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Addressees:

HANFORD FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (TRI-PARTY AGREEMENT) NEGOTIATIONS FOR THE ESTABLISHMENT OF MILESTONES FOR DOUBLE-SHELL TANK (DST) SYSTEM INTEGRITY ASSESSMENTS

The U.S. Department of Energy, Richland Operations Office (RL) and the Office of River Protection (ORP) recognizes a need to comply with the U.S. Code of Federal Regulations and Washington Administrative Code Interim Status Tank System requirements for conducting integrity assessments on the River Protection Project DST System. In support of compliance with these requirements and in conjunction with issuance of the DST Final Status Permit Application, RL and ORP proposes to initiate negotiations to jointly establish Tri-Party Agreement Milestones for the DST System Integrity Assessment Program.

RL and ORP's strategy for conducting DST System integrity assessments is attached. This document will be used as a guide to support negotiations. It is expected that the negotiations will address the project scope and schedule, as well as the State of Washington Department of Ecology's regulatory concerns.

RL and ORP looks forward to closely working with you as partners to achieve the most cost effective Tri-Party Agreement compliance strategy that is in concert with the ORP vision for safe and effective management of the DST System.

If you have any questions, please contact Ami Sidpara, Tank Farm Oversight Division, on (509) 376-0933 or Hector Rodriguez, of my staff, on (509) 376-6421.

Sincerely,

George H. Sanders, Program Manager
Office of Regulatory Liaison

ORL:HMR

Attachment

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Strategy for Completing DST System Integrity Assessment, and Supporting Decisions on DST Replacement

1.0 Background

Configuration and operation of Hanford's DST System is regulated under 40 CFR 265, Subpart J, and Washington's Dangerous Waste Regulations, WAC 173-303-640. These require integrity assessments of tank systems that store dangerous waste, and determination by an independent qualified registered professional engineer (IQRPE) as to whether the tank system is leaking, or otherwise unfit for use. Such assessment must consider design standards, waste characteristics, corrosion protection, tank age, and results of tank system integrity examinations. The regulations also require that the tank system owner/operator maintain a schedule for periodic reassessment. The initial integrity assessment of the DST system supports TPA milestone M-32-00 (*Complete Identified Dangerous Waste Tank Corrective Actions*, 9/30/99). As of that date, integrity assessment reports and supporting tank system examinations had been completed for the following:

- 244-U Double-Contained Receiver Tank (DCRT) (WHC-SD-WM-RPT-092, Rev. 0, August 29, 1995)
- Transfer Piping and Pit System (HNF-SD-WM-ER-623, Rev. 0, November 25, 1997)
- 244-S DCRT (HNF-3608, Rev. 0, December 29, 1998)
- 241-AN Farm (HNF-4680, Rev. 0, September 21, 1999)
- 241-AP Farm (HNF-4958, Rev. 0, September 21, 1999)
- 241-AW Farm (HNF-4529, Rev. 0, September 21, 1999)
- 241-AY Farm (HNF-4959, Rev. 0, September 21, 1999)
- 241-AZ Farm (HNF-4957, Rev. 0, September 21, 1999)
- 241-SY Farm (HNF-4859, Rev. 0, September 21, 1999)

Visual examination, by remote video camera, of the annuli for all 28 DSTs in the early 1990's and ultrasonic examination of selected portions of six DSTs in the late 1990's supported integrity assessment of the six DST farms. Localized wall thinning in excess of specified reporting criteria, requiring further evaluation, was observed in one of the DSTs—241-AN-105. Based on additional evaluations, it was conservatively estimated that a minimum of 17 years operating life remained before localized thinning in this tank progressed to the minimum wall thickness required to meet ASME Code criteria (assuming corrosion will continue at the same rate calculated for its operational history). Also based on those additional evaluations, it was recommended to install a corrosion probe in 241-AN-105 to assess corrosion conditions. That corrosion probe was installed in January 2000, and data from the probe are presently being obtained.

Remaining components of the DST system for which the initial integrity assessment has not yet been completed include 3 DCRTs, 8 catch tanks, the 241-A-350 lift station, and the 204-AR waste unloading station. Completion of integrity assessments and supporting tank examinations for these facilities was budgeted and scheduled during FY 1999, and portions were completed.

Tank examination and assessment of tank conditions are important for reasons other than regulatory compliance. Improved ability to estimate corrosion rates in tanks allows more effective management of program risks. Failure of tank systems--especially DSTs--prior to completion of their planned waste storage mission would have adverse cost and schedule impacts, as well as potential environmental impacts. To the extent tank failure can be predicted, timely mitigating actions can be planned and implemented that can minimize cost and schedule impact, and potentially minimize risk of environmental impacts. Such actions may include, for example, altering waste chemistry to reduce corrosivity, selection of alternate tanks for waste staging, modifying operating parameters (e.g., ventilation rates, temperature, liquid level, transfer rates), or replacing tanks. RPP's current cost, and schedule baselines assume construction of new tanks for waste storage will not be required. Technology Insertion Point (TIP) Milestone T03-05-300, included in RPP's FY 2000 Multi-Year Program Plan, schedules a decision on DST replacement by April 2005.

Strategy for Completing DST System Integrity Assessment, and Supporting Decisions on DST Replacement

2.0 Objective

This document has three objectives, focused on three phases of the RPP mission—a near term phase, an intermediate term phase, and a long term phase. The near term phase extends from now through the end of FY 2000. The intermediate phase extends from FY 2001 through FY 2005--the year when TIP milestone T03-05-300 is scheduled to be completed. The long term phase extends from FY 2006 through the end of the RPP mission. Following are the objectives for this document, for each of these phases:

- Near Term: Reaffirm the commitment to completing the initial integrity assessment of the DST system (i.e., DCRTs, catch tanks, and two miscellaneous tanks), and define the rationale for conducting additional ultrasonic testing (UT) on DSTs and continuing development of corrosion monitoring technology.
- Intermediate Term: Define the tentative strategy for providing input to programmatic decisions on managing risks associated with tank aging.
- Long Term: Propose the basis for developing plans and schedules for tank system integrity assessment over the life of the RPP mission.

3.0 Near Term Strategy

3.1 Integrity Assessments for DCRTs, Catch Tanks, and Miscellaneous Tanks

Evaluation of design standards, waste characteristics and compatibility, corrosion protection, and tank age for the following facilities was completed in FY 1999:

- DCRT 244-BX
- DCRT 244-TX
- DCRT 244-A
- 241-A-350 Lift Station
- 204-AR Waste Unloading Facility
- 241-S-304 Catch Tank
- 241-UX-302A Catch Tank
- 241-TX-302C Catch Tank
- 241-U-301B Catch Tank
- 241-AZ-151 Catch Tank
- 241-ER-311 Catch Tank
- 241-AX-152 Catch Tank
- 241-EW-151 Catch Tank

Field work (tank examination) was also completed in FY 1999 for the 241-S-304 Catch Tank, and partially (annulus visual examination, and leak test) for DCRT 244-BX. The approach for completing the required remaining field work for DCRTs, catch tanks, and miscellaneous tanks has been defined through a series of working sessions from December 1999 through the present, involving representatives from Tank Farm Operations, Production Control, Environmental, Tank Systems Integrity Engineering, and Cogema (including the IQRPE). Results of these working sessions are provided in RPP-5963[1]. Upon completion of the planned field work, a single Integrity Assessment Report will be prepared for all 13 facilities listed. This will incorporate results of the tank evaluations and field work completed in FY 1999, and the tank examinations scheduled for completion in FY 2000. Completion of planned field work, and issuance of an Integrity Assessment Report, is scheduled in FY 2000.

[1] *Engineering Task Plan for Integrity Assessment Examinations of Double-Contained Receiver Tanks, Catch Tanks, and Ancillary Facilities*, RPP-5963, Rev. 0, draft

3.2 Ultrasonic Testing of DSTs

During FY 1999, several schedule delays were incurred due to malfunction of ultrasonic testing equipment. To minimize risk of future schedule delays for this activity, new state of the art equipment has been procured. Ultrasonic examination of portions of two DSTs is now planned in FY 2000. The scope of ultrasonic examination planned for FY 2000 is indicated in Table 3.2.

Table 3.2

DST	primary tank vertical wall strip	primary tank wall horiz. (20') & vert. (20') welds	primary tank lower knuckle	primary tank bottom
241-AP-107	x	x	x	
241-AY-101	x	x	x	x

These two tanks are in addition to the six examined through FY 1999, and were chosen based on information gathered from ultrasonic examination during FY 1999. Tank 241-AP-107 was selected for examination because it contained a small liquid volume prior to receiving process waste for longer than any DST (four years), and thus may represent a more extreme case for conditions that are theorized to have caused the excessive wall thinning observed in 241-AN-105. Tank 241-AY-101 was originally selected for examination during FY 1999. However, excessive corrosion product on the exterior of the primary tank precluded proper operation of the magnetic crawler. Engineering development is required to perform surface preparation to allow the crawler to attach to the tank wall. Potential operations or air permitting issues must also be addressed. Similar conditions, requiring surface preparation to permit ultrasonic examination, may be required in other tanks to be examined in the future. An alternate tank will be selected in the event development of equipment and methods for surface preparation cannot be successfully completed this fiscal year. Table 3.2 indicates the primary tank bottom will be examined for 241-AY-101 but not for 241-AP-107. This is because the two AY farm tanks are the oldest DSTs, and also were constructed with 3/8" plate, whereas all the tank bottoms in all the other DST farms were constructed of half inch plate. Table 3.2 also indicates the primary tank lower knuckle will be examined for both tanks. With existing equipment, it is only possible to examine approximately the top 3 inches of the knuckle, below the weld joining the knuckle to the cylinder. The region of greatest stress is in the lower knuckle, and therefore the region of most concern for stress-corrosion cracking, is beyond the reach of currently available examination equipment. Additional technology development is required before ultrasonic examination of the more critical regions of the lower knuckle can occur. Nevertheless, the portions of these two DSTs that can be examined with existing equipment will be, since even a limited examination provides useful information, and is relatively cost-effective if performed in conjunction with examination of the tank wall.

The scope of the examinations indicated in Table 3.2 is as follows, based on guidelines developed by the Tank Structural Integrity Panel[2]:

Primary Tank Cylinder: A vertical strip along the primary cylinder wall (comprised of one or more strips whose total width is approximately 30 inches wide x 35 feet long).

Primary Tank Welds: 20 feet of the circumferential weld joining the cylinder to the lower knuckle, and 20 feet of vertical weld joining the lowest shell course plates.

Primary Tank Lower Knuckle: 20 feet long in the circumferential direction (or in increments that add up to 20 feet), by the maximum arc length in the meridional direction reachable by the transducer assembly.

[2] Bandyopadhyay, K., S. Bush, M. Kassir, B. Mather, P. Shewmon, M. Streicher, B. Thompson, D. van Rooyen, and J. Weeks, *Guidelines for Development of Structural Integrity Programs for DOE High-Level Waste Storage Tanks*, BNL-52527, Brookhaven National Laboratory, 1997

Primary Tank Bottom: 12 foot length along each accessible air slot in the insulating concrete pad (as permitted by geometry and debris or concrete splatter in air slots within the 45 degree segment accessible through a 24 inch riser.)

3.3 Corrosion Monitoring

Corrosion probes have been designed, fabricated, and installed in 4 DSTs to date (241-AZ-101, 241-AN-107, 241-AN-102, and 241-AN-105). This technology provides real time feedback on corrosivity of tank waste, including identification of corrosion mechanisms (uniform corrosion, pitting corrosion, stress-corrosion cracking) that may be at work, as well as information on corrosion rates. Such information would allow more timely and accurate adjustment of waste chemistry, and better estimates of wall thinning rates used to predict tank life. Due to signal transmission problems, additional troubleshooting and equipment upgrades are needed before this technology is ready for operational use. Depending on results of data evaluation following upgrades planned in FY 2000, an effort will be undertaken in FY 2001 to modify the existing DST operating specifications to allow operational use of corrosion probes.

Further development of this technology supports Technology Insertion Point (TIP) Milestone T03-01-300, *On-Line Monitoring for Waste Tank Corrosion Control*, June 2001, in the RPP FY 2000 Multi-Year Program Plan.

4.0 Intermediate Term Strategy

The purpose of gathering information on tank integrity is to support both regulatory and programmatic decision making. From a regulatory perspective, the purpose is to determine whether a tank is no longer fit for use, and therefore should be emptied and retired from service. From a programmatic perspective, an additional purpose is to provide input to decisions that potentially impact cost and schedule for completing the RPP mission. In order to cost-effectively focus on gathering the right kind of information, it is important to understand what those decisions are, how they will be made, and how they are potentially affected by other considerations.

The balance of this section focuses on programmatic decisions related to DST replacement. Deterioration and failure of other components of the DST system also have potentially serious impacts, but DST failure warrants special consideration, as reflected in TIP Milestone T03-05-300.

4.1 Framework for Programmatic Decision

To develop the strategy for gathering information on DST integrity, in support of programmatic decisions on DSTs, an approach was used that entails the following four steps:

- define the problem
- define the decision to address the problem
- define the criteria for making the decision
- identify the information needed to apply the criteria

<u>Problem</u>: DSTs are assumed to be deteriorating with age, and could potentially fail before completion of the RPP mission. To mitigate consequences of DST failure, new waste storage capacity could be constructed. However, cost for new tank construction is high, and therefore should be undertaken only if justified by evaluating benefits and risks. Available tank capacity is also a consideration in waste volume projections. Decisions on tank construction for purposes of replacing aging tanks prior to their anticipated failure must be integrated with assessment of tradeoffs between waste volume projections and costs/benefits of additional waste storage capacity for operational efficiency and reliability of waste feed delivery in accordance with contractual requirements.

<u>Decision</u>: Whether to build, or not to build, n new waste storage tanks, where n = 1, 2, 3, ...etc.

Criteria for Making the Decision: Yes, build n new tanks, if the cost to build and operate n new tanks is less than:

- reduced waste feed delivery operational cost due to improved efficiency, plus
- the penalty for not meeting feed delivery rates multiplied by the increased probability of meeting contractual waste feed delivery rates times, plus
- the impact of tank failure multiplied by the tank failure probability,

Otherwise, No—don't build new tanks.

Information Needed to Apply Criteria:

- cost to build and operate 1, 2, 3, ...n new tanks
- waste feed delivery operational benefits due to having 1, 2, 3, ...n new tanks
- probability of failure of 1, 2, 3, ...n DSTs prior to the end of the RPP mission, based on planned service life and usage for each DST
- impact of DST failure, as affected by each of the following which are also information needs in their own right:
  - probability of release from the secondary tank to the subsurface, given failure of the primary tank and resulting leakage to the secondary
  - additional cleanup cost for release of DST waste to the subsurface (depends highly on tank farm closure decisions, which are TBD)
  - impacts of operations response to leaks from the primary to the secondary tank (e.g., additional operations costs and schedule delays directly and indirectly resulting from taking a tank out of service and transferring its waste to another tank, in accordance with regulatory requirements and agreements)
- increased probability of meeting contractual waste feed delivery rates, for 1, 2, 3, ...n new tanks
- penalties for not meeting contractual waste feed delivery rates and and missing Tri-Party Agreement milestones and related regulatory commitments.

Information on the last bullet will be given in the contract between ORP and BNFL for building and operating waste vitrification facilities, and from the Tri-Party Agreement and related regulatory commitments and agreements. Information for the other bullets should be provided via engineering studies conducted between now and April 2005, when TIP Milestone T03-05-300 is scheduled to be completed. The attached logic diagram indicates the relationship of proposed activities supporting TIP Milestone T03-05-300.

4.2 Approach for Estimating DST Failure Probability and Gathering Required Data

Minimum wall thicknesses required to satisfy ASME Code criteria in selected regions of the DST primary tanks have been calculated based on nominal design conditions[3]. Minimum wall thickness required to satisfy ASME Code criteria in selected regions of 241-AN-105 was also calculated based on both design and current operating conditions[4]. In addition, the latter reference also includes an estimate of remaining useful life for 241-AN-105, based on linear extrapolation of the corrosion rate obtained by dividing the maximum depth of localized wall thinning observed in each selected region by the tank operating years to date, and conservatively assuming the localized wall thinning was in fact general wall thinning, i.e., over a large area of the

[3] *Double-Shell Tank Useful Life Analysis*, WHC-SD-WM-ER-556, Rev. 0, P. C. Ohl, N. G. Awadalla, R. P. Anantatmula, and C. E. Jensen, Westinghouse Hanford Company; F. G. Abbatt and L. J. Julyk, ICF Kaiser Hanford Company, and L. D. Muhlstein, ARES Corporation, March 29, 1996

[4] *241-AN Double-Shell Tanks Integrity Assessment Report*, HNF-4860, Rev. 0, C. E. Jensen, Lockheed Martin Hanford Corporation, September 21, 1999; Appendix B, *Structural Evaluation of the 241-AN-105 Primary Tank*, L. J. Julyk, July 1999.

tank. For that assumption, remaining service life is calculated as the time for general corrosion to progress to the point where remaining wall thickness is equal to minimum wall thickness required to meet the ASME Code structural criteria.

Chapter 6 of the prior footnoted reference (WHC-SD-WM-ER-556) suggests an alternative approach for calculating remaining tank life. That alternative approach provides two methods--one for general corrosion, and one for pitting corrosion. For general corrosion, the approach is the same as was used in Appendix B of HNF-4860. For pitting corrosion, time to failure is calculated by dividing the entire nominal wall thickness by the estimated corrosion rate. Estimated time to failure would then use whichever calculation gave the minimum number of years.

Chapter 6 of WHC-SD-WM-ER-556 also provides a methodology to account for uncertainty in estimated corrosion rates in the liquid, liquid/vapor interface, and vapor space regions of a tank. Accounting for uncertainty in corrosion rates produces uncertainty in estimated time to failure. This methodology uses a two-parameter Weibull probability density function where the shape parameter and the scale parameter were developed graphically from corrosion sample data available at the time. Monte Carlo simulation using the specified probability density function, and using both nominal and minimum required wall thickness data for a given tank, then produces cumulative distribution functions (CDFs) for failure probability of the given tank, for each assumed corrosion mechanism, and for each region of interest (liquid, liquid/vapor interface, and vapor), as a function of time.

Future DST failure probability estimates will be performed by first compiling the corrosion rate data in various regions of the tank from UT inspection and corrosion probe measurements of DSTs. Since occurrence of stress-corrosion cracking (SCC) has a very low probability in DSTs because the tanks were stress relieved after fabrication and installation (and also because no SCC was observed in any of the tanks examined by UT), SCC will not be included in the DST failure probability estimates. The UT inspection and corrosion probe will both measure uniform as well as pitting corrosion, if pitting is occurring. Model equations will then be developed separately for uniform and pitting corrosion rates in different regions of the DSTs, viz., vapor space, near vapor/liquid interface, and within liquid. If necessary, Hanford in-tank corrosion data, Hanford laboratory corrosion data, and aqueous corrosion data in the literature will be utilized to arrive at a more representative model with appropriate variable parameters. Monte Carlo simulation will be performed to cover the range of the variable parameters using a Weibull or other more appropriate probability density function to yield CDFs for DST failure probability. Then using information on duration of usage for each DST as provided in evaluation of operating scenarios and plans for delivery of feed to BNFL[5], failure probabilities for each DST can be estimated, and for each feed delivery scenario of interest. This data can then be used in a Monte Carlo simulation for all 28 DSTs, to estimate failure probability for 1, 2, 3, ..etc. DSTs for each scenario.

Defensibility of results and conclusions from this approach will be supported by data from ultrasonic testing and corrosion monitoring (should that technology be demonstrated to be feasible—see section 3.3). These data will reduce uncertainty in actual corrosion rates and corrosion mechanisms in DSTs.

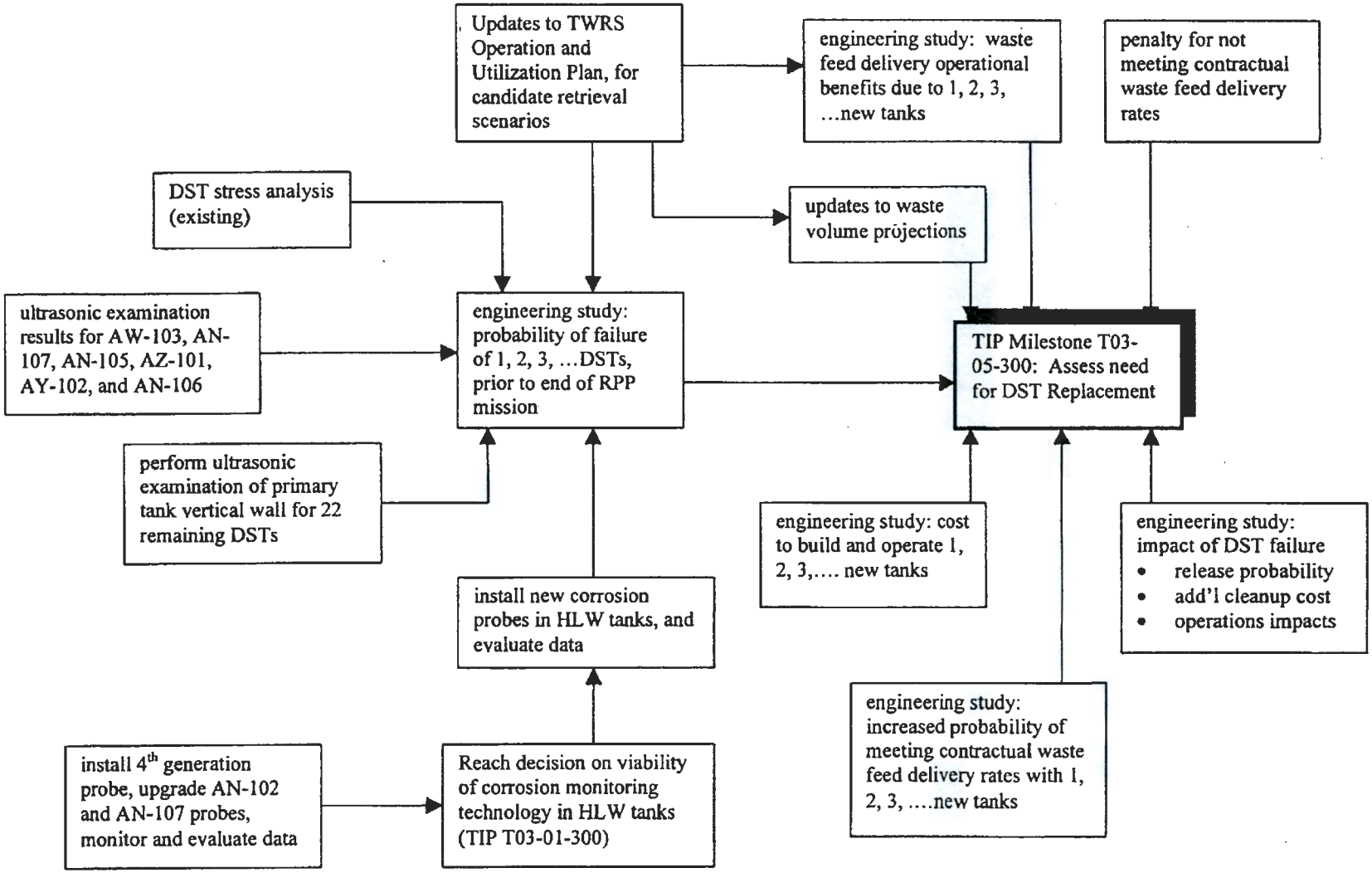
Table 5-9 in footnoted reference WHC-SD-WM-ER-556 provides evidence to suggest that for pitting and uniform corrosion, the critical region for limiting remaining service life for DSTs is the vertical portion of the primary tank wall. Ultrasonic examination of the vertical portion of tank walls has been successfully conducted to date for 6 DSTs, with 2 additional planned for FY 2000. It is recommended that after FY 2000 ultrasonic examination of tanks focus on completing the vertical wall sections for the remaining 20 DSTs, by the end of FY 2005. This would establish a

[5] *Tank Waste Remediation System Operation and Utilization Plan*, HNF-SD-WM-SP-012, Rev. 1, R. A. Kirkbride, G. K. Allen, R. M. Orme, and R. S, Wittman, Numatec Hanford Company; J. H. Baldwin, T. W. Crawford, and J. Jo, Lockheed Martin Hanford Corporation; and L. J. Fergestrom, T. M. Hohl, and D. L. Penwell, Cogema, May 4, 1999

baseline for future reexamination to better estimate corrosion rates. In addition, this would provide sufficient data, from a majority of the DSTs, to reduce uncertainty in accounting for corrosion that has occurred to date, and developing probabilistic estimates of remaining tank life in support of TIP Milestone T03-05-300. Following examination of the 2 DSTs scheduled in FY 2000 (see section 3.2), achieving these objectives would require examining the vertical wall portion of the remaining 20 DSTs at the rate of 4 DSTs per fiscal year.

Concurrent with this initial focus on examining the primary tank vertical wall sections, technology development should proceed on a method for examining the currently unreachable high-stress region of primary tank lower knuckles. Work supporting this objective is currently being funded through the Tanks Focus Area. Once technology is available, ultrasonic examination of primary tank lower knuckles will be incorporated in test plans. In addition, prior to the end of FY 2005, work should proceed to examine primary tank bottoms for selected tanks, and secondary tank knuckles and bottoms for selected tanks, consistent with Tank Structural Integrity Panel guidance.

5.0 Long Term Strategy

Following completion of activities necessary to support TIP Milestone T03-05-300, tank integrity assessment activities will continue throughout the RPP mission life for regulatory compliance, and also for input to programmatic decisions on managing risks associated with tank system aging. If ultrasonic examination of selected portions of the vertical section of tank walls is completed by the end of FY 2005, succeeding examinations would be scheduled to assess changes relative to the baseline examinations, patterned on in-service inspection (ISI) programs used in the commercial nuclear industry for critical pressure boundary components. In addition, tank system integrity assessments would be repeated, based on a schedule to be developed in accordance with WAC 173-303-640(2)(e).

Activities Supporting TIP Milestone T03-05-300, *Assess Need for DST Replacement*