U-ESS-G-00005
Revision 0
June 2015

Evaluation of the Safety of the Situation (ESS): Vulnerabilities Associated with Waste Tank Overflow (PISA PI-2015-0008)

APPROVALS

T.L. Yeager, Author — Date: June 11, 2015

A.L. Orris, Technical Reviewer — Date: 6/11/2015

T.H. Huff, LW Safety Basis Regulatory Authority — Date: 6-11-15

SPB 6/11/2015

E. Patten, Facility Manager, Tank Farm — Date: 6/11/15

1.0 PISA Description/Summary

Potential Inadequacy in the Safety Analysis (PISA) PI-2015-0008 pertains to the Concentration, Storage, and Transfer Facilities (CSTF) Documented Safety Analysis (DSA), WSRC-SA-2002-00007, and is described in the PISA Database as follows:

"The Safety Basis (Ref. 1) and initial Hazard Analysis (Ref. 2) contain an event (WT-30a) related to waste tank overflow resulting from waste tank to waste tank siphons through the Chromate Cooling Water (CRW) System. This event is carried forward into the Safety Basis and linked (via Table 3.3-17) to the Waste Tank Siphon/Pump-Out Design Basis Accident (DBA) in DSA Section 3.4.2.15. However, this progression is not currently described in this DBA. The current Waste Tank Siphon/Pump-Out DBA progression involves a siphon event associated with a leak in a CRW cooling coil inside a waste tank coincident with a leak in a CRW System line outside the tank. This DBA does not cover the progression described in event WT-30a and the existing control set may not be adequate. Additionally, the Transfer Error - Waste Tank Overflow DBA (DSA Section 3.4.2.9) does not provide relevant discussion/controls for event WT-30a."

Additional information pertaining to PISA PI-2015-0008 includes:

- Date of Discovery: 05/08/2015
- ORPS Report Number: EM-SR--SRR-HTANK-2015-0009

References pertaining to PISA PI-2015-0008 include:

1. Concentration, Storage, and Transfer Facilities Documented Safety Analysis, WSRC-SA-2002-00007, Rev. 16, June 2014.
2. Hazard Analysis for the CST Facility (U), S-CLC-H-00858, Rev. 3, February 2007.
3. High Level Waste Emergency Response Data and Waste Tank Data, N-ESR-G-00001, Rev. 730, June 2015.
4. Savannah River Plant 200 Area Type I Tanks 1-8 and 9-12 241-H General Arrangement & Construction Details Concrete and Steel (U), W145573, Rev. 29, April 2004.
5. Waste Characterization System, WCS1.5v008.2.xls, June 9, 2015.
6. Waste Transfer System Siphon Mitigation, G-CLC-G-00083, Rev. 0, February 1995.
7. Instrumentation Uncertainties Evaluation High Level Conductivity Probes Tank Types I, II, III, and IIIA, J-CLC-H-00775, Rev. 1, September 2002.
8. Instrumentation Uncertainties Evaluation High Level Conductivity Probes Tank Types I, III, and IIIA J-CLC-F-00300, Rev. 1, September 2002.
9. System Plan Rev. 19, SRR-LWP-2009-0001, Rev. 19.
10. Tank Farm Morning Report, June 9, 2015

11. Input Data and Assumptions for the Concentration, Storage, and Transfer Facilities (U), S-CLC-G-00235, Rev. 7, June 2011.

2.0 Compensatory Measures / Operational Restrictions

2.1 PISA Compensatory Measures / Operational Restrictions

The following Compensatory Measure is currently in place as documented in PISA-PI-2015-0008:

2.1.1 High Liquid Level Conductivity Probes (HLLCP) setpoint increases for Type I tanks (1-4 & 7-11) from current ERD (Ref. 3) are prohibited. This is not applicable to waste tanks in Closure Mode.

2.2 ESS Compensatory Measures / Operational Restrictions

Based on the evaluation provided in Section 3.1 the following Compensatory Measure will replace the Compensatory Measure 2.1.1. The ESS Compensatory Measure affords the facility more operational flexibility without compromising safety:

2.2.1 HLLCP setpoints for Type I tanks (1-4 & 7-11) shall not exceed those provided in Table 1, "Adjusted Final Fill Limit". This is not applicable to waste tanks in Closure Mode.

3.0 Safety Assessment Results

3.1 Immediate Safety Assessment

Event WT-30a involves a siphon/pump-out through the CRW System that results in an overflow of the waste tank. Currently, the Siphon/Pump-Out DBA only addresses a leak in a CRW cooling coil inside a waste tank below the tank's liquid level coincident with a leak in a CRW System line outside the tank (for a siphon to occur, the CRW System line leak outside the tank must be at a lower elevation than the tank's liquid level).

The DSA controls in Section 3.4.2.15 adequately protect Type II, III, and IIIA Waste Tanks (See Appendix A Waste Tank Siphon/Pump-Out Controls Summary) and the siphon accident is not credible in Type IV Waste Tanks because they do not have cooling coils. Waste Tanks in Closure Mode are precluded from Waste Tank Siphon/Pump-Out because the CRW system is isolated from these tanks.

For Type I Waste Tanks not in Closure Mode (Tanks 1-4 & 7-11) a siphon accident was previously deemed not credible due to the maximum tank level with respect to the CRW System low points. For Waste Tanks 1 and 2 the liquid level is based on the tank fill limit protected by the HLLCPs. However this control neglects to adequately prevent a

tank to tank siphon overflow between two Type I Waste Tanks through the CRW system. The PISA Compensatory Measure prohibiting ERD setpoint increases for Type I tanks prevents tank to tank siphon resulting in waste tank overflow. However, the ESS evaluation revises the PISA Compensatory Measure to increase operational flexibility without compromising safety by allowing minimal setpoint increases from the current HLLCP setpoint while still preventing siphon/pump-out through the CRW System resulting in an overflow of the waste tank. The ESS evaluation of the Type I tank to tank siphon potentials was performed by determining the lowest current maximum fill elevation based on the existing DSA Tank Fill Limits and the appropriate facility drawings. Then the fill limits are adjusted to compensate for the maximum missing waste and instrument uncertainty (see Table 1 and Appendix B).

As long as the waste volumes in Type I Waste Tanks are maintained below the "Adjusted Final Fill Limit" values in Table 1 the siphon/pump-out through the CRW System that results in an overflow of the waste tank event will be prevented. The "Adjusted Final Fill Limit" would be equivalent to the HLLCP setpoints identified in the ERD (Ref. 3).

The intent of the ESS Compensatory Measure is to prevent waste tank to waste tank siphon overflow. Should the HLLCP probes be lowered a waste tank to waste tank siphon may occur, however, it will not result in a waste tank overflow.

Table 1: Waste Tank Fill Height Compensatory Measures (Ref. 3 - 8)

Tank Number	DSA Fill Limit [in]	Source Data for Level Limit	Tank Inside Bottom Elevation [ft]	Fill Limit Elevation [ft]	Fill Limit to Prevent Overflow Due to Tank Siphon (Rounded Down) [in]	Max Missing Waste Plus Uncertainty [in]	Adjusted Final Fill Limit (Rounded Down) [in]**
1	264	Siphon from CRW	244.36	266.36	222	7.7	214
2	264	Siphon from CRW	244.36	266.36	222	7.7	214
3	276	Wall Stress	242.94	265.94	239	7.7	231
4	254	Transient Limit	242.94	264.11	239	7.7	231
7	274	Transient Limit	240.10	262.93*	274	7.7	266
8	274	Transient Limit	240.10	262.93*	274	7.7	266
9	276	Wall Stress	244.39	267.39	254	7.6	246
10	254	Transient Limit	244.39	265.56*	254	7.6	246
11	274	Transient Limit	242.89	265.72	272	7.6	264
12	Closure Tank						

*Most Limiting Fill Elevation
**See Appendix B For Example Calculation

Note: Rounded to the conservative direction
Max Missing Waste Value Origin:
Missing Waste = 15000 [gal] /2710 [gal/in] = 5.6 [in] (Ref. 11)
Uncertainty = 2.1[in] Tanks 1 – 8 HLLCP (Ref. 8)
Uncertainty = 2 [in] Tanks 9 – 12 HLLCP (Ref. 7)

3.2 Final Safety Assessment

An Unreviewed Safety Question Evaluation (USQE), USQ-HTF-2015-00344, was performed for PISA PI-2015-0008 and resulted in a "positive" evaluation. The facility continues normal operation under the operational restrictions identified in the PISA.

The USQE was "positive" based on a "Yes" answer to the following Question:

1. Increase the probability of occurrence of an accident previously evaluated.

The Proposed Activity (PA) is waste tank overflow due to waste tank to waste tank siphons through the CRW System as described by the WT-30a event in the Safety Basis. The DBAs affected by the PA are the Waste Tank Overflow (DSA Section 3.4.2.9), Waste Tank Siphon/Pump-Out (DSA Section 3.4.2.15), and the Seismic Event (DSA Section 3.4.2.18). The probability of occurrence of the Seismic event remains the same, because the PA does not introduce new seismic data.

The Waste Tank Overflow accident initiators currently include tornado/high winds and seismic, operator error, siphon into tank (from waste tank), limited liquid additions and non-batch liquid additions. The current analysis does not include a waste tank to waste tank siphon through the CRW system. This is because a siphon event was deemed not credible in the DSA for Type 1 Waste Tanks based on the elevation of the system low points being higher than tank fill limits and therefore no controls were developed. Since the control set applied from the Waste Tank Siphon/Pump-Out DBA is not adequate to prevent the siphon potential and subsequent overflow for Type I waste tanks, the PA does increase the probability of occurrence of an accident previously evaluated in the Safety Basis.

The Compensatory Measure is not expected to have an impact on operations based upon the near term plan (through FY 16) for salt batch and sludge batch processing (Ref. 9). It is recognized that Tank 8 is one of three identified hub tanks for Actinide Removal Process/Modular Caustic Side Solvent Extraction Unit Salt Batches 9 and 10 and is a potential source tank as well. The two remaining hub tanks (Tanks 23 and 35) are not affected by the PISA. The Compensatory Measure is not expected to impact possible salt dissolution in Tank 10 in early calendar year 2016 due to the "Adjusted Final Fill Limit" in Table 1 (246 inches) as compared to the current tank level (77 inches, Ref. 10). Otherwise, the Compensatory Measure supports small volume increases that may be needed to maintain tank chemistry.

3.3 Path Forward

1. Continue to implement the Compensatory Measure included in the PISA-PI-2015-0008 (ESS Compensatory Measure 2.1.1).

2. Upon DOE approval of this ESS, implement ESS Compensatory Measure 2.2.1.

3. Revise, as appropriate, the associated analysis and Safety Basis associated with the Vulnerabilities Associated with Waste Tank Overflow PISA in the DSA (e.g., Evaluate options to adjust HLLCP setpoints to eliminate the potential for a tank to tank siphon.).

3.4 Summary of Recommendations and Conclusions

Based on the results of USQ-HTF-2015-00344 and further evaluation of items associated with PISA PI-2015-0008, the PISA Compensatory Measure will remain in place until this ESS is approved by DOE. Then ESS Compensatory Measure 2.2.1 will be implemented until a permanent change is made to the Safety Basis and associated support documents. It is expected that the Safety Basis change to resolve the Vulnerabilities Associated with Waste Tank Overflow in the DSA (PISA PI-2015-0008) will be submitted to DOE by October 31, 2015.

Appendix A Waste Tank Siphon/Pump-Out Controls Summary

Table 2: Waste Tank Siphon/Pump-Out Controls Summary (Ref. 1)

Control[a]	Tanks						
	13-14[h]	25-28	29, 31 & 32[b, e]	30[b]	33-34[c]	35[e]	36-51[f, g]
Siphon Breaker (SC)	1st LOC (S/NS)		1st LOC (S/NS)	1st LOC (S/NS)		1st LOC (S/NS)	
Siphon Breaker (SS)					1st LOC (S/NS)		
Cooling Coils (SS)		1st LOC (S/NS)	2nd LOC (NS)		2nd LOC (NS)	2nd LOC (NS)	1st LOC (S/NS)
Event Response Program (SS)	2nd LOC (S/NS)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S)	2nd LOC (S/NS)
CRW Isolation Valves[d] (SS)	2nd LOC (S/NS)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S/NS)	2nd LOC (S)	2nd LOC (S)	2nd LOC (S/NS)
242-16H Evaporator Chemical Cleaning Program (SC)							1st LOC (S/NS)
242-16H Evaporator Isolation Valves (SC)							1st LOC (S/NS)

Notes:
(a) Key: LOC = Level of Control, NS = Non-seismic, S = Seismic, SC = Safety Class, SS = Safety Significant
(b) The siphon breakers on the Tank 30 cooling water headers provide siphon protection for Tanks 29-32.
(c) The siphon breakers on the Tank 34 cooling water headers provide siphon protection for Tanks 33 and 34.
(d) For Tank 30 these are the tank coil isolation valves, for all other tanks these are the tank header isolation valves.
(e) Sludge slurry transfers from Tanks 32 and 35 are prohibited (SC).
(f) Operation of mixing devices in Tank 39 is prohibited (SC).
(g) The 242-16H Evaporator Chemical Cleaning Program and Evaporator Isolation Valves apply to the 242-16H Evaporator drop and/or feed tank during chemical cleaning operations.
(h) For Tank 14, the controls are only required when the tank is connected to the CRW System. The siphon breakers on the Tank 13 cooling water headers provide siphon protection for Tanks 13 and 14.

Appendix B Example Calculation of Adjusted Final Fill Limit

The adjusted Final Fill Limit is determined as follows:

$$\begin{aligned} &Adjusted\ Final\ Fill\ Limit\ [in] \\ &\quad = Fill\ Limit\ to\ Prevent\ Overflow\ Due\ to\ Tank\ Siphon\ [in] \\ &\quad - Max\ Missing\ Waste\ Plus\ Uncertainty\ [in] \end{aligned}$$

$$\begin{aligned} &Fill\ Limit\ to\ Prevent\ Overflow\ Due\ to\ Tank\ Siphon\ [in] \\ &\quad = DSA\ Fill\ Limit\ [in] \\ &\quad - \big((Fill\ Limit\ Elevation\ - Most\ Limiting\ Fill\ Elevation\ [ft]) * 12\ [in]\big) \end{aligned}$$

Example: Calculation of Tank 1 Adjusted Final Fill Limit:

$$DSA\ Fill\ Limit = 264\ [in]$$

$$\begin{aligned} &\big((Fill\ Limit\ Elevation\ - Most\ Limiting\ Fill\ Elevation\ [ft]) * 12\ [in]\big) \\ &\quad = (266.36 - 262.93\ [ft]) * 12[in] = 41.16\ [in] \end{aligned}$$

$$\begin{aligned} &Fill\ Limit\ to\ Prevent\ Overflow\ Due\ to\ Tank\ Siphon\ [in] = 264 - 41.16 \\ &\quad = 222.84\ (round\ down) = 222\ [in] \end{aligned}$$

$$Adjusted\ Final\ Fill\ Limit = 222 - 7.7 = 214.3\ (round\ down) = 214\ [in]$$