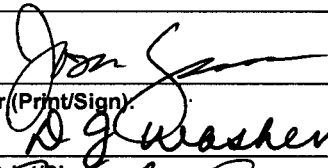
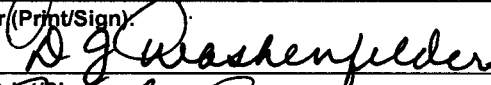
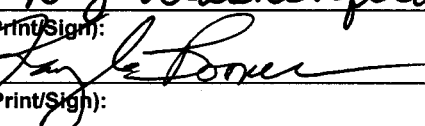



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Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks

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Washington River Protection Solutions

Richland, WA 99352

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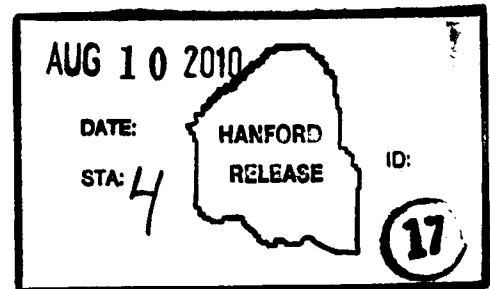
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Visual Inspection Plan for Single-Shell Tanks and Double-Shell Tanks

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Washington River Protection Solution, LLC.

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EXECUTIVE SUMMARY

The mission of the River Protection Project (RPP) is to store, retrieve, treat, and dispose of the highly radioactive waste stored in the Hanford Site underground waste storage tanks in an environmentally sound, safe, and cost-effective manner. The waste is contained in 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs). The 28 DSTs, located in six tank farms, were constructed from 1968 to 1986 and they provide greatly improved protection from leakage and better accessibility for inspection. However, since the DSTs are expected to exceed their design life before the DST waste is removed and sent to the Waste Treatment and Immobilization Plant (WTP), the DST Integrity Project (DSTIP) must ensure that the DST system can meet the RPP mission goals.

The SST Integrity Project (SSTIP) was created with the purpose ensuring the integrity of the SSTs. Recommendations have been made by an appointed panel of subject matter experts to better understand the current structural integrity of the SSTs. These recommendations have been outlined by the Single-Shell Tank Integrity Expert Panel in RPP-RPT-45921, *Single-Shell Tank Integrity Expert Panel Report*. One of the recommendations was to perform a one-time visual inspection of all the SSTs to identify cracks in excess of 0.0625-in, staining, and rust on the tank dome, specifically in the curved haunch and top center sections of the tank dome.

Remote visual inspection is the currently utilized method of performing qualitative in-service inspections. These inspection provide a general overview of the condition of the tank. Remote inspection equipment is used for DST primary and annulus inspections as well as the in-tank inspection of SSTs. The DST inspections primarily focus on the condition of the tank steel and any noticeable signs of active aging mechanisms. While the focus of the SST inspections is on steel liner and any noticeable signs of historic aging mechanisms in addition to the reinforced concrete dome and the presence of cracking, rust stains, and spalling. While the presence of such anomalies haven't been seen in previous inspection and aren't expected, the verification of the concrete's integrity through the use of visual inspection equipment can provide further confidence that the SST concrete domes are sound.

This inspection plan identifies the DST and SST remote visual inspection activities including the frequency, evaluation factors, equipment to be used, and record requirements. This information serves as both a guide for the inspection activities and allows for identifying the resources necessary for the integrity projects. These activities and other are contained in the integrity project plans.

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TERMS

ACI	American Concrete Institute
ALC	Air-lift circulator
DOE	U.S. Department of Energy
DST	Double-shell tank
DSTIP	Double-Shell Tank Integrity Project
Ecology	Washington State Department of Ecology
IQRPE	Independent Qualified Registered Professional Engineer
NDE	Nondestructive examination
ORP	U.S. Department of Energy, Office of River Protection
RPP	River Protection Project
SCC	Stress corrosion cracking
SRS	Savannah River Site
SST	Single-shell tank
TIIG	Tank Integrity Inspection Guide
WTP	Waste Treatment and Immobilization Plant

1.0 INTRODUCTION

The mission of the River Protection Project (RPP) is to store, retrieve, treat, and dispose of the highly radioactive waste in Hanford Site underground waste storage tanks in an environmentally sound, safe, and cost-effective manner. Accomplishing the RPP mission requires providing and maintaining adequate tank capacity for waste storage and waste feed delivery. The use of visual inspections of waste storage tank interiors and annulus space provides a qualitative indication of aging mechanisms present in both single-shell tanks (SSTs) and double-shell tanks (DSTs).

2.0 BACKGROUND

The Hanford radioactive waste is contained in 149 SSTs and 28 DSTs. These tanks are supported by ancillary equipment (e.g., transfer piping, valve pits, and one catch tank), which allow the movement of the waste into, within, and out of the tank system. The SSTs were built in 12 farms between 1943 and 1964 and were designed to hold between 50,000 and 1 million gallons of waste.

Stress corrosion cracking (SCC) of the SST's carbon steel liners was one of the factors causing the leakage of waste from the SSTs to the surrounding soil. This leakage led to a decision by the U.S. Atomic Energy Commission (predecessor to the U.S. Energy Research and Development Administration and subsequently the DOE) in the 1960s to initiate construction of DSTs with improved design, materials, and construction. The construction of the DSTs began in 1968 with the sixth farm being completed in 1986. All of the DSTs have a nominal million-gallon waste capacity.

2.1 DESCRIPTION OF THE DOUBLE-SHELL TANK SYSTEM

The DSTs consist of a primary steel tank inside of a secondary steel liner, which is surrounded by a reinforced concrete structure. Between the primary tank and secondary liner is 8-in of refractory concrete. Both the primary tank and secondary liner are built of the same specification carbon steel. The primary tank of each DST was post-weld heat treated to minimize the possibility of any SCC failures.

2.1.1 Construction of the Double-Shell Tanks

The DSTs were constructed over a period of roughly 18 years (from 1968 to 1986), with a presumed design life of 20 to 50 years. Table 2-1 covers the construction dates, year of initial service, and the expected service life at time of construction. The DSTs were constructed to replace the SSTs, some which had leaked or were suspected of leaking. The SSTs had been constructed with only a projected 20-year life span. The DSTs were designed such that any potential leaks could be detected, the leaking waste could be held in the secondary containment, and corrective action taken long before there could be any release of waste to the environment. To date, none of the 28 DSTs have experienced waste leaks, and all the DSTs have been certified by the Independent Qualified Registered Professional Engineer (IQRPE) as fit for service. Work continues to transfer all waste out of the SSTs into the DSTs (RPP-28538, *Double-Shell Tank Integrity Assessment Report*).

Table 2-1. Double-Shell Tank Construction and Age as of 2010.

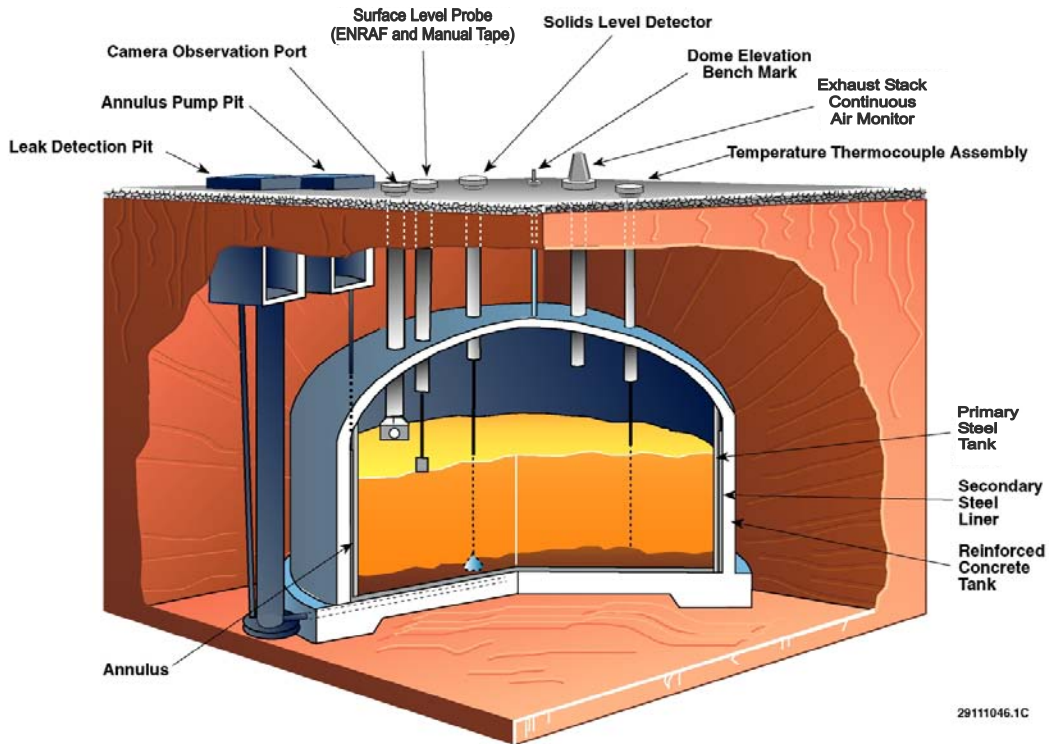
Tank Farm	Number of Tanks	Construction Period	Construction Project	Initial Operation	Service Life	Current Age
241-AY	2	1968 – 1970	IAP-614	1971	40	40
241-AZ	2	1970 – 1974	HAP-647	1976	20	36
241-SY	3	1974 – 1976	B-101	1977	50	34
241-AW	6	1976 – 1979	B-120	1980	50	31
241-AN	7	1977 – 1980	B-130, B-170	1981	50	30
241-AP	8	1982 – 1986	B-340	1986	50	24
Total	28					

2.1.2 Description of the Double-Shell Tanks

Each DST consists of a primary carbon steel tank inside of a secondary carbon steel liner, which is surrounded by a reinforced-concrete structure. The primary steel tank rests atop an 8-in insulating concrete slab, separating it from the secondary steel liner, and providing for air circulation/leak detection channels under the primary tank bottom plate. An annular space of 2.5-ft exists between the secondary liner and primary tank, allowing for visual examination of the tank wall and secondary liner annular surfaces. The annular space also allows for ultrasonic volumetric inspections of the primary tank wall and secondary liner.

Each of the DSTs has between 59 and 126 risers penetrating the dome, providing access for video cameras, ultrasonic inspection devices, waste sampling devices, mixer pumps, and other equipment which requires access to either the primary tank interior or annular space. Above each DST (extending from grade to various depths) are between three to five pits, which house valves and pumps. This equipment allows transfer of waste fluids and sludge from SSTs to DSTs, from DSTs to other DSTs, or from DSTs to other facilities such as the Waste Treatment Plant (WTP).

Figure 2-1. Double-Shell Tank Construction.



2.1.2.1 Primary Tank

The primary tank of a DST is 75-ft in diameter, and measures approximately 46-ft and 9-in in height at the dome center. The bottom of the primary tank consists of a 1-in-thick steel plate, 4-ft in diameter in the center of the tank. The bottom plate thins to 0.375-in at the interfacing weld and extends to a curved, formed section of a 0.875-in -thick plate (or for 241-AP farm 0.938-in), commonly referred to as the “bottom knuckle,” consisting of a horizontal plate, curved section, and vertical plate known as the “bottom transition plate,” also 0.875-in in thickness. The primary tank vertical wall consists of either three or four vertical plates (courses), the courses are either 0.500-in thick or for the bottom course in 241-AP farm 0.750-in thick. In the 241-AY, 241-AZ, and 241-SY farms, there are three plates that are approximately 10-ftfeet in height, followed by a “top transition plate” that is approximately 3-ft in height. In the remainder of the farms, there are four plates that are approximately 8-ft in height. Finally, an inwardly curved section referred to as either the “top knuckle” or “haunch” joins the vertical wall with the roof section of the tank.

The entire primary shell rests atop an 8-in-thick insulating concrete slab that separates it from the secondary shell. A radial pattern of air distribution and drain slots is formed into the concrete to allow air circulation to cool the bottom of the tank and for any leakage from the primary tank to be directed into the annular space, where leak detection instrumentation is installed.

2.1.2.2 Secondary Liner

The secondary liner of a DST is 80-ft in diameter, and measures approximately 40-ft high. The tank bottom consists of 0.25-in thick steel plates, and connects to a bottom knuckle, also 0.25-in thick. The bottom knuckle of the secondary tank also includes a small vertical plate, which connects to the vertical wall plates of the secondary liner. Four vertical plates form the wall of the secondary liner of the DST, between 0.25-in and 0.375-in thickness, which is topped by an inwardly curved secondary top haunch. The secondary haunch approaches the haunch of the primary tank at 460-in. A small gap, from 0.5-in to 1-in in 241-AY tank farm and from 0-in to 1-in in width in all of the other tank farms, exists between the two liners, which 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.

2.1.2.3 Concrete Structure

The concrete foundation of the DSTs is either 88-ft 6-in (for 241-AY farm) or 89-ft 6-in (for the remaining farms) in diameter, and is designed to uniformly distribute all loads. For the farms other than 241-AP, the center portion of the foundation is 2-ft thick and -ft in diameter. From the center, the bottom side of the foundation tapers to about a thickness of 1-ft, which then returns to 2-ft thick at the outer edge. The 241-AP 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 concrete structure is 83-ft in diameter and 1.5-ft thick, and rests on steel plates supported by the tank foundation. The dome of the concrete is 1.25-ft thick and is reinforced with steel rebar. Anchor bolts are threaded into studs welded to the secondary steel liner wall and the primary tank dome, after which the concrete is cast around the rebar and anchor bolts.

2.2 DESCRIPTION OF SINGLE-SHELL TANK SYSTEM

The SSTs consist of a single steel liner which is surrounded by a reinforced concrete structure. Unlike the DSTs, the steel liners of the SSTs terminate at a specified elevation above the maximum liquid level. This liquid level and maximum waste volume varies based on the geometry of the tank type. There are six different types of construction designs for the various SSTs. None of these designs contain a secondary containment or utilized post-weld heat treatment to minimize the possibility of any SCC failures as was performed during the DST construction.

2.2.1 Construction of Single-Shell Tanks

The SSTs were constructed over a period of roughly 22 years (from 1943 to 1965), with a presumed design life of 20 years. Table 2-2 covers the construction dates, number and type of tanks, design capacity, and current age. The SSTs were constructed to store the radioactive waste produced by the multiple processing facilities located in 200 East and 200 West Areas. While the DSTs were designed to detect and contain any potential leaks while in secondary containment, the SSTs were not designed with a secondary containment.

Table 2-2. Single-Shell Tank Construction and Age as of 2010.

Tank Farm	Number of Tanks	Tank Type	Capacity (Gallons)	Construction Period	Initial Operation	Current Age (Years)
241-A	6	Type IVB	1,000,000	1953-1956	1956-1957	56
241-AX	4	Type IVC	1,000,000	1963-1965	1965	45
241-B	4 - 200 Series	Type I	55,000	1943-1944	1952	58
	12 - 100 Series	Type II	530,000	1943-1944	1945-1947	65
241-BX	12	Type II	530,000	1946-1947	1948-1951	62
241-BY	12	Type III	758,000	1948-1949	1950-1951	60
241-C	4 - 200 Series	Type I	55,000	1944-1945	1947-1948	63
	12 - 100 Series	Type II	530,000	1943-1944	1946-1948	64
241-S	12	Type III	758,000	1950-1951	1952-1953	60
241-SX	15	Type IVA	1,000,000	1953-1955	1954-1959	57
241-T	4 - 200 Series	Type I	55,000	1943-1944	1952	58
	12 - 100 Series	Type II	530,000	1943-1944	1945-1947	67
241-TX	18	Type III	758,000	1947-1948	1950-1952	62
241-TY	6	Type III	758,000	1951-1952	1953	59
241-U	4 - 200 Series	Type I	55,000	1943-1944	1954-1956	54
	12 - 100 Series	Type II	530,000	1943-1944	1946-1949	64
Total	149					

2.2.2 Description of Single-Shell Tanks

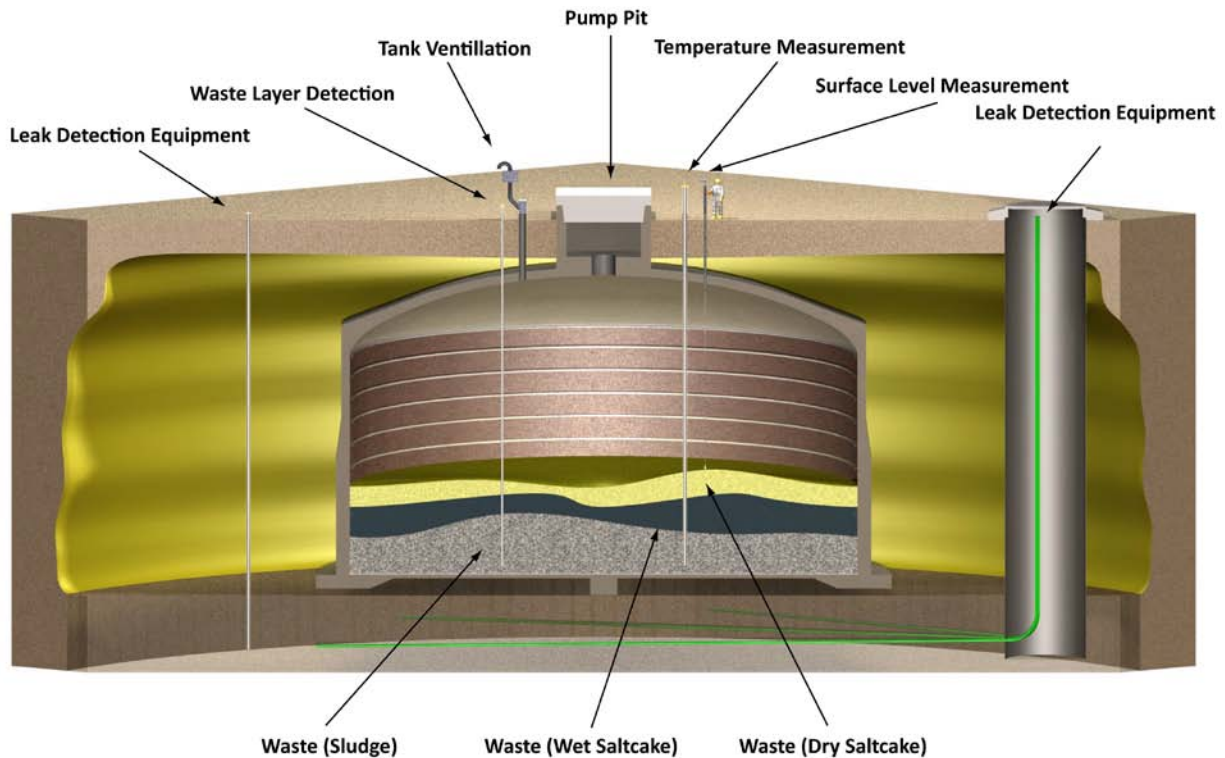
Each SST consists of a carbon steel liner surrounded by a reinforced-concrete structure. The steel liner rests atop a layer of grout and waterproofing membrane that separates it from the concrete structure. The size of the tanks vary between 20-ft to 75-ft diameter as well as height. The concrete structures vary in thickness based on the type of SST as well as the location on the tank structure. While the primary tank headspaces of the DSTs is completely enclosed by welded steel plates, the SST headspaces are enclosed by reinforced concrete.

The number of access risers into the SST headspace varies significantly based on the tank type, with the early constructed tanks having the least amount of access. Unlike the forced ventilation, which is used in the DST tank farms. The SSTs all currently ventilate using passive breather filters, which are periodically replaced. Forced ventilation was initially utilized on some of the later constructed high heat SSTs (i.e., 241-A and 241-AX Farms). However, since all of the

SSTs have been interim stabilized, the ventilation system was taken out of service after the pumpable liquid was removed from those tanks.

Types and locations of equipment vary for each tank type and tank farm. Figure 2-2 provides a generic overview of the waste layers and support equipment, which can be found for many of the SSTs. The configuration of each of the SSTs is maintained by the WRPS Retrieval Closure Project.

Figure 2-2. Single-Shell Tank Construction.

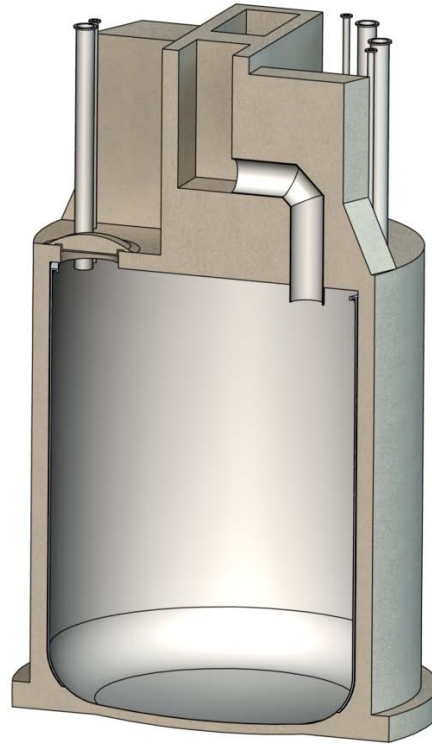


SST_Rendering-4_09022009

2.2.2.1 Type I Single-Shell Tank

Type I tanks are commonly referred to as 200-Series SSTs. These tanks are located in the 241-B, C, T, and U farms. The tanks are 20-ft in diameter with storage capacities of 55,000 gallons. The base slab is 7-in thick reinforced concrete that is formed to match the dish shaped steel liner which extends to being 18-in concrete towards the outer section of the footing. The vertical section of the concrete shell is 12-in thick and extends approximately 24-ft 7-in from the outside top of the footing to the underside of the 12-in thick flat reinforced concrete roof. The inner steel liners were fabricated from 0.25-in thick carbon steel plates. The liner extends up the sidewalls and ends 6-in below the underside of the flat roof. Supporting ventilation and access structures were installed through and built on top of the flat roof. See Figure 2-3 for a generic representation of a Type I SST.

Figure 2-3. Type I Single-Shell Tank.



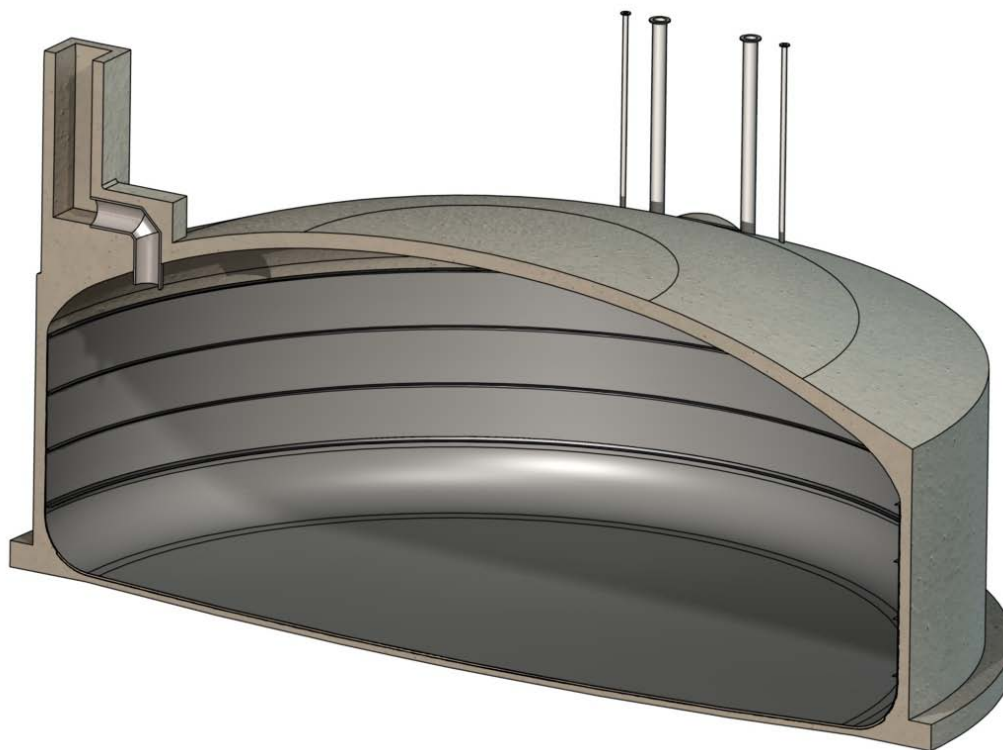
2.2.2.2 Type II Single-Shell Tank

Type II tanks were typically constructed in conjunction with the Type I tanks. In addition to the farms containing Type I tanks, 241-BX is also made up of 12 Type II SSTs. These tanks are significantly larger than the Type I tanks, with 75-ft diameter steel liners and storage capacities of 530,000 gallons. The base slab is 6-in thick reinforced concrete that is formed to match the dish shaped steel liner which extends to being 2-ft thick towards the outer section of the footing. The 12-in thick sidewall extends 16-ft 8-in from the footing to the spring line of the dome.

It is at this point where the elliptical shaped concrete dome begins. The concrete dome is made-up of the haunch section, which is a heavily reinforced region of concrete that is designed to withstand the loads subjected on the dome. The haunch transitions to a 15-in thick strip of reinforced concrete that completes the shape of the dome. The highest point of the elliptical shaped dome extends 13.25-ft above the sidewall spring line producing a total tank height of 32-ft 11-in from the bottom of the tank foundation. Supporting ventilation and access structures were installed through and built on the haunch section of the tank dome.

The inner steel liners for the 241-B, C, T, and U farm Type II tanks were fabricated from 0.25-in and 0.313-in thick carbon steel plates. The tank bottom and sidewalls are 0.25-in thick plate while the curved knuckles are 0.313-in plate. In 241-BX farm Type II tanks, a thicker steel plate (0.375-in) was utilized along the tank bottom. The liner extends up the side walls and ends at the spring line for the concrete roof dome. This point is 19-ft above the tank bottom at the centerline of the tank. Stiffener deposits are welded to the inside surface of the liner at equal distant spacing and lead flashing is installed above the top stiffener ring to prevent tank waste from getting behind the steel liner. See Figure 2-4 for a generic representation of a Type II SST.

Figure 2-4. Type II Single-Shell Tank.



2.2.2.3 Type III Single-Shell Tank

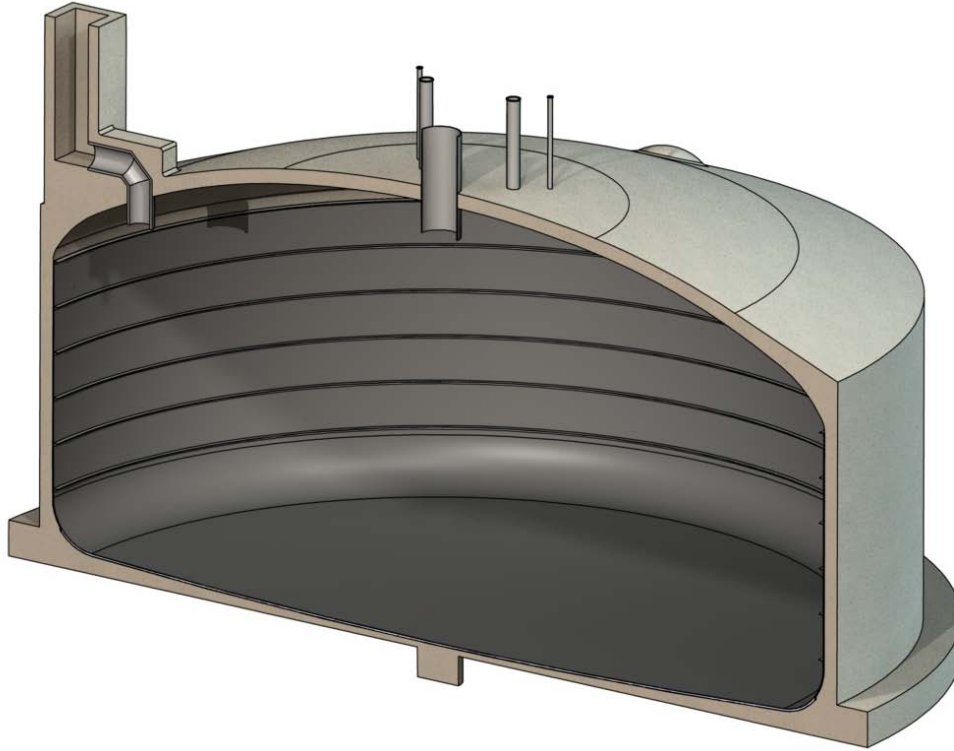
Tanks located in 241-TX, BY, S, and TY farms are Type III, 758,000 gallon capacity SSTs. The Type III tank is next largest tank, with a 75-ft diameter steel liner, similar to the Type II SSTs. However, to increase the tank capacity, the Type III tank liner and dome are about six feet higher than the Type II tanks. The base slab is 6-in thick reinforced concrete at the tank centerline and is formed to match the dish shaped steel liner which extends to being 3-ft thick towards the outer section of the footing. Unlike the Type II tank which maintains a uniform slab thickness along the full length of the tank bottom, the Type III tank bottom is flat. The thickness of the base slab increases when moving towards the vertical sidewall because of the flat bottom of the concrete base. The 12-in thick sidewall extends 22-ft 8-in from the footing to the spring line of the dome.

It is at this point where the elliptical shaped concrete dome begins. The concrete dome is made up of the haunch section, which is a heavily reinforced region of concrete that is designed to withstand the loads subjected on the dome. The haunch transitions to a 15-in thick strip of reinforced concrete that completes the shape of the dome. The highest point of the elliptical shaped dome extends 13-ft 4-in above the sidewall spring line producing a total tank height of 39-ft from the bottom of the dish section of the tank foundation. Supporting ventilation and access structures were installed through and built on the haunch and center sections of the tank dome.

The carbon steel liners were fabricated from varying thicknesses of steel plate. The tank bottoms and curved knuckles are 0.375-in plate. The first row of vertical plates above the knuckle is 0.313-in thick plate that transitions to 0.25-in thick for the upper two vertical plates. The liner extends up the sidewalls and ends at the spring line for the concrete roof dome. This point is 24-ft 11.625-in above the tank bottom at the centerline of the tank. Stiffener deposits are welded

to the inside surface of the liner including an angled ring to allow for the installation of a 12-in wide piece of lead flashing at the top edge of the liner. This flashing was embedded into the concrete wall, sloped downward, and curled around the top stiffener ring to form a drip lip for reflux condensate from the dome. See Figure 2-5 for a generic representation of a Type III SST.

Figure 2-5. Type III Single-Shell Tank.



2.2.2.4 Type IVA Single-Shell Tank

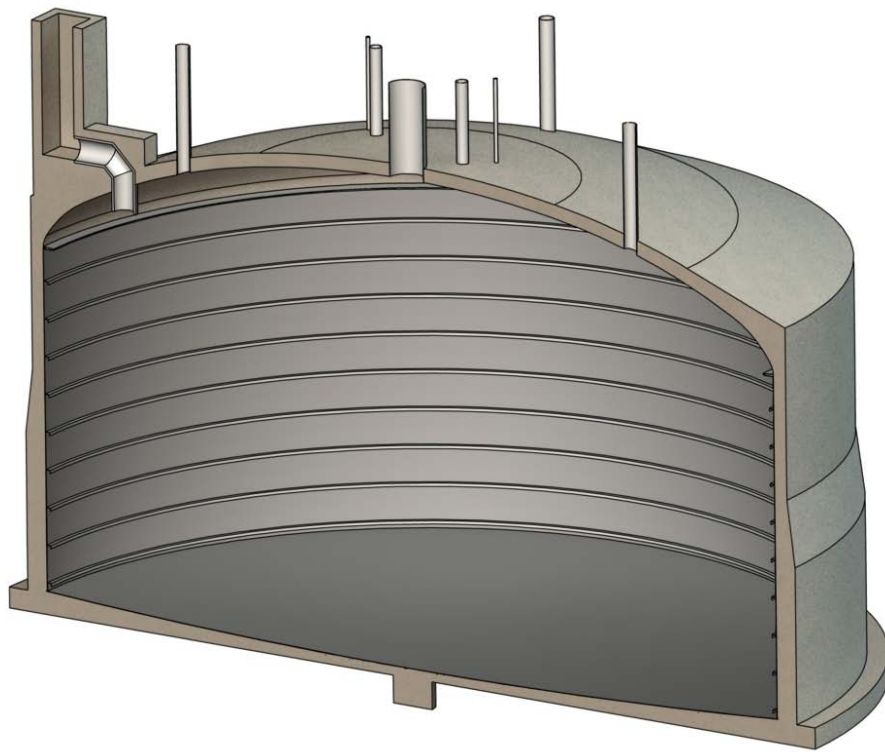
Type IVA SSTs are located in 241-SX tank farm and have a 1,000,000 gallon capacity. The Type IVA tanks contain a 75-ft diameter steel liner, similar to the Type II and Type III SSTs; however, the Type IVA tanks domes and liner are about seven feet higher than the Type III tanks. The base slab is 8-in thick reinforced concrete at the tank centerline and is formed to match the dish shaped steel liner which extends to being 23-in thick towards the outer section of the footing. Similar to the Type III, the outer face of the Type IVA tank bottom is flat. The thickness of the base slab increases when moving towards the vertical sidewall because of the flat bottom of the concrete base. The reinforced concrete sidewall begins with a thickness of 2-ft extending approximately 14-ft before it begins to taper down over the next 6-ft to a 15-in thick sidewall. The 15-in sidewall section is extended the remaining 11-ft 1-in prior to reaching the spring line.

It is at this point where the elliptical shaped concrete dome begins. The concrete dome is made-up of the haunch section which is a heavily reinforced region of concrete that is designed to withstand the loads subjected on the dome. The haunch transitions to a 15-in thick strip of reinforced concrete that completes the shape of the dome. The highest point of the elliptical shaped dome extends 13-ft 3-in above the sidewall spring line producing a total tank height of

46-ft 5.625-in from the bottom of the tank foundation. Supporting ventilation and access structures were installed through and built on the haunch and various points of the tank dome.

The carbon steel liners were fabricated from 0.375-in thick steel plate. The Type IVA SSTs do not have the curved knuckle design used in many of the other type of SSTs. The dished tank bottom and vertical sidewall are joined by a weld where they intersect. The liner extends up the sidewalls and ends at the spring line for the concrete roof dome. This point is 32-ft 3.875-in above the tank bottom at the centerline of the tank. Stiffener deposits are welded to the inside surface of the liner including an angled ring to allow for the installation of a 16-in wide, 0.25-in thick steel plate at the top edge of the liner. This plate was embedded into the concrete wall, sloped downward, and tack welded to the liner to form a drip lip for reflux condensate from the dome. See Figure 2-6 for a generic representation of a Type IVA SST.

Figure 2-6. Type IVA Single-Shell Tank.



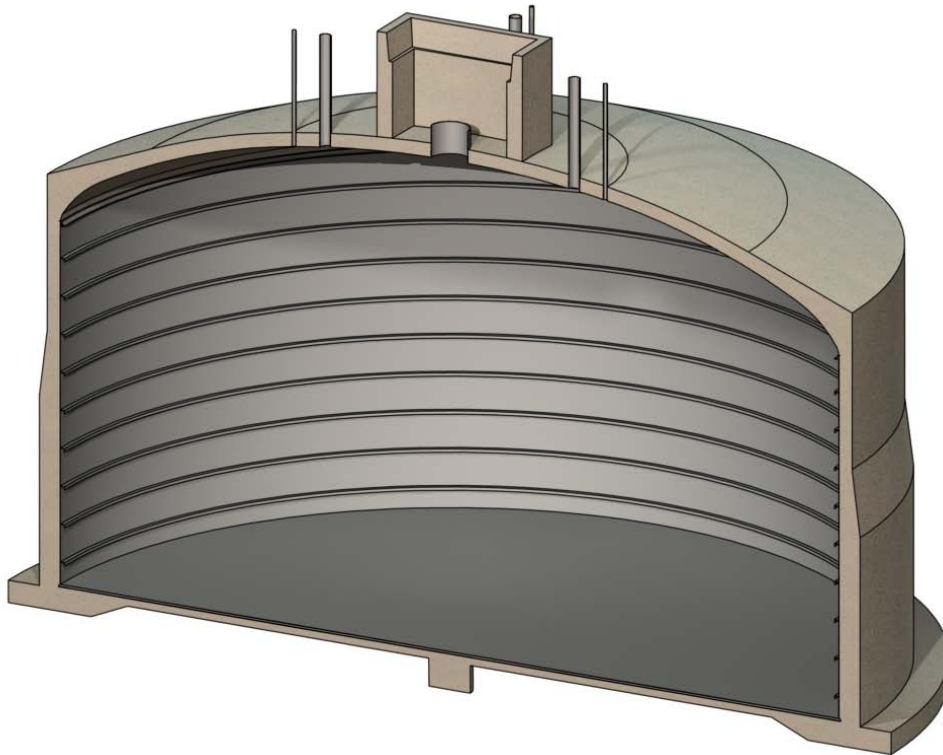
2.2.2.5 Type IVB Single-Shell Tank

Type IVB SSTs are located in 241-A tank farm and have a 1,000,000 gallon capacity. The Type IVB tanks contain a 75-ft diameter steel liner, similar to the Type II and Type III SSTs; however, the Type IVB tanks are greater in height. Unlike the Type IVA concrete base which is dish shape, the Type IVB concrete base is flat to support the flat steel liner. The base slab is 6-in thick reinforced concrete and extends out from the tank centerline to the 8-ft by 2-ft thick circular footing that is centered under the tank sidewall. The reinforced concrete sidewall begins with a thickness of 2-ft extending approximately 17-ft before it begins to taper down over the next 6-ft to a 15-in thick sidewall. The 15-in sidewall section is extended the remaining 9-ft 6.75-in prior to reaching the spring line.

It is at this point where the elliptical shaped concrete dome begins. The concrete dome is made-up of the haunch section which is a heavily reinforced region of concrete that is designed to withstand the loads subjected on the dome. The haunch transitions to a 15-in thick strip of reinforced concrete that completes the shape of the dome. The highest point of the elliptical shaped dome extends 13-ft 3-in above the sidewall spring line producing a total tank height of 47-ft 9.75-in from the bottom of the tank footing. The access risers for Type IVB SSTs were installed in a similar manner to previous tank types, however Type IVB SSTs utilized concrete reinforced pits around large diameter risers as well as forced ventilation instead of passive condensers.

The carbon steel liners were fabricated from 0.375-in thick steel plate. The Type IVB SST does not have the curved knuckle design used in many of the other type of SSTs. The tank bottom and vertical sidewall are joined at a 90-degree angle by a weld. The liner extends up the sidewalls and ends at the spring line for the concrete roof dome. This point is 32-ft 3.875-in above the tank bottom at the centerline of the tank. Stiffener deposits are welded to the inside surface of the liner including an angled ring to allow for the installation of a 12-in wide piece of lead flashing at the top edge of the liner. This flashing was embedded into the concrete wall, sloped downward, and curled around the top stiffener ring to form a drip lip for reflux condensate from the dome. See Figure 2-7 for a generic representation of a Type IVB SST.

Figure 2-7. Type IVB Single-Shell Tank.



2.2.2.6 Type 4C Single-Shell Tank

The Type IVC SSTs located in 241-AX tank farm were the last to be constructed prior to the beginning of construction of the first DST tank farm, 241-AY. Similar to the Type IVA and IVB SSTs the Type IVC tanks also have a 1,000,000 gallon capacity. The Type IVC tanks contain a

75-ft diameter steel liner, similar to the Type II and Type III SSTs; however, the Type IVB tanks are greater in height. Similar to the Type IVB concrete base, the Type IVC concrete base is flat to support the flat steel liner. The base slab was increased in size from the Type IVB slab to 1-ft 6-in thick reinforced concrete to allow for the installation of leak detection drain slots. These drain slots were installed to direct tank leakage into a sump where instruments would monitor for increasing liquid levels. The base slab extends out from the tank centerline to the 10-ft by 3-ft thick circular footing that is centered under the tank sidewall. The reinforced concrete sidewall begins with a thickness of 2-ft extending approximately 19-ft 10-in before it begins to taper down over the next 5-ft to a 15-in thick sidewall. The 15-in sidewall section is extended the remaining 7-ft 8-in prior to reaching the spring line. It is at this point where the elliptical shaped concrete dome begins. The concrete dome is made up of the haunch section, which is a heavily reinforced region of concrete that is designed to withstand the loads subjected on the dome. The haunch transitions to a 15-in thick strip of reinforced concrete that completes the shape of the dome. The highest point of the elliptical shaped dome extends 13-ft 3-in above the sidewall spring line producing a total tank height of 48-ft 11-in from the bottom of the tank footing.

The access risers for Type IVC SSTs were installed in a similar manner to previous tank types; however, Type IVB SSTs utilized concrete reinforced pits around large diameter risers as well as forced ventilation instead of passive condensers. Type IVC SSTs were also the first to have air-lift circulators (ALCs) installed. These systems were installed to minimize the settling of high heat solids which were suspected of contributing to the failure of tank steel liners in other farms such as 241-A tank farm.

The carbon steel liners were fabricated from 0.375-in thick steel plate. The Type IVC SST does have a curved knuckle unlike the Type IVA and IVB SSTs. After the knuckle the liner extends up the sidewalls and ends at the spring line for the concrete roof dome. This point is 32-ft 6-in above the tank bottom at the centerline of the tank. Stiffener deposits are welded to the inside surface of the liner at specified intervals. Type IVC tank construction drawings specified the installation of a piece of bent plate at the top edge of the liner. This bent plate was embedded into the concrete wall, sloped downward, and angled around the top section of the steel liner to prevent intrusion from tank dome condensate. See Figure 2-8 for a generic representation of a Type IVC SST and Figure 2-9 for a more detailed figure of the Type IVC SST supporting infrastructure.

Figure 2-8. Type IVC Single-Shell Tank.

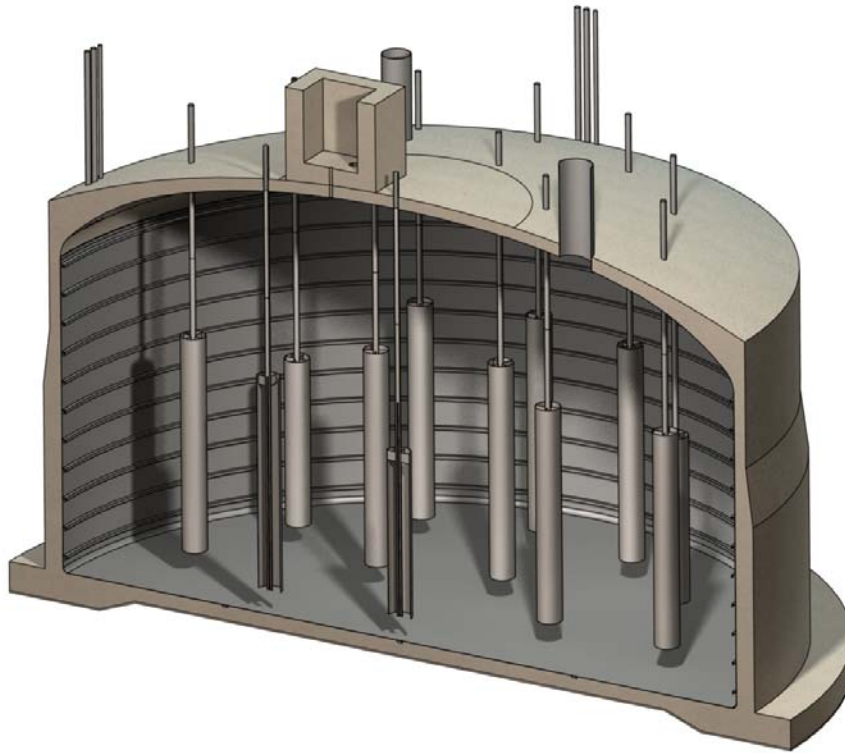
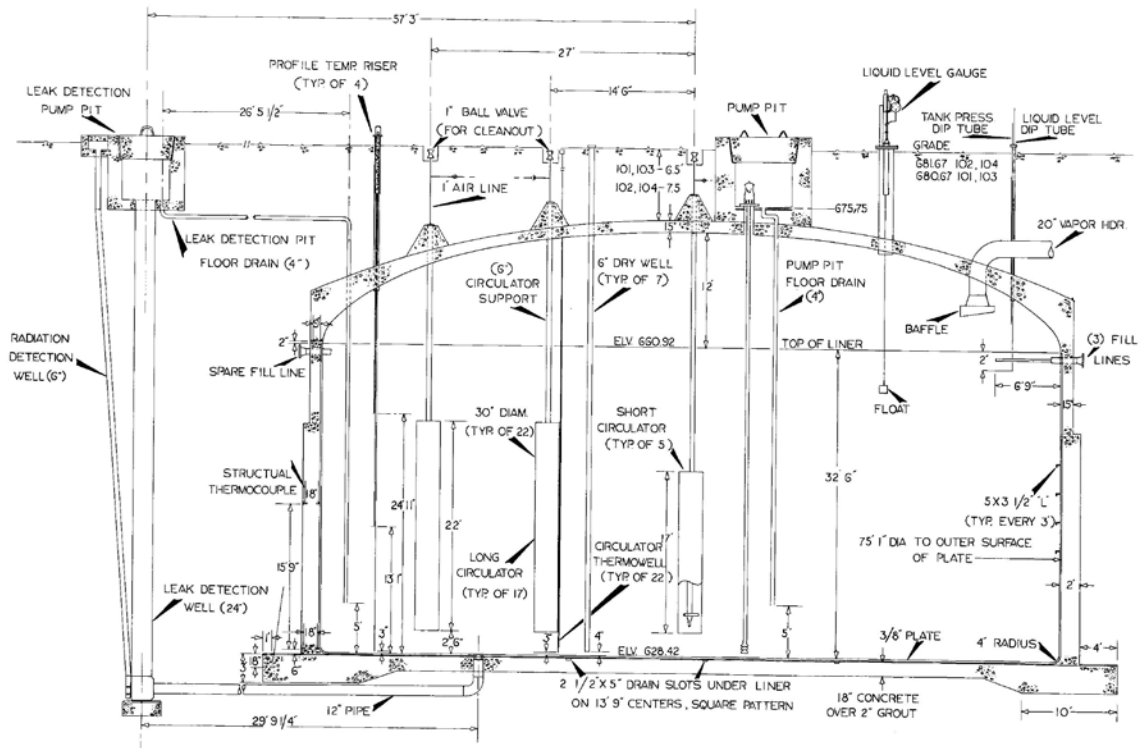


Figure 2-9. Type IVC Single-Shell Tank Supporting Infrastructure.



3.0 HANFORD VISUAL INSPECTIONS

Ecology Publication 94-114, *Guidance for Assessment and Certifying Tank Systems that Store and Treat Dangerous Waste*, identifies external and visual inspection as acceptable tank examination methods. Visual examination of tanks by remote video camera has been demonstrated to provide valuable information for assessing tank conditions and to support deployment of remotely operated nondestructive examination (NDE) equipment.

3.1 BACKGROUND

Visual inspections of the DSTs and SSTs began in the early 1970's using still photography. The camera assembly and housing would be lowered into the tank headspace and positioned to begin a series of photographs. The strobe lights located in the camera housing (See Figure 3-1) would then be used to illuminate the tank wall surface just prior to capturing the photograph. The use of still photography proved to be an effective way of capturing the necessary detail over a large area in a relatively short period of time (See Figure 3-2).

Figure 3-1. Typical Still Photography Camera Assembly and Housing.



Still photography was utilized until 1993 when remote video cameras became commercially available for use in high radiation environments. These camera systems allowed real time inspections, the capability to focus and zoom-in on areas of interest, as well as the ability to easily revisit previous areas of interest (See Figure 3-3).

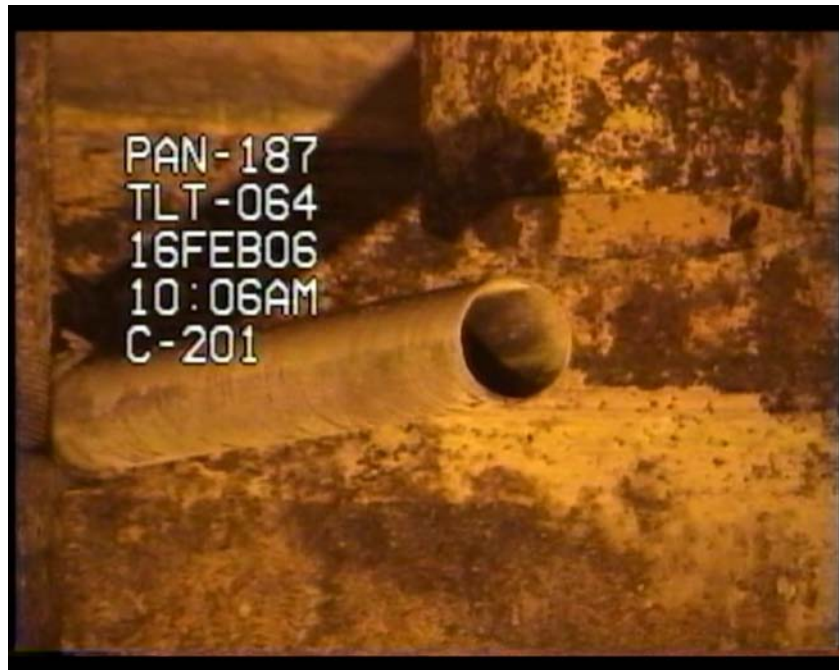
While the inspections continued for the DSTs, periodic visual inspections were no longer performed in the SSTs. However, since SST inspections have restarted, the deployment the new

systems in underway. The requirements for the new SST inspections are identified in Recommendation (SI-4) by the Single-Shell Tank Expert Panel documented in RPP-RPT-45921, *Single-Shell Tank Integrity Expert Panel Report*. In that recommendation the use of visual inspection was selected as the preferred method to identify cracks in excess of 0.0625-in, staining, and rust on the tank dome, specifically in the curved haunch and top center sections of the tank dome.

Figure 3-2. SST Headspace Still Photograph.



Figure 3-3. SST Headspace Remote Video.



3.2 DOUBLE-SHELL TANK VISUAL INSPECTIONS

The DSTs are examined visually for conditions both inside the primary tank (above the waste level) and on the annulus surfaces of the primary tank and secondary liner, using remote video equipment during planned periodic visual assessments. 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.

The DSTs are visually inspected using Tank Farm Operating Procedure TO-020-142, *Video Examination of DST Interiors and Annuli*. Visual examinations will be conducted under the following conditions:

- Visual examinations will be performed, as much as possible in conjunction with periodic scheduled ultrasonic testing, approximately every 5 years (not to exceed 7 years between inspections)
- Visual examinations of selected regions will be performed when ultrasonic testing of the primary tank walls identify conditions or indications requiring additional assessments
- The primary tank interior should be visually inspected following complete pump-down of the tank to view previously inaccessible surfaces that have not been documented for at least 5 years

The primary tank's interior visual examination (including the dome space) will be performed through one of the primary tank's risers; the primary tank annulus side wall and secondary liner annulus visual examination will be performed via four of the annulus risers located so that a near 360-degree visual examination is conducted. These DST visual examinations (completed in 2006) established a baseline that will be used for comparison for future planned reexaminations. The visual baseline information is documented in the Tank Integrity Inspection Guide (TIIG). The 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.

To develop a TIIG, a variety of information is used, which includes previous inspection results, construction drawings, certified vendor information, etc. The information provided by the construction drawings provides the ability to pinpoint the location of the vertical welds along the primary and secondary walls of the DST. This mapping process is then linked with the steel plate data to form the TIIG.

Figure 3-4 represents an example of the inspection map section of the TIIG while Figure 3-5 represents an illustration of the information in the guide section of a TIIG. These figures are annotated with descriptions for each item. These example figures can be used as a template for understanding the TIIGs. Each item of interest has been mapped and is given a unique tank specific photo identification number, which enables the region to be identified and explained in the TIIG.

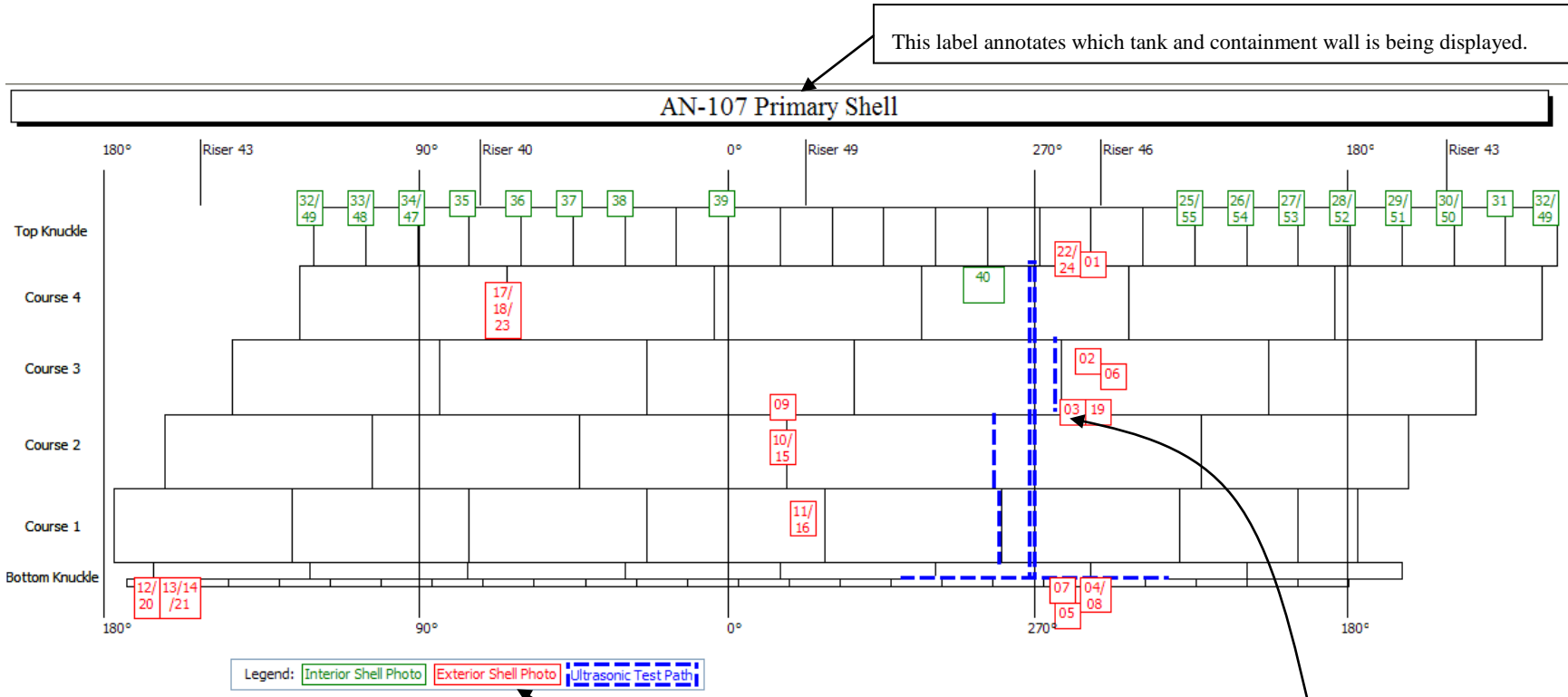
The TIIGs for each tank farm are compiled into a single document. These documents are updated within a calendar year from when a tank primary or annulus inspection is conducted. To date, six of the integrity inspection reports have been prepared:

- RPP-RPT-31599, Double-Shell Tank Integrity Inspection Report for 241-AN Tank Farm

- RPP-RPT-34310, Double-Shell Tank Integrity Inspection Report for 241-AZ Tank Farm
- RPP-RPT-34311, Double-Shell Tank Integrity Inspection Report for 241-AY Tank Farm
- RPP-RPT-38738, Double-Shell Tank Integrity Inspection Report for 241-AP Tank Farm
- RPP-RPT-39149, Double-Shell Tank Integrity Inspection Report for 241-SY Tank Farm
- RPP-RPT-42147, Double-Shell Tank Integrity Inspection Report for 241-AW Tank Farm

DST annulus and primary in-tank inspections are performed to provide early warnings of aging mechanisms and to support volumetric inspection of the primary steel tank. Table 3-1 and 3-2 provide the evaluation factors that make up the inspection criteria for primary in-tank and annulus inspections, respectively. These criteria primarily focus on different forms of corrosion that relate to tank leak integrity (i.e. pitting, cracking, etc) versus the inspection of the concrete dome of the SSTs which pertains to the tank's structural integrity.

Figure 3-4. AN Tank Integrity Inspection Map Example.



3-5

The legend explains the color code for Ultrasonic Testing scan paths, and which colors represent an image from the interior side of the primary tank wall, or the exterior side of the primary wall as seen in the annulus.

Each of these numbers directly correlates to an image in the Tank Inspection Integrity Guide. For instance, number 03, shows the relative location of Photo ID# AN-107-03.

Figure 3-5. AN Tank Integrity Inspection Guide Example.

The Photo ID is the number used to identify the picture and relevant data. The first five characters (i.e. AN-107) identify which tank the photo is from, while the last two digits of this number (i.e. 03) are used to correlate this entry with the Tank Integrity Inspection Map.

Photo ID: AN-107-03
 Date of Inspection: 5/19/1992
 Date of Review: FY2006

Date of Inspection lists the date the visual inspection was performed.
 Date of Review lists the fiscal year an inspection report commented on this region.

Location: Exterior of primary tank shell, along Courses 3 and 2, joining bottom edge of primary shell plate F7301M2 number 5A and primary shell plate F7301M2 number 5B. Riser 46.

Description: DVDID# 10258
 Corrosion along circumferential weld joining Course 2 and 3. Noticeable corrosion product directly above weld continues up to Course 1. Possible surface condensation on the outside of primary shell has accelerated corrosion along this area.

The Description and Location fields give a verbal description of the area of interest and how to locate it, respectively.

The DVDID# is the reference number used to identify the DVD from which the photo was taken. The number represents the number of the DVD stored in the Visual Inspection Archive

Shipping Mark	Heat #	Ingot & Cut	Nominal Thickness	Nominal Length	Nominal Width
F7301M2	3G5922	0400C	0.500	471.25	92.75
F7301M2	3G5922	0600C	0.500	471.25	92.75

Details indicate wall plate data taken from the Certified Material Test Reports.



Color photo of area of interest.

Table 3-1. Criteria for Double Shell Primary In-Tank Inspections.

Double Shell Tank Primary In-Tank Inspection Criteria			
Tank Feature	Evaluation Factors	Probable Locations	Reason to Identify
Primary Tank	Increased general corrosion in comparison to previous inspection	Any visible region on the primary steel tank.	A substantial change in corrosion product between inspections would indicate a corrosion mechanism which was not present or was recently introduced into the tank environment.
Primary Tank	Pitting along the historical liquid-air-interfaces	There are typically beach line marks along the primary tank indicating where the interface between the head space environment and the liquid waste.	These interfaces could be a region where pitting occurs under certain conditions. Over time and under the right conditions, these pits could penetrate through the primary tank compromising the tank's integrity.
Primary Tank	Cracks	Along the visible surface of the vertical section of the primary tank.	Cracking suggests the primary tank integrity has been compromised.
Access Risers	Corrosion of steel access riser penetrations	Along the bottom edge of the riser penetrations.	For steel risers, increased corrosion including metal loss would suggest an environment that is conducive to vapor space corrosion.
In-Tank Equipment	Corrosion	Along the visible surfaces of the tank equipment.	Corrosion of the equipment may provide evidence as to the aggressive/passive nature of the waste and the environment the equipment is used in.

Table 3-2. Criteria for Double Shell Annulus Inspections.

Double Shell Tank Annulus Inspection Criteria			
Tank Feature	Evaluation Factors	Probable Locations	Reason to Identify
Exterior of Primary Tank	Increased general corrosion in comparison to previous inspection	Any visible region on the exterior of the primary steel tank.	A substantial change in corrosion product between inspections would indicate a corrosion mechanism which was not present or was recently introduced into the annulus environment.
Interior of Secondary Liner	Increased general corrosion in comparison to previous inspection	Any visible region on the interior of the secondary liner.	A substantial change in corrosion product between inspections would indicate a corrosion mechanism which was not present or was recently introduced into the annulus environment.
Exterior of Primary Tank	Pitting along the historical liquid-air-interfaces	These regions coincide with the historical interface between the head space environment and the liquid waste.	These interfaces could be a region where pitting occurs under certain conditions. Over time and under the right conditions, these pits could penetrate through the primary tank compromising the tank's integrity.
Exterior of Primary Tank	Cracks	Along the visible exterior surface of the vertical section of the primary tank.	Cracking suggests the primary tank integrity has been compromised.
Exterior of Primary Tank	Annulus intrusion	The converging section of the primary tank and secondary liner near the top of the tank.	Annulus intrusion introduces liquid into the tank increasing the chance for localized corrosion especially if the annulus ventilation system is not active.
Concrete Refractory	Refractory concrete cracking	At the bottom of the annulus located under the primary tank.	Cracking of the refractory concrete provides insight as to the loads it is being subjected to.

3.3 DOUBLE SHELL TANK EVALUATION FACTORS

Historic visual inspections of the DST interiors and annuli provide evidence of anomalies which future inspections should use to help identify areas of interest in other DSTs. In addition to anomalies from previous inspections, there are also evaluation factors which must be identified to ensure the tank's leak integrity. These evaluation factors include cracks in the steel tank, visible rust stains, signs of liquid intrusion in the annulus, pitting along the liquid-air-interface, corrosion of access risers, etc. All these evaluation factors are indicators of various aging mechanisms during the ongoing service of the specific DST. Sections 3.3.1 and 3.3.2 describe and provide visual examples of some of the key evaluation factors.

3.3.1 PRIMARY TANK INSPECTION EVALUATION FACTORS

Increased General Corrosion In Comparison to Previous Inspection:

There is currently no evidence of any substantial increase in corrosion visible from the in-tank inspections that would provide a clear representation of increased general corrosion. Changes in the appearance are typically due to an increase in lighting, camera resolution, or a different viewing angle than the previous inspection. For an example of increase general corrosion in the DST annuli, see Section 3.3.2. A noticeable change in the steel tank's condition might suggest an aggressive change in the waste chemical components or a change in the tank's headspace conditions.

Pitting Along Historical Liquid-Air-Interfaces:

It is known that under specific conditions, there is a potential for pitting to occur along the liquid-air-interface (LAI) in the DSTs. For this reason the inspection of DST interior is to include the current LAI and any other visible signs of previous LAI. Historical LAIs are typically visible due to the presence of salt build-up known as "beach lines".

Figure 3-6. Potential Pitting in Tank 241-SY-103 Liquid-Air-Interface Region.



Figure 3-7. Close-Up of Potential Pitting in Tank 241-SY-103 Liquid-Air-Interface Region.



Primary Tank Cracks:

Confirmation of steel liner cracks as seen from the tank interior is very difficult using standard visual inspection methods in DSTs and SSTs. To increase the ability to identify cracks in the steel tank multiple riser penetrations would be utilized to allow indirect illumination of the surface at an angle different than the camera is utilizing. Even with ideal illumination, physical size and depth of the crack would require a volumetric form of NDE such as an ultrasonic inspection. While there are no known cracks in any DSTs on the Hanford site, there are available examples of cracks of Savannah River Site (SRS) waste storage tanks. As with the SSTs, these tanks at the SRS did not receive post-weld heat treatment thus making them more susceptible to cracking near the connecting welds. See Section 3.3.2 for examples of primary tank cracks as seen from the annulus.

Corrosion of Steel Access Riser Penetrations:

Corrosion of the steel access riser penetrations would be an indication that the moisture level in the headspace of the tank is high. The moisture will condense up inside the riser, depending on the time of year and in-tank temperature, and travel back down concentrating on the lower edges of the penetration. It is at the end of the penetration that the inspection should concentrate to identify increased corrosion. Typical signs of corrosion anywhere else on the riser would be around the heat affected zone where the steel pipe connects to the primary tank dome.

Figure 3-8. Light Corrosion on 241-AP-102 Access Riser Penetration.

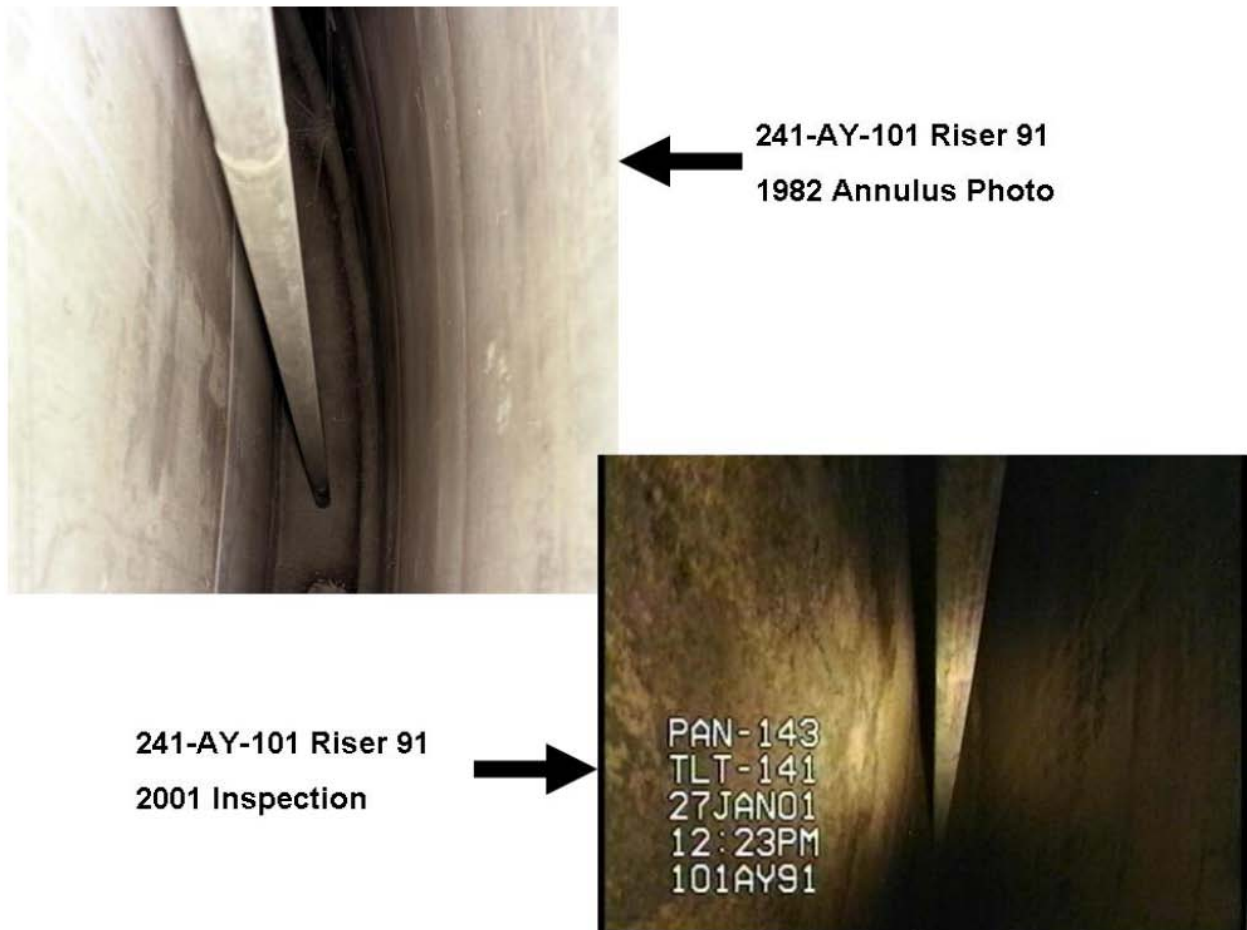


3.3.2 ANNULUS INSPECTION EVALUATION FACTORS

Increased General Corrosion In Comparison to Previous Inspection:

In certain DSTs, primarily 241-AY tank farm, there has been a noticeable increase in general corrosion. This increased level of corrosion was caused by the combination of two items, the shutdown of the annulus ventilation system for several years and the presence of water intrusion into the annulus during the same period of time. While both of these items have been corrected, annulus inspections shall still attempt to identify any dramatic changes in the annulus which may indicate either an equipment issue or the presence of increased moisture in the annulus.

Figure 3-9. Increased General Corrosion in the 241-AY-101 Annulus.



Primary Tank Cracks:

Confirmation of steel liner cracks as seen from the tank annulus is significantly easier than the tank interior. An inspection in the tank interior only provides a line of sight to the steel surface above the liquid level, while an annulus inspection provides a line of sight along the entire exterior of the primary tank. Cracks visible in the annulus would potentially appear similar to that seen in the non heat treated SRS tanks as shown in Figures 3-10 and 3-11.

Figure 3-10. Savannah River Site Tank 16 Crack on Vertical Weld (1972).

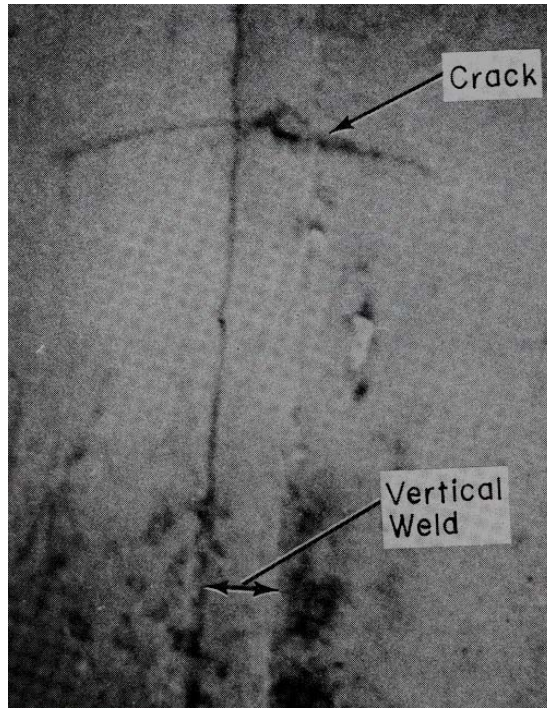


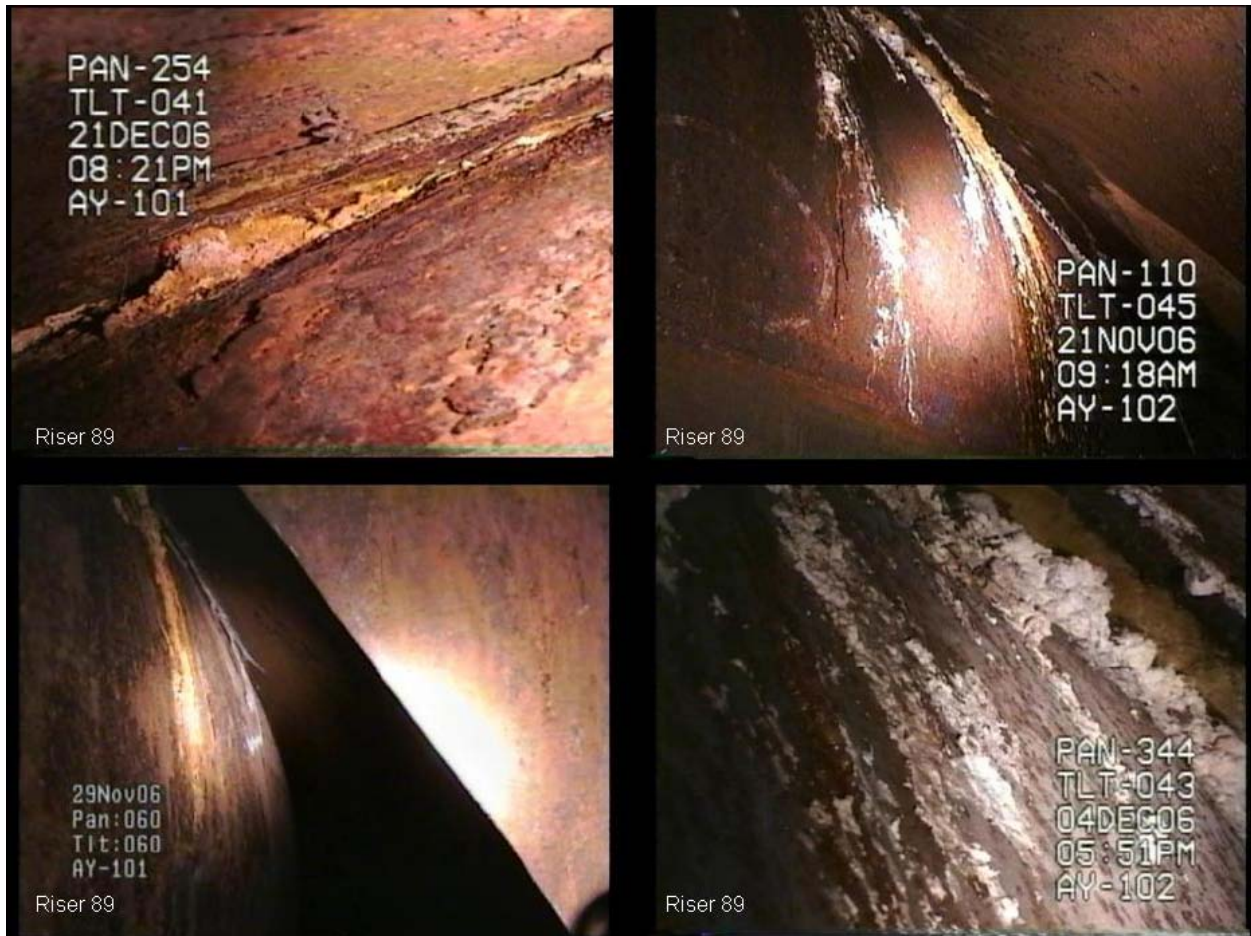
Figure 3-11. Savannah River Site Tank 15 Vapor Space Crack.



Annulus Intrusion:

Water intrusion into the annulus increases the amount of moisture in contact with the primary tank and secondary liner. As seen in 241-AY tank farm, water intrusion caused rust stains which originated from the converging section of the primary tank and secondary liner and traveled down the primary tank terminating at the primary bottom knuckle. Water intrusion increases the rate of corrosion. The primary inspection region for this evaluation factor is at the converging section of the primary tank and section liner as seen in Figure 3-12.

Figure 3-12. Evidence of Water Intrusion in 241-AY Tank Farm Annuli.



3.4 SINGLE-SHELL TANK VISUAL INSPECTIONS

The SSTs are visually examined for conditions inside the tank only (above the waste level) on the surface of the steel liner and concrete dome, using remote video equipment during planned visual assessments. The present approach for conducting visual examinations of SSTs is to perform a video examination of each tank's interior once to identify any areas of concern that would indicate degradation to the tank's structural integrity.

The SSTs are visually inspected using the proper work instructions documented in the individual work packages which include the necessary risers and areas of focus. Visual examinations will be conducted under the following conditions:

- Visual examinations will be performed one time per tank unless the results of the inspection reveal areas of concern that require additional evaluation
- Visual examinations should be performed at a rate of 12 SSTs per year until the completion of all 149 SSTs. If physical access is limited due to SST retrieval operations or equipment obstructions, an SST which has not yet been inspected should be substituted in its place to maintain the desired inspection rate
- Visual examinations will be performed as required by the tank farm contractor to support SST operations

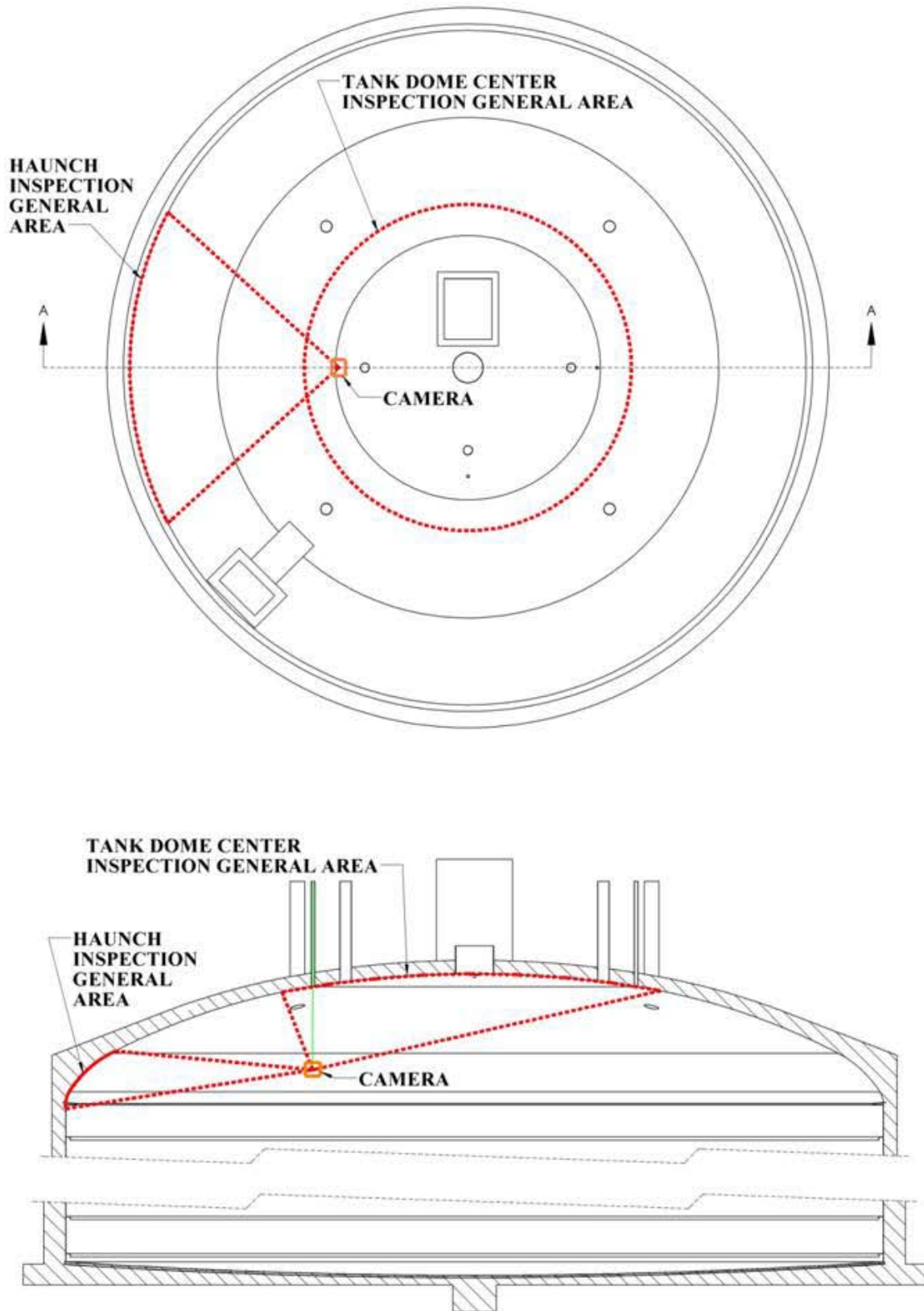
The tank's interior visual examination will be performed through one or two of the tank's risers. The combination of the camera system and location of the risers will allow the inspection of the haunch and center dome region for each SST (See Figure 3-13 for generic concrete inspection regions). The primary focus of the SST inspection is to identify the evaluation factors listed in excess of 0.0625-in, staining, Table 3-3, Criteria for Single Shell Tank Inspections. These criteria can typically be identified using qualitative measure and will provide insight into the condition of the concrete dome. These and steel liner.

The SST visual examinations can be compared against previous in-tank photographs and videos to aid in determining any potential change in specific areas of interest. The results of each fiscal year's inspections will be combined into a single report to document the findings for each of the SSTs. Descriptions of anomalies identified shall utilize terminology in ACI 201.1 R-08, *Guide for Conducting a Visual Inspection of Concrete in Service*, whenever possible. This will provide a consistent definition of terminology throughout the course of the SST inspections.

Table 3-3. Criteria for Single Shell Tank Inspections.

Single Shell Tank In-Tank Inspection Criteria			
Tank Feature	Evaluation Factors	Probable Locations	Reason to Identify
Concrete Dome	Cracking in excess of 1/16-inch, rust stains, and spalling	The curved haunch (above the top section of the steel liner) and the center of the tank dome.	Cracking, rust stains, and spalling would result from degradation mechanisms such as rebar corrosion.
Concrete Dome or Waste Surface	Signs of liquid intrusion	Either moisture stains along the tank dome or pooling on the waste surface.	Water intrusion into SSTs should be minimized to prevent liquid levels in the tanks from increasing.
Access Risers	Corrosion of steel access riser penetrations	Along the bottom edge of the riser penetrations.	For steel risers, increased corrosion including metal loss would suggest an environment that is conducive to vapor space corrosion.
Steel Liner	Pitting along the historical liquid-air-interfaces	There are typically beach line marks along the steel liner indicating where the interface between the head space environment and the liquid waste.	These interfaces could be a region where pitting occurs under certain conditions. Over time and under the right conditions, these pits could have penetrated through the steel liner compromising the liner's integrity.
Steel Liner	Tar Rings	Anywhere along the steel liner.	Several mastic layers were installed between the steel liner and the concrete wall. Evidence of tar on the steel liner may suggest a through wall penetration.
Steel Liner	Cracks	Along the visible surface of the steel liner.	Cracking suggests the liner integrity has been compromised.
In-Tank Equipment	Corrosion	Along the visible surfaces of the tank equipment.	Corrosion of the equipment may provide evidence as to the aggressive/passive nature of the waste and the environment the equipment was used in.

Figure 3-13. SST Concrete Dome General Inspection Regions.



3.5 SINGLE SHELL TANK EVALUATION FACTORS

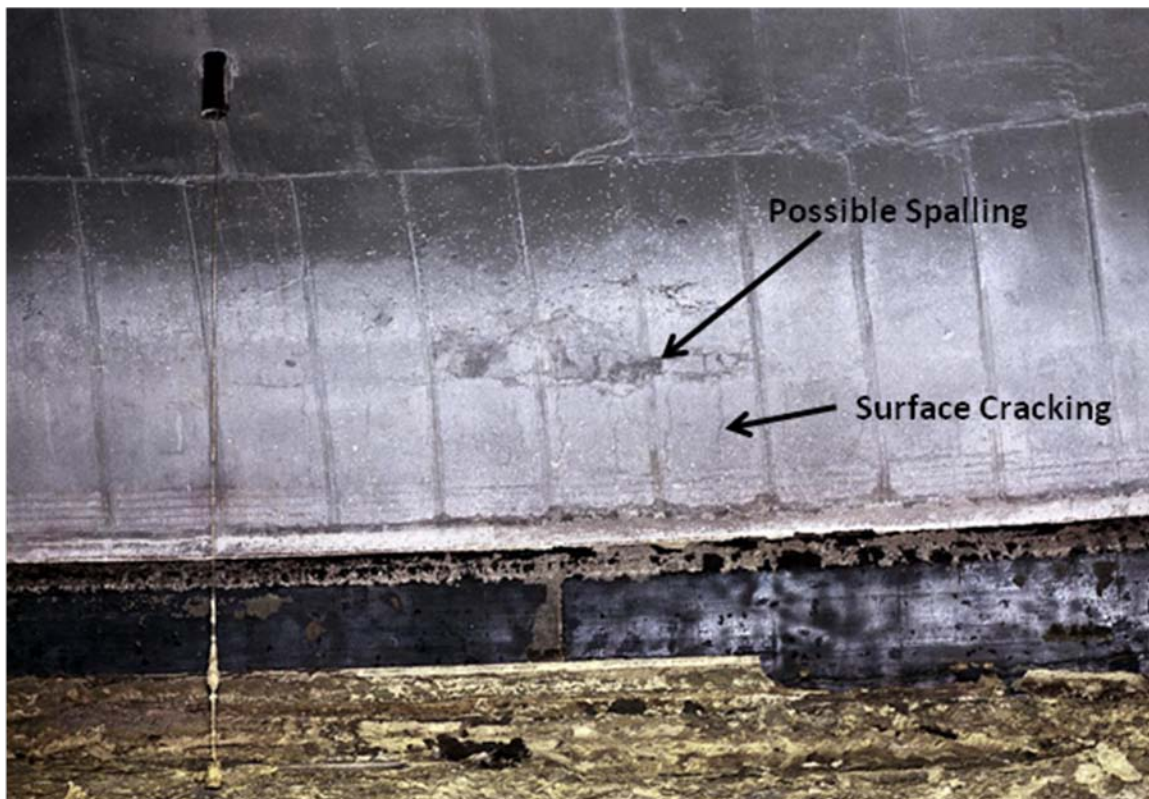
Historic visual inspection records of the SST interiors provide evidence of anomalies which future inspections should use to help identify areas of interest in other SSTs. These anomalies include but are not limited to reinforced concrete cracking, spalling, or visible rust stains on the dome, signs of liquid intrusion, tar rings along the steel liner, cracks in the steel liner, etc. All these evaluation factors are indicators of various aging mechanisms during the service of the specific SST.

Reinforced Concrete Cracking, Rust Stains, and Spalling:

The regions of the tank dome under the largest amounts of stress due to dome loading are the haunch and the peak of the tank dome. Inspection of these two regions will provide qualitative evidence as to the current structural integrity of the dome as well as information which can be compared against previous inspections to help identify changes since the last detailed inspection.

In some tanks, minor surface cracking is noted in the haunch region with minor localized spalling. See Figure 3-14 for an example of this evaluation factor. This region is in SST 241-S-112.

Figure 3-14. Possible Concrete Cracking and Spalling (241-S-112).



Tar Deposits:

Tar deposits were found in multiple SSTs, primarily 241-BY-107, 241-BY-110, and TX-114, suggesting either the potential for through wall perforations or leak past the flashing at the top of the tanks. During tank construction a three-ply asphaltic membrane was applied between the steel liner and the concrete wall. In some cases it appears that the tar-like substance flowed over the edge of the tank flashing, however in the case of 241-BY-107, 241-BY-110, and TX-114, the tar origin appears to be the steel liner itself.

When the discovery of the tar deposits in 241-BY-110 was first identified ARH-1496, *Review of Storage Tank Integrity*, was issued to document the finding and potential causes. In this review it was noted that the liner perforations occurred horizontally at elevations corresponding to levels at which the tank liquid had been held for long periods. It is known that LAI regions can be susceptible to pitting if waste chemistry and tank headspace conditions are not controlled. The LAI regions is an evaluation factor and shall be included in SST inspections. Since all pumpable liquids have been removed from SSTs as a part of interim stabilization, only historical LAI regions can be inspected.

Figure 3-15. Tar Deposits (241-BY-107).



Figure 3-16. Tar Deposits (241-BY-110).



Figure 3-17. Tar Deposits (241-TX-114).



Signs of Liquid Intrusion:

Intrusion into SSTs which have had all the pumpable liquid removed is cause for concern, especially in SSTs which are known or assumed leakers. Liquid provides the medium and driving force to carry contaminated materials through the breached liner into the surrounding soiling, depending on the location of the flaw in the liner. Figure 3-18 provides an example of water intrusion into 241-T-102.

The photograph in Figure 3-11 was taken April 30, 1980. During the period from about 1978 to 1984, Line 6175 in 241-T tank farm was suspected to be actively draining rainwater and snowmelt from the 241-TR-153 Booster Pump Pit into tank T-102 via one of the tank's sidewall nozzles. The estimated drainage during the period was reported as 2,600 gallons.

Figure 3-18. Signs of Liquid Intrusion (241-T-102).



Steel Liner Cracks:

Confirmation of steel liner cracks is very difficult using standard visual inspection methods in DSTs and SSTs. To increase the ability to identify cracks in the steel liner multiple riser penetrations would be utilized to allow indirect illumination of the surface at an angle different than the camera is utilizing. Even with ideal illumination, physical size and depth of the crack would require a volumetric form of NDE such as an ultrasonic inspection. See Figure 3-19 for an example of a possible crack in the 241-SX-112 steel liner.

Figure 3-19. Possible Steel Liner Crack (241-SX-112).



4.0 EQUIPMENT DESCRIPTION

Camera systems used in Hanford DSTs and SSTs for remote visual inspections are all compact radiation resistant units. Tank access riser diameters typically limit the use of some of the more powerful camera and lighting systems available. Each camera used provides a real-time image to a viewing system which is monitored and recorded by tank farm personnel. The lighting intensity can be adjusted based on the application to ensure the minimum luminance requirement of the camera is met. The camera zoom, pan, and tilt functions can also be adjusted by tank farm camera operators to highlight and closely view areas of interest in the tank. See Table 4-1 for features of cameras used for waste storage tank inspections. All equipment used for monitoring or inspection is qualified for use by performance demonstration.

Supplemental lighting is also used in combination with the inspection camera lights to aid in viewing areas at farther distances. These lighting systems vary in size and intensity based on the desired result (i.e. spot lighting or full headspace illumination). The use of supplemental lighting may be required during specific SST inspections due to the proximity of the riser to the regions of interest.

Table 4-1. Remote Camera Inspection System Features.

	Zoom	Pan	Tilt	Resolution	Light Output	Minimum Access Diameter
GE System - PTZ140	36x Optical 12x Digital	360 Degrees	129 Degrees	470 HTV Lines	Two 35 watt lamps	6-inch Riser
GE System - PTZ70	10x Optical 4x Digital	360 Degrees	135 Degrees	470 HTV Lines	Eight 4 watt lamps	3-inch Riser
RJ Electronics RCS- 2010-B	10x Optical 4x Digital	360 Degrees	150 Degrees	470 HTV Lines	One 71 watt lamp	3-Inch Riser

5.0 RECORDS

All photograph and video records will be stored for a minimum of twenty years by records management per TO-020-142 and TFC-BSM-IRM_AD-C-05, *Photographic and Video Production*.

All reports detailing the results of inspections performed in DSTs and SSTs will be submitted and stored by records management per TFC-BSM-IRM_DC-C-02, *Records Management*.

6.0 REFERENCES

- ACI 201.1, 2008, *Guide for Conducting a Visual Inspection of Concrete in Service*, R-08, American Concrete Institute, Farmington Hills, Michigan.
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- Ecology, 1994, Publication 94-114, *Guidance for Assessment and Certifying Tank Systems that Store and Treat Dangerous Waste*, Washington State Department of Ecology, Olympia, Washington.
- TFC-BSM-IRM_AD-C-05, 2010, *Photographic and Video Production*, Rev. E-1, Washington River Protection Solutions, Richland, Washington.
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