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Waste Behavior Analysis for Tank 241-SY-103		ECN No.

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1. EDT 605350

2. To: (Receiving Organization) DISTRIBUTION	3. From: (Originating Organization) WASTE TANK PROCESS CONTROL	4. Related EDT No.:
5. Proj./Prog./Dept./Div.: 7E310	6. Cog. Engr.: N. E. Wilkins	7. Purchase Order No.: N/A
8. Originator Remarks: For original release.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-TI-661		0	Waste Behavior Analysis for Tank 241-SY-103	N/A	1, 2 4	1	

16. KEY											
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)					
E, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval 4. Review 2. Release 5. Post-Review 3. Information 6. Dist. (Receipt Acknow. Required)				1. Approved 4. Reviewed no/comment 2. Approved w/comment 5. Reviewed w/comment 3. Disapproved w/comment 6. Receipt acknowledged					
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RELEASE AUTHORIZATION

Document Number: WHC-SD-WM-TI-661, REV 0

Document Title: Waste Behavior Analysis for Tank 214-SY-103

Release Date: September 27, 1994

* * * * *

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SUPPORTING DOCUMENT

1. Total Pages 31

2. Title

Waste Behavior Analysis for Tank 214-SY-103

3. Number

WHC-SD-WM-TI-661

4. Rev No.

0

5. Key Words

Tank 103-SY, Gas Venting, Surface Level Drop, Gas Release Event, Flammable Gas, Standard Hydrogen Monitoring System (SHMS), Hydrogen

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Organization/Charge Code 7E310/N242U

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7. Abstract

Tank 241-SY-103 is on the Flammable Gas Watch List. The waste in this tank behaves similarly to that in tank 241-SY-101. Both show slurry growth and periodic surface level drops. However, the surface level drops are much smaller than those in tank 101-SY. A standard hydrogen monitoring system (SHMS) was recently installed in tank 103-SY, and waste auger samples were recently taken. This document covers the characterization results to date for the auger samples, and the behavior of the tank waste during both "steady state" periods and gas release events.

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10. RELEASE STAMP

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9. Impact Level N/A

^GMACPATH~GEF1000^G

WHC-SD-WM-TI-661 Rev. 0

WASTE BEHAVIOR ANALYSIS FOR TANK 241-SY-103

N. E. Wilkins

September 26, 1994

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1.0 INTRODUCTION

Tank 241-SY-103 (tank 103-SY) is a double shell, high-level radioactive liquid waste storage tank located in the 200 West Area of the Hanford Site. The tank is 75-ft. in diameter, 45-ft. high and buried approximately 10-ft. below ground. Figure 1 is a schematic of a typical double-shell tank. Plate 1 shows a portion of the tank dome from inside the tank. Plate 2 shows a tank wall and the top of the waste. These pictures were taken with a video camera installed inside the tank. Tank 103-SY contains about 750,000 gallons of waste that was concentrated at the 242-S evaporator. The waste in tank 103-SY is somewhat similar to that of tank 241-SY-101 (tank 101-SY), which produces and accumulates flammable gases such as hydrogen and nitrous oxide. In tank 101-SY, these gases were periodically released in rather large amounts, on two occasions exceeding the lower flammability limit for hydrogen, until a mitigation pump was installed. This pump mixes the waste, and the gas produced is released more gradually and at very much reduced hydrogen concentrations.

Similar gas accumulation and release behavior is suspected for tank 103-SY. A standard hydrogen monitoring system (SHMS), a video camera, and an ENRAF® surface level measuring device were recently installed in the tank. Also, an auger sample was taken recently, and vapor grab samples are now taken once per week. This document covers the characterization results to date for the auger samples, and the behavior of tank 103-SY waste during both "steady state" periods and gas release events.

2.0 FILL HISTORY OF TANK 103-SY

From its initial fill during the second quarter of 1977 until the third quarter of 1980, Concentrated Complexant (CC) waste was pumped in and out of tank 103-SY. During the third quarter of 1980, the tank was pumped down to a heel of 123,000 gallons. Double-shell slurry (DSS) was pumped in on top of the heel to a total volume of 543,000 gal by December 31, 1980. The majority of the DSS addition, 365,000 gallons, took place on October 28, 1980 (Simpson 1984). Uranium sludge from ion exchange processing was placed on top of the DSS a few years later. The Tank Farm's liquid level data book does not show any transfers out of tank 103-SY between January 1, 1981 and March 1990. During the period from January 1981 until March 1990, numerous small additions have been made to the tank such as pumping out West Area catch tanks, tanker trucks, 003 UR sump, and 242-S Evaporator flushes. In Table 1, the major additions to the tank are shown. The minor additions from 6/85 to 3/90 are shown in Table 2. Plate 3 shows the waste surface.

Further information on the late 1980 evaporator campaign that produced the DSS presently in tank 103-SY can be found in Reynolds (1981). Previous waste characterization analyses, temperature and surface level data, a riser diagram, and other miscellaneous information can be found in Brager (1994).

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Figure 1. Double-Shell Storage Tank

Plate 1. Partial View of Tank Dome.

Plate 2. Tank Wall and Waste.

TABLE 1. TANK 103-SY FILL HISTORY

Date	Volume (gal)	Material	Comments
3rd qtr 1980	123,000	CC	Heel left over from pumping out CC
4th qtr 1980	420,000	DSS	Entire 543,000 gal classified as DSS
6/85 - 11/85	32,200	Sodium nitrate sodium hydroxide solution w/uranium	In-tank picture 1985; bottle-and-string sample in 1985
7/1/88 - 8/13/88	131,000	Interstitial liquid and water from 104-SX	104-SX supernate sampled

Note: The current surface level of 271" for tank 103-SY is not expected to be equal to the sum of all the major and minor waste additions due to several cycles of slurry growth and subsequent release of some of the trapped slurry gas. Some evaporation of the tank contents may have also occurred.

TABLE 2. TANK 103-SY DETAILED FILL RECORD
(Data obtained from actual records from 6/18/85 to 5/31/93)

<u>DATE</u>	<u>NUMBER OF INCHES OF WASTE</u>	<u>RECEIVED FROM</u>
6/18/85	2.7"	Tanker Truck
6/20/85	2"	Tanker Truck
6/22/85	1"	Tanker Truck
6/25/85	1.8"	TY 302-A
6/26/85	0.8"	TY 302-A
6/28/85	1.6"	Tanker Truck
6/29/85	1.35"	Tanker Truck
7/2/85	1.35"	Tanker Truck
7/19/85	4.4"	C-100
7/30/85	0.8"	242-S
8/1/85	2.1"	Back Flush
8/6/85	3.3"	C-100
12/5/85	1.35"	C-100
2/17/86	0.9"	242-S Sump
2/28/86	0.7"	P-R Sump
3/14/87	1.3"	C-100
7/1 to 8/13/88	47.6"	104-SX
8/26/88	0.7"	244-S (DCRT)*
11/12/88	4"	244-S (DCRT)
1/26/89	0.5"	244-S (DCRT)
3/9/89	1.2"	244-S (DCRT)
4/13/89	1.1"	244-S (DCRT)
4/29/89	0.5"	244-S (DCRT)
6/8/89	0.7"	244-S (DCRT)
6/22/89	0.5"	244-S (DCRT)
8/4/89	1.7"	C-100 (Catch Tank)
3/90	1"	C-100

*Double Contained Receiver Tank

Plate 3. Waste Surface.

3.0 SURFACE LEVEL BEHAVIOR

Surface level increases were noted in tank 103-SY during the double-shell slurry campaign at the 242-S Evaporator that took place between October 28 and November 8, 1980. The changes in liquid level in the SY tanks are shown in Figure 2 (Reynolds 1981). The liquid level in tank 103-SY increased on November 6 and 7. Since no waste was added to the tank during this period, this surface level increase indicates slurry growth.

Tank 103-SY waste surface level measurements for the three months following the campaign are shown in Figure 3 (Reynolds 1981). The maximum level reached during this period was 201.5 inches. The surface level increased 23.2 inches, a 17% increase.

Figure 4 shows the waste surface level in tank 103-SY during the period 1981 through August 1994. The waste surface fluctuations during periods when no waste transfers occurred were random in nature and lacked a pattern prior to 1985. In the latter part of 1985, uranium ion exchange wastes were pumped into tank 103-SY. After this time, the magnitude of the surface fluctuations seems to increase. Figure 5 shows the waste surface level during the period 1989 through August 17, 1994. The waste surface level fluctuations seem to become more frequent. This may or may not be correlated with the transfer of approximately 131,000 gallons of waste from tank 104-SX during 1988. The most recent drop in surface level occurred on June 17 - June 24, 1994.

4.0 GAS RELEASE EVENTS

Gas release events occur in tank 101-SY, a tank containing waste similar to that in tank 103-SY. Water in the waste is undergoing radiolysis, producing hydrogen. Other waste components are decaying into other degradation products, such as nitrous oxide and ammonia. These gases are trapped in the heavy sludge at the bottom of tank 101-SY. Eventually, enough gas accumulates until this sludge begins to rise. The break-up of the heavy sludge layer releases a large quantity of gas very rapidly. The pressure in the tank dome space increases sharply, and the surface level height will decrease about ten inches over the next few days. This waste rollover is called a gas release event.

Table 3 provides a summary of the postulated gas release events for tank 103-SY. The primary basis for these events is an unexplained drop in the waste surface level.

In tank 101-SY, gas release events were associated with a definite increase in the tank dome space pressure, sometimes exceeding the atmospheric pressure. For each gas release event listed in Table 3 the pressure increase in the dome space was smaller than those in tank 101-SY and always remained negative relative to the atmospheric pressure. Two events, October 1990 and

January 1992, showed small pressure spikes during the release period. The FATHOMS code calculated gas volumes of 2,300 ft³ for the October 1990 release and 2,800 ft³ for the January 1992 release (Wood 1992a, 1992b). Neither event resulted in a pressurization of the tank to atmospheric pressure.

Recent evaluation of the data records for tank 103-SY showed that a gas release event occurred on June 17 - June 24, 1994. The surface level drop was 1.3" and the dome space pressure remained negative with respect to the atmosphere (Hopkins, 1994).

Figure 2. 241-SY Tank Farm Liquid Levels for 1980

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Surface Level (inches)

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Figure 3. Slurry Growth in 241-SY-103 Tank

Figure 4. Surface Level Readings (1981 - present)

Figure 5. Surface Level Readings (1989 - present)

TABLE 3. Gas Release Event Summary for Tank 103-SY

Date/Duration	Liquid level drop (in.)	Interval between events (days)
3/27-4/2, 1989	1.0	100
7/13-17, 1989	1.0	142
12/7-11, 1989	1.5	79
3/1-2, 1990	1.7	107
6/18-20, 1990	0.7	126
10/25-11/8, 1990	1.9	74
1/22-2/2, 1991	1.4	120
6/3-13, 1991	1.2	123
10/15-17, 1991	2.3	91
1/17-20, 1992	1.5	125
5/25-28, 1992	1.1	177
11/21-22, 1992	1.7	220
6/30-7/5, 1993	1.2	137
11/20-23, 1993	1.8	205
6/17-24, 1994	1.3	

5.0 WASTE TEMPERATURE

Temperature data from tank 103-SY are not very reliable. Six temperatures are measured at different depths in the waste, but three of those six thermocouples have failing extension wires. The temperature profile does not clearly show the convective and non-convective waste layers as the profile in tank 101-SY does. Also unlike tank 101-SY, the temperature profile is not changed significantly after a gas release event (Antoniak, 1994). Further information on historical temperature trends in tank 103-SY can be found in Antoniak (1994).

6.0 ADDITIONAL INSTRUMENTATION

A video camera was installed in riser 5B in early May. According to a video taped May 13, 1994, most of the waste's crust is a light color, and the surface is very uneven. Fissures can be seen in the crust. Other areas of the crust are smoother, but more cracks are present, making these areas resemble dried up ponds.

An ENRAF® 854 ATG (Advanced Technology Gauge) surface level measuring device was installed in the tank on July 14, 1994, to replace the FIC (Food Instrument Corporation) level gauge. This gauge measures the waste level in the tanks, whether the waste is solid or liquid, with a displacer. The weight of the displacer is measured by a force transducer. The displacer is then lowered into the tank. When the displacer comes into contact with the waste, the weight of the displacer decreases. Surface level measurements from this device have been steady at about 271 inches.

The ENRAF® surface level gauge has many advantages over the FIC level gauge currently in the tank. It is more accurate, and it has a standard 4-20mA output. Maintenance support is available from the vendor, and little or no calibration is required.

Figure 6 is a riser diagram of tank 103-SY. The locations of the video camera, the ENRAF® surface level gauge, and the SHMS cabinet are labeled.

7.0 HYDROGEN MONITORING

A standard hydrogen monitoring system (SHMS) was installed in tank 103-SY in late June. It is located by riser 7A in the exhaust vent header. Hydrogen in the exhaust gas is detected with two Whittiker cells. One cell has a range of 0 - 1%, and the other has a range of 0 - 10%. The instrument is tested and calibrated quarterly. Currently, the readings are steady at 0% H₂. The stripchart will show changes in concentration only if the change is greater than 100 ppm. Therefore, the hydrogen concentrations in the vent header at the present time are below 100 ppm. Plate 4 shows the internals of

the SHMS cabinet on tank 103-SY. Plate 5 shows the exterior of the J and L cabinets on tank 101-SY, which resemble the cabinet on tank 103-SY.

8.0 VAPOR SAMPLES

Grab samples are taken from the SHMS cabinet once per week. To take a grab sample, the air flow through the SHMS is diverted to a side loop which contains a sample cylinder. The air flow through the loop is set between 0.22 and 0.44 CFM. The air stream passes through the cylinder for at least one minute. The valves leading to the side loop and the sample cylinder are then closed, and the sample cylinder is removed and sent to Pacific National Laboratory (PNL) for analysis. Vapor grab samples have been taken recently, and they are awaiting transport to PNL.

9.0 AUGER SAMPLING

Three auger samples were taken from risers 22A, 14A, and 7B in tank 103-SY in early June. These samples were analyzed for weight percent water. Analyses for total inorganic and total organic carbon content are in progress.

An auger resembles a drill bit (or a large screw). The auger is drilled into the waste, and waste collects in the grooves (flutes) between the screw threads. The auger is then pulled out of the waste into a sleeve which keeps the waste from falling off the auger. Keeping the waste intact on the auger is important because assumptions about waste distribution in the tank are made based on the waste distribution on the auger. The auger and sleeve are transported to the laboratory in a tube (liner). At the laboratory, the auger is removed from the liner and the sleeve and placed horizontally on a stand. The auger flutes are numbered beginning from the top. Plates 6 - 9 show the auger samples.

Weight percent water of the auger sample is determined using thermal gravimetric analysis. The sample is placed in a furnace, which is slowly heated from ambient temperature to 400°C. The weight change of the sample is plotted over time. The amount of water loss is calculated from the weight loss that occurred between the ambient temperature and 100°C. The weight of water lost divided by the original sample weight equals weight percent water.

(WHC Drawing H-2-85104)

Figure 6. Tank 103-SY Riser Diagram

Plate 4. Internal View of SHMS Cabinet.

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Plate 5. External View of SHMS Cabinet.

SY-103

Riser 14A

Riser 14A

Riser 14A

Riser 22A

Riser 22A

Riser 22A

Riser 7B

Riser 7B

Plate 6. Auger Samples.

Plate 7. Auger Sample - Riser 22A.

Plate 8. Auger Sample - Riser 14A.

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Plate 9. Auger Sample - Riser 7B.

SAMPLE DESCRIPTIONSRiser 22A

A white crust material was on flutes 2 and 3. It was somewhat sticky, but it was easy to remove from the auger because it stuck to the spatula. A small amount of dark brown material was on flutes 4 - 8. The material was not homogeneous. Approximately 20 grams of waste were removed from the auger. No sample was left in the sleeve but some liquid was left in the liner. The following table contains subsample descriptions:

<u>Vial #</u>	<u>Lab ID</u>	<u>Material</u>	<u>Test</u>	<u>Weight (g)</u>	<u>Flute</u>
6007	R5372	white crust	DSC/TGA	1.17	2
6009	R5373	white crust	DSC/TGA	1.03	3
6010	R5374	dark brown	DSC/TGA	0.99	6
6011	R5375	dark brown	DSC/TGA	0.97	7

Riser 14A

Crust material was on flute 2. The color of the material varied from light brown to white. Approximately 95% of the material removed from the auger was from flute 2. Ten grams of sample was removed from the auger. No sample was left in the sleeve but some liquid was left in the liner. Some sample material fell off the auger onto a tray when the auger was placed on the auger stand. Subsample information is listed in the following table:

<u>Vial Number</u>	<u>Lab ID</u>	<u>Material</u>	<u>Test</u>	<u>Weight (g)</u>	<u>Flute</u>
6028	R5376	white caulk from auger	DSC/TGA	0.78	2
6029	R5377	sample from tray	DSC/TGA	1.07	

Riser 7B

Sample material was trapped in flutes 1, 2, 3, 4, and 6. Some of the larger chunks of material fell onto the tray when the auger was placed on the auger stand. A small piece of material (either plastic or tape) was observed on flute 4. The material was colorless.

The crust material was a mixture of color ranging from white to light gray. It was hard, dry, and brittle. Its texture was much different than the other auger samples. The other auger samples contained a small amount of liquid in the liner, but this auger contained no trace of liner liquid. Slightly less than 11 grams of sample was removed from the auger. The following table lists subsample information:

<u>Vial Number</u>	<u>Lab ID</u>	<u>Material</u>	<u>Test</u>	<u>Weight (g)</u>
6031	R5398	from auger	DSC/TGA	1.10
6032	R5399	from tray	DSC/TGA	1.21

RESULTS

No exotherms were found in the subsample from riser 22A. The percentage of water in the subsamples is listed below:

<u>Lab ID</u>	<u>Material</u>	<u>Flute</u>	<u>H₂O %</u>
R5372	white crust	2	11.98 11.37
R5373	white crust	3	24.04 23.61
R5374	dark brown	6	26.84 23.93
R5375	dark brown	7	26.29 24.77

No exotherms were found in the subsamples from riser 14A. The percentage of water in the subsamples is listed below:

<u>Lab ID</u>	<u>Material</u>	<u>Flute</u>	<u>H₂O %</u>
R5376	white caulk	2	33.21
	from auger		33.52
R5377	sample from		30.85
	tray		39.17

No exotherms were found in the subsamples from riser 7B. The percentage of water found in these samples are listed below:

<u>Lab ID</u>	<u>Material</u>	<u>H₂O %</u>
R5398	from auger	10.71 w/ 9.69% further weight loss
		8.02
		8.56
R5399	from tray	11.96 w/ 6.49% further weight loss
		17.82 w/ 9.66% further weight loss

10.0 FUTURE WORK

Two additional activities are ongoing that will provide more data about the behavior of the waste in tank 241-SY-103. A multifunctional instrument tree (MIT) will be placed in the tank; it will provide a detailed temperature profile of the waste. This information will help to determine the location of the interface between the upper convective layer and the bottom, nonconvective layer. Also, core samples are being obtained which will yield information on the current tank chemical composition as well as physical property data.

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