumps, jumpers, valves, actuators, and piping. The components in the DST WTS are defined in RPP-RPT-52790, *Tank Farm Waste Transfer System Fitness-for-Service Annual Status Report*. Table S-1 summarizes the DST configurations identified in RPP-41049, *Integrated Waste Feed Delivery Plan*.

## S.2 RISERS, PUMP PITS, VALVE PITS

Between 59 and 126 steel riser pipes penetrate the concrete dome and the top of the primary tank and secondary liner. The risers provide access to the primary tank and the annulus space for waste transfer operations, equipment installation, and monitoring. The risers are accessible from covered pits or at grade-level at specific locations.

Concrete valve pits located above the concrete dome provide access to pipelines, used for transferring liquid waste between tanks. The pits are also used for structural support, allowing the use of large pumps and other equipment. The largest risers in the tanks lead to the pump pits. These pits are kept covered with large concrete blocks to prevent personnel exposure to radioactive materials.

A typical central pump pit consists of a waste transfer pump, a jumper connecting the pump discharge to the pit wall nozzles, a drain, and leak detection. With some similarity, the valve pits consist of multiple jumpers, a drain, and leak detection. The waste transfer pumps in the DST system are most commonly vertical turbine pump with rigid intake; however, there are some submersible pumps.

The scope of the IQRPE review includes all of the active pump pits, valve pits, and leak detection pits. There are some inactive sluice pits on the DTSs that are not part of the scope. The pit inspection approach is defined in RPP-56942, *Tank Farms Waste Transfer Pit Special Protective Coatings Inspection Program Plan*.

## S.3 VALVES AND ACTUATORS

The WTS uses primarily two-way or three-way ball valves. Both T-port and L-port valve configurations are used for the three-way valves. Valve positioning is achieved by valve stops, T-handle, or gear actuator.

**Table S-1: Basic Double-Shell Tank Configuration Identified in the Integrated Waste Feed Delivery Plan**

| Tank details[a] | | | | | | Pump configuration | | | | | Other | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tank[a] | Volume kgal | Construct date | ALCs | Sidefill lines | Sluice pits | Mixer pumps | Incremental lowering? | Transfer basic | Transfer decant | Transfer slurry | Sample loop | Decant capability | Deep sludge? | Sludge capable |
| AN-101 | 1,160 | 1981 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| AN-102 | 1,160 | 1981 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AN-103 | 1,160 | 1981 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AN-104 | 1,160 | 1981 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AN-105 | 1,160 | 1981 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AN-106 | 1,160 | 1981 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| AN-107 | 1,160 | 1981 | ✓ | | | 1 | | ✓ | | | | ✓ | | |
| AP-101 | 1,160 | 1986 | | | | | | ✓ | | | | ✓ | | |
| AP-102 | 1,160 | 1986 | | | | | | ✓ | | | | ✓ | | |
| AP-103 | 1,257 | 1986 | | | | | | ✓ | | | | ✓ | | |
| AP-104 | 1,160 | 1986 | | | | | | ✓ | | | | ✓ | | |
| AP-105 | 1,160 | 1986 | | | | 1 | | ✓ | | | | ✓ | | |
| AP-106 | 1,160 | 1986 | | | | | | ✓ | | | | ✓ | | |
| AP-107 | 1,160 | 1986 | | | | | | ✓ | | | | ✓ | | |
| AP-108 | 1,257 | 1986 | | | | 1 | | ✓ | | | | ✓ | | |
| AW-101 | 1,160 | 1980 | | | | 1 | ✓ | ✓ | | | | ✓ | | |
| AW-102 | 1,160 | 1980 | ✓ | | | 1 | | ✓ | | | | ✓ | | |
| AW-103 | 1,160 | 1980 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AW-104 | 1,160 | 1980 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AW-105 | 1,160 | 1980 | | | | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AW-106 | 1,160 | 1980 | | | | 1 | | ✓ | | | | x | | |
| AY-101 | 1,018 | 1971 | ✓ | ✓ | ✓ | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| *AY-102* | *1,018* | *1976* | ✓ | ✓ | ✓ | *2* | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| AZ-101 | 1,018 | 1975 | ✓ | ✓ | ✓ | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| AZ-102 | 1,018 | 1976 | ✓ | ✓ | ✓ | 2 | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SY-101 | 1,160 | 1977 | | | | 1 | | ✓ | | | | ✓ | | |
| SY-102 | 1,160 | 1977 | ✓ | | | 2 | ✓ | | ✓ | ✓ | | ✓ | | ✓ |
| SY-103 | 1,160 | 1977 | | | | 2 | ✓ | | ✓ | ✓ | | ✓ | | ✓ |

[a] RPP-40149, *Integrated Waste Feed Delivery Plan*, Volume 1, "Process Strategy, and Volume 2, "Campaign Plan," Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

## S.4 JUMPERS

Pump and valve pit jumpers are considered part of the WTS. The jumpers are used to direct waste transfers by connecting various nozzles within the pits, thereby directing the waste to different locations.

Jumpers are attached to the wall nozzles via PUREX connectors (Figure S-1). These connectors provide the clamping force to maintain a seal between the connector block and the nozzle. Jumpers are located inside concrete pits that are designed to contain and detect a leak in the event of a jumper failure.

**Figure S-1: PUREX Connector Jumper**

The rigid jumpers in the DST system are made of either carbon or stainless steel. Older jumpers installed as part of the original DST construction are typically made of ASTM A53 Type S Grade B, Schedule 40 carbon steel. The jumpers were designed and fabricated in accordance with ASME B31.1, *Power Piping*, or B31.3, *Process Piping*. The new rigid jumpers installed in the DST system are typically ASTM A312 GR TP 304L stainless steel, designed and fabricated in accordance with ASME B31.3.

Flexible jumpers found in the DST system can be either metallic or nonmetallic. Metallic flexible hose has a corrugated hose section typically of ASTM A240 316L and hose braiding typically of ASTM A580 304. The nonmetallic flexible hose is made of ethylene propylene diene monomer (EPDM).

## S.5 PIPES

The WTS piping is a pipe-in-pipe design. The supernatant pipelines are 3-in. Schedule 40 primary pipe with a 6-in. Schedule 40 encasement. The slurry lines are generally a 2-in. Schedule 40 primary pipe with a 4-in. Schedule 40 encasement. All of the pipelines were designed, fabricated, and installed in accordance with ASME B31.1 or B31.3. They are made of either a carbon steel (ASTM A53 Type S Grade B or ASTM A106 Grade B) or stainless steel (ASTM A312 Grade TP304L) primary pipe. All encasements are carbon steel. The newer pipelines (Projects W-058, W-211, W-314, and W-566) typically have a stainless steel primary pipe.

All piping encasements feature a protective coating. Most have factory-applied coal-tar enamel and a sprayed polyurethane insulation. The newer pipelines in the DST system are installed with a special coating system considered waterproof, which reduces the need for cathodic protection (some of these lines do have cathodic protection). The system consists of an epoxy coating bonded to the external surface of the encasement pipeline, a high-density foam layer covering the epoxy coating, and a protective fiberglass-reinforced plastic covering the foam. The design of the coating system was derived from the Steel Tank Institute ACT-100®

® ACT-100 is a registered trademark of Steel Tank Institute/Steel Plate Fabricators Association.

specification for underground storage tanks installed without cathodic protection. Two of the transfer lines for lab waste are fiberglass with a fiberglass pit identified as a siphon station.

Waste transfer piping is typically buried at a depth of 2.5 to 4.0 ft. RPP-18652, *Buried Pipe Analysis for DST System Integrity*, identifies the burial depths of the specific drain, slurry, and supernatant pipelines of the DSTs.

## S.6 REFERENCES

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RPP-RPT-52790, *Tank Farm Waste Transfer System Fitness-for-Service Annual Status Report*, Washington River Protection Solutions, LLC, Richland, Washington.

# APPENDIX T
# DOUBLE-SHELL TANK WASTE TRANSFERS AND ADDITIONS

# APPENDIX T DOUBLE-SHELL TANK WASTE TRANSFERS AND ADDITIONS

## LIST OF TABLES

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Table T-3: Volume Transfer Matrix into and out of the Double-Shell Tanks (kgal) ..... T-23

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 4/6/2006 | 4/28/2006 | 825 | 241-C-103 | 241-AN-106 | 22 |
| Generator Transfer | 4/13/2006 | 4/28/2006 | 1135 | Raw Water | 241-SY-102 | 1 |
| Generator Transfer | 4/1/2006 | 4/30/2006 | 606 | Evaporator Water | 241-AW-102 | 30 |
| Generator Transfer | 5/1/2006 | 5/1/2006 | 354 | Raw Water | 241-AP-107 | 12 |
| Generator Transfer | 5/1/2006 | 5/1/2006 | 1133 | Raw Water | 241-SY-101 | 3 |
| Tank Transfer In | 5/2/2006 | 5/12/2006 | 1120 | 241-SY-101 | 241-AP-107 | 767 |
| Tank Transfer Out | 5/2/2006 | 5/12/2006 | 366 | 241-SY-101 | 241-AP-107 | 767 |
| Generator Transfer | 5/12/2006 | 5/12/2006 | 1129 | Raw Water | 241-AP-107 | 9 |
| Generator Transfer | 5/12/2006 | 5/12/2006 | 372 | Raw Water | 241-SY-101 | 6 |
| Tank Transfer In | 5/16/2006 | 5/22/2006 | 1054 | 241-SY-102 | 241-SY-101 | 682 |
| Tank Transfer In | 5/16/2006 | 5/22/2006 | 1224 | 241-S-112 | 241-SY-102 | 88 |
| Tank Transfer Out | 5/16/2006 | 5/22/2006 | 542 | 241-SY-102 | 241-SY-101 | 682 |
| Generator Transfer | 5/4/2006 | 5/26/2006 | 1136 | Raw Water | 241-SY-102 | 8 |
| Tank Transfer In | 6/1/2006 | 6/21/2006 | 563 | 241-S-112 | 241-SY-102 | 21 |
| Generator Transfer | 6/1/2006 | 6/21/2006 | 564 | Raw Water | 241-SY-102 | 1 |
| Tank Transfer In | 6/7/2006 | 6/30/2006 | 838 | 241-C-103 | 241-AN-106 | 11 |
| Generator Transfer | 7/20/2006 | 7/20/2006 | 1055 | Flush Water | 241-SY-101 | 1 |
| Tank Transfer In | 7/21/2006 | 7/21/2006 | 863 | 241-C-103 | 241-AN-106 | 24 |
| Generator Transfer | 7/21/2006 | 7/21/2006 | 1094 | Raw Water | 241-AP-102 | 1 |
| Tank Transfer In | 7/23/2006 | 7/31/2006 | 867 | 241-C-204 | 241-AN-106 | 4 |
| Generator Transfer | 8/2/2006 | 8/2/2006 | 1024 | Raw Water | 241-AP-108 | 1 |
| Tank Transfer In | 8/2/2006 | 8/17/2006 | 876 | 241-C-204 | 241-AN-106 | 9 |
| Generator Transfer | 8/10/2006 | 8/18/2006 | 607 | Raw Water | 241-AW-102 | 1 |
| Generator Transfer | 8/18/2006 | 8/18/2006 | 1130 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 8/22/2006 | 8/22/2006 | 1058 | Flush Water | 241-SY-101 | 2 |
| Tank Transfer In | 8/23/2006 | 8/23/2006 | 903 | 241-C-103 | 241-AN-106 | 27 |
| Tank Transfer In | 8/29/2006 | 8/31/2006 | 613 | 241-S-112 | 241-SY-102 | 51 |
| Tank Transfer Out | 8/31/2006 | 8/31/2006 | 584 | 241-AW-102 | 242A | 23 |
| Tank Transfer In | 9/1/2006 | 9/8/2006 | 1140 | 242A | 241-AP-103 | 247 |
| Tank Transfer Out | 9/1/2006 | 9/12/2006 | 50 | 241-AW-102 | 242A | 534 |
| Generator Transfer | 9/1/2006 | 9/12/2006 | 81 | Evaporator Water | 241-AW-102 | 31 |
| Tank Transfer In | 9/1/2006 | 9/12/2006 | 669 | 241-S-112 | 241-SY-102 | 57 |
| Tank Transfer In | 9/8/2006 | 9/12/2006 | 1055 | 242A | 241-AP-108 | 31 |
| Tank Transfer In | 9/6/2006 | 9/21/2006 | 909 | 241-C-204 | 241-AN-106 | 6 |
| Generator Transfer | 9/11/2006 | 9/24/2006 | 1065 | Raw Water | 241-AN-102 | 2 |
| Tank Transfer In | 10/2/2006 | 10/2/2006 | 678 | 241-S-112 | 241-SY-102 | 9 |
| Generator Transfer | 10/17/2006 | 10/23/2006 | 294 | NaOH | 241-AY-101 | 36 |

## Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 10/18/2006 | 10/23/2006 | 295 | Raw Water | 241-AY-101 | 1 |
| Tank Transfer In | 10/18/2006 | 10/30/2006 | 746 | 241-S-102 | 241-SY-102 | 68 |
| Tank Transfer In | 10/17/2006 | 10/31/2006 | 918 | 241-C-204 | 241-AN-106 | 9 |
| Generator Transfer | 11/14/2006 | 11/16/2006 | 770 | NaOH | 241-SY-102 | 22 |
| Tank Transfer Out | 11/16/2006 | 11/20/2006 | 521 | 241-AN-106 | 241-AW-102 | 416 |
| Tank Transfer In | 11/16/2006 | 11/20/2006 | 496 | 241-AN-106 | 241-AW-102 | 416 |
| Tank Transfer In | 11/1/2006 | 11/30/2006 | 929 | 241-C-204 | 241-AN-106 | 12 |
| Generator Transfer | 11/16/2006 | 11/30/2006 | 937 | Raw Water | 241-AN-106 | 8 |
| Tank Transfer Out | 11/30/2006 | 11/30/2006 | 481 | 241-AN-106 | 241-AW-102 | 40 |
| Tank Transfer In | 11/30/2006 | 11/30/2006 | 536 | 241-AN-106 | 241-AW-102 | 40 |
| Tank Transfer Out | 12/1/2006 | 12/8/2006 | 166 | 241-AN-106 | 241-AW-102 | 315 |
| Tank Transfer In | 12/1/2006 | 12/8/2006 | 851 | 241-AN-106 | 241-AW-102 | 315 |
| Tank Transfer In | 12/3/2006 | 12/11/2006 | 173 | 241-C-204 | 241-AN-106 | 8 |
| Generator Transfer | 12/7/2006 | 12/14/2006 | 174 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer In | 12/16/2006 | 12/19/2006 | 659 | 241-AY-102 | 241-AN-106 | 485 |
| Tank Transfer Out | 12/16/2006 | 12/19/2006 | 446 | 241-AY-102 | 241-AN-106 | 485 |
| Generator Transfer | 12/19/2006 | 12/19/2006 | 661 | Raw Water | 241-AN-106 | 2 |
| Generator Transfer | 12/3/2006 | 12/23/2006 | 931 | Raw Water | 241-AY-102 | 6 |
| Generator Transfer | 12/7/2006 | 12/23/2006 | 850 | Raw Water | 241-AW-102 | 2 |
| Tank Transfer In | 12/21/2006 | 12/23/2006 | 1080 | 241-AY-102 | 241-AW-102 | 230 |
| Tank Transfer Out | 12/21/2006 | 12/23/2006 | 216 | 241-AY-102 | 241-AW-102 | 230 |
| Tank Transfer In | 12/20/2006 | 12/28/2006 | 675 | 241-C-108 | 241-AN-106 | 14 |
| Tank Transfer In | 12/3/2006 | 12/29/2006 | 935 | 241-S-102 | 241-SY-102 | 167 |
| Tank Transfer Out | 1/10/2007 | 1/13/2007 | 329 | 241-AP-101 | 241-AY-102 | 782 |
| Tank Transfer In | 1/10/2007 | 1/13/2007 | 999 | 241-AP-101 | 241-AY-102 | 782 |
| Tank Transfer In | 1/2/2007 | 1/19/2007 | 1134 | 241-S-102 | 241-SY-102 | 196 |
| Tank Transfer In | 1/2/2007 | 1/31/2007 | 702 | 241-C-108 | 241-AN-106 | 27 |
| Tank Transfer In | 2/6/2007 | 2/6/2007 | 1150 | 241-SY-102 | 241-SY-101 | 95 |
| Tank Transfer Out | 2/6/2007 | 2/7/2007 | 1036 | 241-SY-102 | 241-SY-101 | 95 |
| Generator Transfer | 2/8/2007 | 2/8/2007 | 339 | Raw Water | 241-AP-101 | 10 |
| Tank Transfer In | 2/12/2007 | 2/13/2007 | 1130 | 241-S-112 | 241-SY-102 | 75 |
| Tank Transfer In | 2/8/2007 | 2/18/2007 | 1156 | 241-SY-101 | 241-AP-101 | 817 |
| Tank Transfer Out | 2/8/2007 | 2/18/2007 | 333 | 241-SY-101 | 241-AP-101 | 817 |
| Generator Transfer | 2/6/2007 | 2/25/2007 | 1048 | Raw Water | 241-SY-102 | 12 |
| Tank Transfer In | 2/19/2007 | 2/26/2007 | 802 | 241-SY-102 | 241-SY-101 | 469 |
| Tank Transfer Out | 2/19/2007 | 2/26/2007 | 661 | 241-SY-102 | 241-SY-101 | 469 |
| Tank Transfer In | 2/25/2007 | 2/27/2007 | 755 | 241-S-102 | 241-SY-102 | 94 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 2/1/2007 | 2/28/2007 | 707 | 241-C-108 | 241-AN-106 | 5 |
| Generator Transfer | 2/5/2007 | 2/28/2007 | 310 | Raw Water | 241-AY-101 | 1 |
| Tank Transfer In | 2/7/2007 | 2/28/2007 | 1055 | 241-S-112 | 241-SY-102 | 7 |
| Tank Transfer In | 2/27/2007 | 2/28/2007 | 792 | 241-S-112 | 241-SY-102 | 37 |
| Generator Transfer | 2/28/2007 | 2/28/2007 | 316 | Raw Water | 241-AY-101 | 6 |
| Tank Transfer In | 2/28/2007 | 2/28/2007 | 357 | 241-SY-101 | 241-AY-101 | 41 |
| Tank Transfer Out | 2/28/2007 | 2/28/2007 | 751 | 241-SY-101 | 241-AY-101 | 41 |
| Tank Transfer In | 3/1/2007 | 3/5/2007 | 817 | 241-SY-101 | 241-AY-101 | 460 |
| Tank Transfer Out | 3/1/2007 | 3/5/2007 | 291 | 241-SY-101 | 241-AY-101 | 460 |
| Generator Transfer | 3/5/2007 | 3/5/2007 | 831 | Flush Water | 241-AY-101 | 10 |
| Generator Transfer | 3/5/2007 | 3/5/2007 | 296 | Flush Water | 241-SY-101 | 5 |
| Tank Transfer Out | 3/13/2007 | 3/13/2007 | 683 | 241-AN-106 | 241-C-108 | 26 |
| Tank Transfer In | 3/1/2007 | 3/14/2007 | 1277 | 241-S-102 | 241-SY-102 | 485 |
| Tank Transfer In | 3/12/2007 | 3/21/2007 | 1104 | 241-SY-102 | 241-SY-101 | 802 |
| Generator Transfer | 3/12/2007 | 3/21/2007 | 1275 | Flush Water | 241-SY-102 | 2 |
| Tank Transfer Out | 3/12/2007 | 3/21/2007 | 473 | 241-SY-102 | 241-SY-101 | 802 |
| Tank Transfer In | 3/29/2007 | 3/30/2007 | 1141 | 241-AP-103 | 241-AN-101 | 186 |
| Tank Transfer Out | 3/29/2007 | 3/30/2007 | 952 | 241-AP-103 | 241-AN-101 | 186 |
| Tank Transfer In | 3/30/2007 | 3/30/2007 | 707 | 241-C-108 | 241-AN-106 | 24 |
| Generator Transfer | 4/4/2007 | 4/4/2007 | 1143 | Flush Water | 241-AN-101 | 2 |
| Tank Transfer Out | 4/6/2007 | 4/12/2007 | 759 | 241-AP-103 | 241-AP-108 | 192 |
| Tank Transfer In | 4/6/2007 | 4/12/2007 | 1247 | 241-AP-103 | 241-AP-108 | 192 |
| Tank Transfer Out | 4/12/2007 | 4/12/2007 | 683 | 241-AN-106 | 241-C-108 | 25 |
| Generator Transfer | 4/12/2007 | 4/12/2007 | 760 | Raw Water | 241-AP-103 | 1 |
| Tank Transfer In | 4/12/2007 | 4/27/2007 | 708 | 241-C-108 | 241-AN-106 | 25 |
| Generator Transfer | 5/10/2007 | 5/10/2007 | 1136 | Raw Water | 241-AP-105 | 1 |
| Generator Transfer | 6/19/2007 | 6/19/2007 | 760 | Raw Water | 241-AP-103 | 1 |
| Tank Transfer In | 6/19/2007 | 6/29/2007 | 748 | 241-C-109 | 241-AN-106 | 40 |
| Generator Transfer | 6/20/2007 | 6/30/2007 | 1109 | Evaporator Water | 241-AW-102 | 28 |
| Generator Transfer | 7/1/2007 | 7/4/2007 | 1112 | Evaporator Water | 241-AW-102 | 3 |
| Tank Transfer Out | 7/4/2007 | 7/22/2007 | 382 | 241-AW-102 | 242A | 731 |
| Tank Transfer In | 7/4/2007 | 7/22/2007 | 383 | 242A | 241-AW-102 | 1 |
| Generator Transfer | 7/19/2007 | 7/23/2007 | 1107 | 222S Waste | 241-SY-101 | 3 |
| Tank Transfer In | 7/2/2007 | 7/24/2007 | 759 | 241-C-109 | 241-AN-106 | 10 |
| Generator Transfer | 7/22/2007 | 7/24/2007 | 1100 | Raw Water | 241-AP-104 | 3 |
| Tank Transfer Out | 7/24/2007 | 7/24/2007 | 734 | 241-AN-106 | 241-C-109 | 25 |
| Tank Transfer In | 7/25/2007 | 7/26/2007 | 570 | 241-S-102 | 241-SY-102 | 100 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 7/22/2007 | 7/31/2007 | 403 | Evaporator Water | 241-AW-102 | 20 |
| Tank Transfer Out | 7/31/2007 | 7/31/2007 | 995 | 241-AP-104 | 241-AW-102 | 105 |
| Tank Transfer In | 7/31/2007 | 7/31/2007 | 508 | 241-AP-104 | 241-AW-102 | 105 |
| Generator Transfer | 8/3/2007 | 8/3/2007 | 1009 | Raw Water | 241-AW-102 | 1 |
| Tank Transfer Out | 8/1/2007 | 8/4/2007 | 510 | 241-AP-104 | 241-AW-102 | 485 |
| Tank Transfer In | 8/1/2007 | 8/4/2007 | 993 | 241-AP-104 | 241-AW-102 | 485 |
| Generator Transfer | 8/1/2007 | 8/7/2007 | 1008 | Flush Water | 241-AW-102 | 15 |
| Tank Transfer In | 8/7/2007 | 8/16/2007 | 1129 | 242A | 241-AP-103 | 369 |
| Tank Transfer Out | 8/7/2007 | 8/16/2007 | 400 | 241-AW-102 | 242A | 609 |
| Generator Transfer | 8/3/2007 | 8/20/2007 | 506 | Raw Water | 241-AP-104 | 1 |
| Generator Transfer | 8/20/2007 | 8/20/2007 | 872 | Raw Water | 241-AW-102 | 1 |
| Tank Transfer Out | 8/16/2007 | 8/21/2007 | 35 | 241-AP-104 | 241-AW-102 | 471 |
| Tank Transfer In | 8/16/2007 | 8/21/2007 | 871 | 241-AP-104 | 241-AW-102 | 471 |
| Tank Transfer In | 8/13/2007 | 8/23/2007 | 758 | 241-C-109 | 241-AN-106 | 24 |
| Tank Transfer In | 8/21/2007 | 8/23/2007 | 1141 | 242A | 241-AP-103 | 12 |
| Tank Transfer Out | 8/21/2007 | 8/23/2007 | 821 | 241-AW-102 | 242A | 51 |
| Tank Transfer In | 8/23/2007 | 8/31/2007 | 495 | 242A | 241-AP-104 | 460 |
| Tank Transfer Out | 8/23/2007 | 8/31/2007 | 78 | 241-AW-102 | 242A | 743 |
| Tank Transfer In | 9/3/2007 | 9/8/2007 | 109 | 242A | 241-AW-102 | 29 |
| Generator Transfer | 1/25/2008 | 1/25/2008 | 896 | NaOH | 241-AY-101 | 15 |
| Tank Transfer Out | 2/22/2008 | 2/24/2008 | 693 | 241-AP-101 | 241-AW-102 | 462 |
| Tank Transfer In | 2/22/2008 | 2/24/2008 | 572 | 241-AP-101 | 241-AW-102 | 462 |
| Generator Transfer | 2/1/2008 | 2/29/2008 | 1157 | Raw Water | 241-AP-101 | 1 |
| Tank Transfer Out | 3/15/2008 | 3/16/2008 | 711 | 241-AP-105 | 241-AW-102 | 428 |
| Tank Transfer In | 3/15/2008 | 3/16/2008 | 999 | 241-AP-105 | 241-AW-102 | 428 |
| Generator Transfer | 3/16/2008 | 3/16/2008 | 1000 | Raw Water | 241-AW-102 | 1 |
| Tank Transfer In | 3/18/2008 | 3/20/2008 | 1152 | 241-AP-105 | 241-AP-101 | 459 |
| Tank Transfer Out | 3/18/2008 | 3/20/2008 | 253 | 241-AP-105 | 241-AP-101 | 459 |
| Generator Transfer | 3/20/2008 | 3/20/2008 | 1153 | Raw Water | 241-AP-101 | 1 |
| Generator Transfer | 3/16/2008 | 3/21/2008 | 712 | Raw Water | 241-AP-105 | 1 |
| Tank Transfer In | 4/18/2008 | 4/19/2008 | 599 | 241-AP-107 | 241-AP-105 | 345 |
| Tank Transfer Out | 4/18/2008 | 4/19/2008 | 774 | 241-AP-107 | 241-AP-105 | 345 |
| Generator Transfer | 4/19/2008 | 4/19/2008 | 775 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 4/19/2008 | 4/26/2008 | 600 | Raw Water | 241-AP-105 | 1 |
| Tank Transfer In | 4/24/2008 | 4/26/2008 | 754 | 241-AW-106 | 241-AP-105 | 154 |
| Tank Transfer Out | 4/24/2008 | 4/26/2008 | 969 | 241-AW-106 | 241-AP-105 | 154 |
| Generator Transfer | 4/24/2008 | 4/26/2008 | 973 | Raw Water | 241-AW-106 | 4 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 5/1/2008 | 5/1/2008 | 1057 | Raw Water | 241-AN-102 | 1 |
| Generator Transfer | 5/7/2008 | 5/7/2008 | 836 | Raw Water | 241-AZ-101 | 1 |
| Tank Transfer In | 6/7/2008 | 6/8/2008 | 1135 | 241-AZ-102 | 241-AW-106 | 163 |
| Tank Transfer Out | 6/7/2008 | 6/8/2008 | 767 | 241-AZ-102 | 241-AW-106 | 163 |
| Generator Transfer | 6/8/2008 | 6/8/2008 | 1135 | Raw Water | 241-AP-103 | 2 |
| Generator Transfer | 6/8/2008 | 6/8/2008 | 1136 | Raw Water | 241-AW-106 | 1 |
| Tank Transfer In | 6/11/2008 | 6/12/2008 | 980 | 241-AZ-102 | 241-AP-105 | 227 |
| Tank Transfer Out | 6/11/2008 | 6/12/2008 | 538 | 241-AZ-102 | 241-AP-105 | 227 |
| Tank Transfer In | 6/12/2008 | 6/14/2008 | 1121 | 241-AZ-102 | 241-AP-107 | 347 |
| Tank Transfer Out | 6/12/2008 | 6/14/2008 | 188 | 241-AZ-102 | 241-AP-107 | 347 |
| Generator Transfer | 6/14/2008 | 6/14/2008 | 981 | Raw Water | 241-AP-105 | 1 |
| Generator Transfer | 6/14/2008 | 6/14/2008 | 1122 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 6/14/2008 | 6/14/2008 | 187 | Raw Water | 241-AZ-102 | 2 |
| Tank Transfer In | 6/17/2008 | 6/26/2008 | 761 | 241-C-109 | 241-AN-106 | 4 |
| Generator Transfer | 6/12/2008 | 6/29/2008 | 757 | Flush Water | 241-AN-106 | 1 |
| Generator Transfer | 7/1/2008 | 7/10/2008 | 764 | Raw Water | 241-AN-106 | 3 |
| Tank Transfer In | 7/1/2008 | 7/10/2008 | 766 | 241-C-109 | 241-AN-106 | 4 |
| Generator Transfer | 7/31/2008 | 7/31/2008 | 767 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 8/27/2008 | 8/30/2008 | 1005 | Evaporator Water | 241-AW-102 | 5 |
| Generator Transfer | 9/3/2008 | 9/11/2008 | 1047 | Evaporator Water | 241-AW-102 | 41 |
| Generator Transfer | 9/18/2008 | 9/18/2008 | 1048 | Raw Water | 241-AW-102 | 1 |
| Tank Transfer In | 9/22/2008 | 9/24/2008 | 823 | 241-C-110 | 241-AN-106 | 55 |
| Generator Transfer | 9/24/2008 | 9/24/2008 | 824 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 9/25/2008 | 9/29/2008 | 1138 | Raw Water | 241-AP-106 | 7 |
| Generator Transfer | 11/18/2008 | 11/18/2008 | 1108 | 222S Waste | 241-SY-101 | 3 |
| Generator Transfer | 12/3/2008 | 12/30/2008 | 823 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 1/9/2009 | 1/14/2009 | 828 | Raw Water | 241-AN-106 | 3 |
| Generator Transfer | 1/10/2009 | 1/14/2009 | 1133 | Raw Water | 241-AP-103 | 2 |
| Tank Transfer Out | 1/20/2009 | 1/21/2009 | 716 | 241-AN-106 | 241-AZ-101 | 112 |
| Tank Transfer In | 1/20/2009 | 1/21/2009 | 946 | 241-AN-106 | 241-AZ-101 | 112 |
| Tank Transfer In | 1/22/2009 | 1/30/2009 | 767 | 241-C-110 | 241-AN-106 | 51 |
| Tank Transfer Out | 2/7/2009 | 2/7/2009 | 762 | 241-AN-106 | 241-AZ-101 | 52 |
| Generator Transfer | 2/7/2009 | 2/7/2009 | 763 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer In | 2/7/2009 | 2/7/2009 | 999 | 241-AN-106 | 241-AZ-101 | 52 |
| Generator Transfer | 2/7/2009 | 2/7/2009 | 1001 | Raw Water | 241-AZ-101 | 2 |
| Tank Transfer In | 2/2/2009 | 2/27/2009 | 814 | 241-C-110 | 241-AN-106 | 47 |
| Generator Transfer | 2/10/2009 | 2/27/2009 | 1134 | Raw Water | 241-AW-106 | 1 |

## Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 2/27/2009 | 2/27/2009 | 1135 | Raw Water | 241-AW-106 | 1 |
| Generator Transfer | 3/3/2009 | 3/3/2009 | 1135 | Raw Water | 241-AW-106 | 2 |
| Tank Transfer In | 3/2/2009 | 3/5/2009 | 767 | 241-C-110 | 241-AN-106 | 3 |
| Generator Transfer | 3/3/2009 | 3/20/2009 | 1057 | Raw Water | 241-AW-102 | 11 |
| Tank Transfer Out | 3/21/2009 | 3/21/2009 | 1015 | 241-AW-102 | 242A | 42 |
| Tank Transfer In | 3/22/2009 | 3/31/2009 | 1057 | 242A | 241-AW-102 | 42 |
| Generator Transfer | 4/19/2009 | 4/24/2009 | 1074 | Evaporator Water | 241-AW-102 | 17 |
| Tank Transfer In | 4/23/2009 | 4/27/2009 | 767 | 241-C-110 | 241-AN-106 | 1 |
| Tank Transfer Out | 4/24/2009 | 4/27/2009 | 774 | 241-AW-102 | 242A | 300 |
| Tank Transfer In | 4/25/2009 | 4/29/2009 | 629 | 242A | 241-AP-104 | 139 |
| Tank Transfer Out | 4/28/2009 | 4/29/2009 | 965 | 241-AP-101 | 241-AW-102 | 184 |
| Tank Transfer In | 4/28/2009 | 4/29/2009 | 958 | 241-AP-101 | 241-AW-102 | 184 |
| Generator Transfer | 4/28/2009 | 4/29/2009 | 961 | Flush Water | 241-AW-102 | 3 |
| Tank Transfer Out | 4/29/2009 | 4/30/2009 | 916 | 241-AP-101 | 241-AW-102 | 49 |
| Tank Transfer In | 4/29/2009 | 4/30/2009 | 989 | 242A | 241-AW-102 | 28 |
| Tank Transfer In | 4/29/2009 | 4/30/2009 | 1038 | 241-AP-101 | 241-AW-102 | 49 |
| Generator Transfer | 5/14/2009 | 5/14/2009 | 979 | Raw Water | 241-AP-105 | 1 |
| Generator Transfer | 5/18/2009 | 5/18/2009 | 1039 | Evaporator Water | 241-AW-102 | 1 |
| Tank Transfer Out | 5/18/2009 | 5/23/2009 | 682 | 241-AW-102 | 242A | 357 |
| Tank Transfer In | 5/19/2009 | 5/23/2009 | 800 | 242A | 241-AP-104 | 171 |
| Tank Transfer In | 5/23/2009 | 5/28/2009 | 1049 | 242A | 241-AP-104 | 249 |
| Tank Transfer Out | 5/23/2009 | 5/28/2009 | 217 | 241-AW-102 | 242A | 465 |
| Generator Transfer | 5/30/2009 | 5/30/2009 | 221 | Evaporator Water | 241-AW-102 | 4 |
| Tank Transfer In | 5/30/2009 | 5/31/2009 | 1071 | 242A | 241-AP-104 | 22 |
| Tank Transfer Out | 5/30/2009 | 5/31/2009 | 181 | 241-AW-102 | 242A | 40 |
| Tank Transfer Out | 5/31/2009 | 5/31/2009 | 719 | 241-AP-101 | 241-AW-102 | 199 |
| Tank Transfer In | 5/31/2009 | 5/31/2009 | 393 | 241-AP-101 | 241-AW-102 | 199 |
| Tank Transfer Out | 6/1/2009 | 6/3/2009 | 36 | 241-AP-101 | 241-AW-102 | 683 |
| Tank Transfer In | 6/1/2009 | 6/3/2009 | 1076 | 241-AP-101 | 241-AW-102 | 683 |
| Tank Transfer In | 6/3/2009 | 6/4/2009 | 1139 | 242A | 241-AP-104 | 69 |
| Tank Transfer Out | 6/3/2009 | 6/4/2009 | 955 | 241-AW-102 | 242A | 121 |
| Generator Transfer | 6/3/2009 | 6/7/2009 | 38 | Raw Water | 241-AP-101 | 1 |
| Generator Transfer | 6/9/2009 | 6/10/2009 | 782 | NaOH | 241-AN-106 | 15 |
| Generator Transfer | 5/31/2009 | 6/11/2009 | 194 | Raw Water | 241-AW-102 | 13 |
| Tank Transfer In | 6/5/2009 | 6/11/2009 | 1115 | 241-AP-104 | 241-AP-101 | 1077 |
| Tank Transfer Out | 6/5/2009 | 6/11/2009 | 62 | 241-AP-104 | 241-AP-101 | 1077 |
| Tank Transfer In | 6/5/2009 | 6/11/2009 | 1004 | 242A | 241-AW-102 | 49 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer Out | 6/12/2009 | 6/24/2009 | 77 | 241-AW-102 | 242A | 927 |
| Tank Transfer In | 6/13/2009 | 6/24/2009 | 558 | 242A | 241-AP-104 | 493 |
| Tank Transfer In | 6/24/2009 | 6/25/2009 | 107 | 242A | 241-AW-102 | 30 |
| Generator Transfer | 6/28/2009 | 6/28/2009 | 1132 | Raw Water | 241-AP-103 | 1 |
| Generator Transfer | 6/7/2009 | 6/30/2009 | 65 | Raw Water | 241-AP-104 | 3 |
| Tank Transfer In | 6/29/2009 | 6/30/2009 | 1260 | 241-AP-104 | 241-AP-103 | 128 |
| Tank Transfer Out | 6/29/2009 | 6/30/2009 | 430 | 241-AP-104 | 241-AP-103 | 128 |
| Tank Transfer Out | 7/2/2009 | 7/2/2009 | 1237 | 241-AP-103 | 241-AP-104 | 21 |
| Tank Transfer In | 7/2/2009 | 7/2/2009 | 450 | 241-AP-103 | 241-AP-104 | 21 |
| Generator Transfer | 7/2/2009 | 7/21/2009 | 1238 | Raw Water | 241-AP-103 | 1 |
| Generator Transfer | 8/13/2009 | 8/13/2009 | 178 | Raw Water | 241-AZ-102 | 6 |
| Generator Transfer | 8/19/2009 | 8/25/2009 | 991 | Raw Water | 241-AY-101 | 1 |
| Generator Transfer | 8/19/2009 | 8/28/2009 | 1142 | Raw Water | 241-AN-101 | 3 |
| Tank Transfer Out | 8/31/2009 | 8/31/2009 | 948 | 241-AP-105 | 241-AZ-102 | 31 |
| Generator Transfer | 8/31/2009 | 8/31/2009 | 949 | Raw Water | 241-AP-105 | 1 |
| Tank Transfer In | 8/31/2009 | 8/31/2009 | 209 | 241-AP-105 | 241-AZ-102 | 31 |
| Generator Transfer | 9/1/2009 | 9/3/2009 | 1137 | Raw Water | 241-AP-106 | 1 |
| Tank Transfer Out | 9/1/2009 | 9/6/2009 | 247 | 241-AP-105 | 241-AZ-102 | 702 |
| Tank Transfer In | 9/1/2009 | 9/6/2009 | 911 | 241-AP-105 | 241-AZ-102 | 702 |
| Generator Transfer | 9/6/2009 | 9/6/2009 | 247 | Raw Water | 241-AP-105 | 1 |
| Generator Transfer | 9/6/2009 | 9/6/2009 | 917 | Raw Water | 241-AZ-102 | 2 |
| Generator Transfer | 9/1/2009 | 9/21/2009 | 1144 | Raw Water | 241-AN-101 | 2 |
| Generator Transfer | 10/13/2009 | 10/13/2009 | 1131 | Raw Water | 241-AW-106 | 1 |
| Tank Transfer Out | 11/2/2009 | 11/2/2009 | 1102 | 241-AN-101 | 241-AP-105 | 38 |
| Tank Transfer In | 11/2/2009 | 11/2/2009 | 284 | 241-AN-101 | 241-AP-105 | 38 |
| Tank Transfer Out | 11/20/2009 | 11/24/2009 | 249 | 241-AN-101 | 241-AP-105 | 853 |
| Tank Transfer In | 11/20/2009 | 11/24/2009 | 1137 | 241-AN-101 | 241-AP-105 | 853 |
| Generator Transfer | 11/25/2009 | 11/25/2009 | 250 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 12/1/2009 | 12/4/2009 | 579 | 241-AY-101 | 241-AN-101 | 329 |
| Tank Transfer Out | 12/1/2009 | 12/4/2009 | 683 | 241-AY-101 | 241-AN-101 | 329 |
| Generator Transfer | 12/2/2009 | 12/30/2009 | 576 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 1/3/2010 | 1/7/2010 | 576 | Raw Water | 241-AN-101 | 2 |
| Tank Transfer Out | 1/8/2010 | 1/8/2010 | 571 | 241-AN-101 | 241-C-104 | 5 |
| Generator Transfer | 1/9/2010 | 1/28/2010 | 575 | Raw Water | 241-AN-101 | 4 |
| Tank Transfer In | 1/12/2010 | 1/28/2010 | 587 | 241-C-104 | 241-AN-101 | 1 |
| Generator Transfer | 1/31/2010 | 1/31/2010 | 1105 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 2/8/2010 | 2/14/2010 | 1129 | Raw Water | 241-AW-106 | 3 |

## Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 2/10/2010 | 2/14/2010 | 927 | 241-AW-106 | 241-AW-102 | 822 |
| Tank Transfer Out | 2/10/2010 | 2/14/2010 | 307 | 241-AW-106 | 241-AW-102 | 822 |
| Generator Transfer | 2/14/2010 | 2/14/2010 | 928 | Raw Water | 241-AW-102 | 1 |
| Tank Transfer In | 2/1/2010 | 2/25/2010 | 730 | 241-C-104 | 241-AN-101 | 144 |
| Generator Transfer | 2/1/2010 | 2/26/2010 | 586 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 3/3/2010 | 3/22/2010 | 799 | 241-C-104 | 241-AN-101 | 72 |
| Generator Transfer | 3/3/2010 | 3/25/2010 | 931 | Raw Water | 241-AW-102 | 2 |
| Generator Transfer | 4/28/2010 | 4/28/2010 | 798 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 4/22/2010 | 4/29/2010 | 934 | Raw Water | 241-AW-102 | 3 |
| Generator Transfer | 5/27/2010 | 5/27/2010 | 722 | Raw Water | 241-AY-101 | 1 |
| Generator Transfer | 5/18/2010 | 5/28/2010 | 978 | Evaporator Water | 241-AW-102 | 44 |
| Generator Transfer | 6/18/2010 | 6/18/2010 | 1088 | Raw Water | 241-AN-107 | 1 |
| Generator Transfer | 8/26/2010 | 8/29/2010 | 983 | Evaporator Water | 241-AW-102 | 4 |
| Generator Transfer | 8/26/2010 | 8/29/2010 | 309 | Evaporator Water | 241-AW-106 | 1 |
| Tank Transfer Out | 8/29/2010 | 8/29/2010 | 936 | 241-AW-102 | 242A | 47 |
| Generator Transfer | 8/31/2010 | 8/31/2010 | 803 | NaOH | 241-AN-101 | 5 |
| Generator Transfer | 8/31/2010 | 8/31/2010 | 804 | Flush Water | 241-AN-101 | 1 |
| Tank Transfer In | 8/29/2010 | 9/1/2010 | 321 | 242A | 241-AW-106 | 12 |
| Tank Transfer Out | 9/1/2010 | 9/10/2010 | 79 | 241-AW-102 | 242A | 857 |
| Tank Transfer In | 9/1/2010 | 9/10/2010 | 890 | 242A | 241-AW-106 | 568 |
| Tank Transfer In | 9/14/2010 | 9/14/2010 | 807 | 241-C-111 | 241-AN-101 | 2 |
| Generator Transfer | 9/10/2010 | 9/20/2010 | 123 | Evaporator Water | 241-AW-102 | 43 |
| Generator Transfer | 9/20/2010 | 9/20/2010 | 893 | Raw Water | 241-AW-106 | 3 |
| Generator Transfer | 9/21/2010 | 9/21/2010 | 1106 | 222S Waste | 241-SY-101 | 1 |
| Tank Transfer In | 9/20/2010 | 9/23/2010 | 721 | 241-AW-106 | 241-AW-102 | 598 |
| Tank Transfer Out | 9/20/2010 | 9/23/2010 | 295 | 241-AW-106 | 241-AW-102 | 598 |
| Generator Transfer | 9/20/2010 | 9/23/2010 | 308 | Evaporator Water | 241-AW-106 | 13 |
| Generator Transfer | 9/23/2010 | 9/23/2010 | 724 | Raw Water | 241-AW-102 | 1 |
| Generator Transfer | 9/23/2010 | 9/23/2010 | 310 | Raw Water | 241-AW-106 | 2 |
| Generator Transfer | 9/23/2010 | 9/24/2010 | 723 | Evaporator Water | 241-AW-102 | 2 |
| Tank Transfer Out | 9/24/2010 | 10/1/2010 | 496 | 241-AW-102 | 242A | 228 |
| Tank Transfer In | 9/24/2010 | 10/1/2010 | 465 | 242A | 241-AW-106 | 155 |
| Tank Transfer Out | 10/1/2010 | 10/5/2010 | 169 | 241-AW-102 | 242A | 327 |
| Tank Transfer In | 10/1/2010 | 10/5/2010 | 639 | 242A | 241-AW-106 | 176 |
| Generator Transfer | 10/5/2010 | 10/13/2010 | 232 | Evaporator Water | 241-AW-102 | 64 |
| Generator Transfer | 10/5/2010 | 10/13/2010 | 640 | Evaporator Water | 241-AW-106 | 1 |
| Tank Transfer In | 10/28/2010 | 10/29/2010 | 815 | 241-C-111 | 241-AN-101 | 9 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 11/2/2010 | 11/4/2010 | 816 | 241-C-111 | 241-AN-101 | 2 |
| Generator Transfer | 11/5/2010 | 11/5/2010 | 817 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 1/1/2011 | 1/31/2011 | 1135 | Raw Water | 241-AP-106 | 1 |
| Tank Transfer In | 2/8/2011 | 2/9/2011 | 824 | 241-C-104 | 241-AN-101 | 9 |
| Generator Transfer | 2/10/2011 | 2/10/2011 | 825 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 2/10/2011 | 2/14/2011 | 851 | 241-C-104 | 241-AN-101 | 26 |
| Tank Transfer Out | 2/18/2011 | 2/18/2011 | 850 | 241-AN-101 | 241-C-104 | 1 |
| Generator Transfer | 2/18/2011 | 2/18/2011 | 851 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 3/11/2011 | 3/11/2011 | 771 | Raw Water | 241-AN-106 | 2 |
| Tank Transfer Out | 3/11/2011 | 3/14/2011 | 769 | 241-AN-106 | 241-AY-101 | 9 |
| Tank Transfer In | 3/11/2011 | 3/14/2011 | 794 | 241-AN-106 | 241-AY-101 | 9 |
| Generator Transfer | 3/11/2011 | 3/17/2011 | 795 | Raw Water | 241-AY-101 | 1 |
| Tank Transfer Out | 3/16/2011 | 3/17/2011 | 784 | 241-AN-101 | 241-AY-101 | 71 |
| Tank Transfer In | 3/16/2011 | 3/17/2011 | 866 | 241-AN-101 | 241-AY-101 | 71 |
| Generator Transfer | 3/9/2011 | 3/25/2011 | 855 | Raw Water | 241-AN-101 | 4 |
| Tank Transfer In | 3/29/2011 | 3/31/2011 | 793 | 241-C-104 | 241-AN-101 | 9 |
| Generator Transfer | 4/7/2011 | 4/7/2011 | 1112 | 222S Waste | 241-SY-101 | 5 |
| Tank Transfer Out | 4/4/2011 | 4/20/2011 | 768 | 241-AN-101 | 241-C-104 | 25 |
| Tank Transfer In | 4/5/2011 | 4/20/2011 | 794 | 241-C-104 | 241-AN-101 | 26 |
| Generator Transfer | 4/18/2011 | 4/20/2011 | 1235 | Raw Water | 241-AP-103 | 1 |
| Generator Transfer | 4/18/2011 | 4/21/2011 | 444 | Raw Water | 241-AP-104 | 1 |
| Generator Transfer | 4/19/2011 | 4/21/2011 | 1134 | Raw Water | 241-AP-105 | 1 |
| Generator Transfer | 4/19/2011 | 4/21/2011 | 1134 | Raw Water | 241-AP-106 | 1 |
| Generator Transfer | 4/19/2011 | 4/21/2011 | 1096 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 4/19/2011 | 4/21/2011 | 1243 | Raw Water | 241-AP-108 | 1 |
| Generator Transfer | 4/21/2011 | 4/21/2011 | 1078 | Raw Water | 241-AP-102 | 1 |
| Tank Transfer In | 4/21/2011 | 4/26/2011 | 812 | 241-C-104 | 241-AN-101 | 18 |
| Tank Transfer In | 5/2/2011 | 5/6/2011 | 819 | 241-C-104 | 241-AN-101 | 9 |
| Generator Transfer | 5/2/2011 | 5/9/2011 | 820 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 5/6/2011 | 5/9/2011 | 825 | 241-C-104 | 241-AN-101 | 5 |
| Tank Transfer In | 5/9/2011 | 5/9/2011 | 830 | 241-C-104 | 241-AN-101 | 5 |
| Generator Transfer | 5/4/2011 | 5/31/2011 | 772 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 7/13/2011 | 7/29/2011 | 832 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 7/13/2011 | 7/29/2011 | 769 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer Out | 8/29/2011 | 8/31/2011 | 600 | 241-AN-106 | 241-AP-104 | 167 |
| Tank Transfer In | 8/29/2011 | 8/31/2011 | 610 | 241-AN-106 | 241-AP-104 | 167 |
| Generator Transfer | 8/31/2011 | 8/31/2011 | 602 | Raw Water | 241-AN-106 | 2 |

## Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 8/31/2011 | 8/31/2011 | 611 | Raw Water | 241-AP-104 | 1 |
| Tank Transfer Out | 9/26/2011 | 9/27/2011 | 597 | 241-AN-106 | 241-C-107 | 4 |
| Tank Transfer Out | 10/12/2011 | 10/13/2011 | 666 | 241-AN-101 | 241-AP-104 | 168 |
| Tank Transfer In | 10/12/2011 | 10/13/2011 | 779 | 241-AN-101 | 241-AP-104 | 168 |
| Tank Transfer In | 10/13/2011 | 10/14/2011 | 675 | 241-C-108 | 241-AN-106 | 9 |
| Tank Transfer Out | 10/23/2011 | 10/23/2011 | 638 | 241-AN-106 | 241-AP-104 | 37 |
| Tank Transfer In | 10/23/2011 | 10/23/2011 | 816 | 241-AN-106 | 241-AP-104 | 37 |
| Generator Transfer | 10/23/2011 | 10/23/2011 | 818 | Flush Water | 241-AP-104 | 2 |
| Tank Transfer In | 10/10/2011 | 10/28/2011 | 666 | 241-C-107 | 241-AN-106 | 71 |
| Generator Transfer | 11/2/2011 | 11/2/2011 | 639 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 12/27/2011 | 12/27/2011 | 666 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer Out | 12/28/2011 | 12/30/2011 | 652 | 241-AN-101 | 241-C-112 | 14 |
| Tank Transfer In | 1/3/2012 | 1/9/2012 | 666 | 241-C-112 | 241-AN-101 | 15 |
| Tank Transfer Out | 1/5/2012 | 1/9/2012 | 663 | 241-AN-101 | 241-C-112 | 3 |
| Generator Transfer | 1/18/2012 | 1/23/2012 | 683 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 1/4/2012 | 1/24/2012 | 714 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer In | 1/4/2012 | 1/27/2012 | 713 | 241-C-108 | 241-AN-106 | 76 |
| Tank Transfer In | 1/12/2012 | 1/31/2012 | 682 | 241-C-112 | 241-AN-101 | 19 |
| Generator Transfer | 2/1/2012 | 2/23/2012 | 680 | Raw Water | 241-AN-101 | 2 |
| Tank Transfer Out | 2/1/2012 | 2/27/2012 | 678 | 241-AN-101 | 241-C-112 | 3 |
| Tank Transfer In | 2/3/2012 | 2/29/2012 | 719 | 241-C-112 | 241-AN-101 | 39 |
| Tank Transfer In | 3/21/2012 | 3/22/2012 | 744 | 241-C-108 | 241-AN-106 | 30 |
| Generator Transfer | 3/6/2012 | 3/27/2012 | 739 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 3/1/2012 | 3/30/2012 | 738 | 241-C-112 | 241-AN-101 | 19 |
| Generator Transfer | 4/2/2012 | 4/6/2012 | 744 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer In | 4/2/2012 | 4/18/2012 | 745 | 241-C-112 | 241-AN-101 | 5 |
| Generator Transfer | 4/2/2012 | 4/22/2012 | 740 | Raw Water | 241-AN-101 | 3 |
| Tank Transfer In | 5/1/2012 | 5/2/2012 | 753 | 241-C-109 | 241-AN-106 | 11 |
| Tank Transfer Out | 5/2/2012 | 5/4/2012 | 614 | 241-AN-106 | 241-AP-104 | 139 |
| Tank Transfer In | 5/2/2012 | 5/4/2012 | 955 | 241-AN-106 | 241-AP-104 | 139 |
| Generator Transfer | 5/4/2012 | 5/4/2012 | 956 | Raw Water | 241-AP-104 | 1 |
| Generator Transfer | 5/6/2012 | 5/6/2012 | 631 | NaOH | 241-AN-106 | 17 |
| Generator Transfer | 5/1/2012 | 5/8/2012 | 748 | Raw Water | 241-AN-106 | 4 |
| Tank Transfer In | 5/23/2012 | 5/30/2012 | 657 | 241-C-107 | 241-AN-106 | 26 |
| Tank Transfer In | 6/4/2012 | 6/28/2012 | 738 | 241-C-107 | 241-AN-106 | 81 |
| Generator Transfer | 6/8/2012 | 6/29/2012 | 739 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer Out | 7/23/2012 | 7/23/2012 | 719 | 241-AN-106 | 241-AP-104 | 57 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 7/23/2012 | 7/23/2012 | 1013 | 241-AN-106 | 241-AP-104 | 57 |
| Generator Transfer | 7/23/2012 | 7/23/2012 | 1015 | Raw Water | 241-AP-104 | 2 |
| Generator Transfer | 7/24/2012 | 7/24/2012 | 1118 | 222S Waste | 241-SY-101 | 3 |
| Tank Transfer In | 7/25/2012 | 7/25/2012 | 778.3 | 241-C-109 | 241-AN-106 | 59.3 |
| Generator Transfer | 7/2/2012 | 7/31/2012 | 740 | Raw Water | 241-AN-106 | 3 |
| Tank Transfer In | 7/2/2012 | 7/31/2012 | 776 | 241-C-107 | 241-AN-106 | 36 |
| Generator Transfer | 7/13/2012 | 7/31/2012 | 746 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 7/30/2012 | 7/31/2012 | 1257 | 241-AP-105 | 241-AP-101 | 149 |
| Tank Transfer Out | 7/30/2012 | 7/31/2012 | 986 | 241-AP-105 | 241-AP-101 | 149 |
| Tank Transfer Out | 8/6/2012 | 8/6/2012 | 775 | 241-AN-106 | 241-C-107 | 1 |
| Tank Transfer Out | 8/6/2012 | 8/7/2012 | 984 | 241-AP-101 | 241-AP-105 | 272 |
| Tank Transfer In | 8/6/2012 | 8/7/2012 | 1257 | 241-AP-101 | 241-AP-105 | 272 |
| Generator Transfer | 8/6/2012 | 8/9/2012 | 1258 | Raw Water | 241-AP-105 | 1 |
| Tank Transfer In | 8/9/2012 | 8/9/2012 | 998 | 241-AP-105 | 241-AP-101 | 12 |
| Tank Transfer Out | 8/9/2012 | 8/9/2012 | 1246 | 241-AP-105 | 241-AP-101 | 12 |
| Tank Transfer Out | 8/11/2012 | 8/11/2012 | 650 | 241-AN-106 | 241-AP-104 | 128 |
| Tank Transfer In | 8/11/2012 | 8/11/2012 | 1142 | 241-AN-106 | 241-AP-104 | 128 |
| Generator Transfer | 8/13/2012 | 8/13/2012 | 1051 | Raw Water | 241-AN-104 | 2 |
| Tank Transfer Out | 8/13/2012 | 8/13/2012 | 936 | 241-AP-101 | 241-AP-102 | 62 |
| Tank Transfer In | 8/13/2012 | 8/13/2012 | 1140 | 241-AP-101 | 241-AP-102 | 62 |
| Generator Transfer | 8/7/2012 | 8/17/2012 | 986 | Raw Water | 241-AP-101 | 2 |
| Tank Transfer In | 8/14/2012 | 8/17/2012 | 818 | 241-C-104 | 241-AN-101 | 70 |
| Tank Transfer In | 8/14/2012 | 8/17/2012 | 1236 | 241-AW-106 | 241-AP-101 | 300 |
| Tank Transfer Out | 8/14/2012 | 8/17/2012 | 333 | 241-AW-106 | 241-AP-101 | 300 |
| Generator Transfer | 8/20/2012 | 8/23/2012 | 1119 | Raw Water | 241-SY-101 | 1 |
| Generator Transfer | 8/6/2012 | 8/24/2012 | 778 | Raw Water | 241-AN-106 | 3 |
| Generator Transfer | 8/11/2012 | 8/31/2012 | 1144 | Raw Water | 241-AP-104 | 2 |
| Generator Transfer | 8/14/2012 | 8/31/2012 | 341 | Raw Water | 241-AW-106 | 8 |
| Tank Transfer Out | 8/27/2012 | 8/31/2012 | 466 | 241-AP-104 | 241-AW-106 | 671 |
| Tank Transfer In | 8/27/2012 | 8/31/2012 | 1012 | 241-AP-104 | 241-AW-106 | 671 |
| Tank Transfer Out | 9/4/2012 | 9/4/2012 | 338 | 241-AP-104 | 241-AW-106 | 127 |
| Tank Transfer In | 9/4/2012 | 9/4/2012 | 1138 | 241-AP-104 | 241-AW-106 | 127 |
| Generator Transfer | 9/4/2012 | 9/4/2012 | 1139 | Raw Water | 241-AW-106 | 1 |
| Tank Transfer In | 9/11/2012 | 9/12/2012 | 737 | 241-C-109 | 241-AN-106 | 86 |
| Tank Transfer In | 9/13/2012 | 9/13/2012 | 750 | 241-C-107 | 241-AN-106 | 13 |
| Tank Transfer Out | 9/19/2012 | 9/19/2012 | 747 | 241-AN-106 | 241-C-107 | 3 |
| Tank Transfer In | 9/20/2012 | 9/20/2012 | 749 | 241-C-107 | 241-AN-106 | 2 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 9/26/2012 | 9/26/2012 | 435 | Raw Water | 241-AP-104 | 1 |
| Generator Transfer | 9/5/2012 | 9/27/2012 | 651 | Raw Water | 241-AN-106 | 4 |
| Tank Transfer Out | 9/26/2012 | 9/27/2012 | 653 | 241-AN-106 | 241-AP-104 | 96 |
| Tank Transfer In | 9/26/2012 | 9/27/2012 | 434 | 241-AN-106 | 241-AP-104 | 96 |
| Generator Transfer | 10/10/2012 | 10/31/2012 | 819 | Raw Water | 241-AN-101 | 3 |
| Generator Transfer | 11/2/2012 | 11/5/2012 | 824 | Raw Water | 241-AN-101 | 5 |
| Tank Transfer Out | 11/13/2012 | 11/14/2012 | 749 | 241-AN-101 | 241-AP-104 | 75 |
| Tank Transfer In | 11/13/2012 | 11/14/2012 | 509 | 241-AN-101 | 241-AP-104 | 75 |
| Generator Transfer | 12/19/2012 | 12/20/2012 | 567 | NaOH | 241-SY-102 | 26 |
| Tank Transfer In | 12/10/2012 | 12/28/2012 | 768 | 241-C-101 | 241-AN-101 | 20 |
| Generator Transfer | 1/4/2013 | 1/11/2013 | 787 | Raw Water | 241-AN-101 | 1 |
| Tank Transfer In | 1/3/2013 | 1/17/2013 | 786 | 241-C-101 | 241-AN-101 | 19 |
| Tank Transfer Out | 1/11/2013 | 1/22/2013 | 746 | 241-AN-101 | 241-C-101 | 41 |
| Generator Transfer | 2/20/2013 | 2/27/2013 | 791 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 2/27/2013 | 2/27/2013 | 648 | Raw Water | 241-AN-106 | 3 |
| Tank Transfer In | 2/20/2013 | 2/28/2013 | 790 | 241-C-101 | 241-AN-101 | 46 |
| Tank Transfer In | 3/1/2013 | 3/15/2013 | 794 | 241-C-101 | 241-AN-101 | 3 |
| Tank Transfer Out | 3/12/2013 | 3/18/2013 | 783 | 241-AN-101 | 241-C-101 | 9 |
| Generator Transfer | 3/19/2013 | 3/19/2013 | 784 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 3/26/2013 | 3/26/2013 | 1056 | NaOH | 241-AN-102 | 18 |
| Generator Transfer | 4/1/2013 | 4/8/2013 | 1074 | NaOH | 241-AN-102 | 18 |
| Tank Transfer In | 5/14/2013 | 5/14/2013 | 789 | 241-C-101 | 241-AN-101 | 8 |
| Tank Transfer Out | 5/15/2013 | 5/15/2013 | 788 | 241-AN-101 | 241-C-101 | 1 |
| Tank Transfer Out | 5/20/2013 | 5/29/2013 | 599 | 241-AN-106 | 241-C-107 | 41 |
| Tank Transfer In | 5/21/2013 | 5/30/2013 | 638 | 241-C-107 | 241-AN-106 | 37 |
| Generator Transfer | 5/30/2013 | 5/30/2013 | 639 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 5/31/2013 | 5/31/2013 | 957 | Raw Water | 241-AY-101 | 3 |
| Tank Transfer In | 6/4/2013 | 6/5/2013 | 789 | 241-C-101 | 241-AN-101 | 3 |
| Tank Transfer Out | 6/3/2013 | 6/17/2013 | 786 | 241-AN-101 | 241-C-101 | 2 |
| Tank Transfer In | 6/7/2013 | 6/19/2013 | 794 | 241-C-101 | 241-AN-101 | 5 |
| Generator Transfer | 6/7/2013 | 6/19/2013 | 797 | Raw Water | 241-AN-101 | 3 |
| Generator Transfer | 6/10/2013 | 6/26/2013 | 638 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 6/26/2013 | 6/26/2013 | 225 | Evaporator Water | 241-AW-102 | 2 |
| Tank Transfer In | 6/28/2013 | 6/28/2013 | 640 | 241-C-107 | 241-AN-106 | 2 |
| Tank Transfer In | 7/2/2013 | 7/5/2013 | 639 | 241-C-107 | 241-AN-106 | 1 |
| Generator Transfer | 7/5/2013 | 7/22/2013 | 640 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer Out | 7/11/2013 | 7/23/2013 | 798 | 241-AN-101 | 241-C-101 | 2 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 7/9/2013 | 7/25/2013 | 800 | 241-C-101 | 241-AN-101 | 3 |
| Tank Transfer Out | 7/22/2013 | 7/25/2013 | 442 | 241-AP-107 | 241-AW-102 | 639 |
| Tank Transfer In | 7/22/2013 | 7/25/2013 | 863 | 241-AP-107 | 241-AW-102 | 639 |
| Generator Transfer | 7/25/2013 | 7/25/2013 | 864 | Flush Water | 241-AW-102 | 1 |
| Tank Transfer In | 8/8/2013 | 8/14/2013 | 801 | 241-C-101 | 241-AN-101 | 4 |
| Tank Transfer In | 8/14/2013 | 8/14/2013 | 641 | 241-C-110 | 241-AN-106 | 3 |
| Tank Transfer Out | 8/15/2013 | 8/15/2013 | 799 | 241-AN-101 | 241-C-101 | 2 |
| Tank Transfer In | 8/19/2013 | 8/21/2013 | 801 | 241-C-101 | 241-AN-101 | 2 |
| Tank Transfer In | 8/21/2013 | 8/21/2013 | 643 | 241-C-110 | 241-AN-106 | 2 |
| Tank Transfer Out | 9/11/2013 | 9/12/2013 | 825 | 241-AN-101 | 241-C-101 | 1 |
| Tank Transfer Out | 9/11/2013 | 9/18/2013 | 663 | 241-AN-106 | 241-C-110 | 2 |
| Tank Transfer Out | 9/17/2013 | 9/25/2013 | 800 | 241-AN-101 | 241-AP-104 | 25 |
| Tank Transfer In | 9/17/2013 | 9/25/2013 | 534 | 241-AN-101 | 241-AP-104 | 25 |
| Tank Transfer In | 9/10/2013 | 9/26/2013 | 665 | 241-C-110 | 241-AN-106 | 21 |
| Generator Transfer | 9/6/2013 | 9/30/2013 | 803 | Raw Water | 241-AN-101 | 4 |
| Tank Transfer In | 9/9/2013 | 9/30/2013 | 826 | 241-C-101 | 241-AN-101 | 23 |
| Tank Transfer In | 10/1/2013 | 10/16/2013 | 729 | 241-C-110 | 241-AN-106 | 66 |
| Tank Transfer Out | 11/14/2013 | 11/15/2013 | 750 | 241-AN-101 | 241-AP-104 | 47 |
| Tank Transfer In | 11/14/2013 | 11/15/2013 | 581 | 241-AN-101 | 241-AP-104 | 47 |
| Generator Transfer | 11/20/2013 | 11/27/2013 | 751 | Raw Water | 241-AN-101 | 1 |
| Generator Transfer | 11/27/2013 | 11/29/2013 | 1236 | Raw Water | 241-AP-103 | 2 |
| Tank Transfer In | 12/11/2013 | 12/31/2013 | 767 | 241-C-112 | 241-AN-101 | 17 |
| Tank Transfer In | 1/2/2014 | 1/2/2014 | 773 | 241-C-112 | 241-AN-101 | 8 |
| Tank Transfer In | 1/3/2014 | 1/3/2014 | 782 | 241-C-112 | 241-AN-101 | 9 |
| Tank Transfer Out | 1/9/2014 | 1/9/2014 | 645 | 241-AN-106 | 241-AP-104 | 78 |
| Tank Transfer In | 1/9/2014 | 1/9/2014 | 658 | 241-AN-106 | 241-AP-104 | 78 |
| Generator Transfer | 1/9/2014 | 1/16/2014 | 659 | Raw Water | 241-AP-104 | 1 |
| Tank Transfer Out | 1/14/2014 | 1/17/2014 | 789 | 241-AN-101 | 241-AP-104 | 47 |
| Tank Transfer In | 1/14/2014 | 1/17/2014 | 706 | 241-AN-101 | 241-AP-104 | 47 |
| Generator Transfer | 1/21/2014 | 1/23/2014 | 402 | Raw Water | 241-AW-105 | 2 |
| Generator Transfer | 1/27/2014 | 1/27/2014 | 1120 | 222S Waste | 241-SY-101 | 3 |
| Tank Transfer Out | 1/29/2014 | 1/29/2014 | 644.6 | 241-AN-106 | 241-C-107 | 0.4 |
| Generator Transfer | 1/3/2014 | 1/30/2014 | 723 | Raw Water | 241-AN-106 | 3 |
| Generator Transfer | 1/8/2014 | 1/30/2014 | 895 | Evaporator Water | 241-AW-102 | 27 |
| Generator Transfer | 1/8/2014 | 1/31/2014 | 786 | Raw Water | 241-AN-101 | 4 |
| Tank Transfer In | 1/8/2014 | 1/31/2014 | 836 | 241-C-112 | 241-AN-101 | 50 |
| Tank Transfer In | 2/10/2014 | 2/28/2014 | 657 | 241-C-107 | 241-AN-106 | 12 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 2/19/2014 | 2/28/2014 | 915 | Evaporator Water | 241-AW-102 | 20 |
| Tank Transfer In | 3/3/2014 | 3/7/2014 | 660 | 241-C-107 | 241-AN-106 | 5 |
| Generator Transfer | 3/1/2014 | 3/13/2014 | 965 | Evaporator Water | 241-AW-102 | 50 |
| Generator Transfer | 3/11/2014 | 3/13/2014 | 750 | Flush Water | 241-AN-101 | 3 |
| Tank Transfer Out | 3/11/2014 | 3/14/2014 | 747 | 241-AN-101 | 241-AP-104 | 39 |
| Tank Transfer In | 3/11/2014 | 3/14/2014 | 743 | 241-AN-101 | 241-AP-104 | 39 |
| Generator Transfer | 3/24/2014 | 3/24/2014 | 827 | Raw Water | 241-AZ-101 | 2 |
| Generator Transfer | 3/24/2014 | 3/24/2014 | 991 | Raw Water | 241-AZ-102 | 1 |
| Tank Transfer In | 3/10/2014 | 3/28/2014 | 668 | 241-C-107 | 241-AN-106 | 8 |
| Tank Transfer Out | 4/22/2014 | 4/22/2014 | 665 | 241-AN-106 | 241-AP-104 | 2 |
| Tank Transfer In | 4/22/2014 | 4/22/2014 | 747 | 241-AN-106 | 241-AP-104 | 2 |
| Tank Transfer In | 4/27/2014 | 4/27/2014 | 762 | 241-C-102 | 241-AN-101 | 13 |
| Tank Transfer In | 4/27/2014 | 4/28/2014 | 774 | 241-C-102 | 241-AN-101 | 12 |
| Tank Transfer Out | 5/12/2014 | 5/13/2014 | 818 | 241-AN-101 | 241-AP-104 | 51 |
| Tank Transfer In | 5/12/2014 | 5/13/2014 | 798 | 241-AN-101 | 241-AP-104 | 51 |
| Tank Transfer Out | 5/15/2014 | 5/15/2014 | 620 | 241-AN-106 | 241-AP-104 | 43 |
| Tank Transfer In | 5/15/2014 | 5/15/2014 | 841 | 241-AN-106 | 241-AP-104 | 43 |
| Tank Transfer In | 5/9/2014 | 5/18/2014 | 869 | 241-C-102 | 241-AN-101 | 88 |
| Generator Transfer | 5/20/2014 | 5/21/2014 | 639 | NaOH | 241-AN-106 | 14 |
| Generator Transfer | 5/16/2014 | 5/22/2014 | 625 | Raw Water | 241-AN-106 | 5 |
| Tank Transfer Out | 5/28/2014 | 5/28/2014 | 755 | 241-AN-101 | 241-AP-104 | 63 |
| Tank Transfer In | 5/28/2014 | 5/28/2014 | 904 | 241-AN-101 | 241-AP-104 | 63 |
| Generator Transfer | 5/1/2014 | 5/31/2014 | 780 | Raw Water | 241-AN-101 | 6 |
| Generator Transfer | 6/5/2014 | 6/5/2014 | 1122 | 222S Waste | 241-SY-101 | 2 |
| Tank Transfer In | 6/11/2014 | 6/11/2014 | 641 | 241-C-105 | 241-AN-106 | 1 |
| Generator Transfer | 6/11/2014 | 6/14/2014 | 642 | Raw Water | 241-AN-106 | 3 |
| Generator Transfer | 7/4/2014 | 7/10/2014 | 995 | Evaporator Water | 241-AW-102 | 34 |
| Tank Transfer In | 7/1/2014 | 7/15/2014 | 641 | 241-C-105 | 241-AN-106 | 2 |
| Generator Transfer | 7/14/2014 | 7/15/2014 | 768 | NaOH | 241-AN-101 | 14 |
| Tank Transfer Out | 7/2/2014 | 7/16/2014 | 639 | 241-AN-106 | 241-C-105 | 2 |
| Generator Transfer | 7/6/2014 | 7/21/2014 | 640 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer In | 7/18/2014 | 7/30/2014 | 868 | 241-C-102 | 241-AN-101 | 100 |
| Generator Transfer | 7/24/2014 | 7/31/2014 | 1049 | Evaporator Water | 241-AW-102 | 54 |
| Tank Transfer In | 7/25/2014 | 7/31/2014 | 667 | 241-C-107 | 241-AN-106 | 27 |
| Tank Transfer In | 8/1/2014 | 8/9/2014 | 690 | 241-C-107 | 241-AN-106 | 23 |
| Tank Transfer In | 8/3/2014 | 8/17/2014 | 899 | 241-C-102 | 241-AN-101 | 32 |
| Tank Transfer In | 8/18/2014 | 8/26/2014 | 693 | 241-C-105 | 241-AN-106 | 2 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 8/26/2014 | 8/26/2014 | 693 | 241-C-105 | 241-AN-106 | 0 |
| Generator Transfer | 8/29/2014 | 8/29/2014 | 439 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 8/7/2014 | 8/31/2014 | 691 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer Out | 9/3/2014 | 9/3/2014 | 688 | 241-AN-106 | 241-C-105 | 1 |
| Generator Transfer | 9/4/2014 | 9/4/2014 | 1241 | Raw Water | 241-AP-108 | 1 |
| Generator Transfer | 9/4/2014 | 9/8/2014 | 690 | Raw Water | 241-AN-106 | 2 |
| Tank Transfer Out | 9/4/2014 | 9/30/2014 | 307 | 241-AP-107 | 242A | 133 |
| Tank Transfer Out | 9/4/2014 | 9/30/2014 | 606 | 241-AW-102 | 242A | 439 |
| Tank Transfer In | 10/1/2014 | 10/9/2014 | 587 | 242A | 241-AP-107 | 283 |
| Tank Transfer Out | 10/1/2014 | 10/9/2014 | 105 | 241-AW-102 | 242A | 504 |
| Generator Transfer | 10/9/2014 | 10/10/2014 | 109 | Evaporator Water | 241-AW-102 | 4 |
| Generator Transfer | 10/10/2014 | 10/11/2014 | 111 | Flush Water | 241-AW-102 | 2 |
| Tank Transfer In | 10/10/2014 | 10/11/2014 | 117 | 241-AW-106 | 241-AW-102 | 6 |
| Tank Transfer Out | 10/10/2014 | 10/11/2014 | 1130 | 241-AW-106 | 241-AW-102 | 6 |
| Generator Transfer | 10/11/2014 | 10/11/2014 | 1132 | Raw Water | 241-AW-106 | 2 |
| Generator Transfer | 10/11/2014 | 10/15/2014 | 136 | Evaporator Water | 241-AW-102 | 19 |
| Tank Transfer In | 10/15/2014 | 10/15/2014 | 145 | 242A | 241-AW-102 | 3 |
| Generator Transfer | 10/15/2014 | 10/16/2014 | 142 | Evaporator Water | 241-AW-102 | 6 |
| Tank Transfer In | 10/16/2014 | 10/17/2014 | 177 | 242A | 241-AW-102 | 25 |
| Generator Transfer | 10/16/2014 | 10/29/2014 | 152 | Evaporator Water | 241-AW-102 | 7 |
| Generator Transfer | 10/28/2014 | 10/29/2014 | 588 | Evaporator Water | 241-AP-107 | 1 |
| Tank Transfer In | 10/29/2014 | 10/29/2014 | 901 | 241-C-102 | 241-AN-101 | 3 |
| Generator Transfer | 10/29/2014 | 10/29/2014 | 589 | Flush Water | 241-AP-107 | 1 |
| Generator Transfer | 10/19/2014 | 10/30/2014 | 202 | Flush Water | 241-AW-102 | 25 |
| Generator Transfer | 10/30/2014 | 10/30/2014 | 213 | Raw Water | 241-AW-102 | 3 |
| Tank Transfer Out | 11/10/2014 | 11/10/2014 | 895 | 241-AN-101 | 241-C-102 | 4 |
| Generator Transfer | 11/6/2014 | 11/12/2014 | 991 | Raw Water | 241-AZ-102 | 1 |
| Tank Transfer In | 11/11/2014 | 11/12/2014 | 906 | 241-C-102 | 241-AN-101 | 11 |
| Tank Transfer Out | 12/15/2014 | 12/19/2014 | 299 | 241-AP-104 | 241-AW-102 | 599 |
| Tank Transfer In | 12/15/2014 | 12/19/2014 | 812 | 241-AP-104 | 241-AW-102 | 599 |
| Tank Transfer In | 12/7/2014 | 12/24/2014 | 943 | 241-C-102 | 241-AN-101 | 38 |
| Tank Transfer Out | 12/28/2014 | 12/31/2014 | 984 | 241-AP-103 | 241-AW-102 | 248 |
| Tank Transfer In | 12/28/2014 | 12/31/2014 | 1060 | 241-AP-103 | 241-AW-102 | 248 |
| Tank Transfer In | 1/1/2015 | 1/5/2015 | 950 | 241-C-102 | 241-AN-101 | 7 |
| Tank Transfer In | 1/9/2015 | 1/25/2015 | 953 | 241-C-102 | 241-AN-101 | 5 |
| Generator Transfer | 2/17/2015 | 2/24/2015 | 771 | Raw Water | 241-AY-102 | 1 |
| Tank Transfer In | 3/10/2014 | 3/28/2014 | 668 | 241-C-107 | 241-AN-106 | 8 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer In | 4/22/2014 | 4/22/2014 | 747 | 241-AN-106 | 241-AP-104 | 2 |
| Tank Transfer Out | 4/22/2014 | 4/22/2014 | 665 | 241-AN-106 | 241-AP-104 | 2 |
| Tank Transfer In | 4/27/2014 | 4/27/2014 | 762 | 241-C-102 | 241-AN-101 | 13 |
| Tank Transfer In | 4/27/2014 | 4/28/2014 | 774 | 241-C-102 | 241-AN-101 | 12 |
| Tank Transfer In | 5/12/2014 | 5/13/2014 | 798 | 241-AN-101 | 241-AP-104 | 51 |
| Tank Transfer Out | 5/12/2014 | 5/13/2014 | 818 | 241-AN-101 | 241-AP-104 | 51 |
| Tank Transfer In | 5/15/2014 | 5/15/2014 | 841 | 241-AN-106 | 241-AP-104 | 43 |
| Tank Transfer Out | 5/15/2014 | 5/15/2014 | 620 | 241-AN-106 | 241-AP-104 | 43 |
| Tank Transfer In | 5/9/2014 | 5/18/2014 | 869 | 241-C-102 | 241-AN-101 | 88 |
| Generator Transfer | 5/20/2014 | 5/21/2014 | 639 | NaOH | 241-AN-106 | 14 |
| Generator Transfer | 5/16/2014 | 5/22/2014 | 625 | Raw Water | 241-AN-106 | 5 |
| Tank Transfer In | 5/28/2014 | 5/28/2014 | 904 | 241-AN-101 | 241-AP-104 | 63 |
| Tank Transfer Out | 5/28/2014 | 5/28/2014 | 755 | 241-AN-101 | 241-AP-104 | 63 |
| Generator Transfer | 5/1/2014 | 5/31/2014 | 780 | Raw Water | 241-AN-101 | 6 |
| Generator Transfer | 6/5/2014 | 6/5/2014 | 1122 | 222S Waste | 241-SY-101 | 2 |
| Tank Transfer In | 6/11/2014 | 6/11/2014 | 641 | 241-C-105 | 241-AN-106 | 1 |
| Generator Transfer | 6/11/2014 | 6/14/2014 | 642 | Raw Water | 241-AN-106 | 3 |
| Generator Transfer | 7/4/2014 | 7/10/2014 | 995 | Evaporator Water | 241-AW-102 | 34 |
| Generator Transfer | 7/14/2014 | 7/15/2014 | 768 | NaOH | 241-AN-101 | 14 |
| Tank Transfer In | 7/1/2014 | 7/15/2014 | 641 | 241-C-105 | 241-AN-106 | 2 |
| Tank Transfer Out | 7/2/2014 | 7/16/2014 | 639 | 241-AN-106 | 241-C-105 | 2 |
| Generator Transfer | 7/6/2014 | 7/21/2014 | 640 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer In | 7/18/2014 | 7/30/2014 | 868 | 241-C-102 | 241-AN-101 | 100 |
| Generator Transfer | 7/24/2014 | 7/31/2014 | 1049 | Evaporator Water | 241-AW-102 | 54 |
| Tank Transfer In | 7/25/2014 | 7/31/2014 | 667 | 241-C-107 | 241-AN-106 | 27 |
| Tank Transfer In | 8/1/2014 | 8/9/2014 | 690 | 241-C-107 | 241-AN-106 | 23 |
| Tank Transfer In | 8/3/2014 | 8/17/2014 | 899 | 241-C-102 | 241-AN-101 | 32 |
| Tank Transfer In | 8/18/2014 | 8/26/2014 | 693 | 241-C-105 | 241-AN-106 | 2 |
| Tank Transfer In | 8/26/2014 | 8/26/2014 | 693 | 241-C-105 | 241-AN-106 | 0 |
| Generator Transfer | 8/29/2014 | 8/29/2014 | 439 | Raw Water | 241-AP-107 | 1 |
| Generator Transfer | 8/7/2014 | 8/31/2014 | 691 | Raw Water | 241-AN-106 | 1 |
| Tank Transfer Out | 9/3/2014 | 9/3/2014 | 688 | 241-AN-106 | 241-C-105 | 1 |
| Generator Transfer | 9/4/2014 | 9/4/2014 | 1241 | Raw Water | 241-AP-108 | 1 |
| Generator Transfer | 9/4/2014 | 9/8/2014 | 690 | Raw Water | 241-AN-106 | 2 |
| Tank Transfer Out | 9/4/2014 | 9/30/2014 | 307 | 241-AP-107 | 242A | 133 |

**Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)**

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Tank Transfer Out | 9/4/2014 | 9/30/2014 | 606 | 241-AW-102 | 242A | 439 |
| Tank Transfer In | 10/1/2014 | 10/9/2014 | 587 | 242A | 241-AP-107 | 283 |
| Tank Transfer Out | 10/1/2014 | 10/9/2014 | 105 | 241-AW-102 | 242A | 504 |
| Generator Transfer | 10/9/2014 | 10/10/2014 | 109 | Evaporator Water | 241-AW-102 | 4 |
| Generator Transfer | 10/10/2014 | 10/11/2014 | 111 | Flush Water | 241-AW-102 | 2 |
| Generator Transfer | 10/11/2014 | 10/11/2014 | 1132 | Raw Water | 241-AW-106 | 2 |
| Tank Transfer In | 10/10/2014 | 10/11/2014 | 117 | 241-AW-106 | 241-AW-102 | 6 |
| Tank Transfer Out | 10/10/2014 | 10/11/2014 | 1130 | 241-AW-106 | 241-AW-102 | 6 |
| Generator Transfer | 10/11/2014 | 10/15/2014 | 136 | Evaporator Water | 241-AW-102 | 19 |
| Tank Transfer In | 10/15/2014 | 10/15/2014 | 145 | 242A | 241-AW-102 | 3 |
| Generator Transfer | 10/15/2014 | 10/16/2014 | 142 | Evaporator Water | 241-AW-102 | 6 |
| Tank Transfer In | 10/16/2014 | 10/17/2014 | 177 | 242A | 241-AW-102 | 25 |
| Generator Transfer | 10/16/2014 | 10/29/2014 | 152 | Evaporator Water | 241-AW-102 | 7 |
| Generator Transfer | 10/28/2014 | 10/29/2014 | 588 | Evaporator Water | 241-AP-107 | 1 |
| Generator Transfer | 10/29/2014 | 10/29/2014 | 589 | Flush Water | 241-AP-107 | 1 |
| Tank Transfer In | 10/29/2014 | 10/29/2014 | 901 | 241-C-102 | 241-AN-101 | 3 |
| Generator Transfer | 10/19/2014 | 10/30/2014 | 202 | Flush Water | 241-AW-102 | 25 |
| Generator Transfer | 10/30/2014 | 10/30/2014 | 213 | Raw Water | 241-AW-102 | 3 |
| Tank Transfer Out | 11/10/2014 | 11/10/2014 | 895 | 241-AN-101 | 241-C-102 | 4 |
| Generator Transfer | 11/6/2014 | 11/12/2014 | 991 | Raw Water | 241-AZ-102 | 1 |
| Tank Transfer In | 11/11/2014 | 11/12/2014 | 906 | 241-C-102 | 241-AN-101 | 11 |
| Tank Transfer In | 12/15/2014 | 12/19/2014 | 812 | 241-AP-104 | 241-AW-102 | 599 |
| Tank Transfer Out | 12/15/2014 | 12/19/2014 | 299 | 241-AP-104 | 241-AW-102 | 599 |
| Tank Transfer In | 12/7/2014 | 12/24/2014 | 943 | 241-C-102 | 241-AN-101 | 38 |
| Tank Transfer In | 12/28/2014 | 12/31/2014 | 1060 | 241-AP-103 | 241-AW-102 | 248 |
| Tank Transfer Out | 12/28/2014 | 12/31/2014 | 984 | 241-AP-103 | 241-AW-102 | 248 |
| Tank Transfer In | 1/1/2015 | 1/5/2015 | 950 | 241-C-102 | 241-AN-101 | 7 |
| Tank Transfer In | 1/9/2015 | 1/25/2015 | 953 | 241-C-102 | 241-AN-101 | 5 |
| Generator Transfer | 2/17/2015 | 2/24/2015 | 771 | Raw Water | 241-AY-102 | 1 |
| Tank Transfer In | 3/13/2015 | 3/22/2015 | 960 | 241-C-102 | 241-AN-101 | 10 |
| Generator Transfer | 3/23/2015 | 3/31/2015 | 679 | Raw Water | 241-AN-106 | 3 |
| Generator Transfer | 4/9/2015 | 4/9/2015 | 1049 | Raw Water | 241-AN-104 | 1 |
| Generator Transfer | 4/9/2015 | 4/13/2015 | 793 | Raw Water | 241-AZ-101 | 2 |
| Tank Transfer In | 4/3/2015 | 4/18/2015 | 971 | 241-C-102 | 241-AN-101 | 13 |
| Generator Transfer | 4/30/2015 | 4/30/2015 | 1061 | Evaporator Water | 241-AW-102 | 2 |

## Table T-1: Transfers and Additions since March 31, 2006 (18 sheets)

| Type | Start Date | End Date | Tank Volume | Source | Destination | Volume Transferred |
|---|---|---|---|---|---|---|
| Generator Transfer | 5/1/2015 | 5/1/2015 | 1065 | Evaporator Water | 241-AW-102 | 4 |
| Generator Transfer | 5/2/2015 | 5/2/2015 | 1082 | Evaporator Water | 241-AW-102 | 1 |
| Tank Transfer Out | 5/2/2015 | 5/2/2015 | 1056 | 241-AW-102 | 242A | 11 |
| Generator Transfer | 5/2/2015 | 5/5/2015 | 1088 | Evaporator Water | 241-AW-102 | 6 |
| Tank Transfer In | 5/6/2015 | 5/6/2015 | 858 | 242A | 241-AP-107 | 277 |
| Tank Transfer In | 5/9/2015 | 5/9/2015 | 1023 | 241-C-102 | 241-AN-101 | 50 |
| Tank Transfer Out | 5/8/2015 | 5/9/2015 | 973 | 241-AN-101 | 241-C-102 | 1 |
| Tank Transfer Out | 5/5/2015 | 5/11/2015 | 561 | 241-AW-102 | 242A | 527 |
| Generator Transfer | 5/14/2015 | 5/15/2015 | 595 | Evaporator Water | 241-AW-102 | 34 |
| Tank Transfer In | 5/27/2015 | 5/27/2015 | 368 | 241-AN-101 | 241-AP-104 | 68 |
| Tank Transfer Out | 5/27/2015 | 5/27/2015 | 955 | 241-AN-101 | 241-AP-104 | 68 |
| Tank Transfer In | 5/20/2015 | 5/31/2015 | 707 | 241-C-105 | 241-AN-106 | 31 |
| Tank Transfer Out | 6/1/2015 | 6/1/2015 | 704 | 241-AN-106 | 241-C-105 | 3 |
| Tank Transfer Out | 6/7/2015 | 6/8/2015 | 786 | 241-AN-106 | 241-C-105 | 1 |
| Tank Transfer In | 6/2/2015 | 6/15/2015 | 787 | 241-C-105 | 241-AN-106 | 82 |
| Tank Transfer Out | 6/12/2015 | 6/19/2015 | 176 | 241-AW-102 | 242A | 469 |
| Tank Transfer In | 6/13/2015 | 6/21/2015 | 1087 | 242A | 241-AP-107 | 231 |
| Tank Transfer In | 6/22/2015 | 6/28/2015 | 973 | 241-AZ-102 | 241-AW-102 | 797 |
| Tank Transfer Out | 6/22/2015 | 6/28/2015 | 188 | 241-AZ-102 | 241-AW-102 | 797 |
| Generator Transfer | 6/10/2015 | 6/29/2015 | 645 | Raw Water | 241-AW-102 | 50 |
| Generator Transfer | 6/25/2015 | 6/29/2015 | 191 | Raw Water | 241-AZ-102 | 3 |
| Generator Transfer | 7/3/2015 | 7/3/2015 | 580 | Raw Water | 241-AZ-102 | 1 |
| Tank Transfer In | 7/1/2015 | 7/3/2015 | 579 | 241-AP-103 | 241-AZ-102 | 395 |
| Tank Transfer Out | 7/1/2015 | 7/3/2015 | 590 | 241-AP-103 | 241-AZ-102 | 395 |
| Tank Transfer Out | 7/10/2015 | 7/21/2015 | 134 | 241-AW-102 | 242A | 878 |
| Generator Transfer | 7/9/2015 | 7/22/2015 | 1012 | Evaporator Water | 241-AW-102 | 37 |
| Tank Transfer In | 7/12/2015 | 7/22/2015 | 1049 | 242A | 241-AP-103 | 459 |
| Tank Transfer Out | 7/22/2015 | 7/22/2015 | 875 | 241-AN-106 | 241-C-105 | 1 |
| Generator Transfer | 7/23/2015 | 7/23/2015 | 876 | Raw Water | 241-AN-106 | 1 |
| Generator Transfer | 7/22/2015 | 7/23/2015 | 555 | Flush Water | 241-SY-102 | 1 |
| Generator Transfer | 7/24/2015 | 7/24/2015 | 996 | Raw Water | 241-AY-101 | 1 |
| Tank Transfer In | 7/16/2015 | 7/31/2015 | 876 | 241-C-105 | 241-AN-106 | 90 |

**Table T-2: Transfer Matrix into and out of the Double-Shell Tanks (2 sheets)**

| | 241-AN- | | | | | | | 241-AP- | | | | | | | | 241-AW- | | | | | | 241-AY- | | 241-AZ- | | 241-SY- | | | | 241-C- | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **From \ To** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **108** | **101** | **102** | **103** | **104** | **105** | **106** | **101** | **102** | **101** | **102** | **101** | **102** | **103** | **242A** | **101** | **102** | **104** | **105** | **107** | **108** | **109** | **110** | **112** |
| 241-AN-101 | | | | | | | | | | | 9 | 2 | | | | | | | | | | 1 | | | | | | | | 7 | 2 | 3 | | | | | | 3 |
| 241-AN-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-104 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-105 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-106 | | | | | | | | | | | 9 | | | | | | 3 | | | | | 1 | | 2 | | | | | | | | | 5 | 5 | 2 | 1 | 1 | |
| 241-AN-107 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AP-101 | | | | | | | | | 1 | | | 1 | | | | | 5 | | | | | | 1 | | | | | | | | | | | | | | | |
| 241-AP-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AP-103 | 1 | | | | | | | | | | 1 | | | | 1 | | 1 | | | | | | | | 1 | | | | | | | | | | | | | |
| 241-AP-104 | | | | | | | | 1 | | 1 | | | | | | | 4 | | | | 2 | | | | | | | | | | | | | | | | | |
| 241-AP-105 | | | | | | | | 3 | | | | | | | | | 1 | | | | | | | | 2 | | | | | | | | | | | | | |
| 241-AP-106 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AP-107 | | | | | | | | | | | | 1 | | | | | 1 | | | | | | | | | | | | 1 | | | | | | | | | |
| 241-AP-108 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-101 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 23 | | | | | | | | | |
| 241-AW-103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-104 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-105 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-106 | | | | | | | | 1 | | | | 1 | | | | | 3 | | | | | | | | | | | | | | | | | | | | | |
| 241-AY-101 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AY-102 | | | | | | 1 | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| 241-AZ-101 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AZ-102 | | | | | | | | | | | | 1 | | 1 | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | |
| 241-SY-101 | | | | | | | | 1 | | | | | | 1 | | | | | | | | 2 | | | | | | | | | | | | | | | | |
| 241-SY-102 | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | | | | | | | | | | |
| 241-SY-103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 222S Waste | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | | | | | | | | | | | | |
| 241-C-101 | 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-102 | 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-103 | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-104 | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-105 | | | | | | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-107 | | | | | | 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-108 | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-109 | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table T-2: Transfer Matrix into and out of the Double-Shell Tanks (2 sheets)**

| | 241-AN- | | | | | | | 241-AP- | | | | | | | | 241-AW- | | | | | | 241-AY- | | 241-AZ- | | 241-SY- | | | | 241-C- | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **From \ To** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **108** | **101** | **102** | **103** | **104** | **105** | **106** | **101** | **102** | **101** | **102** | **101** | **102** | **103** | **242A** | **101** | **102** | **104** | **105** | **107** | **108** | **109** | **110** | **112** |
| 241-C-110 | | | | | | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-111 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-112 | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-204 | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-S-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | | | | | | | | | |
| 241-S-112 | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | | | | | | | | | | | |
| 242A | | | | | | | | | | 4 | 7 | | | 3 | 1 | | 8 | | | | 4 | | | | | | | | | | | | | | | | | |
| Evaporator Water | | | | | | | | | | | | | | 1 | | | 31 | | | | 3 | | | | | | | | | | | | | | | | | |
| Flush Water | 3 | | | | | 1 | | | | | 1 | | | 1 | | | 5 | | | | | 1 | | | | 3 | 2 | | | | | | | | | | | |
| NaOH | 2 | 2 | | | | 3 | | | | | | | | | | | | | | | | 2 | | | | | 2 | | | | | | | | | | | |
| Raw Water | 30 | 2 | | 2 | | 33 | 1 | 5 | 2 | 8 | 10 | 9 | 4 | 8 | 3 | | 14 | | | 1 | 12 | 8 | 2 | 4 | 7 | 3 | 4 | | | | | | | | | | | |

**Table T-3: Volume Transfer Matrix into and out of the Double-Shell Tanks (kgal) (2 sheets)**

| | 241-AN- | | | | | | | 241-AP- | | | | | | | | 241-AW- | | | | | | 241-AY- | | 241-AZ- | | 241-SY- | | | | 241-C- | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From \ To | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 101 | 102 | 103 | 104 | 105 | 106 | 101 | 102 | 101 | 102 | 101 | 102 | 103 | 242A | 101 | 102 | 104 | 105 | 107 | 108 | 109 | 110 | 112 |
| 241-AN-101 | | | | | | | | | | | 583 | 891 | | | | | | | | | | 71 | | | | | | | | 58 | 5 | 31 | | | | | | 20 |
| 241-AN-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-104 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-105 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AN-106 | | | | | | | | | | | 747 | | | | | | 771 | | | | | 9 | | 164 | | | | | | | | | 8 | 49.4 | 51 | 25 | 2 | |
| 241-AN-107 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AP-101 | | | | | | | | | 62 | | | 272 | | | | | 1577 | | | | | | 782 | | | | | | | | | | | | | | | |
| 241-AP-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AP-103 | 186 | | | | | | | | | | 21 | | | | 192 | | 248 | | | | | | | | 395 | | | | | | | | | | | | | |
| 241-AP-104 | | | | | | | | 1077 | | 128 | | | | | | | 1660 | | | | 798 | | | | | | | | | | | | | | | | | |
| 241-AP-105 | | | | | | | | 620 | | | | | | | | | 428 | | | | | | | | 733 | | | | | | | | | | | | | |
| 241-AP-106 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AP-107 | | | | | | | | | | | | 345 | | | | | 639 | | | | | | | | | | | | 133 | | | | | | | | | |
| 241-AP-108 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-101 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-102 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9230 | | | | | | | | | |
| 241-AW-103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-104 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-105 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AW-106 | | | | | | | | 300 | | | | 154 | | | | | 1426 | | | | | | | | | | | | | | | | | | | | | |
| 241-AY-101 | 329 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AY-102 | | | | | | 485 | | | | | | | | | | | 230 | | | | | | | | | | | | | | | | | | | | | |
| 241-AZ-101 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-AZ-102 | | | | | | | | | | | | 227 | | 347 | | | 797 | | | | 163 | | | | | | | | | | | | | | | | | |
| 241-SY-101 | | | | | | | | 817 | | | | | | 767 | | | | | | | | 501 | | | | | | | | | | | | | | | | |
| 241-SY-102 | | | | | | | | | | | | | | | | | | | | | | | | | | 2048 | | | | | | | | | | | | |
| 241-SY-103 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 222S Waste | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 20 | | | | | | | | | | | | |
| 241-C-101 | 136 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-102 | 382 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-103 | 0 | | | | | 84 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-104 | 394 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-105 | 0 | | | | | 208 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

**Table T-3: Volume Transfer Matrix into and out of the Double-Shell Tanks (kgal) (2 sheets)**

| | 241-AN- | | | | | | | 241-AP- | | | | | | | | 241-AW- | | | | | | 241-AY- | | 241-AZ- | | 241-SY- | | | | 241-C- | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From \ To | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 101 | 102 | 103 | 104 | 105 | 106 | 101 | 102 | 101 | 102 | 101 | 102 | 103 | 242A | 101 | 102 | 104 | 105 | 107 | 108 | 109 | 110 | 112 |
| 241-C-107 | 0 | | | | | 344 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-108 | 0 | | | | | 210 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-109 | 0 | | | | | 238.3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-110 | 0 | | | | | 249 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-111 | 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-112 | 181 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-C-204 | 0 | | | | | 48 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 241-S-102 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 1110 | | | | | | | | | | | |
| 241-S-112 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | 345 | | | | | | | | | | | |
| 242A | 0 | | | | | | | | | 1087 | 1603 | | | 791 | 31 | | 207 | | | | 911 | | | | | | | | | | | | | | | | | |
| Evaporator Water | 0 | | | | | | | | | | | | | 1 | | | 644 | | | | 15 | | | | | | | | | | | | | | | | | |
| Flush Water | 6 | | | | | 1 | | | | | 2 | | | 1 | | | 46 | | | | | 10 | | | | 8 | 3 | | | | | | | | | | | |
| NaOH | 19 | 36 | | | | 46 | | | | | | | | | | | | | | | | 51 | | | | | 48 | | | | | | | | | | | |
| Raw Water | 62 | 3 | | 3 | | 70 | 1 | 15 | 2 | 11 | 16 | 9 | 10 | 27 | 3 | | 91 | | | 2 | 29 | 15 | 7 | 7 | 16 | 10 | 22 | | | | | | | | | | | |

# APPENDIX U
# DOUBLE-SHELL TANK WASTE COMPATIBILITY ASSESSMENTS

# APPENDIX U DOUBLE-SHELL TANK WASTE COMPATIBILITY ASSESSMENTS

## LIST OF TABLES

Table U-1: Waste Compatibility Assessments Reviewed ..... U-3

**Table U-1: Waste Compatibility Assessments Reviewed (6 sheets)**

| Document Number | Title | Date |
|---|---|---|
| RPP-RPT-29371, Rev 0 [DA02409126] | WASTE COMPATIBILITY ASSESSMENT OF TANK 21-SY-101 WASTE WITH TANK 241-AP-107 WASTE | 4/26/2006 |
| RPP-RPT-29528, Rev 0 [DA02515425] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE AND SIMULTANEOUS TRANSFER FROM TANK 241-S-112 TO TANK 241-SY-102 | 5/12/2006 |
| RPP-RPT-29895, Rev 0 [DA02642331] | WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC ADDITION TO TANK 241-S-112 AND TANK 241-S-112 RETRIEVAL WASTE WITH TANK 241-SY-102 WASTE | 5/31/2006 |
| RPP-RPT-29865, Rev 0 [DA02815862] | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-06-01) WITH TANK 241-SY-101 WASTE | 6/21/2006 |
| RPP-RPT-29811, Rev 0 [DA02834625] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-103 & 241-C-204 WASTES WITH TANK 241-AN-106 WASTE & TANK 241-AN-106 WASTE WITH TANK 241-C-103 WASTE | 6/23/2006 |
| RPP-RPT-30257, Rev 0 [DA03128328] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AZ-301 CONDENSATE WITH TANK 241-AY-101 WASTE | 7/31/2006 |
| RPP-RPT-30633, Rev 0 [DA03270052] | WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGN 06-01 WASTE (EVAP-06-01) WITH TANK 241-AP-103, TANK 241-AP-108 AND TANK 241-AW-102 WASTES | 8/17/2006 |
| RPP-RPT-30956, Rev 0 [DA03380553] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-102 WASTE RECIRCULATION | 8/31/2006 |
| RPP-RPT-31033, Rev 0 [DA03427696] | WASTE COMPATIBILITY ASSESSMENT OF CATCH TANKS 241-UX-302A AND 241-ER-311 WASTES WITH TANK 241-AN-106 WASTE | 9/11/2006 |
| RPP-RPT-30685, Rev 0 [DA03427745] | WASTE COMPATIBILITY ASSESSMENT OF CATCH TANKS 241-UX-302A AND 241-ER-311 WASTES WITH TANK 241-SY-102 WASTE | 9/11/2006 |
| RPP-RPT-31276, Rev 0 [DA03625392] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-S-102 WASTE WITH TANK 241-SY-102 WASTE | 10/3/2006 |
| RPP-RPT-31219, Rev 0 [DA03676727] | WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC ADDITION AND TANK 241-AZ-301 CONDENSATE WITH TANK 241-AY-101 WASTE | 10/10/2006 |
| RPP-RPT-31601, Rev 0 [DA03856931] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 WASTE WITH TANK 241-AW-102 WASTE | 11/6/2006 |
| RPP-RPT-31692, Rev 0 [DA03889208] | WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC ADDITION TO TANK 241-SY-102 | 11/10/2006 |
| RPP-RPT-31789, Rev 0 [DA03945230] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-102 WASTE WITH TANK 241-AN-106 WASTE | 11/21/2006 |
| RPP-RPT-32169, Rev 0 [DA04093128] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-102 WASTE WITH TANK 241-AW-102 WASTE | 12/19/2006 |
| RPP-RPT-32308, Rev 0 [DA04247002] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE | 1/16/2007 |
| RPP-RPT-32451, Rev 0 [DA04311420] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-101 WASTE WITH TANK 241-AP-101 WASTE | 1/29/2007 |
| RPP-RPT-32409, Rev 0 [DA04344356] | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-S-112 AND 241-S-102 WASTES WITH TANK 241-SY-102 WASTE | 2/2/2007 |

**Table U-1: Waste Compatibility Assessments Reviewed (6 sheets)**

| Document Number | Title | Date |
|---|---|---|
| RPP-RPT-32690, Rev 0 [DA04424786] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE | 2/16/2007 |
| RPP-RPT-32976, Rev 0 [DA04533038] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE (3RD) AND TANK 241-S-102 WASTES WITH TANK 241-SY-102 WASTE | 3/8/2007 |
| RPP-RPT-32945, Rev 0 [DA04626365] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-103 WASTE WITH TANK 241-AN-101 WASTE | 3/22/2007 |
| RPP-RPT-33252, Rev 0 [DA04769143] | WASTE COMPATIBILITY ASSESSMENT OF 241-SY-103C PIT AND TANK 241-S-102 WASTES WITH TANK 241-SY-102 WASTE | 4/12/2007 |
| RPP-RPT-33565, Rev 0 [DA05088304] | WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGNS 07-01 AND 07-02 | 5/31/2007 |
| RPP-RPT-34000, Rev 0 [DA05326546] | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-07-01) WITH TANK 241-SY-101 WASTE | 7/12/2007 |
| RPP-RPT-36377, Rev 0 [DA06800843] | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-AP-107 241-AW-106 AND 241-AZ-102 WASTES WITH TANK 241-AP-105 WASTE | 3/4/2008 |
| RPP-RPT-37161, Rev 0 [DA07039098] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AZ-102 WASTE WITH TANK 241-AP-107 WASTE | 4/11/2008 |
| RPP-RPT-37671, Rev 0 [DA07258840] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-105 WASTE WITH TANK 241-AZ-102 WASTE AND 241-AP-105 WASTE RECIRCULATION | 6/3/2008 |
| RPP-RPT-37413, Rev 0 [DA07324665] | WASTE COMPATIBILITY ASSESSMENT OF TANK 240-S-302 WASTE WITH TANK 241-AP-106 WASTE | 6/18/2008 |
| RPP-RPT-38122, Rev 0 [DA07435075] | WASTE COMPATIBILITY ASSESSMENT OF 242-A SUMP WASTE WITH TANK 241-AW-102 WASTE FOR EVAPORATOR COLDRUN-08 | 7/18/2008 |
| RPP-RPT-38378, Rev 0 [DA07435127] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AW-106 WASTE | 7/18/2008 |
| RPP-RPT-38160, Rev 0 [DA07435157] | WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGNS 08-01 AND 08-02 | 7/18/2008 |
| RPP-RPT-38415, Rev 0 [0808070281] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-110 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-110 WASTE | 8/6/2008 |
| RPP-RPT-38431, Rev 0 [0808140025] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 AND 241-C-110 WASTE WITH TANK 241-AZ-101 WASTE | 8/13/2008 |
| RPP-RPT-38122, Rev 0A [0808200046] | WASTE COMPATIBILITY ASSESSMENT OF 242-A SUMP WASTE WITH TANK 241-AW-102 WASTE FOR EVAPORATOR COLDRUN-08 | 8/19/2008 |
| RPP-RPT-38857, Rev 0 [0808270224] | WASTE COMPATIBILITY ASSESSMENT OF 25% TANK 241-C-110 RETRIEVED WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-110 WASTE | 8/26/2008 |
| RPP-RPT-38857, Rev 0A [0809080298] | WASTE COMPATIBILITY ASSESSMENT OF 25% TANK 241-C-110 RETRIEVED WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-110 WASTE | 9/6/2008 |
| RPP-RPT-37413, Rev 0A [0809171014] | WASTE COMPATIBILITY ASSESSMENT OF TANK 240-S-302 WASTE WITH TANK 241-AP-106 WASTE | 9/17/2008 |
| RPP-RPT-39193, Rev 0 [0810090072] | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-08-01) WITH TANK 241-SY-101 WASTE | 10/8/2008 |

**Table U-1: Waste Compatibility Assessments Reviewed (6 sheets)**

| Document Number | Title | Date |
|---|---|---|
| RPP-RPT-39193, Rev 0A [0811120733] | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-08-01) WITH TANK 241-SY-101 WASTE | 11/12/2008 |
| RPP-RPT-39193, Rev 0B [0811170219] | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-08-01) WITH TANK 241-SY-101 WASTE | 11/17/2008 |
| RPP-RPT-39636, Rev 0 [0812030862] | WASTEWASTE COMPATIBILITY ASSESSMENT OF 76% TANK 241-C-110 RETRIEVAL WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-110 WASTE | 12/2/2008 |
| RPP-RPT-39866, Rev 0 [0812230448] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-104 04B PIT WASTE WITH TANK 241-C-104 WASTE | 12/23/2008 |
| RPP-RPT-38184, Rev 2 [0903190551] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-101 WASTE AND 242-A SUMP WASTE WITH TANK 241 AW-102 WASTE | 3/19/2009 |
| RPP-RPT-40242, Rev 1 [0904210579] | WASTE COMPATIBILITY ASSESSMENT OF 100 % TANK 241-C-110 RETRIEVED WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-110 WASTE | 4/21/2009 |
| EDT-823049 [0906250583] | MATERIAL COMPATIBILITY ASSESSMENT REPORT FOR THE TANK 241-UX-302A LIQUID PUMPING SYSTEM | 6/25/2009 |
| EDT-823094 [0907071273] | MATERIAL COMPATIBILITY ASSESSMENT REPORT FOR THE 244-CR VAULT LIQUID PUMPING SYSTEM | 7/7/2009 |
| RPP-RPT-41997, Rev 0 [0908060002] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 WASTE WITH TANK 241-AP-105 WASTE | 8/5/2009 |
| RPP-RPT-37671, Rev 2 [0908260001] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-105 WASTE WITH TANK 241-AZ-102 WASTE AND 241-AP-105 WASTE RECIRCULATION | 8/25/2009 |
| WRPS-0901355 Enclosure 1 .pdf | WRPS TRANSMITTAL OF WASTE COMPATIBILITY ASSESSMENT AND SPATIAL BOUNDARY INFORMATION ASSOCIATED WITH THE RETRIEVAL OF TANK 241-C-104 | 9/1/2009 |
| WRPS-0901355 Enclosure 2.pdf | WRPS TRANSMITTAL OF WASTE COMPATIBILITY ASSESSMENT AND SPATIAL BOUNDARY INFORMATION ASSOCIATED WITH THE RETRIEVAL OF TANK 241-C-104 | 9/1/2009 |
| WRPS-0901355 Letter.docx | WRPS TRANSMITTAL OF WASTE COMPATIBILITY ASSESSMENT AND SPATIAL BOUNDARY INFORMATION ASSOCIATED WITH THE RETRIEVAL OF TANK 241-C-104 | 9/1/2009 |
| RPP-RPT-41465, Rev 1 [0909210616] | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-101 RECIRCULATION AND TANK 241-AY-101 WASTE WITH TANK 241-AN-101 WASTE | 9/21/2009 |
| RPP-RPT-40492, Rev 3 [0910091213] | COMPATIBILITY ASSESSMENT OF 241-AZ-301 CONDENSATE TO TANK 241-AY-101 | 10/9/2009 |
| RPP-RPT-43972, Rev 0 [1001050396] | COMPATIBILITY ASSESSMENT OF 241-AZ-301 CONDENSATE TO TANK 241-AY-101 | 1/4/2010 |
| WRPS-1000696 [1004270066] | MATERIAL COMPATIBILITY ASSESSMENT: 241-AN-101-01A PIT DOUBLE CHECK SAFETY VALVE ASSEMBLY TEST COCK POLYMER | 3/31/2010 |
| RPP-RPT-45144, Rev 0 [1003310595] | WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGN 10-01 | 3/31/2010 |

**Table U-1: Waste Compatibility Assessments Reviewed (6 sheets)**

| Document Number | Title | Date |
|---|---|---|
| RPP-RPT-45144, Rev 0A [1005191739] | WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGN 10-01 | 5/16/2010 |
| RPP-RPT-45794, Rev 0A | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-10-01) WITH TANK 241-SY-101 | 7/28/2010 |
| RPP-RPT-47109, Rev 00 | WASTE COMPATIBILITY ASSESSMENT OF 242-A POST EVAPORATOR CAMPAIGN 10-02 PROCESS WATER AND SLURRY WITH TANK 241-AW-102 | 7/28/2010 |
| RPP-RPT-49695, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 WASTE WITH TANK 241-AW-106 WASTE | 6/1/2011 |
| RPP-RPT-49695, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 WASTE WITH TANK 241-AW-106 WASTE | 6/1/2011 |
| RPP-RPT-49695, Rev 0A.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 WASTE WITH TANK 241-AW-106 WASTE | 7/15/2011 |
| RPP-RPT-50082, Rev 01.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-107 WASTE | 8/9/2011 |
| RPP-RPT-50082, Rev 01A.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-107 WASTE | 8/11/2011 |
| RPP-RPT-50843, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 WASTE WITH TANK 241-AP-104 WASTE | 10/6/2011 |
| RPP-RPT-51031, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-112 RETRIEVED WASTE WITH TANK 241-AN-101 WASTE AND TANK 241-AN-101 WASTE WITH TANK 241-C-112 WASTE | 10/31/2011 |
| RPP-RPT-50676, Rev 01A.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-C-107 WASTE AND WATER WASH 241-C-108 HARD HEEL WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-107 WASTE | 11/15/2011 |
| RPP-RPT-50205, Rev 00A.PDF | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-11-02) WITH TANK 241-SY-101 | 11/15/2011 |
| RPP-RPT-50785, Rev 00A.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-108 100% HARD HEEL RETRIEVED WASTE WITH TANK 241-AN-106 WASTE | 12/15/2011 |
| RPP-RPT-50785, Rev 02.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-108 100% HARD HEEL RETRIEVED WASTE WITH TANK 241-AN-106 WASTE | 2/13/2012 |
| RPP-RPT-51031, Rev 01B.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-112 RETRIEVED WASTE WITH TANK 241-AN-101 WASTE AND TANK 241-AN-101 WASTE WITH TANK 241-C-112 WASTE | 3/23/2012 |
| RPP-RPT-52519, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF WATER ADDITION TO TANK 241-C-109 WASTE | 6/25/2012 |
| RPP-RPT-53122, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-109 WATER WASH WASTE WITH TANK 241-AN-106 AND CAUSTIC AND WATER ADDITION TO TANK 241-C-109 | 7/25/2012 |
| RPP-RPT-53156, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 DECANT (AUGUST 2012) | 8/7/2012 |
| RPP-RPT-53207, | WASTE COMPATIBILITY ASSESSMENT OF 241-AZ-301 | 8/13/2012 |

**Table U-1: Waste Compatibility Assessments Reviewed (6 sheets)**

| Document Number | Title | Date |
|---|---|---|
| Rev 00.PDF | CONDENSATE TO TANK 241-AY-101 | |
| RPP-RPT-53276, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-C-107 WASTE AND 241-C-109 WASTE WITH TANK 241-AN-106 WASTE AND WATER ADDITION TO TANKS 241-C-107 AND 241-C-109 | 8/24/2012 |
| RPP-RPT-53382, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 DECANT (SEPTEMBER 2012) WASTE WITH TANK 241-AP-104 WASTE | 9/11/2012 |
| RPP-RPT-53491, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 DECANT WASTE WITH TANK 241-AP-104 WASTE | 10/9/2012 |
| RPP-RPT-52475, Rev 01.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-C-101 WASTE AND 241-C-102 WASTE WITH TANK 241-AN-101 WASTE AND 241-AN-101 WASTE WITH TANKS 241-C-101 AND 241-C-102 WASTE | 12/10/2012 |
| RPP-RPT-52475, Rev 02.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-C-101 WASTE AND 241-C-102 WASTE WITH TANK 241-AN-101 WASTE AND 241-AN-101 WASTE WITH TANKS 241-C-101 AND 241-C-102 WASTE | 1/2/2013 |
| RPP-RPT-53207, Rev 03.PDF | WASTE COMPATIBILITY ASSESSMENT OF 241-AZ-301 CONDENSATE TO TANK 241-AY-101 | 2/21/2013 |
| RPP-RPT-54710, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-107 WASTE AND 242-A SUMP WASTE WITH TANK 241-AW-102 WASTE | 4/18/2013 |
| RPP-RPT-55032, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF 241-AZ-102 LEAK DETECTION PIT WASTE AND AZ-301 CONDENSATE WASTE WITH TANK 241-AZ-102 WASTE | 5/31/2013 |
| RPP-RPT-53920, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-102 WASTE WITH TANK 241-AP-104 WASTE | 6/26/2013 |
| RPP-RPT-55557, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF RETRIEVAL OF TANK 241-C-110 WASTE WITH TANK 241-AN-106 | 7/30/2013 |
| RPP-RPT-55710, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 DECANT WASTE WITH TANK 241-AP-104 WASTE | 8/21/2013 |
| RPP-RPT-55735, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-104 WASTE WITH TANK 241-AP-106 WASTE AND TANK 241-AP-106 WASTE WITH TANK 241-AP-104 WASTE | 9/9/2013 |
| RPP-RPT-56168, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-AN-101 AND 241-AN-106 DECANT WASTE WITH TANK 241-AP-104 WASTE | 10/29/2013 |
| RPP-RPT-55496, Rev 00A.PDF | WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-13-01) WITH TANK 241 SY 101 | 11/1/2013 |
| RPP-RPT-56308, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF 241-AZ-102 LEAK DETECTION PIT WASTE AND AZ-301 CONDENSATE WASTE WITH TANK 241-AZ-102 WASTE | 11/18/2013 |
| RPP-RPT-56228, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE, TANK 241-AN-106 WASTE WITH TANK 241-C-107 WASTE, AND TANK 241-AN-106 WASTE WITH TANK 241-C-105 WASTE | 12/10/2013 |

**Table U-1: Waste Compatibility Assessments Reviewed (6 sheets)**

| Document Number | Title | Date |
|---|---|---|
| RPP-RPT-56669, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-112 WATER AND CAUSTIC WASH WASTE WITH TANK 241-AN-101 WASTE AND WATER AND CAUSTIC ADDITION TO TANK 241-C-112 | 1/21/2014 |
| RPP-RPT-56711, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-105 WASTE | 2/4/2014 |
| RPP-RPT-56711, Rev 01.PDF | WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-105 WASTE | 2/27/2014 |
| RPP-RPT-56943, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-107 WASTE | 3/4/2014 |
| RPP-RPT-57262, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF THE ADDITION OF WATER AND TANK 241-AN-101 WASTE WITH TANK 241-C-102 WASTE | 4/22/2014 |
| RPP-RPT-56711, Rev 02.PDF | WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-106 WASTE WITH TANK 241-C-105 WASTE | 4/29/2014 |
| RPP-RPT-57405, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-102 WASTE WITH TANK 241-AN-101 WASTE AND TANK 241-AN-101 WASTE WITH TANK 241-C-102 WASTE | 5/13/2014 |
| RPP-RPT-57454, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-111 WASTE WITH TANK 241-AN-101 WASTE AND TANK 241-AN-101 WASTE WITH TANK 241-C-111 WASTE | 6/3/2014 |
| RPP-RPT-57651, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF WATER ADDITION TO TANK 241-C-102 WASTE | 6/16/2014 |
| RPP-RPT-58018, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE, TANK 241-AN-106 WASTE WITH TANK 241-C-107 WASTE, AND TANK 241-AN-106 WASTE WITH TANK 241-C-105 WASTE | 7/17/2014 |
| RPP-RPT-58160, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF 13-01 2ND PASS EVAPORATOR SLURRY WASTE WITH TANK 241-AP-107 AND WITH TANK 241-AW-102 WASTE | 8/26/2014 |
| RPP-RPT-58149, Rev 00.PDF | WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AW-106 WASTE WITH TANK 241-AW-102 WASTE | 8/26/2014 |

# APPENDIX V
# DOUBLE-SHELL TANK SAMPLING DATA

# APPENDIX V DOUBLE-SHELL TANK SAMPLING DATA

## LIST OF TABLES

Table V-1: DST Sampling Events since March 31, 2006 ..... V-3

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AN-101 | 1AN-10-01 | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-01DUP | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-01FB | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-02 | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-03 | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-04 | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-05 | Supernate | Grab | 16 | 2/28/2010 |
| 241-AN-101 | 1AN-10-06 | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-06FB | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-07 | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-08 | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-09 | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-09DUP | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-10 | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-10-11 | Supernate | Grab | 16 | 6/23/2010 |
| 241-AN-101 | 1AN-12-02A | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-02B | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-03 | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-03DUP | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-04A | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-04B | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-05A | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-05B | Supernate | Grab | 16 | 2/27/2012 |
| 241-AN-101 | 1AN-12-01 | Supernate | Grab | 16 | 2/28/2012 |
| 241-AN-101 | 1AN-12-01DUP | Supernate | Grab | 16 | 2/28/2012 |
| 241-AN-101 | 1AN-12-01FB | Supernate | Grab | 16 | 2/28/2012 |
| 241-AN-101 | 1AN-12-06 | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-06DUP | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-06FB | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-07 | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-08 | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-09 | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-09DUP | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-10 | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-11 | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-11A | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-12-12 | Supernate | Grab | 16 | 8/29/2012 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AN-101 | 1AN-12-12A | Supernate | Grab | 16 | 8/29/2012 |
| 241-AN-101 | 1AN-13-01 | Supernate | Grab | 16 | 3/6/2013 |
| 241-AN-101 | 1AN-13-01A | Supernate | Grab | 16 | 3/6/2013 |
| 241-AN-101 | 1AN-13-01DUP | Supernate | Grab | 16 | 3/6/2013 |
| 241-AN-101 | 1AN-13-01FB | Supernate | Grab | 16 | 3/6/2013 |
| 241-AN-101 | 1AN-13-02 | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-03 | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-03A | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-04 | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-04A | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-07 | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-07A | Supernate | Grab | 16 | 3/12/2013 |
| 241-AN-101 | 1AN-13-05 | Supernate | Grab | 16 | 3/13/2013 |
| 241-AN-101 | 1AN-13-05A | Supernate | Grab | 16 | 3/13/2013 |
| 241-AN-101 | 1AN-13-06 | Supernate | Grab | 16 | 3/13/2013 |
| 241-AN-101 | 1AN-13-06A | Supernate | Grab | 16 | 3/13/2013 |
| 241-AN-101 | 1AN-14-01 | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-01A | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-01FB | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-02 | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-03 | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-03A | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-04 | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-04A | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-05 | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-05A | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-101 | 1AN-14-05DUP | Supernate | Grab | 18 | 9/17/2014 |
| 241-AN-102 | 2AN-06-01 | Supernate | Grab | 20 | 5/22/2006 |
| 241-AN-102 | 2AN-06-01DUP | Supernate | Grab | 20 | 5/22/2006 |
| 241-AN-102 | 2AN-06-02DUP | Supernate | Grab | 20 | 5/23/2006 |
| 241-AN-102 | 2AN-06-03DUP | Supernate | Grab | 20 | 5/23/2006 |
| 241-AN-102 | 2AN-06-02 | Supernate | Grab | 20 | 5/24/2006 |
| 241-AN-102 | 2AN-06-03 | Supernate | Grab | 20 | 5/24/2006 |
| 241-AN-102 | 2AN-06-01FB | Supernate | Grab | 20 | 5/25/2006 |
| 241-AN-102 | 2AN-09-01 | Supernate | Grab | 20 | 10/20/2009 |
| 241-AN-102 | 2AN-09-01FB | Supernate | Grab | 20 | 10/20/2009 |
| 241-AN-102 | 2AN-09-02 | Supernate | Grab | 20 | 10/20/2009 |
| 241-AN-102 | 2AN-09-02DUP | Supernate | Grab | 20 | 10/20/2009 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AN-102 | 2AN-09-02TRIP | Supernate | Grab | 20 | 10/20/2009 |
| 241-AN-102 | 2AN-09-03 | Supernate | Grab | 20 | 10/20/2009 |
| 241-AN-102 | 2AN-09-03DUP | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-03TRIP | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-04 | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-04DUP | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-04TRIP | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-05 | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-05DUP | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-09-05TRIP | Supernate | Grab | 20 | 10/22/2009 |
| 241-AN-102 | 2AN-12-01 | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-01A | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-01DUP | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-01FB | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-02 | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-03 | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-03A | Supernate | Grab | 20 | 3/20/2012 |
| 241-AN-102 | 2AN-12-04 | Supernate | Grab | 20 | 3/22/2012 |
| 241-AN-102 | 2AN-12-04A | Supernate | Grab | 20 | 3/22/2012 |
| 241-AN-102 | 2AN-12-06A | Supernate | Grab | 20 | 3/26/2012 |
| 241-AN-102 | 2AN-12-04DUP | Supernate | Grab | 20 | 3/27/2012 |
| 241-AN-102 | 2AN-12-05 | Supernate | Grab | 20 | 3/27/2012 |
| 241-AN-102 | 2AN-12-05A | Supernate | Grab | 20 | 3/27/2012 |
| 241-AN-102 | 2AN-12-06 | Supernate | Grab | 20 | 3/27/2012 |
| 241-AN-102 | 2AN-12-07 | Supernate | Grab | 20 | 3/27/2012 |
| 241-AN-102 | 2AN-12-07A | Supernate | Grab | 20 | 3/27/2012 |
| 241-AN-102 | 2AN-13-01 | Supernate | Grab | 20 | 6/28/2013 |
| 241-AN-102 | 2AN-13-01FB | Supernate | Grab | 20 | 6/28/2013 |
| 241-AN-102 | 2AN-13-02 | Supernate | Grab | 20 | 6/28/2013 |
| 241-AN-102 | 2AN-13-03 | Supernate | Grab | 20 | 7/11/2013 |
| 241-AN-102 | 2AN-13-04 | Supernate | Grab | 20 | 7/11/2013 |
| 241-AN-102 | 2AN-13-05 | Supernate | Grab | 20 | 7/12/2013 |
| 241-AN-102 | 2AN-13-06 | Supernate | Grab | 20 | 7/12/2013 |
| 241-AN-102 | 2AN-13-03A | Supernate | Grab | 20 | 7/15/2013 |
| 241-AN-102 | 2AN-13-03B | Supernate | Grab | 20 | 7/15/2013 |
| 241-AN-102 | 2AN-13-04A | Supernate | Grab | 20 | 7/15/2013 |
| 241-AN-102 | 2AN-13-04B | Supernate | Grab | 20 | 7/15/2013 |
| 241-AN-102 | 2AN-13-05A | Supernate | Grab | 20 | 7/15/2013 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AN-106 | 6AN-06-01 | Supernate | Grab | 19 | 5/1/2006 |
| 241-AN-106 | 6AN-06-01FB | Supernate | Grab | 19 | 5/1/2006 |
| 241-AN-106 | 6AN-06-02 | Supernate | Grab | 19 | 5/1/2006 |
| 241-AN-106 | 6AN-06-03 | Supernate | Grab | 19 | 5/1/2006 |
| 241-AN-106 | 6AN-06-04 | Supernate | Grab | 19 | 5/1/2006 |
| 241-AN-106 | 6AN-06-05 | Supernate | Grab | 19 | 5/1/2006 |
| 241-AN-106 | 6AN-07-01 | Supernate | Grab | 19 | 5/22/2007 |
| 241-AN-106 | 6AN-07-02 | Supernate | Grab | 19 | 5/22/2007 |
| 241-AN-106 | 6AN-07-04 | Supernate | Grab | 19 | 5/23/2007 |
| 241-AN-106 | 6AN-07-01FB | Supernate | Grab | 19 | 5/24/2007 |
| 241-AN-106 | 6AN-07-02DUP | Supernate | Grab | 19 | 5/24/2007 |
| 241-AN-106 | 6AN-07-03 | Supernate | Grab | 19 | 5/24/2007 |
| 241-AN-106 | 6AN-08-01 | Supernate | Grab | 19 | 7/14/2008 |
| 241-AN-106 | 6AN-08-01FB | Supernate | Grab | 19 | 7/14/2008 |
| 241-AN-106 | 6AN-08-02 | Supernate | Grab | 19 | 7/14/2008 |
| 241-AN-106 | 6AN-08-02DUP | Supernate | Grab | 19 | 7/14/2008 |
| 241-AN-106 | 6AN-08-03 | Supernate | Grab | 19 | 7/14/2008 |
| 241-AN-106 | 6AN-08-04 | Supernate | Grab | 19 | 7/14/2008 |
| 241-AN-106 | 6AN-09-01 | Supernate | Grab | 19 | 2/2/2009 |
| 241-AN-106 | 6AN-09-01FB | Supernate | Grab | 19 | 2/2/2009 |
| 241-AN-106 | 6AN-09-02 | Supernate | Grab | 19 | 2/2/2009 |
| 241-AN-106 | 6AN-09-03 | Supernate | Grab | 19 | 2/2/2009 |
| 241-AN-106 | 6AN-09-03DUP | Supernate | Grab | 19 | 2/2/2009 |
| 241-AN-106 | 6AN-09-04 | Supernate | Grab | 19 | 2/2/2009 |
| 241-AN-106 | 6AN-09-05 | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-05DUP | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-05FB | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-06 | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-06DUP | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-07 | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-07DUP | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-08 | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-08DUP | Supernate | Grab | 19 | 5/8/2009 |
| 241-AN-106 | 6AN-09-09 | Supernate | Grab | 19 | 6/23/2009 |
| 241-AN-106 | 6AN-09-09FB | Supernate | Grab | 19 | 6/23/2009 |
| 241-AN-106 | 6AN-09-10 | Supernate | Grab | 19 | 6/23/2009 |
| 241-AN-106 | 6AN-09-10DUP | Supernate | Grab | 19 | 6/23/2009 |
| 241-AN-106 | 6AN-09-11 | Supernate | Grab | 19 | 6/23/2009 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AN-106 | 6AN-09-12 | Supernate | Grab | 19 | 6/23/2009 |
| 241-AN-106 | 6AN-11-01 | Supernate | Grab | 19 | 11/16/2011 |
| 241-AN-106 | 6AN-11-01DUP | Supernate | Grab | 19 | 11/16/2011 |
| 241-AN-106 | 6AN-11-03 | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-03A | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-04 | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-04DUP | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-05 | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-05A | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-06 | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-06A | Supernate | Grab | 19 | 11/17/2011 |
| 241-AN-106 | 6AN-11-01FB | Supernate | Grab | 19 | 11/18/2011 |
| 241-AN-106 | 6AN-11-02 | Supernate | Grab | 19 | 11/18/2011 |
| 241-AN-106 | 6AN-12-01 | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-01DUP | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-01FB | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-02 | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-03 | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-03A | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-04 | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-04DUP | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-05 | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-05A | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-05B | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-06 | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-06A | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-06B | Supernate | Grab | 19 | 8/24/2012 |
| 241-AN-106 | 6AN-12-11 | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-11A | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-11DUP | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-11FB | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-12 | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-13 | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-13A | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-14 | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-12-14A | Supernate | Grab | 19 | 11/7/2012 |
| 241-AN-106 | 6AN-14-01 | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-106 | 6AN-14-01A | Supernate | Grab | 17 | 4/8/2014 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AN-106 | 6AN-14-01B | Supernate | Grab | 14 | 4/8/2014 |
| 241-AN-106 | 6AN-14-01FB | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-106 | 6AN-14-02 | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-106 | 6AN-14-03 | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-106 | 6AN-14-04 | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-106 | 6AN-14-04DUP | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-106 | 6AN-14-05 | Supernate | Grab | 17 | 4/8/2014 |
| 241-AN-107 | AN107-10-01 | Supernate | Grab | 16 | 6/16/2010 |
| 241-AN-107 | AN107-10-02 | Supernate | Grab | 16 | 6/16/2010 |
| 241-AN-107 | AN107-10-03 | Supernate | Grab | 16 | 6/16/2010 |
| 241-AN-107 | AN107-10-04 | Supernate | Grab | 16 | 6/16/2010 |
| 241-AN-107 | AN107-10-05 | Supernate | Grab | 16 | 6/16/2010 |
| 241-AN-107 | AN107-10-01DUP | Supernate | Grab | 16 | 6/17/2010 |
| 241-AN-107 | AN107-10-01FB | Supernate | Grab | 16 | 6/17/2010 |
| 241-AN-107 | AN107-10-03DUP | Supernate | Grab | 16 | 6/17/2010 |
| 241-AP-101 | 1AP-07-01 | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-012B | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-01FB1 | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-01FB2 | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-02A | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-02B | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-03B | Supernate | Grab | 23 | 8/1/2007 |
| 241-AP-101 | 1AP-07-04B | Supernate | Grab | 2 | 8/1/2007 |
| 241-AP-101 | 1AP-07-01TB | Supernate | Grab | N/A | 8/2/2007 |
| 241-AP-101 | 1AP-07-03A | Supernate | Grab | 23 | 8/2/2007 |
| 241-AP-101 | 1AP-07-04A | Supernate | Grab | 2 | 8/2/2007 |
| 241-AP-101 | 1AP-15-01FB | Supernate | Grab | 23 | 5/12/2015 |
| 241-AP-101 | 1AP-15-05 | Supernate | Grab | 23 | 5/12/2015 |
| 241-AP-101 | 1AP-15-06 | Supernate | Grab | 23 | 5/12/2015 |
| 241-AP-101 | 1AP-15-07 | Supernate | Grab | 23 | 5/12/2015 |
| 241-AP-101 | 1AP-15-07A | Supernate | Grab | 23 | 5/12/2015 |
| 241-AP-101 | 1AP-15-07DUP | Supernate | Grab | 23 | 5/12/2015 |
| 241-AP-101 | 1AP-15-01 | Supernate | Grab | 23 | 5/13/2015 |
| 241-AP-101 | 1AP-15-02 | Supernate | Grab | 23 | 5/13/2015 |
| 241-AP-101 | 1AP-15-03 | Supernate | Grab | 23 | 5/13/2015 |
| 241-AP-101 | 1AP-15-04 | Supernate | Grab | 23 | 5/13/2015 |
| 241-AP-102 | 2AP-07-01 | Supernate | Grab | 1 | 3/1/2007 |
| 241-AP-102 | 2AP-07-01DUP | Supernate | Grab | 1 | 3/1/2007 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AP-102 | 2AP-07-01FB | Supernate | Grab | 1 | 3/1/2007 |
| 241-AP-102 | 2AP-07-02 | Supernate | Grab | 1 | 3/1/2007 |
| 241-AP-102 | 2AP-07-03 | Supernate | Grab | 1 | 3/14/2007 |
| 241-AP-102 | 2AP-07-03DUP | Supernate | Grab | 1 | 3/14/2007 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 332 | Core | Push mode | 29 | 6/17/2008 |
| 241-AP-103 | 3AP-15-01 | Supernate | Grab | 29 | 6/23/2015 |
| 241-AP-103 | 3AP-15-01FB | Supernate | Grab | 29 | 6/23/2015 |
| 241-AP-103 | 3AP-15-01TB | Supernate | Grab | 29 | 6/23/2015 |
| 241-AP-103 | 3AP-15-02 | Supernate | Grab | 29 | 6/23/2015 |
| 241-AP-103 | 3AP-15-03 | Supernate | Grab | 29 | 6/23/2015 |
| 241-AP-103 | 3AP-15-04 | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-05 | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-05A | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-06 | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-06A | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-06DUP | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-07 | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-103 | 3AP-15-07A | Supernate | Grab | 29 | 6/25/2015 |
| 241-AP-105 | 5AP-07-01 | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-01FB1 | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-01FB2 | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-01TB | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-02A | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-02B | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-03A | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-03B | Supernate | Grab | 21 | 6/27/2007 |
| 241-AP-105 | 5AP-07-04A | Supernate | Grab | 23 | 6/27/2007 |
| 241-AP-105 | 5AP-07-04B | Supernate | Grab | 23 | 6/27/2007 |
| 241-AP-105 | 5AP-11-01 | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-105 | 5AP-11-01FB | Supernate | Grab | 21 | 5/5/2011 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AP-105 | 5AP-11-03 | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-105 | 5AP-11-03DUP | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-105 | 5AP-11-04 | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-105 | 5AP-11-05 | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-105 | 5AP-11-06 | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-105 | 5AP-11-07 | Supernate | Grab | 21 | 5/5/2011 |
| 241-AP-106 | 6AP-14-01 | Supernate | Grab | 26 | 6/25/2014 |
| 241-AP-106 | 6AP-14-01FB | Supernate | Grab | 26 | 6/25/2014 |
| 241-AP-106 | 6AP-14-02DUP | Supernate | Grab | 26 | 6/26/2014 |
| 241-AP-106 | 6AP-14-03 | Supernate | Grab | 26 | 6/26/2014 |
| 241-AP-106 | 6AP-14-04 | Supernate | Grab | 26 | 6/26/2014 |
| 241-AP-106 | 6AP-14-05 | Supernate | Grab | 26 | 6/26/2014 |
| 241-AP-106 | 6AP-14-02 | Supernate | Grab | 26 | 6/27/2014 |
| 241-AP-107 | 7AP-10-01 | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-01FB | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-01TB | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-02A | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-02B | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-03A | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-03B | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-04A | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-107 | 7AP-10-04B | Supernate | Grab | 2 | 5/7/2010 |
| 241-AP-108 | 8AP-05-02 | Supernate | Grab | 2 | 11/9/2006 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AP-108 | 330 | Core | Push mode | 1 | 3/17/2008 |
| 241-AW-102 | 2AW-07-02A | Supernate | Grab | 18 | 1/10/2007 |
| 241-AW-102 | 2AW-07-02B | Supernate | Grab | 18 | 1/10/2007 |
| 241-AW-102 | 2AW-07-03A | Supernate | Grab | 18 | 1/10/2007 |
| 241-AW-102 | 2AW-07-03B | Supernate | Grab | 18 | 1/10/2007 |
| 241-AW-102 | 2AW-07-04B | Supernate | Grab | 22 | 1/10/2007 |
| 241-AW-102 | 2AW-07-05B | Supernate | Grab | 22 | 1/10/2007 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AW-102 | 2AW-07-05C | Supernate | Grab | 22 | 1/10/2007 |
| 241-AW-102 | 2AW-07-01 | Supernate | Grab | 18 | 1/11/2007 |
| 241-AW-102 | 2AW-07-01FB2 | Supernate | Grab | 18 | 1/11/2007 |
| 241-AW-102 | 2AW-07-04A | Supernate | Grab | 22 | 1/11/2007 |
| 241-AW-102 | 2AW-07-05A | Supernate | Grab | 22 | 1/11/2007 |
| 241-AW-102 | 2AW-07-01FB1 | Supernate | Grab | 18 | 1/15/2007 |
| 241-AW-102 | 2AW-07-01TB | Supernate | Grab | N/A | 1/15/2007 |
| 241-AW-102 | 2AW-14-01FB | Supernate | Grab | 18 | 1/8/2015 |
| 241-AW-102 | 2AW-14-01TB | Supernate | Grab | 18 | 1/8/2015 |
| 241-AW-102 | 2AW-014-04DUP | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-01 | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-02 | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-02A | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-03 | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-04 | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-04A | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-05 | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-05A | Supernate | Grab | 18 | 1/9/2015 |
| 241-AW-102 | 2AW-14-04DUP | Supernate | Grab | 18 | 1/19/2015 |
| 241-AW-105 | 5AW-07-01-FB | Supernate | Grab | 14 | 12/12/2007 |
| 241-AW-105 | 5AW-07-01 | Supernate | Grab | 14 | 12/13/2007 |
| 241-AW-105 | 5AW-07-02 | Supernate | Grab | 14 | 12/13/2007 |
| 241-AW-105 | 5AW-07-03 | Supernate | Grab | 14 | 12/13/2007 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 323 | Core | Push mode | 20 | 6/12/2006 |
| 241-AW-106 | 2AW-08-01TB | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-01 | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-01FB | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-01FB1 | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-01FB2 | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-01TB | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-02A | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-02B | Supernate | Grab | 14 | 3/5/2009 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AW-106 | 6AW-08-03A | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-03B | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-08-04B | Supernate | Grab | 14 | 3/5/2009 |
| 241-AW-106 | 6AW-12-02A | Supernate | Grab | 14 | 12/19/2012 |
| 241-AW-106 | 6AW-12-02DUP | Supernate | Grab | 14 | 12/19/2012 |
| 241-AW-106 | 6AW-12-03 | Supernate | Grab | 14 | 12/19/2012 |
| 241-AW-106 | 6AW-12-03A | Supernate | Grab | 14 | 12/19/2012 |
| 241-AW-106 | 6AW-12-04 | Supernate | Grab | 14 | 12/19/2012 |
| 241-AW-106 | 6AW-12-04A | Supernate | Grab | 14 | 12/19/2012 |
| 241-AW-106 | 6AW-12-01 | Supernate | Grab | 14 | 12/20/2013 |
| 241-AW-106 | 6AW-12-01FB | Supernate | Grab | 14 | 12/20/2013 |
| 241-AW-106 | 6AW-12-01TB | Supernate | Grab | 14 | 12/20/2013 |
| 241-AW-106 | 6AW-12-02 | Supernate | Grab | 14 | 12/20/2013 |
| 241-AY-101 | 1AY-06-01 | Supernate | Grab | 57 | 4/18/2006 |
| 241-AY-101 | 1AY-06-01FB | Supernate | Grab | 57 | 4/18/2006 |
| 241-AY-101 | 1AY-06-02 | Supernate | Grab | 57 | 4/18/2006 |
| 241-AY-101 | 1AY-06-03 | Supernate | Grab | 57 | 4/18/2006 |
| 241-AY-101 | 325 | Core | Push mode | 54 | 3/30/2007 |
| 241-AY-101 | 325 | Core | Push mode | 54 | 3/30/2007 |
| 241-AY-101 | 325 | Core | Push mode | 54 | 3/30/2007 |
| 241-AY-101 | 325 | Core | Push mode | 54 | 3/30/2007 |
| 241-AY-101 | 325 | Core | Push mode | 54 | 3/30/2007 |
| 241-AY-101 | 324 | Core | Push mode | 54 | 11/24/2007 |
| 241-AY-101 | 324 | Core | Push mode | 54 | 11/24/2007 |
| 241-AY-101 | 324 | Core | Push mode | 54 | 11/24/2007 |
| 241-AY-101 | 1AY-07-01 | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-01DUP | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-01FB | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-02 | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-03 | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-04 | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-05 | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 1AY-07-06 | Supernate | Grab | 57 | 12/18/2007 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 331 | Core | Push mode | 66 | 5/1/2008 |
| 241-AY-101 | 1AY-10-01 | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-01DUP | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-01FB | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-03 | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-04 | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-04DUP | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-05 | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-10-06 | Supernate | Grab | 54 | 1/21/2010 |
| 241-AY-101 | 1AY-11-01 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-01FB | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-02 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-03 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-04 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-05 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-06 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-07 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-07DUP | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-11-08 | Supernate | Grab | 54 | 5/19/2011 |
| 241-AY-101 | 1AY-13-01 | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-01A | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-01B | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-01DUP | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-01FB | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-02 | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-02A | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-04 | Supernate | Grab | 54 | 6/11/2013 |
| 241-AY-101 | 1AY-13-05 | Supernate | Grab | 54 | 6/12/2013 |
| 241-AY-101 | 1AY-13-06 | Supernate | Grab | 54 | 6/12/2013 |
| 241-AY-101 | 1AY-13-07 | Supernate | Grab | 54 | 6/12/2013 |
| 241-AY-101 | 1AY-13-08 | Supernate | Grab | 54 | 6/12/2013 |
| 241-AY-101 | 1AY-13-09 | Supernate | Grab | 54 | 6/12/2013 |
| 241-AY-101 | 1AY-13-10 | Supernate | Grab | 54 | 6/13/2013 |
| 241-AY-101 | 1AY-15-07A | Supernate | Grab | 54 | 6/9/2015 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AY-101 | 1AY-15-09 | Supernate | Grab | 54 | 6/9/2015 |
| 241-AY-101 | 1AY-15-06A | Supernate | Grab | 54 | 6/10/2015 |
| 241-AY-101 | 1AY-15-07 | Supernate | Grab | 54 | 6/10/2015 |
| 241-AY-101 | 1AY-15-01 | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-01A | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-01FB | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-01TB | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-02 | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-03 | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-04 | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-05 | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-05A | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-06 | Supernate | Grab | 54 | 6/11/2015 |
| 241-AY-101 | 1AY-15-06DUP | Supernate | Grab | 54 | 6/11/2015 |
| 241-AZ-101 | AZ101-10-01 | Supernate | Grab | 60 | 3/22/2010 |
| 241-AZ-101 | AZ101-10-01FB | Supernate | Grab | 60 | 3/22/2010 |
| 241-AZ-101 | AZ101-10-03 | Supernate | Grab | 60 | 3/22/2010 |
| 241-AZ-101 | AZ101-10-05 | Supernate | Grab | 60 | 3/22/2010 |
| 241-AZ-101 | AZ101-10-01DUP | Supernate | Grab | 60 | 3/23/2010 |
| 241-AZ-101 | AZ101-10-01TRIP | Supernate | Grab | 60 | 3/23/2010 |
| 241-AZ-101 | AZ101-10-04 | Supernate | Grab | 60 | 3/23/2010 |
| 241-AZ-101 | AZ101-10-06 | Supernate | Grab | 60 | 3/23/2010 |
| 241-AZ-101 | AZ101-10-06DUP | Supernate | Grab | 60 | 3/23/2010 |
| 241-AZ-101 | AZ101-10-07 | Supernate | Grab | 60 | 3/23/2010 |
| 241-AZ-102 | 2AZ-09-01 | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-01FB1 | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-01TB | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-02A | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-02B | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-03A | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-03B | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-04A | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-09-04B | Supernate | Grab | 64 | 12/20/2009 |
| 241-AZ-102 | 2AZ-12-09 | Supernate | Grab | 64 | 7/17/2012 |
| 241-AZ-102 | 2AZ-12-05 | Supernate | Grab | 64 | 7/19/2012 |
| 241-AZ-102 | 2AZ-12-07 | Supernate | Grab | 64 | 7/19/2012 |
| 241-AZ-102 | 2AZ-12-08 | Supernate | Grab | 64 | 7/19/2012 |
| 241-AZ-102 | 2AZ-12-10 | Supernate | Grab | 64 | 7/19/2012 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-AZ-102 | 2AZ-12-01 | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-01A | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-01DUP | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-01FB | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-02 | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-03 | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-03A | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-04 | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-04DUP | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-12-06 | Supernate | Grab | 64 | 7/22/2012 |
| 241-AZ-102 | 2AZ-14-01 | Supernate | Grab | 64 | 9/3/2014 |
| 241-AZ-102 | 2AZ-14-01FB | Supernate | Grab | 64 | 9/3/2014 |
| 241-AZ-102 | 2AZ-14-01TB | Supernate | Grab | 64 | 9/3/2014 |
| 241-AZ-102 | 2AZ-14-02 | Supernate | Grab | 64 | 9/3/2014 |
| 241-AZ-102 | 2AZ-14-03 | Supernate | Grab | 64 | 9/4/2014 |
| 241-AZ-102 | 2AZ-14-03A | Supernate | Grab | 64 | 9/4/2014 |
| 241-AZ-102 | 2AZ-14-03C | Supernate | Grab | 64 | 9/4/2014 |
| 241-AZ-102 | 2AZ-14-03DUP | Supernate | Grab | 64 | 9/4/2014 |
| 241-AZ-102 | 2AZ-14-03B | Supernate | Grab | 64 | 9/5/2014 |
| 241-AZ-102 | 2AZ-14-04 | Supernate | Grab | 64 | 9/5/2014 |
| 241-AZ-102 | 2AZ-14-04A | Supernate | Grab | 64 | 9/5/2014 |
| 241-AZ-102 | 2AZ-14-05 | Supernate | Grab | 64 | 9/5/2014 |
| 241-AZ-102 | 2AZ-14-05A | Supernate | Grab | 64 | 9/5/2014 |
| 241-AZ-102 | 2AZ-14-06 | Supernate | Grab | 64 | 9/5/2014 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-101 | 327 | Core | Push mode | 21 | 6/19/2007 |
| 241-SY-102 | 2SY-07-01 | Supernate | Grab | 3 | 1/4/2007 |
| 241-SY-102 | 2SY-07-02 | Supernate | Grab | 3 | 1/4/2007 |
| 241-SY-102 | 2SY-07-02 DUP | Supernate | Grab | 3 | 1/5/2007 |
| 241-SY-102 | 2SY-07-03 | Supernate | Grab | 3 | 1/5/2007 |
| 241-SY-102 | 2SY-07-04 | Supernate | Grab | 3 | 1/5/2007 |
| 241-SY-102 | 2SY-07-05 | Supernate | Grab | 3 | 1/5/2007 |
| 241-SY-102 | 2SY-07-01FB | Supernate | Grab | 3 | 1/8/2007 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-SY-102 | 2SY-07-06 | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-06FB | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-07 | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-07DUP | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-08 | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-09 | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-10 | Supernate | Grab | 3 | 3/6/2007 |
| 241-SY-102 | 2SY-07-11 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-11FB | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-12 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-12DUP | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-13 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-14 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-15 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-16 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-07-17 | Supernate | Grab | 3 | 3/15/2007 |
| 241-SY-102 | 2SY-12-01 | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-01DUP | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-01FB | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-02 | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-03 | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-03A | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-04 | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-04DUP | Supernate | Grab | 3 | 9/12/2012 |
| 241-SY-102 | 2SY-12-05 | Supernate | Grab | 3 | 9/13/2012 |
| 241-SY-102 | 2SY-12-05A | Supernate | Grab | 3 | 9/13/2012 |
| 241-SY-102 | 2SY-12-05B | Supernate | Grab | 3 | 9/13/2012 |
| 241-SY-102 | 2SY-12-06 | Supernate | Grab | 3 | 9/13/2012 |
| 241-SY-102 | 2SY-12-06B | Supernate | Grab | 3 | 9/13/2012 |
| 241-SY-102 | 2SY-12-06A | Supernate | Grab | 3 | 9/17/2012 |
| 241-SY-102 | 2SY-13-01 | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 2SY-13-01FB | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 2SY-13-02 | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 2SY-13-03 | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 2SY-13-04 | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 2SY-13-05 | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 2SY-13-06 | Supernate | Grab | 3 | 2/20/2013 |
| 241-SY-102 | 333 | Core | Push mode | 2 | 9/16/2014 |

**Table V-1: DST Sampling Events since March 31, 2006 (15 sheets)**

| Tank Name | Sampling Event | Sample Type | Device Type | Riser | Sample Event End Date |
|---|---|---|---|---|---|
| 241-SY-102 | 333 | Core | Push mode | 2 | 9/16/2014 |
| 241-SY-102 | 333 | Core | Push mode | 2 | 9/16/2014 |
| 241-SY-102 | 333 | Core | Push mode | 2 | 9/16/2014 |
| 241-SY-102 | 333 | Core | Push mode | 2 | 9/16/2014 |
| 241-SY-102 | 333 | Core | Push mode | 2 | 9/16/2014 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-102 | 334 | Core | Push mode | 4 | 2/19/2015 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |
| 241-SY-103 | 326 | Core | Push mode | 15 | 5/10/2007 |

# APPENDIX W
# REFERENCE DOCUMENTS REVIEWED BY SUBJECT MATTER EXPERTS

# APPENDIX W REFERENCE DOCUMENTS REVIEWED BY SUBJECT MATTER EXPERTS

**Table W-1: Reference Review Responsibility Matrix (64 sheets)**

| Document | This document was reviewed in its entirety. Specific IQRPE review activities and any exceptions are described in this report. | This document was partially reviewed. Specific IQRPE review activities and any exceptions are described in this report. | This document was used for information purposes only. The IQRPE certification does not address the specific content of this document. |
|---|---|---|---|
| 09-NSD-024, 2009, Memorandum from ORP to WRPS: *Contract No. De-Ac27-08rv 14800 - Approval Of Tank Farms Safety Basis Amendment That Eliminates Administrative Control 5.16 And Allows The Corrosion Mitigation Controls To Be Moved To An Operating Specification Document.* | | X | |
| 351731_Post-NPH_Qualification_Card. | X | | |
| 3-CATH-690, 2015, *Cathodic Protection System Testing*, Rev. F-3. | X | | |
| 3-CATH-690, Rev. D-0, Cathodic Protection System Testing, Tank Farm Maintenance Procedure. | X | | |
| 3-CATH-690, Rev. E2, Cathodic Protection System Testing, Tank Farm Maintenance Procedure. | X | | |
| 3-CATH-782, 2014, *Cathodic Protection System Individual Anode Output*, Rev. C-0 | X | | |
| 3-LDD-624, 2014, Perform AY/AZ AWF Annulus Cam (AMS-4) Leak Detectors Functional Check, Rev. K-2. | | X | |
| 5-LCD-300, 2014, ENRAF Series 854 Displacer Weight Check and Obtain Sediment Levels, Rev. I-3, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| 6-LDD-485 ENRAF Series 854 Annulus Leak Detection Gauges Calibration and Maintenance | | X | |
| 10 CFR 851, "Worker Safety and Health Program," *Code of Federal Regulations*, as amended. | | X | |
| 40 CFR 265, *"Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities", Code of Federal Regulation,* as amended. | X | | |

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|---|---|---|---|
| 40 CFR 270, *"EPA Administered Permit Programs: The Hazardous Waste Permit Program" Code of Federal Regulations,* as amended. | X | | |
| 49 CFR 195, *"Transportation of Hazardous Liquids by Pipeline," Code of Federal Regulations,* as amended. | X | | |
| 7G410-MEJ-07-004 Waste Pipeline Failures 2007-01-19 DA94381391 | | | X |
| ACI 349-06, 2006, *Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary*, American Concrete Institute, Detroit Michigan. | | X | |
| ACT-100 WRPS-1104067_Enclosure, Technical Basis for Use of Hanford Waste Transfer Lines Protected with ACT-100® Coating Systems | X | | |
| ACT-100 WRPS-1104067_Letter | X | | |
| ACT-100 WRPS-1104067_Letter_Native | X | | |
| AN-06A Test Riser Locations | | | X |
| Anantatmula 2004, *DST Corrosion Mechanisms and Experience.* | | X | |
| AP-102 UT and Airslot Locations | X | | |
| AP-102 UT Crawler | X | | |
| AP-102 UT Data | X | | |
| Appendix to Part 50 -- *Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants* | | X | |
| ARP-T-041-00002, 2015, *Respond to Alarms at TFMCS HMI Stations, Rev. E-2* | | X | |
| ATTACH 1_JKE, Operate Three Way T-Handle Vale | | | X |
| ATTACH B, Operate Three Way T-Handle Valve | | | X |
| AW-B VALVE PIT PROCESS BLANK INSTALL | | | X |
| AW-B Valve Pit Process Blank Install | | | X |
| AY-01A Fitting Box | | | X |
| AY-02A Fitting Box | | | X |

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|---|---|---|---|
| AZVP Encasement Est Valve Line-Up | | | X |
| BNL-52527, 1997, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, Brookhaven National Laboratory, Upton, New York. | | X | |
| CH2M-0502172_Request for Approval to Consolidate WIP Hot Commissioning Feeds Stores in Tanks 241-AP-101_241-AY-102 | | X | |
| Chemical Waste Compatibility Assessment | | X | |
| Cooke, G. A., 2005, "Final Analytical Results from the Examination of Corrosion on Sections of Cross-Site Transfer Pipe," 7S11O-GAC-05-035 interoffice memo, September 16, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
| Copy of Encasement Pressure Test Results Summary | | X | |
| Copy of Pit Coating Inspection Schedule | X | | |
| DCS02562 | | | X |
| De Renzo, 1976, *Corrosion Resistant Materials Handbook* | X | | |
| Dome Penetration Schedules (WST/WSTA) tank 241-SY-101 | | X | |
| Drawing List LIST H-2-90435-3 | | | X |
| DSC00537 | | | X |
| DSC00538 | | | X |
| DSC01257 | | | X |
| DSC01257 | | | X |
| DSC01258 | | | X |
| DSC01258 | | | X |
| DSC01259 | | | X |
| DSC01259 | | | X |
| DSC01260 | | | X |

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|---|---|---|---|
| DSC01260 | | | X |
| DSC01975 | | | X |
| DSC02025 | | | X |
| DSC02028 | | | X |
| DSC02029 | | | X |
| DSC02378 | | | X |
| DSC02541 | | | X |
| DSC03015 | | | X |
| DSC03016 | | | X |
| DSC03017 | | | X |
| DSC03018 | | | X |
| DSC03019 | | | X |
| DSC03020 | | | X |
| DSC03021 | | | X |
| DSC03022 | | | X |
| DSC03023 | | | X |
| DSC05043 | | | X |
| DSC05044 | | | X |
| DSCN1293 | | | X |
| DSCN1294 | | | X |
| DSCN1295 | | | X |
| DSCN1296 | | | X |
| DSCN1297 | | | X |
| DSCN1297_SMALL | | | X |

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|---|---|---|---|
| DST Tank Levels | X | | |
| Duncan, 2007, *Letter Report for Microbially Influenced Corrosion SL-167.* | | X | |
| ECN-20301 R2 | | X | |
| ECN-720301-R2, Dale | | X | |
| ECN-726083-R1 - [0907200768] | | | X |
| EDT-823049_-_MATERIAL COMPATIBILITY ASSESSMENT REPORT FOR THE TANK 241-UX-302A LIQUID PUMPING SYSTEM | | X | |
| EDT-823049_-_MATERIAL COMPATIBILITY ASSESSMENT REPORT FOR THE TANK 244-CR VAULT LIQUID PUMPING SYSTEM | | X | |
| Effects of Metallurgical Factors and Waste Chemistry on Localized Corrosion and SCC of Hanford Radioactive Waste Tank 241 AY-102 | X | | |
| EM-RP-WRPS-TANKFARM-2008-0001 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2009-0015 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2011-0011 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2011-0023 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2012-0012 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2012-0013 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2013-0007 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2013-0009 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2014-0003 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2014-0008 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2014-0010 Final ORPS | | | X |
| EM-RP-WRPS-TANKFARM-2014-0011 Final ORPS | | | X |
| EM-RP-WRPS-TANKSFARM-2011-002 Final ORPS | | | X |

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|---|---|---|---|
| Engeman, Jason, "Re: Pit Coating Inspection Schedule". Message to Jeremy Hailey, 2015, email. | X | | |
| Equipment Failure Summary Table | | | X |
| GJO-HAN-18, 1998, *241-C Farm Vadose Zone{D8444597}*, U.S. Department of Energy, Grand Junction, Colorado. | | | X |
| GJO-HAN-18, 2008, *Addendum to the C Tank Farm Report, {D8444597*, U.S. Department of Energy, Grand Junction, Colorado. | | | X |
| H-14-010501 Sh. 1, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-101*, Rev. 22, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010501 Sh. 2, 2011, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-102*, Rev. 14, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010501 Sh. 3, 2011, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-103*, Rev. 11, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010501 Sh. 4, 2011, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-104*, Rev. 12, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010501 Sh. 5, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-105*, Rev. 10, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010501 Sh. 6, 2011, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-106*, Rev. 15, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010501 Sh. 7, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AN-107*, Rev. 16, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |

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| H-14-010502 Sh. 1, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AW-101*, Rev. 9, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
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| H-14-010502 Sh. 3, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AW-103*, Rev. 7, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
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| H-14-010502 Sh. 5, 2013, *Dome Penetration Schedules (WST/WSTA) Tank 241-AW-105*, Rev. 8, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010502 Sh. 6, 2011, *Dome Penetration Schedules (WST/WSTA) Tank 241-AW-106*, Rev. 8, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010506 241-AY-101_-_Sheet_2_0_Rev_2_-_[1003171115]H-14-010506 Sh. 2, 2012, Dome Penetration Schedules (WST/WSTA) Tank 241-AY-101, Rev. 2, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010506 Sh. 1, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AY-101*, Rev. 18, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010507 Sh. 1, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AZ-101*, Rev. 15, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |

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| H-14-010507 Sh. 2, 2012, *Dome Penetration Schedules (WST/WSTA) Tank 241-AZ-102*, Rev. 12, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010531 Sh. 1, 2015, *Dome Penetration Schedules (WST/WSTA) Tank 241-SY-101*, Rev. 13, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010531 Sh. 2, 2015, *Dome Penetration Schedules (WST/WSTA) Tank 241-SY-102*, Rev. 17, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-010531 Sh. 3, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-SY-103*, Rev. 8, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-020000 001 Rev. 19, Tank Farms System P&ID Structure Legend | | X | |
| H-14-020000 002 Rev. 21, Tank Farms System P&ID Structure Legend | | X | |
| H-14-020000 003 Rev. 15, Tank Farms System P&ID Structure Legend | | | X |
| H-14-020000 004 Rev. 12, Tank Farms System P&ID Structure Legend | | | X |
| H-14-020000 005 Rev. 6, Tank Farms System P&ID Structure Legend | | | X |
| H-14-020501 001 Rev. 11 Waste Storage Tank Annulus Instm Sys (WSTA) O&M Sys P&ID Tank 241-AN-101 | | | X |
| H-14-010531 Sh. 2, 2015, *Dome Penetration Schedules (WST/WSTA) Tank 241-SY-102*, Rev. 17, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-020507 Sh. 3, 2005, Waste Storage Tank Annulus System (WSTA) O&M System P&ID, Rev. 6, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |

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| H-14-101503 Sh. 1, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-101*, Rev. 10, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 2, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-102*, Rev. 9, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 3, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-103*, Rev. 10, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 4, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-104*, Rev. 10, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 5, 2011, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-105*, Rev. 9, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 6, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-106*, Rev. 10, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 7, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-107*, Rev. 11, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-101503 Sh. 8, 2010, *Dome Penetration Schedules (WST/WSTA) Tank 241-AP-108*, Rev. 10, U.S. Department of Energy, Office of River Protection, Richland Washington. | | X | |
| H-14-102650-3, Piping Pump Pits 241-AY-01A and 02A Modification Details | | | X |
| H-14-102653-1, Jumper Assembly 241-AY-01A U13A Drain | | | X |
| H-14-102660-1, Piping Plan 241-AY-01A to 241-AY-02A | | | X |

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|---|---|---|---|
| H-14-103250 AZ-VP JUMPER ARRANGEMENT | | | X |
| H-14-103263-3, Piping Valve Pit 241-AZ-VP Embedded Pipe Details | | | X |
| H-14-103596, Sh. 1, 2001, SY-101 Cross Site Trans System Hose and Hose Assembly, Rev. 3, U.S. Department of Energy, Office of River Protection, Richland, Washington. | | X | |
| H-14-106249, 2014 *HIHTL Tracking Table*, Rev. 31, Washington River Protection Solutions, LLC, Richland, Washington | | X | |
| H-14-107346, 2014, *DST Waste Transfer Piping Diagram*, Sh. 1 (Rev. 20), Sh. 2 (Rev. 13), Sh. 3 (Rev. 24), Sh. 4 (Rev. 12), Sh. 5 (Rev. 25, Sh. 6 (Rev. 31), Sh. 7 (Rev. 25), U.S. Department of Energy, Office of River Protection, Richland, Washington. | | X | |
| H-2-2310-1 Grey Part. Dwg | X | | |
| H-2-34965 004 Rev 23 Leak Detector Assembly Typical Details | | | X |
| H-2-37772-1 SY Tank Cross Section | X | | |
| H-2-64449-1 AY Tank Cross Section Sheet 1 | X | | |
| H-2-64449-2 AY Tank Cross Section Sheet 2 | X | | |
| H-2-67317-1 AZ Tank Cross Section Sheet 1 | X | | |
| H-2-67317-2 AZ Tank Cross Section Sheet 2 | X | | |
| H-2-70394-1 AW Tank Cross Section | X | | |
| H-2-70409-2, Piping Sections and Details | | | X |
| H-2-70415-1, Piping Plan and Details Feed Pump Pit 241-AW-02E | | | X |
| H-2-70432-001-05 Jumper Arragement Feed Pump Pit 241-AW-02E | | | X |
| H-2-71913-3, Structural Cover Blocks 241-AN-A Plan and Details | | | X |
| H-2-71975-1 AN Tank Cross Section Sheet 1 | X | | |
| H-2-71975-2 AN Tank Cross Section Sheet 2 | X | | |
| H-2-71986-1, Piping Plan 241-AN Tank Farm | | | X |

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|---|---|---|---|
| H-2-71988-1, Piping Sections and Details | | | X |
| H-2-71988-2, Piping Sections and Details | | | X |
| H-2-71989-1, Piping Sections and Details | | | X |
| H-2-71990-1, Piping Sections and Details Valve Pits 241-AN-A&B | | | X |
| H-2-71998-1, Piping Plan Central Pump Pit 241-AN-01A thru 07A | | | X |
| H-2-72009-001-07, Jumper Arrangement Valve Pit 241-AN-A | | | X |
| H-2-72010-1, Jumper Arrangement Central Pump Pit 241-AN-01A thru 07A | | | X |
| H-2-81187-1, Engineering Flow Diagram (104 AP Grout Feed Tank) | | | X |
| H-2-81225-1, Jumper Arrangement Central Pump Pit 241-AP-04A | | | X |
| H-2-90534-1 AP Tank Cross Section | X | | |
| H-2-90551-1, Piping Plan 241-AP-Valve Pit, (LINE 20 AND 9 GO TO AP04). | | X | |
| H-2-90561-1, Piping Miscellaneous Details I, Detail 9 | | X | |
| H-2-90562-1, Piping Plan Central Pump Pit 241-AP-01A Thru 08A | | | X |
| H-2-90562-2, Piping Pump Pit 241-AP-02A Modifications | | | X |
| H-2-90598-002-04, Piping Jumper Arrangement 241-AP Valve Pit | | X | |
| HNF-4737, 2000, *Consolidation of Integrity Assessment Reports for Project W-087, I-E-2 Hot Cell (Project W-251), and Rooms 1J and 1K Upgrades,* Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| HNF-EP-0182, *Waste Tank Summary Report*, (monthly), Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| HNF-SD-WM-DQO-001, *Data Quality Objectives for Tank Farms Waste Compatibility Program* | | X | |
| HNF-SD-WM-OCD-015, 2011, Rev. 23, *Tank Farms Waste Transfer Compatibility Program,* Washington River Protection Solutions, LLC, Richland, Washington. | X | | |

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| HNF-SD-WM-TSR-006, 2014, *Tank Farms Technical Safety Requirements*, Rev. 7-V, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| Ignition Source Requirements | X | | |
| IQRPE 2016 DST System Integrity Assessment: Review of Waste Transfer System System Health Reports CY 2006-CY 2014 | | | X |
| ISC Screening for AW-B Encasements | | | X |
| ISC Screening Form Unsigned, Ignition Source Control Requirements Screening , TFC-WO-11-5951, AN Farm SL-166 and SN-266 Encasement Hydro Tests | X | | |
| ISC Screening Form, Ignition Source Control Requirements Screening , TFC-WO-11-5951, AN Farm SL-166 and SN-266 Encasement Hydro Tests | X | | |
| ISC Screening, Ignition Source Control Requirements Screening | X | | |
| Kickoff Meeting Briefing 2014-11-18 | | | X |
| LAB-RPT-11-00006, 2011, *Final Report for the Corrosion Analysis of SN-285 and SN-286 Pipeline for SY Tank Farm*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| LAB-RPT-12-00007, 2012, Rev. 0, *Final Report for the Erosion and Corrosion Analysis of Waste Transfer Primary Pipeline Sections from 241-SY Tank Farm*, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| LAB-RPT-14-00005 R0 Final Report for the Erosion-Corrosion Analysis of Tank 241-AW-02E Feed Pump Pit Jumpers B-2 and 1-4 Removed from Service in 2013 | X | | |

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| Miller, P. C., 2000, "Administrative Orders 00NWPKW 1250 and 00NWPKW 1251 September 18, 2000 Required Actions 1.B, 2, 3, and Completion" (letter CHG 0004750 to D. C. Bryson, U.S. Department of Energy, Office of River Protection, September 12), CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
| Moore, E.L. 1980, "Inspection of Tank 107-AN." Letter to J.F. Albaugh, Richland, Washington. NACE SP0169, 2013, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*, NACE International, Houston, Texas. | | X | |
| NACE SP0169, 2013, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems"*, NACE International, Houston, Texas. | X | | |
| NACE SP0285, 2011, *External Corrosion Control of Underground Storage Tank Systems by Cathodic Protection*, NACE International, Houston, Texas. | X | | |
| NACE TM0497, 2012, *Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping*, NACE International, Houston, Texas. | X | | |
| November 2014 Hanford Cleanup Condition of Tanks May Further Limit DOE's Ability to Respond to Leaks and Intrusions | | | X |
| Occurrence+Off-Normal DST Integrity Reports 2006-Present | | | X |
| OE-05-029, 2005, *Operability Evaluation: 241-AW Tank Farm Transfer Line SL-267 Operability*, Rev. 0, Operability Evaluation 2005-05-16 | | | X |
| Operate Tank Monitor and Control System (TMACS) Surveillance System for Underground Storage Tanks | | X | |
| ORP-11242-07 System Plan Excerpt Basic Tank Farm Schematic | | X | |
| OSD-T-151-00007, REV 12, Operating Specifications for the Double-Shell Storage Tanks | X | | |
| OSD-T-151-00007, Rev. 14, Operating Specifications for the Double-Shell Storage Tanks | X | | |

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| OSD-T-151-00010, Rev. 1, Operating Specifications for Pressure Testing and Leak Detection for Tank Farm Transfer Systems and for Control and use of Temporary Transfer Lines | X | | |
| OSD-T-151-00031 Rev. 5 Operating Specifications for Tank Farm Leak detection and Single-Shell Tank Intrusion Detection | | X | |
| OSD-T-151-00031, 2015, Rev. 6, *Operating Specifications for Tank Farm Leak Detection and Single-Shell Tank Intrusion Detection.* | | X | |
| PCHB No. 98-249; No. 98-250, Pollution Control Hearings Board State of Washington, Settlement Agreement and Stipulated Order of Dismissal | | X | |
| Perry, J. H., ed., 1963, Perry's Chemical Engineering Handbook, 4th Edition; McGraw-Hill Inc., New York, New York. | X | | |
| Pit Coatings Next Due Dates for Pit Coating Inspection (Engeman) | | | X |
| PNL-5488, 1985, *Prediction Equations for Corrosion Rates of A-537 and A-516 Steels in Double-Shell Slurry, Future PUREX, and Hanford Facilities Waste*, Pacific Northwest Laboratory, Richland, Washington. | X | | |
| PNNL-13337, 2001, *Preventing Buoyant Displacement Gas Release Events in Hanford Double-Shell Waste Tanks*, Pacific Northwest National Laboratory, Richland, Washington | X | | |
| PNNL-13571, 2001, *Expert Panel Recommendations for Hanford Double-Shell Tank Life Extension*, Pacific Northwest National Laboratory, Richland, Washington. | X | | |
| PNNL-13781, 2002, Effects of Globally Waste-Disturbing Activities on Gas Generation, Retention, and Release in Hanford Waste Tanks, Pacific Northwest National Laboratory, Richland, Washington. | | X | |
| PNNL-14106, 2002, *Statistical Analyses of AY-101 Ultrasonic Measurements of Wall Thickness*, Pacific Northwest National Laboratory, Richland, Washington. | | | X |

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| PNNL-14176, *Independent Review of Tank 241-AY-101 Fitness for Service*, Pacific Northwest National Laboratory, Richland, Washington. | | X | |
| PNNL-14706, *DST Primary Tank Settlement Evaluation*, Pacific Northwest National Laboratory, Richland, Washington. | | X | |
| PNNL-15136, 2004, *Feasibility Test Report SAFT/T-SAFT Scanning on the Curved Knuckle of Hanford's Double-Shell Tanks*, Pacific Northwest National Laboratory, Richland, Washington. | | | X |
| PNNL-15182, 2005, *Riser Difference Uncertainty Methodology Based on Tank AY-101 Wall Thickness Measurements with Application to Tank AN-107*, Pacific Northwest National Laboratory, Richland, Washington. | X | | |
| PNNL-15415, 2005, *Estimation of Maximum Wall Thickness Loss of Five DSTs (AN-107, AP-102, AW-101, AZ-102, and SY-101)*, Pacific Northwest National Laboratory, Richland, Washington. | X | | |
| PNNL-19010, 2010, *Evaluation of Ultrasonic Measurement Variation in the Double-Shell Tank Integrity Project*, Pacific Northwest National Laboratory, Richland, Washington. | X | | |
| PNNL-19242, 2010, *Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks*, Pacific Northwest National Laboratory, Richland, Washington. | | X | |
| PNNL-19767, 2010, *Chemical Species in the Vapor Phase of Hanford Double-Shell Tanks: Potential Impacts on Waste Tank Corrosion Processes*, Pacific Northwest National Laboratory, Richland, Washington. | X | | |
| Quad Chart Graphic | X | | |
| RPP-10006, 2009, Rev. 9, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |

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| RPP-27591 Piping Table A-1 Conversion + Line Classification Rev. 0 | X | | |
| RPP-27591, 2007, *Volume 2: IQRPE DST System Integrity Assessment – Pipeline Integrity*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
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| RPP-28502, 2010, *Spreadsheet Description Document for Waste Compatibility Assessment*, Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington. | | | X |
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| RPP-28538, 2008, *Volume 1: IQRPE Double-Shell Tank System Integrity Assessment Report HFFACO M-48-14*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
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| RPP-45569, 2010, *AW-B Rigid Jumper A-D Independent Integrity Assessment Report*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
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| RPP-47175, 2010, Cost Benefit Analysis: Selection of Alternative Direct Inspection Technology for Future Encasement Pipeline Integrity Assessments, Rev. 0, ARES Corporation, Richland, Washington. | | X | |
| RPP-47895, 2012, *FY2011 DNV DST Corrosion and Stress Corrosion Cracking Testing Report,* Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-56584 Rev 0 IQRPE Fabrication Assessment Report For 241-AY-02A/AY-02F Jumper Replacements and AY-02F Pump Assembly Report No. FA-251492-01 | | | X |
| RPP-56932 REV 0 IQRPE DESIGN ASSESSMENT REPORT FOR AW-B VALVE PIT JUMPER R-1-R3-C REPLACEMENT REPORT NO DA-258260-01 REV 0 | | X | |
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| RPP-6213, Rev 3, 2003, ADDENDUM 1: Response to Comment No. 4 of May 21. 2003 Relative to Tank Bump Report RPP-6213. Rev. 2 and Tank Bump Accident Analysis Close-out, Fauske & Associates, Inc., Burr Ridge, Illinois. | | X | |
| RPP-6965, 2000, Toxicological Source Terms for Tank Farms Safety Analyses, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
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| RPP-ASMT-27936, REV 0, Evaluation of the Secondary Liner under Postulated Waste Leakage Scenario in a Double-Shell Tank Annulus | | X | |
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| RPP-ASMT-53793, 2012, *Tank 241-AY-102 Leak Assessment Report*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-ASMT-55871, 2013, Rev. 0, *Propensity for Corrosion in the 241-AY-102 Annulus*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-ASMT-56329, 2014, Rev. 0, *First Workshop of the Comprehensive Review of Double-Shell Tank Structural and Leak Integrity Panel: 241-AY-102 Leak Assessment*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-ASMT-56781, 2014, Rev. 0, *Outcomes from the August 2013 Expert Panel Oversight Committee Meeting*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-ASMT-56862, 2014, Rev. 0, *Expert Panel Oversight Committee Fiscal Year 2013 Chemistry Testing Review*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-ASMT-57109, 2014, Rev. 0, *Expert Panel Oversight Committee March 2014 Meeting Outcomes*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-ASMT-57582, 2014, Rev. 0, *Second Workshop of the High Level Waste Integrity Assessment Panel: Extent of Condition and Balance of Program*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
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| RPP-CALC-41282, 2009, Rev. 0, *241-SY Valve Pits A/B Wall Analysis,* AREVA Federal Services LLC, Richland, Washington. | X | | |
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| RPP-PLAN-37138, 2010, Rev. 0, *Work Plan for Assessing the Need for Cathodic Protection on the 241-AZ-301 Condensate Receiver Tank Secondary Containment Vessel,* ARES Corporation, Richland, Washington. | X | | |
| RPP-PLAN-45268, 2010, Rev. 0, *Hanford Site Cathodic Protection Monitoring Program Plan,* ARES Corporation, Richland, Washington. | X | | |
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| RPP-PLAN-55857_-_Rev_00, Cathodic Protection Program Improvement Plan | X | | |
| RPP-RPT-11581, 2003, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-102*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
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| RPP-RPT-23308, *Hanford Double-Shell Tank Thermal and Seismic Project – Thermal and Operating Loads Analysis*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
| RPP-RPT-24476_Rev 1 Ultrasonic Inspection Results for Double Shell Tank 241-AN-103 FY 2005 and FY 2006 | | X | |
| RPP-RPT-25161, 2005, *Project W-314 241-AW02A Pit Structure and Coating Independent Integrity Assessment Report*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-25162, Project W-314, 241-AW-02D Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-25163, Project W-314 SY-A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-25320, 2005, Rev. 0, *AW-01A Pit Coating Strategy Report and Decision Document*, Vista Engineering, Richland, Washington. | X | | |
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| RPP-RPT-25458, 2005, Rev. 0, *AW-04A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25506, 2005, Rev. 0, *AW-06A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25574, 2005, Rev. 1, *SY-02A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25595, 2005, Rev. 0, *SY-02D Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25606, 2005, Rev. 0, *SY-03A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25608, REV 0, Hanford Double-Shell Tank Thermal and Seismic Project - Increased Concentrated Load Analysis | | X | |
| RPP-RPT-25645, 2005, Rev. 0, *AP-01A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25655, 2005, Rev. 0, *AP-03A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25749, 2012, *System Health Report for Waste Transfer Containment for Fourth Quarter CY 2011,* Rev. 27, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-25836, 2005, Rev. 0, *AP-07A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25853, Project W-314 SY-03A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-25854, Project W-314 SY-03A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-25855, Project W-314 241-Aw-01A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |

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|---|---|---|---|
| RPP-RPT-25883, 2005, Rev. 0, *AP-02A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-25978, Project W-314 SY-02D Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-25979_-_Rev_-_-_[DA102012], Project W-314 241-AW-06A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-25980, Project W-314 SY-02A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-26254_Rev_1 Ultrasonic Inspection Results for Double Shell Tank 241-AN-104 FY 2005 and FY 2006 | | X | |
| RPP-RPT-26807, Project W-314 AP-07A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-26808, 2005, *Project W-314 AP-02A Pit Concrete Structure and Coating Independent Integrity Assessment Report*, Rev. 0, Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-26809, Project W-314 AP-01A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-26810, Project W-314 AP-03A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-26811, Project W-314 AP-04A Pit Concrete Structure and Coating Independent Integrity Assessment Report | X | | |
| RPP-RPT-26823, 2005, Rev. 0, *AP-08A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-26835, 2005, Rev. 0, *AP-05A Pit Coating Strategy Report and Decision Document,* Vista Engineering, Richland, Washington. | X | | |

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|---|---|---|---|
| RPP-RPT-26836, 2014, *Gas Retention and Release from Hanford Sludge Waste*, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-26866, 2005, *Project W-314 AP-03D Pit Concrete Structure and Coating Independent Assessment Report,* Rev. 0, MEIER Enterprises, Inc., Richland, Washington. | X | | |
| RPP-RPT-26983, REV 2, Independent Construction Assessment Report of Project E-525 DST Transfer System Modifications | | X | |
| RPP-RPT-27145, 2005, Project W-314 AP-05A Pit Concrete Structure and Coating Independent Integrity Assessment Report, Rev. 0, Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-27146, 2005, *Project W-314 AP-08A Pit Coating Structure and Coating Independent Integrity Assessment Report*, Rev. 0, Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-27147, 2005, *Project W-314 AW-02E Concrete Structure and Coating Independent Integrity Assessment Report*, Rev. 0, Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-27467, 2006, *Supplemental Ultrasonic Inspection Results for Double-Shell Tank 241-AN-105 – FY 2005*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-27574, 2006, *Evaluation and Recommendation of Stress Criteria for Stress Corrosion Cracking of Hanford Double-Shell Tanks,* Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
| RPP-RPT-28500_-_Rev_7_-_, Technical Basis Document for TFC-ENG-STD-22, Piping Jumpers and Valves | X | | |
| RPP-RPT-28933, 2006, Rev. 0, *AP Valve Pit Strategy Report and Decision Document,* CH2M Hill Hanford Group, Inc. | X | | |

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|---|---|---|---|
| RPP-RPT-28963, REV 1, Hanford Double-Shell Tank Thermal and Seismic Project-Dytran Analysis of Seismically Induced Fluid-Structure Interaction in a Double Shell Primary Tank | | X | |
| RPP-RPT-28964, REV 0A, Hanford Double-Shell Tank Thermal and Seismic Project-Establishment of Methodology for Time Domain Soil-Structure Interaction Analysis of a Hanford Double-Shell Tank | | | X |
| RPP-RPT-28965, REV 0A, Hanford Double-Shell Tank Thermal and Seismic Project-ANSYS Benchmark Analysis of Seismically Induced Fluid-Structure Interaction in a Hanford Double-Shell Primary Tank | | | X |
| RPP-RPT-28966, REV 1, Hanford Double-Shell Tank Thermal and Seismic Project-Seismic Analysis of Hanford Double-Shell Tanks | | X | |
| RPP-RPT-28967, REV 2, Hanford Double-Shell Tank Thermal and Seismic Project-Buckling Evaluation Methods and Results for the Primary Tanks | | X | |
| RPP-RPT-28968, REV 1, Hanford Double-Shell Tank Thermal and Seismic Project-Summary of Combined Thermal and Operating Loads with Seismic Analysis | | X | |
| RPP-RPT-29052, 2008, *Double-Shell Tank Integrity Project AP-Valve Pit Concrete Structure and Coating Independent Integrity Assessment Report*, Rev. 0, MEIER Enterprises, Inc., Richland, Washington. | | X | |
| RPP-RPT-29198, 2006, Rev. 0, *Double-Shell Tank Integrity Project AP-02D Pit Coating Strategy Report and Decision Document*, Vista Engineering, Richland, Washington. | X | | |
| RPP-RPT-29199, 2006, *Double-Shell Tank Integrity Project AP-02D Pit Concrete Structure and Coating Independent Integrity Assessment Report*, Rev. 0, MEIER Enterprises, Inc., Richland, Washington. | X | | |
| RPP-RPT-29371_-_Rev_0 Waste Compatibility Assessment of Tank 241-SY-101 with Tank 241-AP-107 Waste | | X | |

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|---|---|---|---|
| RPP-RPT-29425, 2006, Rev. 0, *AP-06A Pit Coating Strategy Report and Decision Document,* CH2M Hill Hanford Group Inc., Richland, Washington. | X | | |
| RPP-RPT-29426, 2006, *Tank Farm Restoration and Safe Operation Project W-314 AP-06A Pit Concrete Structure and Coating Independent Integrity Assessment Report*, Rev. 0, MEIER Enterprises, Inc., Richland, Washington. | X | | |
| RPP-RPT-29528_-_Rev_0_ Waste Compatibility Assessment of Tanks 241-SY-102 Waste with Tank 241-SY-101 Waste and Simultaneou-1 | | X | |
| RPP-RPT-29811_-_Rev_0_ WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-103 & 241-C-204 WASTE (222s-06-01) WITH TANK 241-AN-106 WASTE & TA-1 | | X | |
| RPP-RPT-29961, 2006, Rev. 0, *SY-B Pit Coating Strategy Report and Decision Document,* CH2M Hill Hanford Group, Richland, Washington. | X | | |
| RPP-RPT-29962, 2006, *SY-B Pit Concrete Structure and Coating Independent Integrity Assessment Report,* Rev. 0, MEIER Enterprises, Inc., Richland, Washington | X | | |
| RPP-RPT-30257_-_Rev_0_WASTE COMPATIBLITY ASSESSMENT OF TANK 241-AZ-301 CONDENSATE WITH TANK 241-AY-101 WASTE | | X | |
| RPP-RPT-30633_-_Rev_0_WASTE COMPATIBLITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGN 06-01 WASTE (EVAP-06-01) WITH TANK 241--1 | | X | |
| RPP-RPT-30685_-_Rev_0_WASTE COMPATIBLITY ASSESSMENT OF CATCH TANKS 241-UX-302A AND 241-ER-311 WASTES WITH TANK 241-SY-10-1 | | X | |
| RPP-RPT-30804, 2006, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-103 – FY2006,* CH2M Hill Hanford Group Inc., Richland, Washington. | | | X |

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|---|---|---|---|
| RPP-RPT-30824, 2007, *Electrochemical Corrosion Studies for Tank 241-AN-107, Core 309 Segments 21R1, 21R2*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-30956_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-102 WASTE RECIRCULATION | | X | |
| RPP-RPT-31033_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF CATCH TANKS 241-UX-302A AND 241-ER-311 WASTES WITH TANK 241-AN-10-1 | | X | |
| RPP-RPT-31129, REV 0, Expert Panel Workshop on Double Shell tank Vapor Space Corrosion Testing | X | | |
| RPP-RPT-31219_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC ADDITION AND TANK 241-AZ-301 CONDENSATE WITH TANK 241-AY--1 | | X | |
| RPP-RPT-31276_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-S-102 WASTE WITH TANK 241-SY-102 WASTE | | X | |
| RPP-RPT-31599, 2010, Rev. 3, *Double-Shell Tank Integrity Inspection Report for 241-AN Tank Farm,* Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-31599, 2014, *Double-Shell Tank Integrity Inspection Report for 241-AN Tank Farm,* Rev. 6, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-31599, REV 5, Double-Shell tank Integrity Inspection Report for 241-AN Tank Farm | X | | |
| RPP-RPT-31601_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 WASTE WITH TANK 241-AW-102 WASTE | | X | |

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|---|---|---|---|
| RPP-RPT-31680, 2006, Rev. 0, *Hanford Tanks 241-AN-107 and 241-AN-102: Effect of Chemistry and Other Variables on Corrosion and Stress Corrosion Cracking,* CH2M Hill Hanford Group Inc., Richland, Washington. | | X | |
| RPP-RPT-31692_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC ADDITION TO TANK 241-SY-102 | | X | |
| RPP-RPT-31789_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-102 WASTE WITH TANK 241-AN-106 WASTE | | X | |
| RPP-RPT-32137, REV 0, Ultrasonic Inspection Results for Double-Shell Tank 241-AY-102--FY2007 | | | X |
| RPP-RPT-32169_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-102 WASTE WITH TANK 241-AW-102 WASTE | | X | |
| RPP-RPT-32237, REV 1, Hanford Double-Shell Tank Thermal and Seismic Project-Increased Liquid Level Analysis for 241-AP Tank Farms | | X | |
| RPP-RPT-32238, REV 0, Hanford Double-Shell Tank Thermal and Seismic Project-Primary Tank Minimum Wall Thickness Analysis | | X | |
| RPP-RPT-32308_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE | | X | |
| RPP-RPT-32409_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-S-112 AND 241-S-102 WASTES WITH TANK 241-SY-102 WASTE | | X | |
| RPP-RPT-32451, 2007, Rev. 0, *Waste Compatibility Assessment of Tank 241-SY-101 Waste with Tank 241-AP-101 Waste,* CH2M Hill Hanford Group, Inc., Richland, Washington. | | | X |
| RPP-RPT-32690_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE | | X | |
| RPP-RPT-32945_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-103 WASTE WITH TANK 241-AN-101 WASTE | | X | |

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|---|---|---|---|
| RPP-RPT-32976_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-SY-102 WASTE WITH TANK 241-SY-101 WASTE (3RD) AND TANK 2-1 | | X | |
| RPP-RPT-33252 Rev 0 Waste Compatibility Assessment of 241-SY-103C Pit and Tank 241-S-102 Wastes with Tank 241-SY-102 Waste | | X | |
| RPP-RPT-33565_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGNS 07-01 AND 07-02 | | X | |
| RPP-RPT-33664, REV 0 -Independent Assessment of Cathodic Protection-Related Findings in the 2006 Double-Shell Tank Integrity Assessment Report | X | | |
| RPP-RPT-33906, 2007, *241-AW-02A Pit Concrete Coating - Independent Integrity Assessment Report,* Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |
| RPP-RPT-34000_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-07-01) WITH TANK 241-SY-101 WASTE | | X | |
| RPP-RPT-34310, 2014, Rev. 1, *Double-Shell Tank Integrity Inspection Report for 241-AZ Tank Farm,* Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-34311, 2014, Rev. 02, *Double-Shell Tank Integrity Inspection Report for 241-AY Tank Farm,* Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-34311, 2007, *Double-Shell Tank Integrity Inspection Report for 241-AY Tank Farm,* Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-34311, REV 1 - Double-Shell Tank Integrity Inspection Report for 241-AY Tank Farm | X | | |

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|---|---|---|---|
| RPP-RPT-34475, 2007, *241-AN-A and AN-B Valve Pits Concrete Coating Independent Integrity Assessment Report*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-34697, REV 0 - Electrochemical Corrosion Report for Tanks 241-AW-103, 241-AZ-102, 241-AN-106, 241-AN 107, 241-AY-101, and 241-AY-102 | X | | |
| RPP-RPT-35554, 2008, *Electrochemical Corrosion Tests for Tank 241-AY-101 Core 325, Segments 16R1 and 16R2*, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-35741, 2008, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-107 – FY 2008,* CH2M Hill Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-36377_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-AP-107 241-AW-106 AND 241-AZ-102 WASTES WITH TANK 241-A-1 | | X | |
| RPP-RPT-36567, REV 0 | | | X |
| RPP-RPT-36722, 2008, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-108 – FY 2008*, Rev. 0A, CH2M HILL Hanford Group, Inc., Richland, Washington. | X | | |
| RPP-RPT-37161_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AZ-102 WASTE WITH TANK 241-AP-107 WASTE | | X | |
| RPP-RPT-37413_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-S-302 WASTE WITH TANK 241-AP-106 WASTE | | X | |
| RPP-RPT-37413_-_Rev_0A_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-S-302 WASTE WITH TANK 241-AP-106 WASTE | | X | |
| RPP-RPT-37671_0_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-105 WASTE WITH TANK 241-AZ-102 WASTE AND 241-AP-105 W-1 | | X | |

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|---|---|---|---|
| RPP-RPT-37671_0_Rev_2_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-105 WASTE WITH TANK 241-AZ-102 WASTE AND 241-AP-105 W-1 | | X | |
| RPP-RPT-38122_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 242-A SUMP WASTE WITH TANK 241-AW-102 WASTE FOR EVAPORATOR COLDRU-1 | | X | |
| RPP-RPT-38122_-_Rev_0A_WASTE COMPATIBILITY ASSESSMENT OF 242-A SUMP WASTE WITH TANK 241-AW-102 WASTE FOR EVAPORATOR COLDR-1 | | X | |
| RPP-RPT-38160_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGNS 08-01 AND 08-02 | | X | |
| RPP-RPT-38183_-_Rev_2_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-101 WASTE AND 242-A SUMP W3ASTE WITH TANK 241 AW-102 W-1 | | X | |
| RPP-RPT-38184_-_Rev_2_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-101 WASTE AND 242-1 SUMP WASTE WITH TANK 241 AW-102 W-1 | | X | |
| RPP-RPT-38378, 2008, Rev. 0, *Waste Compatibility Assessment of Tank 241-AW-106 Waste Recirculation,* CH2M Hill Hanford Group, Inc., Richland, Washington. | | | X |
| RPP-RPT-38378_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AW-106 WASTE RECIRCULATION | | X | |
| RPP-RPT-38415_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-110 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN-1-1 | | X | |
| RPP-RPT-38431_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 AND 241-C-110 WASTE WITH TANK 241-AZ-101 WASTE | | X | |

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| RPP-RPT-38738 Rev 3 Double-Shell Tank Integrity Inspection Report for 241-AP Tank Farm | X | | |
| RPP-RPT-38738, 2015, *Double-Shell Integrity Inspection Report for 241-AP Tank Farm,* 2015, Rev. 4, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-38778, 2008, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AN-102 – FY 2008,* CH2M Hill Hanford Group, Inc., Richland, Washington. | | | X |
| RPP-RPT-38857_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 25% TANK 241-C-110 RETRIEVED WASTE WITH TANK 241-AN-106 WASTE AND -1 | | X | |
| RPP-RPT-38857_-_Rev_08_-_[0809170034] - Waste Compatibility Assessment of 25% Tank 241-C-110 Retrieved Waste with Tank 241 AN-106 Waste and Tank 241-AN-106 Waste with Tank 241-C-110 Waste | | X | |
| RPP-RPT-38857_-_Rev_0A_WASTE COMPATIBILITY ASSESSMENT OF 25% TANK 241-C-110 RETRIEVED WASTE WITH TANK 241-AN-106 WASTE AN-1 | | X | |
| RPP-RPT-39121, 2008, *241-AN-01A Pit Concrete Coating Independent Integrity Assessment Report*, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington. | | X | |
| RPP-RPT-39149, 2009, Rev. 0, *Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm,* Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-39149, 2010, *Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm,* Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-39149, REV 1 - Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm | X | | |

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| RPP-RPT-39193_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-08-01) WITH TANK 241-SY-101 WASTE | | X | |
| RPP-RPT-39193_-_Rev_0A_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-08-01) WITH TANK 241-SY-101 WASTE | | X | |
| RPP-RPT-39193_-_Rev_0B_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-08-01) WITH TANK 241-SY-101 WASTE | | X | |
| RPP-RPT-39224, 2008, *Electrochemical Corrosion Testing of Tanks 241-AN-102, 241-AP-107, and 241-AP-108 in Support of Ultrasonic Testing*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-39396, 2009, *Electrochemical Corrosion Testing for Tank 241 AP 108 Core 330, Supernatant and Segments 24BR1 and 24BR2*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-39636, 2008, Rev. 0, *Waste Compatibility Assessment of 76% Tank 241-C-110 Retrieved Waste with Tank 241-AN-106 Waste and Tank 241-AN-106 Waste with Tank 241-C-110 Waste,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-39716, 2009, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-101 – FY 2009,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-39866_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-104 04B PIT WASTE WITH TANK 241-C-104 WASTE | | X | |
| RPP-RPT-40011, 2009, Project W-314 241-AY Pump Pits upgrade Integrity Assessment Report, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. | | X | |

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| RPP-RPT-40242_-_Rev_1_WASTE COMPATIBILITY ASSESSMENT OF 100% TANK 241-C-110 RETRIEVED WASTE WITH TANK 241-AN-106 WASTE A-1 | | X | |
| RPP-RPT-40492_-_Rev_3_COMPATIBILITY ASSESSMENT OF 241-AZ-301 CONDENSATE TO TANK 241-AY-101 | | X | |
| RPP-RPT-40634, 2009, Rev. 1, *Status of Cathodic Protection on Heat-Traced Select-List Lines,* ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-40661, 2010, Rev. 22, *241-AY-102 Multi-Probe Corrosion Monitoring System: February 2010 Monthly Report,* ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-40887, 2009, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-105 – FY 2009,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-41206, 2011, Rev. 19, *241-AY-101 Multi-Probe Corrosion Monitoring System: May, June, July 2010 Quarterly Report,* ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-41335, 2009, Electrochemical Corrosion Testing for Tanks 241-AW-103 Core 321 Segments 18 and 20 and 241-AW-105 Core 322 Segments 8R1 and 8R2, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-41465_-_Rev_1_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-101 RECIRCULATION AND TANK 241-AY-101 WASTE WITH TANK-1 | | X | |
| RPP-RPT-41570, 2009, Rev. 0, *Locating Missing Test Stations on Select List Lines,* ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-41840, 2009, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-106 – FY 2009,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |

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|---|---|---|---|
| RPP-RPT-41997_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 WASTE WITH TANK 241-AP-105 WASTE | | X | |
| RPP-RPT-42147, 2009, *Double-Shell Tank Integrity Inspection Report for 241-AW Tank Farms,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-42147, 2014, *Double-Shell Tank Integrity Inspection Report for 241-AW Tank Farms,* Rev. 2, Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-42147, 2015, *Double-Shell Tank Integrity Inspection Report for 241-AW Tank Farms,* Rev. 3, Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| RPP-RPT-42472, 2009, *241-AY-01A Pit Certified NACE Coating Inspector Report,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-42487, 2009, *Evaluation of Buried Transfer Lines with Cathodic Protection,* Rev. 0, ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-42489, 2009, Rev. 0, *Evaluation of Heat-Traced Buried Transfer Lines with Cathodic Protection,* ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-43115, 2009, *Summary and Recommendations of the Expert Panel Oversight Committee Meeting on Double-Shell Tank Corrosion Monitoring and Testing Held June 1-3, 2009,* Rev. 0, Perot Systems Government Services, Richland, Washington. | | X | |
| RPP-RPT-43609, 2010, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-102 – FY 2010,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-43972_-_Rev_0_COMPATIBILITY ASSESSMENT OF 241-AZ-301 CONDENSATE TO TANK 241-AY-101 | | X | |

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| RPP-RPT-45110, 2010, *Ultrasonic Inspection Results for Double-Shell Tank 241-AW-104 – FY 2010,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-45144_-_Rev_0_WASTE COMPATIBILITY ASSESSMENT OF 242-A EVAPORATOR CAMPAIGN 10-01 | | X | |
| RPP-RPT-45264, 2010, Rev. 1, *Pipeline Configuration Analysis for Applicability of Cathodic Protection,* ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-45723 Retrieval Feasibility Study 2010 | | | X |
| RPP-RPT-45794_-_Rev_0A_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-10-01 WITH TANK 241-SY-101 | | X | |
| RPP-RPT-46309, PNNL-19242 Riser Difference Evaluation from Ultrasonic Wall Thickness Inspection of Thirteen Double-Shell Tanks | X | | |
| RPP-RPT-46378, 2012, *Integrity Assessment Report for Project W-566 Waste Feed Delivery – Transfer Line Upgrades for Clean-Out Boxes Modifications*, Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-46567, Ultrasonic Inspection Results for Double-Shell Tank 241 - AP-1 03 - FY 2010, Rev. 0 | | X | |
| RPP-RPT-46806, 2011, *352-AN-107 Multi-Probe Corrosion Monitoring System: April, May and June 2011 Quarterly Report*, Rev. 16, ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-46860, 2010, *Independent Integrity Assessment Report for 241-AW-02E Pit Jumper Replacement,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington. | | X | |

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|---|---|---|---|
| RPP-RPT-47109_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF 242-A POST EVAPORATOR CAMPAIGN 10-02 PROCESS WASTER AND SLURRY WI-1 | | X | |
| RPP-RPT-47180, 2010, *"Waterproof" Pipeline Assessment Report,* Rev. 0, ARES Corporation, Richland, Washington. | | X | |
| RPP-RPT-47337, 2011, Rev. 0, *Specifications for the Minimization of the Stress Corrosion Cracking Threat in Double-Shell Tank Wastes,* Washington River Protection Solutions LLC, Richland, Washington. | | X | |
| RPP-RPT-47435 Rev. 0 Annual Select Line List 2010 Annual Survey Data | X | | |
| RPP-RPT-47435 Rev. 1 Annual Select Line List 2011 Annual Survey Data | X | | |
| RPP-RPT-47435 Rev. 2 Annual Select Line List 2012 Annual Survey Data | X | | |
| RPP-RPT-47435, 2013, *Annual Select List Line CP Status Report Based on 2013 Annual Survey Data,* Rev. 3, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-47435, 2014, *Modified Annual Select List Line CP Status Report,* Rev. 4, ARES Corporation, Richland, Washington. | X | | |
| RPP-RPT-47563, 2010, *Ultrasonic Inspection Results for Double-Shell Tank 241-AY-101 – FY 2010,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-47645, 2010, *Integrity Assessment for AN-101 Pump Replacement in the C-104 Waste Retrieval System,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-47901, 2010, *Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610,* Rev. 0, ARES Corporation, Richland, Washington. | | | X |
| RPP-RPT-48427, 2011, Rev. 0, *Ultrasonic Inspection Results for Double-Shell Tank 241-AN-107 – FY 2011,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |

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| RPP-RPT-49197, 2011, *Determination of Erosion/Corrosion Sensor Placement Locations for Valve Box POR104*, Rev. 0, ARES Corporation, Richland, Washington. | .X | | |
| RPP-RPT-49200, REV 0 - Direct Assessment of 241-SY Pipelines SN-285 and SN-286 | | | X |
| RPP-RPT-49494, 2011, *Ultrasonic Inspection Results for Double-Shell Tank 241-AN-101 – FY 2011*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-49516, REV 1 - Final IQRPE Report for Design on AY/AZ Farm Infrastructure Upgrades Project T3W12 | | X | |
| RPP-RPT-49517, 2012, *Final IQRPE Report for Design on AW Farm Infrastructure Upgrades Project T3W13*, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-49533, 2012, *Independent Design Integrity Assessment Report for 241-AP Valve Pit Jumpers,* Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-49534, 2012, *Independent Construction Integrity Assessment Report for 241-AP Valve Pit Jumpers,* Rev. 1, Washington River Protection Solutions LLC, Richland, Washington. | | X | |
| RPP-RPT-49695_-_Rev_0_Waste Compatibility Assessment Of Tank 241-AN-1069 Waste With Tank 241-AW-106 Waste | | X | |
| RPP-RPT-50082_-_Rev01_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN--1 | | X | |
| RPP-RPT-50082_-_Rev01A_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN--1 | | X | |

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| RPP-RPT-50189, 2012, Project W-566 AZ-102 Condensate Line Independent Integrity Assessment Report, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-50191, 2012, Independent Integrity Assessment Report for Design and Construction of 241-AN-A Valve Pit Jumpers, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-50192, 2012, *Independent Integrity Assessment Report for Design and Construction of 241-AN-B Valve Pit Jumpers*, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-50205_-_Rev_00A_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-11-02) WITH TANK 241-SY-101 | | X | |
| RPP-RPT-50271, REV 0 - Direct Assessment of 241-AY Farm Line PW-4531 | | | X |
| RPP-RPT-50397, 2013, *Operating History of Transfer lines SN-278, SN-285 and SN-286,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-50440, 2013, *2006 Double-Shell Tank Integrity Assessment Recommendation Dispositions*, Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-50676, 2011, Rev. 1A, *Waste Compatibility Assessment of Tanks 241-C-107 Waste and Water Wash 241-C-108 Hard Heel Waste with Tank 241-AN-106 Waste and Tank 241-AN-106 Waste with Tank 241-C-107 Waste,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-50752, 2012, *Independent Integrity Assessment Report – Project W-566, SY Transfer Lines Upgrades,* Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |

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|---|---|---|---|
| RPP-RPT-50785_-_Rev_00A_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-108 100% HARD HEEL RETRIEVED WASTE WITH TANK 241-AN--1 | | X | |
| RPP-RPT-50785_-_Rev_02_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-108 100% HARD HEEL RETRIEVED WASTE WITH TANK 241-AN--1 | | X | |
| RPP-RPT-50836, 2012, *Project W-566 AZ-102 Jumper and Pump Integrity Assessment Report,* Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-50843_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 WASTE WITH TANK 241-AP-104 WASTE | | X | |
| RPP-RPT-50852 Operating History Statistics of POR104 Portable Valve Box | X | | |
| RPP-RPT-50934, 2011, *Inspection and Test Report for the removed 241-C-107 Dome Concrete,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-51005, 2011, *Ultrasonic Thickness Testing of POR104 Valve Pit Piping in C-Farm,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-51020_-_Rev_00_Ultrasonic Inspection Results for Double-Shell Tank 241-AZ-102-FY 2012 | | X | |
| RPP-RPT-51031_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-112 RETRIEVED WASTE WITH TANK 241-AN-101 WASTE AND TA-1 | | X | |
| RPP-RPT-51031_-_Rev_01B_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-112 RETRIEVED WASTE WITH TANK 241-AN-101 WASTE AND TA-1 | | X | |

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| RPP-RPT-51735, 2012, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-105 – FY 2012*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-51766, 2013, *Corrosion Probe Monitoring Systems: July, August, & September 2013 Quarterly Report*, Rev. 6, ARES Corporation, Richland, Washington. | | X | |
| RPP-RPT-51766, 2013, *Corrosion Probe Monitoring Systems: July, August, & September 2013 Quarterly Report*, Rev. 8. | X | | |
| RPP-RPT-51766, 2013, *Corrosion Probe Monitoring Systems: July, August, & September 2013 Quarterly Report*, Rev. 9. | X | | |
| RPP-RPT-52206, 2012, *Tank Farms Transfer System Fitness-for-Service Requirements and Recommendations*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-52248, REV 0A - Evaluation of Fitness-for-Service forOver-Pressure Events | | X | |
| RPP-RPT-52463, 2012, *IQRPE Integrity Assessment for Design and Installation of AN06A Hydraulic Supernate Pump and Support Components*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-52475, 2012, Rev. 1, *Waste Compatibility Assessment of Tanks 241-C-101 Waste and 241-C-102 Waste with Tank 241-AN-101 Waste and 241-AN-101 Waste with Tanks 241-C-101 and 241-C-102 Waste*, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-52519_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF WATER ADDITION TO TANK 241-C-109 WASTE | | X | |
| RPP-RPT-52537_-_Rev_00_Report on Electrochemical Corrosion Testing of 241-AN-101 Grab Samples from 241-C-112 Midpoint Sampling Campaign | | X | |

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| RPP-RPT-52572, 2012, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-101 – FY 2012,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-52719, 2012, *IQRPE Design Assessment Report for the 241-AP Valve Pit Jumper 13-C-(n) Nozzle Spacer,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-52720, 2012, *IQRPE Installation Assessment Report for the 241-AP Valve Pit Jumper 13-C-(N) Nozzle Spacer,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-52791, 2015, Tank Farm Waste Transfer System Fitness-for-Service Erosion and Corrosion Basis, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington | X | | |
| RPP-RPT-53122_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-109 WATER WASH WASTE WITH TANK 241-AN-106 AND CAUSTIC-1 | | X | |
| RPP-RPT-53156_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OT TANK 241-AN-106 DECANT (AUGUST 2012) WASTE WITH TANK 241-AP-104-I | | X | |
| RPP-RPT-53179, 2015, *Systems, Structures, and Components (SSC) Status Report DST Waste Transfer System First Quarter,* Rev. 11, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-53207_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF 241-AZ-301 CONDENSATE TO TANK 241-AY-101 | | X | |
| RPP-RPT-53276, 2012, Rev. 0, *Waste Compatibility Assessment of Tanks 241-C-107 Waste and 241-C-109 Waste with Tank 241-AN-106 Waste and Water Addition to Tanks 241-C-107 and 241-C-109,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |

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| RPP-RPT-53366 Statistical Analysis of Wall Thickness Readings for POR104 Jumper | | X | |
| RPP-RPT-53382_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-106 DECANT (SEPTEMBER 2012) WASTE WITH TANK 241-AP-1-1 | | X | |
| RPP-RPT-53427, 2014, *Tank 241-AY-101 Multi-Probe Corrosion Monitoring System Data Comparison Report,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-53428, 2014, *241-AN-102 Multi-Probe Corrosion Monitoring System and Coupon Data Comparison Report,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-53488, *Report on the Examination of Tank 241-AY-101 Multi-Probe Corrosion Monitoring System,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-53491_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 DECANT WASTE WITH TANK 241-AP-104 WASTE | | X | |
| RPP-RPT-53884, 2013, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-103 – FY 2013,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-53920_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AY-102 WASTE WITH TANK 241-AP-104 WASTE | | X | |
| RPP-RPT-54092, REV 0 - IQRPE Design and Installation Assessment for the AN-101 Pump Replacement and Related Equipment | | | X |
| RPP-RPT-54241, 2013, *Report on the Examination of Tank 241-AN-102 Multi-Probe Corrosion Monitoring System,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |

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| RPP-RPT-54594, 2013, *Ultrasonic Inspection Results for Double-Shell Tank 241-SY-102 – FY 2013*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-54710_0_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-107 WASTE AND 242-A SUMP WASTE WITH TANK 241-AW-102-1 | | X | |
| RPP-RPT-54817, 2013, *241-AY-101 Tank Construction Extent of Condition Review for Tank Integrity*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-54818, 2013, *241-AZ Tank Farm Construction Extent of Condition Review for Tank Integrity*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-54819, 2013, *241-SY Tank Farm Construction Extent of Condition Review for Tank Integrity*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-54860, 2013, *IQRPE Design and Installation Assessment Reports for AN-106 Pump Replacement and Related Equipment*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-55032 Rev 0 Waste Compatibility Assessment of 241-AZ-102 Leak Detection Pit Waste and AZ-301 Condensate Waste with Tank 241-AZ-102 Waste | | X | |
| RPP-RPT-55204, 2014, *Summary of Fitness-for-Service Testing and Inspection of SL-167*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-55259, 2013, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-101 – FY 2013*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |

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| RPP-RPT-55496_-_Rev_00A_WASTE COMPATIBILITY ASSESSMENT OF 222-S LABORATORY WASTE (222S-13-01) WITH TANK 241-SY-101 | | X | |
| RPP-RPT-55557_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF RETRIEVAL OF TANK 241-C-110 WASTE WITH TANK 241-AN-106 | | X | |
| RPP-RPT-55710_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AN-101 DECANT WASTE WITH TANK 241-AP-104 WASTE | | X | |
| RPP-RPT-55735_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-AP-104 WASTE WITH TANK 241-AP-106 WASTE AND TANK 241-AP-1 | | X | |
| RPP-RPT-55788, 2013, *IQRPE Integrity Assessment Reports for AN-06A Supernatant Pump Anti-Siphon Hoses and Drop Leg Repair*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-55941, 2013, *242-A Evaporator Jumper Ultrasonic Test Report*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-55981, 2013, *241-AW Tank Farm Construction Extent of Condition Review for Tank Integrity*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-55982, 2013, *241-AN Tank Farm Construction Extent of Condition Review for Tank Integrity*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-55983, 2013, *241-AP Tank Farm Construction Extent of Condition Review for Tank Integrity*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |

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| RPP-RPT-56168_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANKS 241-AN-101 AND 241-AN-106 DECANT WASTE WITH TANK 241-AP-10-1 | | X | |
| RPP-RPT-56223, 2014, *Valve Box POR104 Mounted Dry Array Ultrasonic Test Report,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-56228, 2013, Rev. 0, *Waste Compatibility Assessment of Tank 241-C-107 Waste and Tank 241-C-105 Waste with Tank 241-AN-106 Waste, Tank 241-AN-106 Waste with Tank 241-C-107 Waste, and Tank 241-AN-106 Waste with Tank 241-C-105 Waste,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-56230, 2014, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-104 – FY 2014,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-56308, 2013, Rev. 0, *Waste Compatibility Assessment of 241-AZ-102 Leak Detection Pit Waste and AZ-301 Condensate Waste with Tank 241-AZ-102 Waste,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-56410, 2014, Report on the Examination of Tank 241-AY-102 Removable Corrosion Probe Extracted in September 2013 from the Multi-Probe Corrosion Monitoring System, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-56412, 2013, *Independent Qualified Registered Professional Engineer Inspection Report for 241-AW05A, SN-265 Encasement Pressure Test,* Rev. 0, Dana Engineering, Richland, Washington. | | | X |
| RPP-RPT-56669, 2014, Rev. 0, *Waste Compatibility Assessment of Tank 241-C-112 Water and Caustic Wash Waste with Tank 241-AN-101 Waste and Water and Caustic Addition to Tank 241-C-112,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |

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| RPP-RPT-56711_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE AND -1 | | X | |
| RPP-RPT-56711_-_Rev_01_WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE AND -1 | | X | |
| RPP-RPT-56711_-_Rev_02_WASTE COMPATIBILITY ASSESSMENT OF CAUSTIC AND TANK 241-C-105 WASTE WITH TANK 241-AN-106 WASTE AND -1 | | X | |
| RPP-RPT-56943_-_Rev_00_WASTE COMPATIBILITY ASSESSMENT OF TANK 241-C-107 WASTE WITH TANK 241-AN-106 WASTE AND TANK 241-AN--1 | | X | |
| RPP-RPT-57127, 2014, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-106 – FY 2014,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-57262, 2014, *Waste Compatibility Assessment of the Addition of Water and Tank 241-AN-101 Waste with Tank 241-C-102 Waste,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-57405, 2014, *Waste Compatibility Assessment of Tank 241-C-102 Waste with Tank 241-AN-101 Waste and Tank 241-AN-101 Waste with Tank 241-C-102 Waste,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-57454, 2014, *Waste Compatibility Assessment of Tank 241-C-111 Waste with Tank 241-AN-101 Waste and Tank 241-AN-101 Waste with Tank 241-C-111 Waste,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |

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|---|---|---|---|
| RPP-RPT-57651, 2014, Rev. 0, *Waste Compatibility Assessment of Water Addition to Tank 241-C-102 Waste,* Washington River Protection Solutions LLC, Richland, Washington. | | X | |
| RPP-RPT-57774, 2015, *Evaluation of Tank 241-AY-102 Secondary Containment System,* Rev. 1, ARES Corporation, Richland, Washington. | | X | |
| RPP-RPT-58018, 2014, *Waste Compatibility Assessment of Tank 241-C-107 Waste and Tank 241-C-105 Waste with Tank 241-AN-106 Waste, Tank 241-AN-106 Waste with Tank 241-C-107 Waste, and Tank 241-AN-106 Waste with Tank 241-C-105 Waste,* Rev. 0, Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| RPP-RPT-58149, 2014, *Waste Compatibility Assessment of Tank 241-AW-106 Waste and 242-A Sump Waste with Tank 241-AW-102 Waste,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-58160, 2014, *Waste Compatibility Assessment of 13-01 2nd Pass Evaporator Slurry Waste with Tank 241-AP-107 and with Tank 241-AW-102 Waste,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-58233, 2015, *Slurry Line SL-164 Construction Review,* Rev. 1, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-58276, 2015, *Ultrasonic Inspection Results for Double-Shell Tank 241-AP-102 - FY 2015,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| RPP-RPT-58301, 2015, *Summary of Initial Two Rounds of Double-Shell Tank Ultrasonic Testing,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| RPP-RPT-58776, 2015, *Ultrasonic Inspection Results for Double-Shell Tank 241-AN-103 – FY 2015,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |

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|---|---|---|---|
| RPP-TE-53995, 2012, *Technical Evaluation of Nozzle "A: in 241-AN-01A Pit,* Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| SD-RE-TI-044, 1983, *Analysis of Pipeline Failure, SL-176,* Rev. 0, Rockwell Hanford Operations, Richland, Washington. | | | X |
| SD-TWR-RPT-002, 1996, ECN 647030, Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks, Rev. 0A, Westinghouse Hanford Company, Richland, Washington. | | | X |
| SL-166-2012 Results, Pressure Testing of Pipe-In-Pipe Encasements, Rev. K-3. | | X | |
| SL169 ENCASEMENT DATA 001 | | | X |
| SL-169 TEST SETUP #1 | | | X |
| SL-169 TEST SETUP #1 - COPY | | | X |
| SL-169 TEST SETUP #2 | | | X |
| SL-511 RESULTS, 2014, Pressure Testing of Pipe-In-Pipe Encasements, Rev. L-1. | | X | |
| SL-514 RESULTS, 2014, Pressure Testing of Pipe-In-Pipe Encasements, Rev. L-1. | | X | |
| SLE-265282-01, 2014, IQRPE Service Life Extension Review, 241-C-105 Waste Retrieval Efforts, Rev. 0, Dana Engineering, Inc., Richland, Washington. | | X | |
| SN-264, SN-274 TEST RESULTS, 2014, Rev. L-1. | | X | |
| SN-264, SN-274, SL-164 TEST RESULTS, 2014, TFC-WO-14-1905, Rev. L-1. | | X | |
| SN-265 DATASHEETS, 2012, TO-140-170, Rev. L-0. | | X | |
| SN-269 AND SN-270 PRESSURE TEST RESULTS, 2012, TO-140-170, Rev. L-0. | | X | |

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|---|---|---|---|
| SN-271 ENCASEMENT DATA 001, 2012, TO-140-170, Rev. L-0. | | | X |
| SN-611 RESULTS, Pressure Testing of Pipe-In-Pipe Encasements, 2014, TO-140-170, Rev. L-1. | | X | |
| SN-614 RESULTS, Pressure Testing of Pipe-In-Pipe Encasements, 2014, TO-140-170, Rev. L-1. | | X | |
| SN-630 Pressure Testing of Pipe-In-Pipe Encasements, 2012, TO-140-170, Rev. L-0. | | X | |
| SN-631 DATASHEET Pressure Testing of Pipe-In-Pipe Encasements, 2011, TO-140-170, Rev. K-2. | | | X |
| SN-632 DATASHEET Pressure Testing of Pipe-In-Pipe Encasements, 2011, TO-140-170, Rev. K-2. | | | X |
| SN-633 TEST RESULTS Pressure Testing of Pipe-In-Pipe Encasements, 2011, TO-140-170, Rev. K-3. | | X | |
| SN-634 TEST RESULTS Pressure Testing Pipe-In-Pipe Encasements, 2011, TO-140-170, Rev. K-3. | | X | |
| SRNL-STI-2001-00301, Testing of 304L Stainless Steel in Nitric Acid Environments With Fluorides and Chlorides. | X | | |
| SRNL-STI-2010-00509, 2010, *Corrosion Testing in Simulated Tank Solutions,* Savannah River National Laboratory, Aiden, South Carolina. | | X | |
| SRNL-STI-2013-00739 Vapor Space Corrosion Testing Simulating the Environment of Hanford Double-Shell Tanks | X | | |
| SRNL-STI-2013-00743, Liquid-Air Interface Corrosion Testing Simulating the Environment of Hanford Double-Shell Tanks | X | | |
| SVF-2900, *Spreadsheet Verification Form - Caustic Limits Report* | | X | |

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|---|---|---|---|
| Terry, M. T., 2006, "Expert Panel Oversight Committee Assessment of the 241-AN-107 and 241-AN-102 Waste Chemistry Corrosion Testing for Double-Shell Tank Waste Chemistry Optimization" (letter to Robert Popielarczyk, CH2M HILL Hanford Group, Inc., Richland, Washington. | | | X |
| TEST RISER LOCATIONS | | X | |
| TFC-CHEM-P-14, *Operating Specification Documents.* | | X | |
| TFC-ENG-CHEM-D-21, 2015, Rev. C-1, *Process Engineering Waste Surveillance Data Review,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| TFC-ENG-CHEM-P-13, 2014, Tank Waste Compatibility Assessments, Rev. A-13, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| TFC-ENG-CHEM-P-18, *Response to Anomalous Sample Results.* | | X | |
| TFC-ENG-DESIGN-C-30, 2013 *Post-Natural Phenomenon Hazard Assessment,* Rev. A-7, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| TFC-ENG-FACSUP-C-10, 2014, Rev. C-23, *Control of Dome Loading and SSC Load Control,* Washington River Protection Solutions LLC, Richland, Washington. | X | | |
| TFC-ENG-STD-22, 2014, *Piping, Jumpers, and Valves,* Rev. E-11, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| TFC-ENG-STD-25, 2014, *Transfer Pumps,* Rev. D-4 | | X | |
| TFC-ENG-STD-26, 2014, *Waste Transfer, Dilution, and Flushing Requirements,* Rev. B, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| TFC-ENG-STD-34_STANDARD_FOR_THE_SELECTION_OF_NON-METALLIC_MATERIALS_IN_CONTACT_WITH_TANK_WASTE | X | | |
| TFC-ESHQ-AP-C-01, *Management Assessment.* | | X | |

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|---|---|---|---|
| TFC-OPS-OPER-C-10, REV B-22 - Vehicle and Dome Load Control in Tank Farm Facilities | X | | |
| TFC-OPS-OPER-C-24, *Occurrence Reporting and Processing of Operations Information.* | | X | |
| TFC-OPS-OPER-C-57, *Event Notification.* | | X | |
| TFC-OPS-OPER-D-02, REV B-5 - Electronic Dome Load Logs (Cancelled 6/5/14; Incorporated into TFC-OPS-OPER-C-10) | | | X |
| TFC-PLN-10, *Assessment Program Plan.* | | X | |
| TFC-WO-08-1012 | | X | |
| TFC-WO-09-2386 | | X | |
| TFC-WO-10-0760 | | X | |
| TFC-WO-10-1825 | | X | |
| TFC-WO-10-2775 | | X | |
| TFC-WO-10-3862, 241-AP Encasement Pressure Test | | X | |
| TFC-WO-10-4297 | | X | |
| TFC-WO-10-4562 | | X | |
| TFC-WO-10-4563 | | X | |
| TFC-WO-10-4846 - 241-AZ-01A PRESSURE ENCASEMENT TESTING | | X | |
| TFC-WO-10-4848 SN-622 AP-02D TEST, 241-AP-02D Pressure Encasement Testing | | X | |
| TFC-WO-10-4850 - 241-AZ-VP PRESSURE ENCASEMENT TESTING | | X | |
| TFC-WO-10-4850 Ignition Source Control Requirements Screening | X | | |
| TFC-WO-10-4850, 2012, 241-AZ-VP Pressure Encasement Testing. | | | X |
| TFC-WO-1050 | | X | |
| TFC-WO-11-1252 | | X | |

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|---|---|---|---|
| TFC-WO-11-4676 | | X | |
| TFC-WO-11-4827 R6 AW02E ENCASEMENT PRESSURE TEST_JKE 1-18-13 | | X | |
| TFC-WO-11-4827 TEST RECORDS 001 | | X | |
| TFC-WO-11-4827 TEST RECORDS 002 | | X | |
| TFC-WO-11-4827 TEST RECORDS 003 | | X | |
| TFC-WO-11-5518 | | X | |
| TFC-WO-11-5951, 241-AN, Perform AN-06A Encasement Pressure Testing | | X | |
| TFC-WO-12-4109 - Perform Encasement Pressure Test of SL-167 | | X | |
| TFC-WO-12-4191 R4 SN635 ENCASEMENT TESTING AY01A AND 02A_JKE 7-25-12 | | | X |
| TFC-WO-12-5408 | | X | |
| TFC-WO-13-1362 - Perform Encasement Test of SL-169/SN-271 | | X | |
| TFC-WO-13-1362 Encasement Pressure Test SL-169 and SN-271, 13-1362, Work Order | | | X |
| TFC-WO-13-3209, 241-AN, Perform Encasement Pressure Test of SN-630 | | X | |
| TFC-WO-13-5408 - 241-AW 105/6 Pressure Loop Cals & Func | | | X |
| TFC-WO-13-6010 SL-513, Pressure Testing of Pipe-In-Pipe Encasements | | | X |
| TFC-WO-13-6010 SN-613, Pressure Testing of Pipe-In-Pipe Encasements | | | X |
| TFC-WO-14-1905, 2014, *Perform Encasement Test of SL-164, SN-264, SN-274,* Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| TFC-WO-14-3937 | | X | |
| TF-ERP-008, 2015, *Emergency Response Procedure 008 Seismic Event Response,* Rev. N-1, Washington River Protection Solutions, LLC, Richland, Washington. | X | | |

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|---|---|---|---|
| TF-OR-DR-AN, 2015, Rev. A-38, *AN Daily Rounds,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| TF-OR-DR-AN_A-37_241-AN-AP_Annulus_Leak Detectors_Excerpt | X | | |
| TF-OR-DR-AZ-A33, 2015, Rev. A-33, *AZ Daily Rounds,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| TF-OR-DR-EV, 2015, Rev. A-31, *EV Daily Rounds,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| TF-OR-DR-EV, 2015, Rev. A-33, *AZ Daily Rounds,* Washington River Protection Solutions LLC, Richland, Washington. | | | X |
| TF-OR-DR-EV_A-30_241-AW_Annulus_Leak_Detectors_Excerpt | X | | |
| TF-OR-DR-ST_A-34_241-AY_Annulus, Leak Detectors_Excerpt | X | | |
| TO-020-142, REV D7 - Video Examination of DST Interiors and Annuli | | X | |
| TO-040-050, *Performance Inspections of Pit Coatings,* Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| TO-140-170, REV L1 - Pressure Testing of Pipe-In-Pipe Encasements | | | X |
| TOC-PRES-13-3414-FP Hanford Double-Shell Tank Extent -of-Condition Construction Review -- 14174 | | X | |
| USEPA, 1994, Waste Analysis at Facilities that Generate, Treat, Store, and Dispose of Hazardous Wastes: A Guidance Manual, PB94-963603, OSWER, 9938.4-03. | X | | |
| W-314-4L-002, *Engineering Change Notice,* CH2M Hill Hanford Group, Inc., Richland, Washington. | | | X |
| W-314-C-001_-_Rev_2_-_[7710622], W314-C-001_-_Rev_2_-_[D7710622] | X | | |
| W314-C-004_-_Rev_1_-_[7710953], W314 Design Calculations | X | | |
| W314-C-021_-_Rev_2_-_[D7708168], W314 Design Calculations | X | | |
| W314-C-024_-_Rev_2_-_[D7708944], W314 Design Calculations | X | | |

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|---|---|---|---|
| W314-C-025_-_Rev_6_-_[D7709053], W314 Design Calculations | X | | |
| WAC 173-303 | X | | |
| WAC 173-303, SECTION 640 - Dangerous Waste Regulation | X | | |
| WAC 173-303, SECTION 810 - Dangerous Waste Regulations | X | | |
| Week of 04 27 2015 TF-OR-DR-EV Completed 241-AW Daily Rounds | X | | |
| Week of 10 13 2014 TF-OR-DR-AN Completed 241-AN and 241-AP Daily Rounds | X | | |
| WFO-WO-05-003199, 2005, 241-AW-02E Encasement Pressure Test SN-272. | | X | |
| WFO-WO-06-000440 | | X | |
| WFO-WO-07-1110, *Cathodic Protection Native Potential Data,* CH2M Hill Hanford Group, Inc., Richland, Washington. | X | | |
| WFO-WO-07-1730 | | X | |
| WFO-WO-07-2333 | | X | |
| WHC-SD-TWR-RPT-002, *Structural Integrity and Potential Failure Modes of the Hanford High-Level Waste Tanks,* Westinghouse Hanford Company, Richland, Washington. | | X | |
| WHC-SD-WM-DGS-003, REV 0 - Cases of ASME Boiler and Pressure Vessel Code | | | X |
| WHC-SD-WM-ER-414, REV 0A - ECN No. 635063, Hanford Waste Tank System Degradation Mechanisms | X | | |
| WHC-SD-WM-SOIL-001, *Soil Weight (lbf/ft$^3$) at Hanford Waste Storage Tank Locations – Volumes I & II,* Westinghouse Hanford Company, Richland, Washington. | | X | |
| WO-165831 WRPS-IB-15-003 Lessons Learning Using the Appropriate Radiological Work Permit for the Job | | | X |

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|---|---|---|---|
| WO-171956, 2013, Kano Laboratories, Inc. Safety Data Sheet | | | X |
| WRPS-0900715, 2009, Recovery Plan TF-RP-09-01, Tank 241-A N-106 Supernatant Recovery Plan, Revision 0, transmitted via WRPS-0900230, "Request for Approval of Recovery Plan to Restore Chemistry Control to Tank 24 1-AN-106 Supernatant," and approved by 09-NSD-012, "Approval of Recovery Plan To Restore Chemistry Control To Tank 241 -AN- 106 Supernatant." | | X | |
| WRPS-0901335_LETTER_WRPS TRANSMITTAL OF WASTE COMPATIBILITY ASSESSMENT AND SPATIAL BOUNDARY INFORMATION ASSICATED WITH T-1 | | X | |
| WRPS-0901355_ENCLOSURE_1_WRPS TRANSMITTAL OF WASTE COMPATIBILITY ASSESSMENT AND SPATIAL BOUNDARY INFORMATION ASSICIATED W-1 | | X | |
| WRPS-0901355_ENCLOSURE_2_WRPS TRANSMITTAL OF WASTE COMPATIBILITY ASSESSMENT AND SPATIAL BOUNDARY INFORMATION ASSICIATED W-1 | | X | |
| WRPS-1000696, 2010, *Material Compatibility Assessment 241-AN-101-01A Pit Double Check Safety Valve Assembly Test Cock Polymer.* | X | | |
| WRPS-10501035 Letter DST Environmental Pit Leak Detection Requirements | | X | |
| WRPS-1204931, *Double-Shell Tank 241-AY-102 Primary Tank Leak Extent of Condition Evaluation and Recommended Annulus Visual Inspection Intervals,* Washington River Protection Solutions LLC, Richland, Washington. | | X | |
| WRPS-1302595, *Recommended Double-Shell Tank Visual Inspection Changes Resulting from Tank 241-AY-102 Primary Tank Leak Extent of Condition Evaluation,* Washington River Protection Solutions LLC, Richland, Washington. | X | | |

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| WRPS-51189-FP, 2011, *Development and Deployment of Mobile Arm Retrieval System (MARS)*, Rev. 0, Washington River Protection Solutions, LLC, Richland, Washington. | | X | |
| WRPS-20140527-1, 2014, *Cathodic Protection Program Assessment Product Transfer Piping,* Washington River Protection Solutions, LLC, Richland, Washington. | X | | |
| WRPS-56681-FP Tank 241-AY-102 Secondary Liner Corrosion Evaluation | X | | |
| WRPS-PER-2013-1219, Closed 12/07/2014. Problem Evaluation Request. Topic: *AZ-102 Chemistry above limits*. Washington River Protection Solutions LLC, Richland, Washington. | | X | |
| WRPS-PER-2014-0156 | | X | |
| WSRC-MS-OU-00758 - Effect of Nitrite Concentration on Pit Depth in Carbon Steel Exposed to Simulated Radioactive Waste | X | | |
| WSRC-TR-2003-00560 Review of Type I High Level Waste Tanks Ultrasonic Inspection Data (U) | | | X |
| WSRC-TR-2005-00532 Rev 1 A Structural Integrity Evaluation of the Tank Farm Waste Transfer System | | | X |
| Zapp, 2004, *General Pitting Corrosion Experiments at the Savannah River Site*. | | X | |