

**Pacific Northwest  
National Laboratory**

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Expert Panel Recommendations for  
Hanford Double-Shell Tank  
Life Extension

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## Expert Panel Recommendations for Hanford Double-Shell Tank Life Extension

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## **Abstract**

An expert workshop was held in Richland, Washington, May 1–4, 2001 to review the Hanford Double-Shell Tank Integrity Project and make recommendations to extend the life of the double-shell tanks. The scope of the workshop was limited to corrosion of the primary tank liner, and the main areas for review were waste chemistry control, headspace and annulus humidity control, tank inspection, and corrosion monitoring.

Participants included corrosion experts from Hanford, the Savannah River Site, Brookhaven National Laboratory, Pacific Northwest National Laboratory, and several experts from industry. The workshop developed 73 specific recommendations to improve the tank integrity program. A senior review committee selected from the initial workshop participants later grouped and sorted this list into 27 high-priority recommendations. This report describes the current state of the program, the final recommendations of the workshop, and the rationale for their selection.

## Executive Summary

The purpose of the Double-Shell Tank (DST) Life Extension Workshop and the subsequent Senior Review Committee (SRC) meeting was to perform a comprehensive, expert review and assessment of all pertinent technical information associated with DST operations and inspections for the Hanford DST Integrity Project. Additionally, the experts brought together for these assessments were tasked to provide pertinent, prioritized recommendations that, if implemented, would ensure that the DSTs perform their mission past 2028.

### Background

The Hanford DST resource consists of 28 tanks, each of more than one-million-gallon capacity, organized into six tank farms. The DSTs presently contain over 21 million gallons of high-level waste with about 80 million curies of radioactivity. The DSTs have been in service for 15–30 years and were originally designed to provide a 20- to 50-year service life. To meet Hanford programmatic requirements, all the DSTs need to meet or exceed their design life before the mission is completed.

The Hanford Double-Shell Tank Integrity Project (TIP) was established in January 2001 based on the need to ensure DST integrity past an operational horizon of 2028 and in recognition that the waste in four DSTs had remained outside established chemistry controls for years and annulus ventilation systems in several tanks had been out of service for long periods. The objectives of the TIP are to correct out-of-specification waste chemistry conditions, restore inoperable vital support systems (e.g., the tank annulus ventilation), baseline the existing DST conditions, and develop conservative controls and effective surveillance programs to minimize further DST degradation and assess future corrosion concerns.

The DST Life Extension Workshop was chartered to support the TIP objectives. It consisted of two assessment phases, the workshop and the Senior Review Committee (SRC) meeting. The workshop was held May 1–4, 2001, gathering 24 experts from industry, national laboratory, and DOE Hanford and Savannah River sites (see Section 2 for the names and affiliations and Appendix A for biographical sketches). Based on technical presentations of pertinent information, the workshop performed a detailed review of DST design and support systems issues, the chemistry control program, corrosion monitoring and mitigation, and the DST inspection program (visual and ultrasonic methods and results). The review was facilitated by a series of questions designed to elucidate pertinent DST issues and concerns (see Appendix D for this question set and notes on the discussions). The workshop reviews generated 73 individual recommendations (see Appendix E for descriptions and rationale) to enhance the achievement of DST life extension and to resolve uncertainties in DST technical issues.

The Senior Review Committee, which met May 21–22, 2001, was a smaller, multidisciplinary, expert body (see Section 3 for SRC membership). The SRC was tasked to analyze, consolidate, balance, and prioritize the original recommendations to ensure that they directed a coherent and achievable program for DST life extension. The SRC reviewed in detail all the items in these groupings to ensure that the recommendations provided a balance between detection and

prevention of DST problems and covered all the needs of the DST Integrity Project. The team maintained a focus on what is most important for DST life extension. The SRC assigned priority categories to each recommendation set, which should be interpreted as follows:

***Very High Priority:*** Action is **mandatory** on an **aggressive schedule** to protect tanks from immediate damage.

***High Priority:*** Action is **mandatory** to ensure tanks can be operated beyond their design life.

***Nominal Priority:*** Action is **recommended** for possible improvement of tank lifetime, as resources permit.

***Low Priority:*** Action is **not recommended**.

Only Very High Priority and High Priority recommendations are listed in this summary. See Section 3.0 for those of lower priority.

## **Very High Priority and High Priority Recommendations**

Three **Very High Priority** overarching management action recommendations stand out as absolutely necessary and require immediate accomplishment:

- Establish a top management priority to provide sufficient consistent funding for the TIP to perform the immediate and long-term actions required to protect the DST resources.
- Establish a top management priority to provide funding to 1) correct the waste chemistry on the four tanks that are now out of specification as soon as possible and 2) consistently maintain all tanks within specifications.
- Establish a top management priority to provide funding to return the inoperative annulus ventilation systems on AZ-101 and 102 to service and to maintain all DST annulus ventilation and other vital support systems in operational condition.

These recommendations for management priority and focus must be accomplished to maintain and extend the DST lifetime and to prevent loss of vital DST capacity due to failure by corrosion. Without such long-term management commitment, the DST mission cannot succeed.

Other **Very High Priority** recommendations are associated with necessary improvements to chemistry and corrosion controls (additional detail on the basis for these recommendations is summarized in Section 3). They are

- Perform frequent, regular sampling and analysis of the waste instead of depending on caustic depletion models to schedule sampling. Sample and analyze all tank layers to establish existing conditions, including vertical and radial waste uniformity and analytical uncertainty, and to generate a coherent database.
- Establish corrosion chemistry data quality objective (DQO) to ensure that consistent, high-quality corrosion data will be obtained. Archived waste samples should be re-analyzed under the new DQO, as appropriate.

- Through laboratory testing with simulants and waste samples and through improved waste sampling, establish the appropriate chemical limits for each layer to prevent or minimize the potential for stress corrosion cracking (SCC) in the knuckle or pitting and excessive thinning of the tank wall.
- Complete the measurement and analysis of natural mixing dynamics so timely decisions can be made on the need for installing mixing pumps for tank life-extension purposes.
- Evaluate the benefits and feasibility of adding nitrite corrosion inhibitor directly, along with the caustic additions for chemistry control.
- Benchmark the Savannah River Site tank farm operations for tank sampling and analysis efficiencies and effectiveness.

Next, the Workshop/SRC established a series of **High Priority** recommendations associated with maintaining the tanks in specification, minimizing corrosion, and operating vital safety systems effectively, as follows:

- Add corrosion chemistry conditions to the waste compatibility criteria to ensure that the rate or volume of dilute waste or raw water additions do not move the waste out of specification.
- Develop a layup and sampling procedure for tanks left with a waste heel after being pumped out.
- Consider increasing the margin between waste chemistry and the chemistry corrosion limits (i.e., pH >12), based on corrosion studies and information from the Savannah River Site.
- Fully characterize the tank waste simulants originally used to determine tank chemistry controls. Determine free hydroxide, nitrate/nitrite, pH, corrosion potential, etc., in the simulant to compare with actual waste composition data.
- Conduct an optimum experimental test program, possibly including low-strain rate tests, to establish chemical conditions to reach stress corrosion cracking (SCC) thresholds for the most vulnerable tank regions. Analysis of sediment and supernatant composition and analysis of more recent SCC data will guide the experiments.
- Plan and perform cold corrosion tests for bulk corrosion, pitting initiation and inhibition, and waterline corrosion on an appropriate range of conditions, to determine safety margin on present chemistry controls and possibly extend their range.
- Systematically and periodically vary waste levels in DSTs equipped for transfers to minimize the effects of waterline corrosion. Maintain this administrative control unless and until chemistry limits are developed that ensure no waterline corrosion.
- Administratively control DST waste levels to avoid maintaining levels in the minimum calculated wall margin regions (100- to 150-inch range) until reassessment with probabilistic mechanical stress analysis determines the accuracy of and need for the control.

- Provide heating or dehumidification for the annulus ventilation system if relative humidity reaches or exceeds 30% for extended periods. Monitor the humidity in some selected DST annuli or review meteorological records to assess the need.
- Eliminate the potential for rain and snow melt intrusion and groundwater or process water invasion of the annulus.

Next, the Workshop/SRC generated several **High Priority** recommendations for tank corrosion condition inspections and tank repair options.

- Complete the visual inspections for all DSTs to establish a corrosion baseline in two years (not to exceed three years) and increase the frequency of scheduled visual inspections thereafter. Let these results guide the priority and locations of ultrasonic testing (UT) (including UT examination of waterline areas).
- Perform volumetric nondestructive examination (NDE) (UT, eddy current [ET]) on all tanks at least every five years, including a vertical strip to cover changing waterlines. Focus priority efforts on tanks known to be out of specification or with known corrosion.
- Continue to support T-SAFT (tandem-synthetic aperture focusing technique) development to achieve a viable UT inspection of the tank knuckle regions.
- Evaluate the use of pulsed ET techniques to supplement UT inspections.
- Complete the DQO for UT inspections to ensure the consistency and quality of UT measurements.
- Complete the procurement and use of a gas (or other) tracer technology to determine whether tank AY-101 has a perforation. Maintain the technology for other potential tank evaluations.
- Benchmark the Savannah River Site NDE equipment and methodology for potential efficiencies and application to the Hanford DSTs.
- Develop a contingency plan for weld repair of DST defects (e.g., perforation, wall thinning, etc.). Include specifications and procedures, stray current corrosion considerations, and qualification of suppliers. Also, perform an assessment of the potential use of mechanical plugs or sealants (e.g., epoxy) to seal potential tank leaks.

## Conclusions

The DSTs represent a vital resource that is the cornerstone of the Hanford Site remediation program. These DSTs were built to last 20–50 years, and with careful operational controls and management attention, their service life can be extended. Conversely, if appropriate conservative chemistry controls are not routinely maintained, and vital support systems become inoperative, DSTs may not achieve their original design life.

The Workshop and SRC reviews of the technology bases, areas of technical uncertainty, and the necessary actions to maintain and extend the DST useable lifetime to support the Hanford mission resulted in a well-considered set of recommendations to achieve that goal. The

Workshop/SRC's set of "Very High Priority" and "High Priority" recommendations (as described briefly above and in more detail in the report) needs to receive full management and budgetary support for programmatic success.

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# Contents

Executive Summary .....	v
Acknowledgments.....	ix
Acronyms .....	xv
1.0 Introduction.....	1.1
1.1 History and Design of the Hanford DSTs.....	1.1
1.1.1 Design and Construction of the Hanford DSTs.....	1.2
1.1.2 DST Waste Level History.....	1.4
1.1.3 DST Waste Cooling and Ventilation .....	1.10
1.1.4 Summary of Current DST Status and Contents .....	1.12
1.2 Hanford Double-Shell Tank Integrity Program .....	1.13
1.3 Summary of Corrosion Mechanisms .....	1.16
1.3.1 General Corrosion.....	1.16
1.3.2 Pitting Corrosion.....	1.17
1.3.3 Stress Corrosion Cracking .....	1.18
1.3.4 Additional Corrosion Mechanisms .....	1.19
1.3.5 Summary of Corrosion Mechanisms .....	1.19
2.0 Proceedings of the Hanford DST Life Extension Workshop.....	2.1
2.1 Workshop Organization and Method.....	2.1
2.2 Review of the Chemistry Control Program .....	2.2
2.2.1 Background.....	2.2
2.2.2 Summary of Review .....	2.3
2.2.3 SRS Chemistry Control Experience and Lessons Learned.....	2.6
2.2.4 Discussions and Recommendations.....	2.7
2.3 Tank Inspection Program Review.....	2.8
2.3.1 Visual Inspection .....	2.14
2.3.2 Ultrasonic Inspection .....	2.16
2.3.3 SRS Inspection Program and Lessons Learned .....	2.17
2.3.4 Additional Methods to be Considered .....	2.18
2.3.5 Recommendations and Lessons Learned .....	2.19
2.4 Review of the Corrosion Monitoring Program .....	2.20
2.4.1 Summary of Review .....	2.21
2.4.2 Additional Monitoring Considerations .....	2.22
2.4.3 SRS Corrosion and Chemistry Probe.....	2.22
2.4.4 Recommendations for Corrosion Monitoring.....	2.23
2.5 Ranking of Review Recommendations.....	2.23

3.0 Report of the Senior Review Committee.....	3.1
3.1 Purpose and Participants.....	3.1
3.2 Review Methodology.....	3.1
3.3 Results of SRC Review by Category.....	3.2
3.3.1 Chemistry Control .....	3.3
3.3.2 Support Systems Operation .....	3.5
3.3.3 Corrosion Testing .....	3.6
3.3.4 Tank Integrity Inspection .....	3.7
3.3.5 Corrosion Repair and Mitigation .....	3.8
3.3.6 Corrosion Monitoring .....	3.9
3.3.7 Additional Actions .....	3.9
4.0 References.....	4.1
Appendix A: Biographical Sketches.....	A.1
Appendix B: Workshop Agenda.....	B.1
Appendix C: Presentations.....	C.1
Appendix D: Questions for Technical Reviews.....	D.1
Appendix E: Description of Recommendations .....	E.1
Appendix F: Rankings .....	F.1
Appendix G: Summary of Grouped Recommendations.....	G.1
Appendix H: Senior Review Committee Meeting Agenda.....	H.1

## Figures

1.1	Double-Shell Tank Farm under Construction, circa 1980 .....	1.2
1.2	Cross-Section of a Typical Double-Shell Tank .....	1.3
1.3	Interface of Primary and Secondary Liner in Haunch Region.....	1.5
1.4	DST Cross-Section in Lower Knuckle Region.....	1.5
1.5	Level History of Tanks in the AN Farm .....	1.6
1.6	Level History of Tanks in the AP Farm.....	1.7
1.7	Level History of Tanks in the AW Farm .....	1.8
1.8	Level History of Tanks in the AY and AZ Farms .....	1.9
1.9	Level History of Tanks in the SY Farm.....	1.9
1.10	Components of the DST Integrity Program.....	1.16

## Tables

1.1	Summary of Material Design Specifications for Double-Shell Tanks .....	1.3
1.2	DST Age and Design Life Summary .....	1.4
1.3	Concentration (Molar) of Selected Anions and pH in DST Waste.....	1.12
1.4	Summary of Current Knowledge of Status of All Double-Shell Tanks .....	1.14
2.1	Workshop Participants and Senior Review Committee.....	2.2
2.2	Current DST Waste Chemistry Limits.....	2.4
2.3	Comparison of TSIP Guidance and Current NDE Practice for Hanford DSTs.....	2.9
3.1	Senior Review Committee Meeting Participants.....	3.1

## Acronyms

AB	authorization basis
BNL	Brookhaven National Laboratory
CCTV	closed circuit television
CHG	CH2M HILL Hanford Group, Inc.
DQO	Data Quality Objective
DST	double-shell tank
DWPF	Defense Waste Processing Facility
EN	electrochemical noise
ET	eddy current testing
FGWL	Flammable Gas Watch List
FSAR	Final Safety Analysis Report
HAZ	heat-affected zone
HLW	high-level waste
LPR	linear polarization resistance (probe)
NCL	nonconvective layer (aka "sludge")
NDE	nondestructive examination
MIC	microbiologically induced corrosion
PFPP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
PUREX	Plutonium-Uranium Extraction plant
SCC	stress corrosion cracking
SRC	Senior Review Committee
SRS	Savannah River Site
SST	single-shell tank
TPA	Tri-Party Agreement
T-SAFT	tandem-synthetic aperture focusing technique (NDE technology)
TSIP	Tank Structural Integrity Panel
TWINS	Tank Waste Information Network System
UT	Ultrasonic testing (ultrasonic examination)
WHC	Westinghouse Hanford Corp.