Double-Shell Tank Visual Inspection Changes Resulting from the Tank 241-AY-102 Primary Tank Leak – 14193

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ABSTRACT

As part of the Double-Shell Tank (DST) Integrity Program, remote visual inspections are utilized to perform qualitative in-service inspections of the DSTs in order to provide a general overview of the condition of the tanks. During routine visual inspections of tank 241-AY-102 (AY-102) in August 2012, anomalies were identified on the annulus floor which resulted in further evaluations. In October 2012, Washington River Protection Solutions, LLC determined that the primary tank of AY-102 was leaking.

Following identification of the tank AY-102 probable leak cause, evaluations considered the adequacy of the existing annulus inspection frequency with respect to the circumstances of the tank AY-102 leak and the advancing age of the DST structures. The evaluations concluded that the interval between annulus inspections should be shortened for all DSTs, and each annulus inspection should cover > 95 percent of annulus floor area, and the portion of the primary tank (i.e., dome, sidewall, lower knuckle, and insulating refractory) that is visible from the annulus inspection risers. In March 2013, enhanced visual inspections were performed for the six oldest tanks: 241-AY-101, 241-AZ-101, 241-AZ-102, 241-SY-101, 241-SY-102, and 241-SY-103, and no evidence of leakage from the primary tank were observed.

Prior to October 2012, the approach for conducting visual examinations of DSTs was to perform a video examination of each tank's interior and annulus regions approximately every five years (not to exceed seven years between inspections). Also, the annulus inspection only covered about 42 percent of the annulus floor.

BACKGROUND

In October 2012, it was determined that the primary tank of double-shell tank (DST) 241-AY-102 (AY-102) was leaking [1]. Following identification of the tank AY-102 probable leak cause, an Extent of Condition (EOC) evaluation was prepared using U.S. Department of Energy's Energy Facilities Contractors Group (EFCOG) *Guidance for Extent of Conditions Evaluations*. The EFCOG process was used to identify other DSTs with construction, waste storage, or thermal histories similar to that of tank AY-102 [2].

The EOC evaluation also considered the adequacy of the existing annulus inspection frequency with respect to the circumstances of the tank AY-102 leak and the advancing age of the DST structures. The evaluation concluded that the interval between annulus inspections should be shortened for all DSTs, with each tank's inspection interval reflecting its age and the extent to which the tank shares similar construction and operating history with tank AY-102. Six tanks were identified for the enhanced annulus video inspections: 241-AY-101, 241-AZ-101, 241-AZ- 102, 241-SY-101, 241-SY-102, and 241-SY-103. Each tank would require a baseline inspection, covering >95% of annulus floor area, and the portion of the primary tank (i.e., dome, sidewall, lower knuckle, and insulating refractory) that is visible from the annulus inspection risers.

ANNULUS DESCRIPTION

The tank annulus is formed by the difference between the 22.86 meters (75 feet) diameter primary tank and the 24.38 meter (80 feet) diameter secondary liner resulting in a nominal 0.762 meter (2.5 foot) wide annular space wrapping around the entire circumference of the primary tank. Several penetrations exist in the top of the secondary liner, which allow access into the annulus space. This access is used for a variety of activities, including visual inspection cameras, sampling, ultrasonic testing crawlers, and leak detection instruments. Access into the annulus space provides visibility of the primary tank wall, secondary liner wall, outer perimeter of the refractory, refractory stiffener ring, ventilation piping, refractory slots, and installed equipment. Figure 1 and Figure 2 identify some of the features of the annulus of DSTs.

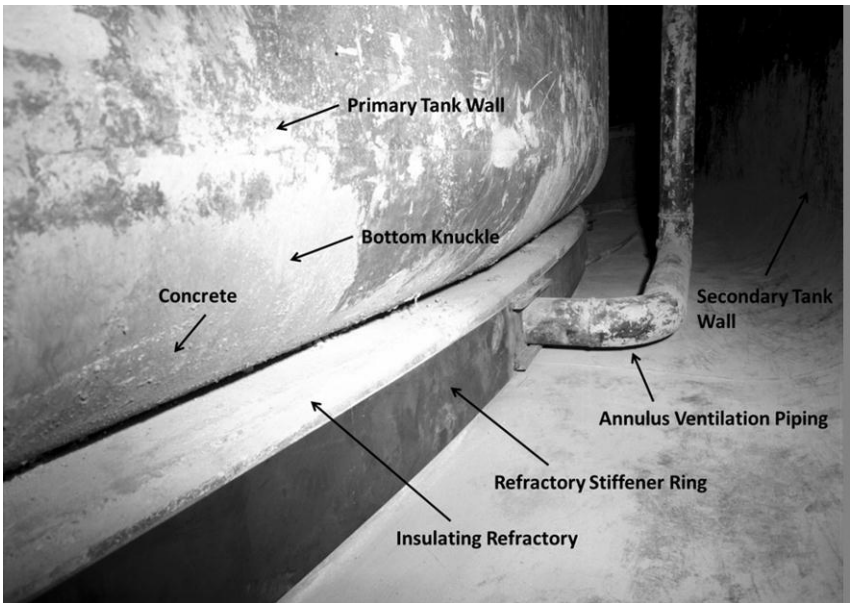

Fig. 1. Typical Double-Shell Tank Annulus Features.

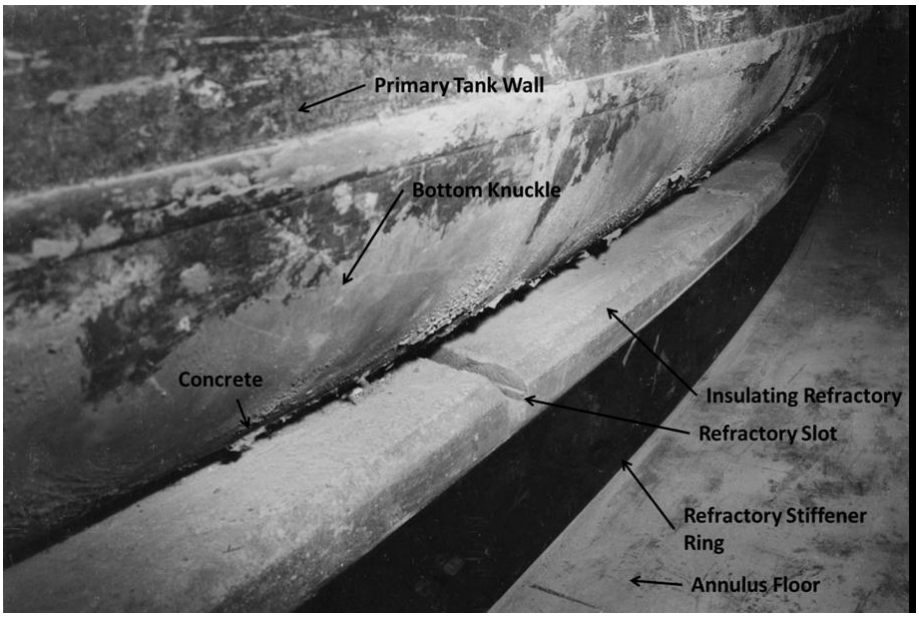

Fig. 2. 241-AY Farm Tank Annulus Showing Refractory Slot.

VISUAL INSPECTIONS

Hanford DSTs are examined visually for conditions both inside the primary tank and on the annulus surface of the primary tank and secondary liner, using remote video equipment during planned periodic visual inspections. Annulus visual inspections were first performed in 1992 through a limited number of risers (typically two) and eventually evolved to utilizing four risers for periodic annulus inspections. Prior to 2012, annulus visual inspections were performed as much as possible in conjunction with periodic schedule ultrasonic testing, or approximately every five years (not to exceed seven years between inspections).

After the primary tank of AY-102 was declared to be leaking, enhanced visual inspections were performed on the six oldest DSTs which utilized 10-12 risers, covering > 95% of the annulus floor area and the portion of the primary tank (i.e., dome, sidewall, lower knuckle, and insulating refractory) that is visible from the annulus inspection risers. Photographs of the general condition of the upper haunch of the primary tank, the bottom knuckle, insulting refractory, refractory slots, stiffener ring, and annulus floor were included in the reports with any areas of interest identified. The condition of the primary tank sidewall was also noted in these reports. Any anomalies identified in the enhanced inspections were compared to previous visual inspections to identify any possible changes in the condition of the area of interest.

The reports that have issued to date which include results of the enhanced baseline inspections are:

[3] RPP-RPT-54814, *Tank 241-AY-101 Annulus Extent of Condition Baseline Inspection*
[4] RPP-RPT-54815, *241-AZ Annulus Extent of Condition Baseline Inspection*
[5] RPP-RPT-54816, *241-SY Annulus Extent of Condition Baseline Inspection*

Inspection results reported in these documents are discussed below.

RESULTS

Tank AY-101

Twelve risers were used for the enhanced visual inspections performed in the tank AY-101 annulus between October 2012 and February 2013 (see Fig. 3). There is evidence of beachlines on the annulus floor as seen from many inspection risers which can be attributed to water couplant used during ultrasonic inspection examinations collecting on the annulus floor at some time and before it evaporated.

Annulus inspections identified small amounts of change in the white and yellow mineralization build-up on the top knuckle region in tank AY-101 (see Fig. 4) as compared to areas previously inspected. The presence of mineralization in the top knuckle has been attributed to water intrusion into both 241-AY Farm tanks from meteorological precipitation. The tank design does not specifically prevent water intrusion (e.g., waterproof membrane) and the extensive amount of excavation above the concrete dome and the use of controlled density fill potentially contribute to the rate in which the water passes through the soil enroute to the tank dome. These changes may be indicative of water intrusion through the outer concrete shell and into the annular space.

Though mineral formations are seen on the top knuckle, some of the changes in the condition of the white and yellow material in the top knuckle region cannot be determined because previous inspections did not view these areas. In regions which did show change, these portions of the top knuckle would be considered to have a small amount of water intrusion since the last inspection.

These indications were above the tank waste level and therefore do not indicate a tank leak.

Despite the presence of foreign material in the annulus, there is no indication that any radioactivity is associated with the material. The annulus of tank AY-101 is operated at a lower pressure than the primary tank so any significant pathways from the primary air space should cause the continuous air monitor to alarm. To date, no clear evidence exists that would indicate either the containment or structural integrity have been compromised in tank AY-101. Future annulus visual inspections, ultrasonic testing, and continuous air monitor surveillance should be continued to identify any changes in the integrity of tank AY-101.

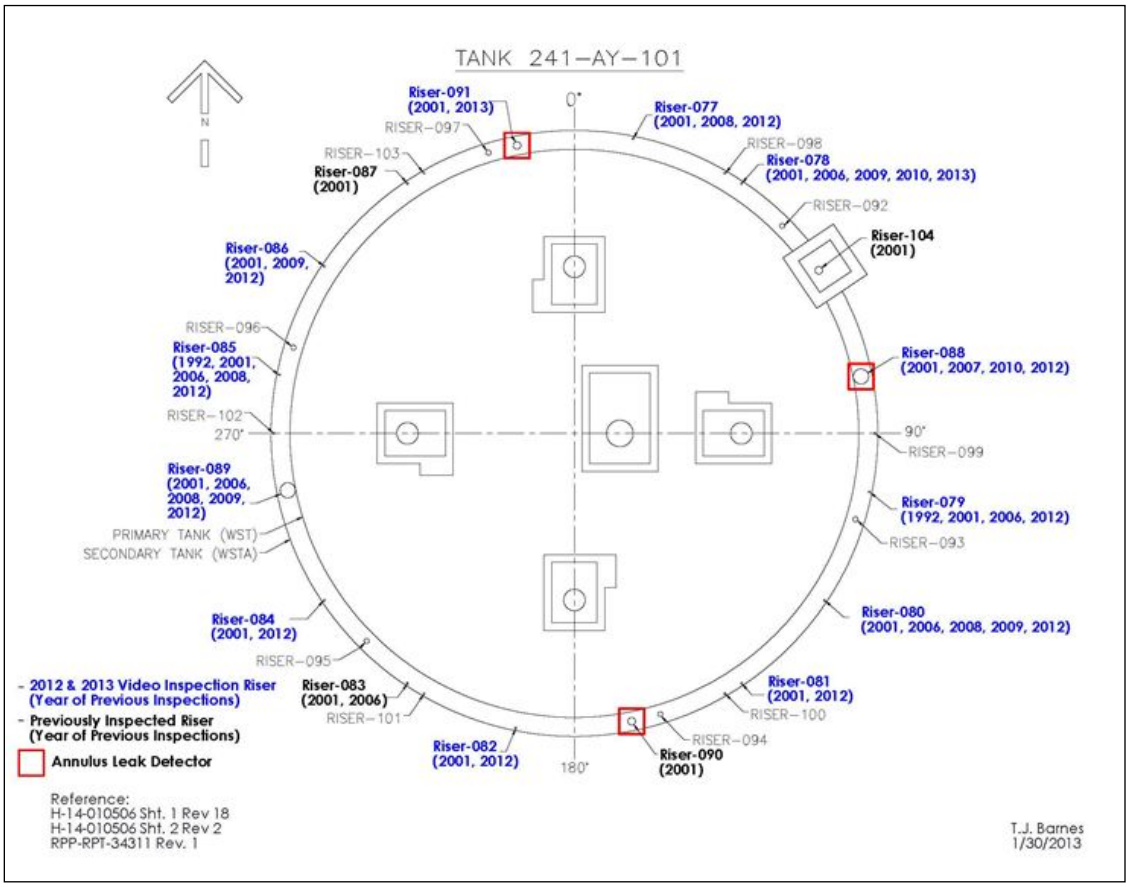

Fig. 3. Tank AY-101 Annulus Video Inspection Risers.

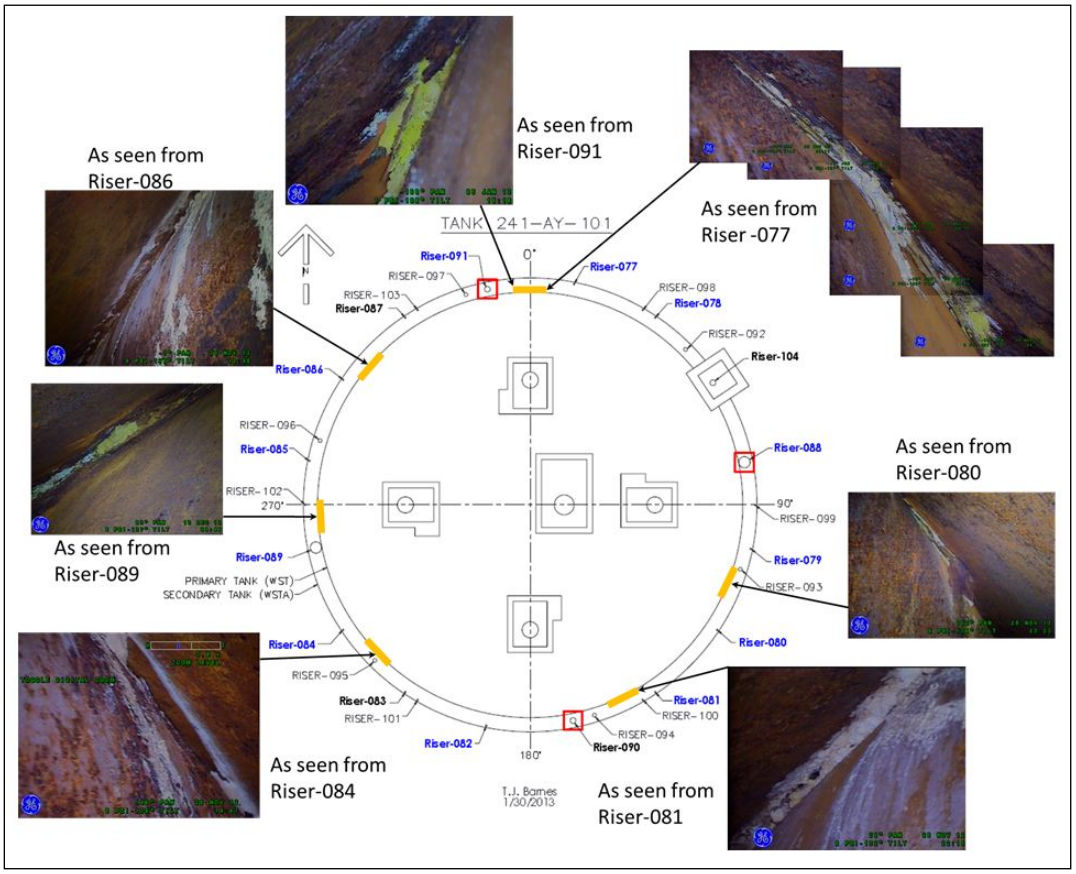

Figure 4. Tank AY-101 Baseline Inspection Results Showing Additional Material in the Top Knuckle Region.

241-AZ Farm

Eleven risers were used for the enhanced visual inspections performed in the tank AZ-101 and tank AZ-102 annulus between January 2013 and February 2013 (see Fig. 5 and Fig. 6). There is evidence of beachlines on the annulus floor as seen from many inspection risers which can be attributed to water couplant used during ultrasonic inspection examinations collecting on the annulus floor at some time and before it evaporated.

Annulus inspections identified small amounts of change on the annulus floor of tanks AZ-101 (see Fig. 7) and AZ-102 (see Fig. 8) as compared to areas previously inspected. These changes are likely attributed to evaporated couplant water from UT examinations that occurred in nearby risers after the previous visual inspection. Additional stains were also identified on the annulus floor of tanks AZ-101 and AZ-102, however, these stains can be correlated back to existing equipment locations (e.g., annulus pump pit, riser penetrations, ENRAFs, etc.). Despite the changes identified in the current inspection, there was no indication of active water intrusion or a primary tank leak for tanks AZ-101 and AZ-102.

In regions which did show a change in condition, these portions of the annulus floor were near risers utilized for UT examinations. To date, no evidence exists that would indicate either the containment or structural integrity have been compromised in tanks AZ-101 and AZ-102.

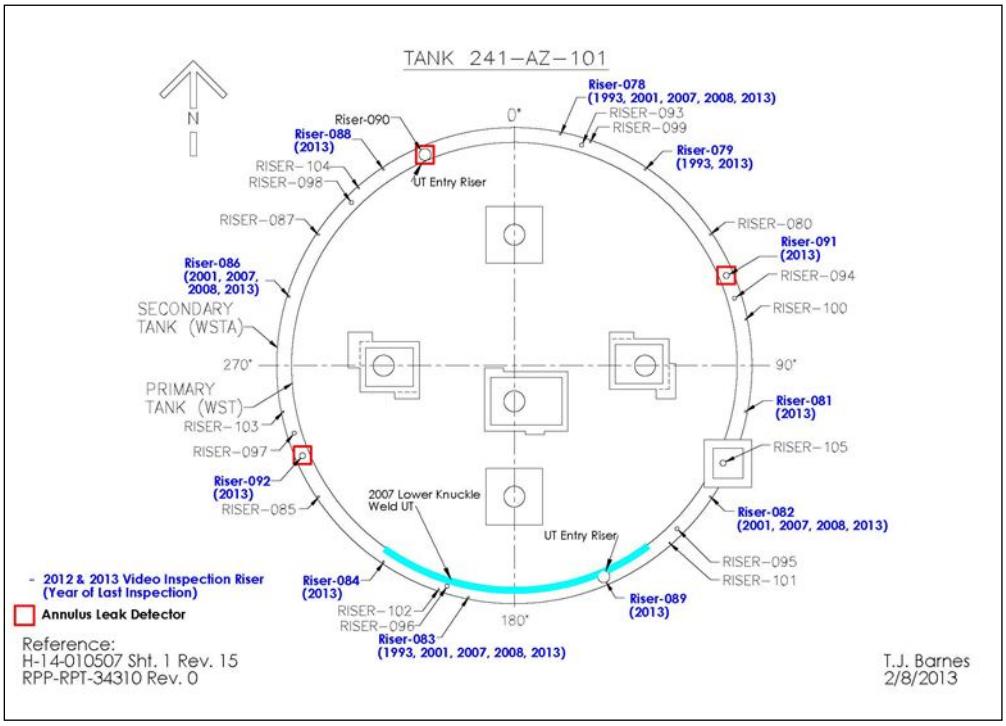

Fig. 5. Tank AZ-101 Annulus Video Inspection Risers.

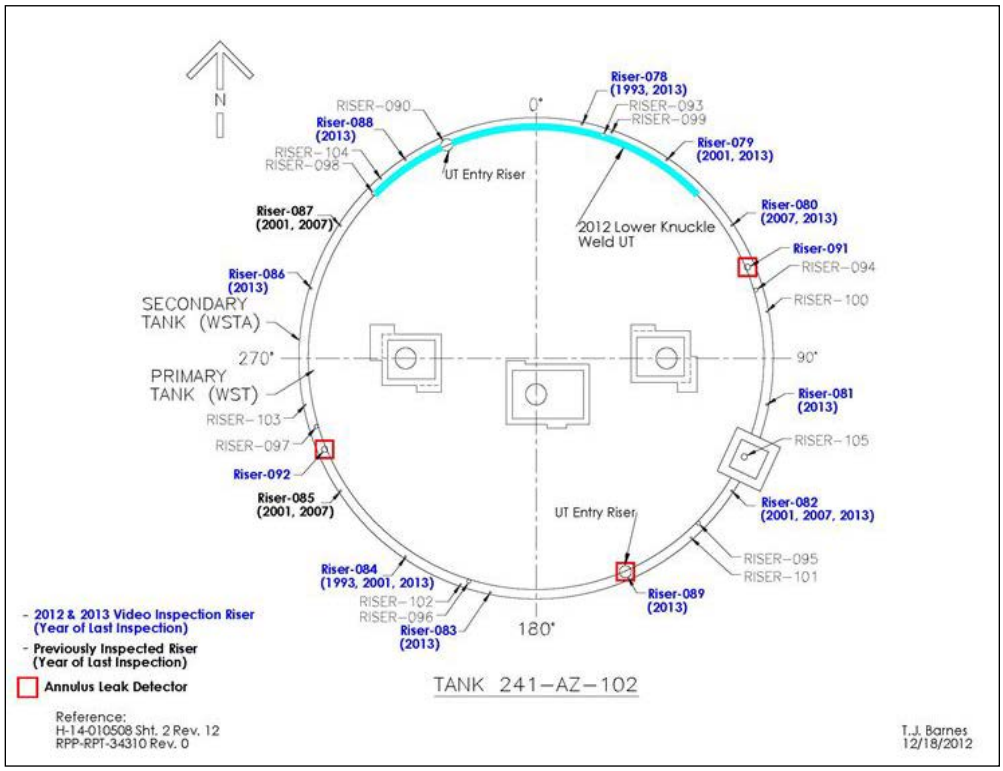

Fig. 6. Tank AZ-102 Annulus Video Inspection Risers.

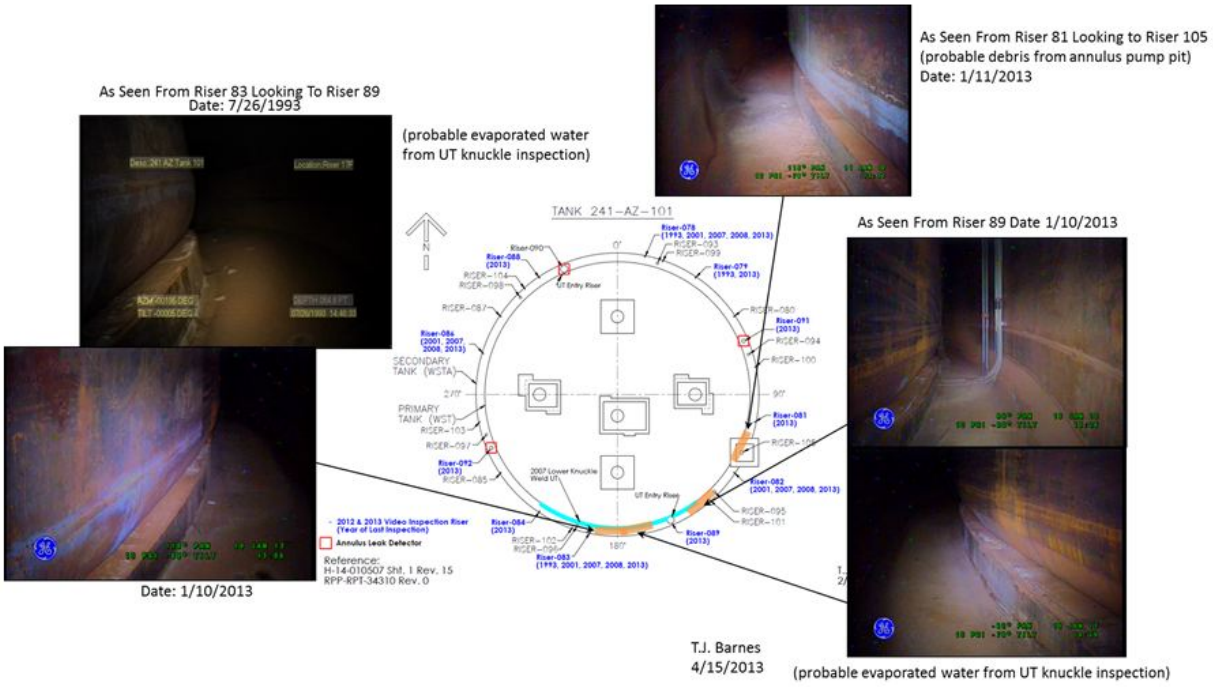

Fig. 7. Tank AZ-101 Baseline Inspection Results Showing Additional Material on the Annulus Floor Attributed to Ultrasonic Inspections, Leak Monitoring Equipment Installation, and Debris Accumulation.

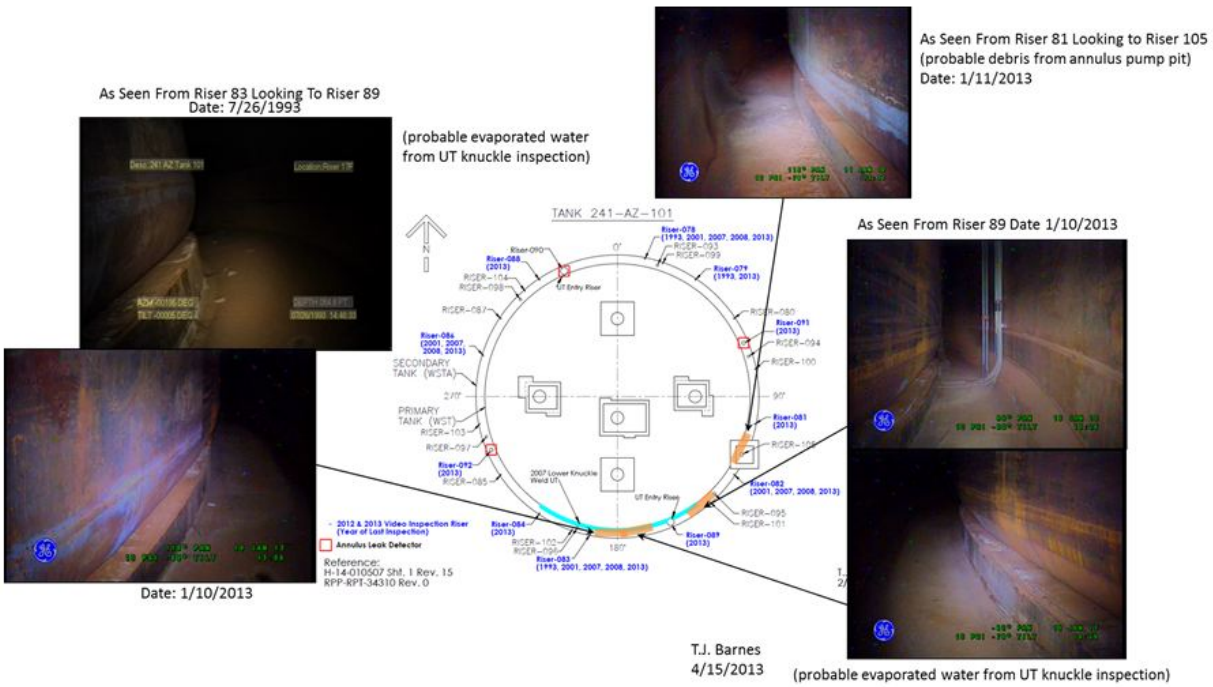

Fig. 8. Tank AZ-102 Baseline Inspection Results Showing Additional Material on the Annulus Floor Attributed to Ultrasonic Inspections and Leak Monitoring Equipment Installation

241-SY Farm

Eleven and twelve risers were used for the enhanced visual inspections performed in the tank SY-101, tank SY-102, and tank SY-103 annulus between May 2012 and March 2013 (see Fig. 9 through Fig. 11). Annulus inspections identified small amounts of change on the annulus floor of tanks SY-101 and SY-102 (see Fig. 12 and Fig. 13, respectively) as compared to areas previously inspected. Additional stains were also identified on the annulus floor of tanks SY-101, SY-102, and SY-103. These changes are attributed to couplant water used during UT examinations, accumulation of condensation on the annulus floor, and/or removal of the annulus pump (see Fig. 12, Fig. 13, and Fig. 14, respectively). The couplant water appears to affect most of the annulus floor as it collects on the annulus floor during UT examinations which can leave additional stains and beachlines after evaporating. Despite the changes identified in the current inspection, there was no evidence indicative of water intrusion or a primary tank leak for tanks SY-101, SY-102, and SY-103.

Previous cracking and surface degradation of the refractory in SY tanks was noted in prior inspections and the surface degradation of the refractory appears consistently on all three tanks. It is likely some of this loose surface layer has washed down and transported to the annulus floor during UT examinations. To date, no evidence exists that would indicate either the containment or structural integrity have been compromised in tanks SY-101, SY-102, and SY-103. Future annulus visual inspections and ultrasonic testing will continue to identify any changes in the integrity of tanks SY-101, SY-102, and SY-103.

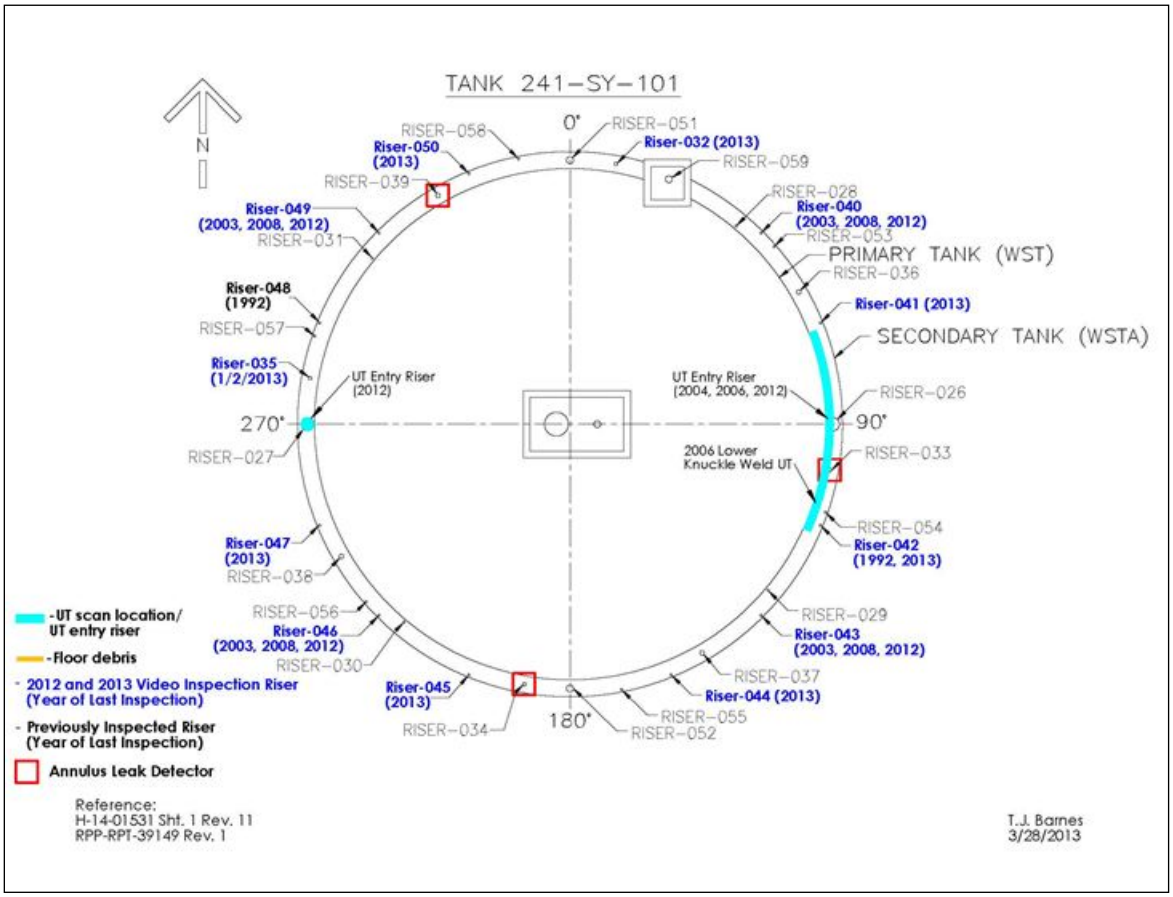

Fig. 9. Tank SY-101 Annulus Video Inspection Risers.

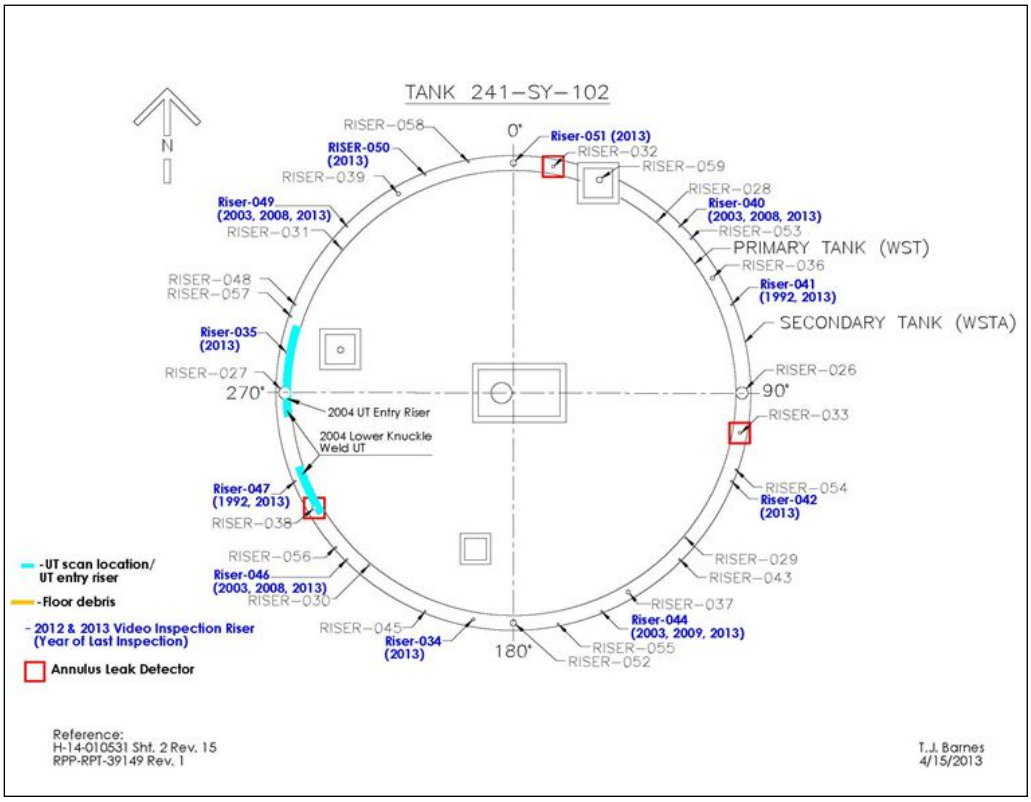

Fig. 10. Tank SY-102 Annulus Video Inspection Risers.

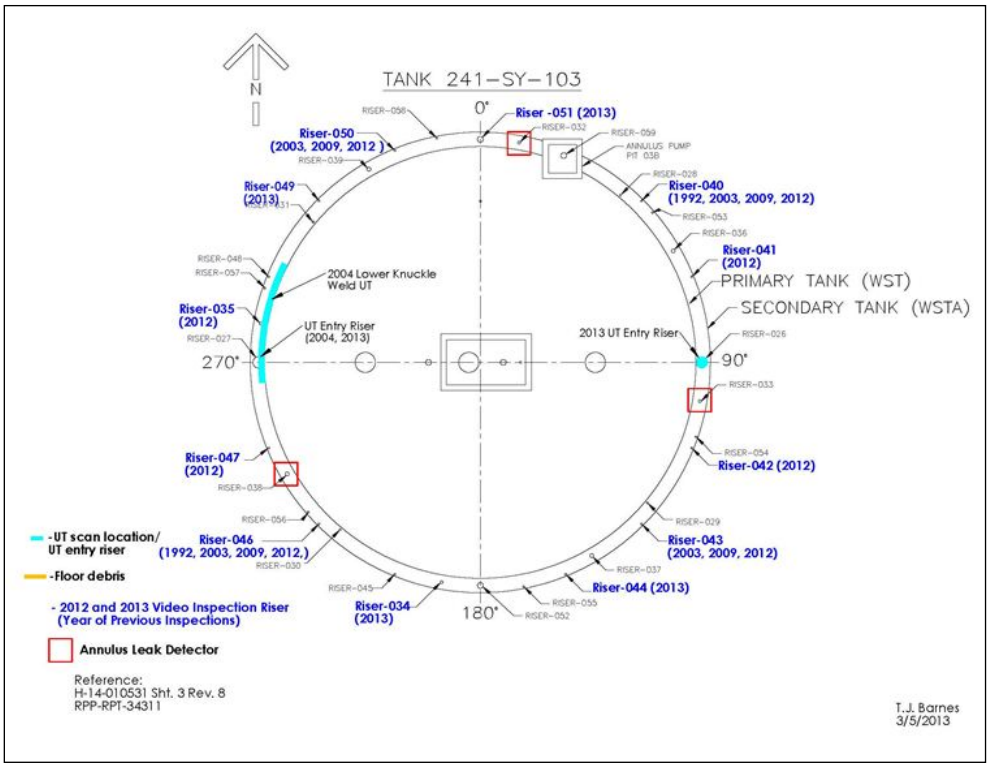

Fig. 11. Tank SY-103 Annulus Video Inspection Risers.

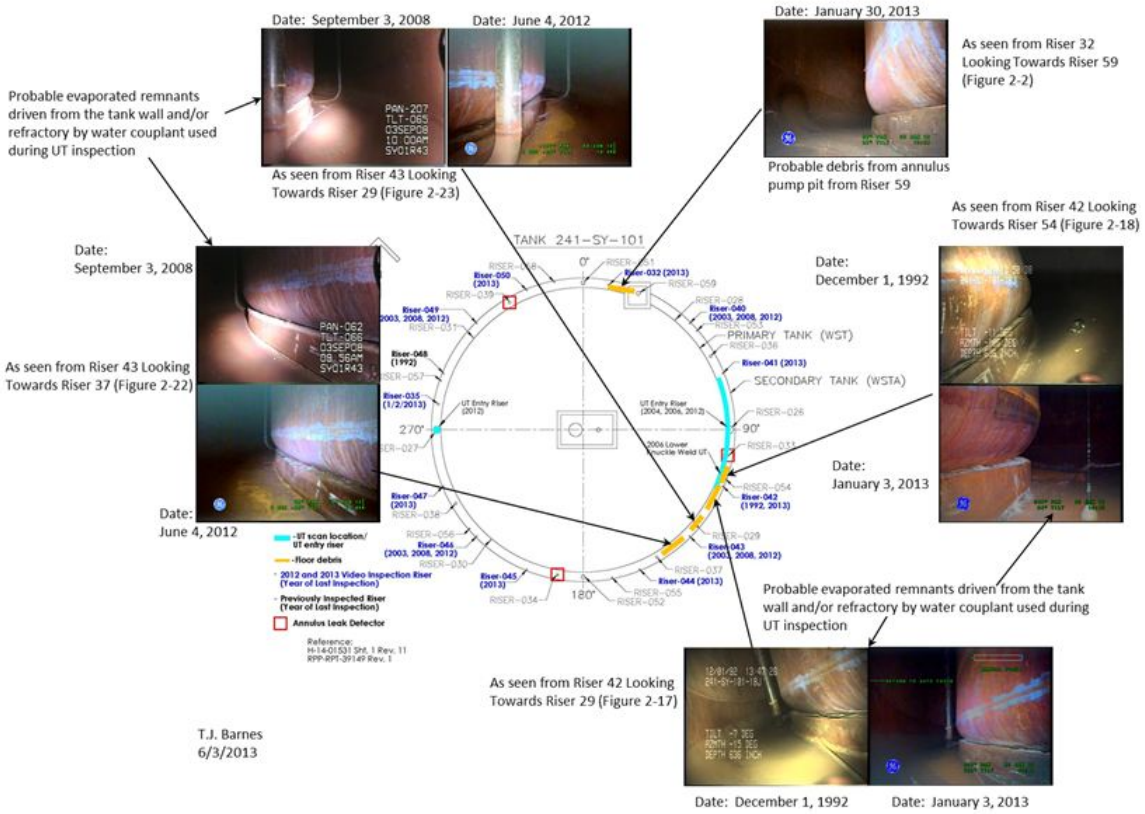

Fig. 12. Tank SY-101 Baseline Inspection Results Showing Additional Material on the Annulus Floor Attributed to Ultrasonic Inspections and Debris Accumulation.

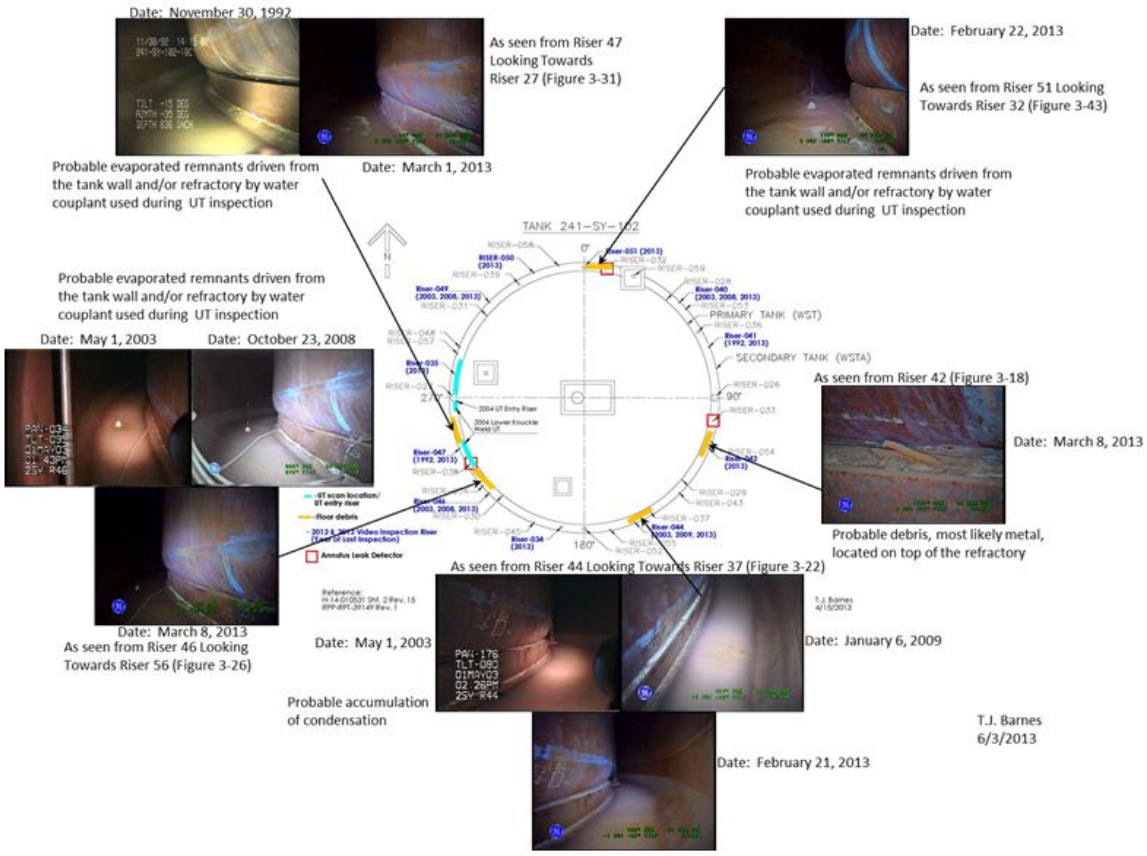

Fig. 13. Tank SY-102 Baseline Inspection Results Showing Additional Material on the Annulus Floor Attributed to Ultrasonic Inspections and Condensation Accumulation.

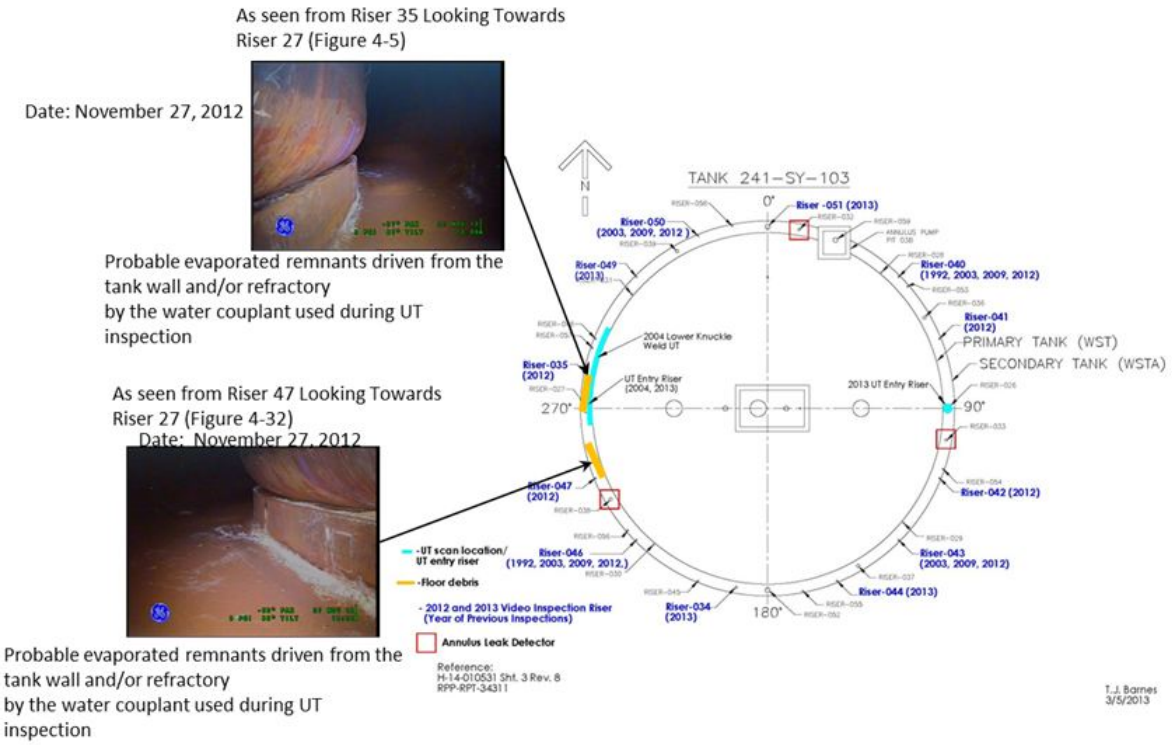

Fig. 14. Tank SY-103 Baseline Inspection Results Showing Additional Material on the Annulus Floor Attributed to Ultrasonic Inspections.

CONCLUSIONS

Prior to October 2012, the approach for conducting visual examinations of DSTs was to perform a video examination of each tank's interior and annulus regions approximately every five years (not to exceed seven years between inspections). The primary tank's interior visual examination was performed through one of the primary tank's risers; the primary tank annulus sidewall and secondary liner annulus visual examination was performed via four of the annulus risers (covering about 42 percent of the annulus floor).

Enhanced visual inspections were performed in tanks AY-101, AZ-101, AZ-102, SY-101, SY-102, and SY-103 in 2012-2013 utilizing eleven to twelve risers for the annulus visual inspections. These inspections were performed to identify any anomalies on the primary tank sidewall, lower knuckle, insulating refractory, refractory air-slots, stiffener ring, or annulus floor, which would be indicative of a primary tank leak. After performing these inspections, there was no evidence indicative of water intrusion or a primary tank leak for all six of these tanks. Some changes were noted from the previous inspection which were attributed to couplant water used during ultrasonic testing, accumulation of condensation on the annulus floor, and/or removal of the annulus pump.

Based on the completed EOC reviews, four changes to the DST visual inspection program have been implemented and/or proposed [2]:

1. Complete annulus visual inspections on the remaining 21 DSTs. The inspections will cover > 95 percent of the annulus floor, and the primary tank dome, upper and lower haunches, sidewall, and insulating refractory visible from the annulus inspection risers.

2. Utilize > 95 percent annulus visual inspections for all future inspections.

3. Annulus visual inspections on a three-year interval for all 28 DSTs are being considered. The three year interval replaces the current five to seven year interval. Adoption of the three year interval will increase the number of annulus inspection riser entries about nine-fold compared to existing practice, and require either nine or ten DST annulus inspections annually in place of the four annual inspections currently scheduled.

4. It has been proposed to eliminate primary tank in-tank visual inspections. In-tank visual inspections are currently performed on a five to seven year interval, not to exceed ten years. There is substantial redundancy between the in-tank visual inspections and the primary tank ultrasonic wall inspections. Both examine the liquid-air interface region as well as a portion of the tank dome above the liquid-air interface – areas suspected of having the highest corrosion rates.

REFERENCES

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2. D. J. WASHENFELDER, 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 (2012).

3. J. K. ENGEMAN, *et al*, RPP-RPT-54814, “Tank 241-AY-101 Annulus Extent of Condition Baseline Inspection,” Revision 0, Washington River Protection Solutions LLC, Richland, Washington (2013).

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