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Retained Gas Inventory Comparison

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Abstract: Gas volume data derived from four different analytical methods were collected and analyzed for comparison to volumes originally used in the technical basis for the Basis for Interim Operations (BIO). The original volumes came from Hodgson (1996) listed in the reference section of this document. Hodgson (1996) screened all 177 single and double-shell tanks for the presence of trapped gas in waste via two analytical methods: Surface Level Rise (SLR), and Barometric Pressure Effect (BPE). More recent gas volume projections have been calculated using different analytical techniques along with updates to the parameters used as input to the SLR and BPE models. Gas volumes derived from new analytical instruments include those as measured by the Void Fraction Instrument (VFI) and Retained Gas Sampler (RGS). The results of this comparison demonstrate that the original retained gas volumes of Hodgson (1996) used as a technical basis in developing the BIO were conservative, and were conservative from a safety analysis standpoint. These results represent only comparisons to the original reported volumes using the limited set of newly acquired data that is available.

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RETAINED GAS INVENTORY COMPARISON

SUMMARY

Gas volume data derived from four different analytical methods were collected and analyzed for comparison to volumes originally used in the technical basis for the Basis for Interim Operations (BIO). The original volumes came from Hodgson (1996). Hodgson (1996) screened all 177 single and double-shell tanks for the presence of trapped gas in the waste via two analytical methods. One method was Surface Level Rise (SLR), which calculates the volume of gas stored in the waste based on observed net changes in surface level, while the second was the Barometric Pressure Effect (BPE), which calculates stored gas volumes based on the magnitude of changes in measured surface level due to changes in atmospheric pressure.

More recent gas volume projections have been calculated using different analytical techniques along with updates to the parameters used as input to the SLR and BPE models described above. Gas volumes derived from new analytical instruments include those as measured by the Void Fraction Instrument (VFI) and Retained Gas Sampler (RGS).

The results of this comparison demonstrate that the original retained gas volumes of Hodgson (1996) used as a technical basis in developing the BIO were suitable, and were conservative from a safety analysis standpoint.

These results represent only comparisons to the original reported volumes using the limited set of newly acquired data that is available.

PURPOSE

The purpose of this comparison study is to determine whether the retained gas volumes originally used in the BIO are significantly different than those estimated from recent data. The methods used for comparison of the reported gas volumes are also discussed.

INTRODUCTION

This document compares gas volume data derived from four different analytical methods to volumes originally used in the technical basis of the Justification for Continued Operation (JCO) (flammable gas safety controls implementation document). The JCO is found as Appendix E of the BIO (Leach, 1997). This document serves as a statement of the applicability of the original gas volumes used in the BIO.

The original retained gas volume estimates used as the technical basis came from Hodgson (1996). Hodgson (1996) screened all 177 single and double-shell tanks for the presence of trapped gas in the waste via two analytical methods. One method was the SLR, which calculates the volume of gas stored in the waste based on observed net changes in surface level, while the second method was the BPE, which calculates stored gas volumes based on the magnitude of changes in measured surface level due to changes in atmospheric pressure (dl/dp). Hodgson (1996) utilized these methods to screen tanks that would likely cause their associated headspace flammable gas concentrations to exceed 25% of the lower flammability limit (LFL) if a significant fraction of their gas inventories was released from the waste.

Since Hodgson (1996) was published, different estimates of retained gas volumes have become available from new analytical techniques along with updates to the parameters used as input to the SLR and BPE models. The updates utilize more recent data, which are often considered to be of higher quality. Additionally, reevaluations were performed correcting discrepancies in the original evaluations.

Gas volumes derived from new analytical instruments include those as measured by the VFI and RGS. These measurements are available for a limited number of tanks, but have the advantage of directly measuring the tank waste conditions present at the time of the measurement or sampling event.

The VFI is designed to measure the volume fraction of free gas at specific locations in a tank. It is deployed directly into the waste to a desired elevation through a tank dome riser. The VFI is lowered through the waste with an open sampling chamber, allowing undisturbed waste to fill the chamber. The sampling chamber is located at the end of a horizontal arm (the arm is vertically positioned when deployed through the tank riser). At the measurement location, the sampling chamber cover is closed to capture a sample. The waste is then compressed in the sampling chamber using nitrogen gas through a connecting line. The void fraction is then calculated from the measured initial and final pressures along with known system temperatures and volumes (Stewart, 1996). The instrument is capable of providing multiple void measurements in the waste at a particular elevation due to the fact that the horizontal arm can be rotated in a circular manner about the riser centerline in the waste. These measured void fractions are then averaged and used to calculate a stored gas volume for a region of waste in the tank; thereby the entire tank gas inventory can be derived.

The RGS is a modified segment from a core sample. During a core sampling effort, specific segments are selected for RGS sampling based on desired locations in the waste. When the segment containing the sampler is deployed to the applicable location in the waste, a valve is opened that allows waste to be collected by the RGS. The valve is then closed, creating a gas-tight seal to the RGS. After the RGS core segment is retrieved, the sampler is subjected to X-rays to estimate the void fraction at the sample elevation. The off gasses from the waste are drawn from the RGS for analysis by vacuum. As was done for the VFI, the void fractions are then integrated over the entire tank contents to derive a total gas volume inventory for the tank.

In addition to the VFI and RGS data that have become available since the issuance of the BIO, a revised BPE model has been developed and additional high quality tank data have been obtained. As better waste level data became available, it was found that the original ideal gas law model was not adequate to describe the waste behavior in some of the tanks. In particular, comparisons of tank waste level data with atmospheric pressure did not show simple linear behavior as would be predicted by the gas law model. Whitney (1997) developed a refined model utilizing surface level data from tanks with ENRAF[1] level gauges connected to the Tank Monitoring and Control System (TMACS) data acquisition system. This refined model estimates dl/dp based on a "linear parallelogram estimation" method (BPE II) and is considered to be more accurate than the gas law model; the tank data used as inputs to the model are of higher quality because of more frequent and precise instrumentation measurements.

Whitney (1997) published new dl/dp estimates for 52 tanks. The median values from these new estimates were analyzed using the same methodology (Hopkins, 1996) employed in Hodgson (1996) to calculate retained gas volumes. These new BPE II gas volumes have been included in this document for comparison to the previously reported retained gas volumes (Hodgson, 1996).

METHODOLOGY

The first step taken was the collection of the original data from Hodgson (1996) used as the technical basis for the JCO. This was obtained from an electronic spreadsheet summary file maintained by Tank Waste Remediation System (TWRS) Process Engineering that tracks the inputs and results of each tank's flammable gas evaluation as reported in Hodgson (1996). Specific data extracted included the volume of trapped gas in the waste from both evaluation methods; the SLR and BPE models.

Hodgson (1996) initially screened all 177 tanks for the presence of trapped gas based upon a tank's current surface level and several enabling assumptions. It is considered to be very conservative. The screening evaluated the tanks assuming they had the gas generating characteristics of tank 241-SY-101. All tanks were evaluated on a pass/fail basis whether the potential existed to exceed 25 % of the LFL of the vapor space. This "quick screen" removed 55 tanks from the SLR and BPE evaluation. However, 3 tanks out of the 55 were still evaluated, and their results included in the original gas volume inventory. The remaining 122 tanks were then screened for applicability to the BPE model by analyzing their surface level histories for correlations with atmospheric pressure swings. If a tank was found to have a correlation with atmospheric pressure, then the BPE model evaluation was performed. All of the 122 tanks that did not pass the quick screen were evaluated for gas volumes based on the SLR model.

One parameter that has been identified as a possible indicator of trapped gas is an increase in the waste surface level. A surface level rise can result from other factors besides trapped gas (for

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[1] Trademark of the ENRAF-NONIUS B.V. Corporation

example, rainwater intrusion), but the Hodgson (1996) evaluation assumed it resulted from trapped gas. These rises in surface level are used to estimate the volume of retained gas via the calculations contained in the SLR model.

The SLR model assumes that the rate of change in waste surface level is a result of gas accumulation in addition to liquid evaporation, waste addition, leakage, density changes, and waste surface structural changes (subsidence). It does not require exceptionally accurate or frequent level measurements or any knowledge about the vertical distribution of gas to estimate the retained gas volume. The minimum number of waste level measurements needed to qualitatively assess the presence of retained gas are approximately six to twelve values over a period of six to twelve months. However, it is subject to the uncertainties associated with water evaporation or condensation, waste transfers to or from the tank, and structural changes in the waste surface (Meyer, 1997).

In practice, the SLR model can be used to 1) identify the probability that a tank is accumulating gas and 2) in limited cases to provide estimates of the quantity of gas retained in the waste. In the second case applying the concept can be challenging because of the long time period, potential correction terms, etc. As a result, SLR is best used as a qualitative indicator of trapped gas.

Since the time of the original evaluations, tanks have been reevaluated using the methodology found in Hopkins (1996) for trapped gas volumes. Reasons for this include:

- New/more data became available
- Tank specific parameters that were input into either of the models changed
- Errors were found in the original evaluations
- Certain evaluations did not account for evaporation of the tank waste
- The tanks that had passed the quick screen were subsequently evaluated using the SLR and BPE

Tanks that were reevaluated are included in this report for comparison to the retained gas volumes found in Hodgson (1996). The criteria used in selecting the tanks included that a tank had to have a BPE reevaluation performed. However, if a reevaluated tank also had additional retained gas volume estimate data, either directly (VFI or RGS) measured or derived from the BPE II model, its' reevaluated volumes were also included in Table 1 for comparison. The results from reevaluating the tanks reside within the TWRS Process Engineering electronic spreadsheet summary file (see Appendix for a table of data inputs and evaluation results adapted from the spreadsheet summary file), with the exception of tanks 241-BY-109, 241-T-110, and 241-BY-103, which are found as Revision 1A, 1B, and 1C to Hodgson (1996) respectively (these revisions were used to facilitate changing the flammable gas facility group designations for these tanks from Facility Group 2 to Facility Group 3). Eight tanks that were reevaluated had originally passed the quick screen evaluation. Their results are included in this report for comparison to retained gas volume estimates derived using the BPE II model. The retained gas volume estimates obtained from the reevaluations are referred to in this document together as "Reevaluations".

VFI and RGS data were also collected for comparison. As mentioned earlier, the data derived from these methods offer the advantage of being directly measured in the waste, but the number of tanks analyzed are limited.

The source for the VFI derived total gas volumes is Stewart (1996) for the non-convective and convective layers, and Meyer (1997) for the crust layer volume. These VFI volumes apply to double-shell tanks (DSTs) 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, 241-SY-101, and 241-SY-103.

The source for the RGS derived total gas volumes pertaining to DSTs is Shekarriz (1997). For tanks 241-AN-104, 241-AN-105, and 241-AW-101, the total volumes are summed from RGS data for the non-convective and convective layers, and Meyer (1997) provides the crust layer gas volumes. RGS data for single shell tanks were taken from Mahoney (1997) for tanks 241-BY-109, 241-S-106 and 241-U-103 and from Shekarriz (1997) for tank 241-A-101.

Total gas volume estimates were also obtained from Meyer (1997) for comparison. Meyer (1997) summarized available gas volume data and refined the models used in the prior documents (Stewart, 1996 and Shekarriz, 1997) for DSTs. Meyer reported gas volumes for tanks 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, 241-SY-101 and 241-SY-103. RGS data were used in combination with VFI data to determine gas volumes for all of these tanks with the exception of tank 241-SY-101 and tank 241-SY-103, which only have VFI data associated with them.

The last source of data used in the comparison was that from the BPE II model published by Whitney (1997) for 52 tanks. The BPE II model can be used at any time without existing knowledge of the retained gas volume. It requires sensitive and frequent waste surface level measurements over some period of time to determine the retained gas volume accurately.

In either of the BPE evaluations, it is important to understand the precision of repeated measurements. The precision/repeatability of the measuring device determines the minimum sensitivity in detecting and the standard deviation in estimating retained gas volumes using the BPE method. The various level measuring devices in use at Hanford do not have the same precision. The ENRAF gauge used exclusively in the BPE II model has a higher accuracy and associated repeatability than other level measuring instruments that were used in the original BPE model. High-frequency high-resolution surface level data provide the information needed to perform the revised evaluation. The precision afforded by the ENRAF gauge is clearly required for reasonably accurate BPE retained gas volume estimations (Meyer, 1997).

Median dl/dp values from Whitney (1997) using the BPE II model were input into the same spreadsheet from Hopkins (1996) to calculate retained gas volumes for comparison to what Hodgson (1996) reported. Because of more recent, frequent and precise instrumentation measurements, the BPE II model is considered to be more accurate than the original BPE model. Retained gas volumes derived using median dl/dp values from the BPE II model provide a "best estimate". These estimates are most accurate for tanks that have a moderately large volume of waste with a liquid waste surface at the region of level measurement, along with the condition of not having a multitude of suspended equipment penetrating the waste (Meyer, 1997). No formal attempt was made to screen the tanks (in this manner for applicability) that Whitney (1997) published dl/dp estimates for. It is believed that the dl/dp values yielded retained gas volume estimates that are sufficiently valid within the uncertainties discussed in the Results section.

It should be emphasized that data from the direct sampling tools (RGS and VFI) and volumes derived using median dl/dp values from the BPE II model provide retained gas volume estimates, while Hodgson (1996) was developed to provide bounding cases per the approved methodology at that time (Hopkins, 1996).

Qualitative comparisons between tanks are discussed in the following results section for those that have more than one type of gas volume estimate.

RESULTS

Table 1 lists 65 tanks which have new retained gas volume estimates available for comparison. The two columns labeled Hodgson (1996) represent gas volumes that were used for the technical basis of the BIO.

Perhaps the most instructive way to look at these data is to ask, "Would the new data indicate a change to a more restrictive Facility Group classification for a tank?" With the exception of tank 241-AX-101, none of the changes identified in Table 1 would result in a change from "pass" to "fail" in the outcome of the evaluation found in Hodgson (1996). Thus, since the Facility Group classification is largely based on Hodgson (1996) no change to a more restrictive Facility Group would result. Conversely, re-assessment of the data has resulted in changing tanks 241-T-110, 241-BY-103, and 241-BY-109 from Facility Group 2 to Facility Group 3. Tank 241-AX-101 has an Unreviewed Safety Question (USQ) declared against it based on preliminary results of RGS sampling (Barker, 1998). This tank has been reevaluated to have an gas inventory such that the result in Hodgson (1996) will change from "pass" to "fail" when it is revised.

When the work documented in Hodgson (1996) was performed, the result which gave the largest retained gas estimate controlled the outcome of the evaluation. Inspection of Table 1 shows that the methods often give widely different results for the same tank. This highlights the need to carefully reconcile the information about a tank and use multiple methods to assure that the analysis results in a "best estimate"of gas volumes.

All the methods for measuring volume of gas retained in a tank have significant uncertainty associated with them. Although two or three digits are reported, gas volumes are rarely measured more accurately than the nearest 25 cubic meters. Thus, when comparing inventory estimates, variations of this magnitude are not significant.

Table 1. Retained Gas Volume Inventory Comparisons (3 Sheets)

Tank (241-)	Hodgson (1996)		Reevaluations (Appendix)		VFI	RGS			BPE II
	Surface Level Rise	BPE	Surface Level Rise	BPE	Stewart 96[1]	Meyer 97[2]	Mahoney 97	Shekarriz 97[3]	Whitney 97 (Median dl/dp)
	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)
A-101	2	782						302	
AN-103	954	854			464	380		281	927
AN-104	1127	527	2154	453	247	236		229	344
AN-105	1318	695	1096	481	184	189		180	367
AW-101	397	400			209	141		126	
AW-103	33	99	33	99					
AW-104	219	231	231	273					
AX-101	BDL		60				340**		
BX-101*			105						4
BX-102*			78						BDL
BX-103*			143						BDL
BX-104	71	81	61	81					32
BX-106*			44						BDL
BX-107	9	190							60
BX-108*			77						BDL
BX-109	BDL								BDL
BX-110	42		50						61
BX-111	31								BDL
BX-112	9	63	45	63					BDL
BY-103	BDL	106	BDL	BDL					
BY-109	BDL	121	BDL	50			140		
C-103	35		BDL						BDL
C-107	BDL	15	BDL	15					9
S-103	265	336							208
S-106	672	808					230		698
S-107	570	136							86

Table 1. Retained Gas Volume Inventory Comparisons (3 Sheets)

Tank (241-)	Hodgson (1996)		Reevaluations (Appendix)		VFI	RGS			BPE II
	Surface Level Rise	BPE	Surface Level Rise	BPE	Stewart 96[1]	Meyer 97[2]	Mahoney 97	Shekarriz 97[3]	Whitney 97 (Median dl/dp)
	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)
S-111	245	570							562
SX-101	729	140	BDL	140					
SX-103	1147	850	173	849					
SX-106	650	349	299	354					340
SY-101	1546	1021			218	181			
SY-103	316	227			176	160			
T-102*			86						BDL
T-107	54	74	24	72					32
T-110	82		58						
T-111	4	13	29	8					
TX-101	123								BDL
TX-102	9	204							172
TX-103	43		102						62
TX-104	91								BDL
TX-105	BDL		BDL						BDL
TX-106	4								BDL
TX-107	BDL	4							BDL
TX-108	BDL								BDL
TX-109	BDL		BDL						BDL
TX-110	BDL								BDL
TX-111	73	179							BDL
TX-112	167	511							BDL
TX-113	66	242							BDL
TX-114	42								BDL
TX-115	140	297							BDL
TX-116	BDL								BDL
TX-117	BDL								BDL
TX-118	BDL		71						BDL
TY-101	9		36						BDL
TY-102	26	72							4
TY-103	BDL	BDL	34	BDL					BDL
TY-104*			57						BDL
TY-105	64		51						5
TY-106*			156						BDL
U-103	177	377	174	369			420		359

Table 1. Retained Gas Volume Inventory Comparisons (3 Sheets)

Tank (241-)	Hodgson (1996)		Reevaluations (Appendix)		VFI	RGS			BPE II
	Surface Level Rise	BPE	Surface Level Rise	BPE	Stewart 96[1]	Meyer 97[2]	Mahoney 97	Shekarriz 97[3]	Whitney 97 (Median dl/dp)
	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)	Standard Volume (m^3)
U-105	732	335							261
U-106	137	78	46	36					41
U-107	112	235							202
U-109	189	278							290

BDL = Below detection limit

* Passed the quick screen described in Hodgson (1996).

** Tank 241-AX-101 has been recently sampled using the RGS. This value is placed in the Mahoney 97 column for clarity (data is unpublished; author unknown at this time). Refer to Barker (1998) for a detailed analysis of the authorization basis for this tank.

[1] Values are based on VFI data for the non-convective and convective layers plus the associated crust gas volume from Meyer (1997).

[2] Values reflect the modeling of combined RGS and VFI data. Data for 241-SY-101 and 241-SY-103 are from VFI only.

[3] Values for 241-AN-104, 241-AN-105 and 241-AW-101 are based on RGS data for the non-convective and convective layers plus the associated crust gas volume from Meyer (1997).

ASSUMPTIONS

Assumptions made during data collection and analysis included:

1) Either of the BPE models can accurately determine the relationship between waste level and barometric pressure changes, thereby yielding a meaningful retained gas volume after subsequent analysis. This assumes that the applicable qualifying conditions for use of the BPE model were met. Meyer (1997) states that the BPE model should *not* be applied to tanks:

    - in which the interstitial liquid level is well below the waste surface;
    - with a very low waste level (volume);
    - that have been saltwell pumped;
    - with a forest of suspended hardware in the waste;
    - when a precise waste level instrument is not available or readings are not taken with sufficient frequency; and

- when the tank and instrument geometry is such that the response of the waste level measuring instrument does not reflect waste behavior (when located near the edge of a dry surface saltcake tank, the instrument might not register the behavior of the waste surface near the center of the tank).

No attempt has been made to validate that these conditions are met.

2) When using the SLR model, observed waste surface level changes are due to the accumulation of retained gas in addition to waste evaporation, addition, leakage and subsidence.

3) VFI and RGS data are generally of higher quality than BPE estimations of void fraction.

4) The BPE II model methodology developed is valid for use (associated dl/dp applicable for input into the evaluating spreadsheet).

5) Gas volumes derived from the SLR model are not suitable for direct comparisons (between Hodgson (1996) and the reevaluations found in the electronic spreadsheet summary file) by themselves because there is a high uncertainty associated with them.

CONCLUSIONS

From the simple analysis of Table 1 one can see (with the exception of tank 241-AX-101) that there are no newly available data that imply that the gas volumes used for the technical basis in the BIO were significantly under estimated such that their facility group would change. Conversely, (based on the majority of the VFI and RGS measurements) it would appear that Hodgson (1996) was conservative in its estimates of retained gas volume based on the SLR model. Any attempt to estimate the gas volume must include careful analysis of the tank specific conditions and should look at the results of multiple methods of estimating.

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Appendix

Summary Data for Tanks Reevaluated Using the Methodology of Hopkins

APPENDIX: Summary Data for Tanks Reevaluated Using the Methodology of Hopkins

This appendix contains a table adapted from an electronic spreadsheet summary file maintained by Tank Waste Remediation System (TWRS) Process Engineering that tracks the inputs and results of each tank's flammable gas evaluation using the methodology of Hopkins (1996). The table provides input data and reevaluation results for 32 of 35 tanks that are used for comparison to results as reported in Hodgson (1996). Specific data extracted from this table include the Compressed Volume of Trapped Gas (results from the SLR evaluation - column 93) and the Compressed Volume of Trapped Gas (results from the BPE evaluation - column 104). Other data columns shown are provided as a general reference for the reader.

1		2	3	4	5	6			7	8	9	10	11	12	14	70	71	72	73	74
Last Updated on 9/15/97 by S.A. Barker				General Tank Information																
TWRS Process Engineering, LMHC																				
Spreadsheet ID		Tank	Tank Type	Waste Depth (in)	Solid Level (in)	Modified Supernatant Depth (in)	Waste - Toxilogical Consequences; Surface Dryness	Waste - Liquid Location	Wet Solids Level (in)	Liquid Level (in)	Total Waste Volume (ft3)	Total Solids Volume (ft3)	Sludge Volume (ft3)	Saltcake Volume (ft3)	Supernatant Volume (ft3)	Selected Vent Rate	Surface Level Rise Basis	Current Level Measurement Device	Analysis Time Period	
a		0																		
C96/03A	10	241-AN-104	DST	385	96	289	1	2	96	385	141,835	35,292	35,292	0	106,543	inp	L	AFIC 1/96	June-85	to 1Q96
C96/03A	11	241-AN-105	DST	414	150	264	1	2	150	414	152,324	55,223	55,223	0	97,101	inp	L	MT 1/96	Oct.-85	to 1Q96
C96/03A	20	241-AW-103	DST	186	132	54	1	2	132	186	68,477	48,597	48,597	0	19,880	inp	L	MT SACS	Oct-94	to 4Q95
C96/03A	21	241-AW-104	DST	410	105	304	1	2	105	410	150,760	38,767	23,929	14,838	111,993	inp	L	MT SACS	May-91	to 3Q95
C96/03A	24	241-AX-101	SST	275	275	0	2	1	275	275	101,243	101,243	401	100,842	0	inp	S	Neutron I	JAN 81	to 4Q95
C96/03A	48	241-BX-101	SST	36	36	0	2	2	36	36	10,628	10,496	10,496	0	133	inp	L	AENRAF	jan-81	to 4Q95
C96/03A	49	241-BX-102	SST	50	50	-22	3	0	27	27	15,598	15,598	15,598	0	0	inp	S	AENRAF	jan 81	to 4Q95
C96/03A	50	241-BX-103	SST	46	42	4	2	2	42	46	14,045	12,705	12,705	0	1,340	inp	L	AENRAF	jan-81	to 4Q95
C96/03A	51	241-BX-104	SST	44	43	1	2	2	43	44	13,378	12,977	12,977	0	401	sam	L	Spreadsh	jan-81	to 4Q95
C96/03A	53	241-BX-106	SST	32	32	-13	3	0	19	19	9,060	9,060	0	9,060	0	inp	S	AENRAF	jan 81	to 4Q95
C96/03A	55	241-BX-108	SST	31	31	-2	2	0	29	29	8,622	8,622	8,622	0	0	inp	S	AENRAF	jan 81	to 4Q95
C96/03A	57	241-BX-110	SST	79	78	1	2	2	78	79	26,429	26,028	26,028	0	401	inp	L	Spreadsh	jan-81	to 4Q95
C96/03A	59	241-BX-112	SST	66	66	0	2	2	66	66	21,588	21,456	21,456	0	133	inp	L	Spreadsh	jan-81	to 4Q95
C96/03A	74	241-C-103	SST	79	31	48	1	2	31	79	26,492	8,688	8,688	0	17,804	inp	L	Spreadsh	jan-81	to 4Q95
C96/03A	78	241-C-107	SST	98	98	-19	3	0	80	80	33,332	33,332	33,332	0	0	sam	S	Manual E	Jul-95	to 4Q95
C96/03A	100	241-SX-101	SST	166	166	0	2	2	166	166	59,316	59,184	14,972	44,212	133	inp	L	SACS EN	Aug-80	to 4Q95
C96/03A	102	241-SX-103	SST	239	239	0	2	2	239	239	86,100	85,967	15,373	70,594	133	inp	L	MFIC 4/3/	April-81	to 2Q95
C96/03A	105	241-SX-106	SST	199	178	20	1	2	178	199	71,289	63,767	1,604	62,163	7,521	inp	L	MENRAF	Jan.-81	to 4Q95
C96/03A	119	241-T-102	SST	31	26	5	2	2	26	31	8,684	6,947	6,947	0	1,738	hl	L	AENRAF	jan-81	to 4Q95
C96/03A	124	241-T-107	SST	68	68	-2	2	0	66	66	22,255	22,255	22,255	0	0	sam	S	ENRAF 4/	Jan-81	to 4Q95
C96/03A	128	241-T-111	SST	169	169	-3	2	0	167	167	59,508	59,508	59,508	0	0	sam	S	MENRAF	Jan-81	to 4Q95
C96/03A	136	241-TX-103	SST	54	54	0	2	0	54	54	17,038	17,038	17,038	0	0	inp	S	AENRAF	Jan. 4, 19	to 4Q95
C96/03A	138	241-TX-105	SST	217	217	-186	3	0	31	31	77,275	77,275	0	77,275	0	inp	L	Spreadsh	jan-81	to 4Q95
C96/03A	142	241-TX-109	SST	138	138	-7	2	0	131	131	47,967	47,967	0	47,967	0	hl	S	AENRAF	Jan.-81	to 4Q95
C96/03A	151	241-TX-118	SST	112	112	-15	3	0	97	97	38,391	38,391	0	38,391	0	sam	S	AENRAF	Jan-81	to 4Q95
C96/03A	152	241-TY-101	SST	51	51	-24	3	0	28	28	16,114	16,114	16,114	0	0	sam	S	AENRAF	Jan.-81	to 4Q95
C96/03A	154	241-TY-103	SST	64	64	-10	3	0	54	54	20,727	20,727	20,727	0	0	sam	L	Spreadsh	jan-81	to 4Q95
C96/03A	155	241-TY-104	SST	24	23	1	2	2	23	24	5,949	5,548	5,548	0	401	inp	L	AENRAF	jan-81	to 4Q95
C96/03A	156	241-TY-105	SST	84	84	-14	3	0	70	70	28,060	28,060	28,060	0	0	inp	S	AENRAF	Jan.-81	to 4Q95
C96/03A	157	241-TY-106	SST	14	14	-6	2	0	7	7	2,278	2,278	2,278	0	0	inp	S	AENRAF	jan 81	to 4Q95
C96/03A	160	241-U-103	SST	179	175	5	2	2	175	179	63,256	61,518	4,278	57,241	1,738	sam	L	MENRAF	Jan-81	to 4Q95
C96/01B	163	241-U-106	SST	90	84	6	2	2	84	90	30,313	28,289	3,476	24,813	2,025	inp	L	Auto ENR	Dec-80	to 4Q95

1		2	75	76	77	78	79	80	81	82	83	84	85	86	91	92	93	94
Last Updated on 9/15/97 by S.A. Bark												Surface Level Results						
TWRS Process Engineering, LMHC																		
Spreadsheet ID		Tank	Evaluation Time Period	Gas Already Present (from Welty) (in)	Leakage out of Tank (in)	Waste Pumped Out, Current Period (in)	Intrusion or Additions (in)	Surface Level Current (in)	Surface Level Original (in)	Evaporation (in)	Adjustments to Surface Level Change (in)	Measured Surface Level Change (in)	Vent Rate, Input (cfm)	Net Growth (in)	Pressure Adjustment	Temperature Adjustment	**Compressed Volume of Trapped Gas (ft3)**	Compressed Volume of Trapped Gas, Measured change (ft3)
a		0																
C96/03A	10	**241-AN-104**	Jun-85 to 1Q96	0.1	0	0	0	385.25	385.9	93.32	93.42	(0.6)	137.00	92.77	2.4	0.9	**34,154**	N/A
C96/03A	11	**241-AN-105**	Oct.-85 to 1Q96	0.1	0	0	0	413.75	406.9	77.39	77.49	6.9	142.00	84.34	2.4	1.0	**16,567**	2,522
C96/03A	20	**241-AW-103**	Oct-94 to 4Q95	0	0	0	0	186	185.25	1.30	1.30	0.8	100.00	2.05	1.5	1.0	**755**	276
C96/03A	21	**241-AW-104**	May-91 to 3Q95	0	0	0	0	409.5	408.25	9.22	9.22	1.3	100.00	10.47	2.1	1.0	**3,854**	460
C96/03A	24	**241-AX-101**	Jan-81 to 4Q95	0	0	0	0	275	275	3.21	3.21	-	10.00	3.21	1.9	0.9	**1,182**	N/A
C96/03A	48	**241-BX-101**	Jan-81 to 4Q95	0	0	0	0	36.33	0	2.95	2.95	36.3	10.00	39.28	1.1	1.0	**3,188**	13,375
C96/03A	49	**241-BX-102**	Jan-81 to 4Q95	0	0	0	0	49.83	0	-	-	49.8	10.00	49.83	1.2	1.0	**2,205**	18,345
C96/03A	50	**241-BX-103**	Jan-81 to 4Q95	0	0	0	0	45.61	0	2.63	2.63	45.6	10.00	48.24	1.2	1.0	**4,213**	16,792
C96/03A	51	**241-BX-104**	Jan-81 to 4Q95	0.25	0	0	0	43.8	39.4	0.12	0.62	4.4	8.72	5.02	1.2	1.0	**1,849**	1,620
C96/03A	53	**241-BX-106**	Jan-81 to 4Q95	0	0	0	0	32.07	0	-	-	32.1	10.00	32.07	1.1	1.0	**1,325**	11,807
C96/03A	55	**241-BX-108**	Jan-81 to 4Q95	0	0	0	0	30.88	0	0.51	0.51	30.9	10.00	31.39	1.1	1.0	**2,366**	11,369
C96/03A	57	**241-BX-110**	Jan-81 to 4Q95	1	0	5	0	79.25	82.25	0.62	6.62	(3.0)	10.00	3.62	1.3	1.0	**1,333**	N/A
C96/03A	59	**241-BX-112**	Jan-81 to 4Q95	0	0	0	0	66.1	67.3	4.54	4.54	(1.2)	10.00	3.34	1.2	1.0	**1,230**	N/A
C96/03A	74	**241-C-103**	Jan-81 to 4Q95	0	0	0	0	79.42	80	0.00	0.00	(0.6)	10.00	(0.58)	1.3	0.9	**-**	N/A
C96/03A	78	**241-C-107**	Jul-95 to 4Q95	0	0	0	0	98	98	-	-	-	3.13	-	1.3	1.0	**-**	N/A
C96/03A	100	**241-SX-101**	Aug-80 to 4Q95	0	0	0	0	166.4	176.5	5.34	5.34	(10.1)	10.00	(4.76)	1.6	0.9	**-**	N/A
C96/03A	102	**241-SX-103**	Apr-81 to 2Q95	9.85	0	0	0	239.15	248.5	10.00	19.85	(9.3)	10.00	10.50	1.8	0.9	**3,864**	N/A
C96/03A	105	**241-SX-106**	Jan.-81 to 4Q95	13.9	0	0	0	198.92	178.4	5.40	(2.90)	20.5	10.00	17.62	1.7	1.0	**6,489**	7,555
C96/03A	119	**241-T-102**	Jan-81 to 4Q95	0	0	0	0	31.05	0	9.30	9.30	31.1	45.56	40.35	1.1	1.0	**2,605**	11,431
C96/03A	124	**241-T-107**	Jan-81 to 4Q95	0	0	6.5	0	67.91	72.6	-	6.50	(4.7)	6.37	1.81	1.2	1.0	**666**	N/A
C96/03A	128	**241-T-111**	Jan-81 to 4Q95	0	0.4	3.49	0	169.1	173.3	-	5.89	(4.2)	6.04	1.69	1.6	1.0	**622**	N/A
C96/03A	136	**241-TX-103**	Jan. 4, 1981 to 4Q95	4	0	28	0	53.74	81.85	4.08	36.08	(28.1)	10.00	7.97	1.2	1.0	**2,934**	N/A
C96/03A	138	**241-TX-105**	Jan-81 to 4Q95	4.25	0	88	0	31.3	147.5	-	92.25	(116.2)	10.00	(23.95)	1.1	1.0	**-**	N/A
C96/03A	142	**241-TX-109**	Jan.-81 to 4Q95	0	0	26.29	0	137.75	169	-	26.29	(31.3)	5.34	(4.96)	1.5	1.0	**-**	N/A
C96/03A	151	**241-TX-118**	Jan-81 to 4Q95	0	0	27.7	0	111.74	134.6	-	27.70	(22.9)	9.97	4.84	1.4	1.0	**1,782**	N/A
C96/03A	152	**241-TY-101**	Jan.-81 to 4Q95	0	0	3	0	51.23	51.5	-	3.00	(0.3)	3.25	2.73	1.2	1.0	**1,005**	N/A
C96/03A	154	**241-TY-103**	Jan-81 to 4Q95	0	0	26	5.3	53.66	69	-	20.70	(15.3)	8.24	5.36	1.2	1.0	**989**	N/A
C96/03A	155	**241-TY-104**	Jan-81 to 4Q95	0	0	0	0	23.62	0	2.11	2.11	23.6	10.00	25.73	1.1	1.0	**1,785**	8,696
C96/03A	156	**241-TY-105**	Jan.-81 to 4Q95	0	12.7	1.3	0	83.68	94	-	14.00	(10.3)	10.00	3.68	1.3	1.0	**1,355**	N/A
C96/03A	157	**241-TY-106**	Jan-81 to 4Q95	0	0	0	0	13.65	0	-	-	13.7	10.00	13.65	1.0	1.0	**5,025**	5,025
C96/03A	160	**241-U-103**	Jan-81 to 4Q95	3.2	0	0	0	179.28	174.85	2.70	5.90	4.4	7.74	10.33	1.6	1.0	**3,803**	1,631
C96/01B	163	**241-U-106**	Dec-80 to 4Q95	7.35	0	0	0	89.8	89.35	2.24	9.59	0.5	0.3	10.04	1.3	1.0	**3,696**	166

1		2	96	97	100	101	102	103	104			105	108	109	110	111	112	113	114
Last Updated on 9/15/97 by S.A. Bark																Baro			
TWRS Process Engineering, LMHC																			
Spreadsheet ID		Tank	Void Fraction, Clipped (%)	Volume of Trapped Gas Released (scf)	% LFL	% LFL, Measured SL Rise Only	% LFL, based on adjustments only	Volume of Entrapped Gas, Clipped (scf)	Compressed Volume of Trapped Gas (ft3)	Gas Releases logged by SHMS (ft3)	Void Fraction (%)	Void Fraction, Clipped (%)	% LFL	% LFL	Whitney 75% Slope	Whitney Mean Slope	Whitney Standard Deviation	Measuring Device Basis	Correlation Time Period
a		0																	
C96/03A	10	241-AN-104	19.7%	8,538	886.0%	-6.2%	892.2%	16,013	7,312			4.2%	212.3%	212.3%	-0.28	-0.17	0.17	FIC	1/90 to 12/95
C96/03A	11	241-AN-105	30.0%	4,142	617.5%	94.0%	1063.3%	16,979	7,389			13.4%	287.2%	287.2%	-0.28	-0.17	0.17	FIC	1/90 to 12/95
C96/03A	20	241-AW-103	1.6%	189	6.2%	2.3%	4.0%	3,503	2,306			4.7%	18.7%	18.7%	-0.14	-0.08	0.09		
C96/03A	21	241-AW-104	9.9%	963	135.3%	16.2%	119.2%	9,637	4,637			12.0%	159.3%	159.3%	-0.2	-0.10	0.14	FIC	4/91 to 9/95
C96/03A	24	241-AX-101	1.2%	295	20.0%	0.0%	20.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	48	241-BX-101	30.0%	797	22.9%	95.9%	7.8%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	49	241-BX-102	30.0%	551	17.8%	147.9%	0.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	50	241-BX-103	30.0%	1,053	32.1%	127.9%	7.4%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	51	241-BX-104	14.3%	462	13.6%	11.9%	1.7%	2,850	2,500			19.3%	18.0%	18.0%	-0.2	-0.13	0.10		
C96/03A	53	241-BX-106	30.0%	331	9.4%	83.4%	0.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	55	241-BX-108	30.0%	591	16.5%	79.5%	1.3%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	57	241-BX-110	5.1%	333	12.9%	-10.6%	23.5%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	59	241-BX-112	5.7%	307	10.9%	-3.9%	14.8%	2,216	1,761			8.2%	15.3%	15.3%	-0.13	-0.05	0.11		
C96/03A	74	241-C-103	0.0%	-	0.0%	0.0%	0.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	78	241-C-107	0.0%	-	0.0%	0.0%	0.0%	532	432			1.6%	4.2%	4.2%	-0.03	-0.01	0.02		
C96/03A	100	241-SX-101	0.0%	-	0.0%	0.0%	0.0%	4,928	3,468			5.9%	28.2%	28.2%	-0.2	-0.09	0.16	FIC	1/80 to 1/95
C96/03A	102	241-SX-103	4.5%	966	45.9%	-40.9%	86.9%	29,975	19,281			22.4%	215.7%	215.7%	-0.96	-0.76	0.31	FIC	1/90 to 9/95
C96/03A	105	241-SX-106	10.2%	1,622	67.3%	78.4%	-11.1%	12,498	7,798			12.2%	79.3%	79.3%	-0.42	-0.31	0.18	FIC	1/90 to 9/95
C96/03A	119	241-T-102	30.0%	651	18.4%	80.5%	24.1%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	124	241-T-107	3.1%	167	5.9%	-15.3%	21.2%	2,537	2,024			9.4%	17.6%	17.6%	-0.15	-0.08	0.11		
C96/03A	128	241-T-111	1.1%	156	12.0%	-29.9%	41.9%	284	175			0.3%	3.3%	3.3%	-0.01	0.01	0.03		
C96/03A	136	241-TX-103	17.2%	734	18.5%	-65.4%	83.9%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	138	241-TX-105	0.0%	-	0.0%	0.0%	0.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	142	241-TX-109	0.0%	-	0.0%	0.0%	0.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	151	241-TX-118	5.4%	445	15.7%	-74.0%	89.7%	-	-			0.0%	0.0%	N/A					
C96/03A	152	241-TY-101	13.5%	251	6.5%	-0.6%	7.1%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	154	241-TY-103	5.8%	247	6.4%	-18.4%	24.8%	-	-			0.0%	0.0%	N/A	0	0.07	0.11		
C96/03A	155	241-TY-104	30.0%	446	9.6%	46.6%	4.2%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	156	241-TY-105	5.9%	339	10.2%	-28.6%	38.8%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	157	241-TY-106	-1200397.5%	1,256	25.4%	0.0%	0.0%	-	-			0.0%	0.0%	N/A	0	0.00	0.00		
C96/03A	160	241-U-103	6.2%	951	75.9%	32.6%	43.4%	13,040	8,199			13.3%	157.6%	157.6%	-0.46	-0.36	0.15	FIC	1/90 to 12/95
C96/01B	163	241-U-106	12.2%	924	36.5%	1.6%	34.9%	2,740	2,133			7.0%	20.8%	20.8%	-0.15	-0.07	0.13	FIC	1/90 to 9/95

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Models and Inventory	Date 09/02/98
Project Title/Work Order		EDT No. EDT-622473
HNF-3296, Rev. 0, "Retained Gas Inventory Comparison"		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
DE&S Hanford, Inc.					
R. E. Bauer	S7-73	X			
D. R. Bratzel	S7-73	X			
R. J. Cash	S7-73	X			
G. W. Gault	R1-44	X			
T. C. Geer	R1-43	X			
G. D. Johnson	S7-73	X			
C. E. Leach	R1-49	X			
Y. G. Noorani	A3-07	X			
U. S. Department of Energy - Richland Field Office					
C. A. Groendyke	S7-54	X			
G. M. Neath	S7-54	X			
Lockheed Martin Hanford Corp.					
S. A. Barker	R2-11	X			
W. B. Barton	R2-11	X			
T. A. Hu	R2-11	X			
N. W. Kirch	R2-11	X			
J. G. Kristofzski	R2-12	X			
D. J. McCain	R2-11	X			
M. A. Payne	R2-58	X			
D. A. Reynolds	R2-11	X			
T.C.S.R.C.	R1-10	X			
Lockheed Martin Services, Inc.					
Central Files	B1-07	X			
MACTC					
J. D. Bingham	R2-11	X			
D. C. Hedengren	R2-11	X			
Pacific Northwest National Laboratory					
J. W. Brothers	K9-20	X			
L. A. Mahoney	K7-15	X			
P. A. Meyer	K7-15	X			
C. W. Steward	K7-15	X			
Self-Employed					
J. M. Grigsby	S7-14	X			