Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site

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Abstract: The document categorizes each of the large waste storage tanks into one of several categories based on each tank's waste characteristics. These waste group assignments reflect a tank's propensity to retain a significant volume of flammable gases and the potential of the waste to release retained gas by a buoyant displacement event. Revision 5 is the annual update of the methodology and calculations of the flammable gas Waste Groups for DSTs and SSTs.

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EXECUTIVE SUMMARY

The Hanford Site contains 177 large underground radioactive waste storage tanks (28 double-shell tanks and 149 single-shell tanks). These tanks are categorized into one of three waste groups (A, B, and C) based on their waste and tank characteristics. These waste group assignments reflect a tank's propensity to retain a significant volume of flammable gases and the potential of the waste to release retained gas by a buoyant displacement gas release event. Assignments of waste groups to tank wastes in the 177 double-shell tanks and single-shell tanks, as reported in this document, are based on a Monte Carlo analysis of three criteria.

The first criterion is the headspace flammable gas concentration following release of retained gas. This criterion determines whether the tank contains sufficient retained gas such that the well-mixed headspace gas flammable gas concentration would reach 100% of the lower flammability limit if the entire tank's retained gas were released. If the volume of retained gas is not sufficient to reach 100% of the lower flammability limit, then flammable conditions cannot be reached and the tank is classified as a waste group C tank independent of the method the gas is released.

The second criterion is the energy ratio and considers whether there is sufficient supernatant on top of the saturated solids such that gas-bearing solids have the potential energy required to break up the material and release gas. Tanks that are not waste group C tanks and that have an energy ratio < 3.0 do not have sufficient potential energy to break up material and release gas and are assigned to waste group B. These tanks are considered to represent a potential induced flammable gas release hazard, but no spontaneous buoyant displacement flammable gas release hazard. Tanks that are not waste group C tanks and have an energy ratio ≥ 3.0, but that pass the third criterion (buoyancy ratio < 1.0, see below) are also assigned to waste group B. Even though the designation as a waste group B (or A) tank identifies the potential for an induced flammable gas release hazard, the hazard only exists for specific operations that can release the retained gas in the tank at a rate and quantity that results in reaching 100% of the lower flammability limit in the tank headspace. The identification and evaluation of tank farm operations that could cause an induced flammable gas release hazard in a waste group B (or A) tank are included in other documents.

The third criterion is the buoyancy ratio. This criterion addresses tanks that are not waste group C double-shell tanks and have an energy ratio ≥ 3.0. For these double-shell tanks, the buoyancy ratio considers whether the saturated solids can retain sufficient gas to exceed neutral buoyancy relative to the supernatant layer and therefore have buoyant displacement gas release events. If the buoyancy ratio is ≥ 1.0, that double-shell tank is assigned to waste group A. These tanks are considered to have a potential spontaneous buoyant displacement flammable gas release hazard in addition to a potential induced flammable gas release hazard.

In determining the final waste group for a tank, uncertainty in the input data parameters used in the above calculations is accounted for by performing a Monte Carlo analysis. For each tank, 5,000 trial calculations of the waste group are performed using the criteria and method described above. For each trial, the input data for the calculations are randomly selected from pre-determined distributions that span the range of uncertainty in each parameter. The final waste group assigned to a tank is based on a 95% confidence level of the 5,000 trials. If the tank exhibits category C behavior at the 95% confidence level or for 95% of the trials, the tank is classified as waste group C. If the tank exhibits category C behavior at less than the 95% confidence level, but exhibits combined category C and category B behavior at more than 95% confidence level, the tank is then classified as a waste group B tank. The remaining tanks, those that exhibit category A behavior for greater than 5% of the trials, are placed in the waste group A category.

Sensitivity studies of waste group assignments were also performed for the cases of water and caustic additions to the waste tanks.

Revision 5 of this document incorporates the following changes:

- Data has been updated to reflect RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5 (*Best-Basis Inventory* effective date of September 21, 2005). Some tanks undergoing retrieval-closure activities were re-evaluated based on a *Best-Basis Inventory* effective date of February 1, 2006.

- A rigorous peer review of all data, calculations, and software (spreadsheets) supporting the calculations has been performed. Spreadsheet verification and description documents have been produced for all spreadsheets that perform the data manipulation and waste group calculations for this document revision in compliance with requirements for critical spreadsheets as defined in TFC-ENG-DESIGN-C-32, *Spreadsheet Development and Verification*.

- A revision was made to the energy ratio equation to agree with the form currently used in PNNL-15238, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Tank Wastes*.

- The buoyancy ratio calibration factor was recalculated based on PNNL-15238 and RPP-5926, Rev. 5. PNNL-15238 is the most recent re-evaluation of all of the tank data for those tanks that display buoyant displacement gas release event behavior in the tank farms.

- In response to issues identified in a 2004 assessment of the flammable gas waste group calculation methodology, RPP-21336, *Flammable Gas Waste Group Assessment FY-2004-ENG-S-0133*, the following changes were made:

  - The methodology for calculating the nonconvective layer density has been modified such that the nonconvective layer density always exceeds the convective layer density in a given tank, thereby ensuring that nonphysical conditions are not predicted. A method was employed in Revision 4 to relate the convective and nonconvective layer densities. However, the method employed in Revision 4 did not effectively predict possible spontaneous buoyant displacement flammable gas release hazard conditions following waste transfers. The revised methodology for calculating the nonconvective layer density for this revision is discussed in Appendix B.

- A change has been made to the dynamic distributions used to determine void fraction to account for changes in the neutral buoyancy void fractions during the simulations. This modification in the methodology overcame a calculation problem in Crystal Ball[1] when the neutral buoyancy void fraction was less than or equal to the void fraction distribution mean.

- In order to address the issues identified in PER-2006-0041, related to the techniques used for the measurement of nonconvective waste layer depth and the use of that data in the flammable gas waste group calculations, a review and compilation of sludge level measurement data was undertaken for the 28 double-shell tanks. The data were evaluated for bias between measurement techniques and revised mean values and associated uncertainties were calculated for all double-shell tanks.

- Hydrogen generation rates from RPP-5926, Rev. 5, were updated to reflect the revised solids levels for the double-shell tanks.

- In response to peer review comments, the tank specific density uncertainties and distributions presented in Revision 4 of this document have been revised. It was determined that the tank specific standard deviations calculated in Revision 4 did not account for transfers into or out of the tank and hence did not correlate with current tank conditions. For this document revision, the published density relative standard deviations for double-shell tanks and single-shell tanks from RPP-7625, *Best-Basis Inventory Process Requirements*, have been adopted for the waste group calculations.

- The following changes were made in the data used for void fraction calculations:

  - In order to address issues identified with the quality of data used for barometric pressure effect method calculations in previous revisions of this document, void fraction distributions for tanks with less than 1 m of supernatant have been recalculated using data from RPP-15488, *Investigation of Tank Void Fraction Using Liquid Level Response to Atmospheric Pressure Changes*.

  - A minimum detection limit for small volumes of retained gas determined by the barometric pressure effect method was incorporated into the void fraction calculations.

  - In order to provide a reproducible documented basis for the void fractions used in the waste group calculations for double-shell tanks 241-AN-107 and 241-SY-101, tank specific void fractions were recalculated using recent tank level data.

- A change was made in the tank volume calculations to allow the waste height to go to 460 in. in 241-AP Tank Farm tanks to accommodate future planned tank fill height increases.

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[1] Crystal Ball is a trademark of Decisioneering, Inc., Denver, Colorado.

- In order to ensure that the flammable gas waste group calculations are not overly constrained by unanticipated operations that would not be performed without further evaluation, the waste group calculations were performed for a 500 gal caustic addition rather than for a 10,000 gal caustic addition as has been the case in previous revisions of this document. The 500 gal allowance is a reasonably generous allowance to accommodate inhibited water additions for equipment flushes or the use of caustic for pit cleaning etc. Additions greater than 500 gal are considered a large chemical addition and will be evaluated on a case-by-case basis as needed.

- The format of this document revision has been streamlined by excluding the voluminous spreadsheet printouts found in previous document revisions. A summary of all spreadsheets used is included in the main body of this document revision. Details of those spreadsheets may be obtained from the new referenced spreadsheet description documents.

Based on the data and methodology changes discussed above, the flammable gas waste groups for 177 double-shell tanks and single-shell tanks have been recalculated. The following changes in flammable gas waste group assignments result when compared with the current waste group classification presented in HNF-IP-1266, Rev. 0b, *Tank Farms Operations Administrative Controls*, Section 5.10a, "Waste Group Designations."

- One double-shell tank 241-AP-108, increased to waste group B from waste group C, based primarily on new estimates of nonconvective waste height.

- Six double-shell tanks, 241-AN-106 (HNF-IP-1266 waste group is based on a compatibility study for C-farm tank transfers), 241-AW-103 (reduction in void fraction), 241-AW-106, 241-AY-102, 241-SY-101, and 241-SY-102 have changed from waste group B to waste group C tanks.

- Three single-shell tanks have increased to waste group B from waste group C, primarily as a result of re-evaluation of void fraction. The three tanks that have changed to waste group B from waste group C are 241-S-104, 241-SX-104, and 241-T-201.

- Eighteen single-shell tanks have reduced to waste group C from waste group B, primarily as a result of re-evaluation of void fraction and for single-shell tank 241-S-102 also due to retrieval progress. The 18 tanks that have changed to waste group C from waste group B are 241-AX-101, 241-B-104, 241-B-105, 241-B-107, 241-BY-102, 241-BY-107, 241-BY-108, 241-S-102, 241-S-105, 241-S-106, 241-SX-105, 241-T-110, 241-TX-110, 241-TX-117, 241-TX-118, 241-U-103, 241-U-107, and 241-U-109.

The following additional changes and improvements will be included in the next annual revision to this document.

- Since the current condition of single-shell tanks precludes the formation of a waste group A tank and since the tanks are inactive unless subject to retrieval, a routine annual re-evaluation of the single-shell tanks will not occur in the future unless there is a significant change in tank properties, as identified from a review of published *Best-Basis Inventory* changes. The tanks will be re-evaluated prior to any planned retrieval activity.

- The density uncertainties used for the waste group calculations will be refined by use of tank specific relative standard deviations, for inventories that are sample-based, based on a new report to be published by the *Best-Basis Inventory*.
- Improvements will be made in the void fraction data used for double-shell tank calculations. Since all double-shell tanks are now fitted with an ENRAF gauge, all double-shell tanks will be evaluated using the barometric pressure effect method and tank specific void fractions calculated when feasible.

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BBI	*Best-Basis Inventory*
BDGRE	buoyant displacement gas release event
BPE	barometric pressure effect
DST	double-shell tank
ENRAF	Enraf-Nonius Series 854 (level gauge)
GRE	gas release event
HGR	hydrogen generation rate
LFL	lower flammability limit
PNNL	Pacific Northwest National Laboratory
RGS	retained gas sampler
SST	single-shell tank
VFI	void fraction instrument

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1.0 INTRODUCTION

Waste stored within tank farm double-shell tanks (DST) and single-shell tanks (SST) generates flammable gas (principally hydrogen) to varying degrees depending on the type, amount, geometry, and condition of the waste. The waste generates hydrogen through the radiolysis of water and organic compounds, thermolytic decomposition of organic compounds, and corrosion of a tank's carbon steel walls. Radiolysis and thermolytic decomposition also generates ammonia. Nonflammable gases, which act as dilutents (such as nitrous oxide), are also produced. Additional flammable gases (e.g., methane) are generated by chemical reactions between various degradation products of organic chemicals present in the tanks. Volatile and semi-volatile organic chemicals in tanks also produce organic vapors. The generated gases in tank waste are either released continuously to the tank headspace or are retained in the waste matrix. Retained gas may be released in a spontaneous or induced gas release event (GRE) that can significantly increase the flammable gas concentration in the tank headspace as described in RPP-7771, *Flammable Gas Safety Issue Resolution*. Appendices A through H provide supporting information.

1.1 GAS RETENTION IN SINGLE-SHELL TANKS AND DOUBLE-SHELL TANKS

Studies have shown that some tanks store significant volumes of gas in their waste. Free gas can accumulate in submerged solids, which are saturated. Convective fluid layers of waste do not retain significant amounts of insoluble gases (e.g., hydrogen and methane) because bubbles rise through liquid waste as fast as they are generated. Soluble gases (primarily ammonia) are also dissolved in liquid waste; however, evaporation of dissolved ammonia is pronounced only when a free liquid surface is freshly exposed or agitated.

Direct measurements of retained gas are not available for most tanks. Estimates of the amount of retained gas stored in each DST and SST were made based on two indirect methods provided in WHC-SD-WM-ER-526, *Evaluation of Hanford Tanks for Trapped Gas*. Based on WHC-SD-WM-ER-526, only 49 of the 177 SSTs and DSTs were determined by the barometric pressure effect (BPE) method to have trapped gas and, of these, only 15 tanks, including 4 DSTs (241-AN-103, 241-AN-104, 241-AN-105, and 241-AW-104) stored relatively large volumes of gas, greater than 10% of the solid waste volume. Sixty-eight tanks have so little waste that gas retention is of little concern when released and mixed in the headspace because of the large headspace dilution factor. However, both of the indirect estimation methods include significant uncertainties, as described in WHC-SD-WM-ER-594, *Evaluation of Recommendation for Addition of Tanks to the Flammable Gas Watch List*.

Uncertainties arise because the models are simplified and approximate the physical condition of the waste in all DSTs and SSTs and because the data used lacks the precision necessary to make estimates of the retained gas. Therefore, given the uncertainty in the methods and data, a conservative assumption is that all the DSTs and SSTs retain gas in their saturated solid layers.

Current estimates of retained gas used in this document are based on the void fraction in the saturated solids of each tank considered. Void fraction distributions are based on all available void fraction instrument (VFI) data, retained gas sampler (RGS) data, appropriate BPE data, and similarities in waste type for the other tanks as described in Appendix A.

1.2 GAS RELEASE EVENTS

Gases released from the waste in a DST or SST in a nearly continuous manner can be managed effectively by ventilation. However, it is much more difficult to manage when a significant amount of the gas retained within waste is released relatively rapidly in a buoyant displacement gas release event (BDGRE). The BDGREs were observed in six of the DSTs (241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, 241-SY-101, and 241-SY-103). Data regarding the physics of GRE in the tanks is provided in Pacific Northwest National Laboratory (PNNL) documents PNNL-11296, *In Situ Rheology and Gas Volume in Hanford Double-Shell Waste Tanks*, and PNNL-11536, *Gas Retention and Release Behavior in Double-Shell Waste Tanks.* The most recent estimations of released gas volumes are found in RPP-6655, *Data Observations on Double-Shell Flammable Gas Watchlist Tank Behavior*. The large GREs that occurred in DST 241-SY-101 before they were mitigated by the mixer pump, and then remediated by transfers and dilution, were unique in size and frequency. The largest release was the December 4, 1991, GRE of 183 to 263 m^3 of gas (RPP-6655), or 39 to 56% of its retained gas inventory.[2] The observed frequency of GREs in DST 241-SY-101, prior to remediation, was every 80 to 150 days (RPP-6517, *Evaluation of Hanford High-Level Waste Tank 241-SY-101*). In contrast, the total tank retained gas volumes (including transient and retained gas in the crust and convective layer) and corresponding release fractions for the other five GRE DSTs based on VFI and RGS data for these tanks are given in Table 1-1.

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[2] DST 241-SY-101 percent gas released is based on the following calculations. The high estimate is calculated using the December 4, 1991, maximum calculated release volume, 263 m^3 (RPP-6655), with a retained gas volume based on the post mixer pump retained gas volume at standard conditions, 195 m^3 (RPP-6655), corrected for the difference in total waste height at the time of the GRE, 416 in. (height on December 4, 1991, from Personal Computer-Surveillance Analysis Computer System) minus post mixer pump waste height of 399 in. (RPP-6517). The volume of gas released by mixer pump operations is determined to be 177 m^3 ([416 in. – 399 in.] x 2,754 gal/in. x 0.003785 m^3/gal) corrected for pressure (i.e., 1.53 pressure ratio [RPP-6655]) to 271 m^3. The conservative retained gas volume at tank headspace conditions on December 4, 1991, is calculated to be 466 m^3 (195 m^3 + 271 m^3). When the maximum calculated volume of gas released is divided by the calculated retained gas volume, all volumes at headspace conditions, the calculated release volume is 56% of the retained gas volume (263 m^3/ 466 m^3). Similarly, the calculated volume for the December 4, 1991, release is 183 m^3, which corresponds to 39% (183 m^3/466 m^3) of the retained gas volume.

Table 1-1. Total Tank Retained Gas Volumes and Corresponding Release Fractions for Five Double-Shell Tanks.*

Tank	Total retained gas volume (Std. m^3)	Release fraction
241-AN-103	393 ± 64	0.02
241-AN-104	259 ± 48	0.07
241-AN-105	202 ± 68	0.15
241-AW-101	153 ± 38	0.19
241-SY-103	198 ± 86	0.12

Note:
*Source: Table ES-1 of RPP-7771, *Flammable Gas Safety Issue Resolution*, Rev. 0-A, CH2M HILL Hanford Group, Inc., Richland, Washington.

The uncertainties for the total retained gas volumes represent a 95% confidence bound. The release fractions were calculated by dividing maximum observed hydrogen release by total retained hydrogen volume (RPP-7771). None of the gas releases in the DSTs, other than DST 241-SY-101 prior to remediation, have been large enough to create flammable mixtures after mixing in the tank headspace as described in RPP-6517 and RPP-7771.

A study of gas retention behavior of SST waste forms has narrowed the number of plausible spontaneous release mechanisms to a few possibilities that are capable of only small releases (less than 10 m^3 compared with 100 to 200 m^3 in DST 241-SY-101) and is discussed in HNF-SP-1193, *Flammable Gas Project Topical Report*. Observation of a number of the most active flammable-gas-retaining SSTs indicates that no large BDGREs are occurring and that only a few SSTs experience small spontaneous GREs. The typical spontaneous GRE in an SST has a small release volume of tens of cubic feet of hydrogen and no release in the SSTs has been observed with the "classic" BDGRE properties as described in RPP-7771 and RPP-7249, *Data and Observations of Single-Shell Flammable Gas Watch List Tank Behavior*. The variation in gas release volumes and fractions within the same tank are a good indication of tank waste inhomogeneity and supports the use of uncertainty distributions for the modeling of this type of behavior.

1.3 WASTE GROUPS FOR SINGLE-SHELL TANKS AND DOUBLE-SHELL TANKS

Waste group assignments have been developed for the 177 DSTs and SSTs for application of flammable gas controls. The SST and DST groupings are based on waste tank characteristics and the propensity of the waste to experience a large BDGRE. Waste group selection criteria were developed based on both empirical data and analytical concepts with the objective of identifying and separating waste tanks into groups that posed similar GRE risks.

The SSTs and DSTs are assigned to one of three groups as described below:

- **Waste Group C:** Tanks with no potential GRE flammable gas hazard. That is, tanks that are conservatively estimated to contain insufficient retained gas to achieve 100% of the lower flammability limit (LFL), even if all of the retained gas is released into the tank headspace.

- **Waste Group B**: Tanks with a potential induced GRE flammable gas hazard, but no potential spontaneous BDGRE flammable gas hazard. That is, tanks that are conservatively estimated to contain sufficient retained gas to achieve 100% of the LFL if all of the retained gas is released into the tank headspace, but are not waste group A tanks (see below).

  Note : Potential induced GRE flammable gas hazards exist in waste group B (and A) tanks only for specific operations that can release the retained gas in the tank at a rate and quantity that results in reaching 100% of the LFL in the tank headspace. The identification and evaluation of tank farm operations that could cause an induced flammable gas release hazard in a waste group B (or A) tank are included in other documents.

- **Waste Group A**: Tanks with a potential spontaneous BDGRE flammable gas hazard in addition to a potential induced GRE flammable gas hazard. That is, tanks that are conservatively estimated to achieve a flammable gas concentration of 100% of the LFL in the tank headspace if all of the retained gas is released from a spontaneous BDGRE.

2.0 WASTE GROUP SELECTION CRITERIA

2.1 CRITERIA USED TO ASSIGN TANKS TO A WASTE GROUP

The waste parameters or combinations of waste parameters that are used to assign individual SSTs and DSTs to waste groups are as follows.

Headspace Flammable Gas Concentration Following Release of Retained Gas: This criterion determines whether the tank contains sufficient retained gas such that the well-mixed headspace gas flammable gas concentration would reach 100% of the LFL if the entire tank's retained gas were released. If there is not sufficient retained gas to reach 100% of the LFL, then flammable conditions cannot be reached and the tank is classified as a waste group C tank independent of the method the gas is released.

The saturated settled solids depth[3] and gas volume fraction distribution can be used to determine whether there is sufficient retained gas in the waste to cause the tank headspace to become flammable if the gas was all released at once. The sediment gas volume fraction may be determined using void fraction data, assigned conservative bounding values, or conservatively calculated as the neutral buoyancy gas fraction (for tanks with liquid-over-sediment waste configuration). This calculation can be used as a quick screen for determining whether a tank poses a potential GRE hazard and does not model expected tank behavior. Equations 1, 2, and 3 are used to make these calculations relating to headspace flammable gas concentration criterion.

In Equation 3, the pressure on the retained gas is determined. The slightly conservative assumption is made that the gas is stored as particle-displacing bubbles (hydro-dendritic bubbles or lithostatic conditions). The depth of the crust, if continuous across the surface, is added to the convective layer depth to determine the pressure contribution from these layers. Because the amount of crust floating above the liquid is not measured, the full crust level is used in the pressure calculation. In addition, it is assumed that the crust has the same density as the convective layer. For tanks with a noncontiguous crust and for which the convective layer surface level is known, there is no need to add the depth of the crust, since the effect of the crust layer would be included in the convective layer surface level.

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[3] Saturated settled solids depth is considered in the retained gas volume determination versus the depth of solids saturated with liquid. The difference is that the volume of saturated solids in a floating crust layer is not included. This simplification is reasonable for several reasons. First, the existing crusts in the DSTs are less than 1 m thick (Appendix H) and only approximately one half of this depth is saturated with liquid and capable of retaining flammable gas. Second, the retained gas within the crust does not have the same pressure head as the retained gas within the main body of solids, because the liquid layer, which contributes a significant portion of the retained gas pressure head, is below the crust layer. The effective head pressure on the retained gas in the settled solids ranges from 1.7 to 2.3 atmospheres (RPP-6655) when compared to the head pressure on the crust retained gas of about 1 atmosphere. These considerations indicate that the crust's retained gas volume at headspace conditions is small relative to the settled solids retained gas volume. Finally, floating crusts are currently only found in waste group A tanks and would have no impact on the final classification of the tank.

Retained Gas Flammability at Headspace Criterion $\%LFL_{HS}$: $\%LFL_{HS} > 100\%$

$$\%LFL_{HS} = \left(\frac{[H_2]_{RG}}{\%LFL_{H2}} + \frac{[CH_4]_{RG}}{\%LFL_{CH4}} + \frac{[NH_3]_{RG}}{\%LFL_{NH3}} \right) * \frac{VG_{WNCL} * F_{GasRelease}}{V_{HS}} \qquad (1)$$

Where

$$VG_{WNCL} = VF_{WNCL} * A * H_{WNCL} * \left(\frac{P_{WNCL}}{P_{HS}} \right) * \left(\frac{T_{HS}}{T_{WNCL}} \right) \qquad (2)$$

$$P_{WNCL} = P_{HS} + \rho_{CL} * g * (H_{CL} + H_{CR} + 0.5 * H_{WNCL}) \qquad (3)$$

$\%LFL_{CH4}$	=	methane concentration at 100% LFL (5.0 vol%)
$\%LFL_{H2}$	=	hydrogen concentration at 100% LFL (4.0 vol%)
$\%LFL_{HS}$	=	headspace flammable gas concentration following gas release
$\%LFL_{NH3}$	=	ammonia concentration at 100% LFL (15.0 vol%)
$[CH_4]_{RG}$	=	methane concentration in the retained gas in nonconvective layer (vol%)
$[H_2]_{RG}$	=	hydrogen concentrations in the retained gas in nonconvective layer (vol%)
$[NH_3]_{RG}$	=	ammonia concentration in the retained gas in nonconvective layer (vol%)
A	=	cross-sectional area of tank (m^2)
$F_{GasRelease}$	=	fraction of gas released (assumed to be 100%)
g	=	gravity acceleration 9.806 m/sec^2
H_{CL}	=	height of the liquid (convective) layer (m)
H_{CR}	=	height of the crust layer (m)
H_{WNCL}	=	height of liquid saturated nonconvective layer (m)
P_{HS}	=	pressure in tank headspace and assume the pressure is 1 atm = 101,325 Pa (or N/m^2)

P_{WNCL} = calculated representative retained gas pressure in saturated settled solids layer in atm or Pa (N/m^2)

T_{HS} = representative temperature of headspace of waste tank (K)

T_{WNCL} = representative temperature of saturated settled solids layer (K)

VF_{WNCL} = representative void fraction in saturated settled solids layer

VG_{WNCL} = calculated volume of gas retained in the saturated settled solids layer at headspace conditions (m^3)

V_{HS} = volume of headspace of waste tank after gas release (m^3)

ρ_{CL} = density of convective layer (kg/m^3).

Note 1: Temperatures used are the maximum daily average layer temperatures recorded over the previous 12 months within the solid waste or within the vapor space as appropriate and are obtained from RPP-5926, Rev. 5.

Note 2: The dilution of released gases by water vapor is not considered.

Note 3: Uncertainty distributions are utilized to account for the scatter of retained gas volumes in the waste and uncertainty in the solid volumes. Void fraction distributions are based on all available VFI data, RGS data, and appropriate BPE data.

Energy Ratio: The presence of a significant supernatant layer introduces the possibility of BDGREs. The supernatant layer depth can be utilized as a criterion for determining susceptibility to BDGREs by using a term called "energy ratio" as described in PNNL-11296. The waste in tanks with supernatant layers below an energy ratio threshold of about 3 is not expected to contain sufficient energy to release gas during a buoyant displacement event.

If a tank's waste fails the retained gas volume criterion, the energy ratio criterion is applied. The process of gas release from a gob undergoing buoyant displacement requires that sufficient energy be released to disrupt the waste surrounding the bubbles to allow them to escape as the gob reaches the waste surface. The amount of energy available is directly proportional to the depth of the supernatant through which the gob rises.

The energy ratio is the ratio of the buoyant potential energy of the gas-bearing gobs to the energy required to yield the waste and release gas from those gobs participating in buoyant displacements. The depth of the convective layer above a nonconvective layer in a tank's waste determines whether gas retained in gobs from the saturated nonconvective layer can be released.

Equations 4, 5, and 6 are used to make energy ratio calculations. If the energy ratio for the waste in a DST or SST is less than 3, for a tank that can reach 100% of the LFL in the headspace based on the calculation in Equation 1, then that tank is classified as a waste group B tank. The DSTs that fail both the retained gas volume criterion and the energy ratio criterion are examined for tendencies to have spontaneous BDGREs. The criterion comparison value of 3 accounts for the energy needed to overcome the yield stress, plus a factor to account for energy lost through other processes during the gas release. Based on experimental observations and tank behavior, some gas can be released when the energy ratio exceeds 3, and release of a large fraction of stored gas can occur when the energy ratio exceeds 5. Although the effect of the critical void fraction is discussed in PNNL-13782, *Analysis of Induced Gas Releases During Retrieval of Hanford Double-Shell Tank Waste*, it requires knowledge of the value for the yield stress, which is accurately known only in tanks where the ball rheometer has been used for in-situ determinations of yield stress. In tanks where this value has not been measured, the uncertainty introduced by estimating this value is not justified, and the neutral buoyancy void fraction is used. In addition, for weak waste, the critical void fraction approaches the neutral buoyancy void fraction.

Energy Ratio Criteria ER: $ER < 3.0$

$$ER = \left(\frac{\alpha_{NB} * \gamma * P_{HS}}{(1-\alpha_{NB}) * \tau_{WNCL} * \varepsilon_y} \right) * \left(\left(1 + \frac{1}{\gamma}\right) * \ln(1+\gamma) - 1 \right) \quad (4)$$

where

$$\gamma = \frac{\rho_{CL} * g * (H_{CL} + H_{CR})}{P_{HS}} \quad (5)$$

$$\alpha_{NB} = 1 - \frac{\rho_{CL}}{\rho_{WNCL}} \quad (6)$$

ER = energy ratio, the ratio of the buoyant potential energy of the gas-bearing gobs to the energy required to yield the waste and release gas from those gobs participating in buoyant displacements

g = gravity acceleration, 9.806 m/sec^2

H_{CL} = height of the liquid (convective) layer (m)

H_{CR} = height of the crust layer (m)

P_{HS} = pressure in tank headspace, assuming the pressure is 1 atm = 101,325 Pa (or N/m^2)

α_{NB} = calculated or measured neutral buoyancy of saturated settled solids layer relative to the convective layer on top of it (calculated neutral buoyancy is one minus the ratio of convective layer density to saturated non-convective layer density)

γ = calculated ratio of pressure head of convective layer in a waste tank to the headspace pressure, which is assumed to be one atmosphere

ρ_{CL} = density of convective layer (kg/m^3)

ρ_{WNCL} = density of saturated non-convective layer (kg/m^3)

τ_{WNCL} = representative yield stress of saturated non-convective layer (Pa)

ε_y = nonconvective layer strain at failure (assumed to be 1).

Only saltcake/salt slurry tanks have exhibited BDGRE behavior. For reasons given in Section 2.4, the energy ratio is considered valid for both saltcake/salt slurry and sludge tanks.

An energy ratio of 3 is the decision criterion currently specified in PNNL-13781, *Effects of Globally Waste-Disturbing Activities on Gas Generation, Retention, and Release in Hanford Waste Tanks*.

Buoyancy Ratio: This is a semi-empirical relation presented in PNNL-13337, *Preventing Buoyant Displacement Gas Release Events in Hanford Double-Shell Waste Tanks*, and updated in PNNL-15238, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Waste Tanks,* which estimates the average waste gas fraction based on a balance of gas generation and background release. The buoyancy ratio represents the average saturated settled solids (nonconvective) layer gas fraction divided by the neutral buoyancy gas fraction. This physics-based buoyancy model was developed from the theory of bubble transport. This model predicts whether there is sufficient gas build up in the saturated settled solids layer in a DST to make gobs of waste buoyant and produce BDGREs (PNNL-13337). If the average void fraction in the saturated settled solids layer of waste is less than the neutral buoyant void fraction, a BDGRE cannot occur. Conversely, an average void fraction greater than the neutral buoyant void fraction predicts that BDGREs will occur prior to reaching steady state. The ratio of the average steady-state void fraction to the neutral buoyant void fraction for the case of constant nucleation is given by Equation 7. The constant in the numerator of the first factor is adjusted so that the minimum buoyancy ratio for DSTs experiencing BDGREs is 1.00. In this report, DST 241-AN-103 is used to calculate the constant.

Buoyancy Ratio Criterion BR: BR < 1

$$BR = \left(\frac{CF}{\rho_{WNCL} - \rho_{CL}}\right) * \left(\frac{\frac{HG_{WNCL}}{[H_2]_{RG}} * T_{WNCL}}{P_{WNCL}}\right)^{\frac{1}{3}} * H_{WNCL}^{\ 2} \qquad (7)$$

$[H_2]_{RG}$ = hydrogen concentrations in the retained gas in nonconvective layer (vol%)

BR = buoyancy ratio, the average saturated settled solids layer gas fraction divided by the neutral buoyancy gas fraction. This ratio predicts whether there is sufficient gas buildup in the saturated settled solids layer in a DST to make gobs of waste buoyant and produce BDGREs

CF = calibration factor contains all the constants along with unknowns, determined empirically from tank data [set to 1,075 (kg/m^4) $(day\text{-}Pa/mole\text{-}K)^{1/3}$ or 23.059 (kg/m^4) $(day\text{-}atm/mole\text{-}K)^{1/3}$]

HG_{WNCL} = hydrogen generation rate (HGR) in saturated settled solids layer $(moles/m^3/day)$

H_{WNCL} = height of liquid saturated non-convective layer (m)

P_{WNCL} = calculated representative retained gas pressure in saturated settled solids layer in atm or Pa (N/m^2)

T_{WNCL} = representative temperature of saturated settled solids layer (K)

ρ_{CL} = density of convective layer (kg/m^3)

ρ_{WNCL} = density of saturated non-convective layer (kg/m^3).

Note 1: Temperatures used are the maximum temperatures recorded over the previous 12 months within the solid waste or within the vapor space as appropriate and are obtained from RPP-5926, Rev. 5.

Note 2: Uncertainty distributions are utilized to account for the scatter of retained gas volumes in the waste and uncertainty in the solid volumes. Void fraction distributions are based on all available VFI data, RGS data, and appropriate BPE data.

Note 3: The calibration factor (CF) is $(3/16)(N^{2/3} R^{1/3} m_\tau/(SKg))$ and includes the parameters N (the bubble nucleation rate per unit volume), R (the gas constant), m_τ (the slope of the yield stress versus depth curve representing the ball rheometer data), S (the proportionality constant in Stokes flow), K (the unknown proportionality constant between the unknown effective viscosity and the yield stress), and g (acceleration due to gravity).

Note 4: The total gas generation, G, in buoyancy ratio (Equation 7) is estimated by the HGR divided by the fraction of hydrogen generation. However, the data of hydrogen fraction in retained gas is used because of the lack of data on the hydrogen generation fraction in total gas generation.

Traditionally, other criteria, such as the Estey Criteria described in WHC-SD-WM-TI-755, *An Analysis of Parameters Describing Gas Retention/Release Behavior in Double Shell Tank Waste*, and waste specific gravity have been used to predict BDGRE behavior in the DSTs (RPP-6517). The buoyancy ratio includes as input parameters the layer depths and densities making up the average specific gravity of the waste that are the basis of the Estey criterion. However, it also includes the other terms that model the underlying physics of BDGRE behavior (PNNL-13337). In application, this model accurately separates the known BDGRE and non-BDGRE tanks with current data. For these reasons, the buoyancy ratio is considered the best discriminator for BDGRE behavior. Use of the other criteria along with the buoyancy ratio does not improve the overall accuracy of the prediction.

The buoyancy ratio criterion is not applicable for SSTs since it is a semi-empirical relation based on BDGRE experience in DSTs. Therefore, large water additions (> 10,000 gal for 100-series tanks, > 1,000 gal for 200-series tanks) to SSTs that could lead to failing the first two criteria (i.e., retained gas volume and energy ratio) are prohibited until re-evaluated. This prevents the creation of an SST with an unknown and unanalyzed GRE flammable gas hazard.

The buoyancy ratio model is very sensitive at conditions where the convective layer and nonconvective layer densities are very close. Layer buoyancy is very dependent on the amount of gas required to balance (or overcome the balance of) the densities of the two layers. Physically, as the densities of the two layers invert, the nonconvective layer will become buoyant and will rise to the surface releasing its gas. It should be noted that the nonconvective layer also has to have sufficient potential energy to overcome the yield strength of the solid particles to release as a gob.

2.2 SELECTION OF BUOYANCY RATIO CALIBRATION FACTOR

The buoyancy ratio was developed to describe the relationship between DSTs that historically exhibited BDGRE behavior. It was found that tanks exhibiting BDGRE behavior have a relationship between the average saturated settled solids layer gas fraction and the neutral buoyancy gas fraction that is greater than the ratio of these values determined for tanks that never exhibited BDGREs. This buoyancy ratio is used to predict whether there is sufficient gas buildup in the saturated settled solids layer in a DST to make gobs of waste buoyant and produce BDGREs. It was determined that tanks with documented BDGREs would have buoyancy ratios greater than 1 (where the calibration factor was set such that the lowest buoyancy ratio for a tank exhibiting BDGRE behavior would be unity) (PNNL-13337).

The buoyancy ratio calibration factor is set based on the median properties for each DST which exhibits BDGRE behavior. However, whether or not a tank is classified as a waste group A tank is based on the 95% confidence level for a given set of current tank conditions (the Monte Carlo analysis). The methodology for calculating convective layer densities has changed since the 1990s and has been incorporated in the rebaselined buoyancy ratio calibration factor. In addition, there have been some changes in the method used to determine the convective layer specific gravities due to adjustments when dealing with solids that precipitate upon sample cooling after removal from the tank. The results of this calibration factor determination will be used for all future waste group analyses unless there is a significant change in the buoyancy ratio formula.

For this analysis, the data in Table 2-1 is taken from the following sources: the total waste depth (RPP-6655), the nonconvective layer depth (PNNL-15238), the crust depth (RPP-6655), the convective layer depth (by difference), the layer densities (PNNL-15238), and the HGRs (RPP-5926, Rev. 0). In addition, the yield stress data and the percent void information are based on information currently used in this document. It was attempted to use the most representative data for the BDGRE tanks. Unfortunately, there is no single source that contains a complete waste data set in the form required for RPP-10006. The data provided in Table 2-1 is believed to be the most accurate property data for the BDGRE tanks and is used to determine the buoyancy ratio calibration factor. This data was first used to find the BDGRE tank with the lowest buoyancy ratio and then the calibration factor was adjusted until the buoyancy ratio calibration factor equaled 1. DST 241-AN-103 was determined to be the BDGRE tank with the lowest buoyancy ratio. The calibration factor was tuned to 1,075 (kg/m^4) (day-Pa/mole-K)$^{1/3}$ where the buoyancy ratio for 241-AN-103 equaled 1. The results of the buoyancy ratio calculation for all the five historical BDGRE tanks are presented in Table 2-1. Table 2-2 compares the buoyancy ratio for the five current waste group A tanks calculated using the calendar year 2000 data used to derive the calibration factor to the buoyancy ratio calculated with the calibration factor of 1,075 and with the current BBI and RPP-5926, Rev. 5, data to illustrate how the buoyancy ratio is decreasing with time. A significant portion of the decrease is due to radioactive decay as time passes.

Table 2-1. Data Specific to Buoyancy Ratio Calibration. (3 sheets)

Tank	Median buoyancy ratio with calibration factor = 1075	Total waste depth (m)[a]	Total waste depth uncertainty (m)[b]	Total nonconvective waste depth (m)[c]	Total nonconvective waste depth uncertainty (m)[c]
241-AN-103	1.00	8.84	0.080	3.79	0.290
241-AN-104	1.75	9.79	0.035	3.96	0.310
241-AN-105	2.13	10.41	0.050	4.36	0.154
241-AW-101	1.46	10.40	0.100	2.89	0.287
241-SY-103	1.87	6.91	0.065	3.26	0.395
Tank	**Total nonconvective waste depth lower bound (m)[d]**	**Wetted nonconvective waste depth (m)[e]**	**Wetted nonconvective waste depth uncertainty (m)[e]**	**Wetted nonconvective waste depth lower bound (m)[e]**	**Convective waste depth (m)[f]**
241-AN-103	0.010	3.79	0.290	0.010	4.17
241-AN-104	0.010	3.96	0.310	0.010	5.42
241-AN-105	0.010	4.36	0.154	0.010	5.60
241-AW-101	0.010	2.89	0.287	0.010	6.71
241-SY-103	0.010	3.26	0.395	0.010	3.07

Table 2-1. Data Specific to Buoyancy Ratio Calibration. (3 sheets)

Tank	Convective waste depth uncertainty (m)	Mean crust depth (m)[a]	Convective waste density mean (kg/m^3)[g]	Convective waste density std dev (kg/m^3)[g]	Convective waste density min (kg/m^3)[g]
241-AN-103	NA	0.89	1,497	34	1,390
241-AN-104	NA	0.41	1,403	34	1,339
241-AN-105	NA	0.45	1,417	46	1,330
241-AW-101	NA	0.80	1,443	39	1,370
241-SY-103	NA	0.58	1,474	46	1,352

Tank	Convective waste density max (kg/m^3)[g]	Convective waste density dist (kg/m^3)[h]	Nonconvective waste density mean (kg/m^3)[i]	Nonconvective waste density std dev (kg/m^3)[i]	Nonconvective waste density min (kg/m^3)[i]
241-AN-103	1,559	Normal	1,733	106	1,590
241-AN-104	1,500	Normal	1,578	45	1,520
241-AN-105	1,534	Normal	1,585	45	1,520
241-AW-101	1,524	Normal	1,570	27	1,540
241-SY-103	1,529	Normal	1,592	40	1,510

Tank	Nonconvective waste density max (kg/m^3)[i]	Nonconvective waste density dist (kg/m^3)[h]	Void percent or maximum wetted solids void percent mean (%)[j]	Void percent or maximum wetted solids void percent uncertainty (%)[j]	Void percent or maximum wetted solids void percent minimum (%)[j]
241-AN-103	1,930	Normal	10.700	5.35	0.01
241-AN-104	1,710	Normal	6.200	3.1	0.01
241-AN-105	1,660	Normal	4.200	2.1	0.01
241-AW-101	1,600	Normal	4.700	2.35	0.01
241-SY-103	1,634	Normal	6.000	3.000	0.00

Tank	Void percent or maximum wetted solids void percent maximum (%)[j]	Void percent or maximum wetted solids void percent dist type (%)[j]	Nonconvective waste yield stress mean (Pa)[k]	Nonconvective waste yield stress std dev (Pa)[k]	Nonconvective waste yield stress min (Pa)[l]
241-AN-103	15.11	Normal	144	13.87	88.52
241-AN-104	15.11	Normal	144	13.87	88.52
241-AN-105	15.11	Normal	144	13.87	88.52
241-AW-101	15.11	Normal	144	13.87	88.52
241-SY-103	15.11	Normal	144	13.87	88.52

Table 2-1. Data Specific to Buoyancy Ratio Calibration. (3 sheets)

Tank	Nonconvective waste yield stress max (Pa)[m]	Nonconvective waste yield stress dist type (Pa)[k]	Hydrogen generation rate in nonconvective waste (moles/m^3/day)[n]	Hydrogen generation rate in nonconvective waste min (moles/m^3/day)[o]	Hydrogen generation rate in nonconvective waste max (moles/m^3/day)[p]
241-AN-103	199.48	Normal	1.26E-03	6.30E-04	2.52E-03
241-AN-104	199.48	Normal	1.62E-03	8.09E-04	3.24E-03
241-AN-105	199.48	Normal	2.02E-03	1.01E-03	4.04E-03
241-AW-101	199.48	Normal	1.82E-03	9.08E-04	3.63E-03
241-SY-103	199.48	Normal	1.68E-03	8.38E-04	3.35E-03

Notes:

[a] Source is RPP-6655, Table 5.1.

[b] Source is RPP-6655, Table 5.1. One-half of crust layer uncertainty (it is assumed that the crust is 50% submerged and only one-half of the uncertainty would be applied to the total waste depth).

[c] Source is PNNL-15238, Table 3.6.

[d] Value assumed to keep Monte Carlo within positive range.

[e] Value is set to the non-convective waste depth for tanks with a convective waste layer.

[f] Calculated by difference.

[g] Source is PNNL-15238, Table 3.2.

[h] It is assumed that the density samples are from a Normal distribution.

[i] Source is PNNL-15238, Table 3.3.

[j] Appendix D, Table D-13.

[k] Appendix F.

[l] Mean – (4 x standard deviation.)

[m] Mean + (4 x standard deviation.)

[n] Source is RPP-5926, Table A-3, converted to proper units.

[o] HGR(mean) / 2.

[p] HGR(mean) x 2.

PNNL-15238, 2005, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Waste Tanks*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

RPP-5926, 2000, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-6655, 2000, *Data Observations on Double-Shell Flammable Gas Watchlist Tank Behavior*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

NA = not applicable.

Table 2-2. Comparison of Buoyancy Ratio Results For Calibration Test and the Most Recent Tank Data for the Five Current Waste Group A Tanks.

Tank	Median buoyancy ratio with calibration factor = 1,075 CY 2000 calibration data	Median buoyancy ratio with calibration factor = 1,075 RPP-5926, Rev. 5, data
241-AN-103	1.00	0.82
241-AN-104	1.75	1.59
241-AN-105	2.13	1.75
241-AW-101	1.46	0.94
241-SY-103	1.87	1.13

Notes:

RPP-5926, 2005, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

CY = calendar year.

2.3 EXPLANATION OF HOW CRITERIA ARE USED

First the retained gas criterion is applied. If there is not enough retained gas in the waste to allow the tank headspace to reach 100% of the LFL, the tank "passes" and is classified as a waste group C tank. No further calculations are performed. If there is sufficient retained gas in the waste to allow the tank headspace to reach 100% of the LFL, the tank "fails." The retained gas criterion determines either that a tank is a waste group C tank (passes criterion) or it is a waste group A or B tank and the next criterion must be applied.

The energy ratio criterion is used next. The energy ratio criterion is the ratio of the buoyant potential energy for gas-bearing gobs to the energy required to yield the waste and release gas from those gobs participating in buoyant displacements. If the ratio is less than 3, the tank "passes" the criterion, the tank is classified as a waste group B tank, and no further calculations are performed. If the energy ratio is equal to or greater than 3, the buoyancy ratio criterion is applied. Failing the energy ratio criterion does not make a tank a BDGRE tank. It only says that there is enough buoyant potential energy to support a BDGRE if all the other factors are present. A tank that fails the energy ratio criterion is still a waste group A or waste group B tank and the next criterion is evaluated.

The buoyancy ratio criteria separates the waste group A and waste group B tanks. This criterion predicts whether there is sufficient gas buildup in the saturated settled solids layer in a DST to make gobs of waste buoyant and produce BDGREs. If the answer is yes, the tank "fails" and is classified as a waste group A tank. If the answer is no, the tank passes and is classified as a waste group B tank.

2.4 APPLICATION OF DATA TO SLUDGE TANKS

In 1996, PNNL-11391, *Gas Retention and Release Behavior in Hanford Single-Shell Waste Tanks*, reported the results of investigations into the gas retention and release behavior of SSTs. It was reported that, given the proper configuration of the materials in the tank, a buoyant displacement was possible in sludge-type materials. In practical experience at the Hanford Site, BDGREs have only been observed in tanks containing saltcake/salt slurry wastes with overlaying supernatant liquid.

The findings (PNNL-11391) were based on bench-scale experiments using Bentonite clay as a simulant for SST sludge materials. The tank used in the experiments was 27 cm in diameter. In the experiment, gases retained in the solids and driving the BDGREs were generated relatively quickly using the decomposition of hydrogen peroxide. The bench-scale observations were then used in the development of the energy ratio criterion, which was found to be applicable to tanks with a significant supernatant layer. When the energy ratio was applied to Hanford DST waste, it was found to be a good predictor of the energetics of buoyant displacements.

The only Hanford tanks to exhibit BDGRE behavior as predicted by the buoyancy ratio are tanks containing saltcake/salt slurry wastes. Because the Hanford tanks containing sludge materials have not historically warranted additional investigation into their behavior with respect to flammable gas retention and release, there is very little data pertaining to these tanks. It has not been demonstrated that the BDGRE prediction criteria, the energy ratio and the buoyancy ratio, apply to the sludge tanks. However, because the original experiments from which the theory of buoyant displacements was developed used sludge simulants, it is assumed that applying the energy criteria will provide a conservative estimation of the propensity of the sludge wastes to exhibit BDGRE behavior.

The buoyancy ratio has been developed using the physics of gas retention and release independent of waste type. The use of the buoyancy ratio to evaluate sludge tanks at the Hanford Site has only predicted non-BDGRE behavior in sludge tanks correctly. Since BDGREs are absent in sludge tanks, no method is available to calibrate the buoyancy ratio model to include sludge wastes. The effect of waste type is reflected by the calibration of the model, which is done on the set of saltcake/salt slurry BDGRE tanks at the Hanford Site.

3.0 CALCULATIONAL METHODOLOGY

Data on tank wastes is available from a variety of sources. Regardless of the database where data is extracted, tank waste information has a degree of uncertainty associated with its value. The size of property or measurement uncertainty is affected by a number of factors, such as the heterogeneous nature of the waste, uncertainties due to the analysis methodology and measuring devices, and incomplete or missing data. In order to account for uncertainty in the data, the values used in this study have been assigned distributions that reflect the uncertainty in the estimation of the various tank waste properties. To perform the calculations necessary to utilize data expressed as distributions, a statistical method known as the Monte Carlo methodology was utilized in this study.

3.1 MONTE CARLO METHODOLOGY

The Monte Carlo methodology is a statistical calculation method. In this method, parameters expressed as distributions are sampled repeatedly and the single-point calculation is run many times to produce a result that is a distribution accounting for the ranges of all of the individual data parameters. In the Monte Carlo analysis, the analyst selects the number of simulation runs to perform, 'n'. A random number table is produced, which allows the calculation to select 'n' discrete values from a given input distribution. These values are then used in 'sampled' order to perform the calculation. This process is repeated for each distribution in the calculation. After this selection is completed, 'n' values have been selected from each distribution. If 'n' is sufficiently large, the frequency of the selected values mirrors the frequency of the values in the original distribution. The 'sampled' values are then used in the order of selection (not in numerical order) in the single-point calculation. The results of the 'n' single-point calculations form a distribution that will reflect the combined uncertainties from the original data. One of the advantages of the Monte Carlo simulation is that bounding property data can be used in the evaluation, but the likelihood of bounding data for all properties to be used simultaneously is very small, therefore, physically unrealistic conditions are less likely to be the basis for a decision.

A confidence level of 95% was chosen for the selection criteria prior to the start of the evaluation in order not to presuppose the result of this analysis. Selecting a confidence level allows bounding property data to be used in the evaluation. While the likelihood of a Monte Carlo simulation result using bounding data for all properties simultaneously is very small, providing a confidence level will limit decisions based on combinations of many physically bounding conditions. On the other hand, the possibility of making a nonconservative waste group assignment is reduced by the conservative assumption that 100% of the gas is released. Past experience with all tanks indicates that the largest observed gas release is on the order of 56% of the retained gas (see Section 1.2). Except for releases from DST 241-SY-101 (preremediation), the largest gas release reported in RPP-7771 was 19% in DST 241-AW-101 (see Section 1.2, Table 1-1).

3.2 RANDOM NUMBER SEED SENSITIVITY TEST

This evaluation includes distributions with uncertainties for 13 parameters. The uncertainty accounts for variability in waste measurements, waste properties, and retained gas volumes and compositions. Each analysis is performed with 5,000 trials. This involves 5,000 randomly sampled values from each of the 13 distributions for a total of 65,000 data points. These values are then combined in the order they are sampled and are used in the model calculation to create a population of results with 5,000 answers that are combined to produce the result distributions. If the number of runs selected is large enough, the results of the Monte Carlo simulation can be run many times with different sets of randomly selected values and the resulting distribution will vary within limits acceptable to the analysis. To test the stability or reproducibility of the model, DST 241-SY-103 and SST 241-TX-105 were selected for evaluation. These tanks are the tanks closest to the boundary between waste groups A and B for DSTs and B and C for SSTs, respectively.

The stability test checks the operation of the model using different "seed" numbers from the random number generation algorithm. This study ran the DST 241-SY-103 and SST 241-TX-105 models 50 times each, with 5,000 trials per run. Fifty 5,000-trial runs equates to 250,000 trials using 3,250,000 data points.

The initial analysis (5,000 trials) for DST 241-SY-103 resulted in 2.38% of the trials indicating tank 241-SY-103 is a waste group A tank, 5.6% indicating waste group B, and 92.02% indicating waste group C. Since less than 95% of the trials were classified as a waste group C tank, DST 241-SY-103 would not be a waste group C tank but would be either a waste group B or waste group A tank. Since less than 5% of the trials indicated the tank would be a waste group A tank, DST 241-SY-103 would be classified as a waste group B tank. The stability test gave a mean value of 2.33% waste group A and a median value of 2.33% waste group A. The range of results of 0.76% (1.96% A to 2.72% A) for 5,000 trials is adequate for a screening criteria. Based on the stability test, DST 241-SY-103 would be classified as a waste group B tank 50 times; the tank would be classified as a waste group A tank for the "as is" case zero times. As a further stability test, 25 runs, with 50,000 trials per run, were performed. This test gave a mean and median value of 2.33% and 2.35% waste group A. The range of results was reduced to 0.24% (2.18% A to 2.42% A) for the 25 50,000 trial runs. Table 3-1 summarizes the stability tests for this tank.

The results for SST 241-TX-105 are shown in Table 3-1. The initial analysis (5,000 trials) for SST 241-TX-105 resulted in 95.04% of the trials indicating that tank SST 241-TX-105 is a waste group C tank. The stability test gave a mean value of 94.64% waste group C and a median value of 94.65% in waste group C, thus the conclusion of the stability test is that SST 241-TX-105 is a waste group B tank. The range of the results of the stability test for SST 241-TX-105 is about 1.2% (94.00% C to 95.20% C).

Table 3-1. Stability Test Results.

Tank	**DST 241-SY-103**	**SST 241-TX-105**
Value tracked	Confidence level tank is a waste group A tank	Confidence level tank is a waste group C tank
Initial run	2.38 (this value is less than the 5 required to classify this tank as a waste group A tank)	95.04 (this value is more than the 95 required to classify this tank as a waste group C tank)
	"As is"	**"As is"**
Number of repetitions	50	50
Number of trials per repetition	5,000	5,000
Mean	2.33	94.64
Median	2.33	94.65
Standard deviation	0.18	0.27
Minimum	1.96	94.00
Maximum	2.72	95.20
Range of results	0.76	1.20
Number of repetitions	25	NA
Mean	3.39	
Median	2.35	
Minimum	2.18	
Maximum	2.42	
Range of results	0.24	

Notes:

The confidence level that DST 241-SY-103 is a waste group A tank is less than 5%.

DST = single-shell tank.
NA = not applicable.
SST = single-shell tank.

Based on the range of results for both DST 241-SY-103 and SST 241-TX-105, any screening run result that is within 1.5 percentage points (the maximum range rounded up to the nearest 0.5%) of 95% or within 1.5 percentage points of 5% if testing for waste group A, should be rerun with 50,000 trials. In the second run of 50,000 trials, any case within 0.5 percentage points of 95% (or 5% for waste group A) (the range rounded up to the nearest 0.5%) should be classified as the more conservative waste group.

As a result of these sensitivity studies and the uncertainty of the results, any result testing for waste group B or C, DST or SST, within 1.5 percentage points of 95% (between 95 to 96.5%) should be rerun using 50,000 trials. For the 50,000 trial rerun, any case within 0.5 percentage points of 95% (between 95 to 95.5%) should be classified as the more conservative waste group.

3.3 APPLICATION OF CRYSTAL BALL[4]

Crystal Ball is an Excel[5] add-in, which performs data sampling and handling for the Monte Carlo simulation. Appropriate distributions are selected and defined as assumptions in the Crystal Ball analysis. The model-calculated results of interest are determined and defined as forecast values. The number of runs and random number seed value (optional) are also selected to control the selection of random numbers and termination of the program. Crystal Ball will generate a table of random numbers sufficiently large to randomly sample all distributions once for each run. The number of random numbers in the table is the product of the number of distributions times the number of runs. Crystal Ball will then sample each distribution based on its random number and perform the model calculation once for each run. The individual run results are kept and a product or forecast distribution is calculated at the completion of the simulation. Crystal Ball can graphically display the forecast distributions as the runs are performed and then produce a report as desired.

3.4 ASSUMPTIONS

The following assumptions are used in this methodology.

- Gas releases are rapid with respect to the ventilation rate.
- One hundred percent of the gas is released.
- The BDGRE models apply to sludge-waste tanks.
- An energy ratio of 3 indicates that a BDGRE is capable of releasing retained gas. Experimental data and tank observations indicate that an energy ratio of 5 or greater is required to produce a significant gas release.
- In-situ measurements of yield stress are not readily available. The distribution for yield stress is conservative towards favoring BDGRE behavior as indicated by the energy ratio.
- Assume the gas is retained under hydrostatic conditions (the solids are self-supporting and only the convective layer and interstitial liquid contributes to the retained gas pressure).
- Assuming the headspace gas concentrations are proportional to retained gas concentrations may be a conservative assumption.
- Available void fraction information for sludge tanks with at least 1 m of supernatant is not sufficient for the creation of a distribution for this tank configuration. The default

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[4] Crystal Ball is a trademark of Decisioneering, Inc., Denver, Colorado.

[5] Excel is a trademark of Microsoft Corporation, Redmond, Washington.

void fraction derived for saltcake/salt slurry tanks with 1 m of liquid is assumed to be conservative for this tank configuration.

- Void fractions are considered constant in tanks that have been saltwell pumped when compared to the prepumping condition of the tank.
- Retained gas void fractions are bound by the neutral buoyancy void fraction in DSTs only.
- There is no correlation assumed between H_2 and NH_3 gas concentrations.
- The volume of waste, when less than the dish height, is assumed to be proportional to the height within the dish. When converting waste height to volume, this is conservative by overestimating the volume of waste and, therefore, overestimating the volume of retained gas when waste is contained only in the dish.
- The volume of waste, when less than the knuckle height, is assumed to be proportional to the height within the knuckle. When converting waste height to volume, this is conservative by overestimating the volume of waste and, therefore, overestimating the volume of retained gas when waste is contained only in the knuckle.

3.5 SOFTWARE USED

The calculations performed to establish the waste group assignments for RPP-10006, Rev. 5, are performed primarily using spreadsheets developed in Microsoft Excel 2003. These spreadsheets compile data, determine ranges of uncertainty, establish distributions to represent the uncertainty, and perform the final waste group calculations. The final spreadsheet used to perform the waste group calculations contains the Excel add-in software Crystal Ball described in Section 3.3, which performs the data sampling and handling for the Monte Carlo simulation that is used to determine the confidence level of the waste group assignment. Figure 3-1 illustrates the hierarchy of the spreadsheets and macros for RPP-10006, Rev. 5. Full details of each spreadsheet used to perform the data manipulation and calculations for RPP-10006, Rev. 5, are provided in the documents listed below.

Spreadsheet Verification Form Number: SVF-1112, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: SVF-1112 All Solids R0.xls
Document: RPP-29166, *Spreadsheet Description Document for SVF-1112 All Solids R0.xls*
Author: J. M. Conner
Purpose: Double-shell tank nonconvective layer depth determination

Spreadsheet Verification Form Number: SVF-1117, *Spreadsheet Verification and Release Form for Spreadsheet 'RPP-10006 R5 Tank Physical Data 060208.xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: RPP-10006 R5 Tank Physical Data 060208.xls.
Document: RPP-29121, *Spreadsheet Description Document for RPP-10006 R5 Tank Physical Data 060208.xls*
Author: V. S. Anda
Purpose: Determination and compilation of the tank physical property data

Spreadsheet Verification Form Number: SVF-1118, *Spreadsheet Verification and Release Form for Spreadsheet 'RPP-10006 Rev 5 Data Rebuild 060306.xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: RPP-10006 Rev 5 Data Rebuild 060306.xls.
Document: RPP-29167, *Spreadsheet Description Document for RPP-10006 Rev 5 Data Rebuild 060306.xls*
Author: V. S. Anda
Purpose: Compilation of tank property data and source of data for RPP-10006 database

Spreadsheet Verification Form Number: SVF-1123, *Spreadsheet Verification and Release Form for Spreadsheet ' RPP-5926 Rev 5 Update for BDGRE.xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: RPP-5926 Rev 5 Update for BDGRE.xls
Document: Appendix E, *Hydrogen Generation Rates Calculations for Buoyant Displacement Gas Release Event Criteria Determinations*
Author: T. A. Hu
Purpose: Calculates HGR for tank wastes where solids were recently found

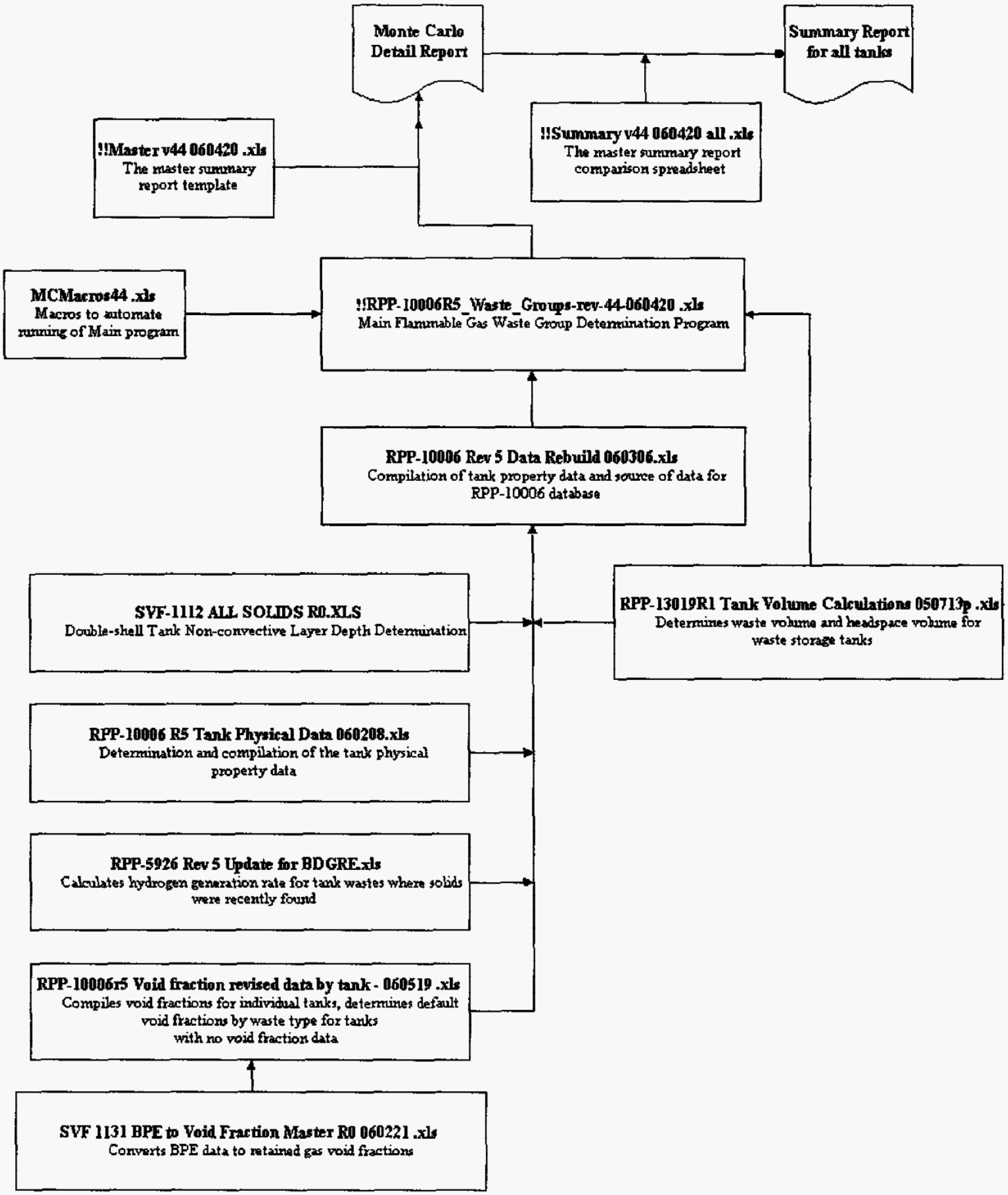
Spreadsheet Verification Form Number: SVF-1127, *Spreadsheet Verification and Release Form for Spreadsheet '!!RPP-10006R5_Waste_Groups-rev-44-060420 .xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: !!RPP-10006R5_Waste_Groups-rev-44-060420 .xls
Document: RPP- 29581, *Spreadsheet Description Document For '!!RPP-10006R5_Waste_Groups-rev-44-060420 .xls'*
Author: S. A. Barker
Purpose: Calculates flammable gas waste group for waste configurations

Spreadsheet Verification Form Number: SVF-1131, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF 1131 BPE to Void Fraction Master R0 060221 .xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: SVF 1131 BPE to Void Fraction Master R0 060221 .xls
Document: RPP-29388, *Spreadsheet Description Document For 'SVF 1131 BPE to Void Fraction Master R0 060221 .xls'*
Author: S. A. Barker
Purpose: Converts BPE data to retained gas void fractions

Spreadsheet Verification Form Number: SVF-1132, *Spreadsheet Verification and Release Form for Spreadsheet ' RPP-10006r5 Void fraction revised data by tank - 060519 .xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: RPP-10006r5 Void fraction revised data by tank - 060519 .xls
Document: RPP-29389, *Spreadsheet Description Document For 'RPP-10006r5 Void fraction revised data by tank - 060519 .xls'*
Author: S. A. Barker
Purpose: Compiles void fractions for individual tanks, determines default void fractions by waste type for tanks with no void fraction data

Spreadsheet Verification Form Number: SVF-1138, *Spreadsheet Verification and Release Form for Spreadsheet 'RPP-13019R1 Tank Volume Calculations 060711u .xls and RPP-13019R1 Tank Volume Calculations 060711p .xls' Data only*, and SVF-1139, *Spreadsheet Verification and Release Form for Spreadsheet 'RPP-13019R1 Tank Volume Calculations 060711u .xls and RPP-13019R1 Tank Volume Calculations 060711p .xls'*
Base Software: Microsoft Excel 2003
Spreadsheet Title: RPP-13019R1 Tank Volume Calculations 060711u .xls and
Spreadsheet Title: RPP-13019R1 Tank Volume Calculations 060711p .xls
Document: RPP-13019, *Determination of Hanford Waste Tank Volumes*, Rev. 1
Author: S. A. Barker
Purpose: Determines waste volume and headspace volume for waste storage tanks. Note that both spreadsheets are equivalent with protection and hidden cells being the sole differences.

Figure 3-1. RPP-10006, Rev. 5, Spreadsheet and Macro Hierarchy.



4.0 SOURCES OF INPUT DATA AND HIERARCHY

The *Best-Basis Inventory* (BBI) database is the preferred database for waste characterization information. This database is used whenever possible to maintain consistency between various engineering documents produced by Hanford Site contractors. For this evaluation, the BBI database was queried on September 21, 2005 (from RPP-5926, Rev. 5) and February 1, 2006 (for active retrieval tanks). The September 21, 2005, BBI data were used in the preparation of RPP-5926, Rev. 5. Data not available in the BBI, such as vapor data, were obtained from other sources as described below. A summary of the input data required for this evaluation and the primary source for that information is presented in Table 4-1. A table of the specific input data used for this evaluation is provided in Appendix H.

Table 4-1. Data Source Summary Table.

Variable	Variable type	Primary source of information
Total nonconvective waste depth	Distribution	Appendix C
Saturated nonconvective waste depth	Distribution	Appendix C
Total waste depth	Distribution	Appendix C
Crust depth	Distribution	Appendix C
Nonconvective waste density	Distribution	Appendix B
Convective waste density	Distribution	Appendix B
Nonconvective waste average temperature	Single point value	RPP-5926 and Appendix E
Tank headspace average temperature	Single point value	RPP-5926 and Appendix E
Tank dimensions	Single point values	RPP-13019
DST OSD design limit	Single point value	OSD-T-151-00007
SST OSD design limit	Single point value	OSD-T-151-00013
Void fraction or maximum saturated solids void fraction	Distribution	Appendix D
Nonconvective waste yield stress	Distribution	Appendix F
Retained gas ratio CH_4	Distribution	Appendix G
Retained gas ratio N_2O	Distribution	Appendix G
Retained gas composition N_2	Distribution	Appendix G
Retained gas composition NH_3	Distribution	Appendix G
Hydrogen generation rate in nonconvective waste	Distribution	RPP-5926 and Appendix E

Notes:

OSD-T-151-00007, 2005, *Operating Specifications for the Double-Shell Storage Tanks*, Rev. J-0, CH2M HILL Hanford Group, Inc., Richland, Washington.

OSD-T-151-00013, 2005, *Operating Specifications for Single-Shell Waste Storage Tanks*, Rev. F-2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-5926, 2005, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13019, 2006, *Determination of Hanford Waste Tank Volumes*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

DST = double-shell tank.

SST = single-shell tank.

The document RPP-5926, Rev. 5 (September 21, 2005, BBI database), is the default source of data for the waste and tank characteristic information. The information obtained from RPP-5926, Rev. 5, includes waste layer depth information, waste layer density information, waste temperatures, and headspace temperatures. Uncertainty information for the BBI data was obtained from RPP-7625, *Best-Basis Inventory Process Requirements*. Data pertaining to the tanks that display buoyant displacement behavior were obtained from RPP-6655 and PNNL-15238. Updates of waste characteristics for these tanks can be obtained from the BBI database. However, the time the sample was taken for analysis in relationship to the BDGRE event can affect the results of the analysis. Retained gas volumes may be reduced in BDGRE tanks following a BDGRE, where the property data can cause misleading results in a waste tank grouping evaluation. Tank dimensions are based on updated tank volume calculations presented in RPP-13019.

For characterization information that is not included in the BBI database, or for information with values that are uncertain, the information is expressed as distributions. PNNL reported yield stress data for six tanks (DSTs 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, 241-SY-103, and 241-SY-101 [premitigation]) based on in-situ ball rheometer testing (RPP-6655). A suitable distribution based on this data was suggested by PNNL (Appendix F).

Gas composition data and void fraction information is not available in the BBI database. Gas composition data distributions are based on RGS results and can be found in Appendix G. The void fraction distributions were completely redone in Revision 5 of RPP-10006. The revised BPE model void fractions are based on previously unused data prepared by PNNL (RPP-15488, *Investigation of Tank Void Fraction Using Liquid Level Response to Atmospheric Pressure Changes*) for all tanks with Enraf-Nonius Series 854 level gauges (ENRAF) surface level measurements in 2000 (see Appendix D). Information from Appendix D and Appendix H includes the results of a statistical evaluation that generates a distribution for the void fraction and retained gas composition for tanks where no data is available. For tanks where gas composition data is available, the RGS measured gas compositions are used. For tanks with acceptable void fraction measurements, such as VFI data or good BPE data, the void fraction used in this evaluation is the measured value.

Current individual tank HGRs are supplied by RPP-5926, Rev. 5. In addition, Appendix E reports updated mean HGRs for several tanks which previously did not have a nonconvective layer reported or where the nonconvective layer is significantly different than that reported in RPP-5926, Rev. 5. Due to the limited amount of data available, it is assumed that a triangular distribution adequately describes the true distribution. The current HGR mean data, the magnitude of the individual tank HGR, and the information below from Appendix E is used to describe the triangular distribution with appropriate upper and lower bounds. Note that the model estimated HGR is the total HGR for the tank. It is assumed that the nonconvective layer HGR has the same upper and lower bound relationships as used for the specific tank's total HGR even though the RPP-10006 model only uses the nonconvective layer HGR.

Model Estimated HGR	Upper Bound	Lower Bound
$HGR_{est} \geq 1.5E\text{-}03$ (ft^3/min)	1.10 * HGR_{est}	HGR_{est} / 3
1.5E-03> $HGR_{est} \geq 1.0E\text{-}03$ (ft^3/min)	1.50 * HGR_{est}	HGR_{est} / 2
1.0E-03 (ft^3/min) > HGR_{est}	1.90 * HGR_{est}	HGR_{est} / 2

Due to the nature of various waste properties, some distributions are constrained to be sure that the sampled properties are in the range of expected values and also so that nonphysical conditions are not selected by the Monte Carlo sampler. There are two types of constraints used in this model: limits on property ranges and dynamically calculated controls on range values or interactions. The limits on property ranges for each distribution are listed in Appendix H. The constraints and dynamic controls are listed in Table 4-2.

Table 4-2. Monte Carlo Model Dynamic Constraints.

Variable	Constraint
Total waste depth	Constrained to tank operating limit
Total nonconvective waste depth	Constrained to total waste depth
Saturated nonconvective waste depth	Constrained to always be less than or equal to "total nonconvective waste depth"
Convective waste depth	Calculated by difference
Crust depth	No dynamic constraint
Convective waste density	No dynamic constraint
Nonconvective waste density offset	Set as the difference between the mean convective waste density and the mean nonconvective waste density with a standard deviation equal to the nonconvective waste density standard deviation.
Nonconvective waste density	Constrained to be greater than the convective waste density as it is set equal to the sum of the convective waste density and the nonconvective waste density offset.
Void fraction or maximum saturated solids void fraction	No dynamic constraint for SSTs. For DSTs the void fraction is dynamically limited to the α_{NB} void fraction.
Nonconvective waste yield stress	No dynamic constraint
Retained gas ratio CH_4	No dynamic constraint
Retained gas ratio N_2O	No dynamic constraint
Retained gas composition N_2	No dynamic constraint
Retained gas composition NH_3	No dynamic constraint
Hydrogen generation rate in nonconvective waste	No dynamic constraint

Notes:
DST = double-shell tank.
SST = single-shell tank.

In order to reflect the inter-dependency between convective and nonconvective waste densities, a nonconvective waste density offset distribution is created. The distribution is determined by setting its mean as the difference between the mean convective waste density and the mean nonconvective waste density with a standard deviation equal to the nonconvective waste density standard deviation. The nonconvective waste density is constrained to be greater than the convective waste density by setting the nonconvective waste density equal to the sum of the convective waste density and the nonconvective waste density offset.

The most complicated distribution is the void fraction distribution. Based on RPP-21336, *Flammable Gas Waste Group Assessment FY-2004-ENG-S-0133*, the truncation point of the void fraction distribution was changed to a distribution with a dynamic upper limit for DSTs. The buoyant GRE model reports that the retained gas void fraction in the nonconvective layer is limited by the neutral buoyancy void fraction. A simple dynamic distribution was created in Crystal Ball which calculates and then applies the limit to the void fraction distribution for each model iteration. This distribution is truncated on the upper end by the neutral buoyancy void fraction.

As the neutral buoyancy void fraction approaches the mean of the original distribution (is less than 0.1% greater than the mean when expressed as a percentage), the mean is adjusted to be equal to the neutral buoyancy void fraction (expressed in percent) minus 0.1%. This modification maintains the shape of the original distribution up to the truncation point. The modification of the distribution mean is performed for each trial in which the neutral buoyancy void fraction approaches or is less than the original distribution mean. This modification does not alter the shape of the original distribution and only affects the one trial.

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5.0 RESULTS OF CALCULATIONS

An evaluation of the SSTs and DSTs at the Hanford Site has been completed using the methodology presented in Section 3.0, and the input data documented in Appendix H. Three conditions are evaluated for each tank:

- Base tank condition as of the selected data date ("as is" case)
- "As is" case with an addition of 10,000 gal of water (10,000-gal water addition case) (1,000-gal addition for 200-series SSTs)
- "As is" case with an addition of 500 gal of 8M caustic (500-gal caustic addition case) (not performed for SSTs).

The last two cases are performed to determine if any tanks change classification as the result of the addition of modest amounts of water or caustic. These two cases demonstrate what can happen to the tank classification during normal operations as the result of a number of water flushes over time, or if caustic is added to the water flush for water conditioning purposes. An additional constraint was placed on the tanks related to these additions, near-full tanks were not allowed to exceed the tank operating limit for waste volume.

The result of the waste group evaluation is shown in Table 5-1, which gives the breakdown of the results of the 5,000 trials for each tank, and whether the result classifies the tank as a waste group A, B, or C for the "As is" case. The results reported for tanks 241-BY-111, 241-SX-104, and 241-TX-105 are based on the 50,000 trial results since the 5,000 trial results were within the range where the outcome is too close to determine the waste group based on the seed sensitivity test criteria (see Section 3.2).

5.1 WASTE GROUP ASSIGNMENTS

The methodology used in this waste classification evaluation indicates that if the tank exhibits category C behavior at the 95% confidence level or for 95% of the trials, the tank is classified as waste group C. If the tank exhibits category C behavior at less than the 95% confidence level, but exhibits combined category C and category B behavior at more than 95% confidence level, the tank is then classified as a waste group B tank. The remaining tanks, those that exhibit category A behavior for greater than 5% of the trials, are placed in the waste group A category.

This classification strategy can be demonstrated using examples from Table 5-1.

- DST 241-AN-101 exhibits category C characteristics for 100% of the trials – it is classified in waste group C.

- DST 241-AN-103 exhibits category C characteristics for 18.9% of the trials, category B characteristics for 58.7% of the trials, and category A characteristics for 22.5% of the trials – it is classified in waste group A.
- DST 241-AN-104 exhibits category C characteristics for 29.1% of the trials, category B characteristics for 11.7% of the trials, and category A characteristics for 59.2% of the trials – it is classified in waste group A.
- DST 241-AW-101 exhibits category C characteristics for 62.6% of the trials, category B characteristics for 27.2% of the trials, and category A characteristics for 10.2% of the trials – it is classified in waste group A.
- DST 241-AW-104 exhibits category C characteristics for 67.2% of the trials, category B characteristics for 32.8% of the trials, and category A characteristics for 0.02% of the trials – because it exhibits category B and C characteristics for 99.98% of the trials, it is classified in waste group B.
- SST 241-A-101 exhibits category C characteristics for 80.6% of the trials, category B characteristics for 19.4% of the trials, and category A characteristics for 0.0% of the trials – it is classified in waste group B.

Table 5-1. Determination of Waste Group Classification. (6 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

As is	Type	Waste type[a]	Category A (%)	Category B (%)	Category C (%)	"As is" waste category
241-AN-101	DST	SC/SS-LIQ	0	0	100	C
241-AN-102	DST	SC/SS-LIQ	0.56	20.3	79.1	B
241-AN-103	DST	SC/SS-LIQ	22.5	58.7	18.9	A
241-AN-104	DST	SC/SS-LIQ	59.2	11.7	29.1	A
241-AN-105	DST	SC/SS-LIQ	69.3	9.78	20.9	A
241-AN-106	DST	MIX-LIQ	0	0.08	99.92	C
241-AN-107	DST	SC/SS-LIQ	0	0	100	C
241-AP-101	DST	LIQ	0	0	100	C
241-AP-102	DST	SL-LIQ	0	0.48	99.5	C
241-AP-103	DST	SC/SS-LIQ	0	0	100	C
241-AP-104	DST	SC/SS-LIQ	0	0.22	99.8	C
241-AP-105	DST	SC/SS-LIQ	0	35.5	64.5	B
241-AP-106	DST	LIQ	0	0	100	C
241-AP-107	DST	SC/SS-LIQ	0	0	100	C
241-AP-108	DST	SC/SS-LIQ	0	35.3	64.7	B
241-AW-101	DST	SC/SS-LIQ	10.2	27.2	62.6	A
241-AW-102	DST	SL-LIQ	0	0	100	C

Table 5-1. Determination of Waste Group Classification. (6 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

As is	Type	Waste type[a]	Category A (%)	Category B (%)	Category C (%)	"As is" waste category
241-AW-103	DST	SL-LIQ	0	0	100	C
241-AW-104	DST	SC/SS-LIQ	0.02	32.92	67.06	B
241-AW-105	DST	SL-LIQ	0	0	100	C
241-AW-106	DST	SC/SS-LIQ	0.06	2.48	97.46	C
241-AY-101	DST	SL-NL	0	0	100	C
241-AY-102	DST	SL-LIQ	0	2.82	97.2	C
241-AZ-101	DST	SL-LIQ	0	0	100	C
241-AZ-102	DST	SL-LIQ	0	2.16	97.8	C
241-SY-101	DST	SC/SS-LIQ	0	0	100	C
241-SY-102	DST	SL-LIQ	0	0	100	C
241-SY-103[c]	DST	SC/SS-LIQ	2.38	5.6	92.02	A[c]
241-A-101	SST	SC/SS-NL	0	19.4	80.6	B
241-A-102	SST	SC/SS-NL	0	0	100	C
241-A-103	SST	SC/SS-NL	0	0	100	C
241-A-104	SST	SL-NL	0	0	100	C
241-A-105	SST	SL-NL	0	0	100	C
241-A-106	SST	MIX-NL	0	0	100	C
241-AX-101	SST	SC/SS-NL	0	0.16	99.84	C
241-AX-102	SST	SC/SS-NL	0	0	100	C
241-AX-103	SST	SC/SS-NL	0	0	100	C
241-AX-104	SST	SL-NL	0	0	100	C
241-B-101	SST	SC/SS-NL	0	0.02	99.98	C
241-B-102	SST	SC/SS-NL	0	0	100	C
241-B-103	SST	SC/SS-NL	0	0	100	C
241-B-104	SST	SL-NL	0	3.40	96.60	C
241-B-105	SST	SC/SS-NL	0	0.44	99.56	C
241-B-106	SST	SL-NL	0	0	100	C
241-B-107	SST	MIX-NL	0	1.72	98.28	C
241-B-108	SST	SC/SS-NL	0	0	100	C
241-B-109	SST	MIX-NL	0	0	100	C
241-B-110	SST	SL-NL	0	0.44	99.56	C
241-B-111	SST	SL-NL	0	0.32	99.68	C
241-B-112	SST	MIX-NL	0	0	100	C
241-B-201	SST	SL-NL	0	6.08	93.92	B
241-B-202	SST	SL-NL	0	5.6	94.4	B

Table 5-1. Determination of Waste Group Classification. (6 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

As is	Type	Waste type[a]	Category A (%)	Category B (%)	Category C (%)	"As is" waste category
241-B-203	SST	SL-NL	0	69.0	31.0	B
241-B-204	SST	SL-NL	0	67.0	33.0	B
241-BX-101	SST	SL-NL	0	0	100	C
241-BX-102	SST	SL-NL	0	0	100	C
241-BX103	SST	SL-NL	0	0	100	C
241-BX-104	SST	SL-NL	0	0	100	C
241-BX-105	SST	MIX-NL	0	0	100	C
241-BX-106	SST	SC/SS-NL	0	0	100	C
241-BX-107	SST	SL-NL	0	0.02	99.98	C
241-BX-108	SST	SL-NL	0	0	100	C
241-BX-109	SST	SL-NL	0	0.04	99.96	C
241-BX-110	SST	MIX-NL	0	0	100	C
241-BX-111	SST	SC/SS-NL	0	0	100	C
241-BX-112	SST	SL-NL	0	0	100	C
241-BY-101	SST	SC/SS-NL	0	14.5	85.5	B
241-BY-102	SST	SC/SS-NL	0	1.18	98.82	C
241-BY-103	SST	SC/SS-NL	0	34.3	65.7	B
241-BY-104	SST	SC/SS-NL	0	10.4	89.6	B
241-BY-105	SST	SC/SS-NL	0	32.3	67.7	B
241-BY-106	SST	SC/SS-NL	0	8.42	91.58	B
241-BY-107	SST	SC/SS-NL	0	1.28	98.72	C
241-BY-108	SST	SC/SS-NL	0	0.54	99.46	C
241-BY-109	SST	SC/SS-NL	0	12.8	87.2	B
241-BY-110	SST	SC/SS-NL	0	14.5	85.5	B
241-BY-111[b]	SST	SC/SS-NL	0	4.20	95.80	C[b]
241-BY-112	SST	SC/SS-NL	0	0	100	C
241-C-101	SST	SL-NL	0	0	100	C
241-C-102	SST	SL-NL	0	1.18	98.82	C
241-C-103	SST	SL-NL	0	0	100	C
241-C-104	SST	SL-NL	0	0.50	99.50	C
241-C-105	SST	SL-NL	0	0	100	C
241-C-106	SST	SL-NL	0	0	100	C
241-C-107	SST	SL-NL	0	0.36	99.64	C
241-C-108	SST	SL-NL	0	0	100	C
241-C-109	SST	SL-NL	0	0	100	C

Table 5-1. Determination of Waste Group Classification. (6 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

As is	**Type**	**Waste type**[a]	**Category A (%)**	**Category B (%)**	**Category C (%)**	**"As is" waste category**
241-C-110	SST	SL-NL	0	0.02	99.98	C
241-C-111	SST	SL-NL	0	0	100	C
241-C-112	SST	SL-NL	0	0	100	C
241-C-201	SST	SL-NL	0	0	100	C
241-C-202	SST	SL-NL	0	0	100	C
241-C-203	SST	SL-NL	0	0	100	C
241-C-204	SST	SL-NL	0	0	100	C
241-S-101	SST	MIX-NL	0	0.06	99.94	C
241-S-102	SST	SC/SS-NL	0	0	100	C
241-S-103	SST	SC/SS-NL	0	18.4	81.6	B
241-S-104	SST	MIX-NL	0	13.9	86.1	B
241-S-105	SST	SC/SS-NL	0	0.88	99.12	C
241-S-106	SST	SC/SS-NL	0	0.20	99.80	C
241-S-107	SST	SL-NL	0	0	100	C
241-S-108	SST	SC/SS-NL	0	8.68	91.32	B
241-S-109	SST	SC/SS-NL	0	12.1	87.9	B
241-S-110	SST	SC/SS-NL	0	33.9	66.1	B
241-S-111	SST	SC/SS-NL	0	38.8	61.2	B
241-S-112	SST	SC/SS-NL	0	0	100	C
241-SX-101	SST	MIX-NL	0	13.1	86.9	B
241-SX-102	SST	SC/SS-NL	0	11.2	88.8	B
241-SX-103	SST	SC/SS-NL	0	7.48	92.52	B
241-SX-104[b]	SST	MIX-NL	0	4.08	95.92	C[b]
241-SX-105	SST	SC/SS-NL	0	2.80	97.20	C
241-SX-106	SST	SC/SS-NL	0	1.84	98.16	C
241-SX-107	SST	SL-NL	0	0	100	C
241-SX-108	SST	SL-NL	0	0	100	C
241-SX-109	SST	SC/SS-NL	0	1.44	98.56	C
241-SX-110	SST	SL-NL	0	0	100	C
241-SX-111	SST	SL-NL	0	0	100	C
241-SX-112	SST	SL-NL	0	0	100	C
241-SX-113	SST	SL-NL	0	0	100	C
241-SX-114	SST	SL-NL	0	0	100	C
241-SX-115	SST	SL-NL	0	0	100	C
241-T-101	SST	MIX-NL	0	0	100	C

Table 5-1. Determination of Waste Group Classification. (6 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

As is	Type	Waste type[a]	Category A (%)	Category B (%)	Category C (%)	"As is" waste category
241-T-102	SST	SL-NL	0	0	100	C
241-T-103	SST	SL-NL	0	0	100	C
241-T-104	SST	SL-NL	0	1.12	98.88	C
241-T-105	SST	SL-NL	0	0	100	C
241-T-106	SST	SL-NL	0	0	100	C
241-T-107	SST	SL-NL	0	0.02	99.98	C
241-T-108	SST	MIX-NL	0	0	100	C
241-T-109	SST	SC/SS-NL	0	0	100	C
241-T-110	SST	SL-NL	0	3.42	96.58	C
241-T-111	SST	SL-NL	0	8.82	91.18	B
241-T-112	SST	SL-NL	0	0	100	C
241-T-201	SST	SL-NL	0	6.82	93.18	B
241-T-202	SST	SL-NL	0	1.02	98.98	C
241-T-203	SST	SL-NL	0	16.4	83.6	B
241-T-204	SST	SL-NL	0	16.3	83.7	B
241-TX-101	SST	SL-NL	0	0	100	C
241-TX-102	SST	SC/SS-NL	0	0.26	99.74	C
241-TX-103	SST	SC/SS-NL	0	0	100	C
241-TX-104	SST	MIX-NL	0	0	100	C
241-TX-105[b]	SST	SC/SS-NL	0	5.33	94.67	B[b]
241-TX-106	SST	SC/SS-NL	0	12.3	87.7	B
241-TX-107	SST	SC/SS-NL	0	0	100	C
241-TX-108	SST	SC/SS-NL	0	0.02	99.98	C
241-TX-109	SST	SL-NL	0	0.72	99.28	C
241-TX-110	SST	SC/SS-NL	0	2.26	97.74	C
241-TX-111	SST	SC/SS-NL	0	3.32	96.68	C
241-TX-112	SST	SC/SS-NL	0	63.0	37.0	B
241-TX-113	SST	SC/SS-NL	0	26.1	73.9	B
241-TX-114	SST	SC/SS-NL	0	16.7	83.3	B
241-TX-115	SST	SC/SS-NL	0	35.4	64.6	B
241-TX-116	SST	SC/SS-NL	0	6.04	93.96	B
241-TX-117	SST	SC/SS-NL	0	0.46	99.54	C
241-TX-118	SST	SC/SS-NL	0	2.88	97.12	C
241-TY-101	SST	MIX-NL	0	0.02	99.98	C
241-TY-102	SST	SC/SS-NL	0	0	100	C

Table 5-1. Determination of Waste Group Classification. (6 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

As is	Type	Waste type[a]	Category A (%)	Category B (%)	Category C (%)	"As is" waste category
241-TY-103	SST	MIX-NL	0	0.16	99.84	C
241-TY-104	SST	SL-NL	0	0	100	C
241-TY-105	SST	SL-NL	0	0	100	C
241-TY-106	SST	SL-NL	0	0	100	C
241-U-101	SST	SL-NL	0	0	100	C
241-U-102	SST	SC/SS-NL	0	17.7	82.3	B
241-U-103	SST	SC/SS-NL	0	0	100	C
241-U-104	SST	SL-NL	0	0	100	C
241-U-105	SST	SC/SS-NL	0	13.0	87.0	B
241-U-106	SST	SC/SS-NL	0	0	100	C
241-U-107	SST	SC/SS-NL	0	1.5	98.5	C
241-U-108	SST	SC/SS-NL	0	56.5	43.5	B
241-U-109	SST	SC/SS-NL	0	0	100	C
241-U-110	SST	SL-NL	0	0	100	C
241-U-111	SST	SC/SS-NL	0	5.34	94.66	B
241-U-112	SST	SL-NL	0	0	100	C
241-U-201	SST	SL-NL	0	0	100	C
241-U-202	SST	SL-NL	0	0	100	C
241-U-203	SST	SL-NL	0	0	100	C
241-U-204	SST	SL-NL	0	0	100	C

Notes:
[a]See Appendix A
[b]Based on 50,000 trials
[c]241-SY-103 is reclassified as a waste group A (see discussion below).

DST = double-shell tank.
LIQ = deep liquid layer above solids, liquid layer is at least 1 m deep.
MIX = mixed waste, less than 75 vol% sludge or saltcake.
NL = no deep liquid layer above solids, liquid layer is less than 1 m deep.
SC/SS = saltcake/salt slurry solids, at least 75 vol% saltcake/salt slurry solids.
SL = sludge solids, at least 75 vol% sludge solids.
SST = single-shell tank.

Table 5-2 lists the six tanks that have a median buoyancy ratio near to or greater than 1. These tanks include the historic BDGRE tanks plus 241-AN-107, which, to date, has not exhibited BDGRE behavior. DSTs 241-AN-103, 241-AN-104, 241-AN-105, and 241-AW-101 exhibit BDGRE behavior and are waste group A tanks.

DST 241-SY-103 has physical properties and recorded observations which indicate BDGREs probably occur within the tank. The calculation results indicate that less than 3% of the trials result in waste group A because of the low probability of achieving 100% of the LFL if all the estimated retained gas is released into the tank headspace; therefore, DST 241-SY-103 is classified as a waste group B tank based on the model results (see also Section 3.2, Random Number Seed Sensitivity Test). However, BDGRE releases clearly and routinely occur within the tank (RPP-6655). In addition, should future solids level measurements in the tank indicate an increase in solids level since the last measurement in 2000 this would result in an increase in the calculated volume of retained gas in the tank and hence in the calculated probability of category A behavior. For these reasons DST 241-SY-103 will continue to be classified as a waste group A tank.

DST 241-AN-107 has a buoyancy ratio greater than 1 due to the small differences between the convective and nonconvective layer densities. However, it has a very low gas retention rate and has not exhibited any BDGRE behavior to date. The tank does not contain sufficient retained gas to reach 100% LFL and, therefore, is classified as a waste group C tank. Historically only DSTs 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, 241-SY-101 (premitigation), and 241-SY-103 have documented cases of BDGRE behavior (RPP-6655).

Table 5-2. Indicators of Buoyant Displacement Gas Release Event Behavior.
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

Tank	Tank type	[%A]	[%B]	[%C]	Energy ratio (dimensionless) (95%CL)	Buoyancy ratio (dimensionless) (Median)	Buoyancy ratio (dimensionless) (95%CL)
241-AN-103	DST	22.5	58.7	18.9	44	0.82	2.76
241-AN-104	DST	59.2	11.7	29.1	42	1.59	7.50
241-AN-105	DST	69.3	9.78	20.9	41	1.75	10.4
241-AN-107	DST	0	0	100	47	1.38	11.2
241-AW-101	DST	10.2	27.2	62.6	60	0.94	6.05
241-SY-103	DST	2.38	5.6	92.02	19	1.13	6.45

Notes:
95% CL = 95% confidence level.
DST = double-shell tank.
LFL = lower flammability limit.
NCL = nonconvective layer.

5.1.1 Double-Shell Tanks

As shown in Table 5-3, 19 of the 28 DSTs are currently classified as waste group C tanks. For these 19 DSTs, even if 100% of the retained gas is released, the headspace flammable gas concentration will not exceed 100% LFL at a 95% confidence level. Four DSTs, 241-AN-102, 241-AP-105, 241-AP-108, and 241-AW-104, are classified as waste group B tanks based on the model for the "as is" condition. Four DSTs, 241-AN-103, 241-AN-104, 241-AN-105, and 241-AW-101, based on this evaluation are classified as waste group A tanks. DST 241-SY-103 is classified as a waste group B tank based on the "as is" condition, however, due to the previously discussed concerns, 241-SY-103 is classified as a waste group A tank.

Table 5-3. Waste Group Assignments for Double-Shell Tanks.
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

Tank	Type	"As is" condition	10,000 gal H_2O addition	500 gal caustic addition
241-AN-101	DST	C	C	C
241-AN-102	DST	B	B	B
241-AN-103	DST	A	A	A
241-AN-104	DST	A	A	A
241-AN-105	DST	A	A	A
241-AN-106	DST	C	C	C
241-AN-107	DST	C	C	C
241-AP-101	DST	C	C	C
241-AP-102	DST	C	C	C
241-AP-103	DST	C	C	C
241-AP-104	DST	C	C	C
241-AP-105	DST	B	B	B
241-AP-106	DST	C	C	C
241-AP-107	DST	C	C	C
241-AP-108	DST	B	B	B
241-AW-101	DST	A	A	A
241-AW-102	DST	C	C	C
241-AW-103	DST	C	C	C
241-AW-104	DST	B	B	B
241-AW-105	DST	C	C	C
241-AW-106	DST	C	C	C
241-AY-101	DST	C	C	C
241-AY-102	DST	C	C	C
241-AZ-101	DST	C	C	C
241-AZ-102	DST	C	C	C
241-SY-101	DST	C	C	C
241-SY-102	DST	C	C	C
241-SY-103*	DST	A*	A*	A*

Notes:

* 241-SY-103 is reclassified as a waste group A (see discussion in Section 5.1).

DST = double-shell tank.

In all cases, additional liquids, up to 10,000 gal of water or 500 gal of 8M caustic, can be added to the DSTs during routine operations without affecting the waste groupings as summarized in Table 5-3.

5.1.2 Single-Shell Tanks

As provided in Table 5-4, 109 of the 149 SSTs are classified as waste group C tanks based on the "worst case" conditions. For these 109 tanks, even if 100% of the retained gas is released, the headspace flammable gas concentration will not exceed 100% LFL at a 95% confidence level. The remaining 40 tanks are classified as waste group B tanks, as the headspace flammable gas concentration can reach 100% of the LFL if all of the retained gas is released at a 95% confidence level. None of the SSTs that could reach 100% LFL in the headspace have energy ratios ≥ 3.

Table 5-4. Waste Group Assignments for Single-Shell Tanks. (3 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

Tank	Type	"As is" condition	10,000 gal water addition[a]	Tank	Type	"As is" condition	10,000 gal water addition[a]
241-A-101	SST	B	B	241-S-110	SST	B	B
241-A-102	SST	C	C	241-S-111	SST	B	B
241-A-103	SST	C	C	241-S-112	SST	C	C
241-A-104	SST	C	C	241-SX-101	SST	B	B
241-A-105	SST	C	C	241-SX-102	SST	B	B
241-A-106	SST	C	C	241-SX-103	SST	B	B
241-AX-101	SST	C	C	241-SX-104	SST	C[b]	B[b]
241-AX-102	SST	C	C	241-SX-105	SST	C	C
241-AX-103	SST	C	C	241-SX-106	SST	C	B
241-AX-104	SST	C	C	241-SX-107	SST	C	C
241-B-101	SST	C	C	241-SX-108	SST	C	C
241-B-102	SST	C	C	241-SX-109	SST	C	C
241-B-103	SST	C	C	241-SX-110	SST	C	C
241-B-104	SST	C	C	241-SX-111	SST	C	C
241-B-105	SST	C	C	241-SX-112	SST	C	C
241-B-106	SST	C	C	241-SX-113	SST	C	C
241-B-107	SST	C	C	241-SX-114	SST	C	C
241-B-108	SST	C	C	241-SX-115	SST	C	C
241-B-109	SST	C	C	241-T-101	SST	C	C
241-B-110	SST	C	C	241-T-102	SST	C	C
241-B-111	SST	C	C	241-T-103	SST	C	C
241-B-112	SST	C	C	241-T-104	SST	C	C
241-B-201	SST	B	B	241-T-105	SST	C	C
241-B-202	SST	B	B	241-T-106	SST	C	C
241-B-203	SST	B	B	241-T-107	SST	C	C
241-B-204	SST	B	B	241-T-108	SST	C	C
241-BX-101	SST	C	C	241-T-109	SST	C	C
241-BX-102	SST	C	C	241-T-110	SST	C	C
241-BX-103	SST	C	C	241-T-111	SST	B	B
241-BX-104	SST	C	C	241-T-112	SST	C	C

Table 5-4. Waste Group Assignments for Single-Shell Tanks. (3 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

Tank	Type	"As is" condition	10,000 gal water addition[a]	Tank	Type	"As is" condition	10,000 gal water addition[a]
241-BX-105	SST	C	C	241-T-201	SST	B	B
241-BX-106	SST	C	C	241-T-202	SST	C	C
241-BX-107	SST	C	C	241-T-203	SST	B	B
241-BX-108	SST	C	C	241-T-204	SST	B	B
241-BX-109	SST	C	C	241-TX-101	SST	C	C
241-BX-110	SST	C	C	241-TX-102	SST	C	C
241-BX-111	SST	C	C	241-TX-103	SST	C	C
241-BX-112	SST	C	C	241-TX-104	SST	C	C
241-BY-101	SST	B	B	241-TX-105	SST	B[b]	B[b]
241-BY-102	SST	C	C	241-TX-106	SST	B	B
241-BY-103	SST	B	B	241-TX-107	SST	C	C
241-BY-104	SST	B	B	241-TX-108	SST	C	C
241-BY-105	SST	B	B	241-TX-109	SST	C	C
241-BY-106	SST	B	B	241-TX-110	SST	C	C
241-BY-107	SST	C	C	241-TX-111	SST	C	B
241-BY-108	SST	C	C	241-TX-112	SST	B	B
241-BY-109	SST	B	B	241-TX-113	SST	B	B
241-BY-110	SST	B	B	241-TX-114	SST	B	B
241-BY-111	SST	C[b]	B[b]	241-TX-115	SST	B	B
241-BY-112	SST	C	C	241-TX-116	SST	B	B
241-C-101	SST	C	C	241-TX-117	SST	C	C
241-C-102	SST	C	C	241-TX-118	SST	C	C
241-C-103	SST	C	C	241-TY-101	SST	C	C
241-C-104	SST	C	C	241-TY-102	SST	C	C
241-C-105	SST	C	C	241-TY-103	SST	C	C
241-C-106	SST	C	C	241-TY-104	SST	C	C
241-C-107	SST	C	C	241-TY-105	SST	C	C
241-C-108	SST	C	C	241-TY-106	SST	C	C
241-C-109	SST	C	C	241-U-101	SST	C	C
241-C-110	SST	C	C	241-U-102	SST	B	B
241-C-111	SST	C	C	241-U-103	SST	C	C
241-C-112	SST	C	C	241-U-104	SST	C	C
241-C-201	SST	C	C	241-U-105	SST	B	B
241-C-202	SST	C	C	241-U-106	SST	C	C
241-C-203	SST	C	C	241-U-107	SST	C	C
241-C-204	SST	C	C	241-U-108	SST	B	B
241-S-101	SST	C	C	241-U-109	SST	C	C
241-S-102	SST	C	C	241-U-110	SST	C	C
241-S-103	SST	B	B	241-U-111	SST	B	B
241-S-104	SST	B	B	241-U-112	SST	C	C
241-S-105	SST	C	C	241-U-201	SST	C	C
241-S-106	SST	C	C	241-U-202	SST	C	C
241-S-107	SST	C	C	241-U-203	SST	C	C
241-S-108	SST	B	B	241-U-204	SST	C	C
241-S-109	SST	B	B				

Table 5-4. Waste Group Assignments for Single-Shell Tanks. (3 sheets)
(Based on "RPP-10006 Rev 5 Data Rebuild 060306.xls" data)

Tank	Type	"As is" condition	10,000 gal water addition[a]	Tank	Type	"As is" condition	10,000 gal water addition[a]

Notes:
[a]In 200-series tanks only 1,000 gal of water are added.
[b] Based on 50,000 trials.

SST = single-shell tank.

There are four tanks that change classification based on the addition of 10,000 gal (or 1,000 gal for 200-series tanks) of water to the tanks.

Since the current condition of SSTs precludes the formation of a waste group A tank (i.e., the tanks contain little or no supernatant) and since the tanks are inactive unless subject to retrieval, a routine annual re-evaluation of the SSTs will not occur in the future unless there is a significant change in tank properties, as identified from a review of published *Best-Basis Inventory* changes. The tanks will be re-evaluated prior to any planned retrieval activity.

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RPP-29166, 2006, *Spreadsheet Description Document For SVF-1112 All Solids R0.XLS*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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RPP-29389, 2006, *Spreadsheet Description Document For 'RPP-10006r5 Void fraction revised data by tank - 060519 .xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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SVF-1112, 2006, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

SVF-1117, 2006, *Spreadsheet Verification and Release Form for Spreadsheet 'RPP-10006 R5 Tank Physical Data 060208.xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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WHC-SD-WM-ER-594, 1996, *Evaluation of Recommendation for Addition of Tanks to the Flammable Gas Watch List*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

WASTE TYPE EVALUATION

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CONTENTS

TABLES

LIST OF TERMS

LIQ	liquid waste form
MIX-LIQ	mixed waste form with ≥ 1 m liquid over solids
MIX-NL	mixed waste form with < 1 m liquid over solids
SC/SS	saltcake/salt slurry
SC/SS-LIQ	saltcake/salt slurry waste form with ≥ 1 m liquid over solids
SC/SS-NL	saltcake/salt slurry waste form with < 1 m liquid over solids
SL	sludge
SL-LIQ	sludge waste form with ≥ 1 m liquid over solids
SL-NL	sludge waste form with < 1 m liquid over solids
vol%	volume percent

Peer Review Checklist (Calculation Review Checklist)

Calculation Reviewed: RPP-10006, Rev 5, Appendix A WASTE TYPE EVALUATION
Scope of Review: Appendix A text and tables
(e.g., document section or portion of calculation)

Engineer/Analyst: V. S. Anda [signature] Date: 7/25/06

Organizational Manager: M. A. Knight [signature] Date: 7/25/06

This document consists of 10 pages and the following attachments (if applicable):

n/a

Yes	No	NA*		
[X]	[]	[]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[X]	[]	[]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[X]	[]	[]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[X]	[]	[]	4.	Input data were checked for consistency with original source information.
[]	[]	[X]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[]	[]	[X]	6.	Mathematical derivations were checked, including dimensional consistency of results.
[]	[]	[X]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[X]	[]	[]	8.	Software verification and validation are addressed adequately.
[X]	[]	[]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[X]	[]	[]	10.	Conclusions are consistent with analytical results and applicable limits.
[X]	[]	[]	11.	Results and conclusions address all points in the purpose.
[X]	[]	[]	12.	Referenced documents are retrievable or otherwise available.
[X]	[]	[]	13.	The version or revision of each reference is cited.
[]	[]	[X]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[]	[]	[X]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[X]	[]	[]	16.	All checker comments have been dispositioned and the design media matches the calculations.

K. D. Fowler [signature] 7/25/06
Checker (printed name and signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.
This appendix is not a calculation and does not directly contain mathematical equations or input data with associated uncertainties. It presents a summary of requirements for waste type assignments as documented in the cited reference SNL-000198 and results of waste group assignments. The spreadsheet used to assign the waste groups is documented in the cited reference RPP-29121.
This appendix does not establish or alter any existing requirement or necessitate revisions to other documents.

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APPENDIX A

WASTE TYPE EVALUATION

A1.0 PURPOSE

This appendix presents the tank waste type assignments, as shown in Table A-1, based on the criteria in SNL-000198, *Flammable Gas Safety Analysis Data Review*. This evaluation updates the waste type information given in RPP-6171, *Determination of Waste Groupings For Safety Analyses*, based on updated Best-Basis Inventory data for the tanks. The waste types presented are used in assigning variables to complete the flammable gas waste group calculations.

A2.0 GROUPING CRITERIA

SNL-000198 identifies seven possible waste forms and criteria for waste type assignment. Table 1 presents the abbreviated waste types and definitions.

Table A-1. Waste Grouping Criteria, from SNL-000198, Section 2.2.2.

Waste Type	Definition
LIQ	Liquid waste with less than 3 vol% solids
MIX-LIQ	Mixed sludge-saltcake waste with ≥ 1 m liquid over solids
MIX-NL	Mixed sludge-saltcake waste with < 1 m liquid over solids
SC/SS-LIQ	Saltcake/salt slurry waste with ≥ 1m liquid over solids
SC/SS-NL	Saltcake/salt slurry waste with < 1m liquid over solids
SL-LIQ	Sludge waste with ≥ 1m liquid over solids
SL-NL	Sludge waste with < 1m liquid over solids

Note:
SNL-000198, 1999, *Flammable Gas Safety Analysis Data Review*, Rev. 0, Sandia National Laboratory, Albequerque, New Mexico.

Liquid waste tanks have at least 97 vol% liquids. Mixed waste tanks, with or without liquid, must be more than 3 vol% solids and the solids composition must be less than 70 vol% of either type of solids. Saltcake/salt slurry tanks, with or without liquid, have greater than 3 vol% solids and at least 70 vol% saltcake and/or salt slurry. Sludge tanks, with or without liquid, have greater than 3 vol% solids and at least 70 vol% sludge.

A3.0 WASTE TYPES

Table A-2 lists the assigned waste type for each tank.

Table A-2. Current Waste Types. (2 sheets)

Tank	Waste type, 2005 data	Tank	Waste type, 2005 data	Tank	Waste type, 2005 data
241-A-101	SC/SS-NL	241-BX-110	MIX-NL	241-SY-103	SC/SS-LIQ
241-A-102	SC/SS-NL	241-BX-111	SC/SS-NL	241-T-101	MIX-NL
241-A-103	SC/SS-NL	241-BX-112	SL-NL	241-T-102	SL-NL
241-A-104	SL-NL	241-BY-101	SC/SS-NL	241-T-103	SL-NL
241-A-105	SL-NL	241-BY-102	SC/SS-NL	241-T-104	SL-NL
241-A-106	MIX-NL	241-BY-103	SC/SS-NL	241-T-105	SL-NL
241-AN-101	SC/SS-LIQ	241-BY-104	SC/SS-NL	241-T-106	SL-NL
241-AN-102	SC/SS-LIQ	241-BY-105	SC/SS-NL	241-T-107	SL-NL
241-AN-103	SC/SS-LIQ	241-BY-106	SC/SS-NL	241-T-108	MIX-NL
241-AN-104	SC/SS-LIQ	241-BY-107	SC/SS-NL	241-T-109	SC/SS-NL
241-AN-105	SC/SS-LIQ	241-BY-108	SC/SS-NL	241-T-110	SL-NL
241-AN-106	MIX-LIQ	241-BY-109	SC/SS-NL	241-T-111	SL-NL
241-AN-107	SC/SS-LIQ	241-BY-110	SC/SS-NL	241-T-112	SL-NL
241-AP-101	LIQ	241-BY-111	SC/SS-NL	241-T-201	SL-NL
241-AP-102	SL-LIQ	241-BY-112	SC/SS-NL	241-T-202	SL-NL
241-AP-103	SC/SS-LIQ	241-C-101	SL-NL	241-T-203	SL-NL
241-AP-104	SC/SS-LIQ	241-C-102	SL-NL	241-T-204	SL-NL
241-AP-105	SC/SS-LIQ	241-C-103	SL-NL	241-TX-101	SL-NL
241-AP-106	LIQ	241-C-104	SL-NL	241-TX-102	SC/SS-NL
241-AP-107	SC/SS-LIQ	241-C-105	SL-NL	241-TX-103	SC/SS-NL
241-AP-108	SC/SS-LIQ	241-C-106	SL-NL	241-TX-104	MIX-NL
241-AW-101	SC/SS-LIQ	241-C-107	SL-NL	241-TX-105	SC/SS-NL
241-AW-102	SL-LIQ	241-C-108	SL-NL	241-TX-106	SC/SS-NL
241-AW-103	SL-LIQ	241-C-109	SL-NL	241-TX-107	SC/SS-NL
241-AW-104	SC/SS-LIQ	241-C-110	SL-NL	241-TX-108	SC/SS-NL
241-AW-105	SL-LIQ	241-C-111	SL-NL	241-TX-109	SL-NL
241-AW-106	SC/SS-LIQ	241-C-112	SL-NL	241-TX-110	SC/SS-NL
241-AX-101	SC/SS-NL	241-C-201	SL-NL	241-TX-111	SC/SS-NL
241-AX-102	SC/SS-NL	241-C-202	SL-NL	241-TX-112	SC/SS-NL
241-AX-103	SC/SS-NL	241-C-203	SL-NL	241-TX-113	SC/SS-NL

Table A-2. Current Waste Types. (2 sheets)

Tank	Waste type, 2005 data	Tank	Waste type, 2005 data	Tank	Waste type, 2005 data
241-AX-104	SL-NL	241-C-204	SL-NL	241-TX-114	SC/SS-NL
241-AY-101	SL-NL	241-S-101	MIX-NL	241-TX-115	SC/SS-NL
241-AY-102	SL-LIQ	241-S-102	SC/SS-NL	241-TX-116	SC/SS-NL
241-AZ-101	SL-LIQ	241-S-103	SC/SS-NL	241-TX-117	SC/SS-NL
241-AZ-102	SL-LIQ	241-S-104	MIX-NL	241-TX-118	SC/SS-NL
241-B-101	SC/SS-NL	241-S-105	SC/SS-NL	241-TY-101	MIX-NL
241-B-102	SC/SS-NL	241-S-106	SC/SS-NL	241-TY-102	SC/SS-NL
241-B-103	SC/SS-NL	241-S-107	SL-NL	241-TY-103	MIX-NL
241-B-104	SL-NL	241-S-108	SC/SS-NL	241-TY-104	SL-NL
241-B-105	SC/SS-NL	241-S-109	SC/SS-NL	241-TY-105	SL-NL
241-B-106	SL-NL	241-S-110	SC/SS-NL	241-TY-106	SL-NL
241-B-107	MIX-NL	241-S-111	SC/SS-NL	241-U-101	SL-NL
241-B-108	SC/SS-NL	241-S-112	SC/SS-NL	241-U-102	SC/SS-NL
241-B-109	MIX-NL	241-SX-101	MIX-NL	241-U-103	SC/SS-NL
241-B-110	SL-NL	241-SX-102	SC/SS-NL	241-U-104	SL-NL
241-B-111	SL-NL	241-SX-103	SC/SS-NL	241-U-105	SC/SS-NL
241-B-112	MIX-NL	241-SX-104	MIX-NL	241-U-106	SC/SS-NL
241-B-201	SL-NL	241-SX-105	SC/SS-NL	241-U-107	SC/SS-NL
241-B-202	SL-NL	241-SX-106	SC/SS-NL	241-U-108	SC/SS-NL
241-B-203	SL-NL	241-SX-107	SL-NL	241-U-109	SC/SS-NL
241-B-204	SL-NL	241-SX-108	SL-NL	241-U-110	SL-NL
241-BX-101	SL-NL	241-SX-109	SC/SS-NL	241-U-111	SC/SS-NL
241-BX-102	SL-NL	241-SX-110	SL-NL	241-U-112	SL-NL
241-BX-103	SL-NL	241-SX-111	SL-NL	241-U-201	SL-NL
241-BX-104	SL-NL	241-SX-112	SL-NL	241-U-202	SL-NL
241-BX-105	MIX-NL	241-SX-113	SL-NL	241-U-203	SL-NL
241-BX-106	SC/SS-NL	241-SX-114	SL-NL	241-U-204	SL-NL
241-BX-107	SL-NL	241-SX-115	SL-NL		
241-BX-108	SL-NL	241-SY-101	SC/SS-LIQ		
241-BX-109	SL-NL	241-SY-102	SL-LIQ		

Notes:

MIX-LIQ = mixed waste form with ≥ 1 m liquid over solids.
MIX-NL = mixed waste form with < 1 m liquid over solids.
SC/SS-LIQ = saltcake/salt slurry waste form with ≥ 1 m liquid over solids.
SC/SS-NL = saltcake/salt slurry waste form with < 1 m liquid over solids.
SL-LIQ = sludge waste form with ≥ 1 m liquid over solids.
SL-NL = sludge waste form with < 1 m liquid over solids.

A4.0 USE OF COMPUTER SOFTWARE

The input data is identified in the spreadsheet described below.

Spreadsheet Verification Form Number: SVF-1117, *Spreadsheet Verification & Release Form for Spreadsheet RPP-10006 R5 Tank Physical Data 060208.xls*

Base Software: Microsoft Excel[1] 2003

Spreadsheet Title: RPP-10006 R5 Tank Physical Data 060208.xls.

Document: RPP-29121, *Spreadsheet Description Document for RPP-10006 R5 Tank Physical Data 060208.xls*

Author: V. S. Anda

Purpose: Determination and compilation of the tank physical property data

A5.0 REFERENCES

RPP-6171, 2000, *Determination Of Waste Groupings For Safety Analyses*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-29121, 2006, *Spreadsheet Description Document for RPP-10006 R5 Tank Physical Data 060208.xls*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

SNL-000198, 1999, *Flammable Gas Safety Analysis Data Review*, Rev. 0, Sandia National Laboratory, Albequerque, New Mexico.

SVF-1117, 2006, *Spreadsheet Verification & Release Form for Spreadsheet RPP-10006 R5 Tank Physical Data 060208.xls*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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[1] Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

APPENDIX B

DENSITY EVALUATION

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CONTENTS

TABLES

LIST OF TERMS

BBI	Best-Basis Inventory
CL	convective layer (liquid)
DST	double-shell tank
LIQ	liquid waste form
LL	lower limit
Max	95% upper limit
Min	95% lower limit
MIX-LIQ	mixed waste form with ≥ 1 m liquid over solids
MIX-NL	mixed waste form with < 1 m liquid over solids
NCL	nonconvective layer (solid)
PNNL	Pacific Northwest National Laboratory
RSD	relative standard deviation
SC/SS	saltcake/salt slurry
SC/SS-LIQ	saltcake/salt slurry waste form with ≥ 1 m liquid over solids
SC/SS-NL	saltcake/salt slurry waste form with < 1 m liquid over solids
SL	sludge
SL-LIQ	sludge waste form with ≥ 1 m liquid over solids
SL-NL	sludge waste form with < 1 m liquid over solids
SST	single-shell tank
TWINS	Tank Waste Information Network System
UL	upper limit

Peer Review Checklist (Calculation Review Checklist)

Calculation Reviewed: RPP-10006, Rev 5, Appendix B DENSITY EVALUATION
Scope of Review: Appendix B text and tables
(e.g., document section or portion of calculation)

Engineer/Analyst: V. S. Anda [signature] Date: 7/25/06

Organizational Manager: M. A. Knight [signature] Date: 7/25/06

This document consists of 24 pages and the following attachments (if applicable):
n/a

Yes	No	NA*		
[X]	[]	[]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[X]	[]	[]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[X]	[]	[]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[X]	[]	[]	4.	Input data were checked for consistency with original source information.
[]	[]	[X]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[]	[]	[X]	6.	Mathematical derivations were checked, including dimensional consistency of results.
[]	[]	[X]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[X]	[]	[]	8.	Software verification and validation are addressed adequately.
[X]	[]	[]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[X]	[]	[]	10.	Conclusions are consistent with analytical results and applicable limits.
[X]	[]	[]	11.	Results and conclusions address all points in the purpose.
[X]	[]	[]	12.	Referenced documents are retrievable or otherwise available.
[X]	[]	[]	13.	The version or revision of each reference is cited.
[]	[]	[X]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[]	[]	[X]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[X]	[]	[]	16.	All checker comments have been dispositioned and the design media matches the calculations.

K. D. Fowler [signature] 7/25/06
Checker (printed name and signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

This appendix is not a calculation and does not directly contain mathematical equations or input data with associated uncertainties. It presents a summary of tank waste phase densities (mean, maximum and mean values) and standard deviations. The spreadsheet used to derive the values is documented in the cited reference RPP-29121.

This appendix does not establish or alter any existing requirement or necessitate revisions to other documents.

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APPENDIX B

DENSITY EVALUATION

B1.0 INTRODUCTION

The purpose of this appendix is to establish the convective layer (CL) and nonconvective layer (NCL) densities, associated uncertainties, and distributions for use in the flammable gas waste group calculations.

B2.0 BACKGROUND

A specialty assessment of the methodology of RPP-10006, *Methodology and Calculations for the Waste Groups for Large Underground Waste Storage Tanks at the Hanford Site,* for assigning flammable gas waste groups was undertaken in 2004 and is documented in RPP-21336, *Flammable Gas Waste Group Assignment: FY2004-ENG-S-0133*.

Observation 2 from RPP-21336 stated that:

> Certain physical relationships are not accounted for in the calculation that make the output distribution of the Monte Carlo analysis artificially broad and create physically impossible states.
>
> 1. Independent selection of CL and NCL densities from their distributions in the Monte Carlo analysis allows density pairs that are not physically achievable.
>
> 2. Liquid and solid densities selected from the distribution may approach each other, artificially indicating an unphysical or improbable waste state.
>
> 3. The retained gas volume for screening Waste Group C tanks is not correctly limited by varying neutral buoyancy void fraction computed from the convective and non-convective layer densities selected during the calculation.
>
> 4. Available liquid SpG [specific gravity] data suggest that the default uncertainty (5%) used in the calculation is larger than necessary. (RPP-21336)

Items 1 and 2 relate to the calculation methodology and item 4 relates to input data for CL and NCL densities used in the Monte Carlo analysis for calculating the flammable gas waste groups. Item 3 relates primarily to the way that void fraction is handled in the Monte Carlo analysis.

Changes in methodology and input data for density for Revision 5 of this document are described in the following sections of this appendix. Changes related to void fraction are discussed in Appendix D.

B3.0 CHANGES TO DENSITY METHODOLOGY AND INPUT DATA

B3.1 CHANGES IN MONTE CARLO ANALYSIS APPROACH

In order to address items 1 and 2 from Observation 2 of RPP-21336 discussed above, changes were made in the waste group determination spreadsheet program to treat CL and NCL waste densities as correlated rather than treating these properties as completely independent. In order to reflect the inter-dependency between convective and nonconvective waste densities, a nonconvective waste density offset distribution is created. The distribution is determined by setting its mean as the difference between the mean convective waste density and the mean nonconvective waste density with a standard deviation equal to the nonconvective waste density standard deviation. The nonconvective waste density is constrained to be greater than the convective waste density by setting the nonconvective waste density equal to the sum of the convective waste density and the nonconvective waste density offset.

The RPP-10006 database values are usually given for the mean, standard deviation, minimum value, and maximum value for the convective and nonconvective layer densities. A density offset distribution is created with a mean that is equal to the difference between the two density means. The density offset distribution is given the same standard deviation as the nonconvective layer density distribution, if one is given, if not, the convective layer density standard deviation is applied. The minimum of the offset is the mean minus 2 times the standard deviation or 1 kg/m^3, whichever is greater. The maximum of the offset is the mean plus 2 times the standard deviation.

During the simulation, a value is taken from the Monte Carlo distribution for the convective layer density and from the density offset distribution. The two values are added to determine the nonconvective layer density. This relationship guarantees that the nonconvective layer density is always at least 1 kg/m^3 greater than the convective layer density.

The methodology described above considers NCL density and void fraction as independent properties. This simplification is made for ease of calculation and due to lack of adequate data to support a more rigorous correlation of NCL density and void fraction. A methodology was proposed by Pacific Northwest National Laboratory (PNNL) in the report PNNL-15238, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Waste Tanks*, which described the NCL density as a function of solid volume fraction, solid particle density, and interstitial liquid density. PNNL applied this methodology only to the waste group A tanks, which are the most studied tanks at Hanford and therefore have the most complete set of data available. PNNL also made a simplifying assumption that the interstitial liquid density was equal to the convective layer density. This approach is reasonable for static tanks such as the waste group A tanks, but is not valid for tanks that are involved in transfers; these tanks would require use of the actual interstitial liquid density in the calculation. Typically, there is much less data for the remaining 172 tanks, and use of the PNNL-15238 methodology for these tanks would be subject to too many data uncertainties and assumptions to justify the added complexity in the equations. In addition, RPP-10006 uses degassed density and volume data for the NCL solids density determination. The combined effect of the lack of data for many tanks and the use of degassed solids densities is that the NCL layer densities and the void fration are independent properties. The layer density differences are used to determine the neutral buoyancy void fraction, which in turn provides the upper limit for the NCL layer void fraction.

B3.2 CHANGES IN APPLIED DENSITY UNCERTAINTY

In order to address item 4 from Observation 2 of RPP-21336 discussed above, a review of sample analysis data for density from the Tank Waste Information Network System (TWINS) was completed and published as part of RPP-10006, Rev. 4. The data review included sample analysis results for specific gravity, solids density, settled solids density, liquid density, density before centrifuging, density, and bulk density, with specific gravity and density assumed to be interchangeable for the purposes of the evaluation. Many data points were excluded from the data set based on criteria included in RPP-10006, Rev. 4, Appendix M. The evaluation documented in Appendix M of RPP-10006, Rev. 4, identified "...the overall uncertainty for density is about 5%. However, for liquid densities the relative error is 3.3% and the relative error for the solids densities is 6.8%." The relative error values generated for the waste types are compared to the Best-Basis Inventory (BBI) published relative standard deviation values in Table B-1. The standard deviation information previously applied in RPP-10006, Rev. 4, for each tank and nonconvective phase is presented for comparison with the standard deviations applied for this revision of RPP-10006 in Tables B-2 and B-3.

The statement, "The BBI typically lists relative uncertainties for solid and liquid densities as 5%," was included in RPP-10006, Rev. 4, Appendix M; however, a source was not referenced. A review of RPP-7625, *Best-Basis Inventory Process Requirements*, Appendix B, "Uncertainty Estimates for the BBI," identified the density uncertainty by tank and waste phase. Table B-1 contains summarized relative standard deviation (RSD) data from RPP-7625, Table B-8. RPP-7625 references RPP-6924, *Statistical Methods for Estimating the Uncertainty in the Best Basis Inventories*, which explains the methodology used to generate the density RSDs and discusses the number of data points utilized.

Table B-1. Best-Basis Inventory Relative Standard Deviation (%) Versus Relative Error (%).

Layer	Relative standard deviation (%) (RPP-7625, Rev. 6, Table B-8)		Relative error (%) (RPP-10006, Rev. 4)
	Single-shell tank	Double-shell tank	
Convective Layer	5.90	8.16	3.3
Nonconvective Layer	7.55	6.50	6.8

Notes:

RPP-7625, 2006, *Best-Basis Inventory Process Requirements*, Rev. 6, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-10006, 2004, *Methodology and Calculations for the Waste Groups for Large Underground Waste Storage Tanks at the Hanford Site*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

The mean CL and NCL densities used to calculate the flammable gas waste group assignments for most of the 177 tanks in this revision of RPP-10006 are taken from RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*. RPP-5926 calculates bulk mean densities for the liquid (CL) and solid (NCL) layers. These bulk liquid and solid densities are based on a volume weighted average of the individual waste phase densities obtained from querying the BBI Tank Density and Percent Water report for the 177 tanks. In order to obtain an accurate tank-by-tank standard deviation for use in conjunction with the mean densities calculated in RPP-5926, it would be necessary to evaluate all sampling events that formed the basis for the BBI for each of the 177 tanks. Since this is not currently done on a tank-by-tank basis as part of the normal BBI process, it was not considered practical to do this for this revision of RPP-10006. Discussions were held with the organization responsible for the BBI and it is planned that standard deviations associated with the reported densities by tank and waste phase will be included in the Tank Density and Percent Water report next fiscal year and will be used in future revisions of RPP-10006.

The tank-specific density uncertainties and distributions presented in Revision 4 of this document have been revised. It was determined that the tank-specific standard deviations calculated in Revision 4 did not account for transfers into or out of the tank and hence did not correlate with current tank conditions. For this document revision, the published density relative standard deviations for double-shell tanks (DST) and single-shell tanks (SST) from RPP-7625 have been adopted.

B3.3 DEVIATIONS IN MEAN DENSITY INPUTS

RPP-5926 is the source for the mean density inputs for all the SSTs and the DSTs except for DSTs 241-AP-103, 241-AP-104, 241-AP-107 and 241-AP-108. Previous to the evaluation discussed in Appendix C of this document, these four 241-AP Tank Farm tanks were not documented as having any solids. As a result of the change from no solids to quantifiable solids, RPP-5926 solids bulk density data (0 g/mL) cannot be applied for these tanks. Solids densities selected for input are identified and discussed in Appendix E of this document.

Tanks that do not have a bulk density reported in RPP-5926 or Appendix E are assigned one to enable completion of the calculation. The lack of a mean bulk density value signifies the related phase does not exist in the tank.

- A mean liquid phase bulk density of 1.10 g/mL is assigned as a default value for bulk density to tanks that do not have a liquid phase.
- A mean solids phase bulk density of 1.75 g/mL is assigned as a default value to tanks that do not have a solid phase.
- For tanks that have a mean solids bulk density reported to be less than the mean liquid bulk density, the mean solid phase bulk density place holder (1.75 g/mL) is assigned.

B4.0 DENSITY DISTRIBUTION

B4.1 RELATIVE STANDARD DEVIATION

The correct BBI RSD is determined based on the tank type, SST or DST, and waste phase, liquid or solid. The RSDs, as shown in Table B-1, are converted into standard deviations using Equations 4-1 and 4-2.

CL standard deviation = CL mean * RSD Equation 4-1

NCL standard deviation = NCL mean * RSD Equation 4-2

B4.2 CONVECTIVE LAYER DENSITY DISTRIBUTION

The convective layer density is assumed to be based on a normal distribution with a known variance. A 95% confidence interval is applied to obtain the minimum and the maximum values. The 95% confidence interval equations specified in RPP-6924, Section 2.3, are based on assumption of a mean based on a normal distribution with a known variance.

The minimum or 95% lower limit is calculated following Equation 4-3 with the maximum or 95% upper limit calculated following Equation 4-4. The equations are based on Equation 2-6 from RPP-6924, Section 2.3, but do not have the same variable references or multiplier order.

95% Lower Limit = Mean – (Mean x RSD x 1.96) Equation 4-3

95% Upper Limit = Mean + (Mean x RSD x 1.96) Equation 4-4

The distribution generated based on Equations 4-3 and 4-4 is applied unless the lower limit for the liquid density falls below 1 g/mL. Calculated minimum liquid bulk densities less than 1 g/mL are truncated at 1 g/mL to maintain a realistic distribution.

B4.3 NONCONVECTIVE LAYER DENSITY DISTRIBUTION

The nonconvective layer density is calculated as the sum of the convective layer density and a density offset as shown in Equation 4-5.

NCL density = CL density + density offset   Equation 4-5

The mean density offset is equal to the difference between the convective and nonconvective mean densities as shown in Equation 4-6.

Density offset mean = NCL density mean – CL density mean   Equation 4-6

The calculated density offset is assumed to be represented by a normal distribution with a standard deviation equal to the nonconvective layer standard deviation. Equations 4-7 and 4-8 are used to generate the minimum and maximum for the density offset distribution. The minimum density offset value is truncated at 1 kg/m^3. Truncation of the minimum density offset ensures the convective layer density will be at least 1 kg/m^3 less than the nonconvective layer density.

Minimum = Density offset mean – (NCL standard deviation * 2)   Equation 4-7

Maximum = Density offset mean + (NCL standard deviation * 2)   Equation 4-8

The nonconvective density is calculated during performance of the Monte Carlo simulation. The nonconvective layer density for the run is calculated as the sum of the convective layer density selected for the run plus the density offset value selected for the run. Equation 4-9 provides the mathematical formula.

NCL density = CL density (from Monte Carlo) + Density offset (from Monte Carlo)
Equation 4-9

Dynamic selection of the nonconvective layer density is embedded in the waste group calculation. RPP-29581, *Spreadsheet Description Document for '!!RPP-10006R5_Waste_Groups-Rev-44-060420 .xls' and Associated Spreadsheets*, discusses the spreadsheet used to perform the waste group calculation in further detail.

B5.0 USE OF COMPUTER SOFTWARE

The waste types, convective layer density means, standard deviations, minimums and maximums, as well as the nonconvective layer density means and standard deviations reported in Tables B-2 and B-3 are compiled from the spreadsheet described below.

Spreadsheet Verification Form Number: SVF-1117, *Spreadsheet Verification & Release Form for Spreadsheet RPP-10006 R5 Tank Physical Data 060208.xls*

Base Software: Microsoft Excel[1] 2003

Spreadsheet Title: RPP-10006 R5 Tank Physical Data 060208.xls.

Document: RPP-29121, *Spreadsheet Description Document for RPP-10006 R5 Tank Physical Data 060208.xls*

Author: V. S. Anda

Purpose: Determination and compilation of the tank physical property data

B6.0 RESULTS

B6.1 CONVECTIVE LAYER DENSITY DISTRIBUTIONS

Convective layer density distribution results for the 177 tanks are presented in Table B-2.

[1] Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

Table B-2. Convective Layer Distributions. (6 sheets)

Tank	Waste type, 2005 data	Convective layer density (2005)				RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Max (g/mL)	Min (g/mL)	Standard deviation (g/mL)
241-A-101	SC/SS-NL	1.49	0.09	1.66	1.32	0.045
241-A-102	SC/SS-NL	1.57	0.09	1.75	1.39	0.059
241-A-103	SC/SS-NL	1.51	0.09	1.68	1.34	0.032
241-A-104	SL-NL	1.64	0.10	1.83	1.45	0.038
241-A-105	SL-NL	1.10	0.06	1.23	1.00	NA
241-A-106	MIX-NL	1.10	0.06	1.23	1.00	0.038
241-AN-101	SC/SS-LIQ	1.41	0.12	1.64	1.18	0.079
241-AN-102	SC/SS-LIQ	1.41	0.12	1.64	1.18	0.043
241-AN-103	SC/SS-LIQ	1.48	0.12	1.72	1.24	0.046
241-AN-104	SC/SS-LIQ	1.40	0.11	1.62	1.18	0.069
241-AN-105	SC/SS-LIQ	1.42	0.12	1.65	1.19	0.050
241-AN-106	MIX-LIQ	1.11	0.09	1.29	1.00	0.065
241-AN-107	SC/SS-LIQ	1.43	0.12	1.66	1.20	0.072
241-AP-101	LIQ	1.30	0.11	1.51	1.09	0.024
241-AP-102	SL-LIQ	1.39	0.11	1.61	1.17	0.008
241-AP-103	SC/SS-LIQ	1.35	0.11	1.57	1.13	0.035
241-AP-104	SC/SS-LIQ	1.28	0.10	1.48	1.08	0.006
241-AP-105	SC/SS-LIQ	1.27	0.10	1.47	1.07	0.051
241-AP-106	LIQ	1.21	0.10	1.40	1.02	0.007
241-AP-107	SC/SS-LIQ	1.28	0.10	1.48	1.08	0.048
241-AP-108	SC/SS-LIQ	1.43	0.12	1.66	1.20	0.005
241-AW-101	SC/SS-LIQ	1.47	0.12	1.71	1.23	0.069
241-AW-102	SL-LIQ	1.26	0.10	1.46	1.06	0.047
241-AW-103	SL-LIQ	1.24	0.10	1.44	1.04	0.064
241-AW-104	SC/SS-LIQ	1.35	0.11	1.57	1.13	0.022
241-AW-105	SL-LIQ	1.06	0.09	1.23	1.00	0.038
241-AW-106	SC/SS-LIQ	1.30	0.11	1.51	1.09	0.015
241-AX-101	SC/SS-NL	1.10	0.06	1.23	1.00	0.108
241-AX-102	SC/SS-NL	1.10	0.06	1.23	1.00	0.046
241-AX-103	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-AX-104	SL-NL	1.10	0.06	1.23	1.00	0.038
241-AY-101	SL-NL	1.19	0.10	1.38	1.00	0.068
241-AY-102	SL-LIQ	1.17	0.10	1.36	1.00	0.048
241-AZ-101	SL-LIQ	1.24	0.10	1.44	1.04	0.019

Table B-2. Convective Layer Distributions. (6 sheets)

Tank	Waste type, 2005 data	Convective layer density (2005)				RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Max (g/mL)	Min (g/mL)	Standard deviation (g/mL)
241-AZ-102	SL-LIQ	1.11	0.09	1.29	1.00	0.020
241-B-101	SC/SS-NL	1.10	0.06	1.23	1.00	0.000
241-B-102	SC/SS-NL	1.26	0.07	1.41	1.11	0.042
241-B-103	SC/SS-NL	1.10	0.06	1.23	1.00	0.042
241-B-104	SL-NL	1.10	0.06	1.23	1.00	0.000
241-B-105	SC/SS-NL	1.10	0.06	1.23	1.00	0.042
241-B-106	SL-NL	1.26	0.07	1.41	1.11	0.000
241-B-107	MIX-NL	1.10	0.06	1.23	1.00	0.025
241-B-108	SC/SS-NL	1.10	0.06	1.23	1.00	0.025
241-B-109	MIX-NL	1.10	0.06	1.23	1.00	0.047
241-B-110	SL-NL	1.19	0.07	1.33	1.05	0.039
241-B-111	SL-NL	1.19	0.07	1.33	1.05	0.039
241-B-112	MIX-NL	1.51	0.09	1.68	1.34	0.049
241-B-201	SL-NL	1.10	0.06	1.23	1.00	0.038
241-B-202	SL-NL	1.10	0.06	1.23	1.00	0.038
241-B-203	SL-NL	1.05	0.06	1.17	1.00	0.007
241-B-204	SL-NL	1.05	0.06	1.17	1.00	0.012
241-BX-101	SL-NL	1.10	0.06	1.23	1.00	0.042
241-BX-102	SL-NL	1.10	0.06	1.23	1.00	0.038
241-BX-103	SL-NL	1.07	0.06	1.19	1.00	0.035
241-BX-104	SL-NL	1.28	0.08	1.43	1.13	0.014
241-BX-105	MIX-NL	1.29	0.08	1.44	1.14	0.042
241-BX-106	SC/SS-NL	1.10	0.06	1.23	1.00	0.038
241-BX-107	SL-NL	1.10	0.06	1.23	1.00	0.038
241-BX-108	SL-NL	1.10	0.06	1.23	1.00	0.038
241-BX-109	SL-NL	1.10	0.06	1.23	1.00	0.005
241-BX-110	MIX-NL	1.44	0.08	1.61	1.27	0.130
241-BX-111	SC/SS-NL	1.10	0.06	1.23	1.00	0.064
241-BX-112	SL-NL	1.18	0.07	1.32	1.04	0.029
241-BY-101	SC/SS-NL	1.10	0.06	1.23	1.00	0.050
241-BY-102	SC/SS-NL	1.10	0.06	1.23	1.00	0.003
241-BY-103	SC/SS-NL	1.10	0.06	1.23	1.00	0.053
241-BY-104	SC/SS-NL	1.10	0.06	1.23	1.00	0.000
241-BY-105	SC/SS-NL	1.10	0.06	1.23	1.00	0.076

Table B-2. Convective Layer Distributions. (6 sheets)

Tank	Waste type, 2005 data	Convective layer density (2005)				RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Max (g/mL)	Min (g/mL)	Standard deviation (g/mL)
241-BY-106	SC/SS-NL	1.10	0.06	1.23	1.00	0.123
241-BY-107	SC/SS-NL	1.10	0.06	1.23	1.00	0.024
241-BY-108	SC/SS-NL	1.10	0.06	1.23	1.00	0.056
241-BY-109	SC/SS-NL	1.10	0.06	1.23	1.00	0.020
241-BY-110	SC/SS-NL	1.10	0.06	1.23	1.00	0.036
241-BY-111	SC/SS-NL	1.10	0.06	1.23	1.00	0.009
241-BY-112	SC/SS-NL	1.10	0.06	1.23	1.00	0.007
241-C-101	SL-NL	1.10	0.06	1.23	1.00	0.038
241-C-102	SL-NL	1.10	0.06	1.23	1.00	0.038
241-C-103	SL-NL	1.07	0.06	1.19	1.00	0.063
241-C-104	SL-NL	1.10	0.06	1.23	1.00	0.005
241-C-105	SL-NL	1.10	0.06	1.23	1.00	0.070
241-C-106	SL-NL	1.02	0.06	1.14	1.00	0.060
241-C-107	SL-NL	1.10	0.06	1.23	1.00	0.032
241-C-108	SL-NL	1.10	0.06	1.23	1.00	0.038
241-C-109	SL-NL	1.10	0.06	1.23	1.00	0.000
241-C-110	SL-NL	1.10	0.06	1.23	1.00	0.064
241-C-111	SL-NL	1.10	0.06	1.23	1.00	0.038
241-C-112	SL-NL	1.10	0.06	1.23	1.00	0.107
241-C-201	SL-NL	1.10	0.06	1.23	1.00	0.038
241-C-202	SL-NL	1.10	0.06	1.23	1.00	0.038
241-C-203	SL-NL	1.00	0.06	1.12	1.00	0.038
241-C-204	SL-NL	1.10	0.06	1.23	1.00	0.038
241-S-101	MIX-NL	1.10	0.06	1.23	1.00	0.054
241-S-102	SC/SS-NL	1.10	0.06	1.23	1.00	0.122
241-S-103	SC/SS-NL	1.45	0.09	1.62	1.28	0.025
241-S-104	MIX-NL	1.10	0.06	1.23	1.00	0.017
241-S-105	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-S-106	SC/SS-NL	1.10	0.06	1.23	1.00	0.051
241-S-107	SL-NL	1.31	0.08	1.46	1.16	0.084
241-S-108	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-S-109	SC/SS-NL	1.10	0.06	1.23	1.00	0.049
241-S-110	SC/SS-NL	1.10	0.06	1.23	1.00	0.067
241-S-111	SC/SS-NL	1.45	0.09	1.62	1.28	0.069

Table B-2. Convective Layer Distributions. (6 sheets)

Tank	Waste type, 2005 data	Convective layer density (2005)				RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Max (g/mL)	Min (g/mL)	Standard deviation (g/mL)
241-S-112	SC/SS-NL	1.10	0.06	1.23	1.00	0.029
241-SX-101	MIX-NL	1.10	0.06	1.23	1.00	0.019
241-SX-102	SC/SS-NL	1.10	0.06	1.23	1.00	0.098
241-SX-103	SC/SS-NL	1.47	0.09	1.64	1.30	0.039
241-SX-104	MIX-NL	1.10	0.06	1.23	1.00	0.014
241-SX-105	SC/SS-NL	1.10	0.06	1.23	1.00	0.029
241-SX-106	SC/SS-NL	1.10	0.06	1.23	1.00	0.043
241-SX-107	SL-NL	1.10	0.06	1.23	1.00	0.049
241-SX-108	SL-NL	1.10	0.06	1.23	1.00	0.038
241-SX-109	SC/SS-NL	1.10	0.06	1.23	1.00	0.046
241-SX-110	SL-NL	1.10	0.06	1.23	1.00	0.038
241-SX-111	SL-NL	1.10	0.06	1.23	1.00	0.049
241-SX-112	SL-NL	1.10	0.06	1.23	1.00	0.049
241-SX-113	SL-NL	1.10	0.06	1.23	1.00	0.038
241-SX-114	SL-NL	1.10	0.06	1.23	1.00	0.049
241-SX-115	SL-NL	1.10	0.06	1.23	1.00	0.038
241-SY-101	SC/SS-LIQ	1.30	0.11	1.51	1.09	0.035
241-SY-102	SL-LIQ	1.27	0.10	1.47	1.07	0.109
241-SY-103	SC/SS-LIQ	1.47	0.12	1.71	1.23	0.081
241-T-101	MIX-NL	1.10	0.06	1.23	1.00	0.054
241-T-102	SL-NL	1.14	0.07	1.27	1.01	0.037
241-T-103	SL-NL	1.19	0.07	1.33	1.05	0.039
241-T-104	SL-NL	1.10	0.06	1.23	1.00	0.101
241-T-105	SL-NL	1.10	0.06	1.23	1.00	0.092
241-T-106	SL-NL	1.10	0.06	1.23	1.00	0.038
241-T-107	SL-NL	1.10	0.06	1.23	1.00	0.090
241-T-108	MIX-NL	1.10	0.06	1.23	1.00	0.047
241-T-109	SC/SS-NL	1.10	0.06	1.23	1.00	0.042
241-T-110	SL-NL	1.05	0.06	1.17	1.00	0.028
241-T-111	SL-NL	1.10	0.06	1.23	1.00	0.089
241-T-112	SL-NL	1.10	0.06	1.23	1.00	0.004
241-T-201	SL-NL	1.06	0.06	1.18	1.00	0.006
241-T-202	SL-NL	1.10	0.06	1.23	1.00	0.038
241-T-203	SL-NL	1.10	0.06	1.23	1.00	0.002

Table B-2. Convective Layer Distributions. (6 sheets)

Tank	Waste type, 2005 data	Convective layer density (2005)				RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Max (g/mL)	Min (g/mL)	Standard deviation (g/mL)
241-T-204	SL-NL	1.10	0.06	1.23	1.00	0.038
241-TX-101	SL-NL	1.10	0.06	1.23	1.00	0.047
241-TX-102	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-103	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-104	MIX-NL	1.44	0.08	1.61	1.27	0.015
241-TX-105	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-106	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-107	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-108	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-109	SL-NL	1.10	0.06	1.23	1.00	0.038
241-TX-110	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-111	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-112	SC/SS-NL	1.10	0.06	1.23	1.00	0.047
241-TX-113	SC/SS-NL	1.10	0.06	1.23	1.00	0.054
241-TX-114	SC/SS-NL	1.10	0.06	1.23	1.00	0.044
241-TX-115	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TX-116	SC/SS-NL	1.10	0.06	1.23	1.00	0.003
241-TX-117	SC/SS-NL	1.10	0.06	1.23	1.00	0.042
241-TX-118	SC/SS-NL	1.10	0.06	1.23	1.00	0.048
241-TY-101	MIX-NL	1.10	0.06	1.23	1.00	0.047
241-TY-102	SC/SS-NL	1.10	0.06	1.23	1.00	0.045
241-TY-103	MIX-NL	1.10	0.06	1.23	1.00	0.047
241-TY-104	SL-NL	1.18	0.07	1.32	1.04	0.038
241-TY-105	SL-NL	1.10	0.06	1.23	1.00	0.038
241-TY-106	SL-NL	1.10	0.06	1.23	1.00	0.038
241-U-101	SL-NL	1.10	0.06	1.23	1.00	0.012
241-U-102	SC/SS-NL	1.48	0.09	1.65	1.31	0.095
241-U-103	SC/SS-NL	1.44	0.08	1.61	1.27	0.044
241-U-104	SL-NL	1.10	0.06	1.23	1.00	0.052
241-U-105	SC/SS-NL	1.10	0.06	1.23	1.00	0.034
241-U-106	SC/SS-NL	1.34	0.08	1.49	1.19	0.068
241-U-107	SC/SS-NL	1.39	0.08	1.55	1.23	0.112
241-U-108	SC/SS-NL	1.40	0.08	1.56	1.24	0.074
241-U-109	SC/SS-NL	1.10	0.06	1.23	1.00	0.017

Table B-2. Convective Layer Distributions. (6 sheets)

Tank	Waste type, 2005 data	Convective layer density (2005)				RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Max (g/mL)	Min (g/mL)	Standard deviation (g/mL)
241-U-110	SL-NL	1.10	0.06	1.23	1.00	0.038
241-U-111	SC/SS-NL	1.10	0.06	1.23	1.00	0.022
241-U-112	SL-NL	1.10	0.06	1.23	1.00	0.038
241-U-201	SL-NL	1.26	0.07	1.41	1.11	0.001
241-U-202	SL-NL	1.28	0.08	1.43	1.13	0.015
241-U-203	SL-NL	1.28	0.08	1.43	1.13	0.005
241-U-204	SL-NL	1.11	0.07	1.24	1.00	0.002

Notes:

RPP-10006, 2004, *Methodology and Calculations for the Waste Groups for Large Underground Waste Storage Tanks at the Hanford Site*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

LIQ = liquid waste form.
MIX-LIQ = mixed waste form with ≥ 1 m liquid over solids.
MIX-NL = mixed waste form with < 1 m liquid over solids.
NA = not applicable.
SL-NL = sludge waste form with < 1 m liquid over solids.
SL-LIQ = sludge waste form with ≥ 1 m liquid over solids.
SC/SS-LIQ = saltcake/salt slurry waste form with ≥ 1 m liquid over solids.
SC/SS-NL = saltcake/salt slurry waste form with < 1 m liquid over solids.

B6.2 NONCONVECTIVE LAYER DENSITY INPUT DATA

Nonconvective layer density input data for the 177 tanks are presented in Table B-3. The nonconvective layer density mean data compiled in this table is used to calculate the density offset as discussed in Section B4.3. The nonconvective layer density standard deviation included in Table B-3 is utilized to generate the density offset distribution (see Section B4.3).

Table B-3. Nonconvective Layer Density Input Data. (6 sheets)

Tank	Waste type, 2005 data	Nonconvective layer density (2005)		RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Standard deviation (g/mL)
241-A-101	SC/SS-NL	1.70	0.13	0.078
241-A-102	SC/SS-NL	1.67	0.13	0.088
241-A-103	SC/SS-NL	1.75	0.13	0.101
241-A-104	SL-NL	1.75	0.13	0.121
241-A-105	SL-NL	1.54	0.12	0.114
241-A-106	MIX-NL	1.70	0.13	0.125
241-AN-101	SC/SS-LIQ	1.55	0.10	0.117
241-AN-102	SC/SS-LIQ	1.53	0.10	0.057
241-AN-103	SC/SS-LIQ	1.72	0.11	0.007
241-AN-104	SC/SS-LIQ	1.59	0.10	0.055
241-AN-105	SC/SS-LIQ	1.57	0.10	0.048
241-AN-106	MIX-LIQ	1.55	0.10	0.093
241-AN-107	SC/SS-LIQ	1.48	0.10	0.058
241-AP-101	LIQ	1.75	0.11	0.033
241-AP-102	SL-LIQ	1.75	0.11	0.106
241-AP-103	SC/SS-LIQ	1.61	0.10	0.033
241-AP-104	SC/SS-LIQ	1.61	0.10	0.033
241-AP-105	SC/SS-LIQ	1.61	0.10	0.028
241-AP-106	LIQ	1.75	0.11	0.033
241-AP-107	SC/SS-LIQ	1.61	0.10	0.033
241-AP-108	SC/SS-LIQ	1.61	0.10	0.033
241-AW-101	SC/SS-LIQ	1.59	0.10	0.079
241-AW-102	SL-LIQ	1.32	0.09	0.080
241-AW-103	SL-LIQ	1.49	0.10	0.144
241-AW-104	SC/SS-LIQ	1.48	0.10	0.112
241-AW-105	SL-LIQ	1.36	0.09	0.107
241-AW-106	SC/SS-LIQ	1.61	0.10	0.052

Table B-3. Nonconvective Layer Density Input Data. (6 sheets)

Tank	Waste type, 2005 data	Nonconvective layer density (2005)		RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Standard deviation (g/mL)
241-AX-101	SC/SS-NL	1.70	0.13	0.108
241-AX-102	SC/SS-NL	1.58	0.12	0.107
241-AX-103	SC/SS-NL	1.58	0.12	0.040
241-AX-104	SL-NL	1.80	0.14	0.133
241-AY-101	SL-NL	1.68	0.11	0.291
241-AY-102	SL-LIQ	1.54	0.10	0.133
241-AZ-101	SL-LIQ	1.61	0.10	0.101
241-AZ-102	SL-LIQ	1.41	0.09	0.056
241-B-101	SC/SS-NL	1.49	0.11	0.101
241-B-102	SC/SS-NL	1.61	0.12	0.110
241-B-103	SC/SS-NL	1.61	0.12	0.110
241-B-104	SL-NL	1.38	0.10	0.102
241-B-105	SC/SS-NL	1.65	0.12	0.112
241-B-106	SL-NL	1.38	0.10	0.037
241-B-107	MIX-NL	1.63	0.12	0.053
241-B-108	SC/SS-NL	1.68	0.13	0.109
241-B-109	MIX-NL	1.78	0.13	0.014
241-B-110	SL-NL	1.36	0.10	0.007
241-B-111	SL-NL	1.27	0.10	0.054
241-B-112	MIX-NL	1.75	0.13	0.110
241-B-201	SL-NL	1.26	0.10	0.120
241-B-202	SL-NL	1.22	0.09	0.099
241-B-203	SL-NL	1.19	0.09	0.034
241-B-204	SL-NL	1.19	0.09	0.050
241-BX-101	SL-NL	1.68	0.13	0.120
241-BX-102	SL-NL	1.75	0.13	0.077
241-BX-103	SL-NL	1.66	0.13	0.119
241-BX-104	SL-NL	1.68	0.13	0.208
241-BX-105	MIX-NL	1.69	0.13	0.121
241-BX-106	SC/SS-NL	1.62	0.12	0.057
241-BX-107	SL-NL	1.44	0.11	0.036
241-BX-108	SL-NL	1.46	0.11	0.107
241-BX-109	SL-NL	1.52	0.11	0.014
241-BX-110	MIX-NL	1.67	0.13	0.116

Table B-3. Nonconvective Layer Density Input Data. (6 sheets)

Tank	Waste type, 2005 data	Nonconvective layer density (2005)		RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Standard deviation (g/mL)
241-BX-111	SC/SS-NL	1.45	0.11	0.098
241-BX-112	SL-NL	1.31	0.10	0.031
241-BY-101	SC/SS-NL	1.83	0.14	0.124
241-BY-102	SC/SS-NL	1.57	0.12	0.235
241-BY-103	SC/SS-NL	1.66	0.13	0.113
241-BY-104	SC/SS-NL	1.71	0.13	0.055
241-BY-105	SC/SS-NL	1.80	0.14	0.064
241-BY-106	SC/SS-NL	1.67	0.13	0.140
241-BY-107	SC/SS-NL	1.69	0.13	0.145
241-BY-108	SC/SS-NL	1.48	0.11	0.083
241-BY-109	SC/SS-NL	1.71	0.13	0.125
241-BY-110	SC/SS-NL	1.57	0.12	0.081
241-BY-111	SC/SS-NL	1.67	0.13	0.120
241-BY-112	SC/SS-NL	1.74	0.13	0.120
241-C-101	SL-NL	1.78	0.13	0.078
241-C-102	SL-NL	1.68	0.13	0.124
241-C-103	SL-NL	1.59	0.12	0.116
241-C-104	SL-NL	1.68	0.13	0.165
241-C-105	SL-NL	1.55	0.12	0.114
241-C-106	SL-NL	1.56	0.12	0.029
241-C-107	SL-NL	1.55	0.12	0.156
241-C-108	SL-NL	1.48	0.11	0.286
241-C-109	SL-NL	1.55	0.12	0.072
241-C-110	SL-NL	1.34	0.10	0.131
241-C-111	SL-NL	1.55	0.12	0.114
241-C-112	SL-NL	1.60	0.12	0.151
241-C-201	SL-NL	1.44	0.11	0.106
241-C-202	SL-NL	1.44	0.11	0.106
241-C-203	SL-NL	1.62	0.12	0.107
241-C-204	SL-NL	1.62	0.12	0.119
241-S-101	MIX-NL	1.65	0.12	0.085
241-S-102	SC/SS-NL	1.70	0.13	0.109
241-S-103	SC/SS-NL	1.61	0.12	0.110
241-S-104	MIX-NL	1.67	0.13	0.124

Table B-3. Nonconvective Layer Density Input Data. (6 sheets)

Tank	Waste type, 2005 data	Nonconvective layer density (2005)		RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Standard deviation (g/mL)
241-S-105	SC/SS-NL	1.66	0.13	0.113
241-S-106	SC/SS-NL	1.72	0.13	0.134
241-S-107	SL-NL	1.78	0.13	0.123
241-S-108	SC/SS-NL	1.68	0.13	0.114
241-S-109	SC/SS-NL	1.66	0.13	0.113
241-S-110	SC/SS-NL	1.66	0.13	0.136
241-S-111	SC/SS-NL	1.54	0.12	0.098
241-S-112	SC/SS-NL	1.71	0.13	0.123
241-SX-101	MIX-NL	1.68	0.13	0.139
241-SX-102	SC/SS-NL	1.70	0.13	0.097
241-SX-103	SC/SS-NL	1.73	0.13	0.146
241-SX-104	MIX-NL	1.69	0.13	0.008
241-SX-105	SC/SS-NL	1.63	0.12	0.126
241-SX-106	SC/SS-NL	1.58	0.12	0.104
241-SX-107	SL-NL	1.77	0.13	0.129
241-SX-108	SL-NL	1.77	0.13	0.130
241-SX-109	SC/SS-NL	1.73	0.13	0.118
241-SX-110	SL-NL	1.76	0.13	0.129
241-SX-111	SL-NL	1.76	0.13	0.128
241-SX-112	SL-NL	1.77	0.13	0.129
241-SX-113	SL-NL	1.75	0.13	0.080
241-SX-114	SL-NL	1.75	0.13	0.125
241-SX-115	SL-NL	1.77	0.13	0.132
241-SY-101	SC/SS-LIQ	1.52	0.10	0.075
241-SY-102	SL-LIQ	1.56	0.10	0.140
241-SY-103	SC/SS-LIQ	1.61	0.10	0.049
241-T-101	MIX-NL	1.54	0.12	0.082
241-T-102	SL-NL	1.80	0.14	0.132
241-T-103	SL-NL	1.71	0.13	0.126
241-T-104	SL-NL	1.29	0.10	0.095
241-T-105	SL-NL	1.46	0.11	0.241
241-T-106	SL-NL	1.59	0.12	0.117
241-T-107	SL-NL	1.56	0.12	0.113
241-T-108	MIX-NL	1.55	0.12	0.082

Table B-3. Nonconvective Layer Density Input Data. (6 sheets)

Tank	Waste type, 2005 data	Nonconvective layer density (2005)		RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Standard deviation (g/mL)
241-T-109	SC/SS-NL	1.65	0.12	0.109
241-T-110	SL-NL	1.25	0.09	0.045
241-T-111	SL-NL	1.24	0.09	0.095
241-T-112	SL-NL	1.28	0.10	0.095
241-T-201	SL-NL	1.31	0.10	0.095
241-T-202	SL-NL	1.18	0.09	0.076
241-T-203	SL-NL	1.22	0.09	0.078
241-T-204	SL-NL	1.18	0.09	0.046
241-TX-101	SL-NL	1.74	0.13	0.128
241-TX-102	SC/SS-NL	1.61	0.12	0.110
241-TX-103	SC/SS-NL	1.61	0.12	0.110
241-TX-104	MIX-NL	1.74	0.13	0.135
241-TX-105	SC/SS-NL	1.63	0.12	0.111
241-TX-106	SC/SS-NL	1.62	0.12	0.110
241-TX-107	SC/SS-NL	1.78	0.13	0.121
241-TX-108	SC/SS-NL	1.62	0.12	0.110
241-TX-109	SL-NL	1.43	0.11	0.105
241-TX-110	SC/SS-NL	1.62	0.12	0.110
241-TX-111	SC/SS-NL	1.61	0.12	0.110
241-TX-112	SC/SS-NL	1.63	0.12	0.111
241-TX-113	SC/SS-NL	1.61	0.12	0.085
241-TX-114	SC/SS-NL	1.63	0.12	0.111
241-TX-115	SC/SS-NL	1.63	0.12	0.111
241-TX-116	SC/SS-NL	1.66	0.13	0.113
241-TX-117	SC/SS-NL	1.58	0.12	0.107
241-TX-118	SC/SS-NL	1.69	0.13	0.160
241-TY-101	MIX-NL	1.63	0.12	0.086
241-TY-102	SC/SS-NL	1.76	0.13	0.119
241-TY-103	MIX-NL	1.68	0.13	0.124
241-TY-104	SL-NL	1.65	0.12	0.122
241-TY-105	SL-NL	1.53	0.12	0.113
241-TY-106	SL-NL	1.40	0.11	0.103
241-U-101	SL-NL	1.77	0.13	0.130
241-U-102	SC/SS-NL	1.67	0.13	0.076

Table B-3. Nonconvective Layer Density Input Data. (6 sheets)

Tank	Waste type, 2005 data	Nonconvective layer density (2005)		RPP-10006 (2004)
		Mean (g/mL)	Standard deviation (g/mL)	Standard deviation (g/mL)
241-U-103	SC/SS-NL	1.70	0.13	0.106
241-U-104	SL-NL	1.43	0.11	0.075
241-U-105	SC/SS-NL	1.67	0.13	0.073
241-U-106	SC/SS-NL	1.55	0.12	0.107
241-U-107	SC/SS-NL	1.74	0.13	0.183
241-U-108	SC/SS-NL	1.68	0.13	0.075
241-U-109	SC/SS-NL	1.65	0.12	0.134
241-U-110	SL-NL	1.72	0.13	0.126
241-U-111	SC/SS-NL	1.61	0.12	0.109
241-U-112	SL-NL	1.74	0.13	0.128
241-U-201	SL-NL	1.63	0.12	0.226
241-U-202	SL-NL	1.51	0.11	0.111
241-U-203	SL-NL	1.59	0.12	0.405
241-U-204	SL-NL	1.47	0.11	0.121

Notes:

RPP-10006, 2004, *Methodology and Calculations for the Waste Groups for Large Underground Waste Storage Tanks at the Hanford Site*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

LIQ = liquid waste form.
MIX-LIQ = mixed waste form with ≥ 1 m liquid over solids.
MIX-NL = mixed waste form with < 1 m liquid over solids.
SL-NL = sludge waste form with < 1 m liquid over solids.
SL-LIQ = sludge waste form with ≥ 1 m liquid over solids.
SC/SS-LIQ = saltcake/salt slurry waste form with ≥ 1 m liquid over solids.
SC/SS-NL = saltcake/salt slurry waste form with < 1 m liquid over solids.

B7.0 REFERENCES

PNNL-15238, 2005, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Waste Tanks*, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

RPP-5926, 2005, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-6924, 2000, *Statistical Methods for Estimating the Uncertainty in the Best Basis Inventories*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-7625, 2006, *Best-Basis Inventory Process Requirements*, Rev. 6, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-10006, 2004, *Methodology and Calculations for the Waste Groups for Large Underground Waste Storage Tanks at the Hanford Site*, Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-21336, 2004, *Flammable Gas Waste Group Assignment: FY2004-ENG-S-0133*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-29121, 2006, *Spreadsheet Description Document for RPP-10006 R5 Tank Physical Data 060208.xls*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-29581, 2006, *Spreadsheet Description Document for '!!RPP-10006R5_Waste_Groups-Rev-44-060420 .xls' and Associated Spreadsheets*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

SVF-1117, 2006, *Spreadsheet Verification & Release Form for Spreadsheet RPP-10006 R5 Tank Physical Data 060208.xls*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

APPENDIX C

WASTE LAYER HEIGHT AND UNCERTAINTY DETERMINATION

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CONTENTS

FIGURES

TABLES

LIST OF TERMS

BBI	Best Basis Inventory
BDGRE	buoyant displacement gas release event
DST	double-shell tank
ENRAF	Enraf-Nonius Series 854 (gauge)
ILL	interstitial liquid level
MIT	multifunction instrument tree
NCL	nonconvective layer
SLIM	solid-liquid interface monitor
SST	single-shell tank

Peer Review Checklist (Calculation Review Checklist)

Calculation Reviewed: RPP-10006, Rev 5, Appendix C WASTE LAYER HEIGHT AND UNCERTAINTY DETERMINATION

Scope of Review: Appendix C text and tables
(e.g., document section or portion of calculation)

Engineer/Analyst: J. M. Conner [signature] Date: 7/25/06

Organizational Manager: M. A. Knight [signature] Date: 7/25/06

This document consists of 50 pages and the following attachments (if applicable):

n/a

Yes	No	NA*		
[X]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[X]	[ ]	[ ]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[ ]	[ ]	[X]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[X]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[X]	[ ]	[ ]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[ ]	[ ]	[X]	6.	Mathematical derivations were checked, including dimensional consistency of results.
[X]	[ ]	[ ]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[ ]	[ ]	[X]	8.	Software verification and validation are addressed adequately.
[X]	[ ]	[ ]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[X]	[ ]	[ ]	10.	Conclusions are consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	11.	Results and conclusions address all points in the purpose.
[X]	[ ]	[ ]	12.	Referenced documents are retrievable or otherwise available.
[X]	[ ]	[ ]	13.	The version or revision of each reference is cited.
[ ]	[ ]	[X]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[X]	[ ]	[ ]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[X]	[ ]	[ ]	16.	All checker comments have been dispositioned and the design media matches the calculations.

V. S. Anda [signature] 7/25/06
Checker (printed name and signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

3. This appendix discusses calculations previously completed and documented to be verified by SVF-1112, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 all solids R0.'*
6. No mathematical derivations are included.
8. Software verification and validation is not addressed as it is not used to generate the information in this appendix.
14. This appendix is not calculation; therefore the guidance in Attachment A is not applicable, this checklist is used as a peer review checklist to ensure important items have been verified.

APPENDIX C

WASTE LAYER HEIGHT AND UNCERTAINTY DETERMINATION

C1.0 INTRODUCTION

The purpose of this appendix is to establish waste layer height estimates and uncertainties that are used in the flammable gas waste group calculations. In addition, because of recent concerns about potential bias and measurement error in double-shell tank (DST) solids level measurement techniques (PER-2006-0041, *Waste Groups as a Result of Additional Uncertainty in Solids Level*), an extensive re-evaluation of the DST nonconvective layer (NCL) heights and height uncertainties is performed in this appendix.

The following sections describe the data used for waste layers, consisting of the total waste height, and the crust, convective layer, and NCL, as applicable. All waste layer data is assumed to be normally distributed, and will be evaluated in Monte Carlo calculations using mean and standard deviation data.

C2.0 TOTAL WASTE HEIGHT (SURFACE LEVEL) AND UNCERTAINTY

RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, compiles tank waste layer and total waste volumes from the Best-Basis Inventory (BBI). DST and single-shell tank (SST) total waste heights are calculated from volumes given in this reference except as noted below. The total waste volumes are converted to height by applying standard tank dimension factors documented in Appendix B of RPP-7625, *Best Basis Inventory Process Requirements*, Rev. 6 (again, with exceptions noted below).

Exceptions for volume data are SSTs 241-C-201, 241-C-202, 241-C-204 and 241-S-102. Because of ongoing retrieval activities, waste volumes are not taken from RPP-5926. Instead, waste phase summary data are obtained from the Recent Best Basis Derivation Text effective October 1, 2005 (BBI 2006).

Exceptions for waste height calculations are the 241-B, 241-C, 241-T, and 241-U 200-series tanks, along with SSTs 241-SX-115 and 241-U-108. Waste heights for these tanks are not calculated using the conversion factors from RPP-7625, but are calculated with a special calculator based on re-evaluation of tank drawings. The calculator is an updated version of RPP-13019, *Determination of Hanford Waste Tank Volumes*. The updated calculator is documented via SVF-1139, *RPP-13019R1 Tank Volume Calculations 050713p.xls.*

Total waste height uncertainty is the same as surface level uncertainty. For tanks with free liquid surfaces, the surface level uncertainty is assumed to be 0.25 in. This is the uncertainty assumed in RPP-7625, Rev. 6, Appendix B, for tanks with an ENRAF (Enraf-Nonius Series 854 [gauge]) surface level measurement. This uncertainty applies to all of the DSTs except those with crusts (241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103). It is also assumed that this applies to all SSTs with free liquid (i.e., supernatant).

For the DST crust tanks, the surface level uncertainty is assumed to be the crust layer uncertainty. The crust layer uncertainty is derived from RPP-6655, *Data Observations on Double-Shell Flammable Gas Watch List Tank Behavior*, Table 5-1, which gives the crust height mean and range (e.g., 89 ± 16 cm for 241-AN-103). Standard deviations are derived from the mean and range values in SVF-1118, *Spreadsheet Verification and Release Form for Spreadsheet RPP-10006 Rev 5 Data Rebuild 060306.xls*.

SSTs with no free liquid are assumed to have a surface level uncertainty of 11.5 in. based on the surface level uncertainty (standard deviation) calculated for saltcake tanks in RPP-7625. The reference indicates a smaller uncertainty for sludge tanks, but for this analysis, 11.5 in. is assumed regardless of waste type.

C3.0 DOUBLE-SHELL TANK CRUST LAYER HEIGHT AND UNCERTAINTY

Five DSTs have crust layers: 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103. As described above, crust layer thicknesses are taken from RPP-6655, Table 5-1, which gives the crust height mean and range (e.g., 89 ± 16 cm for 241-AN-103). Uncertainties (standard deviations) are derived from the mean and range values in SVF-1118.

C4.0 INTERSTITIAL LIQUID LAYER HEIGHT AND UNCERTAINTY

The interstitial liquid level (ILL) marks the top of the saturated (wetted) solids. It is assumed that only saturated solids can retain gas. For tanks that have little or no supernatant, the ILL may be below the average surface level. This configuration is seen in many SSTs due to saltwell pumping. Analyzing only the saturated solids volume rather than the total solids volume provides a more accurate, less conservative Waste Group calculation for tanks with this waste configuration.

ILL heights were taken from SACS (PCSACS 2006) and consist of the latest ILL measurement available for each tank as of November 22, 2005. Relevant data are available for 76 SSTs (the ILL measurements for tanks 241-S-102 and 241-S-112 are not relevant since these tanks are being retrieved).

If the ILL is lower than the NCL (see Section C6.0 for discussion of SST NCLs), then the ILL or saturated solids height is used in Waste Group calculations rather than the NCL height.

An uncertainty of 2.36 cm is applied to the ILL measurements. This is the maximum standard deviation for SST neutron ILL measurements reported in Appendix B of PNNL-11373, *Flammable Gas Data Evaluation Report*.

Finally, saturated NCL heights are constrained within certain limits to avoid physically impossible conditions in the Monte Carlo analysis. For DSTs, the lower limits are essentially zero (0.01 m or less may be used to avoid calculational difficulties that can be encountered with zero values).

C5.0 CONVECTIVE LAYER HEIGHT AND UNCERTAINTY

Convective layer height is not determined independently. The convective layer height can be determined from the total layer height, the NCL height, and the crust height (if any). Convective layer height uncertainty is also considered a dependent variable, and is not calculated nor used in the Waste Group calculations.

C6.0 NONCONVECTIVE LAYER HEIGHT AND UNCERTAINTY FOR SINGLE-SHELL TANKS

Although uncertainty exists in NCL height for the SSTs, it is of less concern than for the DSTs because the SSTs no longer contain supernatant liquid and solids surfaces in SSTs are typically visible via camera. SST solids volumes in the BBI have typically been established from interim stabilization evaluations (HNF-SD-RE-TI-178, *Single-Shell Tank Interim Stabilization Record*), which took into account the surface topography of the waste on completion of interim stabilization. The lack of significant supernatant in SSTs also ensures that they cannot display buoyant displacement gas release event (BDGRE) behavior in their current configuration. Hence, a rigorous evaluation of SST NCL height uncertainty was not considered warranted and was not attempted.

For the purposes of this document, mean NCL heights for SSTs have been calculated based on the BBI solids volume and the tank diameter and dish dimensions. The actual NCL heights used as input data for the analysis are provided in Appendix A.

A standard deviation of 11.5 in. was used as the uncertainty associated with SST NCL height. This uncertainty was based on the stated BBI surface level uncertainty for saltcake tanks taken from Appendix B of RPP-7625. The documented uncertainty for sludge tanks was less, so using the larger saltcake uncertainty for all SSTs is conservative.

Finally, NCL heights are constrained within certain limits to avoid physically impossible conditions in the Monte Carlo analysis. For DSTs, the lower limits are essentially zero (0.01 m or less may be used to avoid calculational difficulties that can be encountered with zero values).

C7.0 NONCONVECTIVE LAYER HEIGHT AND UNCERTAINTY FOR DOUBLE-SHELL TANKS

C7.1 DOUBLE-SHELL TANK NONCONVECTIVE LAYER HEIGHT AND MEASUREMENT CONCERNS

Previous revisions of this document have used a mean NCL height for the DSTs based on the solids volume documented in the BBI. A standard deviation of 6.5 in. was used as the associated uncertainty in NCL height, based on the same data presented in the BBI solids level measurement uncertainty analysis in RPP-7625.

BBI solids volumes for the DSTs are based on solids level measurements determined using a variety of measurement techniques. The primary techniques used are sludge weight, zip cord, and core sample extrusion. The solids height in DST 241-SY-101 is based on gamma scans. Three tanks are based on a more complex analysis considering a number of techniques. Other techniques that have been used include ball rheometer data, temperature validation scans, and most recently measurements made using an ENRAF densitometer.

The waste configuration found in certain DSTs consisting of a large volume of concentrated supernatant on top of a large volume of settled solids is the only configuration in which BDGREs have actually occurred. Therefore, it is important to understand the volume of solids in the NCL, as this is a key factor in estimating the amount of gas that can be retained and released in a BDGRE. The DSTs are in active use for both routine transfers and as receiver tanks for solid wastes from SST retrievals and it is important to be able to preclude conditions that would result in BDGRE behavior. However, determining an accurate NCL height in the DSTs is inhibited by the presence of a supernatant liquid layer that prevents direct observation of the underlying solids layer.

PER-2006-0041 identified that the different techniques used for measuring the height of settled solids (i.e. NCL height) in DSTs may not provide a conservative estimate of the height of settled solids relative to measurement techniques originally used in the Waste Group A tanks as the basis of the methodology established to analyze BDGRE behavior. In particular, it is postulated that certain measurement techniques, such as sludge weight and zip cord, may provide a low estimate of the NCL height compared to (for example) ball rheometer measurements that were the original basis for the BDGRE methodology. PER-2006-0041 also identified that significant uncertainty exists in the topography of the settled solids surface that may not be adequately bounded by the stated uncertainty used in previous revisions of this document. Uncertainty in solids level measurements may result from the contribution of two primary factors:

- Some measurement methods may be less sensitive than other methods and may provide a relative bias compared to each other or more significantly to the techniques used to develop the BDGRE Waste Group calculation methodology.

- Measurements taken in the same tank at different times or different locations may result in different solids level readings. This may be the result of subjectivity of the measurement method resulting in variability between readings or differences in topography of the solids surface resulting in different readings at different locations.

The following sections of this appendix attempt to address these issues by quantifying relative bias between measurement methods and by determining an overall uncertainty (or standard deviation) in readings after adjusting for any bias between methods.

The present evaluation does not address these issues to the fullest extent possible. The data set of solids level measurements currently assembled, although extensive, is not complete and the analysis is limited to more of a reasonably conservative treatment of these issues.

C7.2 NONCONVECTIVE LAYER HEIGHT MEASUREMENT METHODS

C7.2.1 Description of Measurement Methods

A brief outline of solids (or NCL) measurement techniques is as follows.

<u>Ball rheometer</u>: The ball rheometer is a tungsten ball (3.6 in. in diameter and 16 lb) that was deployed in the flammable gas watch list tanks. The ball was raised and lowered through the waste and the wire tension measured via a load cell. PNNL-11296, *In Situ Rheology and Gas Volume in Hanford Double-Shell Waste Tanks*, states how the interface between the convective and NCLs was detected in each tank:

> . . . we locate the top of the non-convective layer by slowly dropping the ball from the convective region and observing the apparent weight of the ball. At the boundary the apparent weight begins to drop as the ball becomes increasingly supported by the fluid." (p. 2.2)
>
> The ball rheometer locates the liquid level and the top of the non-convective layer in each riser to within one ball radius (4.6 cm). Passage of the ball through the liquid is taken to be the midpoint of the decrease in tension due to increasing buoyancy as the ball submerges." (p. 2.6)

Figure C-1. Ball Rheometer Data for Nonconvective Layer Interface for Double-Shell Tank 241-AN-105 (Figure 2.5 of PNNL-11296).

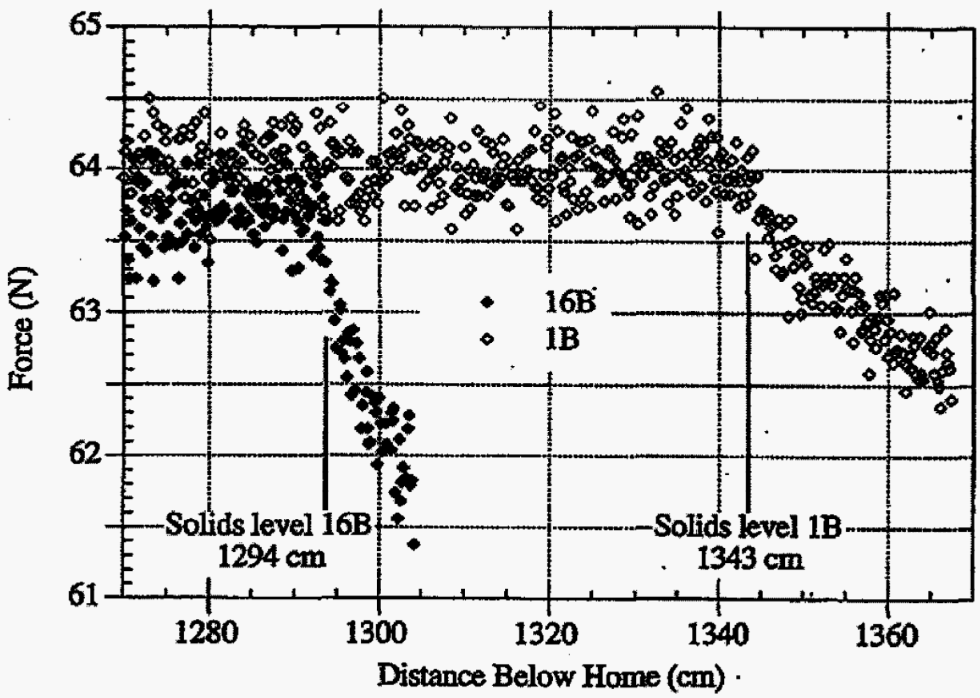


Figure C-1 shows this graphically. As the ball is lowered at a constant rate, the wire tension is constant through the convective layer and then deflects (decreases) as more resistance is detected in the NCL.

Core sample extrusions: Based on lab photos and video, sample recovery data, and field core sampling data, the level of solids can be estimated. This was considered (PNNL-15238, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Tank Wastes*, Appendix D) to be the least accurate of the three methods typically used in the flammable gas tanks (i.e., ball rheometer, temperature validation probe, or core sample extrusion).

ENRAF densitometers: This device consists of a weight (displacer) on a wire, which is lowered into the supernatant. The device detects interfaces and density by measuring the weight or tension of the wire. The solids layer is determined as a decrease in wire tension by a specified amount. For the current DST 241-AN-106 application, the displacer has a mass of 239 g and the solids level is determined by a decrease in tension equivalent to 25 g. As of January 2006, densitometers are installed in DSTs 241-SY-102, 241-AN-106, 241-AY-102, and two densitometers are installed in DST 241-AN-107.

ENRAF surface level devices: The standard ENRAF surface level measurement device installed on many DSTs and SSTs can be reprogrammed to detect a second interface (i.e., the solids level interface). This is not a standard operation and requires a field activity (e.g., reprogramming, flushing). Solids level measurements of this type have been performed in DSTs 241-SY-101 and 241-SY-102 in the past (2W-99-00456, *Flush 101-SY-1C ENRAF and Place in I-2 Mode to Determine Sludge Level of Tank 241-SY-101*, and 2W-99-00251, *Obtain Sludge Level in SY-102*).

Temperature validation scan: The Group A flammable gas tanks (DSTs 241-AN-103, 241-AN-104, 241-AN-105, 241-AW-101, and 241-SY-103) have a multi-function instrument tree (MIT) installed with 22 thermocouples spaced out at 12 to 48 in. intervals. In addition, DST 241-AY-102 has an MIT installed, and DST 241-SY-101 has two MITs. The MIT is a hollow pipe through which other measuring devices can be deployed. A temperature validation probe has been deployed in these tanks consisting of a resistance temperature detector. The probe is in contact with the pipe which conducts heat from the waste. By pausing periodically (approximately every 4 to 6 in.) for temperature equilibration, the probe is used to measure the temperature profile. The layer interface is identified by the transition from the isothermal convective layer to the warmer NCL. This technique can only be used in tanks with MITs. Most other tanks have regular thermocouple trees with thermocouples spaced at 24 to 48 in. intervals, which is not close enough for precise determinations of convective and NCLs.

Gamma and neutron scans: Gamma detectors and neutron source/detectors have been deployed in MITs and drywells in DSTs and liquid observation wells in SSTs. The gamma scan is usually considered to be an indication of ^{137}Cs activity, the primary gamma emitter in the waste. Cesium is largely soluble, so counts are usually higher in the liquid. Thus, the solids level is estimated as the point where the gamma counts begin to decrease from the higher levels in the convective layer. If the solids interstitial liquid is higher in ^{137}Cs than the supernatant (because of transfers), or if the solids are high in radioactive ^{90}Sr/^{90}Y, then the counts in the solids layer can be higher than in the liquid layer.

Neutron scans have been more useful for detecting interstitial liquid levels or the presence of trapped gas such as the old crust layer in DST 241-SY-101. This technique measures neutrons reflected by hydrogen (considered an indication of water), and is often not sensitive to differences between liquid and wetted solids.

Sludge weights: Sludge weight readings are performed via procedure TO-040-560, *Tank Farm Sludge Level Readings*, on an as-needed basis to support Engineering. A sludge weight with a known cable length hangs from the riser cap of selected risers. The weight is a short (approximately 2 in.) section of 1.5 or 2 in. diameter pipe weighing up to approximately 1.5 lb. Sludge weight designs can differ slightly from farm to farm. The operator attaches a measuring tape to the cable and lowers the assembly until a solid interface is detected. The sludge weight is suspended in the waste if the tank is filled, and over time salt solids can build up, resulting in reduced sensitivity. Repeated measurements can cause a localized depression in the solids. This has been observed for surface level measurements in SSTs with exposed solids.

Zip cords: A zip cord is an insulated conductive wire attached to a plummet, which is lowered into the riser from the riser flange or a fixed elevation above it (the riser adapter or top hat). "The distance from the riser to the waste surface is required for many jobs such as leak detection, sampling, level gauge installations or repairs, or tank equipment installations" (RPP-10141, *Exceptions to Ignition Source Controls*). The liquid or surface level is indicated when an electrical signal (continuity) is detected. Zip cords are also used for solids level measurements. The solids level is calculated from the depth at which physical resistance is sensed, or the cable goes slack. Solids level zip cord measurements are typically associated with a core or grab sampling event, and are performed to determine sample points, or at the request of Engineering (e.g., in the Tank Sampling and Analysis Plan). Different plummets are used for different applications. Up until mid-2004, the plummet used for solids level determinations was a 1.5 in. section of 1.5-in.-diameter, schedule 160, steel pipe weighing approximately 0.6 lb. Since then, the zip cord weights have been the same as the sludge weights (approximately 1 to 1.5 lb).

Other techniques: A method under development is the Solid-Liquid Interface Monitor (SLIM). This is a low-frequency acoustic imaging system which may allow mapping much of the tank from one installed location rather than single point measurements like the techniques described above. Installation of the first SLIM devices in Hanford DSTs is planned for fiscal year 2007 or 2008.

Photograph and video evaluation can be used for volume determination when solids are exposed. SST solids volumes are typically estimated in this way (HNF-SD-RE-TI-178). One technique used during historical tank sluicing was solids mapping from photographs, used in coordination with pumping and liquid level measurement to allow contour mapping (RHO-ST-30, *Hanford Radioactive Tank Cleanout and Sludge Processing*). Transfer material balances can also provide useful information on the presence of solids (TFC-ENG-CHEM-D-44, *Resolution of Waste Transfer Material Balance Discrepancies*).

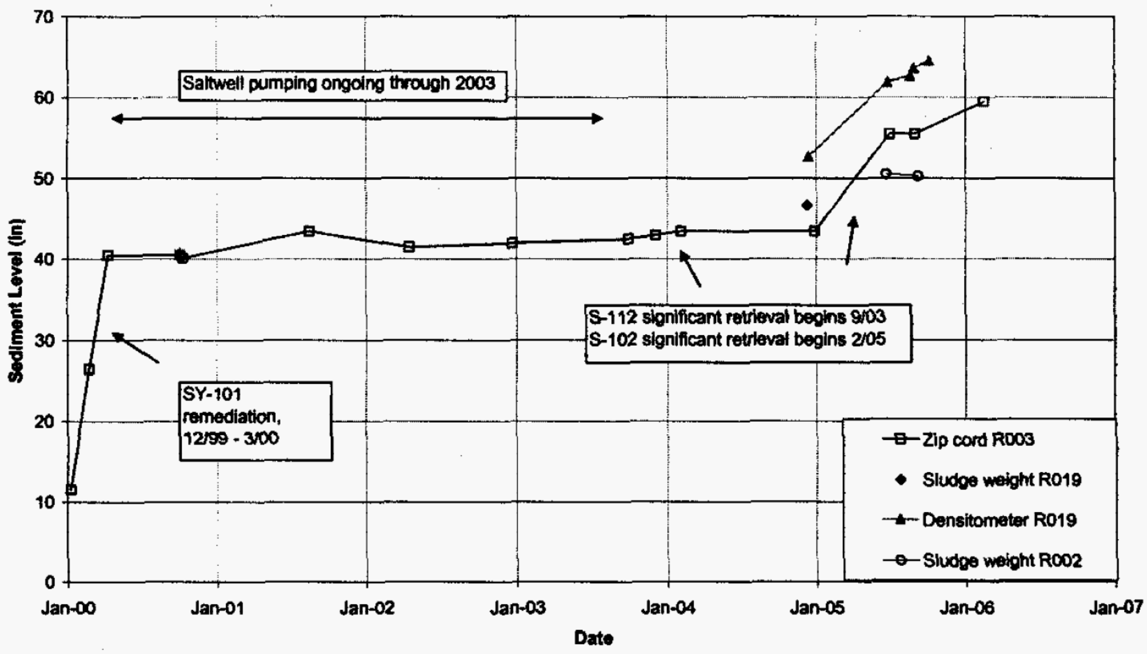
C7.2.2 Effect of Waste Consistency on Measurement Uncertainty

Conceptually, it seems evident that the waste consistency will affect the measurement techniques differently. For example, hard layers are difficult to retrieve with core sampling, especially push mode. Core sample recoveries have indicated solids heights could be biased low in these wastes. Measurements in tanks with hard solids layers should exhibit good agreement between physical measurement methods such as sludge weight, zip cord, densitometer, and ball rheometer, as well as indirect methods such as gamma and temperature profiles.

Loosely settled solids (waste with low-yield strength) should be easily recovered in core sampling, and thus core sampling, temperature profiles, and perhaps gamma scans should result in the most conservative measurements. Methods that rely on solids layer resistance to slow or stop a descending weight (zip cord, sludge weight, densitometer) may be biased lower in these types of solids. Automated physical measurements (densitometer and ball rheometer) should provide more consistent measurements than human techniques (sludge weights and zip cords).

Some examples of sludge weight and zip cord data show good consistency among measurements. The 241-SY-102 zip cord measurements have been taken in riser 3 during sampling events for many years. These measurements correlate well with the process history of the tank as noted on Figure C-2. The variability observed from April 2000 to December 2004 is only 3 in., part of which can be explained as actual solids increase due to saltwell pumping activities.

Figure C-2. Sediment Level History for Selected Risers, Double-Shell Tank 241-SY-102.



However, other examples of measurements in solids with low-yield stress illustrate the subjectivity inherent in zip cord and sludge weight measurements.

Sludge level measurements taken in DST 241-AN-107 in March 2003 initially indicated 85, 83, and 92 in. (rounded to the nearest inch) in risers 3, 18, and 19, respectively. The work package 2E-03-00339, *Perform 241-AN-107 Sludge Level Readings*, indicates that a measurement in riser 20 did not detect resistance until the sound of metal on metal was heard when the weight assembly contacted the tank bottom. This sludge weight felt lighter than the other three. The existence of the sludge weight on the cable was confirmed and the measurement was reperformed a few days later. The field work supervisor and two operators felt a very slight difference in resistance at a cable depth corresponding to a sludge level of 82 in. During readings taken 2 months later in May 2003, the reading in riser 3 was not recorded, because the sludge weight could not be felt (i.e., there was "no restriction in the waste") (2E-03-00794, *241-AN-107 Sludge Weight Readings*).

A zip cord measurement was taken in February 1998 in riser 20 of DST 241-AN-102. A solids level measurement of 38 in. is calculated based on the first indication of solids (ES-97-00599, *241-AN-102 Obtain Grab Samples*). A "slack cable" reading was noted at 26 in. of solids. Several subsequent readings from 2000 to 2004 have indicated 63 to 73 in. of solids at that riser. Solids precipitation from depletion of hydroxide and other mechanisms may account for some of the increase.

The DST 241-AP-108 sludge weight measurements were taken in September 2005. Results were 63, 63, and 33 in. of solids (rounded to the nearest inch) in risers 18, 19, and 20, respectively.

Conversations with the field work supervisor and an operator (personal communication, Chapman 2005) indicated that the lowest measurement (riser 20) was taken first. In taking measurements in the other risers, a slight resistance was detected at cable depths corresponding to the higher measurements. It was conveyed that the same response might have been indicated at the first riser if measurements were retaken.

In summary, the measurement method is expected to make little difference if the solids layer is firm and the interface between solids and liquids is distinct. In weaker solids, differences can be substantial. The human interpretation involved in the zip cord and sludge weight measurements will inevitably lead to much larger variability than mechanical techniques such as densitometers.

C7.2.3 Current Measurement Techniques Compared to Those Used to Develop Waste Group Methodology

The concern identified in PER-2006-0041 is that the solids level measurement methods currently used are not the same as the methods originally used in the Waste Group A flammable gas tanks. The buoyancy ratio criterion, which is a critical part of the waste group methodology, was developed by Pacific Northwest National Laboratory (PNNL-13337, *Derivation of the Buoyancy Ratio Equation From the Bubble Migration Model*) based on an extensive data set collected mostly in the historical flammable gas tanks from approximately 1995 through 2000. This data included measurements of NCL height using a variety of techniques.

The techniques used to measure the NCL height for the Waste Group A tanks included ball rheometer, MIT temperature validation profile, and core sample extrusion. After the original analysis of NCL heights was completed, measurements were made for DST 241-SY-101 using MIT gamma scans. These solids level measurements for the Waste Group A tanks are presented in PNNL-15238 (except for DST 241-SY-101, which is no longer a Group A tank), and summarized in Section C7.4.1 of this appendix.

Ball rheometer, MIT temperature validation, and gamma scan techniques were not typically and are not normally used in other tanks. The typical techniques currently used for the remaining DSTs are core extrusion, sludge weight, and zip cord, with ENRAF densitometers now being used in a handful of tanks, and gamma scans are available for DSTs 241-SY-101 and 241-AY-101.

If there is a bias between the methods typically used now (almost exclusively sludge weight, zip cord, and densitometer) and the methods originally used to define the Waste Group A flammable gas tanks, then the calculation may not be conservative.

Conceptually, ball rheometers, core extrusions, MIT temperature validation probes, gamma scans, and densitometers would seem to be conservative compared to sludge weight and zip cord measurements. As discussed above, several factors are involved, including waste consistency and human interpretation factors. The data generally seem to bear this out. Sludge weights do appear to have a bias relative to densitometers.

The following sections attempt to confirm and quantify this suspected bias by comparing the measurement techniques.

C7.3 DETERMINATION OF BIAS BETWEEN MEASUREMENT TECHNIQUES

C7.3.1 Comparison of Different Techniques in Same Riser

The most directly relevant measurement comparisons are measurements taken using different techniques in the same location (riser), at or near the same time. Measurements compared in this way will exclude differences that result from changes in surface topography or from changes in solids level with time. Examples of such direct comparisons are provided in the subsections below. A comparison of different techniques taken from different locations in the same tank is presented in Section C7.3.2.

C7.3.1.1 Comparison of Sludge Weight and Zip Cord Measurements

In DST 241-SY-101, a sludge weight measurement of 86.8 in. was recorded for riser 6 on August 22, 2005. The sludge weight was removed for sampling and a zip cord measurement corresponding to 84.5 in. was taken on January 15, 2006. This is consistent with expectations for these two methods. Conceptually, they are identical, although results would be expected to vary based upon the sludge weight or plummet design, salt buildup, and the human interpretation involved.

C7.3.1.2 Comparison of ENRAF Densitometer and Sludge Weight Measurements

Sediment levels measured by the ENRAF densitometers recently installed in DST 241-SY-102 and DST 241-AN-106 can be compared to sludge weight measurements in the same risers. Sludge level measurements prior to the DST 241-AY-102 and 241-AN-107 densitometer installations were not available.

For DST 241-SY-102, a sludge weight measurement was taken in riser 19 on December 9, 2004. The reading was 46.6 in. An ENRAF densitometer was installed in riser 19 on December 14 (5 days later) and the sediment level measured was 52.7 in. Transfer activities were minimal during that time. The difference between these readings is 6.1 in.

For DST 241-AN-106, the riser 1 sludge weight readings are considered to be in error by 17 in. because of an incorrect sludge weight cable length. This is described in the work package for the densitometer installation (2E-04-01498, *241-AN-106 Install New ENRAF Densitometer*). Given that, the sludge weight measurement taken in riser 1 on December 13, 2005, of 45.1 in. should be 17 in. less, or 28.1 in. The densitometer sediment level reading in that riser taken about 1 month later (January 16, 2006) was 36.8 in., a difference of 8.7 in. Tank surface level data indicate no change, other than evaporation, during that span (TWINS 2006).

Both tanks were receiving SST retrieval waste, including solids, immediately prior to the measurements. Recently transferred solids should be relatively "soft" and thus any measurement bias between methods should be magnified in these tanks. Therefore, the average offset or bias of about 7 in. between sludge weight and densitometer measurements should be slightly conservative for most wastes. Table C-1 presents the data for these two cases in both absolute (offset) and relative (ratio) comparisons.

Table C-1. Comparison of Densitometer and Sludge Weight Data.

Tank	Sludge weight (in.)	Densitometer (in.)	Offset (densitometer – sludge weight)	Ratio, sludge weight/ densitometer	Comment
241-SY-102	46.6	52.7	6.1	88%	--
241-AN-106	28.125	36.81	8.7	76%	Adjusted sludge weight data based on data sheet in work package 2E-04-01498.
Average			7.4	82%	--

C7.3.1.3 Comparison of Zip Cords and Core Extrusions

Solids level measurements are typically taken by zip cord prior to core sampling. Tanks for which the BBI solids estimate is based on core samples are compared to the zip cord readings taken prior to sampling in Table C-2.

Table C-2. Comparison of Core Extrusion and Zip Cord Data. (2 sheets)

Tank	Core extrusion (BBI) (in.)	Zip cord (in.)	Offset (core – zip cord) (in.)	Ratio, core extrusion/ zip cord	Comment
241-AN-103	149.00	--	--	--	1996 core samples, risers 12A and 21A. No zip cord data readily available.
241-AW-101	112.00	--	--	--	1996 cores in risers 24A and 24B. No zip cord data readily available.
241-AW-103	113.75	121.2	-7.5	94%	The solid waste volumes were determined from the 1997 and 1999 core samples. Risers 11 and 13 in 1997 and riser 3 in 1999 (new riser numbering). Zip cord result averaged from applicable data in Table C-7.
241-AW-104	81.00	82.1	-1.1	99%	BBI based on 1997 core samples, risers 13, 14, and 17 (new numbering). Zip cord result averaged from applicable data in Table C-7.
241-AW-105	96.00	94.6	1.4	101%	1997 core samples, risers 11 and 13 (new numbering). Zip cord result averaged from applicable data in Table C-7.

Table C-2. Comparison of Core Extrusion and Zip Cord Data. (2 sheets)

Tank	Core extrusion (BBI) (in.)	Zip cord (in.)	Offset (core – zip cord) (in.)	Ratio, core extrusion/ zip cord	Comment
241-SY-102	52.83	40.3	12.5	131%	November 2000 cores, 2 from riser 21 and one from riser 3. Zip cords from October 2000. Zip cord result averaged from applicable data in Table C-7.
241-SY-103	121.04	--	--	--	March 2000 core samples. No zip cords were performed.

More data could be found by expanding the scope to include laboratory data reports and core sample work package records. This comparison is limited to core extrusion solids levels stated directly in BBI, which require no additional analysis. Based on the data presented, there is not an obvious bias between the methods. The data for DSTs 241-AW-104 and 241-AW-105 are very similar. The average zip cord measurement is higher for 241-AW-103 and significantly lower for 241-SY-102. The 241-AW-103 comparison is problematic. The zip cords from 1997 (both 114 in.) are consistent with the core samples. The zip cord from 1999 of 135 in. is significantly different than the core extrusion of 117 in. Also, two of the three measurements show a discrepancy between zip cord calculation methods (RPP-CALC-28931, *Zip Cord Solids Measurements for Double-Shell Tanks*), perhaps indicating a problem with the measurements.

C7.3.1.4 Comparison of Gamma Scans and Temperature Profiles

Gamma scans and temperature profiles were extensively evaluated in DST 241-SY-101 (RPP-6754, *Remediation of Crust Growth and Buoyant Displacement Gas Release Behavior in Tank 241-SY-101*). Figures 3-5 and 3-6 of RPP-6754 present gamma scans and temperature data from 241-SY-101 following dilution, transfer, and mixer pump runs to remediate gas retention safety issues. The document estimates an NCL height of 103 in. based on gamma scans and 101 in. based on temperature profiles as of August 31, 2000.

C7.3.1.5 Summary of Direct Method Comparisons

Comparisons of the measurement techniques of zip cord and sludge weight did not indicate a bias between the techniques, and conceptually these methods are virtually identical. The comparison between core sample extrusion and zip cord measurements in the same riser indicates good agreement in some cases and variability in others, with no consistent bias indicated. Comparing the original Waste Group A measurement techniques of gamma scan and temperature profile to each other in 241-SY-101 did not indicate a bias between these methods.

No direct comparison data (same riser, similar date) are available to compare the more accurate Waste Group A measurement techniques of ball rheometer, temperature validation probe, or gamma scan, to the current primary measurement techniques of sludge weight and zip cord. Measurements made using ENRAF densitometers conceptually are considered to be similar to measurements made using the ball rheometer originally used in the Waste Group A tanks, since both methods are instrumented to detect small changes in cable tension. Comparison of measurements taken using the ENRAF densitometer to sludge weight readings in the same riser using the two examples in DSTs 241-AN-106 and 241-SY-102 do indicate a bias of approximately 7 in., with the densitometer reading higher than the sludge weights.

Some data is available to compare gamma scan data to sludge weight data, albeit at different locations (or times) within the same tank. Since these comparisons may include effects due to topography, they are not used specifically to determine a measurement bias, but rather to provide additional support to the postulated difference in accuracy between different measurement techniques. These comparisons are discussed in Section C7.3.2.2.

The data set is sparse for all of these comparisons. The postulated bias or offset observed between sludge weight and densitometer seems to be confirmed by the direct measurements. To err on the conservative side in Waste Group calculations, this correction factor of 7 in. should be applied when utilizing sludge weight and zip cord data with densitometer data. No other method biases should be applied based on the data evaluated. Thus, densitometer measurements should be considered equivalent to the remaining measurement techniques (e.g., gamma scan, core extrusion). Therefore, the net effect is that the sludge weight and zip cord measurements should be adjusted upward by 7 in. for calculations in this appendix, and all other measurements should not be adjusted.

C7.3.2 Comparison of Different Techniques in Different Risers

Drawing firm conclusions based on comparisons of different methods taken from different risers within a tank is more difficult. Differences between measurement techniques may only be apparent if the solids surface is fairly uniform, or if the bias between techniques is dramatic, since variations in solids level due to topography changes may mask the differences due to measurement technique.

C7.3.2.1 Comparison of Sludge Weight, Zip Cord, and Densitometer Data

For this comparison, the unadjusted, "recent," sludge weight, zip cord, and densitometer data from Table C-7 below were used to calculate average results for each method from each tank. Using recent data for comparison should eliminate most concerns about changing solids levels over time rendering much of the data irrelevant. Results are shown in Table C-3. Most tanks presented had both sludge weight and zip cord data. Same-tank comparisons indicate significant variability in these averages, but with no obvious bias towards either technique. This is consistent with the conceptual arguments that these techniques will show more variability, but are essentially the same technique. The densitometer and gamma scan data, although not as numerous, indicate consistently higher measurements versus zip cord and sludge weights, with the possible exception of DST 241-AN-107. This is consistent with the conceptual arguments regarding bias and the offset calculated for densitometers above. A caveat is that surface level variability may be significant, and is not accounted for in this analysis. The effect of different measurement locations is discussed in Section C7.5.1.

Table C-3. Average Recent Data by Technique (Unadjusted).

Tank	Sludge weight (in.)	Zip cord (in.)	Densitometer (in.)	Gamma scan (in.)
241-AN-101	8.4	17.2	--	--
241-AN-102	47.7	66.7	--	--
241-AN-106	30.4	20.2	36.8	--
241-AN-107	84.5	84.1	85.9	--
241-AP-103	7.7	8.7	--	--
241-AP-105	40.1	41.4	--	--
241-AP-108	53.3	27.3	--	--
241-AW-106	103.0	98.6	--	--
241-AY-101	--	35.0	--	42.2
241-AY-102	54.8	60.9	--	--
241-SY-101	79.8	84.5	--	105.1
241-SY-102	50.3	59.5	64.6	--

Notes:

Source data from Table C-7.

Averages documented via SVF-1112, 2006, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington. An "average" may consist of only one result for that technique.

Tanks with only one technique reported are not included.

C7.3.2.2 Comparison of Gamma Scan, Sludge Weight and Zip Cord Data

DST 241-SY-101 has been of particular interest in previous revisions of this document because the BBI solids level has been based on gamma scans, unlike any other tank. Previous solids levels from gamma scans in the MITs of 103 in. (2000) and 102 in. (2001) are discussed in Section C7.3.1.4. Gamma scans were performed on February 9, 2006, in riser 18 (called MIT 17B per the old riser numbering) and riser 19 (MIT 17C). Results are reported in PCSACS (PCSACS 2006) as 8.751 ft (105.0 in.) for riser 18 and 8.761 ft (105.1 in.) for riser 19. These measurements are significantly higher than the latest sludge weight and zip cord readings as shown in Table C-4.

Table C-4. Recent Solids Measurements in Double-Shell Tank 241-SY-101.

Date	Riser	Measurement (in.)	Technique
1/15/2006	6	84.5	zip cord
8/22/2005	6	86.8	sludge weight
8/22/2005	21	79.8	sludge weight
2/9/2006	18	105.0	gamma scans
2/9/2006	19	105.1	gamma scans

The reasons for the large difference may be due to different locations (topography) or to a methodology bias exaggerated by a relatively soft solids consistency in DST 241-SY-101.

C7.3.3 Recommended Bias Adjustment

Conceptually, ball rheometers, core extrusions, temperature profiles, gamma scans, and densitometers would seem to yield conservative measurements of NCL height compared to sludge weight and zip cord measurements. The data reviewed above generally seem to bear this out. Densitometer measurements are considered equivalent to ball rheometer measurements that were the primary methodology used in the Waste Group A tanks. The measurement comparisons show that sludge weights do appear to have a bias relative to densitometers. This bias is considered to be representative of the bias between current measurement methods and the original methods used to develop the Waste Group methodology.

The recommendation that will be used throughout this document is that all measurement techniques will be treated equally except sludge weight and zip cord measurements. These techniques are considered to be biased low based on the comparison to densitometer measurements documented in Section C7.3. Therefore, average NCL heights measured by sludge weight or zip cord will be adjusted upwards by 7 in. to normalize those measurements to the same basis used to develop the original waste group methodology prior to calculating an average tank solids level for this appendix.

C7.4 DETERMINATION OF UNCERTAINTY (STANDARD DEVIATION) IN MEASUREMENTS

As discussed in Section C7.1, differences in solids level measurements may be the result of a bias between measurement techniques, as discussed in the previous section, or may be the result of variability due to subjectivity of the technique or due to differences in topography of the solid surface within a tank. If all solids level measurements are adjusted to the same basis, then the variability between measurements resulting from subjectivity of technique and surface topography effects can be quantified. This section of the document attempts to quantify this uncertainty through calculating a standard deviation between measurements.

C7.4.1 Recommended Uncertainties for Waste Group A Tanks

PNNL-15238 presents a detailed investigation of the NCL height uncertainties related to the five Waste Group A tanks. In PNNL-15238, Appendix D, the results of the NCL height evaluation are presented as follows.

> Sediment layer depth data for Hanford tanks AN-104, AN-105, AW-101, and SY-103 are investigated in this appendix. For each tank, we have up to three different measurement methods to evaluate the sediment depth. From sampler configuration and/or application, estimates are provided as to the "believability" or "reliability/repeatability" of that measurement method, denoted as σ_{mi}. The

three methods are ball rheometer, core samples, and the temperature validation probes deployed in the multifunction instrument trees (MITvip).

For each source, the believability is given as one standard deviation of the total range (assumed to be normally distributed; one standard deviation is 1/6 of the range) of the instrument. Layer interface identification is made with the ball rheometer by the changing buoyancy of the ball. To account for the changing buoyancy as the ball passes through the interface, the ball diameter, 10 cm, is taken to be the range. For the core samples, two 19-inch segment lengths to identify interfaces (range is increased to 40 inches to allow for possible partially full segments). Validation probe temperature measurements are typically taken every 4 inches, and two to three readings are typically required to determine an interface so the range is estimated at 12 inches. The respective σ_{mi} for each method are thus 0.017, 0.17, and 0.051 m. (PNNL-15238)

The "repeatability" estimates of 0.017, 0.17, and 0.051 m, or 1/6 of the range, correspond to 0.7, 6.7, and 2.0 in. for ball rheometer, core extrusion, and temperature validation profile, respectively. The document then states that "estimated mean and median depths should be weighted according to the believability of each instrument," and derives weighting factors of 0.89 for ball rheometer, 0.01 for core extrusions, and 0.10 for MIT validation profiles. So the weighted means below are based almost exclusively on the ball rheometer, and the core extrusions are virtually insignificant. The source data from the tanks evaluated in PNNL-15238, Appendix D, is shown in Table C-5.

Table C-5. Sediment Height Data by Tank (from Table D.2 of PNNL-15238).

Tank	Ball rheometer (m)	Core samples (m)	MIT validation profile (m)
241-AN-103	3.74, 3.86	2.92, 3.86	3.64, 3.71, 3.71, 3.71
241-AN-104	4.12, 3.72	4.4, 3.65, 4.6	4.47, 4.17, 4.17, 4.25
241-AN-105	4.55, 4.05	3.95, 3.98	4.93, 4.78, 5.01, 4.93,4.93
241-AW-101H*	2.59, 2.78	2.9	--
241-AW-101C*	--	--	2.57, 2.95, 2.95 ,2.87, 3.1
241-SY-103	3.2, 3.29	3.37, 2.9, 2.84	2.57, 3.556, 3.71, 2.95, 3.25, 4.09, 3.64, 3.1, 3.56, 3.71

Notes:

*"H" or "C" denotes hot and cold states for double-shell tank 241-AW-101, postulated in PNNL-15238 as a point in time where the waste behavior changed markedly.

PNNL-15238, 2005, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Tank Wastes*, Pacific Northwest National Laboratory, Richland, Washington.

MIT = multi-function instrument tree.

PNNL-15238 continues,

> …sediment layer depth distributions were made based on combination of measurements, resulting in the weighted mean and median estimates presented in Table 3.6. The maximum and minimum values are the weighted median ± 3 standard deviations. The standard deviations for hot and cold AW-101 are affected by the available data sources. This artifact is negated by assigning the average standard deviation of the other tanks. The difference in the median and mean in AW-101C is neglected given the altered standard deviation and assuming a normal distribution.
>
> The standard deviations are such that application in a normal distribution results in sediment depths that are expected to bound the measurements (compare Tables 3.4 and 3.5). The exception is the maximum AN-105 depth, a result of the weighting methodology that takes into account the relative accuracy of the measurements. (PNNL-15238)

The standard deviations are also weighted based on the "believability" and the number of observations for each method. The effect is not as simple as with the means. The effect seems to be that the core and especially temperature profiles have a much greater effect on the variability than they do on the mean. Weighted average NCL heights and weighted standard deviations as presented in PNNL-15238, Table 3-6, are shown in Table C-6, along with conversions from meters to inches.

Table C-6. Weighted Averages and Variability for Group A Tanks.[a]

Tank	Weighted median m (in.)	Weighted mean m (in.)	Standard deviation m (in.)	Data points
241-AN-103	3.787 (149.1)	3.785 (149.0)	0.29 (11.4)	8
241-AN-104	3.954 (155.7)	3.957 (155.8)	0.31 (12.2)	9
241-AN-105	4.360 (171.7)	4.358 (171.6)	0.154 (6.1)	9
241-AW-101H	2.687 (105.8)	2.687 (105.8)	0.287 (11.3)	3
241-AW-101C	2.950 (116.1)	2.888 (113.7)	0.287 (11.3)	5
241-SY-103	3.273 (128.9)	3.260 (128.3)	0.395 (15.6)	15

Notes:

[a]Data (m) from PNNL-15238, Table 3-6.

[b]"H" or "C" denotes hot and cold states for double-shell tank 241-AW-101, postulated in PNNL-15238 as a point in time where the waste behavior changed markedly.

PNNL-15238, 2005, *Predicting Peak Hydrogen Concentrations from Spontaneous Gas Releases in Hanford Tank Wastes*, Pacific Northwest National Laboratory, Richland, Washington.

The data (means and standard deviations) in PNNL-15238 for these tanks are not currently used in BBI. The standard deviations estimated in the table are much larger (5 to 9 in. more) for four of the five tanks listed above than the 6.5 in. applied generically in RPP-10006, *Methodology* *and Calculations for Assignment of Waste Groups for Large Underground Storage Tanks at Hanford*, Rev. 4. Therefore, for the current revision of this document it is recommended that these standard deviations be used for these tanks. This will provide some conservatism in the analyses for these tanks, which do seem to exhibit significant solids level variability.

C7.4.2 Compilation of Nonconvective Layer Height Measurements

Recently compiled zip cord, sludge weight, and densitometer solids level measurements are presented in Table C-7. Additional data is known to be available, including data for many of the DSTs not included here. However, the data was not readily available to support this compilation and analysis. A more complete data set would be helpful for this analysis, as well as to other users.

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AN-101				
10/8/2002	16	17.2	zip cord	RPP-CALC-28931
11/6/2003	16	17.2		
9/25/2003	3	7.9	sludge weight	2E-03-01249
	19	9.0		
Tank 241-AN-102				
6/29/1989	1	26	sludge weight	RPP-7625, Rev. 6, App B.
	3	32.25		
	20	39.25		
Mar-01	1	48.4		RPP-7918, Rev. 1A
	3	60.4		
	19	43.4		
11/16/2001	1	42.4		2E-01-01171
	3	62.1		
	19	41.5		
12/11/2001	1	39.375		
	19	41.5		
2/17/1998	20	38.2	zip cord	RPP-CALC-28931
8/9/2000	22	62.2		
11/8/2001	20	64.2		
5/14/2002	22	66.2		
3/14/2003	20	73.2		
11/30/2004	20	67.2		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AN-105				
11/8/2001	20	see note	zip cord	RPP-CALC-28931. Solid/liquid measurements in work package are ambiguous.
Tank 241-AN-106				
7/30/2002	19	2.2	zip cord	RPP-CALC-28931
3/11/2004	19	20.2		
7/10/2003	1	18.4	sludge weight	2E-03-00827. Riser 1 sludge weight data are suspect. Believed to be off (high) by 17 in.)
	18	1.6		2E-03-00827
	20	1.4		
9/14/2005	1	45.6		2E-04-01791. Riser 1 sludge weight data are suspect. Believed to be off (high) by 17 in.)
	18	31.6		2E-04-01791
	20	29.1		
12/13/2005	1	45.1		2E-04-01498. Riser 1 sludge weight data are suspect. Believed to be off (high) by 17 in.)
1/16/2006	1	36.8	ENRAF densitometer	WFO-WO-05-002504
Tank 241-AN-107				
1/28/2002	18	-31.1	sludge weight	2E-01-00798. No explanation for negative reading.
2/5/2002	19	73.1		2E-01-00798
	20	79.4		
3/3/2003	3	85.1		2E-03-00339
	18	83.1		
	19	91.6		
3/7/2003	20	81.6		
5/6/2003	18	57.6		2E-03-00794
	3	see note		2E-03-00794. No reading obtained, sludge weight could not be felt (no restriction in waste).
7/10/2003	18	84.4		2E-03-00827
	19	84.1		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AN-107 (continued)				
8/26/2002	avg	84.9	sludge weights	RPP-7917, Rev. 1A
7/3/2002	avg	86.1		
3/8/2002	avg	86.9		
2/14/2002	avg	88.4		
5/8/2001	avg	85.9	ENRAF densitometer	
3/5/2001	avg	85.9	sludge weights	
3/1/1996	avg	89.8		
2/10/1996	avg	81.6	ENRAF densitometer	
11/9/1994	avg	86.9	sludge weights	
10/22/1984	avg	35.5		
6/29/1989	19	46.10	sludge weight	RPP-7625, Rev. 6, App B.
	1	51.65		
	2	48.95		
8/26/2002	3	87.0	sludge weight	RPP-9759, Rev. 3
	18	84.0		
	20	83.0		
8/23/2002	1	90.5	ENRAF densitometer	2E-00-02199
8/22/2002	17	81.3		
7/2/2002	17	81.3		
3/8/2002	1	87.9		
	17	82.8		
2/13/2002	17	82.3		
	1	86.7		
1/31/2002	17	82.6		
	1	86.6		
2/5/2001	19	88.1	zip cord	RPP-CALC-28931
4/10/2002	19	88.1		
8/20/2002	19	79.1		
5/29/2003	20	84.1		
Tank 241-AP-103				
10/15/2002	2	8.7	zip cord	RPP-CALC-28931
9/28/2005	18	8.3	sludge weight	2E-04-01793
	19	7.3		
	20	8.3		
	22	7.0		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AP-104				
10/13/2005	18	7.3	sludge weight	WFO-WO-05-002284. "It felt like the bottom of the tank (very solid)."
	19	6.3		WFO-WO-05-002284
	22	7.3		WFO-WO-05-002284. "It felt like the bottom of the tank (very solid)."
Tank 241-AP-105				
6/23/1997	21	15.3	zip cord	RPP-CALC-28931
6/27/1997	23	35.4		
	29	34.4		
12/19/2001	12	38.0		
1/14/2002	12	39.5		
	21	44.3		
7/17/2003	21	43.3		
10/5/2005	18	37.8	sludge weight	2E-04-01793
	19	38.3		
	20	44.3		
Tank 241-AP-107				
7/10/2002	2	7.4	zip cord	RPP-CALC-28931
12/30/2003	2	5.4		
Tank 241-AP-108				
7/29/2003	1	1.7	zip cord	RPP-CALC-28931
4/27/2004	2	0.3		
1/8/2006	2	27.3		
9/29/2005	18	63.5	sludge weight	2E-04-01793
	19	63.0		
	20	33.3		
Tank 241-AW-101				
9/13/1987	2	25.88	sludge weight	RPP-7625, Rev. 6, App B.
7/8/1988	15B (not on riser map)	12		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AW-102				
12/23/2003	18	2.1	zip cord	RPP-CALC-28931
10/20/1994	22	20.5	sludge weight	RPP-7625, Rev. 6, App B.
	22	19.5		
Tank 241-AW-103				
4/24/1997	11	114.2	zip cord	RPP-CALC-28931
	13	114.1		
8/24/1999	3	135.4		
10/24/2005	17	118.9		
Tank 241-AW-104				
6/10/1997	13	82.1	zip cord	RPP-CALC-28931
6/9/1997	14	82.1		
6/10/1997	17	82.1		
1/29/2003	14	55.4		
Tank 241-AW-105				
4/28/1997	11	93.1	zip cord	RPP-CALC-28931
	13	96.1		
9/2/2001	22	99.1		
3/7/2003	19	71.6		
4/16/2004	14	86.6		
Tank 241-AW-106				
7/7/1991	2	99.9	sludge weight	RPP-7625, Rev. 6, App B.
	18	95.5		
	20	72.5		
Jun-94	3	61.0	sludge weight	Data from BBI derivation text, post campaign 94-1. Date listed is approximate (likely within ~ 1 or 2 months).
	22	53.4		
Dec-94	2	97.6	sludge weight	Data from BBI derivation text, post campaign 94-2. Date listed is approximate (likely within ~ 1 or 2 months).
	3	72.5		
	18	99.8		
	20	73.0		
	22	52.4		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AW-106 (continued)				
Aug-95	2	100.5	sludge weight	Data from BBI derivation text, post campaign 95-1. Date listed is approximate (likely within ~ 1 or 2 months).
	3	73.4		
	18	112.9		
	20	73.4		
	22	52.0		
Jun-96	2	102.4	sludge weight	Data from BBI derivation text, post campaign 96-1. Date listed is approximate (likely within ~ 1 or 2 months).
	3	76.0		
	18	113.3		
	20	61.9		
	22	54.5		
Apr-97	2	102.1	sludge weight	Data from BBI derivation text, post campaign 97-1. Date listed is approximate (likely within ~ 1 or 2 months).
	3	73.4		
	18	113.3		
	20	74.3		
	22	51.1		
Oct-97	3	74.8	sludge weight	Data from BBI derivation text, post campaign 97-2. Date listed is approximate (likely within ~ 1 or 2 months).
	20	74.5		
	22	69.7		
4/26/1999	3	74.8	sludge weight	Data from BBI derivation text.
	20	74.5		
	22	69.6		
2/8/2004	2	115.1		
	3	83.8		
	18	120.8		
	20	96.8		
	22	98.4		
4/1/2003	19	98.6	zip cord	RPP-CALC-28931
Tank 241-AY-101				
7/1/1997	51	39.5	sludge weight	RPP-7625, Rev. 6, App B.
	53	40.5		
	55	39.0		
	59	39.5		
	63	38.0		
	67	38.5		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AY-101 (continued)				
3/30/2001	44	43.1	gamma scan in drywell	PCSACS
4/26/2001	44	40.7		
3/30/2001	48	46.1		
4/26/2001	48	46.1		
3/30/2001	45	38.0		
4/26/2001	45	39.0		
4/26/2001	50	42.9	estimated from neutron scan in drywell	PCSACS, ILL Reinterpretation data comments
4/3/2002	61	35.0	zip cord	RPP-CALC-28931
Tank 241-AY-102				
10/29/1988	52	19.5	sludge weight	RPP-7625, Rev. 6, App B.
	53	8.0		
	56	6.5		
	58	10.3		
	60	12.0		
	68	11.0		
2/28/2001	56	61.3		2E-04-01788
	58	62.3		
	60	60.0		
7/1/2004	56	53.5		
	58	54.3		
	60	56.8		
3/6/2001	64	60.0	zip cord	RPP-CALC-28931
4/19/2003	65	61.9		
9/3/1998	55	9.3	ENRAF densitometer	2E-98-01827
10/26/1998	55	9.15	ENRAF densitometer	2E-98-01996 (supporting 241-C-106 sluicing)
11/15/1998	55	9.00		
11/19/1998	55	10.49		
11/19/1998	55	11.43		
11/20/1998	55	12.16		
11/20/1998	55	12.29		
11/21/1998	55	12.64		
11/21/1998	55	12.73		
11/23/1998	55	12.90		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AY-102 (continued)				
11/24/1998	55	12.78		
11/25/1998	55	12.47		
11/30/1998	55	12.40		
12/1/1998	55	12.21		
12/7/1998	55	12.11		
12/17/1998	55	12.14	ENRAF densitometer	2E-98-02533
12/17/1998	55	12.18		
12/18/1998	55	12.26		
12/18/1998	55	12.22		
12/19/1998	55	12.28		
12/19/1998	55	12.25		
12/22/1998	55	12.17		
12/29/1998	55	12.17		
1/6/1999	55	12.15		
Tank 241-AZ-101				
1/23/1989	70	15.75	sludge weight	RPP-7625, Rev. 6, App B.
	71	11.25		
	73	23		
	74	15.5		
	75	13		
	76	22.5		
2/28/1989	70	15.5		
	71	9.75		
	73	22.5		
	74	15.25		
	75	13		
	76	14.5		
5/30/1989	70	15.5		
	71	10.25		
	74	14.75		
	75	12.25		
	76	15.25		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AZ-101 (continued)				
12/26/1989	71	11.25		
	74	15.25		
	75	11.75		
	76	14.75		
6/28/2000	70	16.75	sludge weight	2E-00-00250
	74	26.5		
	75	22.5		
	76	15.5		
8/16/2000	70	15.5		
	74	24		
	75	20		
	76	15		
7/19/2000	RMIS image p. 75 too faint to tell what is on data sheet.			
6/21/2000	76	19		
	70	15.5		
	74	25		
	75	22		
6/14/2000	70	5.5		
	74	22		
	75	17		
	76	21		2E-00-00250. First contact; slack tape was 11 in. lower.
Unknown date	RMIS image p. 88 too faint to tell what is on data sheet.			2E-00-00250
6/5/2000	70	4		
	74	22.25		
	75	19.5		
	76	4		
6/4/2000	70	RMIS image p. 95 too faint.		
	74			
	75			
	76			

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AZ-101 (continued)				
6/2/2000	70	1.5		
	74	20		
	75	12.5		
	76	1		
6/1/2000	70	1		
	74	14.7		
	75	13		
	76	0.75		
5/30/2000	RMIS image p. 113 too faint to tell what is on data sheet.			
4/18/2000	74	17.75		
	75	16.5		
	70	16.75		
	76	18.75		
2/3/2000	70	16.625		
	74	18		
	75	16.625		
	76	18.75		
Tank 241-AZ-102				
1/23/1989	71	19.25	sludge weight	RPP-7625, Rev. 6, App B.
	73	33.25		
	74	39.25		
	75	38.75		
	76	29.25		
2/28/1989	71	20.25		
	73	33.25		
	74	40.75		
	75	40.25		
	76	28.25		
5/30/1989	71	19.75		
	73	32.75		
	74	39.25		
	75	39.25		
	76	27.25		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-AZ-102 (continued)				
12/26/1989	71	19.75		
	73	32.25		
	74	39.25		
	75	41.45		
	76	27.95		
8/21/2003	59	37.7	zip cord	RPP-CALC-28931
Tank 241-SY-101				
4/4/2000	6	10.0	zip cord	RPP-CALC-28931
6/20/2000	6	35.0		
9/19/2003	6	84.5		
10/14/2003	6	83.3		
1/15/2006	6	84.5		
8/22/2005	6	86.8	sludge weight	2W-04-01792
	21	79.8		
2/9/2006	18	105.0	gamma scan in MIT	PCSACS, ILL Reinterpretation data comments
	19	105.1		
Tank 241-SY-102				
1/30/1987	1	21	sludge weight	RPP-7625, Rev. 6, App B.
	19	18		
5/12/1987	1	40		
	19	32		
	20	17.25		
7/2/1997	19	13.7	zip cord	RPP-CALC-28931
7/8/1997	22	16.2		
2/16/1999	4	23.8	ENRAF solids level measurement	2W-99-00251
9/9/1999	2	10.3	zip cord	RPP-CALC-28931
1/10/2000	3	11.5		
2/25/2000	3	26.5		
4/11/2000	3	40.5		
10/3/2000	3	40.5		
8/15/2001	3	43.5		
4/17/2002	3	41.5		
12/23/2002	3	42.0		
9/29/2003	3	42.5		

Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment
Tank 241-SY-102 (continued)				
12/4/2003	3	43.0		
2/4/2004	3	43.5		
12/28/2004	3	43.5		
6/30/2005	3	55.5		
8/31/2005	3	55.5		
2/15/2006	3	59.5		
10/10/2000	21	40.1		
12/9/2004	19	46.6	sludge weight	2W-04-01377
12/14/2004	19	52.7	ENRAF densitometer	2W-04-01377
6/24/2005	19	61.9		CLO-WO-05-001621
8/18/2005	19	62.7		CLO-WO-05-01825
8/29/2005	19	63.6		CLO-WO-05-01891
10/5/2005	19	64.6		CLO-WO-05-1964
6/22/2005	2	50.5	sludge weight	2W-04-01792
9/8/2005	2	50.3		

Notes:

Data documented via SVF-1112, 2006, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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Table C-7. Unadjusted Solids Levels in Double-Shell Tanks from Available Zip Cord, Sludge Weight, and Densitometer Readings. (13 sheets)

Date	Riser	Measurement (in)	Method	Comment

Notes (continued):

2E-98-01827, 1998, *241-AY-102 Densitometer Operation for Data*, Lockheed Martin Hanford Corporation, Richland, Washington.

2E-98-01996, 1999, *241-AY Obtain Densitometer Readings at 102-AY*, Lockheed Martin Hanford Corporation, Richland, Washington.

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2W-99-00251, 1999, *Obtain Sludge Level in SY-102*, Lockheed Martin Hanford Corporation, Richland, Washington.

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WFO-WO-05-002504, 2005, *241-AN-106 Densitometer Calibration Supporting 241-04-01498*, CH2M HILL Hanford Group, Inc., Richland, Washington.

BBI = best basis inventory.
ENRAF = Enraf-Nonius Series 854 (gauge).
ILL = interstitial liquid level.
MIT = multifunction instrument tree.
PCSACS = personal computer Surveillance Analysis Computer System.

C7.4.3 Normalized Solids Level Data

Based on the evaluation in Section C7.3, zip cord and sludge weight data should be adjusted upward by 7 in. to provide a more conservative estimate of solids levels for use in Waste Group calculations and to normalize the measurements to the techniques used for the Waste Group A tanks. Table C-8 presents a subset of the zip cord, sludge weight, and densitometer data of Table C-7. The last measurement in each riser of a tank is presented. Older data or measurements taken prior to significant tank changes (e.g., evaporator slurry transfers or retrieval transfers) were typically excluded. The recommended adjustment is made to zip cord and sludge weight data, and statistics are calculated.

Table C-8. Recent Solids Level Measurements Adjusted for Presumed Method Bias. (4 sheets)

Date	Riser	Measurement (in.)	Method	Adjusted measurement (in.)*	Adjusted mean (in.)	Std dev (in.)	Count
Tank 241-AN-101							
9/25/2003	3	7.9	sludge weight	14.9	18.3	5.1	3
11/6/2003	16	17.2	zip cord	24.2			
9/25/2003	19	9.0	sludge weight	16.0			
Tank 241-AN-102							
12/11/2001	1	39.375	sludge weight	46.4	62.3	13.7	5
11/16/2001	3	62.1		69.1			
12/11/2001	19	41.5		48.5			
11/30/2004	20	67.2	zip cord	74.2			
5/14/2002	22	66.2		73.2			
Tank 241-AN-106							
1/16/2006	1	36.8	ENRAF densitometer	36.8	34.7	5.1	4
9/14/2005	18	31.6	sludge weight	38.6			
3/11/2004	19	20.2	zip cord	27.2			
9/14/2005	20	29.1	sludge weight	36.1			
Tank 241-AN-107							
8/23/2002	1	90.5	ENRAF densitometer	90.5	89.6	4.1	6
3/3/2003	3	85.1	sludge weight	92.1			
8/22/2002	17	81.3	ENRAF densitometer	81.3			
7/10/2003	18	84.4	sludge weight	91.4			
7/10/2003	19	84.1		91.1			
5/29/2003	20	84.1	zip cord	91.1			

Table C-8. Recent Solids Level Measurements Adjusted for Presumed Method Bias. (4 sheets)

Date	Riser	Measurement (in.)	Method	Adjusted measurement (in.)*	Adjusted mean (in.)	Std dev (in.)	Count
Tank 241-AP-103							
10/15/2002	2	8.7	zip cord	15.7	14.9	0.7	5
9/28/2005	18	8.3	sludge weight	15.3			
9/28/2005	19	7.3		14.3			
9/28/2005	20	8.3		15.3			
9/28/2005	22	7.0		14.0			
Tank 241-AP-104							
10/13/2005	18	7.3	sludge weight	14.3	13.9	0.6	3
10/13/2005	19	6.3		13.3			
10/13/2005	22	7.3		14.3			
Tank 241-AP-105							
1/14/2002	12	39.5	zip cord	46.5	47.6	3.0	5
10/5/2005	18	37.8	sludge weight	44.8			
10/5/2005	19	38.3		45.3			
10/5/2005	20	44.3		51.3			
7/17/2003	21	43.3	zip cord	50.3			
Tank 241-AP-107							
12/30/2003	2	5.4	zip cord	12.4	12.4	--	--
Tank 241-AP-108							
1/8/2006	2	27.3	zip cord	34.3	53.8	19.2	4
9/29/2005	18	63.5	sludge weight	70.5			
9/29/2005	19	63.0		70.0			
9/29/2005	20	33.3		40.3			
Tank 241-AW-102							
12/23/2003	18	2.1	zip cord	9.1	9.1	--	--
Tank 241-AW-103							
10/24/2005	17	118.9	zip cord	125.9	125.9	--	--
Tank 241-AW-104							
1/29/2003	14	55.4	zip cord	62.4	62.4	--	--
Tank 241-AW-105							
4/16/2004	14	86.6	zip cord	93.6	92.8	13.8	3
3/7/2003	19	71.6		78.6			
9/2/2001	22	99.1		106.1			

Table C-8. Recent Solids Level Measurements Adjusted for Presumed Method Bias. (4 sheets)

Date	Riser	Measurement (in.)	Method	Adjusted measurement (in.)*	Adjusted mean (in.)	Std dev (in.)	Count
Tank 241-AW-106							
2/8/2004	2	115.1	sludge weight	122.1	109.2	13.5	6
2/8/2004	3	83.8		90.8			
2/8/2004	18	120.8		127.8			
4/1/2003	19	98.6	zip cord	105.6			
2/8/2004	20	96.8	sludge weight	103.8			
2/8/2004	22	98.4		105.4			
Tank 241-AY-101							
4/26/2001	44	40.7	gamma scan in drywell	40.7	42.1	2.6	5
4/26/2001	45	39.0		39.0			
4/26/2001	48	46.1		46.1			
4/26/2001	50	42.9	estimated from neutron scan in drywell	42.9			
4/3/2002	61	35.0	zip cord	42.0			
Tank 241-AY-102							
7/1/2004	56	53.5	sludge weight	60.5	64.3	3.6	5
7/1/2004	58	54.3		61.3			
7/1/2004	60	56.8		63.8			
3/6/2001	64	60.0	zip cord	67.0			
4/19/2003	65	61.9		68.9			
Tank 241-AZ-101							
8/16/2000	70	15.5	sludge weight	22.5	25.6	4.2	4
8/16/2000	74	24		31.0			
8/16/2000	75	20		27.0			
8/16/2000	76	15		22.0			
Tank 241-AZ-102							
8/21/2003	59	37.7	zip cord	44.7	44.7	--	--
Tank 241-SY-101							
1/15/2006	6	84.5	zip cord	91.5	97.1	9.4	4
8/22/2005	21	79.8	sludge weight	86.8			
2/9/2006	18	105.0	gamma scan in MIT	105.0			
2/9/2006	19	105.1		105.1			

Table C-8. Recent Solids Level Measurements Adjusted for Presumed Method Bias. (4 sheets)

Date	Riser	Measurement (in.)	Method	Adjusted measurement (in.)*	Adjusted mean (in.)	Std dev (in.)	Count
Tank 241-SY-102							
9/8/2005	2	50.3	sludge weight	57.3	62.8	4.9	3
2/15/2006	3	59.5	zip cord	66.5			
10/5/2005	19	64.6	ENRAF densitometer	64.6			

Notes:

*The method bias is assumed to be -7 in. for sludge weight and zip cord measurements relative to densitometer and all other measurements. Therefore, 7 in. is added to the sludge weight and zip cord data prior to performing statistics. All data documented via SVF-1112, 2006, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

ENRAF = Enraf-Nonius Series 854 (gauge).
MIT = multifunction instrument tree.

C7.4.4 Calculation of Nonconvective Layer Height Standard Deviation for Double-Shell Tanks

Prior revisions of this document have used a solid level variability (standard deviation) of 6.0 or 6.5 in. (RPP-10006, Rev. 4, Appendix I). These estimates were based on sludge weight data for 10 tanks presented in RPP-7625. Data for individual tanks were grouped and a mean and standard deviation were calculated. The combined variability was calculated as a pooled standard deviation, using the mean, standard deviation, and number of measurements for each tank.

For this document revision, the same statistical approach has been applied to the adjusted recent solids level data from Table C-8. The statistical data are summarized in Table C-9.

Table C-9. Summarized Statistical Data[a] From Table C-8. (2 sheets)

Tank[b]	Mean (in.)	Standard deviation (in.)	Count
241-AN-101	18.3	5.1	3
241-AN-102	62.3	13.7	5
241-AN-106	34.7	5.1	4
241-AN-107	89.6	4.1	6
241-AP-103	14.9	0.7	5
241-AP-104	13.9	0.6	3
241-AP-105	47.6	3.0	5
241-AP-108	53.8	19.2	4
241-AW-105	92.8	13.8	3

Table C-9. Summarized Statistical Data[a] From Table C-8. (2 sheets)

Tank[b]	Mean (in.)	Standard deviation (in.)	Count
241-AW-106	109.2	13.5	6
241-AY-101	42.1	2.6	5
241-AY-102	64.3	3.6	5
241-AZ-101	25.6	4.2	4
241-SY-101	97.1	9.4	4
241-SY-102	62.8	4.9	3
Pooled Standard Deviation[c]: 8.8 in.			

Notes:

[a]These data are based on adjusted values from Table C-8.

[b]Tanks with only one measurement not do not affect the calculation and are not included in this table.

[c]Pooled standard deviation calculation documented via SVF-1112, 2006, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

The pooled standard deviation based on the data presented above is 8.8 in. (documented via SVF-1112, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF-1112 All Solids R0.xls'*, Rev. 0). Some of the variability estimates in the table are based on numerous measurements. The recommended variability used for Waste Group calculations should be based on the individual tank standard deviation if the tank has four or more measurements in the table. If the tank has three measurements or less, or if it is not listed and no other information is available, then the pooled standard deviation of 8.8 in. should be used.

C7.5 OTHER CONSIDERATIONS

C7.5.1 Effect of Multiple Riser Locations

NCL heights can vary widely across the tanks. It is very important to obtain a number of readings over the tank, especially as the NCL height becomes greater and approaches levels that could be of concern for creating Waste Group A conditions (approximately 80 in. and greater). Tanks with NCL levels taken at one or two locations can give a false sense of security due to possible differences in NCL height within a given tank.

A tank that illustrates the effect of location on solids height is DST 241-AW-106. Five sludge weight readings were taken across the tank. The NCL heights ranged from 69.6 in. to 113.3 in., a difference of almost 44 in. It also appears that tanks with air lift circulators (241-AY and 241-AZ tank farms) have more uniform surfaces. Also, solids that are relatively weak, such as in

DST 241-AN-107, may have a self-leveling effect, as this tank shows less variability than many other tanks.

Solids topography in SSTs is evaluated by photograph or video to document stabilization (HNF-SD-RE-TI-178) as discussed in Section C7.0. Large variations, especially from tank wall to center, are common. Reported surface level differences range from an average of 23 in. in saltcake tanks to 7 in. in sludge tanks (RPP-7625, Appendix B). SST design, wastes, and process histories (e.g., saltwell pumping) may differ substantially from the DSTs. However, there are ample reasons to consider radial variability as a significant issue in the DSTs. Radial variability has been noted in DST 241-AP-105 (HNF-SD-WM-ER-360, *Tank Characterization Report for Double-Shell Tank 241-AP-105*). Temperature cooling from the annulus is most likely the major reason for radial variability but transfer history will play a part, too. For example, transfer pumps are most often stick pumps located in the central pump pits of a DST. The elevation of the pump suction is typically low in the tank (within 10 in. of the bottom). Such configurations are likely to transfer some solids from around the region of the pump suction and leave settled solids further away undisturbed.

Most techniques (except video, photographs, and proposed SLIM) are limited to single point measurements under risers.

Another point to be made about riser locations is that the outermost tank risers in the 241-AN, 241-AW, and 241-SY tank farms are on a 28-ft radius. The tanks are 75 ft in diameter or 37.5 ft in radius. Area (and volume for a cylinder such as the DST waste configuration) is a function of the radius squared. Thus, the waste volume outside of the 28 ft radius is

$$\frac{(37.5)^2 - (28)^2}{(37.5)^2} = 44\%.$$

This means that 44% of the waste is outside of the region that can be sampled or evaluated by single point measurements under risers for tanks in these farms. However, this was also the case for the Group A tanks from which the waste group correlation was developed. The furthest risers in the 241-AP tank farm are on a 30-ft radius, and on a 34.75-ft radius for the 241-AY and 241-AZ tank farms.

C7.5.2 Changes in Solids Levels Over Time

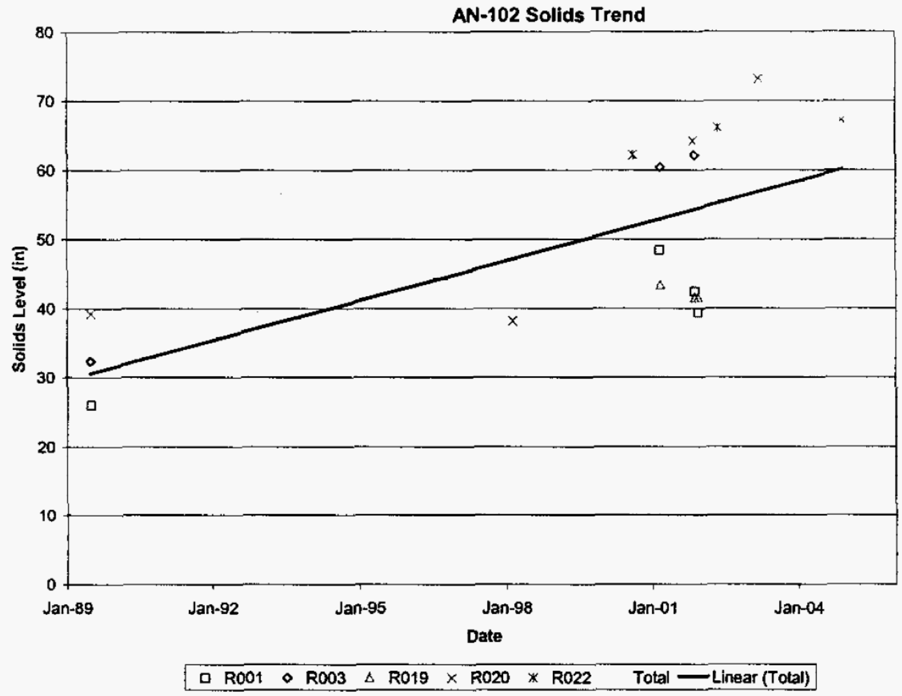
A number of ongoing processes may change the solids level in a tank over time, especially in tanks with concentrated waste. These include evaporation, absorption of carbon dioxide from air, chemistry (pH) changes, organic degradation reactions, temperature changes, chemical additions, and transfers. A brief description of these processes follows.

- Evaporation removes water and concentrates dissolved species. If a compound is at equilibrium between the precipitated and aqueous phases, it will precipitate and add to the solids layer.

- Absorption of carbon dioxide leads to carbonate saturation and precipitation and caustic (pH) depletion.
- pH reduction or caustic depletion leads to precipitation of pH dependent species, especially dissolved aluminum.
- Aging of organic causes precipitation of relatively insoluble species such as oxalate, along with caustic depletion.
- Waste temperature changes cause solubility changes. The DSTs are generally cooling as radionuclide concentrations decay, and lower temperatures result in reduced solubility for almost all species.
- Chemical additions may dissolve solids (e.g., aluminum compounds with caustic addition) or may cause precipitation by increasing solution ionic strength.
- Transfers may result in precipitation (e.g., mixing of wastes with differing fluoride and phosphate concentrations may lead to precipitation of the double salt natrophosphate) or could result in dissolution if different caustic concentrations are involved. Transfers may result in inadvertent pumping of solids due to waste and pump configuration. Tanks that have received transfers of evaporator slurry, either directly or from another tank, are often observed to have an increase in solids. Transfers can cause solids with trapped gas to expand or compress as the hydrostatic pressure from the supernatant layer changes.

One example of an increase of solids with time is DST 241-AN-102. The solids history back to 1989 is presented in Figure C-3. The transfer history since 1984 is very limited, consisting of a small waste transfer in 1992 and a caustic addition in 2001. The solids level was about 33 in. in 1989 and has increased to over 60 in. based on measurements taken during the last 2 years. All of the mechanisms described above, except waste transfers, have probably contributed to the increased solids.

Figure C-3. Double-Shell Tank 241-AN-102 Solids History.



Because of these issues, it is recommended that Waste Group B and C DSTs should have solids level measurements at least every 5 years.

C7.6 RECOMMENDED APPROACH TO ESTABLISH NONCONVECTIVE LAYER HEIGHTS FOR DOUBLE-SHELL TANKS

In order to address the issues identified in PER-2006-0041, including accounting for bias between measurement techniques compared to the techniques originally used in the Waste Group A tanks; accounting for surface topography changes and variability in measurements across a tank; and incorporating recently acquired solids level data for several tanks, the following approach is recommended to establish DST mean solids levels (NCL) and standard deviations for use in the flammable gas waste group calculations:

- If the adjusted tank mean is given in Table C-9, then this result should be used, unless the mean BBI solids level (given in Table C-10) is higher. The adjusted means include the conservative adjustment (7 in.) of zip cord and sludge weight data relative to other measurements.

- If the tank is not in Table C-9, and the BBI derivation is based completely on zip cord and/or sludge weights, then apply the 7-in. adjustment to the BBI solids level.

- For DST 241-SY-101, a mean of 105 in. from the February 2006 gamma scans is used.
- For variability, if the tank is listed in Table C-9, and there are four or more measurements, then the variability (standard deviation) listed in Table C-9 should be used.
- For variability, if the tank is one of the Group A tanks listed in Table C-6 (from PNNL-15238), then the standard deviation listed in Table C-6 should be used.
- If the tank is not listed in Table C-6 nor Table C-9, or if the data in Table C-9 are based on three measurements or less, then the pooled standard deviation of 8.8 in. (documented in Section C7.4.4) should be used.

The BBI settled solids height used to derive the solids volume is presented in Table C-10, along with the basis for the solids level estimate. Also presented are the recommended adjusted solids heights and standard deviations for use in the Waste Group calculations.

Table C-10. Recommended Nonconvective Layer Heights and Variances for Double-Shell Tank Waste Group Calculations. (2 sheets)

Tank	BBI solids level* (in.)	BBI basis	Adjusted solids level (in.)	Variability (standard deviation) (in.)
241-AN-101	11.3	Sludge level and zip cord	18.3	8.8
241-AN-102	56.1	Sludge level and zip cord	62.3	13.7
241-AN-103	149	Core extrusion	149	11.4
241-AN-104	163	Analysis	163	12.2
241-AN-105	177	Analysis	177	6.1
241-AN-106	18	Sludge level or zip cord	34.7	5.1
241-AN-107	83.8	Sludge level	89.6	4.1
241-AP-101	0	No solids	0	8.8
241-AP-102	8.5	Sludge level	15.5	8.8
241-AP-103	0	No solids	14.9	0.7
241-AP-104	0	No solids	13.9	8.8
241-AP-105	32.4	Analysis	47.6	3.0
241-AP-106	0	No solids	0	8.8
241-AP-107	0	No solids	12.4	8.8
241-AP-108	0	Zip cord	53.8	19.2
241-AW-101	112	Core extrusion	112	11.3
241-AW-102	2.44	Zip cord	9.1	8.8
241-AW-103	113.75	Core extrusion	125.9	8.8

Table C-10. Recommended Nonconvective Layer Heights and Variances for Double-Shell Tank Waste Group Calculations. (2 sheets)

Tank	BBI solids level* (in.)	BBI basis	Adjusted solids level (in.)	Variability (standard deviation) (in.)
241-AW-104	81	Core extrusion	81.0	8.8
241-AW-105	96	Core extrusion	96.0	8.8
241-AW-106	102.95	Sludge weight	109.2	13.5
241-AY-101	35	Sludge weight	42.1	2.6
241-AY-102	54.83	Sludge weight	64.3	3.6
241-AZ-101	18.9	Sludge weight	25.6	4.2
241-AZ-102	38	Sludge weight	44.7	8.8
241-SY-101	100	Gamma scans	105.0	9.4
241-SY-102	52.83	Core extrusion	62.8	8.8
241-SY-103	121.04	Core extrusion	121.04	15.6

Notes:

*BBI Tank Interpretive Reports accessed February 2006 (BBI 2006).

C7.7 SUMMARY OF DOUBLE-SHELL TANK NONCONVECTIVE LAYER CHANGES

Additional solids level measurement data is compiled and presented to improve mean and variability calculations. It is recognized that the data set could be enlarged with additional effort.

The issue of bias between solids level measurement techniques is addressed in a preliminary fashion. The conclusion is that zip cord and sludge weight measurements may be biased low relative to densitometer measurements (and by extrapolation, to all other techniques as well). Thus, for the calculations in this document, an offset of 7 in. is added to zip cord and sludge weight measurements used to calculate mean DST solids levels. This attempts to account for the difference between current measurement methods and those originally used for the tanks that define Waste Group A conditions.

Variability estimates are updated based on the data analyzed herein and in PNNL-15238.

Because of many factors affecting solids levels over time, it is recommended that solids level measurements be performed in DSTs at least every 5 years. Waste Group A tanks could reasonably be excluded from this recommendation.

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APPENDIX D

DETERMINATION OF VOID FRACTION

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CONTENTS

FIGURES

TABLES

LIST OF TERMS

acf	actual cubic feet (gas conditions at depth at mid-point of nonconvective layer layer)
BPE	barometric pressure effect
BPE1	original BPE model
BPE2	steep slope form of the BPE model
dL/dP	change in tank level divided by corresponding change in pressure
DST	double-shell tank
ENRAF	Enraf-Nonius Series 854 (gauge)
MIX-LIQ	mixed waste form with ≥ 1 m liquid over solids
MIX-NL	mixed waste form with < 1 m liquid over solids
PCSACS	personal computer Surveillance Analysis Computer System
PNNL	Pacific Northwest National Laboratory
RGS	Retained Gas Sampler
SC/SS	saltcake/salt slurry
SC/SS-LIQ	saltcake/salt slurry waste form with ≥ 1m liquid over solids
SC/SS-NL	saltcake/salt slurry waste form with < 1m liquid over solids
SL-LIQ	sludge waste form with ≥ 1 m liquid over solids
SL-NL	sludge waste form with < 1 m liquid over solids
SST	single-shell tank
VFI	Void Fraction Instrument

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

Scope of Review: Appendix D – Determination Of Void Fraction
(e.g., document section or portion of calculation)

Engineer/Analyst: S. A. Barker [signature] Date: 7/25/2006

Organizational Mgr: M. A. Knight [signature] Date: 7/25/2006

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APPENDIX D

DETERMINATION OF VOID FRACTION

D1.0 OBJECTIVE

When analyzing tank hazards relating to flammable gas accidents it is important understand the ability of solid wastes to retain gas and then release it due to change in tank characteristics or due to outside influence or waste disturbing activities. This appendix documents the calculations performed to develop void fraction estimates along with the statistical information for the 177 waste tanks at Hanford.

D2.0 BACKGROUND DATA SOURCES FOR VOID FRACTION

Void fraction data can be obtained or derived from the following available field measured data sources:

- **Void Fraction Instrument (VFI):** An average gas volume fraction may be estimated from direct measurements of the local gas volume fraction with the VFI.
- **Retained Gas Sampler (RGS):** A localized average gas volume fraction may be estimated from direct measurements of the local gas volume fraction with the RGS.
- **Barometric pressure effect (BPE) method:** An average void fraction can be computed from the correlation of the changes in waste surface level in response to barometric pressure fluctuations.
- **Surface level rise:** An increase in global average void fraction may be indicated by a rise in waste surface level such as 241-SY-101 prior to remediation (not used in this report).
- **Core sample X-ray:** Voids or gaps shown in X-rays of core samples may indicate stored gas. However, these observations are only qualitative and cannot be used to derive an average void fraction value (not used in this report).

In this report, only the data from VFI, RGS and BPE are used to obtain or derive the void fraction for waste tanks at Hanford. Void fraction is available directly from the data sources of VFI and RGS, while it requires extra data such as waste level, waste density, etc., and calculations to convert the BPE data to a void fraction. Once the void fraction data are obtained, a value is assigned to each individual tank based on the data quality preference given in Section 4.0. For those tanks that do not have field measured data, a default value is assigned based on the tank waste type (as defined in SNL-000198 and listed in Appendix A). The default values for each waste type are developed statistically based on the available measured field data. Details of VFI, RGS and BPE data measurements are given below.

D2.1 VOID FRACTION INSTRUMENT

A VFI deployment produces a relatively large number of data points in the vertical direction, but only from two risers. Each measurement is based on sampling a 367 mL waste volume (roughly a cylinder 3 in. in diameter and 3 in. long). A basic assumption made in computing the average void fraction is that data from two risers represent the entire tank. In five of the six double-shell tanks (DST) sampled with the VFI, RGS samples from two additional risers and BPE results have provided independent corroboration that this assumption is valid. Uncertainties in the average void fraction derived from VFI data range from 10 to 30% standard deviation due mainly to variability in the data (PNNL-11536, *Gas Retention and Release Behavior in Hanford Double-Shell Waste Tanks*). For these reasons the Analyst Team concluded that VFI data, with or without additional data from RGS samples, are sufficiently representative to characterize the average void fraction for a specific tank.

D2.2 RETAINED GAS SAMPLER

A single RGS gas fraction measurement is made on a 19-in. core sample segment. The void value from an RGS segment is generally as accurate as a single VFI data point, but there are far fewer RGS data. There are usually only 3 to 6 RGS measurements per tank, 1 to 3 per riser, compared to 20 to 40 VFI data points. Therefore, it is much more difficult to show that the RGS measurements are representative of the entire tank. In comparing the results for DSTs, the RGS differed from the VFI by about 50% for two tanks (DSTs 241-AN-103 and 241-AW-101) where the sparse RGS data missed the bulk of the stored gas (PNNL-11450, *Composition and Quantities of Retained Gas Measured in Hanford Waste Tanks 241-AW-101, A-101, AN-105, AN-104, and AN-103*). VFI data for single-shell tank (SST) waste are not available. For SSTs, the average gas fraction measurements with the RGS are compared with results from BPE and surface level rise analyses. Where the latter two support each other, the RGS value may differ by 50% (PNNL-11450, PNNL-11777, *Composition and Quantities of Retained Gas Measured in Hanford Waste Tanks 241-U-103, S-106, BY-101, and BY-109*). Based on these comparisons, where only RGS data are available, Pacific Northwest National Laboratory (PNNL) assigns an uncertainty of ±50% to the RGS value. For these reasons, the Analyst Team concluded that RGS data alone are not sufficiently representative to characterize the average void fraction in the tank waste, but can be used in determining void fraction distributions for the respective waste forms.

D2.3 BAROMETRIC PRESSURE EFFECT METHOD

The BPE method is the only means available to directly measure the total gas volume in the tank waste independent of its past history. A correlation between waste level change and barometric pressure indicates the presence of gas. However, the waste and surface level measurement system must meet the following criteria before the correlation can be used as a measurement (PNNL-11536):

- The waste must be wet. The free liquid level must be above or within a few inches of the top of the gas-retaining solids, or the solids must contain sufficient gas to float on the liquid, or both.
- The tank must contain minimal suspended hardware items (that could support the waste and interfere with level change measurements).
- The waste must not be disturbed by mixing (such as was done in DST 241-SY-101) that suspends solids and gas bubbles during the period of the BPE measurement.
- The effective pressure on the stored gas must not change significantly during the BPE measurement (e.g., by transfers).
- The precision of the waste surface level instrument must be within 0.1 in. and the level must be recorded at least daily. Because of an amplification effect that is not fully understood, the BPE method cannot be applied to interstitial liquid level data obtained with the neutron probe.

Ideally, the pressure-level correlation should be developed using data obtained from November through February when barometric pressure fluctuations are greatest. The "steep slope" BPE model, abbreviated here as the BPE2 model, uses only data obtained during these months to correlate barometric pressure and waste level. The BPE2 model also accounts for the effect of waste strength (PNNL-11693, *Estimating Retained Gas Volumes in the Hanford Tanks using Waste Level Measurements*), unlike the original, more simplified BPE model (which will be abbreviated here as the BPE1 model). In cases where only BPE1 data are available, they will be included in the development of an average void fraction value on a case-by-case basis.

The overall uncertainty in the void fraction value determined with a BPE model is driven by the uncertainty in determining both the effective pressure of the stored gas and the correlation of waste height change with barometric pressure change (the dL/dP value). The computed uncertainty varies from 20 to 50%, and void fractions determined with a BPE model can differ from RGS and VFI average void values by about the same amount.

D3.0 INPUT DATA

The void fraction assigned to all 177 tanks is either a field-measured value or statistically determined default value for each waste type. To derive the default void fraction distributions the input data of field observed void fraction data and waste property data are required. The field observed VFI and RGS void fraction data are used to assign individual tank void fractions as well as to determine the default void fraction distributions statistically. The VFI and RGS void fraction data along with the waste type data are listed in Section D7.3. The VFI and VFI with RGS results are presented in PNNL-11536, and RGS results are reported in PNNL-11373, *Flammable Gas Data Evaluation Progress Report*.

The other type of input data is dL/dP data from the BPE method along with other data such as density and waste level, which are used to derive the void fraction. Once the void fraction is derived from BPE then the void fraction values are assigned to individual data and also join the field measured void fraction data from VFI and RGS to determine the default value statistically for each waste type. Table D-1 lists the dL/dP data from BPE together with other data required to derive the void fraction. RPP-15488, *Investigation of Tank Void Fraction Using Liquid Level to Atmospheric Pressure Changes*, calculated the BPEs over the period from 1997 through 1999 using the BPE2 model for tanks with Enraf-Nonius Series 854 (ENRAF) gauges and meeting BPE requirements, and the results were reported at the Data Review Workshops in 1999.

The additional data, including density and waste level to determine the void fraction, are taken from RPP-5926, *Steady-State Flammable Gas Release Rate Calculation or Lower Flammability Evaluation for Hanford Tank Waste*, Rev. 0, which provides data from the corresponding time period as the BPE data. RPP-10006, Rev. 5, Appendix A, is used to update waste types of selected tanks based on improved tank content analysis.

In addition, the dL/dP data of tanks 241-AN-107 and 241-SY-101 have been newly developed using waste level and pressure data, which were queried from personal computer Surveillance Analysis Computer System (PCSACS) for various time periods from October 1, 2004, through November 1, 2005, as listed in the Section D7.1.

Table D-1. dL/dP Data from Barometric Pressure Effects and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	NCL volume (m^3)	CL volume (m^3)	NCL depth (in)	CL depth (in)	CL density (g/mL)	BPE slope (in/in Hg)
References	Appendix A	RPP-5926, Rev. 0, 2000					RPP-15488
241-A-101[a]	SC/SS-NL	1,685	1,923	161.8	184.7	1.40	-0.364
241-A-103	SC/SS-NL	1,385	19	133.1	1.8	1.48	-0.013
241-A-106	MIX-NL	473	0	45.5	0.0	1.17	0.005
241-AN-101	SC/SS-LIQ	125	481	12.0	46.2	1.16	0.000
241-AN-103	SC/SS-LIQ	1,552	2,074	149.1	199.3	1.49	-0.535
241-AN-104	SC/SS-LIQ	1,700	2,286	163.3	219.6	1.40	-0.226
241-AN-105	SC/SS-LIQ	1,851	2,411	177.8	231.6	1.42	-0.180
241-AW-101	SC/SS-LIQ	1,158	3,104	111.3	298.2	1.4	-0.255
241-AW-103	SL-LIQ	1,317	613	126.6	58.9	1.02	-0.029
241-AW-104	SC/SS-LIQ	874	3,361	84.0	322.9	1.25	-0.076
241-AW-105	SL-LIQ	1,060	564	101.8	54.2	1.02	0.001
241-AW-106	SC/SS-LIQ	863	927	82.9	89.1	1.38	-0.062
241-AX-101[a]	SC/SS-NL	1,370	1,461	131.6	140.4	1.48	-0.003
241-AX-102	SC/SS-NL	114	0	10.9	0.0	1.39	0.005
241-AX-103	SC/SS-NL	424	0	40.7	0.0	1.39	-0.002

Table D-1. dL/dP Data from Barometric Pressure Effects and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	NCL volume (m^3)	CL volume (m^3)	NCL depth (in)	CL depth (in)	CL density (g/mL)	BPE slope (in/in Hg)
References	Appendix A	RPP-5926, Rev. 0, 2000					RPP-15488
241-AX-104	SL-NL	30	0	2.9	0.0	1.17	0.000
241-AY-101	SL-NL	409	174	39.3	16.7	1.08	-0.050
241-AY-102	SL-LIQ	799	1,556	76.7	149.5	1.09	-0.018
241-AZ-101	SL-LIQ	178	3,021	17.1	290.2	1.19	0.093
241-B-102	SC/SS-NL	106	15	17.6	1.5	1.39	-0.001
241-B-112	MIX-NL	114	11	18.4	1.1	1.27	-0.002
241-BX-101	SL-NL	159	4	22.7	0.4	1.28	-0.010
241-BX-102	SL-NL	363	0	42.4	0.0	1.17	-0.003
241-BX-103	SL-NL	235	34	30.0	3.3	1.28	-0.003
241-BX-104	SL-NL	363	11	42.4	1.1	1.29	-0.082
241-BX-105	MIX-NL	174	19	24.2	1.8	1.29	-0.002
241-BX-106	SC/SS-NL	144	0	21.3	0.0	1.17	0.001
241-BX-107	SL-NL	1,302	4	132.6	0.4	1.17	-0.088
241-BX-108	SL-NL	98	0	16.9	0.0	1.17	0.001
241-BX-109	SL-NL	731	0	77.6	0.0	1.17	-0.007
241-BX-110	MIX-NL	772	11	81.6	1.1	1.40	-0.086
241-BX-111	SC/SS-NL	609	4	66.0	0.4	1.39	-0.002
241-BX-112	SL-NL	621	4	67.1	0.4	1.18	-0.009
241-C-103	SL-NL	450	299	50.7	28.7	1.08	-0.001
241-C-106	SL-NL	30	159	10.4	15.3	1.09	0.009
241-C-107	SL-NL	973	0	100.9	0.0	1.17	-0.004
241-S-101	MIX-NL	1,571	45	158.4	4.4	1.36	-0.171
241-S-102	SC/SS-NL	1,946	0	194.4	0.0	1.39	-0.518
241-S-103[b]	SC/SS-NL	874	0	91.5	6.2	1.39	-0.349
241-S-106[b]	SC/SS-NL	1,613	0	162.4	19.3	1.39	-0.316
241-S-107	SL-NL	1,370	53	139.1	5.1	1.17	-0.087
241-S-108	SC/SS-NL	1,703	0	171.1	0.0	1.39	-0.001
241-S-110	SC/SS-NL	1,476	0	149.3	0.0	1.43	0.026
241-S-111	SC/SS-NL	1,624	420	163.5	40.4	1.39	-0.437
241-SX-101	MIX-NL	1,696	0	171.1	0.0	1.50	-1.513
241-SX-103	SC/SS-NL	2,400	0	238.7	0.0	1.47	-3.103
241-SX-104	MIX-NL	1,768	0	178.0	0.0	1.39	-0.056
241-SX-105	SC/SS-NL	2,411	0	239.8	0.0	1.47	-3.181
241-SX-106	SC/SS-NL	1,223	379	125.6	36.4	1.42	-0.407

Table D-1. dL/dP Data from Barometric Pressure Effects and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	NCL volume (m^3)	CL volume (m^3)	NCL depth (in)	CL depth (in)	CL density (g/mL)	BPE slope (in/in Hg)
References	Appendix A	RPP-5926, Rev. 0, 2000					RPP-15488
241-SY-102	SL-LIQ	333	1,984	32.0	190.6	1.18	-0.006
241-SY-103	SC/SS-LIQ	1,370	1,446	131.6	138.9	1.47	-0.196
241-T-101	MIX-NL	382	4	44.2	0.4	1.40	-0.001
241-T-102	SL-NL	72	49	14.4	4.7	1.14	0.000
241-T-107	SL-NL	655	0	70.4	0.0	1.17	-0.024
241-T-108	MIX-NL	167	0	23.5	0.0	1.40	-0.013
241-T-109	SC/SS-NL	220	0	28.6	0.0	1.39	-0.003
241-TX-101	SL-NL	318	11	38.0	1.1	1.17	-0.002
241-TX-102	SC/SS-NL	821	0	86.4	0.0	1.39	-1.570
241-TX-103	SC/SS-NL	594	0	64.6	0.0	1.39	-0.100
241-TX-104	MIX-NL	227	19	29.3	1.8	1.45	-0.002
241-TX-105	SC/SS-NL	2,305	0	228.9	0.0	1.39	-0.001
241-TX-106	SC/SS-NL	1,291	0	131.5	0.0	1.39	-0.002
241-TX-107	SC/SS-NL	132	4	20.2	0.4	1.39	-0.003
241-TX-108	SC/SS-NL	507	0	56.2	0.0	1.39	0.004
241-TX-109	SL-NL	1454	0	147.1	0.0	1.17	-0.002
241-TX-110	SC/SS-NL	1,749	0	175.5	0.0	1.39	-0.004
241-TX-111	SC/SS-NL	1,401	0	142.0	0.0	1.39	0.001
241-TX-112	SC/SS-NL	2,457	0	243.5	0.0	1.39	-0.002
241-TX-113	SC/SS-NL	2,298	0	228.2	0.0	1.40	0.000
241-TX-114	SC/SS-NL	2,025	0	202.0	0.0	1.39	0.000
241-TX-115	SC/SS-NL	2,150	0	214.0	0.0	1.39	-0.004
241-TX-116	SC/SS-NL	2,389	0	236.9	0.0	1.39	-0.002
241-TX-117	SC/SS-NL	2,370	0	235.1	0.0	1.39	0.001
241-TX-118	SC/SS-NL	1,136	0	116.6	0.0	1.39	0.003
241-TY-101	MIX-NL	447	0	50.4	0.0	1.40	-0.004
241-TY-102	SC/SS-NL	242	0	30.7	0.0	1.39	-0.008
241-TY-103	MIX-NL	613	0	66.4	0.0	1.23	-0.014
241-TY-104	SL-NL	163	11	23.1	1.1	1.17	-0.002
241-TY-105	SL-NL	874	0	91.5	0.0	1.17	-0.009
241-TY-106	SL-NL	79	0	15.1	0.0	1.17	-0.003
241-U-103	SC/SS-NL	1,722	49	172.9	4.7	1.41	-0.334
241-U-105	SC/SS-NL	1,442	140	146.0	13.5	1.46	-0.257
241-U-106	SC/SS-NL	799	57	84.2	5.5	1.35	-0.034

Table D-1. dL/dP Data from Barometric Pressure Effects and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	NCL volume (m^3)	CL volume (m^3)	NCL depth (in)	CL depth (in)	CL density (g/mL)	BPE slope (in/in Hg)
References	Appendix A	RPP-5926, Rev. 0, 2000					RPP-15488
241-U-107	SC/SS-NL	1,420	125	143.8	12.0	1.41	-0.267
241-U-109	SC/SS-NL	1,688	72	169.6	6.9	1.47	-0.165
241-U-110	SL-NL	704	0	75.1	0.0	1.17	0.004

Notes:

[a]CL depth is 0 for calculation purposes – waste layers were inverted prior to saltwell pumping.

[b]CL Depth is based on information from HNF-EP-0182-130, 1999, *Waste Tank Summary Report for Month Ending 01/31/1999*, Lockheed Martin Hanford Company, Richland, Washington.

RPP-5926, 2000, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-15488, 2004, *Investigation of Tank Void Fraction Using Liquid Level to Atmospheric Pressure Changes*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

BBI	= Best-Basis Inventory.
BPE	= barometric pressure effect.
CL	=convective layer.
MIX-NL	= mixed waste form with < 1 m liquid over solids
NCL	= nonconvective layer.
SC/SS-LIQ	= saltcake/salt slurry waste form with ≥ 1m liquid over solids.
SC/SS-NL	= saltcake/salt slurry waste form with < 1m liquid over solids.
SL-LIQ	= sludge waste form with ≥ 1 m liquid over solids.
SL-NL	= sludge waste form with < 1 m liquid over solids.

D4.0 ASSUMPTIONS

The following assumptions pertain to the void fraction development using the dL/dP data of BPE which is calculated in the spreadsheet "SVF 1131 BPE to Void Fraction Master R0 060221 .xls".

1. BPE sample data is normally distributed.
2. Surface of waste is not fixed by waste intrusion such as risers, liquid observation wells, etc.
3. The surface of the waste was at least a small depth of liquid supernatant at the time of the level readings. The liquid pool should cover a majority of the waste surface.
4. The retained gas is subject to the pressure due to the liquid head only. The solids are self-supporting and do not contribute to the pressure on the retained gas.
5. Minimum retained gas volume is 100 ft^3

The following assumptions pertain to the default void fraction development for each waste type using all available field measured void fractions, which is calculated in the spreadsheet "RPP-10006r5 Void fraction revised data by tank - 060519 .xls."

1. Individual tank void fractions are normally distributed.

2. The default void fractions for the various waste types are fit to specific continuous distributions based on the results of a regression performed using Crystal Ball.[1]

3. The distributions selected for analysis are

   - Normal
   - LogNormal
   - Uniform
   - Triangular
   - Gamma.

4. The following waste groups have insufficient data to be regressed by themselves. It is assumed that the following table will provide conservative default distributions for these waste types.

   - SL-LIQ (sludge waste form with ≥ 1 m liquid over solids) tanks – Use SC/SS-LIQ (saltcake/salt slurry waste form with ≥ 1m liquid over solids) distribution results bounded by the void fraction at neutral buoyancy.

   - Liquid waste tanks – Set the void fraction to 0.

   - MIX-NL (mixed waste form with < 1 m liquid over solids) tanks – Use SC/SS-NL (saltcake/salt slurry waste form with < 1m liquid over solids) distribution results.

   - MIX-LIQ (mixed waste form with ≥ 1 m liquid over solids) tanks – Use SC/SS-LIQ distribution results bounded by the void fraction at neutral buoyancy.

5. The following list gives the order of void fraction data preference, the most preferred data source is given first:

   - VFI + RGS
   - VFI
   - BPE
   - Derived default distribution based on waste type
   - RGS (not to be used as a basis for individual tank mean void fraction).

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[1] Crystal Ball is a trademark of Decisioneering, Inc., Denver, Colorado.

D5.0 METHODOLOGY

The void fraction assigned to all 177 tanks is either field-measured data or statistically determined default value of each waste type. The void fractions of several tanks (Table D-7) have been reported based on the field-measured void fraction data from the VFI or RGS project. These data can be assigned to individual tanks and can also be used to determine the default value for each waste group.

The other field measured dL/dP data is taken from the BPE method, which is the change in level corresponding to a unit change in pressure, can be used to derive the void fraction. The relationship between dL/dP and the average in-situ void fraction, (PNNL-11693) based on the ideal gas law, is given as follows:

$$\alpha = \frac{P}{L} \times \left(-\frac{dL}{dP} \right) \qquad \text{(D-1)}$$

where P is the effective pressure at which the gas is stored, L is the total depth of the wetted waste. In the calculation, the effective pressure can be calculated as follows:

$$P = P_{HS} + \rho_{CL} * g * (H_{CL} + H_{CR} + 0.5 * H_{WNCL}) \qquad \text{(D-2)}$$

where P_{HS} is the pressure in the tank headspace (assumed to be 1 atmosphere), g is the gravity acceleration (9.806 m/sec^2), H_{CL} is the height of the liquid (convective) layer (m), H_{CR} is the height of the crust layer (m), and H_{WNCL} is the height of liquid saturated nonconvective layer (m). The total in-situ gas volume V_{gas} is obtained by multiplying Equation D-1 by the total waste volume

$$V_{gas} = AP \times \left(-\frac{dL}{dP} \right) \qquad \text{(D-3)}$$

where A is the tank cross-sectional area and P is the effective pressure of the gas stored.

As mentioned in Section D2.0, even though the dL/dP are developed for all tanks that currently had ENRAF data, there are additional criteria for discarding the BPE data. Tanks that have a BPE response that is positive or equal to zero are not used. Tanks that do not have a liquid surface (greater than 0.3 in. of liquid) are also not used. In addition, if the calculated retained gas volume is less than 100 ft^3, the retained gas volume is increased to 100 ft^3. This is a conservative assumption which allows the use of BPE data from low volume tanks. Details of individual tank data are discussed in Section D7.0.

For DSTs 241-AN-107 and 241-SY-101, the dL/dP data are determined based on the waste level and pressure. The void fraction of DST 241-AN-107 has been evaluated using PCSACS data over 12 months, from October 1, 2004, through November 1, 2005. Using the spreadsheet "BP Correlation with DB Connect .xls" template, the ENRAF and meteorological data was retrieved from PCSACS and regressed to determine the BPE correlation for the time period selected. The methodology used in the spreadsheet is a simplified version of the methodology used in RPP-15488 and verified in Software Verification Form 1002. The spreadsheet "BP Correlation with DB Connect .xls" performs the evaluation of the surface level (ENRAF data from PCSACS) response to atmospheric pressure. The user estimates an approximate slope to the surface level response, then the program uses the Excel[2] solver function to minimize the error to produce a statistical fit to the observed data, which returns the negative of the BPE slope.

Once all the available void fraction data are collected or derived from the field-measurements, data are assigned to the specific tank and are used to determine the default void fraction distributions based on waste type. The individual tank void fractions are selected based on the priority of data as listed in the assumptions, Section D4.0. The tank specific void fractions for those with VFI or BPE data use an uncertainty of one half of the mean void fraction.

For tanks with no void fraction measurements, a default void fraction distribution is used. The default void fraction distributions are developed based on tanks with similar waste types. All void fraction data for a specific waste type is grouped together, no matter the source. There may be multiple void fractions for selected tanks, such as a collection of BPE, RGS, and VFI data. The collected data is ordered in increasing magnitude, and fit by Crystal Ball. The distributions evaluated -- normal, lognormal, uniform and gamma -- are listed in Section D4.0. When the regression data is returned, the best fit results are used to describe the default distribution for the evaluated waste type. Waste types with sparse data, less than seven samples, are assigned a conservative default distribution from the waste types that have been successfully evaluated. Similar waste types may also be grouped together for the creation of a default distribution. For example, SC/SS-NL and MIX-NL data are grouped together. Currently, for all waste types, SC/SS-LIQ is the conservative waste type.

[2] Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

D6.0 COMPUTER SOFTWARE USE AND VERIFICATION

The spreadsheets used in the calculations are as follows.

Spreadsheet: "BP Correlation with DB Connect .xls"

Spreadsheet Verification Form Number: SVF-1002, *Spreadsheet Verification and Release Form for Spreadsheet ' BP Correlation with DB Connect .xls '*

Author: Barnes, D. A.

Revision: Rev. 0, released 6/27/2005

Purpose: Identify if there is a statistically significant correlation between tank level changes and atmospheric barometric pressure and quantify the effects.

Spreadsheet Name: "SVF 1131 BPE to Void Fraction Master R0 060221 .xls"

Spreadsheet Verification Form Number: SVF-1131, *Spreadsheet Verification and Release Form for Spreadsheet 'SVF 1131 BPE to Void Fraction Master R0 060221 .xls'*

Author: Barker, S. A.

Spreadsheet Description Document: RPP-29388, *Spreadsheet Description Document For 'SVF 1131 BPE to Void Fraction Master R0 060221 .xls'*

Purpose: Converts raw BPE data to void fraction.

Spreadsheet Name: "RPP-10006r5 Void fraction revised data by tank - 060519 .xls"

Spreadsheet Verification Form Number: SVF-1132, *Spreadsheet Verification and Release Form for Spreadsheet ' RPP-10006r5 Void fraction revised data by tank - 060519 .xls'*

Author: Barker, S. A.

Spreadsheet Description Document: RPP-29389, *Spreadsheet Description Document For 'RPP-10006r5 Void fraction revised data by tank - 060519 .xls'*

Purpose: Calculates the various default distributions based on waste type.

D7.0 RESULTS

The results for the calculations documented in this appendix are given as follows.

- The dL/dP data development and related void fraction calculations are performed for DSTs 241-AN-107 and 241-SY-101 based on the latest waste level and pressure with results in Section D7.1.

- There are 86 dL/dP data points available from the BPE study (RPP-15488). Void fractions are derived from the dL/dP data using the density, waste level, and waste type data. Only 39 void fractions are validated and adopted for use (excluding 241-AN-107 and 241-SY-101) (see Section D7.2).

- With all the available void fraction data from VFI, RGS, and BPE methods, the default value for the waste types given below are listed in Section D7.3. Default void fraction assignments are made for the waste types below using available VFI, RGS, and BPE void fraction data.

  - SC/SS-NL, and MIX-NL wastes using SC/SS-NL data
  - SL-NL wastes
  - SC/SS-LIQ, SL-LIQ, and MIX-LIQ wastes using SC/SS-LIQ data.

  In addition, liquid waste is assigned a zero void fraction.

- Table 13, Section D.7.4 contains the void fraction value assigned to all 177 DSTs and SSTs.

D7.1 VOID FRACTION FOR DOUBLE-SHELL TANKS 241-AN-107 AND 241-SY-101

Void fractions are determined using waste level, pressure, and dL/dP data for DSTs 241-AN-107 and 241-SY-101. Section D.7.1.1 summarizes the evaluation for DST 241-AN-107. Section D.7.1.2 summarizes the void fraction determination for DST 241-SY-101.

D7.1.1 Determination of Void Fraction for Double-Shell Tank 241-AN-107

Figure D-1 illustrates the relationship between the surface level in DST 241-AN-107 and the inverse barometric pressure for the time period between March 14, 2005, and May 16, 2005. The R-squared value of 0.93 indicates the fit of inverse barometric pressure to surface level is significant. Note that the sign convention for this procedure is opposite the sign convention used by PNL-10821, *Screening the Hanford Tanks for Trapped Gas*. Positive slopes for the BPE correlation are valid responses to the BPE test in spreadsheet "BP Correlation with DB Connect .xls," whereas negative slopes are valid responses to the BPE test in the PNL-10821 analyses.

In the analysis of DST 241-AN-107, it was found that six of the seven periods of time met the criteria required for a good fit to BPE data. Table D-2 presents the statistics and results for this analysis. The BPE results were then entered into the spreadsheet template “SVF 1131 BPE to Void Fraction Master R0 060221 .xls” to convert the results into void fraction (see Table D-3). After data analysis, an average void fraction of 0.011 was found and used to generate the void fraction distribution. The standard deviation of the good BPE data from all six periods with good fit is 0.003 and the observed void fractions ranged from 0.007 to 0.017.

Figure D-1. Example of the Correlation Between Double-Shell Tank 241-AN-107 Surface Level With the Inverse Barometric Pressure.

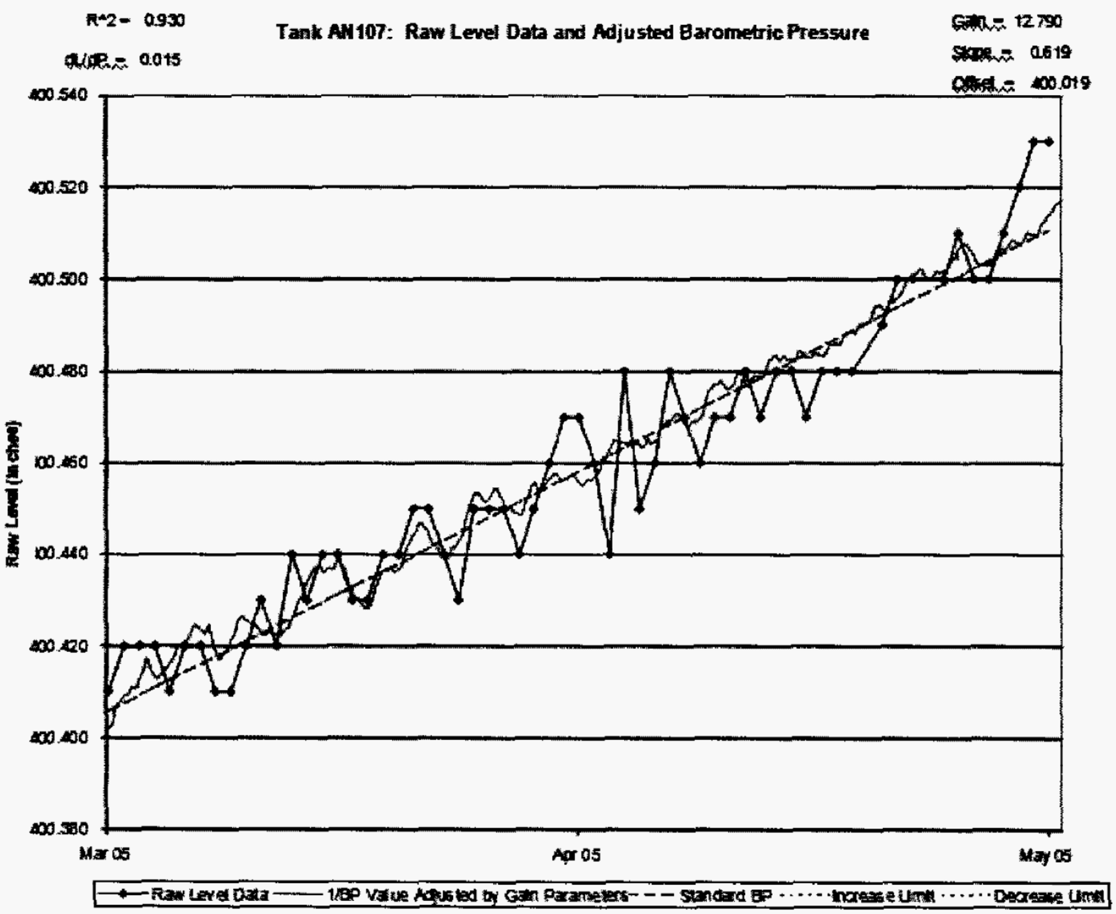


Table D-2. Results of the Barometric Pressure Effect Evaluation for Double-Shell Tank 241-AN-107.

No.	Start date	End date	Barometric pressure effect (in./in._Hg)*	Gain	Offset	Slope	r 2	Error	Max baro press change (in._Hg)
1	10/1/2004	12/10/2004	0.012	9.97	400.100	-1.289	0.981	0.007	1.37
2	12/10/2004	1/9/2005	0.009	7.44	400.099	0.819	0.925	0.001	1.46
3	3/14/2005	5/16/2005	0.015	12.79	400.019	0.619	0.930	0.004	1.03
4	5/16/2005	6/2/2005	0.012	10.00	400.152	-1.402	0.936	0.000	0.81
5	6/3/2005	7/17/2005	-0.011	-9.19	400.873	-1.005	0.972	0.001	0.62
6	7/18/2005	9/3/2005	0.014	12.01	400.152	1.234	0.987	0.001	0.71
7	9/9/2005	11/1/2005	0.022	18.68	399.866	-2.137	0.990	0.006	0.85

Note:

*For the analysis using "BP Correlation with DB Connect .xls," a positive barometric pressure effect indicates the data is valid.

Table D-3. Results of the Void Fraction Determination for Double-Shell Tank 241-AN-107.

No.	PCSACs waste level (in.)	Liquid layer depth (in.)	Solid layer depth (in.)	Liquid density (g/mL)	Head pressure on gas (psi)	BPE slope (in./in. Hg)	Volume of retained gas (acf)	Volume of solids (ft^3)	Void fraction
1	400.4	310.58	89.82	1.43	33.06	-0.012	297	33,019	0.009
2	400.4	310.58	89.82	1.43	33.06	-0.009	223	33,019	0.007
3	400.5	310.68	89.82	1.43	33.06	-0.015	372	33,019	0.011
4	400.5	310.68	89.82	1.43	33.06	-0.012	297	33,019	0.009
5	400.6	310.78	89.82	1.43	33.07	0.011	NA	33,019	NA
6	400.6	310.78	89.82	1.43	33.07	-0.014	347	33,019	0.011
7	400.5	310.68	89.82	1.43	33.06	-0.022	545	33,019	0.017

Notes:

BPE = barometric pressure effect.

PCSACS = personal computer Surveillance Analysis Computer System.

D7.1.2 Determination of Void Fraction for Double-Shell Tank 241-SY-101

Figure D-2 illustrates the relationship between the surface level in DST 241-SY-101 and the inverse barometric pressure for the time period between March 14, 2005, and May 16, 2005. The R-squared value of 0.785 indicates that the fit of inverse barometric pressure to surface level is adequate. Figure D-2 shows much more movement in the hourly barometric pressure readings than can be explained by the number of surface readings stored in PCSACS (one surface level reading per day).

In the analysis of DST 241-SY-101, it was found that 11 periods of time met the criteria required for a good fit to BPE data. Table D-4 presents the statistics and results for this analysis. Between October 2004 and September 2005, about 270 in. of liquid were added to the tank. The transfer into DST 241-SY-101 was completed on June 30, 2005. As expected, a slight decrease in void fraction was noted as the result of the increased head pressure on the retained gas due to this additional liquid.

The BPE results were then entered into the spreadsheet template "SVF 1131 BPE to Void Fraction Master R0 060221 .xls" to convert the results into void fraction. In all cases, the retained gas volume was found to be greater than 1,000 ft^3. The mean void fraction for DST 241-SY-101 is 0.085 with a standard deviation of 0.024 and a range from 0.041 to 0.125. Table D-5 presents the summary of retained gas volumes and void fraction.

Figure D-2. Example of the Correlation Between Double-Shell Tank 241-SY-101 Surface Level With the Inverse Barometric Pressure.

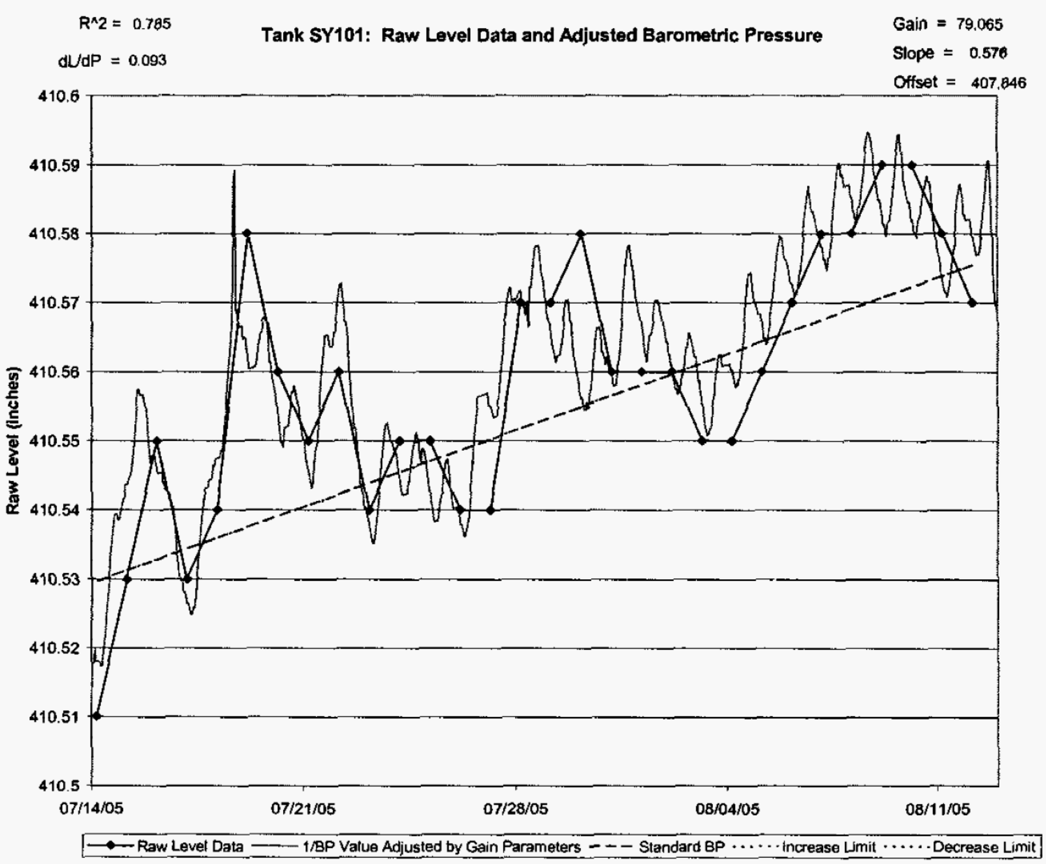


Table D-4. Results of the Barometric Pressure Effect Evaluation for Double-Shell Tank 241-SY-101.

No.	Start date	End date	Barometric pressure effect (in./in._hg)*	Gain	Offset	Slope	r^2	Error	Baro press change (in._Hg)
1	9/13/2005	9/29/2005	0.063	53.38	409.612	0.901	0.71	0.001	0.56
2	8/25/2005	9/13/2005	0.112	95.33	408.193	0.019	0.71	0.002	0.56
3	7/14/2005	8/13/2005	0.093	79.06	407.846	0.576	0.785	0.002	0.69
4	5/13/2005	5/29/2005	0.24	205.1	138.591	0.992	0.799	0.013	0.81
5	4/13/2005	5/12/2005	0.24	205.1	140.58	2.396	0.886	0.026	0.66
6	3/31/2005	4/12/2005	0.227	193.83	140.58	0.496	0.694	0.017	0.9
7	3/7/2005	3/30/2005	0.278	237.01	137.432	0.496	0.831	0.017	0.9
8	3/7/2005	3/4/2005	0.25	212.90	138.338	-0.72	0.904	0.000	0.38
9	1/21/2005	3/4/2005	0.25	210.63	131.157	-0.72	0.722	0.024	0.66
10	1/21/2005	1/18/2005	0.325	277.41	128.989	-2.093	0.917	0.041	1.57
11	10/17/2004	1/18/2004	0.231	196.78	131.746	-2.191	0.914	0.131	1.48

Note:

*For the analysis using "BP Correlation with DB Connect .xls," a positive barometric pressure effect indicates the data is valid.

Table D-5. Results of the Void Fraction Determination for Double-Shell Tank 241-SY-101.

No.	PCSACS waste level (in)	Liquid layer depth (in)	Solid layer depth (in)	Liquid density (g/mL)	Head pressure on gas (psi)	BPE slope (in/in Hg)	Volume of retained gas (acf)	Volume of solids (ft^3)	Void fraction
1	411.4	311.4	100	1.30	31.66	0.063	NA	36,833	NA
2	411.5	311.5	100	1.30	31.67	-0.112	2,659	36,833	0.072
3	410.6	310.6	100	1.30	31.63	-0.093	2,205	36,833	0.060
4	145.6	45.6	100	1.30	19.18	-0.24	3,450	36,833	0.094
5	145.6	45.6	100	1.30	19.18	-0.24	2,473	36,833	0.067
6	145.5	46	100	1.30	19.18	-0.227	3,264	36,833	0.089
7	145.6	46	100	1.30	19.18	-0.278	3,997	36,833	0.109
8	145.6	45.6	100	1.30	19.18	-0.25	3,594	36,833	0.098
9	138.3	38.3	100	1.30	18	-0.25	3,488	36,833	0.095
10	138.5	38.5	100	1.30	18.85	-0.325	4,592	36,833	0.125
11	138.5	38.5	100	1.30	18.85	-0.231	3,264	36,833	0.089

Notes:

BPE = barometric pressure effect.
PCSACS = personal computer Surveillance Analysis Computer System.

D7.2 BEST VOID FRACTION DATA

The distribution of all available tank average void fraction values determined from VFI data (with or without RGS data added) or RGS and BPE data are used to derive an average void fraction distribution for a waste form. When available for a specific tank, RGS and VFI data are combined into a single average. A distribution of individual RGS segment voids is not appropriate to characterize a tank average void since, at present, there are very few data points per tank (e.g., three to six) and they represent local effects. Therefore, in the cases where RGS data are available, it is only appropriate to use them to develop an average void fraction distribution for each waste form.

Table D-6 summarizes the BPE evaluation final results. The actual values used for the tank void fraction means or the default distribution regression are identified in the "Validated void fraction from dL/dP data" column.

Table D-6. Void Fraction Data from Barometric Pressure Effect and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	Effective Pressure (psi)	Calculated void fraction (unitless)	Calculated retained gas volume (acf)	Validated void fraction from dL/dP data
241-A-101	SC/SS-NL	18.78	0.086	5,124	Adopted value 0.086
241-A-103	SC/SS-NL	18.35	0.004	179	Adopted value 0.004
241-A-106	MIX-NL	15.65	NA	-59	Dropped due to zero or positive dL/dP
241-AN-101	SC/SS-LIQ	16.88	NA	0	Dropped due to zero or positive dL/dP
241-AN-103	SC/SS-LIQ	29.43	0.215	11,802	Adopted value 0.215
241-AN-104	SC/SS-LIQ	29.93	0.084	5,070	Adopted value 0.084
241-AN-105	SC/SS-LIQ	31.13	0.064	4,200	Adopted value 0.064
241-AW-101	SC/SS-LIQ	32.59	0.152	6,229	Adopted value 0.152
241-AW-103	SL-LIQ	19.19	0.009	417	Adopted value 0.009
241-AW-104	SC/SS-LIQ	31.17	0.058	1,776	Adopted value 0.058
241-AW-105	SL-LIQ	18.56	NA	-14	Dropped due to zero or positive dL/dP
241-AW-106	SC/SS-LIQ	21.2	0.032	985	Adopted value 0.032
241-AX-101	SC/SS-NL	18.21	0.002	41	Updated value w/ 100 ft^3 RG 0.002 Not used – too far from RGS sample 0.170
241-AX-102	SC/SS-NL	14.96	NA	-56	Dropped due to zero or positive dL/dP
241-AX-103	SC/SS-NL	15.71	NA	24	Dropped due to no liquid layer
241-AX-104	SL-NL	14.75	NA	0	Dropped due to zero or positive dL/dP
241-AY-101	SL-NL	16.11	0.042	604	Adopted value 0.042
241-AY-102	SL-LIQ	22.09	0.011	298	Dropped due to waste transfer interrupt
241-AZ-101	SL-LIQ	27.53	NA	-1,919	Dropped due to zero or positive dL/dP
241-B-102	SC/SS-NL	15.2	0.027	11	Updated value w/ 100 ft^3 RG 0.027

Table D-6. Void Fraction Data from Barometric Pressure Effect and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	Effective Pressure (psi)	Calculated void fraction (unitless)	Calculated retained gas volume (acf)	Validated void fraction from dL/dP data
241-B-112	MIX-NL	15.16	0.025	23	Updated value w/ 100 ft^3 RG 0.025
241-BX-101	SL-NL	15.23	0.020	114	Adopted value 0.02
241-BX-102	SL-NL	15.59	NA	35	Dropped due to no liquid layer
241-BX-103	SL-NL	15.53	0.012	35	Updated value w/ 100 ft^3 RG 0.012
241-BX-104	SL-NL	15.73	0.075	967	Adopted value 0.075
241-BX-105	MIX-NL	15.34	0.016	23	Updated value w/ 100 ft^3 RG 0.016
241-BX-106	SC/SS-NL	15.14	NA	-11	Dropped due to zero or positive dL/dP
241-BX-107	SL-NL	17.51	0.025	1,155	Adopted value 0.025
241-BX-108	SL-NL	15.05	NA	-11	Dropped due to zero or positive dL/dP
241-BX-109	SL-NL	16.33	NA	86	Dropped due to no liquid layer
241-BX-110	MIX-NL	16.81	0.040	1,084	Adopted value 0.040
241-BX-111	SC/SS-NL	16.37	0.005	25	Updated value w/ 100 ft^3 RG 0.005
241-BX-112	SL-NL	16.14	0.005	109	Adopted value 0.005
241-C-103	SL-NL	16.8	0.006	13	Updated value w/ 100 ft^3 RG 0.006
241-C-106	SL-NL	15.5	NA	-105	Dropped due to zero or positive dL/dP
241-C-107	SL-NL	16.82	NA	50	Dropped due to no liquid layer
241-S-101	MIX-NL	18.8	0.043	2,410	Adopted value 0.043
241-S-102	SC/SS-NL	19.57	NA	7,599	Dropped due to no liquid layer
241-S-103	SC/SS-NL	17.3	0.147	4,526	Adopted value 0.147
241-S-106	SC/SS-NL	19.74	0.082	4,676	Adopted value 0.082
241-S-107	SL-NL	17.84	0.024	1,163	Adopted value 0.024
241-S-108	SC/SS-NL	18.99	NA	14	Dropped due to no liquid layer
241-S-110	SC/SS-NL	18.55	NA	-362	Dropped due to zero or positive dL/dP
241-S-111	SC/SS-NL	20.82	0.119	6,820	Adopted value 0.119
241-SX-101	MIX-NL	19.33	NA	21,922	Dropped due to no liquid layer
241-SX-103	SC/SS-NL	21.03	NA	48,914	Dropped due to no liquid layer
241-SX-104	MIX-NL	19.16	NA	804	Dropped due to no liquid layer
241-SX-105	SC/SS-NL	21.06	NA	50,215	Dropped due to no liquid layer
241-SX-106	SC/SS-NL	19.78	0.140	6,034	Adopted value 0.140
241-SY-102	SL-LIQ	23.5	0.009	106	Adopted value 0.009
241-SY-103	SC/SS-LIQ	25.56	0.078	3,755	Adopted value 0.078
241-T-101	MIX-NL	15.83	0.007	12	Updated value w/ 100 ft^3 RG 0.007
241-T-102	SL-NL	15.18	NA	0	Dropped due to zero or positive dL/dP
241-T-107	SL-NL	16.18	NA	291	Dropped due to no liquid layer
241-T-108	MIX-NL	15.28	NA	149	Dropped due to no liquid layer

Table D-6. Void Fraction Data from Barometric Pressure Effect and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	Effective Pressure (psi)	Calculated void fraction (unitless)	Calculated retained gas volume (acf)	Validated void fraction from dL/dP data
241-T-109	SC/SS-NL	15.41	NA	35	Dropped due to no liquid layer
241-TX-101	SL-NL	15.54	0.009	23	Updated value w/ 100 ft^3 RG 0.009
241-TX-102	SC/SS-NL	16.86	NA	19,841	Dropped due to no liquid layer
241-TX-103	SC/SS-NL	16.31	NA	1,223	Dropped due to no liquid layer
241-TX-104	MIX-NL	15.55	0.012	23	Updated value w/ 100 ft^3 RG 0.012
241-TX-105	SC/SS-NL	20.44	NA	15	Dropped due to no liquid layer
241-TX-106	SC/SS-NL	17.99	NA	27	Dropped due to no liquid layer
241-TX-107	SC/SS-NL	15.22	0.021	34	Updated value w/ 100 ft^3 RG 0.021
241-TX-108	SC/SS-NL	16.1	NA	-48	Dropped due to zero or positive dL/dP
241-TX-109	SL-NL	17.8	NA	27	Dropped due to no liquid layer
241-TX-110	SC/SS-NL	19.1	NA	57	Dropped due to no liquid layer
241-TX-111	SC/SS-NL	18.26	NA	-14	Dropped due to zero or positive dL/dP
241-TX-112	SC/SS-NL	20.8	NA	31	Dropped due to no liquid layer
241-TX-113	SC/SS-NL	20.46	NA	0	Dropped due to zero or positive dL/dP
241-TX-114	SC/SS-NL	19.76	NA	0	Dropped due to zero or positive dL/dP
241-TX-115	SC/SS-NL	20.06	NA	60	Dropped due to no liquid layer
241-TX-116	SC/SS-NL	20.64	NA	31	Dropped due to no liquid layer
241-TX-117	SC/SS-NL	20.59	NA	-15	Dropped due to zero or positive dL/dP
241-TX-118	SC/SS-NL	17.62	NA	-33	Dropped due to zero or positive dL/dP
241-TY-101	MIX-NL	15.96	NA	48	Dropped due to no liquid layer
241-TY-102	SC/SS-NL	15.46	NA	93	Dropped due to no liquid layer
241-TY-103	MIX-NL	16.17	NA	170	Dropped due to no liquid layer
241-TY-104	SL-NL	15.22	0.017	23	Updated value w/ 100 ft^3 RG 0.017
241-TY-105	SL-NL	16.62	NA	112	Dropped due to no liquid layer
241-TY-106	SL-NL	15.01	NA	34	Dropped due to no liquid layer
241-U-103	SC/SS-NL	19.33	0.080	4,839	Adopted value 0.080
241-U-105	SC/SS-NL	19.25	0.073	3,708	Adopted value 0.073
241-U-106	SC/SS-NL	17.01	0.015	434	Adopted value 0.015
241-U-107	SC/SS-NL	18.96	0.076	3,795	Adopted value 0.076
241-U-109	SC/SS-NL	19.56	0.041	2,419	Adopted value 0.041
241-U-110	SL-NL	16.28	NA	-49	Dropped due to zero or positive dL/dP

Table D-6. Void Fraction Data from Barometric Pressure Effect and Related Data to Calculate Void Fraction. (4 sheets)

Tank name	Waste type	Effective Pressure (psi)	Calculated void fraction (unitless)	Calculated retained gas volume (acf)	Validated void fraction from dL/dP data

Notes:

MIX-NL = mixed waste form with < 1 m liquid over solids
NA = not applicable.
SC/SS-LIQ = saltcake/salt slurry waste form with ≥ 1m liquid over solids.
SC/SS-NL = saltcake/salt slurry waste form with < 1m liquid over solids.
SL-LIQ = sludge waste form with ≥ 1 m liquid over solids.
SL-NL = sludge waste form with < 1 m liquid over solids.

The average void fraction distribution determined for a specific tank from VFI data (with or without RGS data added) or BPE should be used in preference to the default void fraction distribution for the tank waste form.

D7.3 DEFAULT VOID FRACTIONS FOR EACH WASTE TYPE

The void fraction analysis was performed based on the type of waste found in the tanks. A full discussion of the waste type classification can be found in SNL-000198 and RPP-6171. Default distributions are generated for the following waste categories: saltcake/salt slurry waste without at least 1 m of supernatant liquid (SC/SS-NL), sludge waste without at least 1 m of supernatant liquid (SL-NL), saltcake/salt slurry waste with at least 1 m of supernatant liquid (SC/SS-LIQ), sludge waste with at least 1 m of supernatant liquid (SL-LIQ), liquid waste (LIQUID), mixed waste without at least 1 m of supernatant liquid (MIX-NL), and mixed waste with at least 1 m of supernatant liquid (MIX-LIQ). Current waste type classifications are based on the waste volumes found in RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, and have been updated from the waste types presented in RPP-6171. The void fraction results are grouped together to conservatively estimate void fractions for waste types, which do not have sufficient void fraction data to perform a valid statistical analysis. A complete listing of the tanks and their waste types can be found in Appendix A.

D7.3.1 SC/SS-NL and MIX-NL Default Void Fraction

The data for SC/SS-NL and MIX-NL wastes (Table D-7) have been regressed using Crystal Ball to fit a normal distribution which is then truncated to bound the values to those expected for the void fraction for the given waste type as shown in Figure D-3. The original boundary recommendations are presented in SNL-000198. The graph represents a truncated normal distribution with a mean and standard deviation as shown below. The default void fraction of 8.84 and its statistical distribution for SC/SS-NL and MIX-NL waste is given in Table D-8.

Table D-7. Summary of Mean Void Fraction Data for SC/SS-NL and MIX-NL Tanks With Measured Values. (2 sheets)

Tank ID	BPE data[a]	BPE method calc'd retained gas volume (acf)	VFI only data	VFI+RGS data[b]	Mahoney RGS void fraction[c]	Huckaby/ Whitney BPE data 10/01/03[d]	Barker-Barnes 2/8/2006	Waste type
241-B-112	0.025	23	--	--	--	--		MIX-NL
241-BX-105	0.016	23	--	--	--	--	--	MIX-NL
241-BX-110	0.04	1,084	--	--	--	--	--	MIX-NL
241-S-101	0.043	2,410	--	--	--	--	--	MIX-NL
241-T-101	0.007	12	--	--	--	--	--	MIX-NL
241-TX-104	0.012	23	--	--	--	--	--	MIX-NL
241-A-101	0.086	5,124	--	--	0.18	--	--	SC/SS-NL
241-A-103	0.004	179	--	--	--	--	--	SC/SS-NL
241-AX-101	--	41	--	--	0.17	--	--	SC/SS-NL
241-B-102	0.027	11	--	--	--	--	--	SC/SS-NL
241-BX-111	0.005	25	--	--	--	--	--	SC/SS-NL
241-BY-109	--	86	--	--	0.094	--	--	SC/SS-NL
241-S-102	--	7,599	--	--	0.26	--	--	SC/SS-NL
241-S-103	0.147	4,526	--	--	--	--	--	SC/SS-NL
241-S-106	0.082	4,676	--	--	0.1	--	--	SC/SS-NL
241-S-111	0.119	6,820	--	--	0.15	--	--	SC/SS-NL
241-SX-106	0.14	6,034	--	--	0.14	--	--	SC/SS-NL
241-TX-107	0.021	34	--	--	--	--	--	SC/SS-NL
241-U-103	0.08	4,839	--	--	0.19	--	--	SC/SS-NL
241-U-105	0.073	3,708	--	--	--	--	--	SC/SS-NL
241-U-106	0.015	434	--	--	--	--	--	SC/SS-NL
241-U-107	0.076	3,795	--	--	--	--	--	SC/SS-NL
241-U-109	0.041	2,419	--	--	0.22	--	--	SC/SS-NL

Notes:

[a]Based on BPE data from RPP-15488, 2004, *Investigation of Tank Void Fraction Using Liquid Level to Atmospheric Pressure Changes*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

[b]PNNL-11536, 1997, *Gas Retention and Release Behavior in Hanford Single-Shell Waste Tanks*, Pacific Northwest National Laboratory, Rev 1, Richland, Washington.

[c]PNNL-13317, 2000, *Ammonia Results Review for Retained Gas Sampling*, Pacific Northwest National Laboratory, Richland, Washington.

[d]RPP-10006, 2004, *Methodology and Calculations for the Assignment of Waste for the Large Underground Storage Tanks at Hanford Site*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table D-7. Summary of Mean Void Fraction Data for SC/SS-NL and MIX-NL Tanks With Measured Values. (2 sheets)

Tank ID	BPE data[a]	BPE method calc'd retained gas volume (acf)	VFI only data	VFI+RGS data[b]	Mahoney RGS void fraction[c]	Huckaby/ Whitney BPE data 10/01/03[d]	Barker-Barnes 2/8/2006	Waste type

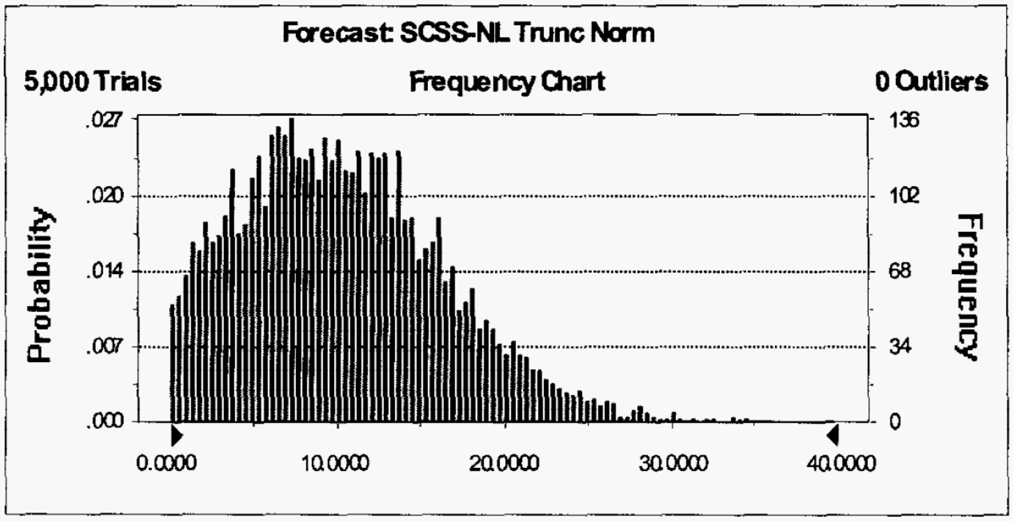
Notes (cont.):

BPE = barometric pressure effect.
MIX-NL = mixed waste from with < 1 m liquid over solids.
NA = not applicable.
RGS = retained gas sampler.
SC/SS-NL = saltcake/salt slurry waste form with < 1 m liquid over solids.
VFI = void fraction instrument.

Table D-8. Default Void Fraction for SC/SS-NL and MIX-NL Waste with Truncated Normal Distribution.

Mean	8.84
Standard deviation	7.13
Truncate low	0.01
Truncate high	40

Figure D-3. Void Fraction Regression Results for SC/SS-NL and MIX-NL Wastes.



D7.3.2 SL-NL Default Void Fraction

The data for SL-NL wastes (Table D-9) have been regressed using Crystal Ball to fit a normal distribution which is then truncated to bound the values to those expected for the given waste type void fraction, as shown in Figure D-4. The original boundary recommendations are presented in SNL-000198. Figure D-4 represents a truncated normal distribution with a mean and standard deviation as shown below. The default void fraction of 2.44 and the statistical distribution for SL-NL waste is given in Table D-10.

Table D-9. Summary of Average Void Fraction Data for SL-NL Tanks With Measured Values.

Tank ID	BPE data[a]	BPE method calc'd retained gas volume (acf)	VFI only data	VFI+RGS data[b]	Mahoney RGS void fraction[c]	Huckaby/ Whitney BPE data 10/01/03[d]	Barker-Barnes 2/8/2006	Waste type
241-AY-101	0.042	604	--	--	--	--	--	SL-NL
241-BX-101	0.02	114	--	--	--	--	--	SL-NL
241-BX-103	0.012	35	--	--	--	--	--	SL-NL
241-BX-104	0.075	967	--	--	--	--	--	SL-NL
241-BX-107	0.025	1,155	--	--	--	--	--	SL-NL
241-BX-112	0.005	109	--	--	--	--	--	SL-NL
241-C-103	0.006	13	--	--	--	--	--	SL-NL
241-S-107	0.024	1,163	--	--	--	--	--	SL-NL
241-TX-101	0.009	23	--	--	--	--	--	SL-NL
241-TY-104	0.017	23	--	--	--	--	--	SL-NL

Notes:

[a]Based on BPE data from RPP-15488, 2004, *Investigation of Tank Void Fraction Using Liquid Level to Atmospheric Pressure Changes*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

[b]PNNL-11536, 1997, *Gas Retention and Release Behavior in Hanford Single-Shell Waste Tanks*, Pacific Northwest National Laboratory, Rev. 1, Richland, Washington.

[c]PNNL-13317, 2000, *Ammonia Results Review for Retained Gas Sampling*, Pacific Northwest National Laboratory, Richland, Washington.

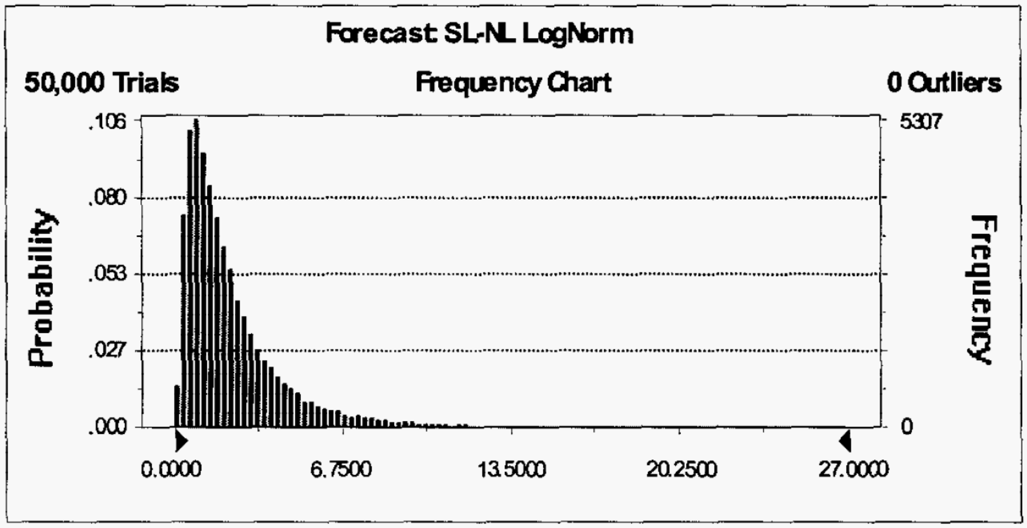
[d]RPP-10006, 2004, *Methodology and Calculations for the Assignment of Waste for the Large Underground Storage Tanks at Hanford Site*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

BPE = barometric pressure effect.
RGS = retained gas sampler.
SL-NL = sludge waste form with < 1 m liquid over solids.
VFI = void fraction instrument.

Table D-10. The Default Void Fraction for SL-NL Waste with Truncated LogNormal Distribution.

Mean	2.44
Standard deviation	2.49
Truncate low	0.01
Truncate high	26.5

Figure D-4. Void Fraction Regression Results for SL-NL Wastes.



D7.3.3 SC/SS-LIQ, SL-LIQ, and MIX-LIQ Default Void Fraction

The data for SC/SS-LIQ wastes (Table D-11) have been regressed to fit a truncated normal distribution as shown in Figure D-5. Figure D-5 represents a truncated normal distribution with a mean and standard deviation as shown below. In addition, wastes with significant supernatant (greater than 1 m depth) have an upper bound at the neutral buoyancy void fraction for the waste. The modification of the upper limit of the void fraction to account for the neutral buoyancy void fraction within a given tank is done within the model at execution time and is not reflected here. The default void fraction of 6.37 and its statistical distribution for SC/SS-LIQ waste is given in Table D-12.

Although no SL-LIQ or MIX-LIQ waste type tanks are used in the regression of this default distribution, the SC/SS-LIQ default distribution will be applied to SL-LIQ and MIX-LIQ tanks.

Table D-11. Summary of Average Void Fraction Data for SC/SS-LIQ Tanks With Measured Values.

Tank ID	BPE data[a]	BPE method calc'd retained gas volume (acf)	VFI only data	VFI+RGS data[b]	Mahoney RGS void fraction[c]	Huckaby /Whitney BPE data 10/01/03[d]	Barker-Barnes 2/8/2006	Waste type
241-AN-103	0.215[e]	11,802	0.122	0.107	0.092	--	--	SC/SS-LIQ
241-AN-104	0.084	5,070	0.059	0.062	0.08	--	--	SC/SS-LIQ
241-AN-105	0.064	4,200	0.038	0.042	0.051	--	--	SC/SS-LIQ
241-AN-107	--	--	--	--	--	--	0.011	SC/SS-LIQ
241-AW-101	0.152[e]	6,229	0.047	0.038	0.037	--	--	SC/SS-LIQ
241-AW-104	0.058	1,776	--	--	--	--	--	SC/SS-LIQ
241-AW-106	0.032	985	--	--	--	--	--	SC/SS-LIQ
241-SY-101	--	--	--	--	--	0.091	0.085	SC/SS-LIQ
241-SY-103	0.078	3,755	0.06	--	--	--	--	SC/SS-LIQ

Notes:

[a]Based on BPE data from RPP-15488, 2004, *Investigation of Tank Void Fraction Using Liquid Level to Atmospheric Pressure Changes*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

[b]PNNL-11536, 1997, *Gas Retention and Release Behavior in Hanford Single-Shell Waste Tanks*, Pacific Northwest National Laboratory, Rev. 1, Richland, Washington.

[c]PNNL-13317, 2000, *Ammonia Results Review for Retained Gas Sampling*, Pacific Northwest National Laboratory, Richland, Washington.

[d]RPP-10006, 2004, *Methodology and Calculations for the Assignment of Waste for the Large Underground Storage Tanks at Hanford Site*, Rev. 3, CH2M HILL Hanford Group, Inc., Richland, Washington.

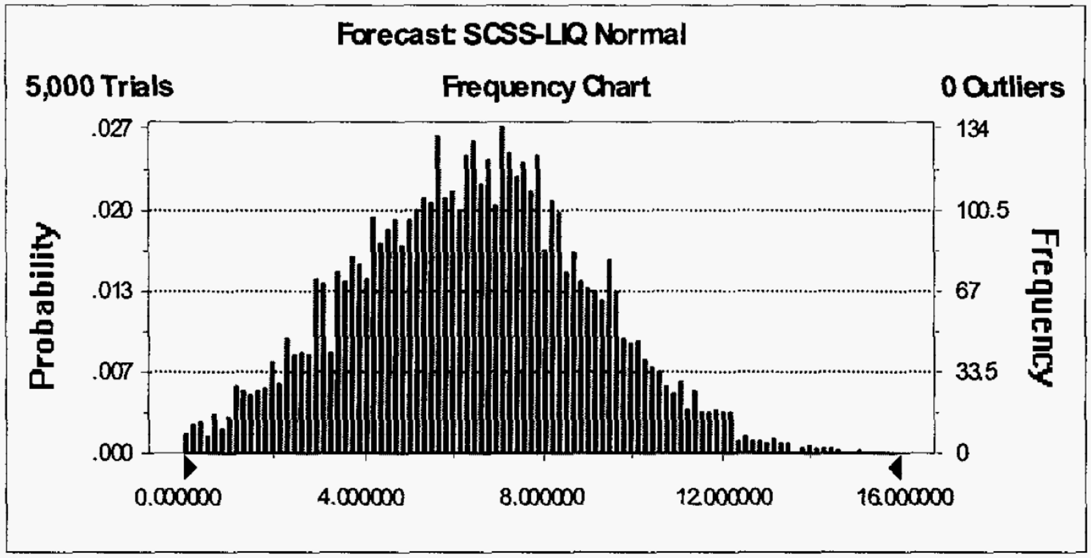
[e]Data not used since it appears to be inconsistent with higher quality data.

BPE = barometric pressure effect.
RGS = retained gas sampler.
SC/SS-LIQ = saltcake/salt slurry waste form with $\geq$ 1 m liquid over solids.
VFI = void fraction instrument.

Table D-12. Default Void Fraction for SC/SS-LIQ, SL-LIQ, and MIX-LIQ Waste with Truncated Normal Distribution.

Mean	6.37
Standard deviation	2.73
Truncate low	0.01
Truncate high	15.11

Figure D-5. Void Fraction Regression Results for SC/SS-LIQ, SL-LIQ, and MIX-LIQ Wastes.



D7.3.4 Liquid Waste Void Fractions

Liquid wastes do not retain gas. Any gas found in the liquid wastes is considered transient and is not considered as trapped or retained gas. Therefore, the void fraction for liquid waste is set to 0.0. In order to comply with Crystal Ball run-time requirements, the mean of the liquid distribution will be set to 0.15 vol % gas, otherwise simulations with liquid wastes will fail.

D7.4 VOID FRACTION ASSIGNMENT FOR 177 DOUBLE-SHELL TANKS AND SINGLE-SHELL TANKS

Table D-13 presents the void fraction distributions and their source for all 177 tanks. The data source for tanks with void fraction measurements is listed as VFI, RGS/VFI, or BPE. All other tanks use default distributions based on waste type.

Table D-13. Void Percent Distributions for All 177 Tanks. (6 sheets)

Tank	Void Percent or Maximum Wetted Solids Void Percent					Data source	Waste type
	Mean (%)	Uncertainty (%)	Minimum (%)	Maximum (%)	Distri-bution (%)		
241-A-101	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-A-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-A-103	0.40	0.20	0.01	40.00	Normal	BPE	SC/SS-NL
241-A-104	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-A-105	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-A-106	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-AN-101	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AN-102	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AN-103	10.70	5.35	0.01	15.11	Normal	RGS/VFI	SC/SS-LIQ
241-AN-104	6.20	3.10	0.01	15.11	Normal	RGS/VFI	SC/SS-LIQ
241-AN-105	4.20	2.10	0.01	15.11	Normal	RGS/VFI	SC/SS-LIQ
241-AN-106	6.37	2.73	0.01	15.11	Normal	Default	MIX-LIQ
241-AN-107	1.10	0.55	0.01	15.11	Normal	BPE	SC/SS-LIQ
241-AP-101	0.02	0.00	0.01	0.02	Normal	Default	LIQ
241-AP-102	6.37	2.73	0.01	15.11	Normal	Default	SL-LIQ
241-AP-103	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AP-104	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AP-105	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AP-106	0.02	0.00	0.01	0.02	Normal	Default	LIQ
241-AP-107	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AP-108	6.37	2.73	0.01	15.11	Normal	Default	SC/SS-LIQ
241-AW-101	4.70	2.35	0.01	15.11	Normal	RGS/VFI	SC/SS-LIQ
241-AW-102	6.37	2.73	0.01	15.11	Normal	Default	SL-LIQ
241-AW-103	0.90	0.45	0.01	15.11	Normal	BPE	SL-LIQ
241-AW-104	5.80	2.90	0.00	15.11	Normal	BPE	SC/SS-LIQ
241-AW-105	6.37	2.73	0.01	15.11	Normal	Default	SL-LIQ
241-AW-106	3.20	1.60	0.01	15.11	Normal	BPE	SC/SS-LIQ
241-AX-101	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-AX-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-AX-103	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-AX-104	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-AY-101	4.20	2.10	0.00	26.50	Normal	BPE	SL-NL
241-AY-102	6.37	2.73	0.01	15.11	Normal	Default	SL-LIQ
241-AZ-101	6.37	2.73	0.01	15.11	Normal	Default	SL-LIQ

Table D-13. Void Percent Distributions for All 177 Tanks. (6 sheets)

Tank	Void Percent or Maximum Wetted Solids Void Percent					Data source	Waste type
	Mean (%)	Uncertainty (%)	Minimum (%)	Maximum (%)	Distri-bution (%)		
241-AZ-102	6.37	2.73	0.01	15.11	Normal	Default	SL-LIQ
241-B-101	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-B-102	2.70	1.35	0.01	40.00	Normal	BPE	SC/SS-NL
241-B-103	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-B-104	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-105	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-B-106	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-107	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-B-108	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-B-109	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-B-110	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-111	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-112	2.50	1.25	0.01	40.00	Normal	BPE	MIX-NL
241-B-201	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-202	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-203	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-B-204	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-BX-101	2.00	1.00	0.00	26.50	Normal	BPE	SL-NL
241-BX-102	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-BX-103	1.20	0.60	0.00	26.50	Normal	BPE	SL-NL
241-BX-104	7.50	3.75	0.00	26.50	Normal	BPE	SL-NL
241-BX-105	1.60	0.80	0.01	40.00	Normal	BPE	MIX-NL
241-BX-106	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BX-107	2.50	1.25	0.00	26.50	Normal	BPE	SL-NL
241-BX-108	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-BX-109	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-BX-110	4.00	2.00	0.01	40.00	Normal	BPE	MIX-NL
241-BX-111	0.50	0.25	0.01	40.00	Normal	BPE	SC/SS-NL
241-BX-112	0.50	0.25	0.00	26.50	Normal	BPE	SL-NL
241-BY-101	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-103	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-104	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-105	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-106	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL

Table D-13. Void Percent Distributions for All 177 Tanks. (6 sheets)

Tank	Void Percent or Maximum Wetted Solids Void Percent					Data source	Waste type
	Mean (%)	Uncertainty (%)	Minimum (%)	Maximum (%)	Distribution (%)		
241-BY-107	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-108	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-109	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-110	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-111	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-BY-112	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-C-101	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-102	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-103	0.60	0.30	0.00	26.50	Normal	BPE	SL-NL
241-C-104	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-105	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-106	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-107	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-108	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-109	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-110	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-111	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-112	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-201	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-202	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-203	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-C-204	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-S-101	4.30	2.15	0.01	40.00	Normal	BPE	MIX-NL
241-S-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-S-103	14.70	7.35	0.01	40.00	Normal	BPE	SC/SS-NL
241-S-104	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-S-105	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-S-106	8.20	4.10	0.01	40.00	Normal	BPE	SC/SS-NL
241-S-107	2.40	1.20	0.01	26.50	Normal	BPE	SL-NL
241-S-108	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-S-109	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-S-110	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-S-111	11.90	5.95	0.01	40.00	Normal	BPE	SC/SS-NL
241-S-112	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-SX-101	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL

Table D-13. Void Percent Distributions for All 177 Tanks. (6 sheets)

Tank	Void Percent or Maximum Wetted Solids Void Percent					Data source	Waste type
	Mean (%)	Uncertainty (%)	Minimum (%)	Maximum (%)	Distribution (%)		
241-SX-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-SX-103	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-SX-104	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-SX-105	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-SX-106	14.00	7.00	0.01	40.00	Normal	BPE	SC/SS-NL
241-SX-107	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-108	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-109	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-SX-110	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-111	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-112	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-113	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-114	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SX-115	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-SY-101	8.50	4.25	0.00	15.11	Normal	BPE	SC/SS-LIQ
241-SY-102	0.90	0.45	0.01	15.11	Normal	BPE	SL-LIQ
241-SY-103	6.00	3.00	0.00	15.11	Normal	VFI	SC/SS-LIQ
241-T-101	0.70	0.35	0.01	40.00	Normal	BPE	MIX-NL
241-T-102	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-103	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-104	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-105	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-106	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-107	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-108	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-T-109	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-T-110	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-111	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-112	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-201	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-202	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-203	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-T-204	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-TX-101	0.90	0.45	0.01	26.50	Normal	BPE	SL-NL
241-TX-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL

Table D-13. Void Percent Distributions for All 177 Tanks. (6 sheets)

Tank	Void Percent or Maximum Wetted Solids Void Percent					Data source	Waste type
	Mean (%)	Uncertainty (%)	Minimum (%)	Maximum (%)	Distri-bution (%)		
241-TX-103	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-104	1.20	0.60	0.01	40.00	Normal	BPE	MIX-NL
241-TX-105	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-106	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-107	2.10	1.05	0.01	40.00	Normal	BPE	SC/SS-NL
241-TX-108	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-109	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-TX-110	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-111	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-112	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-113	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-114	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-115	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-116	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-117	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TX-118	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TY-101	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-TY-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-TY-103	8.84	7.13	0.01	40.00	Normal	Default	MIX-NL
241-TY-104	1.70	0.85	0.01	26.50	Normal	BPE	SL-NL
241-TY-105	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-TY-106	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-101	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-102	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-U-103	8.00	4.00	0.01	40.00	Normal	BPE	SC/SS-NL
241-U-104	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-105	7.30	3.65	0.01	40.00	Normal	BPE	SC/SS-NL
241-U-106	1.50	0.75	0.01	40.00	Normal	BPE	SC/SS-NL
241-U-107	7.60	3.80	0.01	40.00	Normal	BPE	SC/SS-NL
241-U-108	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-U-109	4.10	2.05	0.01	40.00	Normal	BPE	SC/SS-NL
241-U-110	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-111	8.84	7.13	0.01	40.00	Normal	Default	SC/SS-NL
241-U-112	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-201	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL

Table D-13. Void Percent Distributions for All 177 Tanks. (6 sheets)

Tank	Void Percent or Maximum Wetted Solids Void Percent					Data source	Waste type
	Mean (%)	Uncertainty (%)	Minimum (%)	Maximum (%)	Distri-bution (%)		
241-U-202	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-203	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL
241-U-204	2.44	2.49	0.01	26.50	Lognorm	Default	SL-NL

Notes:
- BPE = barometric pressure effect.
- LIQ = liquid
- MIX-LIQ = mixed waste form with ≥ 1 m liquid over solids.
- MIX-NL = mixed waste form with < 1 m liquid over solids.
- RGS = retained gas sampler.
- SC/SS-LIQ = saltcake/salt slurry waste form with ≥ 1m liquid over solids.
- SC/SS-NL = saltcake/salt slurry waste form with < 1m liquid over solids.
- SL-LIQ = sludge waste form with ≥ 1 m liquid over solids.
- SL-NL = sludge waste form with < 1 m liquid over solids.
- VFI = void fraction instrument.

D8.0 CONCLUSIONS

The field measured data from VFI, RGS, and BPE have been thoroughly examined to determine, calculate, and develop the void fractions for the 177 DSTs and SSTs. The void fraction is being validated, adopted, and calculated using 39 of the 86 dL/dP data points from RPP-15884. In addition, dL/dP data have been developed for DSTs 241-AN-107 and 241-SY-101, and the void fractions were calculated. The dL/dP data from Huckaby (RPP-10006, *Methodology and Calculations for the Assignment of Waste for the Large Underground Storage Tanks at Hanford Site*, Rev. 3) and the void fraction data reported using VFI and RGS have been used to develop three default void fractions for SC/SS-NL and MIX-NL waste types, for SL-NL waste type, and for SC/SS-LIQ, SL-LIQ and MIX-LIQ waste types.

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APPENDIX E

HYDROGEN GENERATION RATES CALCULATIONS FOR BUOYANT DISPLACEMENT GAS RELEASE EVENT CRITERIA DETERMINATIONS

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CONTENTS

TABLES

LIST OF TERMS

BBI	Best-Basis Inventory
BDGRE	buoyant displacement gas release event
CL	convective layer
DST	double-shell tank
HGR	hydrogen generation rate
NA	not applicable
NCL	nonconvective layer
RGS	retained gas solids
TOC	total organic carbon

Calculation Review Checklist.

Calculation Reviewed: Appendix E, RPP-10006, Rev 5

Scope of Review: Appendix E
(e.g., document section or portion of calculation)

Engineer/Analyst: T. A. Hu [signature] Date: 7/25/06

Organizational Manager: M. A. Knight [signature] Date: 7/25/06

This document consists of 20 pages

Yes	No	NA*		
[✓]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[✓]	[ ]	[ ]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[✓]	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[✓]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[ ]	[ ]	[✓]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[✓]	[ ]	[ ]	6.	Mathematical derivations were checked, including dimensional consistency of results.
[✓]	[ ]	[ ]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[✓]	[ ]	[ ]	8.	Software verification and validation are addressed adequately.
[ ]	[ ]	[✓]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[✓]	[ ]	[ ]	10.	Conclusions are consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	11.	Results and conclusions address all points in the purpose.
[✓]	[ ]	[ ]	12.	Referenced documents are retrievable or otherwise available.
[✓]	[ ]	[ ]	13.	The version or revision of each reference is cited.
[✓]	[ ]	[ ]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[✓]	[ ]	[ ]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[✓]	[ ]	[ ]	16.	All checker comments have been dispositioned and the design media matches the calculations.

K. D. Fowler [signature] — 7/25/06
Checker (printed name and signature) — Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

APPENDIX E

HYDROGEN GENERATION RATES CALCULATIONS FOR BUOYANT DISPLACEMENT GAS RELEASE EVENT CRITERIA DETERMINATIONS

E1.0 OBJECTIVE

The purpose of this appendix is to calculate and update the hydrogen generation rates (HGR) for 28 double-shell tanks (DST) from RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, Appendix B, for the buoyant displacement gas release event (BDGRE) criteria model determinations based on the newly established solid levels in RPP-10006, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*, Rev. 5, Appendix C.

In addition, an evaluation is documented in Section E6.0 to determine the distribution ranges for the HGR based on a comparison between calculated and observed HGRs as presented in HNF-3851, *Empirical Rate Equation Model and Rate Calculations of Hydrogen Generation for Hanford Tank Waste*.

E2.0 BACKGROUND

In the BDGRE waste group selection criteria for Hanford tank waste (RPP-10006, Section 2.0), all three criteria calculations require the depth of the nonconvective (solid) waste layer (NCL). The buoyancy ratio is proportional to the solid waste depth to second power. In the original input data preparation for BDGRE calculations, the waste depths of 177 tanks were estimated by converting the Best-Basis Inventory (BBI) waste volumes to waste levels (RPP-5926). Also, the HGRs were calculated for both solid (NCL) and liquid (convective layer [CL]). These input data used in the DST HGR update are presented in Section E3.0.

During the data evaluation for the uncertainty of the solid waste level (RPP-10006, Appendix C) the solid waste depths for the DSTs were updated based on field measurements using various techniques (e.g., sludge weight measurement, void fraction instruments, ball reohmeter). The solid level update resulted in changes to associated tank waste HGR since HGR is a function of tank waste volume and waste depth. This appendix uses the updated NCL depth and other input data to calculate the waste volumes and HGRs for both liquids (CL) and solids (NCL) for all 28 DSTs. Results are given in Section E7.0.

E3.0 INPUT DATA

The required input data for the spreadsheet are divided into two groups. The first type of input data is for the tanks that had a solid layer originally and is given in Table E-1. For these tanks, the required input data are as follows:

- Current unit HGRs of radiolysis, thermolysis, and corrosion from the NCL (solid layer) in moles per cubic meter per second (mole/m^3-s)
- Total unit HGRs from the CL (supernatant layer)
- Volume of the solid layer and volume of total non-RGS (degassed solids) in kiloliters (kL)
- Depth of the solid layer in inches (in.)
- Temperature of the dome space in degrees Celsius (°C)
- Updated solid level in inches (in.).

Table E-1. Input Data from RPP-5926, Appendix B. (2 sheets)

Tank	NCL HGR radio-lysis $RC_{rad}^{b/r}$ (M/m^3-s)	NCL HGR radio-lysis RC_{rad}^{α} (M/m^3-s)	NCL HGR thermo-lysis RC_{therm} (M/m^3-s)	NCL HGR corrosion RC_{corr} (M/m^3-s)	CL HGR total RC_{tot} (M/m^3-s)	NCL waste level Dw (inch)	Total non-RGS waste volume (kL)	RGS volume (kL)	Dome temp. Td (°C)
241-AN-101	3.46E-09	2.20E-11	3.36E-09	9.12E-09	8.74E-09	11.3	3,624	NA	25
241-AN-102	2.20E-08	3.96E-10	2.64E-08	2.19E-09	4.54E-08	56.0	4,052	NA	31
241-AN-103	3.06E-09	3.19E-12	8.37E-09	1.17E-09	1.71E-08	166.6	3,419	208	32
241-AN-104	6.26E-09	1.20E-11	1.24E-08	1.12E-09	1.41E-08	161.6	3,864	119	32
241-AN-105	4.37E-09	5.41E-12	6.96E-09	9.94E-10	9.34E-09	195.1	4,152	109	30
241-AN-106	1.50E-07	2.21E-09	5.42E-10	5.94E-09	4.37E-09	17.8	3,527	--	22
241-AN-107	2.85E-08	6.19E-10	1.69E-08	1.61E-09	3.56E-08	83.6	4,169	NA	31
241-AP-101	NA	NA	NA	NA	3.87E-09	NA	4,219	NA	22
241-AP-102	1.11E-09	4.65E-13	1.77E-09	1.21E-08	5.08E-09	8.4	4,141	NA	19
241-AP-103	NA	NA	NA	NA	7.54E-09	NA	3,385	NA	21
241-AP-104	NA	NA	NA	NA	6.90E-09	NA	4,164	NA	22
241-AP-105	5.13E-09	6.36E-12	4.06E-10	3.48E-09	3.47E-09	32.3	4,311	NA	18
241-AP-106	NA	NA	NA	NA	7.32E-09	NA	4,301	NA	19
241-AP-107	NA	NA	NA	NA	5.32E-09	NA	794	NA	19
241-AP-108	NA	NA	NA	NA	1.00E-08	NA	4,326	NA	26
241-AW-101	4.98E-09	6.54E-11	4.30E-09	1.20E-09	9.17E-09	143.7	4,173	95	21

Table E-1. Input Data from RPP-5926, Appendix B. (2 sheets)

Tank	NCL HGR radio-lysis $RC_{rad}^{b/r}$ (M/m^3-s)	NCL HGR radio-lysis RC_{rad}^{α} (M/m^3-s)	NCL HGR thermo-lysis RC_{therm} (M/m^3-s)	NCL HGR corrosion RC_{corr} (M/m^3-s)	CL HGR total RC_{tot} (M/m^3-s)	NCL waste level Dw (inch)	Total non-RGS waste volume (kL)	RGS volume (kL)	Dome temp. Td (°C)
241-AW-102	1.30E-08	9.59E-10	1.03E-09	4.14E-08	4.18E-09	2.4	2,099	NA	22
241-AW-103	5.42E-10	1.65E-10	1.73E-09	1.30E-09	2.81E-09	113.6	4,163	NA	21
241-AW-104	2.44E-09	4.24E-10	3.85E-09	1.65E-09	8.91E-09	80.9	4,064	NA	25
241-AW-105	2.59E-09	8.73E-10	3.86E-11	1.46E-09	1.88E-09	95.8	1,592	NA	20
241-AW-106	4.91E-09	1.97E-11	1.91E-09	1.39E-09	4.55E-09	102.8	3,405	NA	25
241-AY-101	2.12E-07	3.19E-08	2.33E-09	8.13E-09	5.87E-09	34.9	689	NA	34
241-AY-102	7.94E-07	2.51E-08	9.70E-09	5.58E-09	5.20E-09	54.8	3,438	NA	40
241-AZ-101	6.68E-07	6.25E-08	3.40E-08	5.64E-09	8.02E-08	18.9	3,409	NA	72
241-AZ-102	6.85E-07	9.72E-08	7.65E-09	3.02E-09	6.63E-08	38.0	3,712	NA	49
241-SY-101	4.19E-09	2.58E-10	8.78E-10	1.56E-09	3.58E-09	99.9	1,421	93	20
241-SY-102	4.96E-09	1.80E-08	1.89E-09	2.30E-09	2.46E-09	52.8	3,902	NA	26
241-SY-103	6.61E-09	3.78E-10	1.02E-08	1.32E-09	1.49E-08	124.1	2,706	91	25

Notes:

RPP-5926, 2005, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, CH2M HILL Hanford Group, Inc, Richland, Washington.

CL = convective layer.
HGR = hygrogen generation rate.
NA = not applicable.
NCL = nonconvective layer.
RGS volume = retained gas volume based on the retained gas sampler.
Non-RGS waste volume = non-convective waste volume without the retained gas volume.

These input data were taken from RPP-5926, Appendix B, except for the updated solid level, which was taken from Appendix C of RPP-10006.

The second type of input data is for the tanks that had no solid layer originally and is given in Tables E-2 and E-3. For these tanks, the HGR for both CLs and NCLs were calculated using the spreadsheet "RPP-5926-8050-R4-LFL-CAL-T2-102004.xls" (SVF-032, *Spreadsheet Verification and Release Form for RPP-5926-8050-R4-LFL-CAL-T2-102004.xls*, Rev. 4). The methodology is documented in RPP-5926.

The required input data are as follows:

- Chemical concentrations of total organic carbon (TOC), NO_3, NO_2, Na, Al, and OH in the supernatant and interstitial liquid of the solid layer in micrograms per milliliter (μg/mL)

- Bulk radionuclide concentrations of ^{90}Sr, ^{241}Am, ^{240}Pu, ^{239}Pu, ^{238}Pu, and ^{137}Cs in the liquid and solid layers in microcuries per gram (μCi/g)
- Bulk densities of the liquid and solid layers and the interstitial liquid in grams per milliliter (g/mL)
- Weight percent (wt%) water of the solid and liquid layers
- Volume of the liquid and solid layers in kiloliters (kL)
- Temperature of the liquid and solid layers and the tank dome space in degrees Celsius (°C).

Most of these input data are taken from RPP-5926, Appendix B, with the exception of the temperatures for DSTs 241-AP-103 and 241-AP-108, which are taken from personal computer-surveillance analysis computer system (PCSACS 2006).

Table E-2. Input Data of Chemical and Radionuclide for Hydrogen Generation Rate Calculations on Buoyant Displacement Gas Release Event Criteria Determination.

Tank	TOC in liquid [TOC] (µg/mL)	NO_2 in liquid [NO2] (µg/mL)	NO_3 in liquid [NO3] (µg/mL)	Na in liquid [Na] (µg/mL)	Al in liquid [Al] (µg/mL)	^{90}Sr in waste [Sr] (µCi/g)	^{137}Cs in waste [Cs] (µCi/g)
241-AP-103 CL	7.27E+03	8.04E+04	1.49E+05	1.78E+05	1.83E+04	1.78E+00	1.70E+02
241-AP-103 NCL	7.27E+03	8.04E+04	1.49E+05	1.78E+05	1.83E+04	1.78E+00	1.70E+02
241-AP-104 CL	4.15E+03	6.39E+04	1.01E+05	1.28E+05	1.68E+04	1.30E+00	1.45E+02
241-AP-104 NCL	4.15E+03	6.39E+04	1.01E+05	1.28E+05	1.68E+04	1.30E+00	1.45E+02
241-AP-107 CL	2.33E+03	5.14E+04	1.12E+05	1.22E+05	1.39E+04	7.85E-01	1.04E+02
241-AP-107 NCL	2.33E+03	5.14E+04	1.12E+05	1.22E+05	1.39E+04	7.85E-01	1.04E+02
241-AP-108 CL	4.18E+03	8.02E+04	1.76E+05	1.99E+05	2.38E+04	5.01E-01	1.40E+02
241-AP-108 NCL	4.18E+03	8.02E+04	1.76E+05	1.99E+05	2.38E+04	5.01E-01	1.40E+02

Notes:
CL = convective layer.
NCL = nonconvective layer.
TOC = total organic carbon.

Table E-3. Input Data of Physical Properties for Hydrogen Generation Rate Calculation on Buoyant Displacement Gas Release Event Criteria Determination.

Tank	Bulk density D (g/mL)	Liquid Density DL (g/ml)	Non-RGS waste volume (kL)	Bulk water [H2O] (wt%)	Liquid water [H2O] (wt%)	Waste temp. Tw (°C)	Dome temp. Td (°C)
241-AP-103 CL	1.35	1.35	3,230	57%	57%	21	21
241-AP-103 NCL	1.61	1.35	155	43%	57%	21	21
241-AP-104 CL	1.28	1.28	4,019	66%	66%	23	22
241-AP-104 NCL	1.61	1.28	145	43%	66%	25	22
241-AP-107 CL	1.28	1.28	665	66%	66%	20	19
241-AP-107 NCL	1.61	1.28	129	43%	66%	20	19
241-AP-108 CL	1.43	1.43	3,766	53%	53%	26	26
241-AP-108 NCL	1.61	1.43	560	43%	53%	26	26

Notes:
CL = convective layer.
NCL = nonconvective layer.
RGS = retained gas solids.

The interstitial liquid chemical concentrations and bulk radionuclide concentrations are assumed to be the same as the liquid layer (CL). The solid bulk density and weight percent water are assumed to be the same as the solids in DST 241-AW-106, as given in Table E-4.

Table E-4. Update of Table A-1 in RPP-5926, Best Basis Inventory by Waste Type, Waste Volume, Density, and Wt% Water. (2 sheets)

Tank name	Waste phase	Waste type	Original volume (kL)	Updated volume (kL)	Density (g/mL)	Wt% water
241-AN-106	Supernatant	NA	3,341	3,166	1.11	82
241-AN-106	Saltcake	NA	65	126	1.58	37.8
241-AN-106	Sludge	NA	109	212	1.52	37
241-AN-106	Sludge	HS (Solid)	12	23	1.62	26.5
241-AP-103	Supernatant	Waste Transfer	3,385	3,230	1.35	57
241-AP-103	Saltcake	A2-SltSlr (Solid)	NA	155	1.61	43
241-AP-104	Supernatant	Waste Transfer	4,164	4,019	1.28	66
241-AP-104	Saltcake	A2-SltSlr (Solid)	NA	145	1.61	43
241-AP-107	Supernatant	Waste Transfer	794	665	1.28	66
241-AP-107	Saltcake	A2-SltSlr (Solid)	NA	129	1.61	43
241-AP-108	Supernatant	Waste Transfer	4,326	3,766	1.43	53
241-AP-108	Saltcake	A2-SltSlr (Solid)	NA	560	1.61	43
241-AW-103	Supernatant	NA	2,979	2,853	1.24	65.9

Table E-4. Update of Table A-1 in RPP-5926, Best Basis Inventory by Waste Type, Waste Volume, Density, and Wt% Water. (2 sheets)

Tank name	Waste phase	Waste type	Original volume (kL)	Updated volume (kL)	Density (g/mL)	Wt% water
241-AW-103	Sludge	CWZr2 (Solid)	1,033	1,143	1.47	55.8
241-AW-103	Saltcake (S)	A1-SltCk (Solid)	115	127	1.69	45.2
241-AW-103	Saltcake (L)	A1-SltCk (Liquid)	36	40	1.45	49.1
241-AW-106	Supernatant	Waste Transfer	3,405	2,333	1.3	72
241-AW-106	Saltcake	A2-SltSlr (Solid)	NA	1,072	1.61	43

Notes:

RPP-5926, 2005, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, CH2M HILL Hanford Group, Inc, Richland, Washington.

NA = not applicable.

E4.0 ASSUMPTIONS

It is assumed that the total waste level in each tank has not changed. Therefore, the updated solid level results in updated supernatant (CL layer) and crust layer volumes.

It also is assumed that the waste chemical and radionuclide concentrations, densities, weight percents water, and temperatures have not changed. The solids level change will cause the HGR from corrosion to change. Other HGRs are not changed.

For tanks that previously contained no solids, the bulk density and weight percent water of the solids are assumed to be the same as the solids in DST 241-AW-106.

E5.0 METHODOLOGY

Total and unit HGRs for the three generation mechanisms (thermolysis, beta/gamma and total alpha radiolysis, and corrosion) have been calculated for the supernatant and solid layers in each of the 177 waste tanks based on BBI data of September 21, 2005, and documented in RPP-5926. The unit HGRs from thermolysis and radiolysis are volume based and remain unchanged for the updated solid level. The HGR from corrosion is proportional to the wetted tank surface area and needs to be corrected for the updated solid level.

The updated unit HGRs from corrosion (HGR_{new}^{corr}) can be calculated by scaling the original unit HGR from corrosion (HGR_{old}^{corr}) using the ratios of the original and updated waste levels and contacted tank surface areas as follows (Equation E-1):

$$\mathrm{HGR}_{\mathrm{new}}^{\mathrm{corr}} = \mathrm{HGR}_{\mathrm{old}}^{\mathrm{corr}}\left(\frac{\mathrm{h}_{\mathrm{old}} \times (R + 2 \times h_{new})}{\mathrm{h}_{new} \times (R + 2 \times h_{old})}\right) \qquad \text{(E-1)}$$

Where h_{old} and h_{new} are the existing and updated solids levels, respectively, and R is the tank radius.

The spreadsheet "RPP-5926 Rev 5 update for BDGRE.xls" is structured in two parts for 28 DSTs. The first part contains the input data from Appendix B of RPP-5926, and the second part contains the HGR and waste volume calculations from RPP-10006, based on the updated solid levels and the input data. The calculations provide updated solid (NCL) and liquid (CL) waste volumes, the unit HGRs from corrosion, total unit HGRs from NCL, and the total HGRs from NCL for the whole tank. The spreadsheet is documented in RPP-29261 and verified with spreadsheet verification form SVF-1123, *Spreadsheet Verification and Release Form for Spreadsheet RPP-5926 Rev 5 Update for BDGRE.xls*.

DSTs 241-AP-103, 241-AP-104, 241-AP-107, and 241-AP-108 did not have the HGRs calculated in RPP-5926 because there were no solids (NCL) reported in BBI. In Appendix C of RPP-10006, solids layers (NCL) were established for these four tanks as shown in first column of Table E-9. The HGRs of these tanks are recalculated using the spreadsheet documented in RPP-5926, Rev. 5 and verified with spreadsheet verification form SVF-032.

E6.0 HYDROGEN GENERATION RATE DISTRIBUTIONS

The HGR distributions are based on the evaluation of model-calculated and field-observed rates from HNF-3851, as presented in Table E-5. In Table E-5, positive "Relative Differences" indicate overestimation of the HGR; negative "Relative Differences" indicate model underestimation of the HGR.

Table E-5. Comparison of Model-Calculated and Field-Observed Hydrogen Generation Rates (HNF-3851).

Tanks	G_{mod} (ft^3/min) total HGR from model	G_{field} (ft^3/min) total HGR from field	G_{mod} (L/day) total HGR from model	G_{field} (L/day) total HGR from field	Relative differences [model vs. field data]
241-AN-101	1.73E-04	2.50E-04	7	10	-31%
241-U-107	4.71E-04	8.27E-04	19	34	-43%
241-U-109	5.44E-04	7.11E-04	22	29	-23%
241-SX-101	6.64E-04	4.20E-04	27	17	58%
241-U-108	9.42E-04	1.41E-03	39	57	-33%
241-SY-102	9.66E-04	7.26E-04	40	30	33%
241-U-102	1.05E-03	1.10E-03	43	45	-4%
241-U-106	1.12E-03	6.62E-04	46	27	69%
241-S-102	1.25E-03	1.64E-03	51	67	-24%
241-SX-104	1.31E-03	2.51E-04	53	10	420%
241-U-105	1.37E-03	1.61E-03	56	65	-15%
241-U-103	1.46E-03	1.48E-03	60	60	-1%
241-SX-106	1.53E-03	1.24E-03	63	50	24%
241-C-104	2.56E-03	2.21E-03	105	90	16%
241-SX-103	3.03E-03	1.27E-03	124	52	139%
241-AW-101	3.55E-03	3.17E-03	146	129	12%
241-SY-103	3.63E-03	3.54E-03	149	145	2%
241-AN-103	4.54E-03	4.76E-03	186	195	-5%
241-AN-105	5.14E-03	3.06E-03	211	125	68%
241-AN-104	5.53E-03	2.55E-03	227	104	117%
241-A-101	5.76E-03	2.14E-03	236	87	169%
241-SX-105	5.77E-03	4.82E-03	236	197	20%
241-AN-107	1.09E-02	5.25E-03	447	214	108%
241-C-106	1.62E-02	9.03E-03	664	368	79%
241-AY-102	2.10E-02	1.70E-02	859	691	24%
241-AZ-101	2.79E-02	9.44E-03	1144	385	196%
241-AZ-102	2.90E-02	1.90E-02	1190	775	53%
241-SY-101	5.96E-02	2.44E-02	2441	993	145%

Notes:

HNF-3851, 2004, *Empirical Rate Equation Model and Rate Calculations of Hydrogen Generation for Hanford Tank Waste*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland Washington.

HGR = hydrogen generation rate.

Based on the evaluations given below the HGR distributions are described by a triangular distribution with the upper and lower bounds defined as listed below.

Model Estimated HGR	Upper Bound	Lower Bound
$HGR_{est} \geq 1.5E\text{-}03$ (ft^3/min)	1.1 * HGR_{est}	HGR_{est} / 3
1.5E-03> $HGR_{est} \geq 1.0E\text{-}03$ (ft^3/min)	1.5 * HGR_{est}	HGR_{est} / 2
1.0E-03 (ft^3/min) > HGR_{est}	1.9 * HGR_{est}	HGR_{est} / 2

Note: The model estimated HGR is the total HGR for the tank. It is assumed that the nonconvective layer HGR has the same upper and lower bound relationships as used for the specific tank's total HGR.

Previously the distribution maximum and minimums for the HGRs were defined loosely as the "HGR_{mean} + 2 times HGR_{mean}" and "HGR_{mean} - HGR_{mean} /2," respectively. When tanks are arranged in order from smallest to largest HGR it was found that the larger model HGRs consistently overestimated the observed HGRs and the smaller HGRs typically underestimated the observed HGRs. As a result, it was decided to divide the range of model-generated HGR values such that the ranges of the observed HGRs were underestimated, overestimated, or mixed (overestimated and underestimated).

The range of HGRs was arbitrarily divided in to the following three groups:

- HGRest ≥1.5E-03 ft^3/min
- 1.5E-03 ft^3/min ≥HGRest ≥1.0E-03 ft^3/min
- 1.0E-03 ft^3/min ≥HGRest.

For tanks with tanks with HGRest > 1.5E-03 ft^3/min, the data ranges from underestimating the observed value by 5% (only 1 value underestimated the observed value) to overestimating the observed HGR by a factor of 3 (15 values overestimated the observed HGR). The distribution ranges were set to encompass the range of observations in this bin. To cover the underestimated values, the upper bound for the range was set to "110 % of the mean" (100% plus twice "the relative difference for 241-AN-103"), and the lower bound was set to the "mean /3" (the mean divided by "100% plus the relative difference for 241-AZ-101"). The resulting distributions for this range of data are presented in Table E-6.

Table E- 6. Hydrogen Generation Rate Distribution for Tanks with HGRest > 1.5E-03 ft³/min.

Tanks	G_{mod} (ft³/min) total HGR from model	G_{field} (ft³/min) total HGR from field	G_{mod} (L/day) total HGR from model	G_{field} (L/day) total HGR from field	Relative differences (model vs. field data)	Resulting distribution using $HGR_{est}/3 \leq HGR_{est} \leq 1.10 * HGR_{est}$		
						Lower bound (L/day)	Mean (L/day)	Upper bound (L/day)
241-AN-103	4.54E-03	4.76E-03	186	195	-5%	62	186	204
241-SY-103	3.63E-03	3.54E-03	149	145	2%	50	149	163
241-AW-101	3.55E-03	3.17E-03	146	129	12%	49	146	160
241-C-104	2.56E-03	2.21E-03	105	90	16%	35	105	115
241-SX-105	5.77E-03	4.82E-03	236	197	20%	79	236	260
241-AY-102	2.10E-02	1.70E-02	859	691	24%	286	859	945
241-SX-106	1.53E-03	1.24E-03	63	50	24%	21	63	69
241-AZ-102	2.90E-02	1.90E-02	1,190	775	53%	397	1,190	1,309
241-AN-105	5.14E-03	3.06E-03	211	125	68%	70	211	232
241-C-106	1.62E-02	9.03E-03	664	368	79%	221	664	730
241-AN-107	1.09E-02	5.25E-03	447	214	108%	149	447	492
241-AN-104	5.53E-03	2.55E-03	227	104	117%	76	227	249
241-SX-103	3.03E-03	1.27E-03	124	52	139%	41	124	137
241-SY-101	5.96E-02	2.44E-02	2,441	993	145%	814	2,441	2,685
241-A-101	5.64E-03	2.14E-03	231	87	164%	77	231	254
241-AZ-101	2.79E-02	9.44E-03	1,144	385	196%	381	1,144	1,258

Note:
HGR = hydrogen generation rate.

Six tanks fell into the tanks with 1.5E-03 ft³/min > HGRest > 1.0E-03 ft³/min bin. Of these, four tanks underestimated the HGR by up to 25%, and two tanks overestimated the HGR by up to 420%. To account for this range, the underestimated values the upper bound for the range was set to "150 % of the mean" (100% plus twice "the relative difference for 241-S-102"), and the lower bound was set to the "mean /2" (the mean divided by "100% plus ¼ of the relative difference for 241-SX-104." This is a conservative assumption). The resulting distributions for this range of data are presented in Table E-7.

Table E-7. Hydrogen Generation Rate Distribution for Tanks with 1.5E-03 ft^3/min > HGRest > 1.0E-03 ft^3/min.

Tanks	G_{mod} (ft^3/min) total HGR from model	G_{field} (ft^3/min) total HGR from field	G_{mod} (L/day) total HGR from model	G_{field} (L/day) total HGR from field	Relative differences (model vs. field data)	Resulting distribution using $HGR_{est}/2 \leq HGR_{est} \leq 1.5 * HGR_{est}$		
						Lower bound (L/day)	Mean (L/day)	Upper bound (L/day)
241-S-102	1.25E-03	1.64E-03	51	67	-24%	26	51	77
241-U-105	1.37E-03	1.61E-03	56	65	-15%	28	56	84
241-U-102	1.05E-03	1.10E-03	43	45	-4%	22	43	65
241-U-103	1.46E-03	1.48E-03	60	60	-1%	30	60	90
241-U-106	1.12E-03	6.62E-04	46	27	69%	23	46	69
241-SX-104	1.31E-03	2.51E-04	53	10	420%	27	53	80

Note:
HGR = hydrogen generation rate.

Six tanks fell into the 1.0E-03 ft^3/min ≥HGRest bin. Of these, tanks four tanks underestimated the HGR by up to 43%, and two tanks overestimated the HGR by up to 60%. To account for this range, the underestimated values the upper bound for the range was set to "190 % of the mean" (100% plus twice "the relative difference for 241-U-107"), and the lower bound was set to the "mean /2" (the mean divided by "100% plus ~2 times of the relative difference for 241-SX-101"). The resulting distributions for this range of data are presented in Table E-8.

Table E-8. Hydrogen Generation Rate Distribution for Tanks with 1.0E-03 ft^3/min ≥HGRest.

Tanks	G_{mod} (ft^3/min) total HGR from model	G_{field} (ft^3/min) total HGR from feld	G_{mod} (L/day) total HGR from model	G_{field} (L/day) total HGR from field	Relative differences (model vs. field data)	Resulting distribution using $HGR_{est}/2 \leq HGR_{est} \leq 1.9 * HGR_{est}$		
						Lower bound (L/day)	Mean (L/day)	Upper bound (L/day)
241-U-107	4.71E-04	8.27E-04	19	34	-43%	10	19	37
241-U-108	9.42E-04	1.41E-03	39	57	-33%	19	39	73
241-AN-101	1.73E-04	2.50E-04	7	10	-31%	4	7	13
241-U-109	5.44E-04	7.11E-04	22	29	-23%	11	22	42
241-SY-102	9.66E-04	7.26E-04	40	30	33%	20	40	75
241-SX-101	6.64E-04	4.20E-04	27	17	58%	14	27	52

E7.0 COMPUTER SOFTWARE USE AND VERIFICATION

The spreadsheets used in the calculations are as follows:

- For the spreadsheet used to update HGR using the existing HGRs taken from RPP-5926, based on the updated solid levels from Appendix C of this document:
  - Microsoft Excel[1] 2003 was used to create the spreadsheet
  - Spreadsheet owner: T. A. Hu
  - Spreadsheet file name: RPP-5926 Rev 5 Update for BDGRE.xls
  - File location: \\AP003\Baro\flammable gas program\RPP-10006 Rev 5\HGR
  - The spreadsheet is verified and documented in Spreadsheet Verification and Release Form SVF-1123, Rev. 0.
- For the spreadsheet used to calculate HGR for tanks with newly established solid layers.
  - Microsoft Excel 2003 was used to create the spreadsheet
  - Spreadsheet owner: T. A. Hu
  - Spreadsheet file name: RPP-5926-8050-R4-LFL-CAL-T2-102004.xls
  - File location: \\DS005\FlamGas\RPP-5926 Rev 4\Calculations
  - The spreadsheet is verified and documented in Spreadsheet Verification and Release Form SVF-032, Rev. 4.
- For the spreadsheet used to determine the HGR distribution limits.
  - Microsoft Excel 2003 was used to create the spreadsheet
  - Spreadsheet owner: S. A. Barker
  - Spreadsheet file name: RPP-10006r4 HGR Dists 041014 .xls
  - File location: \\AP003\Baro\SteveB\RPP-10006r4\ DatabaseBuild
  - The spreadsheet is verified and documented in Spreadsheet Verification and Release Form SVF-269 *Spreadsheet Verification and Release Form for RPP-10006r4 HGR Dists 041014 .xls*, Rev. 0.

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[1] Microsoft Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

E8.0 RESULTS

Table E-9 lists the input data for the calculation and is taken from RPP-5926, Appendix B. The unit rates for the NCL are scaled for updated solid levels. The unit rates of the CL are used to calculate the total generation rates and to determine the uncertainty in the HGR for the BDGRE model.

The calculations of the HGRs for DSTs 241-AP-103, 241-AP-104, 241-AP-107, and 241-AP-108 are given in Tables E-10a through E-12. Detailed derived variables, unit HGRs, and total HGRs are given in Tables E-10a and E-10b, E-11, and E-12, respectively.

Table E-9. Spreadsheet Calculation Results. (2 sheets)

Tank	Updated solid waste level Dw (in.)	Non-RGS NCL volume (m^3)	CL waste volume (m^3)	NCL HGR corrosion RC_{corr} (mole/m^3-s)	Total NCL unit HGR RC_{TOT} (mole/m^3-s)	NCL Total HGR RC_{NCLTOT} (ft^3/min)	Total HGR RC_{TOT} (ft^3/min)
241-AN-101	18	191	3,433	5.79E-09	1.26E-08	1.251E-04	1.68E-03
241-AN-102	62	648	3,404	2.02E-09	5.09E-08	1.740E-03	9.90E-03
241-AN-103	149	1,343	2,076	1.25E-09	1.27E-08	9.037E-04	2.79E-03
241-AN-104	163	1,578	2,286	1.12E-09	1.98E-08	1.659E-03	3.38E-03
241-AN-105	177	1,734	2,418	1.05E-09	1.24E-08	1.130E-03	2.32E-03
241-AN-106	35	361	3,166	3.27E-09	1.56E-07	2.890E-03	3.60E-03
241-AN-107	90	933	3,236	1.53E-09	4.75E-08	2.338E-03	8.41E-03
241-AP-101	0	0	4,219	NA	NA	NA	8.36E-04
241-AP-102	16	161	3,980	6.78E-09	9.65E-09	7.915E-05	1.11E-03
241-AP-103	15	155	3,230	7.04E-09	1.31E-08	1.036E-04	1.28E-03
241-AP-104	14	145	4,019	7.50E-09	1.31E-08	9.721E-05	1.47E-03
241-AP-105	48	496	3,815	2.50E-09	8.04E-09	2.019E-04	8.73E-04
241-AP-106	0	0	4,301	NA	NA	NA	1.60E-03
241-AP-107	12	129	665	8.34E-09	1.13E-08	7.417E-05	2.10E-04
241-AP-108	54	560	3,766	2.26E-09	7.85E-09	2.288E-04	1.52E-03
241-AW-101	112	1,071	3,102	1.40E-09	1.07E-08	5.878E-04	2.04E-03
241-AW-102	9	95	2,004	1.12E-08	2.62E-08	1.271E-04	5.57E-04
241-AW-103	126	1,310	2,853	1.22E-09	3.65E-09	2.447E-04	6.54E-04
241-AW-104	81	843	3,221	1.65E-09	8.36E-09	3.653E-04	1.85E-03
241-AW-105	96	999	593	1.46E-09	4.97E-09	2.528E-04	3.10E-04
241-AW-106	109	1,137	2,268	1.34E-09	8.18E-09	4.809E-04	1.01E-03
241-AY-101	42	439	250	6.92E-09	2.53E-07	5.926E-03	6.00E-03
241-AY-102	64	669	2,769	4.91E-09	8.33E-07	3.032E-02	3.11E-02
241-AZ-101	26	267	3,142	4.27E-09	7.69E-07	1.231E-02	2.75E-02
241-AZ-102	45	465	3,247	2.64E-09	7.92E-07	2.060E-02	3.26E-02

Table E-9. Spreadsheet Calculation Results. (2 sheets)

Tank	Updated solid waste level Dw (in.)	Non-RGS NCL volume (m^3)	CL waste volume (m^3)	NCL HGR corrosion RC_{corr} (mole/m^3-s)	Total NCL unit HGR RC_{TOT} (mole/m^3-s)	NCL Total HGR RC_{NCLTOT} (ft^3/min)	Total HGR RC_{TOT} (ft^3/min)
241-SY-101	105	1,000	421	1.51E-09	6.83E-09	3.483E-04	4.25E-04
241-SY-102	63	653	3,249	2.00E-09	2.68E-08	9.099E-04	1.33E-03
241-SY-103	121	1,169	1,537	1.31E-09	1.85E-08	1.123E-03	2.31E-03

Notes:

CL = convective layer.
HGR = hydrogen generation rate.
NCL = nonconvective layer.
RGS = retained gas solids.

Table E-10a. Detail Derived Terms for Hydrogen Generation Rate Calculations.

Tank	Waste level Dw (in.)	Total mass M (kg)	Liquid in waste (wt%)	Wetted area A_{wet} (ft^2)	Heat load per kg $HL^{\beta\gamma}$ (watt/kg)	Tank heat loadb/r HL (watt)	Tank heat loada HL alpha (watt/kg)	NO_3 in liquid [NO3]M (mole/L)	NO_2 in liquid [NO2]M (mole/L)	Excess Na in liquid [Na]ex (mole/mL)
241-AP-103 CL	309.8	4.36E+06	100%	6084	8.14E-04	3.55E+03	2.94E-07	2.41	1.75	3.59
241-AP-103 NCL	14.9	2.50E+05	76%	4710	8.14E-04	2.03E+02	2.94E-07	2.41	1.75	3.59
241-AP-104 CL	385.5	5.14E+06	100%	7570	6.94E-04	3.57E+03	6.36E-07	1.62	1.39	2.57
241-AP-104 NCL	13.9	2.33E+05	65%	4691	6.94E-04	1.62E+02	6.36E-07	1.62	1.39	2.57
241-AP-107 CL	63.7	8.49E+05	100%	1252	4.95E-04	4.20E+02	1.56E-08	1.81	1.12	2.39
241-AP-107 NCL	12.4	2.08E+05	65%	4662	4.95E-04	1.03E+02	1.56E-08	1.81	1.12	2.39
241-AP-108 CL	361.3	5.39E+06	100%	7094	6.66E-04	3.58E+03	1.67E-08	2.83	1.74	4.09
241-AP-108 NCL	53.7	9.01E+05	81%	5472	6.66E-04	6.00E+02	1.67E-08	2.83	1.74	4.09

Notes:
CL = convective layer.
NCL = nonconvective layer.

Table E-10b. Detail Derived Terms for Hydrogen Generation Rate Calculations.

Tank	OH in liquid [OH] (mole/L)	TOC in liquid [TOC]% (wt%)	Al in liquid [Al]% (wt%)	E_{H2} Efficiency of H_2 by corrosion	G values for water G_{H2O} b/r (H_2/100eV)	Total G values G_{TOT} b/r (H_2/100eV)	G values for water G_{H2O}alpha (H_2/100eV)	Total G values G_{TOT} alpha (H_2/100eV)
241-AP-103 CL	0.98	0.54	1.36	0.20	0.027	0.035	0.133	0.137
241-AP-103 NCL	0.98	0.54	1.36	0.20	0.027	0.035	0.133	0.137
241-AP-104 CL	1.16	0.32	1.31	0.20	0.041	0.047	0.182	0.185
241-AP-104 NCL	1.16	0.32	1.31	0.20	0.041	0.047	0.182	0.185
241-AP-107 CL	1.07	0.18	1.08	0.20	0.041	0.044	0.174	0.175
241-AP-107 NCL	1.07	0.18	1.08	0.20	0.041	0.044	0.174	0.175
241-AP-108 CL	2.33	0.29	1.67	0.20	0.023	0.029	0.118	0.121
241-AP-108 NCL	2.33	0.29	1.67	0.20	0.023	0.029	0.118	0.121

Notes:

CL = convective layer.
NCL = nonconvective layer.
TOC = total organic carbon.

Table E-11. Unit Hydrogen Generation Rates.

Tank	HGR from radiolysis $RC_{rad}^{\beta\gamma}$ (M/kg-d)	HGR from radiolysis RC_{rad}^{α} (M/kg-d)	HGR thermal RC_{therm} (M/kg-d)	HGR corrosion RC_{corr} (M/kg-d)	Total HGR model RC_{tot} (M/kg-d)	HGR from radiolysis $RC_{rad}^{\beta\gamma}$ (M/m^3-s)	HGR from radiolysis RC_{rad}^{α} (M/m^3-s)	HGR from thermal RC_{therm} (M/m^3-s)	HGR from corrosion RC_{corr} (M/m^3-s)	Total HGR from model RC_{tot} (M/m^3-s)
241-AP-103 CL	2.55E-07	3.61E-10	1.73E-07	2.79E-08	4.55E-07	3.98E-09	5.64E-12	2.70E-09	4.37E-10	7.12E-09
241-AP-103 NCL	1.93E-07	2.74E-10	1.31E-07	3.78E-07	7.02E-07	3.59E-09	5.10E-12	2.44E-09	7.05E-09	1.31E-08
241-AP-104 CL	2.90E-07	1.05E-09	1.29E-07	2.95E-08	4.49E-07	4.29E-09	1.56E-11	1.91E-09	4.37E-10	6.65E-09
241-AP-104 NCL	1.91E-07	6.83E-10	1.09E-07	4.03E-07	7.03E-07	3.56E-09	1.27E-11	2.03E-09	7.51E-09	1.31E-08
241-AP-107 CL	1.95E-07	2.44E-11	4.84E-08	2.95E-08	2.73E-07	2.88E-09	3.61E-13	7.16E-10	4.37E-10	4.03E-09
241-AP-107 NCL	1.27E-07	1.60E-11	3.17E-08	4.48E-07	6.07E-07	2.37E-09	2.97E-13	5.90E-10	8.35E-09	1.13E-08
241-AP-108 CL	1.73E-07	1.81E-11	1.99E-07	2.64E-08	3.98E-07	2.86E-09	2.99E-13	3.29E-09	4.37E-10	6.59E-09
241-AP-108 NCL	1.39E-07	1.46E-11	1.60E-07	1.22E-07	4.22E-07	2.60E-09	2.72E-13	2.99E-09	2.27E-09	7.86E-09

Notes:
CL = convective layer.
HGR = hydrogen generation rate.
NCL = nonconvective layer.

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Table E-12. Calculated Total Hydrogen Generation Rates and Percentages.

Tank	HGR from radiolysis $G_{rad}^{\beta\gamma}$ (ft^3/min)	HGR from radiolysis G_{rad}^{α} (ft^3/min)	HGR from thermal G_{therm} (ft^3/min)	HGR from corrosion Gcorr (ft^3/min)	Percent of HGR radiolysis $(G_{rad}^{\beta\gamma})$%	Percent of HGR radiolysis (G_{rad}^{α}) %	Percent of HGR thermal (G_{therm})%	Percent of HGR corrosion (G_{corr})%	Total HGR from model G_{mod} (ft^3/min)	Total HGR from model Gmod (L/day)
241-AP-103 CL	6.57E-04	9.31E-07	4.45E-04	7.21E-05	55.9%	0.08%	37.9%	6.1%	1.17E-03	48
241-AP-103 NCL	2.85E-05	4.04E-08	1.93E-05	5.58E-05	27.5%	0.04%	18.6%	53.9%	1.04E-04	4
241-AP-104 CL	8.84E-04	3.21E-06	3.93E-04	8.99E-05	64.5%	0.23%	28.7%	6.6%	1.37E-03	56
241-AP-104 NCL	2.64E-05	9.44E-08	1.51E-05	5.57E-05	27.1%	0.10%	15.5%	57.3%	9.73E-05	4
241-AP-107 CL	9.69E-05	1.22E-08	2.41E-05	1.47E-05	71.4%	0.01%	17.8%	10.8%	1.36E-04	6
241-AP-107 NCL	1.56E-05	1.95E-09	3.87E-06	5.48E-05	21.0%	0.00%	5.2%	73.8%	7.42E-05	3
241-AP-108 CL	5.61E-04	5.86E-08	6.45E-04	8.56E-05	43.4%	0.00%	49.9%	6.6%	1.29E-03	53
241-AP-108 NCL	7.57E-05	7.92E-09	8.71E-05	6.61E-05	33.1%	0.00%	38.0%	28.9%	2.29E-04	9

Notes:

CL = convective layer.
HGR = hydrogen generation rate.
NCL = nonconvective layer.

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E9.0 REFERENCES

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SVF-1123, *Spreadsheet Verification and Release Form for Spreadsheet RPP-5926 Rev 5 Update for BDGRE.xls*, CH2M HILL Hanford Group, Inc., Richland, Washington.

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APPENDIX F

WELLS, B. E., AND S. A. BARKER,
2003,
***SUMMARY OF YIELD STRESS IN SHEAR DATA FOR HANFORD WASTE*,**
TWS03.044,
PACIFIC NORTHWEST NATIONAL LABORATORY,
RICHLAND, WASHINGTON

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TWS03.044

Pacific Northwest
National Laboratory
Operated by Battelle for the
U.S. Department of Energy

September 15, 2003

Bill Cowley, Manager
Flammable Gas Project
CH2M HILL Hanford Group, Inc.
MSIN S4-44
Richland, WA 99352

Dear Bill:

SUMMARY OF YIELD STRESS IN SHEAR DATA FOR HANFORD WASTE

Enclosed is PNNL letter report TWS03.044, *Summary of Yield Stress in Shear Data for Hanford Waste*, by BE Wells and SA Barker.

If you have any questions, please call me at 375-6671. Changes to distribution can be made by e-mail or phone.

Sincerely,

Beric E. Wells, Manager
PNNL Flammable Gas Project

BEW:ekm

cc:	File T1.3.1/LB	
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TWS03.044

Summary of Yield Stress in Shear Data for Hanford Waste

BE Wells
Pacific Northwest National Laboratory

SA Barker
CH2MHILL Hanford Group, Inc.

September 2003

Pacific Northwest National Laboratory
Richland, Washington

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1.0 Introduction

The Hanford waste tanks are categorized into waste groups based on the tank's retention of flammable gas and the potential for that gas to be released by a buoyant displacement gas release event (BDGRE). In support of this categorization, data pertaining to the yield stress in shear of the waste sediments are herein reviewed.

Waste management and retrieval issues such as flammable gas retention and release and waste mixing are dependent on the yield stress in shear of the waste sediment. The waste sediment is a solid, liquid, and gas matrix that varies in composition from tank to tank. Yield stress in shear, or shear strength as it is commonly referred to in Hanford literature, may be defined as the point at which the sediment material ceases to deform like a solid under applied stress but instead flows like a truly viscous material with a finite viscosity.

Limitations of available instrumentation, the varied sediment conditions and compositions, and the influence of the sediment history for a given tank or waste sample render the determination of in situ sediment shear strength a challenging task. In this document, sediments are grouped into categories similar to those of Barker and Lechelt (2000), and representative shear strength data pertaining to these waste types are reviewed.

In Section 2, an overview of shear strength measurement techniques used on the Hanford sediment is presented. Data is presented in Section 3, and general trends related with waste type are discussed. Cited references are listed in Section 4.

2.0 Shear Strength Measurement Techniques

Ex-tank (laboratory measurements performed on samples removed from the waste tank) and in situ shear strength measurements have been conducted on Hanford sediment. The ex-tank measurement techniques are discussed in Section 2.1, and the in situ measurements are discussed in Section 2.2.

2.1 Ex-tank Shear Strength Measurements

Numerous techniques to determine a material's shear strength have been developed. A review of both direct (direct assessment of the point at which the material yields or starts to flow) and indirect (extrapolation of shear stress-shear rate data to zero shear rate) techniques is presented by Nguyen and Boger (1992). Typical ex-tank measurements at Hanford are made with a shear vane (direct) or Couette type viscometers (indirect). Shear strength estimates have also been made based on horizontal waste core extrusion behavior.

2.1.1 Couette Viscometer

As discussed in the literature (Nguyen and Boger 1983 and 1992, Barnes 1999), Couette viscometer data at low shear rates suffers due to the sensitivity of the instrument and additional shearing and slip caused by the configuration of the instrument. The model assumed (i.e. Bingham, Casson, etc.) for the data can also affect the results (Nguyen and Boger 1992, Chhabra 1992). The data presented in Tingey et al. (2003) demonstrates that, at least for those wastes they considered, the waste has overshoot behavior, resulting in under-prediction of the yield point if the traditional models are applied.

Additionally, as has been noted in the referenced literature and with Hanford sediment (Onishi et al. 2003), sample disturbance history can have a direct impact on the measured shear stress. Aside from sample history prior to introduction into the viscometer, the configuration of the Couette viscometer itself may therefore also preclude the applicability of shear strength estimates from this devise to in situ conditions.

2.1.2 Shear Vane

Issues with the Coutte type viscometers such as slip and the sensitivity at low rotational speeds may be resolved by the use of a rotating vane device. However, although the instrument sample configuration is more representative of in situ conditions than that of the Couette viscometer, the sample history may still have significant impact on the results. Results of shear vane measurements are typically significantly larger than the in situ shear strength (Gauglitz and Aikin 1997, Heath 1987, Onishi et al. 2003).

2.1.3 Waste Core Extrusion Behavior

Gauglitz and Aikin (1997) developed a methodology to determine the shear stress of waste sediment based on a visual comparison of horizontal waste core extrusion behavior for simulants with known shear strength to that of Hanford Waste. In this document, estimates based on this methodology are termed "visual observations." Their results generally agreed within a factor of two with the in situ ball rheometer data (see Section 2.2 for a discussion of the ball rheometer).

An "extrusion length" methodology based on the simulant extrusion data of Gauglitz and Aikin (1997) for estimating the yield stress in shear of Hanford Waste was developed in Rassat et al. (2003). This methodology relies on measuring the initial extrusion length of the waste core at plastic failure and produces shear strength values similar in magnitude and with similar trends as the ball rheometer results. It was concluded that, in the absence of definitive in situ measurements, or in support of them, this methodology is expected to produce representative results for the waste shear strength.

Note that although both of the waste core extrusion estimates rely on ex-tank core extrusion behavior, they are as representative of in situ conditions as is available ex-tank. Further, all applicable core segments from a given tank are evaluated, which, given that differences in shear strength have been observed with depth, may provide a more complete data set.

2.2 In Situ Shear Strength Measurements

The ball rheometer was developed to meet the need for measurement of the in situ rheological properties in Hanford double-shell tanks. The rheology of the waste material can be estimated in situ directly from the drag force on a ball as it moves through the waste at various speeds. The ball rheometer results are typically accepted as being more representative of in situ waste conditions than laboratory measurements (Hedengren et al. 2000).

3.0 Hanford Shear Strength Data

Sediments with shear strength measurements considered in this review are grouped into categories similar to those of Barker and Lechelt (2000). These categories include:

- Saltcake waste with >= 1m liquid over solids (SC-LIQ)
- Saltcake waste with < 1m liquid over solids (SC-NL)
- Sludge waste with >= 1m liquid over solids (SL-LIQ)
- Sludge waste with < 1m liquid over solids (SL-NL)

Data comparing the various ex-tank and in situ measurements are presented in Table 1. For this general analysis, measurements given are typically average or median values. In some instances, multiple measurements are available throughout the depth and/or at different radial locations in the tank. In others, single measurements are reported. No attempt is made to reconcile these differences, and the average values reported are simple arithmetic averages of the data and do not take into account measurement location, etc. Sample results are chosen as close to in situ waste conditions (i.e. solid volume fraction and temperature) as possible.

As expected (see Section 2), for all waste types with both Couette viscometer and shear vane data, the viscometer results are significantly lower than the shear vane results. For SC-LIQ tanks, the waste core extrusion methodologies compare well with the ball rheometer results, are larger that the viscometer results, and are significantly lower than the shear vane results. In SL-LIQ tanks, where the ball rheometer has not been deployed, the extrusion length results compare favorably with the shear vane results. The extrusion length results are also similar in magnitude to the shear vane values in SL-NL wastes. It is postulated that the shear vane and extrusion results are more similar in sludge than saltcake waste due to solids precipitation in the saltcake samples.

Table 1. Hanford Sediment Measured Shear Strength (Pa), [Reference]

Tank	Waste Type	Measurement Technique				
		Couette Viscometer	Shear Vane	Visual Observation	Extrusion Length	Ball Rheometer
AN-103	SC-LIQ		8,000 [2]	225 [2][1]	990 [3]	160 [1][1]
AN-104	SC-LIQ	0.5 [5]			130 [3]	125 [1]
AN-105	SC-LIQ	0.75 [14]				135 [1]
AW-101	SC-LIQ		900 [2]	100 [2]	150 [3]	150 [1]
SY-101[3]	SC-LIQ	60 [15]	290 [15] 730 [8]			
SY-103	SC-LIQ	4 [4]	1,500 [2, 4]	195 [2]	160 [3]	150 [1]
A-101	SC-NL			525 [11]		
S-102	SC-NL			800 [2]		
U-103	SC-NL			885 [11]		
U-107	SC-NL		50 [8]	315 [11]		
AW-103	SL-LIQ		590 [6]			
AY-102	SL-LIQ		510 [6]		1,090 [7]	
AZ-101	SL-LIQ	4.7 [12]	1,770 [6] 1,500 [13]		740 [7]	
AZ-102	SL-LIQ		870 [6]			
AY-101	SL-NL		2,020 [6]			
B-201	SL-NL		1,270 [8]			
B-203	SL-NL	12.3 [9][2]	2,280 [9] 60 [9][2]		1,140 [10]	
B-204	SL-NL				860 [10]	
C-104	SL-NL		850 [6]			
C-107	SL-NL		1,050 [8]			
T-110	SL-NL				1,150 [10]	
T-201	SL-NL				1,770 [10]	
T-202	SL-NL				950 [10]	
T-203	SL-NL	40 [9][2]	3,770 [9] 310 [9][2]		1,030 [10]	
T-204	SL-NL		1,520 [9]		1,090 [10]	

Table References:

[1] Hedengren et al. 2000
[2] Gauglitz and Aikin 1997
[3] Rassat et al. 2003
[4] Bredt PR, JD Hudson, and JM Tingey. 1995. *Effects of Dilution on the Physical, Rheological, and Chemical Properties of Tank 241-SY-103*. Letter Report PNL MIT 092995, Pacific Northwest National Laboratory, Richland, WA.
[5] Herting 1998
[6] Memorandum from DB Bechtold to KE Bell, RA Esch, and FH Steen. *Correction of Shear Strength Measurements Reported by 222-S Laboratory*. March 28, 2001. 8D500-DBB-01-018. Fluor Hanford, Richland, WA.
[7] Analysis performed for W-211 project.

[8] TWINS, Tank Waste Information System, http://twins.pnl.gov/
[9] Tingey et al. 2003
[10] Rassat et al. 2003
[11] Hedengren et al. 2001
[12] Urie et al. 2002
[13] Gray et al. 1993
[14] Herting 1997
[15] Tingey et al. 1994

[1] Upper portion of sediment layer only
[2] Diluted sample; results included to illustrate difference in viscometer and shear vane results.
[3] SY-101 prior to mixer pump and mitigation.

The most representative shear strength values for in situ waste conditions are obtained with the ball rheometer. For waste processing conditions, other methods may be more appropriate. The accuracy of the extrusion length waste core extrusion methodology in reproducing the ball rheometer results indicates that, in the absence of in situ measurements, this methodology is expected to produce representative results for the waste shear strength. The similarity between the extrusion length and shear vane results in sludge suggest that the shear vane results in sludge waste may be representative of in situ conditions. Therefore, using these guidelines, the following methodology to assign shear strength based on waste type is proposed:

- SC-LIQ, Figure 1, Normal distribution with mean 144 and standard deviation 13.87; data from AN-103, AN-104, AN-105, AW-101, and SY-103, ball rheometer
- SC-NL, Figure 2, Normal distribution with mean 631.25, standard deviation 260.88, and minimum truncated at two standard deviations; data from A-101, S-102, U-103, and U-107, visual observation
- SL-LIQ, Figure 3, Log-normal distribution with mean 829.55 and standard deviation 218.64; data from AW-103 and AZ-102, shear vane; AY-102 and AZ-101, extrusion length
- SL-NL, Figure 4, Log-normal distribution with mean 1,143.27 and standard deviation 272.08; data from AY-101, B-201, C-104, and C-107, shear vane; B-203, B-204, T-110, T-201, T-202, T-203, and T-204, extrusion length

The distributions were determined from the data sources specified. The shear strength values listed in Table 1 have varying degrees of uncertainty. Although the uncertainty in the data is not specifically accounted for, by fitting a distribution to the data, some uncertainty is allowed for. A series of goodness-of-fit tests were conducted using Crystal Ball™ to determine the distribution that best fits the data. Normal and log-normal distributions were preferentially chosen. With the limited amount of data points and their varied pedigree, these distributions should not be interpreted as the true distribution; they are representations of the above listed data.

Differences in shear strength in a given waste type exist, and location in the waste, history, etc. may potentially affect shear strength values. As such, the results presented here should only be used as representative values, and should not be used as substitute for specific analysis of a given waste.

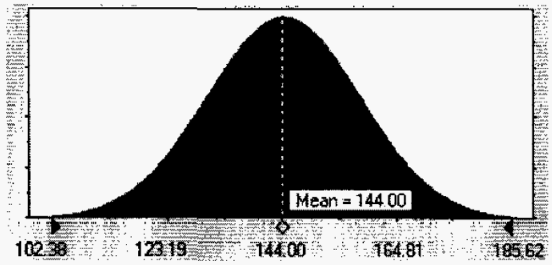

Figure 1. SC-LIQ Shear Strength Distribution (horizontal axis is shear strength (Pa), vertical axis is probability of occurrence)

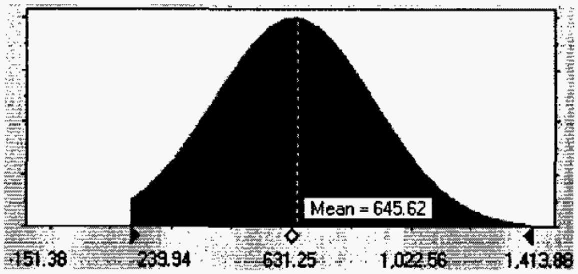

Figure 2. SC-NL Shear Strength Distribution (horizontal axis is shear strength (Pa), vertical axis is probability of occurrence)

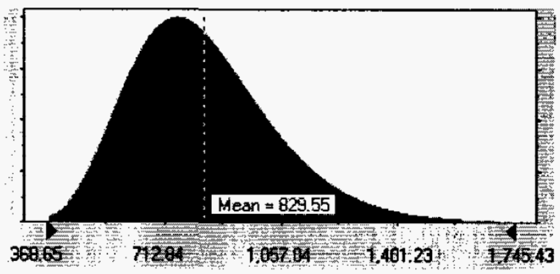

Figure 3. SL-LIQ Shear Strength Distribution (horizontal axis is shear strength (Pa), vertical axis is probability of occurrence)

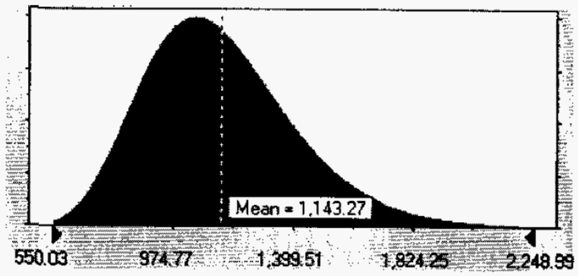

Figure 4. SL-NL Shear Strength Distribution (horizontal axis is shear strength (Pa), vertical axis is probability of occurrence)

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APPENDIX G

DERIVATION OF RETAINED GAS COMPOSITIONS

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CONTENTS

FIGURES

TABLES

Calculation Reviewed: Appendix J -- Derivation Of Retained Gas Compositions, RPP-10006 Rev 4, Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site

Scope of Review: Appendix J (See also Spreadsheet Verification 271)
(e.g., document section or portion of calculation)

Engineer/Analyst: S. A. Barker [signature] Date: 10/27/2004

Organizational Mgr: T. M. Horner [signature] Date: 10/27/2004

This document consists of 60 pages and the following attachments (if applicable):

Yes	No	NA*		
[X]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
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[X]	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
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[X]	[ ]	[ ]	16.	All checker comments have been dispositioned and the design media matches the calculations.

T. A. Campbell [signature] 10/27/2004
Checker (Printed Name and Signature) Date

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APPENDIX G
DERIVATION OF RETAINED GAS COMPOSITIONS

G1.0 INTRODUCTION

This report provides the documentation for the derivation of the retained gas composition parameters. The major components for of the flammable gases generated within the Hanford wastes are hydrogen (H_2), nitrogen (N_2), methane (CH_4), ammonia (NH_3), and nitrous oxide (N_2O). The values for these compositions within a tank are quite variable and are best expressed as a distribution. In order to constrain the compositions in the gas phase during the Monte Carlo simulation, the concentration of N_2O and CH_4 are expressed as ratios with H_2, and the H_2 concentration is determined by difference. The retained gas composition is required in the determination of the waste groupings described in the document. This gas composition determined the flammability of the headspace following a release of retained gas.

G1.1 OBJECTIVES

The objective of this appendix is to use the available Retained Gas Sampler (RGS) data for 16 tanks to derive the distributions required to predict the gas composition for the 16 sampled tanks and to prepare default retained gas composition distributions for tanks that have not been sampled.

G1.2 DISTRIBUTIONS REQUIRED TO DETERMINE THE RETAINED GAS COMPOSITIONS.

In order to determine the total retained gas composition, the concentration of the five gases, which make up the retained gas must be estimated. These gases are H_2, N_2, CH_4, NH_3, and N_2O. A Monte Carlo simulation picking random values from the individual gas compositions without constrains will rarely pick a set of five concentrations that would add up to exactly 100%. In order to constrain the Monte Carlo, the following method for determining the retained gas composition has bee developed. The concentrations of N_2 and NH_3 are determined directly. The compositions for the CH_4 and N_2O gases are described as ratios to the hydrogen concentrations. Equations 1 through 7 describe these ratios and an example solution to the retained gas concentrations is presented.

Given:

Retained gas concentration of N_2	=	$[N_2] = 29.2\%$
Retained gas concentration of NH_3	=	$[NH_3] = 0.079\%$

CH_4 gas ratio = $[CH_4]/\{[CH_4] + [H_2]\}$ (Equation 1)

CH_{4ratio_rg} = 0.114

N_2O gas ratio = $[N_2O]/\{[CH_4] + [H_2] + [N_2O]\}$ (Equation 2)

$N_2O_{ratio\_rg}$ = 0.271

The CH_4 term is defined as

$$t_{CH4} = \frac{CH_{4ratio\_rg}}{1 - CH_{4ratio\_rg}} \quad \text{(Equation 3)}$$

$t_{CH4} = 0.1287$

The N_2O term is defined as

$$t_{N2O} = \frac{N2O_{ratio\_rg}}{1 - N2O_{ratio\_rg}} \quad \text{(Equation 4)}$$

$t_{N2O} = 0.3717$

The H_2 concentration is calculated from the equation

$$[H_2] = \frac{1 - ([NH_3] + [N_2])}{1 + t_{CH4} + t_{CH4} * t_{N2O} + t_{N2O}} \quad \text{(Equation 5)}$$

$[H_2] = 45.68\%$

The CH_4 concentration is calculated from the equation

$[CH_4] = [H_2] * t_{ch4}$ (Equation 6)

$[CH_4] = 5.88\%$

And finally the N_2O concentration is calculated from the equation

$[N_2O] = ([H_2] + [CH_4]) * t_{N2O}$ (Equation 7)

$[N_2O] = 19.17\%$

G2.0 CALCULATION PROCEDURE

The process for calculating the retained gas compositions is outlined in the following procedure. The retained gas composition is based on the RGS results published in PNNL-13317, "*Ammonia Results Review for Retained Gas Sampling*". This procedure begins with scanned in images of Table 2.3 of PNNL-13317.

All calculations are done in EXCEL[1] with the Crystal Ball[2] Monte Carlo add-in.

G2.1 SCAN IN RGS DATA TABLES

Spreadsheet "rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls", Tab "1-Major Components"

1. Scan Data into digital format from document and proofread.

Tab "2-Minor comps"

Scan unpublished data on minor component compositions and proofread. The minor components are often listed in the tables as "other". This breakdown allows the approximately 3% of the gases listed as other to be broken down and assigned to the appropriate gas. In this case CH_x hydrocarbons are assigned to methane (CH_4) and nitrous oxides (NO_x) are assigned to nitrogen (N_2).

G2.2 COMBINE PAIRED DISTRIBUTIONS

Combine Paired Distributions for High and Low Salt Conditions to Make a Single Distribution

Assume that a combined stepwise distribution adequately describes combination of high and low salt compositions.

Tab "3-revised comps"

1. Copy values from Tabs 1 and 2 and paste and transpose into appropriate column "C" cells.

Combine Distributions for All Tanks Except for SY-101

2. Create Crystal Ball assumption for components listed below with mean and standard deviation data in Columns "D" and "H."

   H2, N2, N2O, CH4, NH3, C2Hx, C3Hx, Other HC , Other NOx

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[1] EXCEL is a trademark of Microsoft Corporation, Redmond, Washington.

[2] Crystal Ball is a trademark of Decisioneering, Inc, Denver, Colorado.

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls", Tab "1-Major Components"

Tank and Sample (or Layer)	Mole Percent of Constituent in Bubbles						Gas Volume Percent	Elevation (cm , in.)
	H2	N2	N2O	CH4	NH3	Other		
AN-103 - C	19±12 to 18±12	70±62 to 76±69	7.5±4.8 to 2.1±1.4	1.4±1.1	0.9±0.6	1.4±0.6 to 1.7±0.8	0.7±0.3 to 0.6±0.3	586, 231
AN-103 - NC	61±7.7 to 62±7.7	33±4.3	4.1±0.6 to 3.4±0.5	0.6±0.1	0.8±0.2	0.4±0.09	9.2±4.6 to 9.0±4.5	160, 63
U-103-7-2	23±1.3	36±2.1 to 37±2.1	40±2.1 to 39±2.1	0.4±0.03	0.13±0.04 to 0.07±0.02	0.5±0.05	42±2.6 to 41±2.6	362, 142.5
U-103-7-5	14±0.9 to 16±1.0	32±2.0 to 36±2.2	51±3.1 to 46±2.8	0.26±0.06	1.6±0.6	0.4±0.1	9.8±0.8 to 8.5±0.8	217, 85.5
U-103-7-7	24±1.5 to 25±1.6	41±2.6 to 44±2.8	32±1.9 to 28±1.7	0.6±0.1	1.1±0.3	1.0±0.1 to 1.1±0.1	11±1.2 to 10±1.2	121, 47.5
U-103-7-8	31±3.1 to 33±3.3	36±3.6 to 39±3.9	29±2.9 to 24±2.4	0.8±0.1	1.1±0.6	1.7±0.2 to 1.8±0.2	7.8±1.0 to 7.1±1.0	72, 28.5
U-103 - NC	23±1.4 to 24±1.5	36±2.3 to 38±2.4	39±2.4 to 37±2.2	0.4±0.05	0.6±0.3 to 0.5±0.2	0.7±0.08	19±9.5 to 18±9.0	277, 109
S-106-7-3	59±5.0 to 60±5.1	32±3.1 to 33±3.2	7.8±0.7 to 5.9±0.5	0.4±0.2	0.3±0.2	0.2±0.1	9.6±0.9 to 9.3±0.9	362, 142.5
S-106-7-5	62±5.5 to 65±5.7	23±3.6	14+1.2 to 11±1.0	0.01±0.01	0.3±0.1	0.5±0.2 to 0.6±0.2	10±1.0	265, 104.5
S-106-8-6	63±8.6 to 65±8.8	25±3.6 to 26±3.7	9.9±1.5 to 7.2±1.1	0.5±0.2	0.5±0.3	0.9±0.5 to 1.0±0.5	7.6±0.8 to 7.3±0.8	217, 85.5
S-106-8-10	65±4.9 to 66±5.1	23±4.2 to 24±4.3	11±0.8 to 9.0±0.7	0.2±0.02	0.2±0.1	0.4±0.2	14±1.2	24, 9.5
S-106 - NC	63±5.7 to 65±5.9	25±3.7 to 26±3.8	11±1.0 to 8.4±0.8	0.3±0.08	0.3±0.2	0.5±0.2	10±5.0	151, 59.5
High composition error bands result from a combination of relatively small amounts of sample gas and large amounts of air contamination.								
The ± values represent the measurement error band. The two central values are, first, the one based on the highest salt effect on gas solubility (lower-bound solubility); second, the one based on the lowest salt effect on gas solubility (upper-bound solubility). Only one central value is given in cases where gas solubility has too little effect to show up in the significant figures.								
Tank and Sample								
(or Layer)	Mole Percent of Constituer	Gas Volume Percent	Elevation (cm , in.)					
	H2	N2	N2O	CH4	NH3	Other		
BY-109-12C-4	35±3.6 to 36±3.8	40±7.9 to 42±8.3	21±2.2 to 18±1.9	1.0±0.2	0.3±0.2	2.2±0.3 to 2.3±0.3	6.3±0.4 to 6.1±0.4	121, 47.5
BY-109-10B-5	52±5.5 to 53±5.6	29±5.0	16±1.7 to 15±1.6	0.7±0.1	0.2±0.1	1.8±0.3	8.7±0.8 to 8.4±0.8	121, 47.5
BY-109-10B-6	56±6.4 to 57±6.5	23±3.8	17±3.3 to 16±3.1	0.9±0.1	0.2±0.1	2.6±0.4 to 2.7±0.4	12±1.0	72, 28.5
BY-109 below ILL	50±5.5 to 51±5.6	29±5.1	18±2.5 to 16±2.3	0.9±0.1	0.2±0.1	2.3±0.3	9.4±4.7 to 9.2±4.6	120, 47
SX-106-3-2	22±2.9 to 15±2.4	63±11 to 74±14	11±1.5 to 1.7±0.3	1.4±0.5 to 1.0±0.4	1.0±0.2 to 0.4±0.1	1.9±0.7 to 7.7±2.9	0.1±0.04 to 0.03±0.03	458, 180.5
SX-106-3-4	19±6.1 to 16±5.1	65±28 to 78±34	13±4.8 to 2.2±0.8	0.9±0.4 to 0.7±0.3	0.8±0.3 to 0.4±0.1	1.0±0.4 to 2.5±0.9	0.2±0.07 to 0.07±0.07	362, 142.5
SX-106-6-6	50±5.0 to 53±5.4	23±3.3 to 25±3.5	18±1.9 to 16±1.7	1.9±0.3 to 2.0±0.3	6.7±0.8 to 3.0±0.4	1.0±0.3 to 1.1±0.3	9.1±1.0 to 8.4±1.0	265, 104.5
SX-106-6-6A	51±5.6 to 56±6.2	19±3.3 to 21±3.7	22±2.9 to 17±2.2	2.7±0.9 to 3.0±1.0	4.0±0.5 to 1.8±0.2	1.4±0.4 to 1.6±0.4	4.1±0.6 to 3.6±0.6	265, 104.5
SX-106-3-7	48±8.5 to 50±8.5	19±8.6 to 20±9.0	27±7.1	0.5±0.09	5.7±2.7 to 2.5±1.2	0.3±0.08	30±11 to 29±11	217, 85.5
SX- 106-6-9	60±3.6 to 62±3.6	17±2.0 to 18±2.0	17±1.1	0.4±0.1	4.9±0.8 to 2.2±0.3	0.3±0.09	36±2.2 to 34±2.2	121, 47.5
SX-106-3-10	44±2.8 to 47±2.7	21±2.4 to 22±2.5	28±1.8	0.6±0.05	5.5±0.8 to 2.4±0.4	0.3±0.08	32±2.0 to 31±2.0	72, 28.5
SX-106-C	21±4.9 to 16±4.0	64±21 to 77±26	12±3.4 to 2.1±0.6	1.1±0.4 to 0.8±0.4	0.9±0.2 to 0.4±0.1	1.4±0.5 to 3.9±1.4	0.2±0.1 to 0.05±0.05	418, 164
SX-106 - NC	50±4.5 to 52±4.5	20±3.8 to 21±4.0	24±2.8 to 24±2.7	0.6±0.1	5.5±1.2 to 2.4±0.5	0.3±0.08	26±13 to 25±13	136, 53
AX-101-9D-8	61±6.5 to 64±5.5	17±2.6 to 18±2.7	11±1.0	2.4±0.2 to 2.5±0.2	8.4±1.9 to 4.3±1.0	0.7±0.2	17±1.3 to 16±1.3	362, 142.5
S-102-16-2	36±2.5 to 37±2.5	37±4.4 to 38±4.4	26±1.8 to 24±1.7	0.4±0.05	0.6±0.4 to 0.4±0.2	0.1±0.02	33±4.3 to 32±4.3	458, 180.5
S-102-16 4R	33±2.9 to 37±3.2	31±4.1 to 36±4.7	34±3.4 to 26±2.5	0.2±0.07 to 0.3±0.08	1.3±0.9 to 0.7±0.5	0.3±0.09	7.4±0.7 to 6.4±0.7	362, 142.5
S-102-16-7	27±3.1 to 28±3.2	29±4.2 to 30±4.4	42±4.8 to 41±4.6	0.4±0.06	1.5±0.4 to 0.8±0.2	0.07±0.03	30±1.9 to 29±1.9	217, 85.5
S-102-16-10	43±3.8 to 46±4.1	29±4.3 to 31±4.6	25±2.2 to 21±1.9	0.7±0.08 to 0.8±0.08	1.2±0.3 to 0.6±0.2	0.6±0.1	12±1.1 to 11±1.1	72, 28.5
S-102 tank avg.	33±3.0 to 35±3.1	32±4.3 to 33±4.5	33±3.1 to 31±2.9	0.4±0.06 to 0.5±0.06	1.1±0.4 to 0.6±0.2	0.2±0.04	26±13 to 25±13	292, 115
S-111-6-2	6.3±3.4 to 5.8±3.2	90±68 to 92±70	1.7±1.0 to 0.7±0.4	0.3±0.2	0.2±0.2 to 0.1±0.1	1.0±0.8 to 1.2±0.9	0.8±0.2 to 0.7±0.2	458, 180.5
S-111-6-4	48±24 to 51±25	36±22 to 38±23	14±5.5 to 9.8±4.0	0.6±0.2	0.9±0.4 to 0.5±0.2	0.3±0.08	6.9±2.1 to 6.5±2.1	362, 142.5
S-111-6-6	58±5.1 to 60±5.2	26±3.4 to 27±3.5	14±1.3 to 11±1.1	0.8±0.1	1.2±0.4 to 0.7±0.2	0.5±0.2	15±5	265, 104.5
S-111-6-8	67±7.1 to 68±7.2	20±2.8	12±1.3 to 11±1.2	0.6±0.08	0.7±0.2 to 0.4±0.1	0.2±0.07	20±2.8 to 20±2.9	169, 66.5
S-111-6-10	73±5.6 to 74±5.7	16±2.0 to 16±2.0	9.2±0.8 to 8.5±0.7	0.3±0.04	1.6±0.4 to 0.9±0.3	0.09±0.04	23±3.2 to 22±3.2	72, 28.5

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls", Tab "1-Major Components"

Tank and Sample (or Layer)	Mole Percent of Constituent in Bubbles						Gas Volume Percent	Elevation (cm , in.)
	H2	N2	N2O	CH4	NH3	Other		
S-111 - C	6.3±3.4 to 5.8±3.2	90±68 to 92±70	1.7±1.0 to 0.7±0.4	0.3±0.2	0.2±0.2 to 0.1±0.1	1.0±0.8 to 1.2±0.9	0.8±0.2 to 0.7±0.2	439, 173
S-111 -NC	66±10 to 67±11	21±5.6 to 22±5.8	11±1.7 to 9.6±1.5	0.5±0.08	1.1±0.4 to 0.6±0.2	0.2±0.05	15±7.5 to 14±7.0	139, 55
High composition error bands result from a combination of relatively small amounts of sample gas and large amounts of air contamination.								
The ± values represent the measurement error band. The two central values are, first, the one based on the highest salt effect on gas solubility (lower-bound solubility); second, the one based on the lowest salt effect on gas solubility (upper-bound solubility). Only one central value is given in cases where gas solubility has too little effect to show up in the significant figures.								
Tank and Sample								
(or Layer)	Mole Percent of Constituer	Gas Volume Percent	Elevation (cm , in.)					
	H2	N2	N2O	CH4	NH3	Other		
U-109-8-2	20±2.9 to 21±3.1	42±7.6 to 45±8.0	3616.3 to 33±5.7	0.5±0.1 to 0.6±0.09	0.8±0.3 to 0.41±0.2	0.4±0.2	20±2.5 to 19±2.5	362, 142.5
U-109-8-4	24±3.2 to 25±3.3	38±6.3 to 40±6.6	35±4.0 to 33±3.7	0.6±0.08	2.2±0.9 to 1.2±0.5	0.3±0.07	23±2.2 to 22±2.2	265, 104.5
U-109-8-6	28±5.0 to 30±5.2	43±11 to 45±11	26±5.1 to 23±4.4	1.1±0.2 to 1.2±0.2	1.0±0.3 to 0.5±0.2	0.7±0.2	15±1.0 to 14±1.0	169, 66.5
U-109-8-8	27±2.4 to 28±2.5	52±7.5 to 53±7.7	19±1.7 to 17±1.6	0.8±0.9	1.10±4 to 0.5±0.2	0.4+0.07	30±1.9 to 29±1.8	72, 28.5
U-109 - NC	25±3.1 to 26±3.2	46±7.8 to 48±8.1	27±3.5 to 24±3.2	0.7±0.1 to 0.8±0.1	1.2±0.5 to 0.6±0.2	0.4±0.1	22±11 to 21±10	204, 80
SY-101-23A-1	22±3.2 to 23±3.3	47±9.4 to 51±10	23±3.4 to 21±3.1	0.8±0.1 to 0.9±0.1	6.2±1.6 to 2.9±0.8	0.7±0.1 to 0.8±0.1	20±1.5 to 18±1.5	1022, 402
SY-101-23A-2	34±4.8 to 38±5.1	27±4.5 to 30±4.8	21±3.0 to 23±3.0	0.6±0.09	16±3.7 to 7.1±1.6	0.9±0.3 to 1.0±0.3	39±2.9 to 35±2.9	974, 383.5
SY-101-22A-3	34±4.4 to 37±4.6	30±4.9 to 33±5.2	24±3.3 to 24±3.2	0.6±0.2 to 0.7±0.2	11±2.6 to 5.0±1.2	0.4±0.2 to 0.5±0.2	33±2.7 to 30±2.7	959, 377.5
SY-101-23A-3	40±4.4 to 45±4.4	23±3.3 to 26±3.4	18±1.9 to 20±1.8	0.5±0.07 to 0.6±0.07	18±4.7 to 7.6±1.9	0.5±0.09 to 0.6±0.1	61±3.9 to 53±3.9	926, 364.5
SY-101-22A-4	35±3.9 to 44±3.6	21±3.2 to 26±3.4	17±1.8 to 20±1.6	0.5±0.08 to 0.7±0.08	26±6.8 to 8.6±2.1	0.5±0.08	73±7 to 58±3.8	911, 358.5
SY-101-4A-5	38±8.7 to 43±10	27±7.9 to 33±9.4	24±6.1 to 17±4.3	1.1±0.3 to 1.2±0.4	8.8±2.4 to 4.2±1.1	1.1±0.4 to 1.3±0.4	6.0±1.8 to 4.9±1.7	845, 332.5
SY-101-23A-8	24±6.6 to 27±7.5	46±14 to 55±17	21±6.3 to 12±3.5	1.4±0.5 to 1.6±0.6	5.9±1.0 to 2.8±0.8	1.4±0.6 to 1.7±0.7	3.5±1.2 to 2.8±1.2	685, 269.5
SY-101-22A-10	29±10 to 35±12	35±14 to 44±17	25±8.7 to 14±4.7	1.4±0.5 to 1.7±0.6	8.0±2.7 to 3.8±1.3	1.4±0.5 to 1.8±0.6	3.2±1.1 to 2.4±1.0	621, 244.5
SY-101-23A-13	29±9.9 to 34±12	37±14 to 46±18	25±8.6 to 13±4.4	1.2±0.4 to 1.4±0.5	6.7±1.5 to 3.2±1.2	1.5±0.6 to 2.0±0.8	2.8±0.9 to 2.1±0.9	443, 174.5
SY-101-22A-17	30±7.5 to 36±9.2	35±1l to 45±14	27±7.0 to 13±3.5	1.5±0.4 to 1.8±0.5	4.8±0.9 to 2.3±0.7	1.3±0.4 to 1.7±0.6	2.5±0.7 to 1.8±0.7	316, 124.5
SY-101-23A-21	29±8.8 to 34±10	40±13 to 49±17	23±6.9 to 11±3.2	1.6±0.5 to 1.8±0.6	4.6±0.9 to 2.2±0.7	1.4±0.5 to 1.9±0.8	2.3±0.7 to 1.7±0.7	75, 29.5
SY-101-22A-23	32+8.7 to 38±10	36±12 to 45±15	26±7.6 to 12±3.6	1.3±0.4 to 1.6±0.5	4.0±0.6 to 1.9±0.6	1.2±0.4 to 1.7±0.6	2.5±0.8 to 1.9±0.8	28, 11
SY-101-23A crust	35±4.4 to 39±4.5	28±4.6 to 32±4.9	20±2.5 to 21±2.4	0.6±0.09	16±3.9 to 6.7±1.6	0.7±0.2	40±20 to 35±18	953, 375
SY-101-23A liq	27±8.3 to 31±9.8	41±14 to 51±17	23±7.2 to 12±3.7	1.4±0.5 to 1.6±0.6	5.8±1.8 to 2.8±0.9	1.4±0.5 to 1.8±0.7	2.8±1.4 to 2.2±1.1	445, 175
SY-101-22A crust	33±3.9 to 38±4.0	27±4.5 to 32±5.0	20±2.4 to 22±2.3	0.6±0.1 to 0.7±0.1	19±4.8 to 6.6±1.6	0.4±0.1 to 0.5±0.1	54±27 to 46±23	942, 371
SY-101-22A liq.	32±8.8 to 38±10	33±11 to 42±14	26±7.3 to 14±4.1	1.3±0.4 to 1.6±0.5	6.4±1.9 to 3.1±0.9	1.2±0.4 to 1.6±0.6	3.1±1.6 to 2.4±1.2	451, 177
High composition error bands result from a combination of relatively small amounts of sample gas and large amounts of air contamination.								
The ± values represent the measurement error band. The two central values are, first, the one based on the highest salt effect on gas solubility (lower-bound solubility); second, the one based on the lowest salt effect on gas solubility (upper-bound solubility). Only one central value is given in cases where gas solubility has too little effect to show up in the significant figures.								

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "2-Minor comps"

Step 2 of 7 - Original Tables for breakdown of "Other" components
Source: "rgs FinalSumTable.doc" Personal Communication from Lenna Mahoney. Not previously published.

Tank and Sample (or Layer)	Mole Percent of Constituent in Bubbles					
		Other				
	CH4	C2Hx	C3Hx	Other HC	Other NOx	Total "Other"
AW-101 solids	1.7±0.2	1.1±0.2 to 1.2±0.2	0.26±0.1 to 0.27±0.1	1.3±0.3 to 1.4±0.3	0.12±0.06 to 0.12±0.07	2.8±0.5 to 2.9±0.6
A-101 upper	0.7±0.1	0.12±0.02	0.07±0.03	0.11±0.03	0.07±0.02	0.3±0.06
AN-105 solids	0.7±0.07	0.11±0.04 to 0.12±0.06	0.05±0.02	0.19±0.06 to 0.20±0.07	0.18±0.04 to 0.21±0.04	0.6±0.1
AN-104 solids	0.9±0.2	0.30±0.10 to 0.31±0.11	0.08±0.03	0.44±0.18 to 0.46±0.19	0.03±0.02	0.8±0.3 to 0.9±0.3
AN-103 crust	0.6±0.07	0.13±0.02	0.04±0.01	0.05±0.01	0.02±0.01	0.2±0.05
AN-103 solids	0.6±0.1	0.15±0.05 to 0.16±0.05	0.07±0.02 to 3.6±0.5	0.15±0.06	0.02±0.02 to 0.03±0.02	0.4±0.1
U-103 slurry	0.4±0.03	0.41±0.04	0±0.02	0.04±0.01	0.01±0.01	0.5±0.06
U-103 solids	0.4±0.06 to 0.5±0.09	0.59±0.10 to 0.64±0.10	0.02±0.02	0.09±0.02	0.14±0.04 to 0.16±0.05	0.8±0.2 to 0.9±0.2
S-106 solids	0.2±0.07	0.24±0.19 to 0.25±0.19	0.13±0.07	0.06±0.03	0.05±0.04 to 0.06±0.04	0.5±0.3
BY-109 below ILL	0.8±0.1	1.0±0.2 to 1.1±0.2	0.15±0.07	1.1±0.2	0.01±0.01 to 0.02±0.01	2.3±0.4
SX-106 solids	0.6±0.1	0.20±0.07 to 0.21±0.07	0.08±0.01	0.06±0.03 to	0.01±0.01 to 0.01±0.01	0.4±0.1
AX-101-9D-8	2.4±0.2 to 2.5±0.2	0.45±0.19 to 0.48±0.20		0.22±0.12 to 0.24±0.13		0.7±0.3
S-102 tank avg.	0.4±0.07	0.10±0.03		0.06±0.03 to 0.07±0.03		0.2±0.06
S-111 solids	0.4±0.07 to 0.5±0.07	0.08±0.03		0.07±0.04		0.2±0.07
U-109 tank avg.	0.7±0.1	0.28±0.08 to 0.29±0.08		0.13±0.07 to		0.4±0.2
SY-101-022 crust	0.6±0.08 to 0.7±0.09	0.56±0.15 to 0.67±0.17		0.06±0.03 to 0.07±0.04		0.6±0.2 to 0.7±0.2
SY-101-021 crust	0.6±0.1 to 0.7±0.1	0.38±0.08 to 0.47±0.10		0.05±0.02 to 0.06±0.03		0.4±0.1 to 0.5±0.1
SY-101-022 liq.	1.3±0.5 to 1.6±0.6	0.70±0.32 to 0.87±0.40		0.67±0.41 to 0.83±0.51		1.4±0.7 to 1.7±0.9
SY-101-021 liq.	1.3±0.4 to 1.6±0.5	0.66±0.27 to 0.83±0.34		0.54±0.31 to 0.67±0.39		1.2±0.6 to 1.5±0.7

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

Tank and Sample (or Layer)		AW-101 solids	cb dists high salt	high salt mean (±)	high salt range (to)	high salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range: forecasts	high salt range: mean	std dev	range normalize: mean	std dev	low salt range: forecasts	low salt range: mean
Mole Percent of Constituent in Bubbles	H2	32±3.2 to 33±3.2	31.906	32.000	3.200	1.067	33.000	33.000	3.200	1.067	31.906	32.06	1.08	30.40	1.08	33.000	32.96
	N2	56±6.2 to 58±6.4	55.000	56.000	6.200	2.067	57.000	58.000	6.400	2.133	55.120	56.21	2.08	53.30	2.08	57.120	58.24
	N2O	7.2±0.8 to 4.4±0.5	7.500	7.200	0.800	0.267	5.000	4.400	0.500	0.167	7.500	7.20	0.28	6.83	0.28	5.000	4.40
	CH4	1.7±0.2	1.700	1.700	0.200	0.067		-	-	0.001	9.383	9.39	0.43	8.90	0.43	8.275	8.26
	NH3	0.6±0.3	0.800	0.600	0.300	0.100		-	-	0.001	0.800	0.80	0.10	0.57	0.10	-	-
	Other	2.8±0.5 to 2.9±0.6		2.800	0.500	0.167		2.900	0.600	0.200							
	CH4	1.7±0.2		1.700	0.200	0.067		-	-	0.001							
	C2Hx	1.1±0.2 to 1.2±0.2	1.100	1.100	0.200	0.067	1.200	1.200	0.200	0.067							
	C3Hx	0.26±0.1 to 0.27±0.1	0.260	0.260	0.100	0.033	0.270	0.270	0.100	0.033							
	Other HC	1.3±0.3 to 1.4±0.3	1.300	1.300	0.300	0.100	1.400	1.400	0.300	0.100							
	Other NOx	0.12±0.06 to 0.12±0.07	0.120	0.120	0.060	0.020	0.120	0.120	0.070	0.023							
	Total "Other"	2.8±0.5 to 2.9±0.6		2.800	0.500	0.167		2.900	0.600	0.200							0
				100.28							104.709	105.45		100.00		103.395	103.85

Tank and Sample (or Layer)		A-101 upper	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range: forecasts	high salt range: mean	std dev	range normalize: mean	std dev	low salt range: forecasts	low salt range: mean
Mole Percent of Constituent in Bubbles	H2	72±7.1	69.000	72.000	7.100	2.367		-	-	0.001	69.000	72.01	2.30	71.37	2.30	-	-
	N2	19±4.9	20.000	19.000	4.900	1.633	-	-	-	0.001	20.070	19.07	1.64	18.90	1.64	-	-
	N2O	5.8±0.6 to 5.3±0.5	5.700	5.800	0.600	0.200	5.500	5.300	0.500	0.167	5.700	5.80	0.20	5.75	0.20	5.500	5.30
	CH4	0.7±0.1	0.700	0.700	0.100	0.033	-	-	-	0.001	1.515	1.51	0.06	1.50	0.06	-	-
	NH3	2.5±0.9	4.400	2.500	0.900	0.300		-	-	0.001	4.400	2.49	0.30	2.47	0.30	-	-
	Other	0.3±0.06		0.300	0.060	0.020		-	-	0.001							
	CH4	0.7±0.1		0.700	0.100	0.033		-	-	0.001							
	C2Hx	0.12±0.02	0.120	0.120	0.020	0.007	-	-	-	0.001							
	C3Hx	0.07±0.03	0.070	0.070	0.030	0.010	-	-	-	0.001							
	Other HC	0.11±0.03	0.110	0.110	0.030	0.010	-	-	-	0.001							
	Other NOx	0.07±0.02	0.070	0.070	0.020	0.007	-	-	-	0.001							
	Total "Other"	0.3±0.06		0.300	0.060	0.020		-	-	0.001							0
				100.37							100.685	100.90		100.00		5.5	5.30

Tank and Sample (or Layer)		AN-105 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range: forecasts	high salt range: mean	std dev	range normalize: mean	std dev	low salt range: forecasts	low salt range: mean
Mole Percent of Constituent in Bubbles	H2	60±5.4 to 62±5.5	61.000	60.000	5.400	1.800	63.000	62.000	5.500	1.833	61.000	59.96	1.79	59.67	1.79	63.000	61.85
	N2	24±4.0 to 25±3.9	22.000	24.000	4.000	1.333	23.000	25.000	3.900	1.300	22.180	24.24	1.38	24.13	1.38	23.210	25.24
	N2O	14±1.5 to 11±1.1	15.000	14.000	1.500	0.500	12.000	11.000	1.100	0.367	15.000	14.01	0.49	13.94	0.49	12.000	10.99
	CH4	0.7±0.09	0.700	0.700	0.090	0.030	-	-	-	0.001	1.768	1.77	0.09	1.76	0.09	1.000	1.00
	NH3	0.5±0.2	0.600	0.500	0.200	0.067	-	-	-	0.001	0.600	0.50	0.06	0.50	0.06	-	-
	Other	0.6±0.1		0.600	0.100	0.033	-	-	-	0.001							

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

	CH4	0.7±0.07		0.700	0.070	0.023		-	-	0.001							
	C2Hx	0.11±0.04 to 0.12±0.05	0.110	0.110	0.040	0.013	0.120	0.120	0.050	0.017							
	C3Hx	0.05±0.02	0.050	0.050	0.020	0.007	-	-	-	0.001							
	Other HC	0.19±0.06 to 0.20±0.07	0.190	0.190	0.080	0.020	0.200	0.200	0.070	0.023							
	Other NOx	0.18±0.04 to 0.21±0.04	0.180	0.180	0.040	0.013	0.210	0.210	0.040	0.013							
	Total "Other"	0.6±0.1		0.600	0.100	0.033		-	-	0.001							0
				99.73							100.5483	100.48		100.00		99.21	99.08

Tank and Sample (or Layer)		AN-104 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range forecasts	mean	std dev	range normalize mean	std dev	low salt range forecasts	mean
Mole Percent of Constituent in Bubbles	H2	45±6.9 to 47±7.1	45.000	45.000	6.900	2.300	46.000	47.000	7.100	2.367	45.000	45.01	2.32	44.41	2.32	46.000	46.88
	N2	29±4.8 to 31±5.1	29.000	29.000	4.800	1.600	30.000	31.000	5.100	1.700	29.030	29.06	1.56	28.67	1.56	30.000	30.92
	N2O	23±3.7 to 20±3.2	23.000	23.000	3.700	1.233	21.000	20.000	3.200	1.067	23.000	23.02	1.20	22.72	1.20	21.000	20.05
	CH4	0.9±0.2	0.900	0.900	0.200	0.067	-	-	-	0.001	3.360	3.36	0.24	3.31	0.24	2.357	2.34
	NH3	0.9±0.4	1.400	0.900	0.400	0.133		-	-	0.001	1.400	0.90	0.13	0.88	0.13	-	-
	Other	0.8±0.3 to 0.9±0.3		0.800	0.300	0.100		0.900	0.300	0.100							
	CH4	0.9±0.2		0.900	0.200	0.067		-	-	0.001							
	C2Hx	0.30±0.10 to 0.31±0.11	0.300	0.300	0.100	0.033	0.310	0.310	0.110	0.037							
	C3Hx	0.08±0.03	0.080	0.080	0.030	0.010	-	-	-	0.001							
	Other HC	0.44±0.18 to 0.46±0.19	0.440	0.440	0.180	0.060	0.460	0.460	0.190	0.063							
	Other NOx	0.03±0.02	0.030	0.030	0.020	0.007	-	-	-	0.001							
	Total "Other"	0.8±0.3 to 0.9±0.3		0.800	0.300	0.100		0.900	0.300	0.100							0
				99.65							101.79	101.35		100.00		99.35667	100.19

Tank and Sample (or Layer)		AN-103 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range forecasts	mean	std dev	high salt range mean	std dev	low salt range forecasts	mean
Mole Percent of Constituent in Bubbles	H2	61±7.7 to 62±7.7	61.000	61.000	7.700	2.567	62.000	62.000	7.700	2.567	61.000	61.10	2.59	60.74	2.59	62.000	61.88
	N2	33±4.3	33.000	33.000	4.300	1.433	-	-	-	0.001	33.020	33.15	1.44	32.96	1.44	-	-
	N2O	4.1±0.6 to 3.4±0.5	4.200	4.100	0.600	0.200	3.600	3.400	0.500	0.167	4.200	4.11	0.19	4.08	0.19	3.600	3.39
	CH4	0.6±0.1	0.600	0.600	0.100	0.033	-	-	-	0.001	1.625	1.63	0.09	1.62	0.09	9.267	9.26
	NH3	0.6±0.2	0.900	0.600	0.200	0.067		-	-	0.001	0.900	0.60	0.06	0.60	0.06	-	-
	Other	0.4±0.1		0.400	0.100	0.033		-	-	0.001							
	CH4	0.6±0.1		0.600	0.100	0.033		-	-	0.001							
	C2Hx	0.15±0.05 to 0.16±0.05	0.150	0.150	0.050	0.017	0.160	0.160	0.050	0.017							
	C3Hx	0.07±0.02 to 3.6±0.5	0.070	0.070	0.020	0.007	3.600	3.600	0.500	0.167							
	Other HC	0.15±0.06	0.150	0.150	0.060	0.020	-	-	-	0.001							
	Other NOx	0.02±0.02 to 0.03±0.02	0.020	0.020	0.020	0.007	-	0.030	0.020	0.007							
	Total "Other"	0.4±0.1		0.400	0.100	0.033		-	-	0.001							0
				99.69							100.745	100.58		100.00		74.86667	74.53

high salt range   range normalize   low salt range

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Tank and Sample (or Layer)		U-103 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	23±1.4 to 24±1.5	21.000	23.000	1.400	0.467	22.000	24.000	1.500	0.500	21.000	23.01	0.46	22.87	0.46	22.000	24.01
	N2	38±2.3 to 38±2.4	35.000	38.000	2.300	0.767	38.000	38.000	2.400	0.800	35.140	36.19	0.77	35.97	0.77	38.180	38.12
	N2O	39±2.4 to 37±2.2	41.000	39.000	2.400	0.800	38.000	37.000	2.200	0.733	41.000	39.03	0.79	38.79	0.79	38.000	37.00
	CH4	0.4±0.05	0.400	0.400	0.050	0.017		-	-	0.001	1.793	1.79	0.07	1.78	0.07	1.067	1.06
	NH3	0.6±0.3 to 0.5±0.2	1.500	0.600	0.300	0.100	0.800	0.500	0.200	0.067	1.500	0.60	0.10	0.59	0.10	0.800	0.50
	Other	0.8±0.2 to 0.9±0.2		0.800	0.200	0.067		0.900	0.200	0.067							
	CH4	0.4±0.08 to 0.5±0.09		0.400	0.080	0.027		0.500	0.090	0.030							
	C2Hx	0.59±0.10 to 0.64±0.10	0.590	0.590	0.100	0.033	0.640	0.640	0.100	0.033							
	C3Hx	0.02±0.02	0.020	0.020	0.020	0.007	-	-	-	0.001							
	Other HC	0.09±0.02	0.090	0.090	0.020	0.007	-	-	-	0.001							
	Other NOx	0.14±0.04 to 0.16±0.05	0.140	0.140	0.040	0.013	0.160	0.160	0.050	0.017							
	Total "Other"	0.8±0.2 to 0.9±0.2		0.800	0.200	0.067		0.900	0.200	0.067							1
				99.84							100.4333	100.63		100.00		100.0267	100.70

											high salt range			high salt		low salt range	
Tank and Sample (or Layer)		S-106 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	63±5.7 to 65±5.9	63.000	63.000	5.700	1.900	65.000	65.000	5.900	1.967	63.000	62.94	1.90	62.57	1.90	65.000	64.96
	N2	25±3.7 to 26±3.8	25.000	25.000	3.700	1.233	-	26.000	3.800	1.267	25.050	25.06	1.24	24.91	1.24	0.060	0.06
	N2O	11±1.0 to 8.4±0.8	11.000	11.000	1.000	0.333	9.000	8.400	0.800	0.267	11.000	11.03	0.34	10.96	0.34	9.000	8.40
	CH4	0.3±0.08	0.200	0.300	0.080	0.027	-	-	-	0.001	1.165	1.27	0.14	1.26	0.14	0.417	0.41
	NH3	0.3±0.2	0.400	0.300	0.200	0.067		-	-	0.001	0.400	0.30	0.07	0.30	0.07	-	-
	Other	0.5±0.3		0.500	0.300	0.100		-	-	0.001							
	CH4	0.2±0.07		0.200	0.070	0.023		-	-	0.001							
	C2Hx	0.24±0.19 to 0.25±0.19	0.240	0.240	0.190	0.063	0.250	0.250	0.190	0.063							
	C3Hx	0.13±0.07	0.130	0.130	0.070	0.023	-	-	-	0.001							
	Other HC	0.06±0.03	0.060	0.060	0.030	0.010	-	-	-	0.001							
	Other NOx	0.05±0.04 to 0.06±0.04	0.050	0.050	0.040	0.013	0.060	0.060	0.040	0.013							
	Total "Other"	0.5±0.3		0.500	0.300	0.100		-	-	0.001							0
				100.08							100.615	100.59		100.00		74.47667	73.83

											high salt range			high salt range		low salt range	
Tank and Sample (or Layer)		BY-109 below salt ILL	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	50±5.5 to 51±5.6	50.000	50.000	5.500	1.833	51.000	51.000	5.600	1.667	50.000	50.03	1.87	47.86	1.87	51.000	51.03
	N2	29±5.1	28.000	29.000	5.100	1.700		-	-	0.001	28.010	29.02	1.78	27.77	1.78	0.020	0.02
	N2O	18±2.5 to 16±2.3	18.000	18.000	2.500	0.833	17.000	16.000	2.300	0.767	18.000	17.93	0.84	17.15	0.84	17.000	16.00
	CH4	0.9±0.1	0.800	0.900	0.100	0.033	-	-	-	0.001	7.242	7.35	0.29	7.03	0.29	1.833	1.83
	NH3	0.2±0.1	0.300	0.200	0.100	0.033		-	-	0.001	0.300	0.20	0.03	0.19	0.03	-	-
	Other	2.3±0.4		2.300	0.400	0.133		-	-	0.001							
	CH4	0.8±0.1		0.800	0.100	0.033		-	-	0.001							

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

	C2Hx	1.0±0.2 to 1.1±0.2	1.000	1.000	0.200	0.067	1.100	1.100	0.200	0.067							
	C3Hx	0.15±0.07	0.150	0.150	0.070	0.023	-	-	-	0.001							
	Other HC	1.1±0.2	1.100	1.100	0.200	0.067	-	-	-	0.001							
	Other NOx	0.01±0.01 to 0.02±0.01	0.010	0.010	0.010	0.003	0.020	0.020	0.010	0.003							
	Total "Other"	2.3±0.4		2.300	0.400	0.133		-	-	0.001							0
				100.36							103.5517	104.53		100.00		69.85333	68.88

Tank and Sample (or Layer)		SX-106 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range			high salt range		low salt range	
											forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	50±4.5 to 52±4.5	51.000	50.000	4.500	1.500	53.000	52.000	4.500	1.500	51.000	50.03	1.48	49.60	1.48	53.000	51.87
	N2	20±3.8 to 21±4.0	20.000	20.000	3.800	1.267	21.000	21.000	4.000	1.333	20.010	19.99	1.24	19.81	1.24	21.020	20.99
	N2O	24±2.8 to 24±2.7	24.000	24.000	2.800	0.933	-	24.000	2.700	0.900	24.000	23.99	0.92	23.78	0.92	-	-
	CH4	0.6±0.1	0.600	0.600	0.100	0.033	-	-	-	0.001	1.373	1.37	0.07	1.36	0.07	1.833	0.35
	NH3	5.5±1.2 to 2.4±0.5	4.400	5.500	1.200	0.400	1.600	2.400	0.500	0.167	4.400	5.49	0.39	5.45	0.39	1.600	2.41
	Other	0.4±0.1		0.400	0.100	0.033		-	-	0.001							
	CH4	0.6±0.1		0.600	0.100	0.033		-	-	0.001							
	C2Hx	0.20±0.07 to 0.21±0.07	0.200	0.200	0.070	0.023	1.100	0.210	0.070	0.023							
	C3Hx	0.08±0.01	0.080	0.080	0.010	0.003	-	-	-	0.001							
	Other HC	0.06±0.03 to	0.060	0.060	0.030	0.010	-	-	-	0.001							
	Other NOx	0.01±0.01 to 0.01±0.01	0.010	0.010	0.010	0.003	0.020	0.010	0.010	0.003							
	Total "Other"	0.4±0.1		0.400	0.100	0.033		-	-	0.001							0
				100.45							100.7833	100.88		100.00		77.45333	75.61

Tank and Sample (or Layer)		AX-101-9D-8	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range			high salt range		low salt range	
											forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	61±5.5 to 64±5.5	60.000	61.000	5.500	1.833	64.000	64.000	5.500	1.833	60.000	60.99	1.81	60.10	1.81	64.000	63.98
	N2	17±2.6 to 18±2.7	16.000	17.000	2.600	0.867	18.000	18.000	2.700	0.900	16.000	17.02	0.89	16.77	0.89	18.000	17.99
	N2O	11±1.0	11.000	11.000	1.000	0.333	-	-	-	0.001	11.000	11.01	0.34	10.85	0.34	-	-
	CH4	2.4±0.2 to 2.5±0.2	2.400	2.400	0.200	0.067	2.500	2.500	0.200	0.067	4.030	4.03	0.21	3.97	0.21	3.300	3.29
	NH3	8.4±1.9 to 4.3±1.0	9.200	8.400	1.900	0.633	3.500	4.300	1.000	0.333	9.200	8.43	0.65	8.30	0.65	3.500	4.30
	Other	0.7±0.3		0.700	0.300	0.100		-	-	0.001							
	CH4	2.4±0.2 to 2.5±0.2		2.400	0.200	0.067		2.500	0.200	0.067							
	C2Hx	0.45±0.19 to 0.48±0.20	0.450	0.450	0.190	0.063	0.480	0.480	0.200	0.067							
	C3Hx		-	-	-	0.001	-	-	-	0.001							
	Other HC	0.22±0.12 to 0.24±0.13	0.220	0.220	0.120	0.040	-	-	-	0.001							
	Other NOx		-	-	-	0.001	-	-	-	0.001							
	Total "Other"	0.7±0.3		0.700	0.300	0.100		-	-	0.001							0
				100.47							100.23	101.48		100.00		88.8	89.57
											high salt range			range normalize		low salt range	

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

Tank and Sample (or Layer)		S-102 tank avg.	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	33±3.0 to 35±3.1	32.000	33.000	3.000	1.000	34.000	35.000	3.100	1.033	32.000	33.05	1.05	33.08	1.05	34.000	35.01
	N2	32±4.3 to 33±4.5	31.000	32.000	4.300	1.433	32.000	33.000	4.500	1.500	31.000	31.97	1.41	31.99	1.41	32.000	33.06
	N2O	33±3.1 to 31±2.9	33.000	33.000	3.100	1.033	32.000	31.000	2.900	0.967	33.000	33.00	1.04	33.03	1.04	32.000	31.02
	CH4	0.4±0.06 to 0.5±0.06	0.400	0.400	0.060	0.020	0.500	0.500	0.060	0.020	0.807	0.81	0.05	0.81	0.05	0.500	0.50
	NH3	1.1±0.4 to 0.6±0.2	3.200	1.100	0.400	0.133	1.300	0.600	0.200	0.067	3.200	1.10	0.14	1.10	0.14	1.300	0.60
	Other	0.2±0.06		0.200	0.060	0.020		-	-	0.001							
	CH4	0.4±0.07		0.400	0.070	0.023		-	-	0.001							
	C2Hx	0.10±0.03	0.100	0.100	0.030	0.010	-	-	-	0.001							
	C3Hx		-	-	-	0.001	-	-	-	0.001							
	Other HC	0.08±0.03 to 0.07±0.03	0.060	0.060	0.030	0.010	-	-	-	0.001							
	Other NOx		-	-	-	0.001	-	-	-	0.001							
	Total "Other"	0.2±0.06		0.200	0.060	0.020		-	-	0.001							
																	1
				99.66							100.0067	99.93		100.00		99.8	100.19

Tank and Sample (or Layer)		S-111 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range			high salt range		low salt range	
											forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	66±10 to 67±11	68.000	66.000	10.000	3.333	69.000	67.000	11.000	3.667	68.000	65.84	3.21	65.90	3.21	69.000	66.95
	N2	21±5.8 to 22±5.8	20.000	21.000	5.600	1.867	22.000	22.000	5.800	1.933	20.000	21.02	1.91	21.04	1.91	22.000	21.94
	N2O	11±1.7 to 9.6±1.5	11.000	11.000	1.700	0.567	10.000	9.600	1.500	0.500	11.000	11.04	0.59	11.05	0.59	10.000	9.63
	CH4	0.5±0.08	0.400	0.500	0.080	0.027		-	-	0.001	0.813	0.91	0.07	0.91	0.07	-	-
	NH3	1.1±0.4 to 0.6±0.2	1.000	1.100	0.400	0.133	0.600	0.600	0.200	0.067	1.000	1.10	0.13	1.10	0.13	0.600	0.60
	Other	0.2±0.07		0.200	0.070	0.023		-	-	0.001							
	CH4	0.4±0.07 to 0.5±0.07		0.400	0.070	0.023		0.500	0.070	0.023							
	C2Hx	0.08±0.03	0.080	0.080	0.030	0.010	-	-	-	0.001							
	C3Hx		-	-	-	0.001	-	-	-	0.001							
	Other HC	0.07±0.04	0.070	0.070	0.040	0.013	-	-	-	0.001							
	Other NOx		-	-	-	0.001	-	-	-	0.001							
	Total "Other"	0.2±0.07		0.200	0.070	0.023		-	-	0.001							
																	0
				99.75							100.8133	99.91		100.00		101.6	99.12

Tank and Sample (or Layer)		U-109 solids	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range			high salt range		low salt range	
											forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	25±3.1 to 26±3.2	25.000	25.000	3.100	1.033	26.000	26.000	3.200	1.067	25.000	24.95	1.04	24.75	1.04	26.000	26.03
	N2	46±7.8 to 48±8.1	45.000	46.000	7.800	2.600	47.000	48.000	8.100	2.700	45.000	46.02	2.66	45.65	2.66	47.000	48.19
	N2O	27±3.5 to 24±3.2	28.000	27.000	3.500	1.167	28.000	24.000	3.200	1.067	28.000	26.95	1.17	26.73	1.17	26.000	23.97
	CH4	0.7±0.1 to 0.8±0.1	0.700	0.700	0.100	0.033	0.800	0.800	0.100	0.033	1.687	1.69	0.11	1.68	0.11	0.800	0.80
	NH3	1.2±0.5 to 0.6±0.2	0.800	1.200	0.500	0.167	0.400	0.600	0.200	0.067	0.800	1.19	0.17	1.18	0.17	0.400	0.60
	Other	0.4±0.2		0.400	0.200	0.067		-	-	0.001							

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

	CH4	0.7±0.1		0.700	0.100	0.033		-	-	0.001							
	C2Hx	0.28±0.08 to 0.29±0.08	0.280	0.280	0.080	0.027	-	0.290	0.080	0.027							
	C3Hx		-	-	-	0.001	-	-	-	0.001							
	Other HC	0.13±0.07 to	0.130	0.130	0.070	0.023	-	-	-	0.001							
	Other NOx		-	-	-	0.001	-	-	-	0.001							
	Total "Other"	0.4±0.2		0.400	0.200	0.067		-	-	0.001							1
				100.31							100.4867	100.80		100.00		100.2	99.56

Tank and Sample (or Layer)		SY-101 ave (see below)	cb dists high salt	high salt mean	high salt range	low salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range			high salt range		low salt range	
											forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	31.75±6.35 to 36.5±7.0	31.750	31.750	6.350	2.117	26.000	36.500	7.075	2.358	31.750	31.69	2.17	31.29	2.17	26.000	36.41
	N2	32.25±8.525 to 39.25±1	45.000	32.250	8.525	2.842	47.000	39.250	10.225	3.408	45.000	32.28	2.62	31.88	2.62	47.000	39.35
	N2O	22.25±4.85 to 17.25±3.	26.000	22.250	4.850	1.617	26.000	17.250	3.125	1.042	28.000	22.20	1.60	21.92	1.60	26.000	17.27
	CH4	0.975±0.2725 to 0.975±	0.700	0.975	0.273	0.091	1.150	0.975	0.300	0.100	1.687	3.25	0.30	3.21	0.30	1.150	0.97
	NH3	11.8±3.1 to 4.8±1.25	0.800	11.800	3.100	1.033	0.400	4.800	1.250	0.417	0.800	11.65	1.06	11.70	1.06	0.400	4.80
	Other	0.9±0.4 to 1.1±0.475		0.900	0.400	0.133		1.100	0.475	0.158							
	CH4	0.95±0.27 to 1.15±0.3225		0.950	0.270	0.090		1.150	0.323	0.108							
	C2Hx	0.575±0.205 to 0.71±0.	0.280	0.575	0.205	0.068	-	0.710	0.253	0.084							
	C3Hx		-	-	-	0.001	-	-	-	0.001							
	Other HC	0.33±0.1925 to 0±0	0.130	0.330	0.193	0.064	-	-	-	0.001							
	Other NOx		-	-	-	0.001	-	-	-	0.001							
	Total "Other"	0.9±0.4 to 1.1±0.475		0.900	0.400	0.133		1.100	0.475	0.158							1
				99.93							107.2367	101.25		100.00		100.55	98.80

Tank and Sample (or Layer)		SY-101-022A crust	cb dists high salt	high salt mean	high salt range	high salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev	high salt range			high salt		low salt range	
											forecasts	mean	std dev	mean	std dev	forecasts	mean
Mole Percent of Constituent in Bubbles	H2	33±3.9 to 38±4.0	33.000	33.000	3.900	1.300	38.000	38.000	4.000	1.333	33.000	-	-	#DIV/0!	0.00	38.000	-
	N2	27±4.5 to 32±5.0	27.000	27.000	4.500	1.500	32.000	32.000	5.000	1.667	27.000	-	-	#DIV/0!	0.00	32.000	-
	N2O	20±2.4 to 22±2.3	20.000	20.000	2.400	0.800	22.000	22.000	2.300	0.767	20.000	-	-	#DIV/0!	0.00	22.000	-
	CH4	0.6±0.1 to 0.7±0.1	0.600	0.600	0.100	0.033	0.700	0.700	0.100	0.033	1.773	-	-	#DIV/0!	0.00	0.700	-
	NH3	19±4.8 to 6.6±1.6	19.000	19.000	4.800	1.600	6.600	6.600	1.600	0.533	19.000	-	-	#DIV/0!	0.00	6.600	-
	Other	0.6±0.2 to 0.7±0.2		0.600	0.200	0.067		0.700	0.200	0.067							
	CH4	0.6±0.08 to 0.7±0.09		0.600	0.080	0.027		0.700	0.090	0.030							
	C2Hx	0.56±0.15 to 0.67±0.17	0.560	0.560	0.150	0.050	-	0.670	0.170	0.057							
	C3Hx		-	-	-	-	-	-	-	-							
	Other HC	0.06±0.03 to 0.07±0.04	0.060	0.060	0.030	0.010	-	-	-	-							
	Other NOx		-	-	-	-	-	-	-	-							
	Total "Other"	0.6±0.2 to 0.7±0.2		0.600	0.200	0.067		0.700	0.200	0.067							0
				100.22							100.7733	-		#DIV/0!		99.3	-

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

Tank and Sample (or Layer)		SY-101-023A crust	cb dists high salt	high salt mean	high salt range	high salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev
Mole Percent of Constituent in Bubbles	H2	35±4.4 to 39±4.5	25.000	35.000	4.400	1.467	26.000	39.000	4.500	1.500
	N2	28±4.6 to 32±4.9	45.000	28.000	4.600	1.533	47.000	32.000	4.900	1.633
	N2O	20±2.5 to 21±2.4	28.000	20.000	2.500	0.833	26.000	21.000	2.400	0.800
	CH4	0.6±0.09	0.700	0.600	0.090	0.030	-	-	-	-
	NH3	16±3.9 to 6.7±1.6	0.800	16.000	3.900	1.300	0.400	6.700	1.600	0.533
	Other	0.4±0.1 to 0.5±0.1		0.400	0.100	0.033		0.500	0.100	0.033
	CH4	0.6±0.1 to 0.7±0.1		0.600	0.100	0.033		0.700	0.100	0.033
	C2Hx	0.38±0.08 to 0.47±0.10	0.280	0.380	0.080	0.027	-	0.470	0.100	0.033
	C3Hx		-	-	-	-	-	-	-	-
	Other HC	0.05±0.02 to 0.06±0.03	0.130	0.050	0.020	0.007	-	-	-	-
	Other NOx		-	-	-	-	-	-	-	-
	Total "Other"	0.4±0.1 to 0.5±0.1		0.400	0.100	0.033		0.500	0.100	0.033
				100.03						

Tank and Sample (or Layer)		SY-101-022A liq.	cb dists high salt	high salt mean	high salt range	high salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev
Mole Percent of Constituent in Bubbles	H2	32±8.8 to 38±10	25.000	32.000	8.800	2.933	26.000	38.000	10.000	3.333
	N2	33±11 to 42±14	45.000	33.000	11.000	3.667	47.000	42.000	14.000	4.667
	N2O	26±7.3 to 14±4.1	28.000	26.000	7.300	2.433	26.000	14.000	4.100	1.367
	CH4	1.3±0.4 to 1.6±0.5	0.700	1.300	0.400	0.133	-	1.600	0.500	0.167
	NH3	6.4±1.9 to 3.1±0.9	0.800	6.400	1.900	0.633	0.400	3.100	0.900	0.300
	Other	1.4±0.7 to 1.7±0.9		1.400	0.700	0.233		1.700	0.900	0.300
	CH4	1.3±0.5 to 1.6±0.6		1.300	0.500	0.167		1.600	0.600	0.200
	C2Hx	0.70±0.32 to 0.87±0.40	0.280	0.700	0.320	0.107	-	0.870	0.400	0.133
	C3Hx		-	-	-	-	-	-	-	-
	Other HC	0.67±0.41 to 0.83±0.51	0.130	0.670	0.410	0.137	-	-	-	-
	Other NOx		-	-	-	-	-	-	-	-
	Total "Other"	1.4±0.7 to 1.7±0.9		1.400	0.700	0.233		1.700	0.900	0.300
				100.07						

Tank and Sample (or Layer)		SY-101-021 liq.	cb dists high salt	high salt mean	high salt range	high salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev
Mole Percent of Constituent in Bubbles	H2	27±8.3 to 31±9.8	25.000	27.000	8.300	2.767	26.000	31.000	9.800	3.267
	N2	41±14 to 51±17	45.000	41.000	14.000	4.667	47.000	51.000	17.000	5.667
	N2O	23±7.2 to 12±3.7	28.000	23.000	7.200	2.400	26.000	12.000	3.700	1.233
	CH4	1.4±0.5 to 1.6±0.6	0.700	1.400	0.500	0.167	-	1.600	0.600	0.200
	NH3	5.8±1.8 to 2.8±0.9	0.800	5.800	1.800	0.600	0.400	2.800	0.900	0.300
	Other	1.2±0.6 to 1.5±0.7		1.200	0.600	0.200		1.500	0.700	0.233
	CH4	1.3±0.4 to 1.6±0.5		1.300	0.400	0.133		1.600	0.500	0.167
	C2Hx	0.66±0.27 to 0.83±0.34	0.280	0.660	0.270	0.090	-	0.830	0.340	0.113

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"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Combine Original and "Other" Component Tables

	C3Hx		-	-	-	-	-	-	-	-
	Other HC	0.54±0.31 to 0.67±0.39	0.130	0.540	0.310	0.103	-	-	-	-
	Other NOx		-	-	-	-	-	-	-	-
	Total "Other"	1.2±0.6 to 1.5±0.7		1.200	0.600	0.200		1.500	0.700	0.233
				99.4						

Tank and Sample (or Layer)		SY-101 ave.	cb dists high salt	high salt mean	high salt range	high salt std dev	cb dists low salt	low salt mean	low salt range	low salt std dev
Mole Percent of Constituent in Bubbles	H2	31.75±8.35 to 36.5±7.075		31.8	6.4			36.5	7.1	
	N2	32.25±8.525 to 39.25±10.225		32.3	8.5			39.3	10.2	
	N2O	22.25±4.85 to 17.25±3.125		22.3	4.9			17.3	3.1	
	CH4	0.975±0.2725 to 0.975±0.3		1.0	0.3			1.0	0.3	
	NH3	11.8±3.1 to 4.8±1.25		11.8	3.1			4.8	1.3	
	Other	0.9±0.4 to 1.1±0.475		0.9	0.4			1.1	0.5	
	CH4	0.95±0.27 to 1.15±0.3225		1.0	0.3			1.2	0.3	
	C2Hx	0.575±0.205 to 0.71±0.2525		0.6	0.2			0.7	0.3	
	C3Hx			-	-			-	-	
	Other HC	0.33±0.1925 to 0±0		0.3	0.2			-	-	
	Other NOx			-	-			-	-	
	Total "Other"	0.9±0.4 to 1.1±0.475		0.9	0.4			1.1	0.5	
				99.93						

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Comt

Tank and Sample (or Layer)		std dev	mean (range normalize)	std dev	Forecast: I5	I4	I5	I6	I7	I8	q4	q5	q6	q7	q8
Mole Percent of Constituent in Bubbles	H2	1.07	32.96	1.07	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	2.12	58.24	2.12	Trials	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00	1,000
	N2O	0.16	4.40	0.16	Mean	32.06	56.21	7.20	9.39	0.60	32.96	58.24	4.40	8.26	0
	CH4	0.44	8.26	0.44	Median	32.05	56.20	7.19	9.39	0.60	32.97	58.30	4.40	8.26	0
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	—
	Other				Standard Deviation	1.08	2.08	0.28	0.43	0.10	1.07	2.12	0.16	0.44	0
	CH4				Variance	1.17	4.34	0.08	0.19	0.01	1.13	4.50	0.03	0.20	0
	C2Hx				Skewness	0.01	0.07	0.15	0.04	(0.04)	(0.01)	(0.09)	0.12	(0.01)	0
	C3Hx				Kurtosis	3.08	2.90	2.97	2.98	3.10	3.07	2.83	3.01	2.82	0
	Other HC				Coeff. of Variability	0.03	0.04	0.04	0.05	0.17	0.03	0.04	0.04	0.05	0
	Other NOx				Range Minimum	28.59	49.17	6.34	8.07	0.24	29.48	52.31	3.96	6.91	0
	Total "Other"				Range Maximum	35.50	63.64	8.14	10.66	0.93	36.26	64.08	4.90	9.59	0
			103.85		Range Width	6.91	14.47	1.80	2.58	0.69	6.78	11.77	0.95	2.67	0
					Mean Std. Error	0.03	0.07	0.01	0.01	0.00	0.03	0.07	0.01	0.01	0

Tank and Sample (or Layer)		std dev	mean (range normalize)	std dev	Forecast: I18	I19	I20	I21	I22	I23	q19	q20	q21	q22	q23
Mole Percent of Constituent in Bubbles	H2	-	-	0.00	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	-	-	0.00	Trials	1,000.00	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	N2O	0.16	5.30	0.16	Mean	72.01	19.07231	5.804437	1.514441	2.491777	0	0	5.30306	0	0
	CH4	-	-	0.00	Median	71.99	19.10886	5.805911	1.513705	2.490027	0	0	5.297358	0	0
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	—
	Other				Standard Deviation	2.30	1.637624	0.197938	0.056187	0.30377	0	0	0.16398	0	0
	CH4				Variance	5.29	2.681812	0.039179	0.003157	0.092276	0	0	0.02689	0	0
	C2Hx				Skewness	(0.01)	0.002951	0.083533	-0.015194	-0.03119	0	0	0.014966	0	0
	C3Hx				Kurtosis	3.00	2.908455	2.75474	3.342326	2.927584	0	0	2.853926	0	0
	Other HC				Coeff. of Variability	0.03	0.085864	0.034101	0.037101	0.121909	0	0	0.030922	0	0
	Other NOx				Range Minimum	63.84	14.12633	5.175467	1.264558	1.439239	0	0	4.78108	0	0
	Total "Other"				Range Maximum	79.51	23.93819	6.379857	1.706608	3.427062	0	0	5.796693	0	0
			5.30		Range Width	15.66	9.811861	1.20439	0.44205	1.987823	0	0	1.015613	0	0
					Mean Std. Error	0.07	0.051786	0.006259	0.001777	0.009606	0	0	0.005186	0	0

Tank and Sample (or Layer)		std dev	mean (range normalize)	std dev	Forecast: I33	I34	I35	I36	I37	I38	q34	q35	q36	q37	q38
Mole Percent of Constituent in Bubbles	H2	1.87	61.85	1.87	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	1.34	25.24	1.34	Trials	1,000	1,000	1,000	1,000	1,000	1000	1000	1,000	1,000	1,000
	N2O	0.36	10.99	0.36	Mean	59.95776	24.24491	14.00738	1.770787	0.501593	61.854	25.238	10.98679	0.997884	0
	CH4	0.10	1.00	0.10	Median	59.95472	24.25552	13.99685	1.767847	0.49809	61.851	25.228	10.98165	1.000053	0
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	—
	Other				Standard Deviation	1.785854	1.364731	0.493763	0.089343	0.084696	1.870	1.343	0.360386	0.098247	0

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Comt

	CH4				Variance	3.189274	1.86249	0.243802	0.007982	0.004186	3.496	1.804	0.129878	0.009652	0
	C2Hx				Skewness	-0.005243	-0.174528	-0.017678	0.134001	0.142467	-0.01	0.02	0.049127	-0.091965	0
	C3Hx				Kurtosis	3.040792	3.195469	2.923574	2.7839	2.962868	2.70	2.70	3.126106	3.213292	0
	Other HC				Coeff. of Variability	0.029785	0.056289	0.03525	0.050454	0.12898	0.03	0.05	0.032802	0.098455	0
	Other NOx				Range Minimum	54.04147	19.02917	12.41771	1.516606	0.305079	56.699	21.203	9.886958	0.673734	0
	Total "Other"				Range Maximum	65.61884	28.23635	15.42897	2.071723	0.702529	66.932	29.468	12.31259	1.305372	0
			99.08		Range Width	11.57736	9.207179	3.011265	0.555117	0.39745	10.233	8.265	2.425627	0.631638	0
					Mean Std. Error	0.056474	0.043157	0.015614	0.002825	0.002046	0.059	0.042	0.011396	0.003107	0

range normalize

Tank and Sample (or Layer)		std dev	mean	std dev	Forecast: forecasts	l50	l51	l52	l53	l54	q50	q51	q52	q53	q54
Mole Percent of Constituent in Bubbles	H2	2.34	46.88	2.34	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	1.72	30.92	1.72	Trials	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	N2O	1.07	20.05	1.07	Mean	45.01309	29.06324	23.0237	3.358001	0.896019	46.88424	30.91883	20.05061	2.337768	0
	CH4	0.25	2.34	0.25	Median	44.99726	29.04332	23.05964	3.357393	0.891358	46.97183	30.8813	20.05277	2.339867	0
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	—
	Other				Standard Deviation	2.324619	1.560725	1.199418	0.238141	0.131958	2.342188	1.72249	1.069311	0.254815	0
	CH4				Variance	5.403855	2.435863	1.438603	0.056711	0.017413	5.485845	2.966971	1.143425	0.064931	0
	C2Hx				Skewness	0.064836	0.03668	0.072719	0.026606	0.075635	-0.08027	-0.044557	0.035086	0.011753	0
	C3Hx				Kurtosis	2.949772	2.884611	2.865125	2.888823	2.734561	3.213638	3.078716	2.842746	3.001134	0
	Other HC				Coeff. of Variability	0.051643	0.053701	0.052095	0.070917	0.147271	0.049957	0.05571	0.053331	0.108999	0
	Other NOx				Range Minimum	38.10845	24.77493	19.28304	2.677887	0.535348	38.86256	24.67646	16.60584	1.536088	0
	Total "Other"				Range Maximum	52.91185	33.78235	26.65321	4.080312	1.295246	53.92881	36.58766	23.88315	3.208745	0
			100.19		Range Width	14.8032	9.007419	7.370176	1.402425	0.759898	15.06624	11.9112	7.277312	1.672657	0
					Mean Std. Error	0.073511	0.049354	0.037929	0.007531	0.004173	0.074086	0.05447	0.033815	0.008058	0

low salt range

Tank and Sample (or Layer)		std dev	mean	std dev	Forecast: forecasts	l66	l67	l68	l69	l70	q66	q67	q68	q69	q70
Mole Percent of Constituent in Bubbles	H2	2.45	61.88	2.45	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	-	-	0.00	Trials	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	N2O	0.17	3.39	0.17	Mean	61.09724	33.15394	4.107946	1.625054	0.600153	61.87888	0	3.393619	9.256306	0
	CH4	0.43	9.26	0.43	Median	61.08775	33.19719	4.106573	1.623509	0.602614	61.91958	0	3.390024	9.253442	0
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	—
	Other				Standard Deviation	2.589754	1.443614	0.192837	0.090859	0.064592	2.449459	0	0.169177	0.426529	0
	CH4				Variance	6.706826	2.084022	0.037186	0.008255	0.004172	5.999847	0	0.028621	0.181927	0
	C2Hx				Skewness	-0.030381	-0.14043	0.027975	-0.005071	-0.092141	0.008726	0	-0.075192	-0.119742	0
	C3Hx				Kurtosis	3.098639	2.995687	3.209291	2.95928	2.87668	2.738604	0	2.895973	2.91869	0
	Other HC				Coeff. of Variability	0.042387	0.043543	0.046943	0.055912	0.107625	0.039586	0	0.049851	0.04608	0
	Other NOx				Range Minimum	51.37039	28.11163	3.337206	1.335281	0.406588	55.24226	0	2.89077	7.875715	0
	Total "Other"				Range Maximum	69.89569	38.28999	4.795109	1.935551	0.774052	68.8558	0	3.928313	10.69459	0
			74.53		Range Width	18.5253	10.17837	1.457902	0.60027	0.367464	13.61353	0	1.037543	2.818879	0
					Mean Std. Error	0.081895	0.045651	0.006098	0.002873	0.002043	0.077459	0	0.00535	0.013488	0

range normalize

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Comt

Tank and Sample (or Layer)		std dev	mean	std dev	Forecast: forecasts	l82	l83	l84	l85	l86	q82	q83	q84	q85	q86
Mole Percent of Constituent in Bubbles	H2	0.51	23.84	0.51	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	0.85	37.86	0.85	Trials	1,000	1000	1000	1000	1000	1,000	1000	1000	1000	1000
	N2O	0.73	36.75	0.73	Mean	23.01222	38.191	39.032	1.793	0.598	24.01025	38.123	37.002	1.065	0.498
	CH4	0.06	1.06	0.06	Median	22.99235	38.218	39.028	1.793	0.599	24.00625	38.129	37.009	1.067	0.497
	NH3	0.07	0.49	0.07	Mode	—	—	—	—	—	—	—	—	—	—
	Other				Standard Deviation	0.463645	0.768	0.793	0.068	0.101	0.513694	0.848	0.726	0.057	0.066
	CH4				Variance	0.214966	0.590	0.628	0.005	0.010	0.263681	0.719	0.527	0.003	0.004
	C2Hx				Skewness	0.037809	-0.04	0.00	0.02	-0.01	0.09577	0.06	-0.06	0.03	0.00
	C3Hx				Kurtosis	2.863881	2.86	3.00	3.11	3.07	3.0713	2.90	3.18	2.76	2.90
	Other HC				Coeff. of Variability	0.020148	0.02	0.02	0.04	0.17	0.021395	0.02	0.02	0.05	0.13
	Other NOx				Range Minimum	21.47335	33.822	36.456	1.551	0.205	22.56076	35.285	34.324	0.906	0.296
	Total "Other"				Range Maximum	24.8611	38.750	41.607	2.035	0.965	25.93175	40.818	39.371	1.233	0.684
			100.00		Range Width	3.187744	4.928	5.151	0.483	0.760	3.370996	5.534	5.047	0.327	0.389
					Mean Std. Error	0.014662	0.024	0.025	0.002	0.003	0.016244	0.027	0.023	0.002	0.002

low salt

Tank and Sample (or Layer)		std dev	mean	std dev	Forecast: forecasts	l98	l99	l100	l101	l102	q98	q99	q100	q101	q102
Mole Percent of Constituent in Bubbles	H2	1.97	64.96	1.97	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	0.01	0.06	0.01	Trials	1,000	1,000	1,000	1,000	1000	1000	1000	1000	1000	1000
	N2O	0.26	8.40	0.26	Mean	62.93817	25.06257	11.02574	1.267329	0.300	64.956	0.059	8.401	0.411	0.000
	CH4	0.10	0.41	0.10	Median	62.94575	25.03802	11.01643	1.270495	0.302	65.037	0.059	8.402	0.408	0.000
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	0.000
	Other				Standard Deviation	1.90308	1.238056	0.340172	0.135504	0.066	1.966	0.013	0.260	0.104	0.000
	CH4				Variance	3.621636	1.632782	0.115717	0.018361	0.004	3.863	0.000	0.067	0.011	0.000
	C2Hx				Skewness	-0.031757	0.069583	0.070258	0.024109	-0.10	-0.04	0.01	-0.02	-0.04	0.00
	C3Hx				Kurtosis	3.187417	2.961485	2.824637	3.361847	2.87	2.91	2.84	2.96	2.90	+Infinity
	Other HC				Coeff. of Variability	0.030237	0.049399	0.030853	0.106921	0.22	0.03	0.22	0.03	0.25	+Infinity
	Other NOx				Range Minimum	56.74468	21.36598	9.959403	0.806792	0.082	59.155	0.021	7.591	0.036	0.000
	Total "Other"				Range Maximum	69.74762	29.04999	12.01873	1.711023	0.478	70.761	0.096	9.246	0.710	0.000
			73.83		Range Width	13.00294	7.684008	2.059326	0.904231	0.396	11.606	0.076	1.656	0.674	0.000
					Mean Std. Error	0.06018	0.039151	0.010757	0.004285	0.002	0.062	0.000	0.008	0.003	0.000

low salt range

Tank and Sample (or Layer)		std dev	mean	std dev	Forecast: forecasts	l114	l115	l116	l117	l118	q114	q115	q116	q117	q118
Mole Percent of Constituent in Bubbles	H2	1.87	51.03	1.87	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
	N2	0.00	0.02	0.00	Trials	1,000	1000	1000	1000	1000	1000	1000	1000	1000	1,000
	N2O	0.75	16.00	0.75	Mean	50.0274	29.025	17.931	7.349	0.199	51.029	0.020	15.995	1.834	0
	CH4	0.11	1.63	0.11	Median	50.01945	29.012	17.896	7.351	0.199	50.979	0.020	15.980	1.833	0
	NH3	-	-	0.00	Mode	—	—	—	—	—	—	—	—	—	0
	Other				Standard Deviation	1.865785	1.785	0.838	0.269	0.033	1.873	0.003	0.752	0.109	0
	CH4				Variance	3.481152	3.186	0.701	0.083	0.001	3.510	0.000	0.565	0.012	0

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Comt

C2Hx				Skewness	0.055144	-0.08	0.03	0.06	0.04	0.09	-0.06	0.03	0.04	0
C3Hx				Kurtosis	2.883377	2.87	2.97	2.94	2.98	3.10	2.95	2.95	2.83	+Infinity
Other HC				Coeff. of Variability	0.037295	0.06	0.05	0.04	0.17	0.04	0.17	0.05	0.06	+Infinity
Other NOx				Range Minimum	44.24394	23.386	15.329	6.324	0.091	45.483	0.008	13.721	1.514	0
Total "Other"				Range Maximum	55.60083	34.544	20.507	8.207	0.298	56.993	0.029	18.360	2.147	0
		68.88		Range Width	11.35688	11.158	5.177	1.883	0.207	11.510	0.021	4.639	0.632	0
				Mean Std. Error	0.059001	0.056	0.026	0.009	0.001	0.059	0.000	0.024	0.003	0

Tank and Sample (or Layer)		low salt range												
	std dev	mean	std dev	Forecast: forecasts	l130	l131	l132	l133	l134	q130	q131	q132	q133	q134
Mole Percent of Constituent in Bubbles: H2	1.59	51.87	1.59	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
N2	1.36	20.99	1.36	Trials	1000	1000	1000	1,000	1000	1,000	1000	1,000	1000	1,000
N2O	-	-	0.00	Mean	50.035	19.987	23.993	1.373	5.493	51.86914	20.987	0	0.352	2.406496
CH4	0.04	0.35	0.04	Median	50.017	19.931	23.969	1.371	5.496	51.84798	21.010	0	0.351	2.405735
NH3	0.17	2.41	0.17	Mode	—	—	—	—	—	—	—	0	—	—
Other				Standard Deviation	1.482	1.240	0.924	0.066	0.391	1.589249	1.359	0	0.037	0.167437
CH4				Variance	2.195	1.538	0.854	0.004	0.153	2.525711	1.846	0	0.001	0.028035
C2Hx				Skewness	0.07	0.00	0.01	0.08	-0.02	0.123631	-0.11	0	0.12	0.08208
C3Hx				Kurtosis	2.87	2.95	2.88	2.82	2.67	3.160258	3.14	+Infinity	2.88	2.753777
Other HC				Coeff. of Variability	0.03	0.06	0.04	0.05	0.07	0.03064	0.06	+Infinity	0.11	0.069577
Other NOx				Range Minimum	45.881	15.596	21.324	1.183	4.387	46.48411	16.662	0	0.242	1.916467
Total "Other"				Range Maximum	55.077	24.147	26.801	1.575	6.570	57.43874	25.374	0	0.476	2.932501
		75.81		Range Width	9.196	8.551	5.477	0.393	2.204	10.95462	8.712	0	0.234	1.016035
				Mean Std. Error	0.047	0.039	0.029	0.002	0.012	0.050256	0.043	0	0.001	0.005295

Tank and Sample (or Layer)		low salt range												
	std dev	mean	std dev	Forecast: forecasts	l146	l147	l148	l149	l150	q146	q147	q148	q149	q150
Mole Percent of Constituent in Bubbles: H2	1.90	63.98	1.90	Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
N2	0.91	17.99	0.91	Trials	1,000	1000	1000	1000	1000	1000	1000	1000	1000	1000
N2O	-	-	0.00	Mean	60.99244	17.020	11.012	4.029	8.427	63.982	17.993	0.000	3.292	4.301
CH4	0.13	3.29	0.13	Median	60.95552	17.048	11.006	4.024	8.428	63.976	17.972	0.000	3.297	4.302
NH3	0.32	4.30	0.32	Mode	—	—	—	—	—	—	—	0.000	—	—
Other				Standard Deviation	1.806333	0.886	0.338	0.206	0.647	1.903	0.911	0.000	0.128	0.320
CH4				Variance	3.262841	0.784	0.114	0.042	0.419	3.622	0.831	0.000	0.016	0.103
C2Hx				Skewness	0.037275	-0.12	0.03	-0.04	0.07	0.06	0.12	0.00	0.01	0.14
C3Hx				Kurtosis	3.02641	2.75	3.02	3.17	3.45	2.83	3.07	+Infinity	3.03	3.00
Other HC				Coeff. of Variability	0.029616	0.05	0.03	0.05	0.08	0.03	0.05	+Infinity	0.04	0.07
Other NOx				Range Minimum	54.38262	14.379	9.958	3.293	6.358	58.016	15.082	0.000	2.883	3.496
Total "Other"				Range Maximum	67.08688	19.280	12.082	4.615	10.966	70.198	21.555	0.000	3.714	5.681
		89.57		Range Width	12.70426	4.901	2.126	1.321	4.607	12.181	6.473	0.000	0.831	2.186
				Mean Std. Error	0.057121	0.028	0.011	0.007	0.020	0.060	0.029	0.000	0.004	0.010

range normalize

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Comt

Tank and Sample (or Layer)		std dev	mean	std dev
Mole Percent of Constituent in Bubbles	H2	1.04	34.94	1.04
	N2	1.51	33.00	1.51
	N2O	0.96	30.96	0.96
	CH4	0.02	0.50	0.02
	NH3	0.07	0.60	0.07
	Other			
	CH4			
	C2Hx			
	C3Hx			
	Other HC			
	Other NOx			
	Total "Other"			
			100.00	
			low salt range	

Forecast: forecasts	I162 Value	I163 Value	I164 Value	I165 Value	I166 Value	q162 Value	q163 Value	q164 Value	q165 Value	q166 Value
Statistic										
Trials	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Mean	33.053	31.969	33.003	0.809	1.100	35.011	33.065	31.015	0.500	0.599
Median	33.047	31.949	32.992	0.808	1.098	34.999	33.108	30.978	0.499	0.600
Mode	—	—	—	—	—	—	—	—	—	—
Standard Deviation	1.049	1.409	1.039	0.048	0.135	1.040	1.514	0.955	0.020	0.066
Variance	1.099	1.986	1.080	0.002	0.018	1.081	2.292	0.913	0.000	0.004
Skewness	-0.10	-0.02	0.09	0.09	-0.04	0.00	0.01	0.15	0.08	-0.17
Kurtosis	3.02	2.80	2.95	2.74	2.94	3.15	2.71	3.21	2.90	3.28
Coeff. of Variability	0.03	0.04	0.03	0.06	0.12	0.03	0.05	0.03	0.04	0.11
Range Minimum	29.403	27.588	29.675	0.654	0.579	31.489	29.137	27.823	0.446	0.349
Range Maximum	36.214	36.207	36.434	0.955	1.499	38.221	37.258	35.156	0.566	0.807
Range Width	6.811	8.619	6.760	0.301	0.921	6.733	8.122	7.532	0.120	0.458
Mean Std. Error	0.033	0.045	0.033	0.002	0.004	0.033	0.048	0.030	0.001	0.002

Tank and Sample (or Layer)		std dev	mean	std dev
Mole Percent of Constituent in Bubbles	H2	3.65	66.95	3.65
	N2	1.92	21.94	1.92
	N2O	0.49	9.63	0.49
	CH4	-	-	0.00
	NH3	0.07	0.60	0.07
	Other			
	CH4			
	C2Hx			
	C3Hx			
	Other HC			
	Other NOx			
	Total "Other"			
			99.12	
			low salt range	

Forecast: Q160	I178 Value	I179 Value	I180 Value	I181 Value	I182 Value	q178 Value	q179 Value	q180 Value	q181 Value	q182 Value
Statistic										
Trials	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Mean	65.836	21.022	11.037	0.912	1.096	66.945	21.939	9.634	0.000	0.601
Median	65.883	21.062	11.056	0.914	1.092	66.963	22.009	9.618	0.000	0.600
Mode	—	—	—	—	—	—	—	—	0.000	—
Standard Deviation	3.205	1.911	0.586	0.065	0.134	3.651	1.917	0.490	0.000	0.065
Variance	10.274	3.652	0.343	0.004	0.018	13.332	3.674	0.240	0.000	0.004
Skewness	0.02	-0.13	-0.12	-0.02	0.07	-0.08	-0.12	0.16	0.00	-0.01
Kurtosis	3.10	3.20	2.92	2.97	3.06	2.85	2.92	3.20	+Infinity	3.01
Coeff. of Variability	0.05	0.09	0.05	0.07	0.12	0.05	0.09	0.05	+Infinity	0.11
Range Minimum	55.091	13.643	9.250	0.706	0.653	55.800	16.077	7.823	0.000	0.386
Range Maximum	76.886	26.540	12.951	1.121	1.587	77.875	27.331	11.443	0.000	0.791
Range Width	21.795	12.897	3.701	0.415	0.934	22.075	11.254	3.620	0.000	0.406
Mean Std. Error	0.101	0.060	0.019	0.002	0.004	0.115	0.061	0.015	0.000	0.002

Tank and Sample (or Layer)		std dev	mean	std dev
Mole Percent of Constituent in Bubbles	H2	1.08	26.14	1.08
	N2	2.76	48.39	2.76
	N2O	1.05	24.07	1.05
	CH4	0.03	0.80	0.03
	NH3	0.07	0.60	0.07
	Other			

Forecast: forecasts	I194 Value	I195 Value	I196 Value	I197 Value	I198 Value	q194 Value	q195 Value	q196 Value	q197 Value	q198 Value
Statistic										
Trials	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Mean	24.950	46.021	26.949	1.689	1.193	26.028	48.185	23.967	0.802	0.598
Median	24.962	46.060	26.978	1.686	1.194	25.986	48.098	23.964	0.800	0.597
Mode	—	—	—	—	—	—	—	—	—	—
Standard Deviation	1.040	2.663	1.167	0.114	0.166	1.083	2.755	1.052	0.035	0.067

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"

Step 3 of 7 - Comt

CH4	
C2Hx	
C3Hx	
Other HC	
Other NOx	
Total "Other"	
	100.00

Variance	1.082	7.091	1.363	0.013	0.028	1.172	7.591	1.107	0.001	0.004
Skewness	-0.02	-0.06	-0.03	-0.04	0.01	-0.03	0.04	0.10	0.05	-0.06
Kurtosis	2.76	2.97	3.01	2.98	3.07	3.11	3.06	3.32	2.93	2.94
Coeff. of Variability	0.04	0.06	0.04	0.07	0.14	0.04	0.06	0.04	0.04	0.11
Range Minimum	21.951	38.041	23.451	1.314	0.648	22.102	39.269	20.321	0.694	0.346
Range Maximum	28.293	55.583	31.345	1.997	1.728	29.107	58.391	28.111	0.906	0.787
Range Width	6.342	17.542	7.894	0.683	1.080	7.005	19.122	7.790	0.212	0.442
Mean Std. Error	0.033	0.084	0.037	0.004	0.005	0.034	0.087	0.033	0.001	0.002

Tank and Sample (or Layer)		std dev	low salt range mean	std dev
Mole Percent of Constituent in Bubbles	H2	2.32	36.85	2.32
	N2	3.36	39.83	3.36
	N2O	1.06	17.48	1.06
	CH4	0.10	0.98	0.10
	NH3	0.41	4.86	0.41
	Other			
	CH4			
	C2Hx			
	C3Hx			
	Other HC			
	Other NOx			
	Total "Other"			
			100.00	

Forecast: forecasts	t210	t211	t212	t213	t214	q210	q211	q212	q213	q214
Statistic	Value	Value	Value	Value	Value	Value	Value	Value	Value	Value
Trials	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Mean	31.687	32.275	22.197	3.249	11.846	36.410	39.352	17.270	0.973	4.799
Median	31.720	32.286	22.249	3.256	11.817	36.448	39.233	17.240	0.973	4.790
Mode	—	—	—	—	—	—	—	—	—	—
Standard Deviation	2.171	2.625	1.596	0.301	1.063	2.321	3.358	1.059	0.099	0.413
Variance	4.715	6.890	2.548	0.090	1.129	5.385	11.276	1.121	0.010	0.170
Skewness	-0.01	-0.03	0.00	0.06	0.00	0.05	0.09	0.00	0.01	-0.05
Kurtosis	2.79	2.91	2.91	2.93	3.04	2.95	3.01	3.05	2.92	3.06
Coeff. of Variability	0.07	0.08	0.07	0.09	0.09	0.06	0.09	0.06	0.10	0.09
Range Minimum	24.928	25.188	17.544	2.399	8.357	28.634	28.320	13.529	0.655	3.352
Range Maximum	38.640	40.524	27.870	4.280	15.561	44.079	51.256	20.510	1.263	6.247
Range Width	13.711	15.336	10.326	1.881	7.204	15.444	22.936	6.981	0.609	2.895
Mean Std. Error	0.069	0.083	0.050	0.010	0.034	0.073	0.106	0.033	0.003	0.013

Tank and Sample (or Layer)		std dev	low salt mean	std dev
Mole Percent of Constituent in Bubbles	H2	-	-	0.00
	N2	-	-	0.00
	N2O	-	-	0.00
	CH4	-	-	0.00
	NH3	-	-	0.00
	Other			
	CH4			
	C2Hx			
	C3Hx			
	Other HC			
	Other NOx			
	Total "Other"			
			-	

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"
Cell Equations

Cell	Value	Formula
c4	32±3.2 to 33±3.2	32±3.2 to 33±3.2
c5	56±6.2 to 58±6.4	56±6.2 to 58±6.4
c6	7.2±0.8 to 4.4±0.5	7.2±0.8 to 4.4±0.5
c7	1.7±0.2	1.7±0.2
c8	0.6±0.3	0.6±0.3
c9	2.8±0.5 to 2.9±0.6	2.8±0.5 to 2.9±0.6
c10	1.7±0.2	1.7±0.2
c11	1.1±0.2 to 1.2±0.2	1.1±0.2 to 1.2±0.2
c12	0.26±0.1 to 0.27±0.1	0.26±0.1 to 0.27±0.1
c13	1.3±0.3 to 1.4±0.3	1.3±0.3 to 1.4±0.3
c14	0.12±0.06 to 0.12±0.07	0.12±0.06 to 0.12±0.07
c15	2.8±0.5 to 2.9±0.6	2.8±0.5 to 2.9±0.6
c16		
d4	31.90562462	31.90562462
d5	55	55
d6	7.5	7.5
d7	1.7	1.7
d8	0.8	0.8
d9		
d10		
d11	1.1	1.1
d12	0.26	0.26
d13	1.3	1.3
d14	0.12	0.12
d15		
d16		
e4	32	"=IF (ISERR (FIND (E2, C307, 1)), 0, VALUE (LEFT (C307, FIND (E2, C307, 1) - 1)))
e5	56	"=IF (ISERR (FIND (E2, C308, 1)), 0, VALUE (LEFT (C308, FIND (E2, C308, 1) - 1)))
e6	7.2	"=IF (ISERR (FIND (E2, C309, 1)), 0, VALUE (LEFT (C309, FIND (E2, C309, 1) - 1)))
e7	1.7	"=IF (ISERR (FIND (E2, C310, 1)), 0, VALUE (LEFT (C310, FIND (E2, C310, 1) - 1)))
e8	0.6	"=IF (ISERR (FIND (E2, C311, 1)), 0, VALUE (LEFT (C311, FIND (E2, C311, 1) - 1)))
e9	2.8	"=IF (ISERR (FIND (E2, C312, 1)), 0, VALUE (LEFT (C312, FIND (E2, C312, 1) - 1)))
e10	1.7	"=IF (ISERR (FIND (E2, C313, 1)), 0, VALUE (LEFT (C313, FIND (E2, C313, 1) - 1)))
e11	1.1	"=IF (ISERR (FIND (E2, C314, 1)), 0, VALUE (LEFT (C314, FIND (E2, C314, 1) - 1)))
e12	0.26	"=IF (ISERR (FIND (E2, C315, 1)), 0, VALUE (LEFT (C315, FIND (E2, C315, 1) - 1)))
e13	1.3	"=IF (ISERR (FIND (E2, C316, 1)), 0, VALUE (LEFT (C316, FIND (E2, C316, 1) - 1)))
e14	0.12	"=IF (ISERR (FIND (E2, C317, 1)), 0, VALUE (LEFT (C317, FIND (E2, C317, 1) - 1)))
e15	2.8	"=IF (ISERR (FIND (E2, C318, 1)), 0, VALUE (LEFT (C318, FIND (E2, C318, 1) - 1)))
e16	100.28	"=SUM (E307:E318) - E312 - E313 - E318
f4	3.2	"=IF (ISERR (FIND (E2, C307)), 0, IF (ISERR (FIND (F2, C307)), VALUE (RIGHT (C307, LEN (C307) - FIND (E2, C307))), VALUE (MID (C307, FIND (E2, C307) + 1, FIND (F2, C307) - FIND (E2, C307) - 1))))
f5	6.2	"=IF (ISERR (FIND (E2, C308)), 0, IF (ISERR (FIND (F2, C308)), VALUE (RIGHT (C308, LEN (C308) - FIND (E2, C308))), VALUE (MID (C308, FIND (E2, C308) + 1, FIND (F2, C308) - FIND (E2, C308) - 1))))
f6	0.8	"=IF (ISERR (FIND (E2, C309)), 0, IF (ISERR (FIND (F2, C309)), VALUE (RIGHT (C309, LEN (C309) - FIND (E2, C309))), VALUE (MID (C309, FIND (E2, C309) + 1, FIND (F2, C309) - FIND (E2, C309) - 1))))
f7	0.2	"=IF (ISERR (FIND (E2, C310)), 0, IF (ISERR (FIND (F2, C310)), VALUE (RIGHT (C310, LEN (C310) - FIND (E2, C310))), VALUE (MID (C310, FIND (E2, C310) + 1, FIND (F2, C310) - FIND (E2, C310) - 1))))

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"
Cell Equations

Cell	Value	Formula
f8	0.3	"=IF (ISERR (FIND (E2, C311)) , 0, IF (ISERR (FIND (F2, C311)) , VALUE (RIGHT (C311, LEN (C311) - FIND (E2, C311))) , VALUE (MID (C311, FIND (E2, C311) + 1, FIND (F2, C311) - FIND (E2, C311) - 1))))
f9	0.5	"=IF (ISERR (FIND (E2, C312)) , 0, IF (ISERR (FIND (F2, C312)) , VALUE (RIGHT (C312, LEN (C312) - FIND (E2, C312))) , VALUE (MID (C312, FIND (E2, C312) + 1, FIND (F2, C312) - FIND (E2, C312) - 1))))
f10	0.2	"=IF (ISERR (FIND (E2, C313)) , 0, IF (ISERR (FIND (F2, C313)) , VALUE (RIGHT (C313, LEN (C313) - FIND (E2, C313))) , VALUE (MID (C313, FIND (E2, C313) + 1, FIND (F2, C313) - FIND (E2, C313) - 1))))
f11	0.2	"=IF (ISERR (FIND (E2, C314)) , 0, IF (ISERR (FIND (F2, C314)) , VALUE (RIGHT (C314, LEN (C314) - FIND (E2, C314))) , VALUE (MID (C314, FIND (E2, C314) + 1, FIND (F2, C314) - FIND (E2, C314) - 1))))
f12	0.1	"=IF (ISERR (FIND (E2, C315)) , 0, IF (ISERR (FIND (F2, C315)) , VALUE (RIGHT (C315, LEN (C315) - FIND (E2, C315))) , VALUE (MID (C315, FIND (E2, C315) + 1, FIND (F2, C315) - FIND (E2, C315) - 1))))
f13	0.3	"=IF (ISERR (FIND (E2, C316)) , 0, IF (ISERR (FIND (F2, C316)) , VALUE (RIGHT (C316, LEN (C316) - FIND (E2, C316))) , VALUE (MID (C316, FIND (E2, C316) + 1, FIND (F2, C316) - FIND (E2, C316) - 1))))
f14	0.06	"=IF (ISERR (FIND (E2, C317)) , 0, IF (ISERR (FIND (F2, C317)) , VALUE (RIGHT (C317, LEN (C317) - FIND (E2, C317))) , VALUE (MID (C317, FIND (E2, C317) + 1, FIND (F2, C317) - FIND (E2, C317) - 1))))
f15	0.5	"=IF (ISERR (FIND (E2, C318)) , 0, IF (ISERR (FIND (F2, C318)) , VALUE (RIGHT (C318, LEN (C318) - FIND (E2, C318))) , VALUE (MID (C318, FIND (E2, C318) + 1, FIND (F2, C318) - FIND (E2, C318) - 1))))
f16		
g4	2.366666667	"=IF (ISERR (F307 / 3) , 0.001, MAX (+ F307 / 3, 0.001))
g5	1.633333333	"=IF (ISERR (F308 / 3) , 0.001, MAX (+ F308 / 3, 0.001))
g6	0.2	"=IF (ISERR (F309 / 3) , 0.001, MAX (+ F309 / 3, 0.001))
g7	0.033333333	"=IF (ISERR (F310 / 3) , 0.001, MAX (+ F310 / 3, 0.001))
g8	0.3	"=IF (ISERR (F311 / 3) , 0.001, MAX (+ F311 / 3, 0.001))
g9	0.02	"=IF (ISERR (F312 / 3) , 0.001, MAX (+ F312 / 3, 0.001))
g10	0.033333333	"=IF (ISERR (F313 / 3) , 0.001, MAX (+ F313 / 3, 0.001))
g11	0.006666667	"=IF (ISERR (F314 / 3) , 0.001, MAX (+ F314 / 3, 0.001))
g12	0.01	"=IF (ISERR (F315 / 3) , 0.001, MAX (+ F315 / 3, 0.001))
g13	0.01	"=IF (ISERR (F316 / 3) , 0.001, MAX (+ F316 / 3, 0.001))
g14	0.006666667	"=IF (ISERR (F317 / 3) , 0.001, MAX (+ F317 / 3, 0.001))
g15	0.02	"=IF (ISERR (F318 / 3) , 0.001, MAX (+ F318 / 3, 0.001))
g16		
h4	33	33
h5	57	57
h6	5	5
h7		
h8		
h9		
h10		
h11	1.2	1.2
h12	0.27	0.27
h13	1.4	1.4
h14	0.12	0.12
h15		
h16		
i4	33	"=IF (ISERR (FIND (F2, C307)) , 0, VALUE (MID (C307, FIND (F2, C307) + LEN (F2) , FIND (E2, C307, FIND (F2, C307) + 1) - (FIND (F2, C307) + LEN (F2)))))
i5	58	"=IF (ISERR (FIND (F2, C308)) , 0, VALUE (MID (C308, FIND (F2, C308) + LEN (F2) , FIND (E2, C308, FIND (F2, C308) + 1) - (FIND (F2, C308) + LEN (F2)))))
i6	4.4	"=IF (ISERR (FIND (F2, C309)) , 0, VALUE (MID (C309, FIND (F2, C309) + LEN (F2) , FIND (E2, C309, FIND (F2, C309) + 1) - (FIND (F2, C309) + LEN (F2)))))
i7	0	"=IF (ISERR (FIND (F2, C310)) , 0, VALUE (MID (C310, FIND (F2, C310) + LEN (F2) , FIND (E2, C310, FIND (F2, C310) + 1) - (FIND (F2, C310) + LEN (F2)))))

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps" Cell Equations

Cell	Value	Formula
I8	0	'=IF (ISERR (FIND (F2, C311)) , 0, VALUE (MID (C311, FIND (F2, C311) + LEN (F2) , FIND (E2, C311, FIND (F2, C311) + 1) - (FIND (F2, C311) + LEN (F2)))))
I9	2.9	'=IF (ISERR (FIND (F2, C312)) , 0, VALUE (MID (C312, FIND (F2, C312) + LEN (F2) , FIND (E2, C312, FIND (F2, C312) + 1) - (FIND (F2, C312) + LEN (F2)))))
I10	0	'=IF (ISERR (FIND (F2, C313)) , 0, VALUE (MID (C313, FIND (F2, C313) + LEN (F2) , FIND (E2, C313, FIND (F2, C313) + 1) - (FIND (F2, C313) + LEN (F2)))))
I11	1.2	'=IF (ISERR (FIND (F2, C314)) , 0, VALUE (MID (C314, FIND (F2, C314) + LEN (F2) , FIND (E2, C314, FIND (F2, C314) + 1) - (FIND (F2, C314) + LEN (F2)))))
I12	0.27	'=IF (ISERR (FIND (F2, C315)) , 0, VALUE (MID (C315, FIND (F2, C315) + LEN (F2) , FIND (E2, C315, FIND (F2, C315) + 1) - (FIND (F2, C315) + LEN (F2)))))
I13	1.4	'=IF (ISERR (FIND (F2, C316)) , 0, VALUE (MID (C316, FIND (F2, C316) + LEN (F2) , FIND (E2, C316, FIND (F2, C316) + 1) - (FIND (F2, C316) + LEN (F2)))))
I14	0.12	'=IF (ISERR (FIND (F2, C317)) , 0, VALUE (MID (C317, FIND (F2, C317) + LEN (F2) , FIND (E2, C317, FIND (F2, C317) + 1) - (FIND (F2, C317) + LEN (F2)))))
I15	2.9	'=IF (ISERR (FIND (F2, C318)) , 0, VALUE (MID (C318, FIND (F2, C318) + LEN (F2) , FIND (E2, C318, FIND (F2, C318) + 1) - (FIND (F2, C318) + LEN (F2)))))
I16		
j4	3.2	'=IF (ISERR (FIND (F2, C307)) , 0, VALUE (RIGHT (C307, LEN (C307) - FIND (E2, C307, FIND (F2, C307) + 1) - (LEN (E2) - 1))))
j5	6.4	'=IF (ISERR (FIND (F2, C308)) , 0, VALUE (RIGHT (C308, LEN (C308) - FIND (E2, C308, FIND (F2, C308) + 1) - (LEN (E2) - 1))))
j6	0.5	'=IF (ISERR (FIND (F2, C309)) , 0, VALUE (RIGHT (C309, LEN (C309) - FIND (E2, C309, FIND (F2, C309) + 1) - (LEN (E2) - 1))))
j7	0	'=IF (ISERR (FIND (F2, C310)) , 0, VALUE (RIGHT (C310, LEN (C310) - FIND (E2, C310, FIND (F2, C310) + 1) - (LEN (E2) - 1))))
j8	0	'=IF (ISERR (FIND (F2, C311)) , 0, VALUE (RIGHT (C311, LEN (C311) - FIND (E2, C311, FIND (F2, C311) + 1) - (LEN (E2) - 1))))
j9	0.6	'=IF (ISERR (FIND (F2, C312)) , 0, VALUE (RIGHT (C312, LEN (C312) - FIND (E2, C312, FIND (F2, C312) + 1) - (LEN (E2) - 1))))
j10	0	'=IF (ISERR (FIND (F2, C313)) , 0, VALUE (RIGHT (C313, LEN (C313) - FIND (E2, C313, FIND (F2, C313) + 1) - (LEN (E2) - 1))))
j11	0.2	'=IF (ISERR (FIND (F2, C314)) , 0, VALUE (RIGHT (C314, LEN (C314) - FIND (E2, C314, FIND (F2, C314) + 1) - (LEN (E2) - 1))))
j12	0.1	'=IF (ISERR (FIND (F2, C315)) , 0, VALUE (RIGHT (C315, LEN (C315) - FIND (E2, C315, FIND (F2, C315) + 1) - (LEN (E2) - 1))))
j13	0.3	'=IF (ISERR (FIND (F2, C316)) , 0, VALUE (RIGHT (C316, LEN (C316) - FIND (E2, C316, FIND (F2, C316) + 1) - (LEN (E2) - 1))))
j14	0.07	'=IF (ISERR (FIND (F2, C317)) , 0, VALUE (RIGHT (C317, LEN (C317) - FIND (E2, C317, FIND (F2, C317) + 1) - (LEN (E2) - 1))))
j15	0.6	'=IF (ISERR (FIND (F2, C318)) , 0, VALUE (RIGHT (C318, LEN (C318) - FIND (E2, C318, FIND (F2, C318) + 1) - (LEN (E2) - 1))))
j16		
k4	1.066666667	'=IF (ISERR (J4 / 3) , 0.001, MAX (+ J4 / 3, 0.001))
k5	2.133333333	'=IF (ISERR (J5 / 3) , 0.001, MAX (+ J5 / 3, 0.001))
k6	0.166666667	'=IF (ISERR (J6 / 3) , 0.001, MAX (+ J6 / 3, 0.001))
k7	0.001	'=IF (ISERR (J7 / 3) , 0.001, MAX (+ J7 / 3, 0.001))
k8	0.001	'=IF (ISERR (J8 / 3) , 0.001, MAX (+ J8 / 3, 0.001))
k9	0.2	'=IF (ISERR (J9 / 3) , 0.001, MAX (+ J9 / 3, 0.001))
k10	0.001	'=IF (ISERR (J10 / 3) , 0.001, MAX (+ J10 / 3, 0.001))
k11	0.066666667	'=IF (ISERR (J11 / 3) , 0.001, MAX (+ J11 / 3, 0.001))
k12	0.033333333	'=IF (ISERR (J12 / 3) , 0.001, MAX (+ J12 / 3, 0.001))
k13	0.1	'=IF (ISERR (J13 / 3) , 0.001, MAX (+ J13 / 3, 0.001))
k14	0.023333333	'=IF (ISERR (J14 / 3) , 0.001, MAX (+ J14 / 3, 0.001))
k15	0.2	'=IF (ISERR (J15 / 3) , 0.001, MAX (+ J15 / 3, 0.001))
k16		

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"
Cell Equations

Cell	Value	Formula
l4	31.90562462	"= + D307
l5	55.12	"= + D308 + D317
l6	7.5	"= + D309
l7	9.383333333	"= + D310 + D314*5 / 3 + D315*5 / 2 + D316*4
l8	0.8	"= + D311
l9		
l10		
l11		
l12		
l13		
l14		
l15		
l16	104.708958	"=SUM (L307:L318)
m4	32.05737627	"= + X309
m5	56.20912925	"= + Y309
m6	7.199081032	"= + Z309
m7	9.38931521	"= + AA309
m8	0.599613297	"=AB309
m9		
m10		
m11		
m12		
m13		
m14		
m15		
m16	105.4545151	"=SUM (M307:M318)
n4	1.081848013	"= + X312
n5	2.08239897	"= + Y312
n6	0.278946023	"= + Z312
n7	0.431529823	"= + AA312
n8	0.101245517	"= + AB312
n9		
n10		
n11		
n12		
n13		
n14		
n15		
n16		
o4	30.39924488	"= + M307 / M319*100
o5	53.30177586	"= + M308 / M319*100
o6	6.828716739	"= + M309 / M319*100
o7	8.903663541	"= + M310 / M319*100
o8	0.56859898	"= + M311 / M319*100
o9		
o10		
o11		
o12		
o13		
o14		
o15		
o16	100	"=SUM (O307:O318)
p4	1.081848013	"= + N307
p5	2.08239897	"= + N308
p6	0.278946023	"= + N309
p7	0.431529823	"= + N310
p8	0.101245517	"= + N311
p9		
p10		
p11		
p12		
p13		
p14		

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"
Cell Equations

Cell	Value	Formula
p15		
p16		
q4	33	"= + H307
q5	57.12	"= + H308 + H317
q6	5	"= + H309
q7	8.275	"= + H310 + H314*5 / 3 + H315*5 / 2 + H316*4
q8	0	"= + H311
q9		
q10		
q11		
q12		
q13		
q14		
q15		
q16	103.396	"=SUM (Q307:Q316)
r4	32.95593137	"= + AC309
r5	58.23768653	"= + AD309
r6	4.40194146	"= + AE309
r7	8.256572689	"= + AF309
r8	0	"=AG309
r9		
r10		
r11		
r12		
r13		
r14		
r15	0	"=IF (OR (R307"=0, R308"=0, R309"=0, R310"=0, R311"=0) , 0, 1)
r16	103.852132	"=SUM (R307:R312)
s4	1.065328453	"= + AC312
s5	2.122268326	"= + AD312
s6	0.164811603	"= + AE312
s7	0.442054928	"= + AF312
s8	0	"= + AG312
s9		
s10		
s11		
s12		
s13		
s14		
s15		
s16		
t4	32.95593137	"=IF (R318"=0, + R307, + R307 / R319*100)
t5	58.23768653	"=IF (R318"=0, + R308, + R308 / R319*100)
t6	4.40194146	"=IF (R318"=0, + R309, + R309 / R319*100)
t7	8.256572689	"=IF (R318"=0, + R310, + R310 / R319*100)
t8	0	"=IF (R318"=0, + R311, + R311 / R319*100)
t9		
t10		
t11		
t12		
t13		
t14		
t15		
t16	103.852132	"=SUM (T307:T318)
u4	1.065328453	"= + S307
u5	2.122268326	"= + S308
u6	0.164811603	"= + S309
u7	0.442054928	"= + S310
u8	0	"= + S311
u9		
u10		
u11		
u12		

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "3-Revised comps"
Cell Equations

Cell	Value	Formula
u13		
u14		
u15		
u16		

3. Create forecasts in columns "L" and "Q" for the major components. Minor components are added to major components (NOx add to N2 and fuels are added to CH4).
4. Run Crystal Ball for 1,000 trials.
5. Prepare Crystal Ball report.
6. Copy summary statistics to Columns "X" through "AG."

Combine Distributions for SY-101

7. Copy combined SY-101 values from range "C290 to C301" to "C210 to C221."
8. Repeat Step 2 for SY-101.
9. Repeat Step 3 for SY-101.
10. Repeat Step 4 for SY-101.
11. Repeat Step 5 for SY-101.
12. Repeat Step 6 for SY-101.
13. Clear all forecasts and assumptions from spreadsheet.

G2.3 CREATE DISTRIBUTIONS FOR RGS TANKS

Create the Four Distributions Required to Specify the Retained Gas Distributions for Each of the RGS Tanks

Tab "4-Gas comp by tanks"

1. Recalculate spreadsheet.
2. Set up "Step-wise Continuous" assumptions in cells in rows 8, 20, 32, 45, 58, 71, 84, 97, 110, 123, 136, 149, 162, 175 and columns "O", "S", "W", "AA."
   a. Clear any existing assumptions.
   b. Select custom distribution.
   c. Select data, then enter the range of cells listed below the cell where the assumption cells.
   d. Rescale to 1.00.
   e. Save assumption.
   f. If there are not four values to choose from use the original normal distribution.

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

Tank and Sample (or Layer)		high salt range normalized		low salt range normalized		assumptions			
AW-101 solids		mean	std dev	mean	std dev	low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	30.40	1.08	32.98	1.07	26.07	30.40	32.98	37.22
	N2	53.30	2.08	58.24	2.12	44.97	53.30	58.24	66.73
	N2O	6.83	0.28	4.40	0.16	3.74	4.40	6.83	7.94
	CH4	8.90	0.43	8.26	0.44	6.49	8.26	8.90	10.83
	NH3	0.57	0.10	-	-	-	-	0.57	0.97
1		100.00		100.00					

	AW-101 H2			N2O	
	26.0719	-	31.6576	3.7427	
	30.3992	1.0000	I8:N11	4.4019	
	32.9559	1.0000		6.8267	
	37.2172	-		7.9425	
		12 AW-101 H2	31.6576		1
retainedGasCompositionNH3	0.6000				12 A
retainedGasCompositionN2	53.7300	MEAN	AW-101 H2	31.1400	MEAN
headspaceGasRatioCH4	0.2136	STDDEV	AW-101 H2	2.3991	STDDEV
headspaceGasRatioN2O	0.1256				MEAN STDDEV

Tank and Sample (or Lay		high salt range normal		low salt range		assumptions			
A-101 upper		mean	std dev	mean	std dev	low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	71.37	2.30	-	-	-	-	71.37	80.58
	N2	18.90	1.64	-	-	-	-	18.90	25.45
	N2O	5.75	0.20	5.30	0.18	4.65	5.30	5.75	6.54
	CH4	1.50	0.08	-	-	-	-	1.50	1.73
	NH3	2.47	0.30	-	-	-	-	2.47	3.68
2		100.00		79.23					

	A-101 H2			N2O	
	-	-	50.6499	4.6471	
	-	1.0000	I20:N23	5.3031	
	71.3740	1.0000	I17:N20	5.7528	
	80.5757	-		6.5445	
		24 A-101 H2	50.6499		
retainedGasCompositionNH3	0.6000				24
retainedGasCompositionN2	53.7300	MEAN	4 A-101 H2	31.1400	MEAN
headspaceGasRatioCH4	0.2100	STDDEV	4 A-101 H2	2.2719	STDDEV
headspaceGasRatioN2O	0.1300				MEAN STDDEV

Tank and Sample (or Lay		high salt range normal		low salt range normalize		assumptions			
AN-105 solids		mean	std dev	mean	std dev	low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	59.67	1.79	61.85	1.87	52.53	59.67	61.85	69.33
	N2	24.13	1.36	25.24	1.34	18.67	24.13	25.24	30.61
	N2O	13.94	0.49	10.99	0.38	9.55	10.99	13.94	15.92
	CH4	1.76	0.09	1.00	0.10	0.80	1.00	1.76	2.12

AN-105 H2			N2O
52.5265	-	60.8674	9.6452
59.6699	1.0000	I32:N35	10.9868
61.8540	1.0000	I25:N28	13.9401
69.3331	-		15.9152

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

	NH3	0.50	0.06	-	-	-	-	0.50	0.76			36 AN-105 H2	60.8674	
3		100.00		100.00										

retainedGasCompositionNH3	0.6000				36 /
retainedGasCompositionN2	53.7300	MEAN	AN-105 H2	31.1400	MEAN
headspaceGasRatio CH4	0.2100	STDDEV	AN-105 H2	3.3698	STDDEV
headspaceGasRatio N2O	0.1300				MEAN STDDEV

Tank and Sample (or Layer)		high salt range normalized		low salt range normalized		assumptions				AN-104				
AN-104 solids		mean	std dev	mean	std dev	low	mean1	mean2	high	H2				N2O
Mole Percent of Constituent in Bubbles	H2	44.41	2.32	46.88	2.34	35.11	44.41	46.88	56.25	35.1133		-	45.6702	15.7734
	N2	28.67	1.58	30.92	1.72	22.43	28.67	30.92	37.81	44.4117		1.0000	145:N48	20.0506
	N2O	22.72	1.20	20.05	1.07	15.77	20.05	22.72	27.61	46.8842		1.0000	134:N37	22.7161
	CH4	3.31	0.24	2.34	0.25	1.32	2.34	3.31	4.27	56.2530		-		27.5138
	NH3	0.88	0.13	-	-	-	-	0.88	1.41			49 AN-104 H2	45.6702	4
4		100.00		100.00										

retainedGasCompositionNH3	0.6000				49 /
retainedGasCompositionN2	53.7300	MEAN	AN-104 H2	31.1400	MEAN
headspaceGasRatio CH4	0.2100	STDDEV	AN-104 H2	4.3661	STDDEV
headspaceGasRatio N2O	0.1300				MEAN STDDEV

Tank and Sample (or Layer)		high salt range normalized		low salt range normalized		assumptions				AN-103				
AN-103 solids		mean	std dev	mean	std dev	low	mean1	mean2	high	H2				N2O
Mole Percent of Constituent in Bubbles	H2	60.74	2.59	61.88	2.45	50.38	60.74	61.88	71.67	50.3633		-	61.1273	2.7169
	N2	32.98	1.44	-	-	-	-	32.98	38.74	60.7423		1.0000	158:N61	3.3936
	N2O	4.08	0.19	3.39	0.17	2.72	3.39	4.08	4.86	61.8769		1.0000	143:N46	4.0641
	CH4	1.62	0.09	9.26	0.43	1.25	1.62	9.26	10.98	71.6747		-		4.8554
	NH3	0.60	0.06	-	-	-	-	0.60	0.86			62 AN-103 H2	61.1273	6
5		100.00		76.06										

retainedGasCompositionNH3	0.6000	62 /

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

retainedGasCompositionN2	53.7300	MEAN	AN-103 H2	31.1400	MEAN
headspaceGasRatioCH4	0.2100	STDDEV	AN-103 H2	4.3860	STDDEV
headspaceGasRatioN2O	0.1300				MEAN STDDEV

Tank and Sample (or U-103 solids		high salt range mean	high salt range std dev	low salt range mean	low salt range std dev	assumptions low	mean1	mean2	high	U-103 H2			N2O
Mole Percent of Constituent in Bubbles	H2	22.87	0.46	23.84	0.51	21.01	22.87	23.84	25.90	21.0142	-	23.4174	33.8427
	N2	35.97	0.77	37.88	0.85	32.89	35.97	37.88	41.25	22.8687	1.0000	I71:N74	36.7458
	N2O	38.79	0.79	38.75	0.73	33.84	38.75	38.79	41.98	23.8437	1.0000	I52:N55	38.7891
	CH4	1.78	0.07	1.06	0.06	0.83	1.06	1.78	2.05	25.8985	-		41.9594
	NH3	0.59	0.10	0.49	0.07	0.23	0.49	0.59	1.00		75 U-103 H2	23.4174	
1		100.00		100.00									

retainedGasCompositionNH3	0.6000				75
retainedGasCompositionN2	53.7300	MEAN	5 U-103 H2	31.1400	MEAN
headspaceGasRatioCH4	0.2100	STDDEV	5 U-103 H2	1.0217	STDDEV
headspaceGasRatioN2O	0.1300				MEAN STDDEV

Tank and Sample (or S-106 solids		high salt range mean	high salt range std dev	low salt range mean	low salt range std dev	assumptions low	mean1	mean2	high	S-106 H2			N2O
Mole Percent of Constituent in Bubbles	H2	62.57	1.90	64.96	1.97	54.95	62.57	64.96	72.82	54.9544	-	63.8400	7.3625
	N2	24.91	1.24	0.08	0.01	0.01	0.08	24.91	29.87	62.5667	1.0000	I84:N87	8.4011
	N2O	10.96	0.34	8.40	0.28	7.36	8.40	10.96	12.32	64.9564	1.0000		10.9607
	CH4	1.28	0.14	0.41	0.10	-	0.41	1.28	1.80	72.8187	-		12.3213
	NH3	0.30	0.07	-	-	-	-	0.30	0.56		88 S-106 H2	63.8400	
2		100.00		74.67									

retainedGasCompositionNH3	0.6000				88
retainedGasCompositionN2	53.7300	MEAN	8 S-106 H2	31.1400	MEAN
headspaceGasRatioCH4	0.2100	STDDEV	8 S-106 H2	3.6360	STDDEV
headspaceGasRatioN2O	0.1300				MEAN STDDEV

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

Tank and Sample (or BY-109 hohigh salt		high salt range mean	std dev	low salt range mean	std dev	assumptions low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	47.86	1.87	51.03	1.87	40.40	47.86	51.03	58.52
	N2	27.77	1.78	0.02	0.00	0.01	0.02	27.77	34.91
	N2O	17.16	0.84	16.00	0.75	12.99	16.00	17.15	20.50
	CH4	7.03	0.29	1.83	0.11	1.40	1.83	7.03	8.18
	NH3	0.19	0.03	-	-	-	-	0.19	0.32
3		100.00		100.00					

BY-109		H2				N2O	
		40.3963		-	49.4537	12.8889	
		47.8594		1.0000	I97:N100	15.9951	
		51.0292		1.0000		17.1537	
		58.5226		-		20.5039	
				101 BY-109 H2	49.4537		10
	retainedGasCompositionNH3	0.6000					101
	retainedGasCompositionN2	53.7300	MEAN	BY-109 H2	31.1400		MEAN
	headspaceGasRatioCH4	0.2100	STDDEV	BY-109 H2	3.7146		STDDEV
	headspaceGasRatioN2O	0.1300					MEAN STDDEV

Tank and Sample (or SX-106 solids		high salt range mean	std dev	low salt range mean	std dev	assumptions low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	49.60	1.48	51.87	1.59	43.67	49.60	51.87	58.23
	N2	19.81	1.24	20.99	1.36	1.74	2.41	5.45	7.01
	N2O	23.78	0.92	-	-	-	-	23.78	27.48
	CH4	1.36	0.07	0.35	0.04	0.20	0.35	1.36	1.83
	NH3	5.45	0.39	2.41	0.17	1.74	2.41	5.45	7.01
4		100.00		75.99					

SX-106		H2				N2O	
		43.6717		-	50.8674	-	
		49.5979		1.0000	I110:N113	-	
		51.8691		1.0000		23.7835	
		58.2261		-		27.4795	
				114 SX-106 H2	50.8674		1
	retainedGasCompositionNH3	0.6000					114
	retainedGasCompositionN2	53.7300	MEAN	SX-106 H2	31.1400		MEAN
	headspaceGasRatioCH4	0.2100	STDDEV	SX-106 H2	2.9926		STDDEV
	headspaceGasRatioN2O	0.1300					MEAN STDDEV

Tank and Sample (or AX-101-9D-8		high salt range mean	std dev	low salt range mean	std dev	assumptions low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	60.10	1.81	63.98	1.90	52.68	60.10	63.98	71.59
	N2	16.77	0.89	17.99	0.91	13.23	16.77	17.99	21.64
	N2O	10.85	0.34	-	-	-	-	10.85	12.20
	CH4	3.97	0.21	3.29	0.13	2.78	3.29	3.97	4.79
	NH3	8.30	0.65	4.30	0.32	3.02	4.30	8.30	10.89

AX-101	H2			N2O	
	52.8775	-	62.1605	-	
	60.1029	1.0000	H23:N128	-	
	63.9822	1.0000		10.8512	
	71.5947	-		12.2019	
		127 AX-101 H2	62.1605		1

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

5	100.00	88.80

retainedGasCompositionNH3	0.6000					127
retainedGasCompositionN2	53.7300	MEAN	AX-101 H2	31.1400		MEAN
headspaceGasRatioCH4	0.2100	STDDEV	AX-101 H2	3.8815		STDDEV
headspaceGasRatioN2O	0.1300					MEAN STDDEV

Tank and Sample (or S-102 tank avg.		high salt range mean	high salt range std dev	low salt range mean	low salt range std dev	assumptions low	mean1	mean2	high	S-102 H2			N2O
Mole Percent of Constituent in Bubbles	H2	33.08	1.05	34.94	1.04	28.88	33.08	34.94	39.10	28.8810	-	33.9988	27.1357
	N2	31.99	1.41	33.00	1.51	26.35	31.99	33.00	39.06	33.0750	1.0000	136:N139	30.9567
	N2O	33.03	1.04	30.98	0.98	27.14	30.98	33.03	37.18	34.9445	1.0000		33.0252
	CH4	0.81	0.05	0.50	0.02	0.42	0.50	0.81	1.00	39.1030	-		37.1824
	NH3	1.10	0.14	0.60	0.07	0.33	0.60	1.10	1.64		140 S-102 H2	33.9988	

6	100.00	99.30

retainedGasCompositionNH3	0.6000					140
retainedGasCompositionN2	53.7300	MEAN	0 S-102 H2	31.1400		MEAN
headspaceGasRatioCH4	0.2100	STDDEV	0 S-102 H2	2.1742		STDDEV
headspaceGasRatioN2O	0.1300					MEAN STDDEV

Tank and Sample (or S-111 solids		high salt range mean	high salt range std dev	low salt range mean	low salt range std dev	assumptions low	mean1	mean2	high	S-111 H2			N2O
Mole Percent of Constituent in Bubbles	H2	65.90	3.21	68.95	3.85	53.06	65.90	68.95	81.55	53.0769	-	67.0058	7.6752
	N2	21.04	1.91	21.94	1.92	13.40	21.04	21.94	29.81	65.8981	1.0000	149:N152	9.6339
	N2O	11.06	0.59	9.63	0.49	7.68	9.63	11.06	13.39	66.9453	1.0000		11.0479
	CH4	0.91	0.07	-	-	-	-	0.91	1.17	81.5507	-		13.3921
	NH3	1.10	0.13	0.60	0.07	0.34	0.60	1.10	1.64		153 S-111 H2	67.0058	

7	100.00	80.10

retainedGasCompositionNH3	0.6000					153
retainedGasCompositionN2	53.7300	MEAN	3 S-111 H2	31.1400		MEAN
headspaceGasRatioCH4	0.2100	STDDEV	3 S-111 H2	5.8283		STDDEV

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

headspaceGasRatio N2O	0.1300		MEAN STDDEV

Tank and Sample (or U-109 tank avg)		high salt range mean	std dev	low salt range mean	std dev	assumptions low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	24.75	1.04	26.14	1.08	20.59	24.75	26.14	30.47
	N2	45.65	2.66	48.39	2.76	0.33	0.60	1.18	1.85
	N2O	26.73	1.17	24.07	1.05	19.86	24.07	26.73	31.40
	CH4	1.68	0.11	0.60	0.03	0.67	0.60	1.68	2.13
	NH3	1.18	0.17	0.60	0.07	0.33	0.60	1.18	1.85
8		100.00		99.40					

U-109 H2			N2O
20.5604	-	25.4975	19.8594
24.7512	1.0000	I162:N165	24.0682
26.1374	1.0000		26.7349
30.4683	-		31.4044
	166 U-109 H2	25.4975	

retainedGasCompositionNH3	0.6000					166
retainedGasCompositionN2	53.7300	MEAN	6 U-109 H2	31.1400	MEAN	
headspaceGasRatio CH4	0.2100	STDDEV	6 U-109 H2	1.9986	STDDEV	
headspaceGasRatio N2O	0.1300				MEAN STDDEV	

Tank and Sample (or SY-101 ave		high salt range mean	std dev	low salt range mean	std dev	assumptions low	mean1	mean2	high
Mole Percent of Constituent in Bubbles	H2	31.29	2.17	36.85	2.32	22.61	31.29	36.85	46.13
	N2	31.88	2.62	39.83	3.36	21.38	31.88	39.83	53.28
	N2O	21.92	1.60	17.48	1.06	13.24	17.48	21.92	28.31
	CH4	3.21	0.30	0.98	0.10	0.59	0.98	3.21	4.41
	NH3	11.70	1.06	4.86	0.41	3.21	4.86	11.70	75.95
9		100.00		99.40					

SY-101 H2			N2O
22.6097	-	34.2531	13.2448
31.2949	1.0000	I175:N178	17.4790
36.8513	1.0000		21.8224
46.1337	-		28.3075
	179 SY-101 H2	34.2531	1:

retainedGasCompositionNH3	0.6000					179 :
retainedGasCompositionN2	53.7300	MEAN	SY-101 H2	31.1400	MEAN	
headspaceGasRatio CH4	0.2100	STDDEV	SY-101 H2	5.1338	STDDEV	
headspaceGasRatio N2O	0.1300				MEAN STDDEV	

Forecasts					
1	AW-101	NH3	AW-101 NH3	AW-101 sol	31.8576
2	A-101	NH3	A-101 NH3	A-101 uppe	50.6499
3	AN-105	NH3	AN-105 NH3	AN-105 soli	60.8674

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

Mole Percent of Constituent in Bubbles

4	AN-104	NH3	AN-104 NH3			AN-104 soli	45.6702		
5	AN-103	NH3	AN-103 NH3			AN-103 soli	61.1273		
6	U-103	NH3	U-103 NH3			U-103 solid	23.4174		
7	S-106	NH3	S-106 NH3			S-106 solid	63.8400		
8	BY-109	NH3	BY-109 NH3			BY-109 bel	49.4537		
9	SX-106	NH3	SX-106 NH3			SX-106 soli	50.8674		
10	AX-101	NH3	AX-101 NH3			AX-101-9D-	62.1605		
11	S-102	NH3	S-102 NH3			S-102 tank	33.9988		
12	S-114	NH3	S-114 NH3			S-114 solid	67.0058		
13	U-109	NH3	U-109 NH3			U-109 tank	25.4975		
14	SY-101	NH3	SY-101 NH3			SY-101 ave	34.2531		
			Min	-				Min	-
			Max	81.5507				Max	41.9594
						Min	23.4174		
						Max	67.0058		

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

															H2
		CH4				NH3				N2			Row ==>	12 O	
-	5.7387	8.4884		-	8.5670	-		-	0.5141					Trials	1000
1.0000	P6:R11	8.2566		1.0000	T8:V11	-		1.0000	X8:Z11					Mean	31.5657
1.0000		8.9037		1.0000		0.5686		1.0000						Median	31.5002
-		10.8298		-		0.9738		-						Mode	—
2 AW-101 N2O	5.7387			12 AW-101 CH4	8.5670			12 AW-101 NH3	0.5141		12 AW-101 N2	53.5228		Standard D	2.3991
AW-101 R_N2O	0.1249			12 R_CH4	0.2130									Variance	5.7556
12 AW-101 N2(	6.0600		MEAN	12 AW-101 CH4	8.4700		MEAN	12 AW-101 I	0.6000	MEAN	12 AW-101	53.7300		Skewness	0.04
12 AW-101 N2(	0.9980		STDDEV	12 AW-101 CH4	0.8462		STDDEV	12 AW-101 I	0.0999	STDDEV	12 AW-101	2.7074		Kurtosis	2.29
W-101 R_N2O	0.1256		MEAN	12 R_CH4	0.2136									Coeff. of V:	0.08
W-101 R_N2O	0.0205		STDDEV	12 R_CH4	0.0210									Range Min	28.1555
														Range Ma	37.1098
		CH4				NH3				N2			Row ==>	24 O	
-	5.5689	-		-	4.0891	-		-	2.0514					Trials	1000
1.0000	P20:R23	-		1.0000	T20:V23	-		1.0000	X20:Z23					Mean	71.4638
1.0000	P17:R20	1.5010		1.0000	T17:V20	2.4898		1.0000	X17:Z20					Median	71.4515
-		1.7257		-		3.6847		-						Mode	—
24 A-101 N2O	5.5689			24 A-101 CH4	4.0891			24 A-101 NH3	2.0514		24 A-101 N2	37.6307		Standard D	2.2719
4 A-101 R_N2O	0.0923			24 R_CH4	0.0749									Variance	5.1614
24 A-101 N2O	6.0600		MEAN	24 A-101 CH4	8.4700		MEAN	24 A-101 NH	0.6000	MEAN	24 A-101 N	53.7300		Skewness	0.06
24 A-101 N2O	0.4097		STDDEV	24 A-101 CH4	0.0552		STDDEV	24 A-101 NH	0.2953	STDDEV	24 A-101 N	2.3255		Kurtosis	2.98
A-101 R_N2O	0.1300		MEAN	24 R_CH4	0.2100									Coeff. of V:	0.03
A-101 R_N2O	0.0053		STDDEV	24 R_CH4	0.0010									Range Min	64.3838
														Range Ma	78.1475
		CH4				NH3				N2			Row ==>	36 O	
-	12.6131	0.6049		-	1.3702	-		-	1.2940					Trials	1000
1.0000	P32:R35	0.9879		1.0000	T32:V35	-		1.0000	X32:Z35					Mean	60.8886
1.0000	P25:R28	1.7623		1.0000	T25:V28	0.4992		1.0000	X25:Z28					Median	60.9210
-		2.1197		-		0.7580		-						Mode	—

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

36 AN-105 N2O	12.6131		36 AN-105 CH4	1.3702		36 AN-105 NH3	1.2940		36 AN-105 N2	23.8553	Standard E	3.3698
AN-105 R_N2O	0.1685		36 R_CH4	0.0220							Variance	11.3558
36 AN-105 N2(	6.0600	MEAN	36 AN-105 CH4	8.4700	MEAN	36 AN-105 N	0.6000	MEAN	36 AN-105	53.7300	Skewness	-0.03
36 AN-105 N2(	1.4296	STDDEV	36 AN-105 CH4	0.3469	STDDEV	36 AN-105 N	0.0849	STDDEV	36 AN-105	3.6349	Kurtosis	2.34
AN-105 R_N2O	0.1300	MEAN	36 R_CH4	0.2100							Coeff. of V	0.06
AN-105 R_N2O	0.0178	STDDEV	36 R_CH4	0.0056							Range Min	52.7813
											Range Max	88.7882
		CH4			NH3			N2			Row ==> 49	O
-	21.5408	1.3185	-	2.8060	-	-	2.5263				Trials	1000
1.0000	P45:R48	2.3378	1.0000	T45:V48	-	1.0000	X45:Z48				Mean	45.5987
1.0000	P34:R37	3.3131	1.0000	T34:V37	0.8840	1.0000	X34:Z37				Median	45.7040
-		4.2657	-		1.4119	-					Mode	—
49 AN-104 N2O	21.5408		49 AN-104 CH4	2.8060		49 AN-104 NH3	2.5263		49 AN-104 N2	27.4568	Standard E	4.3661
AN-104 R_N2O	0.3077		49 R_CH4	0.0579							Variance	19.0632
49 AN-104 N2(	6.0600	MEAN	49 AN-104 CH4	8.4700	MEAN	49 AN-104 N	0.6000	MEAN	49 AN-104	53.7300	Skewness	-0.06
49 AN-104 N2(	2.4500	STDDEV	49 AN-104 CH4	0.6511	STDDEV	49 AN-104 N	0.1337	STDDEV	49 AN-104	4.9184	Kurtosis	2.35
AN-104 R_N2O	0.1300	MEAN	49 R_CH4	0.2100							Coeff. of V	0.10
AN-104 R_N2O	0.0321	STDDEV	49 R_CH4	0.0139							Range Min	35.6334
											Range Max	56.1041
		CH4			NH3			N2			Row ==> 62	O
-	3.7665	1.2522	-	5.7860	-	-	6.7396				Trials	1000
1.0000	P58:R61	1.8158	1.0000	T58:V61	-	1.0000	X58:Z61				Mean	61.1509
1.0000	P43:R46	9.2563	1.0000	T43:V46	0.5967	1.0000	X43:Z46				Median	61.1759
-		10.9824	-		0.8550	-					Mode	—
62 AN-103 N2O	3.7665		62 AN-103 CH4	5.7860		62 AN-103 NH3	6.7396		62 AN-103 N2	22.5816	Standard E	4.3860
AN-103 R_N2O	0.0533		62 R_CH4	0.0865							Variance	19.2373

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

62 AN-103 N2C	6.0600	MEAN	62 AN-103 CH4		8.4700	MEAN	62 AN-103 N	0.6000	MEAN	62 AN-103	53.7300	Skewness	0.01
62 AN-103 N2C	0.4416	STDDEV	62 AN-103 CH4		2.5736	STDDEV	62 AN-103 N	0.0661	STDDEV	62 AN-103	5.1532	Kurtosis	2.40
AN-103 R_N2O	0.1300	MEAN	62 R_CH4		0.2100							Coeff. of V	0.07
AN-103 R_N2O	0.0071	STDDEV	62 R_CH4		0.0356							Range Min	50.5034
												Range Max	71.3726
		CH4				NH3			N2			Row ==>	75 O
-	37.8475	0.8314	-		1.4322	0.2313	-	0.5892				Trials	1000
1.0000	P71:R74	1.0576	1.0000	T71:V74		0.4944	1.0000	X71:Z74				Mean	23.4438
1.0000	P52:R55	1.7817	1.0000	T52:V55		0.5947	1.0000	X52:Z55				Median	23.4259
-		2.0542	-			1.0001	-					Mode	—
75 U-103 N2O	37.8475		75 U-103 CH4		1.4322		75 U-103 NH3	0.5892		75 U-103 N2	36.7136	Standard D	1.0217
5 U-103 R_N2O	0.6037		75 R_CH4		0.0576							Variance	1.0438
75 U-103 N2O	6.0600	MEAN	75 U-103 CH4		8.4700	MEAN	75 U-103 N	0.6000	MEAN	75 U-103 N	53.7300	Skewness	0.03
75 U-103 N2O	1.7223	STDDEV	75 U-103 CH4		0.2897	STDDEV	75 U-103 N	0.1560	STDDEV	75 U-103 N	2.0176	Kurtosis	2.32
5 U-103 R_N2O	0.1300	MEAN	75 R_CH4		0.2100							Coeff. of V	0.04
5 U-103 R_N2O	0.0152	STDDEV	75 R_CH4		0.0111							Range Min	21.1146
												Range Max	25.8652
		CH4				NH3			N2			Row ==>	88 O
-	9.7700	-	-		0.8721	-	-	0.2866				Trials	1000
1.0000	P84:R87	0.4110	1.0000	T84:V87		-	1.0000	X84:Z87				Mean	63.8677
1.0000	P62:R65	1.2598	1.0000	T62:V65		0.2982	1.0000	X62:Z65				Median	63.8747
-		1.8019	-			0.5615	-					Mode	—
88 S-106 N2O	9.7700		88 S-106 CH4		0.8721		88 S-106 NH3	0.2866		88 S-106 N2	25.2314	Standard D	3.6360
8 S-106 R_N2O	0.1312		88 R_CH4		0.0135							Variance	13.2203
88 S-106 N2O	6.0600	MEAN	88 S-106 CH4		8.4700	MEAN	88 S-106 N	0.6000	MEAN	88 S-106 N	53.7300	Skewness	0.03
88 S-106 N2O	1.1464	STDDEV	88 S-106 CH4		0.4001	STDDEV	88 S-106 N	0.0673	STDDEV	88 S-106 N	3.7891	Kurtosis	2.34
3 S-106 R_N2O	0.1300	MEAN	88 R_CH4		0.2100							Coeff. of V	0.06
3 S-106 R_N2O	0.0150	STDDEV	88 R_CH4		0.0062							Range Min	55.4556

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

														Range Max	72.6088
		CH4				NH3				N2				101 O	
-	16.6814	1.3998		-	4.6200	-		-	0.1711					Trials	1000
1.0000	P97:R100	1.8340		1.0000	T97:V100	-		1.0000	X97:Z100					Mean	49.4113
1.0000		7.0301		1.0000		0.1900		1.0000						Median	49.2762
-		8.1645		-		0.3232		-						Mode	—
01 BY-109 N2O	16.6814			101 BY-109 CH4	4.6200			101 BY-109 NH3	0.1711			101 BY-109 N2	29.0738	Standard D	3.7146
BY-109 R_N2O	0.2358			101 R_CH4	0.0854									Variance	13.7982
101 BY-109 N2	6.0600		MEAN	101 BY-109 CH4	8.4700		MEAN	101 BY-109	0.6000		MEAN	101 BY-10	53.7300	Skewness	-0.01
101 BY-109 N2	1.5678		STDDEV	101 BY-109 CH4	1.7919		STDDEV	101 BY-109	0.0338		STDDEV	101 BY-10	4.4366	Kurtosis	2.28
BY-109 R_N2O	0.1300		MEAN	101 R_CH4	0.2100									Coeff. of V	0.08
BY-109 R_N2O	0.0213		STDDEV	101 R_CH4	0.0313									Range Min	40.8163
														Range Max	58.0221
		CH4				NH3				N2				114 O	
-	4.1514	0.2028		-	0.8869	1.7367		-	4.1694					Trials	1000
1.0000	P110:R113	0.3521		1.0000	T110:V113	2.4065		1.0000	X110:Z113					Mean	50.89347
1.0000		1.3610		1.0000		5.4454		1.0000						Median	50.75708
-		1.6250		-		7.0069		-						Mode	—
14 SX-106 N2O	4.1514			114 SX-106 CH4	0.8869			114 SX-106 NH3	4.1694			114 SX-106 N2	39.9249	Standard D	2.992561
SX-106 R_N2O	0.0743			114 R_CH4	0.0171									Variance	8.955424
114 SX-106 N2	6.0600		MEAN	114 SX-106 CH4	8.4700		MEAN	114 SX-106	0.6000		MEAN	114 SX-10	53.7300	Skewness	0.089372
114 SX-106 N2	0.9292		STDDEV	114 SX-106 CH4	0.3585		STDDEV	114 SX-106	1.2553		STDDEV	114 SX-10	3.4462	Kurtosis	2.257485
SX-106 R_N2O	0.1300		MEAN	114 R_CH4	0.2100									Coeff. of V	0.0588
SX-106 R_N2O	0.0150		STDDEV	114 R_CH4	0.0069									Range Min	43.90172
														Range Max	57.8058
		CH4				NH3				N2				127 O	
-	7.6844	2.7768		-	3.7220	3.0191		-	6.6646					Trials	1000
1.0000	P123:R126	3.2923		1.0000	T123:V126	4.3011		1.0000	X123:Z126					Mean	62.1476
1.0000		3.9701		1.0000		8.3042		1.0000						Median	62.0682
-		4.7941		-		10.8920		-						Mode	—
27 AX-101 N2O	7.6844			127 AX-101 CH4	3.7220			127 AX-101 NH3	6.6646			127 AX-101 N2	19.7688	Standard D	3.8615

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

AX-101 R_N2O	0.1045		127 R_CH4	0.0565							Variance	14.9112
127 AX-101 N2	6.0600	MEAN	127 AX-101 CH4	8.4700	MEAN	127 AX-101	0.6000	MEAN	127 AX-101	53.7300	Skewness	0.06
127 AX-101 N2	0.3294	STDDEV	127 AX-101 CH4	0.4351	STDDEV	127 AX-101	1.7692	STDDEV	127 AX-101	4.2841	Kurtosis	2.25
AX-101 R_N2O	0.1300	MEAN	127 R_CH4	0.2100							Coeff. of V	0.06
AX-101 R_N2O	0.0080	STDDEV	127 R_CH4	0.0073							Range Min	53.4810
											Range Max	71.3259
		CH4			NH3			N2			Row ==>	140 O
-	32.0935	0.4201	-	0.6853	0.3326	-	0.9262				Trials	1000
1.0000	P136:R139	0.4987	1.0000	T136:V139	0.5978	1.0000	X136:Z139				Mean	33.9914
1.0000		0.8095	1.0000		1.1005	1.0000					Median	34.0062
-		1.0013	-		1.6406	-					Mode	—
140 S-102 N2O	32.0935		140 S-102 CH4	0.6853		140 S-102 NH3	0.9262		140 S-102 N2	32.2943	Standard D	2.1742
0 S-102 R_N2O	0.4806		140 R_CH4	0.0198							Variance	4.7272
140 S-102 N2C	6.0600	MEAN	140 S-102 CH4	8.4700	MEAN	140 S-102 N	0.6000	MEAN	140 S-102 I	53.7300	Skewness	-0.01
140 S-102 N2C	2.0580	STDDEV	140 S-102 CH4	0.1340	STDDEV	140 S-102 N	0.2880	STDDEV	140 S-102 I	3.0736	Kurtosis	2.31
) S-102 R_N2O	0.1300	MEAN	140 R_CH4	0.2100							Coeff. of V	0.06
) S-102 R_N2O	0.0220	STDDEV	140 R_CH4	0.0040							Range Min	29.1613
											Range Max	38.8988
		CH4			NH3			N2			Row ==>	153 O
-	10.4567	-	-	0.6959	0.3403	-	0.9292				Trials	1000
1.0000	P149:R152	-	1.0000	T149:V152	0.6014	1.0000	X149:Z152				Mean	66.7076
1.0000		0.9133	1.0000		1.0966	1.0000					Median	66.5125
-		1.1744	-		1.6358	-					Mode	—
153 S-111 N2O	10.4567		153 S-111 CH4	0.6959		153 S-111 NH3	0.9292		153 S-111 N2	20.9124	Standard D	5.8283
3 S-111 R_N2O	0.1338		153 R_CH4	0.0103							Variance	33.9686
153 S-111 N2C	6.0600	MEAN	153 S-111 CH4	8.4700	MEAN	153 S-111 N	0.6000	MEAN	153 S-111 I	53.7300	Skewness	0.09
153 S-111 N2C	1.1898	STDDEV	153 S-111 CH4	0.0647	STDDEV	153 S-111 N	0.2852	STDDEV	153 S-111 I	5.9632	Kurtosis	2.45

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

3 S-111 R_N2O	0.1300	MEAN	153 R_CH4	0.2100							Coeff. of V.	0.09
3 S-111 R_N2O	0.0167	STDDEV	153 R_CH4	0.0016							Range Min	53.2953
											Range Max	81.0610
		CH4			NH3			N2			Row ==>	166 O
-	25.5407	0.6665	-	1.3270	0.3331	-	1.0064				Trials	1000
1.0000	P162:R165	0.8050	1.0000	T162:V165	0.6007	1.0000	X162:Z165				Mean	25.3635
1.0000		1.8758	1.0000		1.1834	1.0000					Median	25.3495
-		2.1337	-		1.8493	-					Mode	—
166 U-109 N2O	25.5407		166 U-109 CH4	1.3270		166 U-109 NH3	1.0064		166 U-109 N2	46.6283	Standard D	1.9986
3 U-109 R_N2O	0.4877		166 R_CH4	0.0495							Variance	3.9945
166 U-109 N2C	6.0600	MEAN	166 U-109 CH4	8.4700	MEAN	166 U-109 N	0.6000	MEAN	166 U-109	53.7300	Skewness	0.01
166 U-109 N2C	2.4396	STDDEV	166 U-109 CH4	0.3576	STDDEV	166 U-109 N	0.3279	STDDEV	166 U-109	3.1883	Kurtosis	2.36
i U-109 R_N2O	0.1300	MEAN	166 R_CH4	0.2100							Coeff. of V.	0.08
i U-109 R_N2O	0.0306	STDDEV	166 R_CH4	0.0133							Range Min	20.8141
											Range Max	30.1725
		CH4			NH3			N2			Row ==>	179 O
-	20.3360	0.5877	-	2.3156	3.2059	-	8.9931				Trials	1000
1.0000	P175:R178	0.9847	1.0000	T175:V178	4.8567	1.0000	X175:Z178				Mean	34.1341
1.0000		3.2063	1.0000		11.6990	1.0000					Median	34.1906
-		4.4115	-		15.9497	-					Mode	—
79 SY-101 N2O	20.3360		179 SY-101 CH4	2.3156		179 SY-101 NH3	8.9931		179 SY-101 N2	34.1020	Standard D	5.1338
SY-101 R_N2O	0.3574		179 R_CH4	0.0633							Variance	26.3559
179 SY-101 N2	6.0600	MEAN	179 SY-101 CH4	8.4700	MEAN	179 SY-101	0.6000	MEAN	179 SY-101	53.7300	Skewness	0.04
179 SY-101 N2	3.2064	STDDEV	179 SY-101 CH4	0.9013	STDDEV	179 SY-101	2.9869	STDDEV	179 SY-101	6.7839	Kurtosis	2.25
SY-101 R_N2O	0.1300	MEAN	179 R_CH4	0.2100							Coeff. of V.	0.15
SY-101 R_N2O	0.0491	STDDEV	179 R_CH4	0.0257							Range Min	22.9031
											Range Max	45.6397
AW-101 solids	5.7387		AW-101 solids CH	8.5670		AW-101 NH	0.5141					
A-101 upper N2	5.5689		A-101 upper CH4	4.0991		A-101 NH3	2.0514					
AN-105 solids N	12.6131		AN-105 solids CH	1.3702		AN-105 NH3	1.2940					

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

AN-104 solids I	21.5408		AN-104 solids CH	2.8060		AN-104 NH3	2.5263
AN-103 solids I	3.7665		AN-103 solids CH	5.7850		AN-103 NH3	6.7396
U-103 solids N2	37.8475		U-103 solids CH4	1.4322		U-103 NH3	0.5892
S-106 solids N2	9.7700		S-106 solids CH4	0.8721		S-106 NH3	0.2866
BY-109 behigh	16.6814		BY-109 behigh as	4.6200		BY-109 NH3	0.1711
SX-106 solids I	4.1514		SX-106 solids CH	0.6869		SX-106 NH3	4.1694
AX-101-9D-8 N	7.6844		AX-101-9D-8 CH	3.7220		AX-101 NH3	6.6646
S-102 tank avg	32.0935		S-102 tank avg. C	0.6853		S-102 NH3	0.9262
S-114 solids N2	10.4567		S-114 solids CH4	0.6959		S-114 NH3	0.9292
U-109 tank avg	25.5407		U-109 tank avg. C	1.3270		U-109 NH3	1.0064
SY-101 ave N2	20.3360		SY-101 ave CH4	2.3158		SY-101 NH3	8.9931
	Min	-		Min	-		
	Max	10.9624		Max	15.9497		
Min	3.7665		Min	0.6853		Min	0.1711
Max	37.8475		Max	8.5670		Max	8.9931

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

N2)	CH4	NH3	N2		R_N2O	R_CH4
S	W	AA	AE	13	S	W
1000	1000	1000	1000		1000	1000
5.7606	8.5526	0.5706	53.5503		0.1256	0.2136
5.8013	8.5615	0.5753	53.5713		0.1256	0.2136
—	—	—	—		—	—
0.9980	0.8462	0.0999	2.7074		0.0205	0.0210
0.9960	0.7160	0.0100	7.3298		0.0004	0.0004
-0.01	-0.01	0.01	0.00		0.02	0.07
1.90	2.37	3.07	2.59		2.10	2.63
0.17	0.10	0.18	0.05		0.16	0.10
3.8339	6.5431	0.2715	45.4532		0.0779	0.1565
7.9000	10.5557	0.9587	62.0123		0.1739	0.2751
S	W	AA	AE	25	S	W
1000	1000	1000	1000		########	1000
5.5769	1.5018	2.4569	19.0006		0.071038	0.020601
5.5857	1.5047	2.4429	19.0320		0.071142	0.020606
—	—	—	—		—	—
0.4097	0.0552	0.2953	2.3255		0.005261	0.000975
0.1678	0.0030	0.0872	5.4081		2.77E-05	9.5E-07
-0.02	-0.08	0.03	-0.05		0.030571	-0.045602
2.27	2.84	3.28	3.08		2.509441	2.675621
0.07	0.04	0.12	0.12		0.074061	0.047322
4.6557	1.3021	1.2415	11.3516		0.057656	0.017668
6.5122	1.6906	3.3466	26.5940		0.084372	0.023642
S	W	AA	AE	37	S	W
1000	1000	1000	1000		1000	1000
12.6562	1.3838	0.5001	24.5713		0.16897	0.02226
12.6099	1.4046	0.4980	24.4745		0.168387	0.022398
—	—	—	—		—	—

Tank	Gas	Mean	Std Dev	Min	Max	Type
AW-101	N2	53.5503	2.7074	45.4532	62.0123	Normal
AW-101	NH3	0.5706	0.0999	0.2715	0.9587	Normal
AW-101	N2O Ratio	0.1256	0.0205	0.0779	0.1739	Normal
AW-101	CH4 Ratio	0.2136	0.0210	0.1565	0.2751	Normal
A-101	N2	19.0006	2.3255	11.3516	26.5940	Normal
A-101	NH3	2.4569	0.2953	1.2415	3.3466	Normal
A-101	N2O Ratio	0.0710	0.0053	0.0577	0.0844	Normal
A-101	CH4 Ratio	0.0206	0.0010	0.0177	0.0236	Normal
AN-105	N2	24.5713	3.6349	14.1664	34.3390	Normal
AN-105	NH3	0.5001	0.0649	0.3029	0.7618	Normal
AN-105	N2O Ratio	0.1690	0.0178	0.1246	0.2198	Normal
AN-105	CH4 Ratio	0.0223	0.0066	0.0108	0.0359	Normal

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

1.4296	0.3469	0.0649	3.6349		0.017601	0.005617							
2.0437	0.1203	0.0042	13.2122		0.000317	3.16E-05							
0.07	-0.11	0.12	0.05		0.062049	-0.052725							
2.15	2.00	3.04	2.70		2.425953	2.070183							
0.11	0.26	0.13	0.16		0.105352	0.262341							
9.6383	0.8188	0.3029	14.1664		0.124804	0.010841							
15.7712	2.0688	0.7618	34.3390		0.219849	0.035699							
S	W	AA	AE	50	S	W							
1000	1000	1000	1000		1000	1000	AN-104	N2	29.1727	4.9184	14.3337	41.4358	Normal
21.5176	2.8291	0.8820	29.1727		0.308064	0.058752	AN-104	NH3	0.8820	0.1337	0.3767	1.2932	Normal
21.4626	2.8696	0.8861	29.0970		0.307336	0.059095	AN-104	N2O Ratio	0.3081	0.0321	0.2231	0.4011	Normal
—	—	—	—		—	—	AN-104	CH4 Ratio	0.0588	0.0139	0.0268	0.0967	Normal
2.4500	0.6511	0.1337	4.9184		0.032057	0.013932							
6.0023	0.4240	0.0179	24.1907		0.001028	0.000194							
0.09	-0.08	-0.07	0.02		0.130719	0.017436							
2.33	2.17	2.96	2.63		2.709504	2.34522							
0.11	0.23	0.15	0.17		0.10406	0.237128							
16.0419	1.3793	0.3767	14.3337		0.223149	0.026568							
27.3782	4.2057	1.2932	41.4358		0.401107	0.0967							
S	W	AA	AE	63	S	W							
1000	1000	1000	1000		1000	1000	AN-103	N2	28.6602	5.1532	14.9119	42.8042	Normal
3.7613	5.8310	0.5966	28.6602		0.053411	0.066029	AN-103	NH3	0.5966	0.0661	0.4003	0.7619	Normal
3.7417	5.8219	0.5978	28.5760		0.053069	0.067424	AN-103	N2O Ratio	0.0534	0.0071	0.0374	0.0768	Normal
—	—	—	—		—	—	AN-103	CH4 Ratio	0.0860	0.0358	0.0215	0.1639	Normal
0.4416	2.5736	0.0661	5.1532		0.007098	0.035624							
0.1950	6.6235	0.0044	26.5559		5.04E-06	0.001269							

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

0.13	0.01	-0.08	-0.04		0.25907	-0.032474								
2.26	1.75	2.83	2.57		2.738004	1.83637								
0.12	0.44	0.11	0.18		0.132855	0.414089								
2.7635	1.3003	0.4003	14.9119		0.037432	0.021524								
4.8238	10.7868	0.7819	42.8042		0.076807	0.163913								
S	W	AA	AE	76	S	W								
1000	1000	1000	1000		1000	1000	U-103	N2	36.7114	2.0176	30.9455	42.5608	Normal	
37.8238	1.4250	0.5960	36.7114		0.6032	0.057236	U-103	NH3	0.5960	0.1560	0.2463	0.9627	Normal	
37.8124	1.4164	0.5887	36.7171		0.603535	0.057138	U-103	N2O Ratio	0.6032	0.0152	0.5609	0.6449	Normal	
—	—	—	—		—	—	U-103	CH4 Ratio	0.0572	0.0111	0.0340	0.0820	Normal	
1.7223	0.2897	0.1560	2.0176		0.015214	0.011062								
2.9664	0.0839	0.0243	4.0707		0.000231	0.000122								
0.01	0.03	0.15	-0.04		-0.002635	0.03366								
2.30	1.93	2.33	2.59		2.604428	2.009707								
0.05	0.20	0.26	0.05		0.025222	0.193275								
33.9731	0.8448	0.2463	30.9455		0.560694	0.03398								
41.8525	2.0322	0.9827	42.5608		0.644936	0.082005								
S	W	AA	AE	89	S	W								
1000	1000	1000	1000		1000	1000	S-106	N2	25.2167	3.7891	15.2492	34.9225	Normal	
9.7450	0.8718	0.2988	25.2167		0.130954	0.013483	S-106	NH3	0.2988	0.0673	0.0942	0.5200	Normal	
9.6765	0.8727	0.3008	25.3057		0.130202	0.013615	S-106	N2O Ratio	0.1310	0.0150	0.0982	0.1695	Normal	
—	—	—	—		—	—	S-106	CH4 Ratio	0.0135	0.0062	0.0002	0.0297	Normal	
1.1464	0.4001	0.0673	3.7891		0.01501	0.008204								
1.3143	0.1601	0.0045	14.3575		0.000225	3.85E-05								
0.11	0.07	-0.08	-0.01		0.140627	0.104516								
2.01	2.16	3.03	2.43		2.23079	2.241314								
0.12	0.46	0.23	0.15		0.114816	0.460099								
7.3841	0.0142	0.0942	15.2492		0.096175	0.000211								

“rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls”,Tab “4-Gas comp by tanks”

12.2462	1.7881	0.5200	34.9225		0.169499	0.029665							
S	W	AA	AE	102	S	W							
1000	1000	1000	1000		1000	1000	BY-109	N2	29.0445	4.4366	16.6779	42.3766	Normal
16.6879	4.6650	0.1912	29.0445		0.236212	0.065707	BY-109	NH3	0.1912	0.0338	0.0612	0.3206	Normal
16.6419	4.7290	0.1902	29.0978		0.236007	0.06591	BY-109	N2O Ratio	0.2362	0.0213	0.1781	0.3051	Normal
—	—	—	—		—	—	BY-109	CH4 Ratio	0.0657	0.0313	0.0278	0.1609	Normal
1.5678	1.7919	0.0338	4.4366		0.021337	0.031271							
2.4581	3.2109	0.0011	19.6835		0.000455	0.000978							
0.07	-0.01	0.06	-0.03		0.047369	-0.00373							
2.40	1.82	3.00	2.59		2.740707	1.925684							
0.09	0.38	0.18	0.15		0.090331	0.364864							
13.0703	1.4917	0.0612	16.6779		0.176076	0.027751							
20.3392	8.1345	0.3206	42.3766		0.30508	0.160899							
S	W	AA	AE	115	S	W							
1000	1000	1000	1000		1000	1000	SX-106	N2	20.2029	3.4462	10.1979	29.5507	Normal
23.81926	0.88216	4.202221	20.20287		0.315482	0.017059	SX-106	NH3	4.2022	1.2553	1.7899	6.8047	Normal
23.81457	0.860751	4.197705	20.24646		0.315041	0.016474	SX-106	N2O Ratio	0.3155	0.0150	0.2753	0.3600	Normal
—	—	—	—		—	—	SX-106	CH4 Ratio	0.0171	0.0069	0.0046	0.0340	Normal
0.929249	0.358488	1.2553	3.446216		0.015031	0.00695							
0.863503	0.128513	1.576779	11.87641		0.000226	4.83E-05							
0.119374	0.089557	0.025571	-0.130026		0.1494	0.140778							
3.26284	1.846724	1.978149	2.482025		2.607714	1.939413							
0.039012	0.406375	0.298723	0.17058		0.047643	0.407385							
20.45172	0.239585	1.789907	10.19791		0.275264	0.004601							
27.17027	1.594964	6.804738	29.55066		0.360009	0.033974							
S	W	AA	AE	128	S	W							
1000	1000	1000	1000		1000	1000	AX-101	N2	16.6825	4.2841	4.6480	27.3917	Normal
10.8483	3.7365	6.5851	16.6825		0.14172	0.056888	AX-101	NH3	6.5851	1.7692	3.0943	10.7840	Normal
10.8489	3.7218	6.6081	16.8103		0.141378	0.056377	AX-101	N2O Ratio	0.1417	0.0080	0.1219	0.1633	Normal
—	—	—	—		—	—	AX-101	CH4 Ratio	0.0569	0.0073	0.0402	0.0764	Normal
0.3294	0.4351	1.7692	4.2841		0.00604	0.00726							

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

0.1085	0.1893	3.1300	18.3533		6.46E-05	6.27E-05								
-0.02	0.10	0.08	-0.10		0.1553	0.152108								
2.87	2.12	2.11	2.48		2.413915	2.292104								
0.03	0.12	0.27	0.26		0.056732	0.127623								
9.9324	2.8278	3.0943	4.8480		0.121906	0.040168								
11.9319	4.7405	10.7840	27.3917		0.163299	0.076391								
S	W	AA	AE	141	S	W								
1000	1000	1000	1000		1000	1000	S-102	N2	32.2461	3.0736	23.9737	40.7194	Normal	
32.1436	0.8872	0.9317	32.2461		0.481049	0.019883	S-102	NH3	0.9317	0.2880	0.3470	1.6237	Normal	
32.1775	0.6856	0.9216	32.1659		0.480957	0.019694	S-102	N2O Ratio	0.4810	0.0220	0.4138	0.5485	Normal	
—	—	—	—		—	—	S-102	CH4 Ratio	0.0199	0.0040	0.0116	0.0307	Normal	
2.0580	0.1340	0.2880	3.0736		0.022026	0.004036								
4.2354	0.0180	0.0830	9.4468		0.000485	1.63E-05								
0.03	0.11	0.17	0.00		0.067397	0.219662								
2.33	2.04	2.15	2.60		2.74117	2.165423								
0.06	0.20	0.31	0.10		0.045788	0.202997								
27.4178	0.4271	0.3470	23.9737		0.413829	0.011642								
37.0568	0.9930	1.6237	40.7194		0.548543	0.030686								
S	W	AA	AE	154	S	W								
1000	1000	1000	1000		1000	1000	S-111	N2	20.9901	5.9532	4.5555	34.7510	Normal	
10.4610	0.9126	0.9287	20.9901		0.134526	0.0136	S-111	NH3	0.9287	0.2852	0.3545	1.8036	Normal	
10.4608	0.9136	0.9043	21.1214		0.134671	0.013492	S-111	N2O Ratio	0.1345	0.0167	0.0824	0.1900	Normal	
—	—	—	—		—	—	S-111	CH4 Ratio	0.0136	0.0016	0.0098	0.0192	Normal	
1.1898	0.0647	0.2852	5.9532		0.016671	0.001556								
1.4156	0.0042	0.0813	35.4405		0.000278	2.42E-06								
0.03	-0.13	0.19	-0.08		0.13788	0.35888								
2.31	3.01	2.17	2.40		2.727512	3.003592								

"rgs FinalSumTable Rev 1 Tab_6MC 030823 .xls",Tab "4-Gas comp by tanks"

0.11	0.07	0.31	0.28		0.123923	0.114375							
7.7837	0.7009	0.3545	4.5565		0.092432	0.009773							
13.1623	1.1045	1.6035	34.7510		0.190021	0.019236							
S	W	AA	AE	167	S	W							
1000	1000	1000	1000		1000	1000	U-109	N2	46.7771	3.1883	36.8539	56.6181	Normal
25.5498	1.3026	1.0071	46.7771		0.488936	0.048947	U-109	NH3	1.0071	0.3279	0.3542	1.8118	Normal
25.5228	1.2787	0.9995	46.8855		0.489142	0.048328	U-109	N2O Ratio	0.4889	0.0306	0.4021	0.5769	Normal
—	—	—	—		—	—	U-109	CH4 Ratio	0.0489	0.0133	0.0239	0.0874	Normal
2.4395	0.3575	0.3279	3.1883		0.03062	0.013326							
5.9511	0.1278	0.1075	10.1655		0.000938	0.000178							
0.04	0.18	0.15	-0.09		-0.014956	0.251231							
2.23	1.94	2.18	2.70		2.546964	2.172118							
0.10	0.27	0.33	0.07		0.062625	0.272249							
20.0417	0.6707	0.3542	36.8539		0.402124	0.023692							
31.3397	2.0859	1.8118	56.6181		0.576907	0.087352							
S	W	AA	AE	180	S	W							
1000	1000	1000	1000		1000	1000	SY-101	N2	33.8747	6.7839	13.3597	53.3132	Normal
20.4748	2.3443	9.1721	33.8747		0.360501	0.065052	SY-101	NH3	9.1721	2.9869	3.2737	15.7673	Normal
20.4076	2.3458	9.2867	33.8499		0.360514	0.063944	SY-101	N2O Ratio	0.3605	0.0491	0.2261	0.5013	Normal
—	—	—	—		—	—	SY-101	CH4 Ratio	0.0651	0.0257	0.0146	0.1498	Normal
3.2064	0.9013	2.9869	6.7839		0.049085	0.025704							
10.2810	0.8124	8.9215	46.0215		0.002409	0.000661							
0.11	0.03	0.00	0.00		0.072111	0.260286							
2.23	2.00	2.00	2.61		2.700979	2.463738							
0.16	0.38	0.33	0.20		0.136158	0.395124							
13.3765	0.6343	3.2737	13.3597		0.226125	0.014589							
26.0281	4.3541	15.7673	53.3132		0.501277	0.14984							

3. Setup forecasts in cells in rows 12, 13, 24, 25, 36, 37, 49, 50, 62, 63, 75, 76, 88, 89, 101, 102, 114, 115, 127, 128, 140, 141, 153, 154, 166, 167, 179, 180, and columns "O", "S", "W", "AA."
    a. Clear any existing forecasts.
4. Run Crystal Ball for 1,000 trials.
5. Prepare Crystal Ball report.
6. Copy summary statistics from Crystal Ball report to columns "AH" through "AO."
    a. Save assumption.
7. Final database distributions for the RGS tanks are given in rows "AQ" through "AW."

G2.4 CREATE DISTRIBUTIONS FOR NON-RGS TANKS

Create the Four Distributions Required to Specify the Retained Gas Distributions for Non-RGS Tanks

- Capture 1,000 data points from each RGS distribution, then reduce data down to 420 points for each gas including 30 points from each RGS tank.
- Determine the default N2 distribution for non-RGS tanks.
- Assume that the first 30 data points from the 1,000 are random and represent the overall distribution for the tank.

Tab "5 - 'CB05all Tab_5mc RGS Forecast Values 030823 .xls'" (Note this tab is in separate spreadsheet)
Note: This spreadsheet is set up for 1,000 trials with the same variables as given in 'CB05all Tab_5mc RGS Forecast Values 030823.xls'

1. Extract forecast data from Crystal Ball using the menu items "RUN" "EXTRACT DATA."
2. Open spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' or a copy.
3. Copy all extracted data to tab "All Tab_5mc RGS Forecast Values."
4. On the following tab copy range 'Q5:Q424' to 'R5:R424' and 'S5:S424' using "Paste Special" "values."
    a. Use tabs "H2", "N2O", "CH4", "NH3" and "N2."
5. On Tab "N2" regress all 420 combined data points for N2 to produce a combined distribution using Crystal Ball.
    a. Create a distribution using Crystal Ball to fit the data by:
        1.) Create assumption.
        2.) Select fit data.

3.) Enter range of data, S5:S424.

4.) Allow Crystal Ball to fit the data to the regression curves.

- Reduce the 420 data points for "H2", "N2O", "CH4", "NH3" and the minimum and maximum values from all 16,000 data points for each gas to produce continuous linear distribution made up of 55 data pairs.
- Use every eighth data point from the 420 combined points, following numerical sorting of the values, to define 53 of the data pairs.
- Use the minimum and maximum data points as the bounding values for the continuous linear distributions

Tab "6- Gas Forecast Data"

1. Copy from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' to this spreadsheet, tab "6- Gas Forecast Data."
   a. For H2 - from range 'S5:S424 in tab "H2" to 'b5:b424' using "Paste Special" "values."
   b. For N2O - from range 'S5:S424 in tab "N2O" to 'k5:k424' using "Paste Special" "values."
   c. For CH4 - from range 'S5:S424 in tab "CH4" to 't5:t424' using "Paste Special" "values."
   d. For NH3 - from range 'S5:S424 in tab "NH3" to 'ac5:ac424' using "Paste Special" "values."
2. Sort the raw data as given below.
   a. For H2 - sort range a5:c424 with sort keys: 1 -- column C descending; 2 – column A ascending; 3 -- NONE.
   b. For N2O - sort range J5:L424 with sort keys: 1 -- column J descending; 2 -- column L ascending; 3 -- NONE.
   c. For CH4 - sort range S5:U424 with sort keys: 1 -- column U descending; 2 -- column S ascending; 3 -- NONE.
   d. For NH3 - sort range AB5:AD424 with sort keys: 1 -- column AD descending; 2 -- column AB ascending; 3 -- NONE.

3. Sort columns based on mask in columns to the right of the original data
   a. For H2 -
      1.) Copy range B5:B57 to range D7:D59.
      2.) Copy H2 minimum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O39' in tab H2 to this spreadsheet in tab "6- Gas Forecast Data" cell 'D6.'

3.) Copy H2 maximum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O40' in tab H2 to this spreadsheet in tab "6- Gas Forecast Data" cell 'D60.'

b. For N2O -

1.) Copy range K5:K57 to range M7:M59.

2.) Copy N2O minimum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O39' in tab N2O to this spreadsheet in tab "6- Gas Forecast Data" cell 'M6.'

3.) Copy N2O maximum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O40' in tab N2O to this spreadsheet in tab "6- Gas Forecast Data" cell 'M60.'

c. For CH4 -

1.) Copy range T5:T57 to range V7:V59.

2.) Copy CH4 minimum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O39' in tab CH4 to this spreadsheet in tab "6- Gas Forecast Data" cell 'V6.'

3.) Copy CH4 maximum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O40' in tab CH4 to this spreadsheet in tab "6- Gas Forecast Data" cell 'V60.'

a. For NH3 -

1.) Copy range AC5:AC57 to range AE7:AE59.

2.) Copy NH3 minimum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O39' in tab NH3 to this spreadsheet in tab "6- Gas Forecast Data" cell 'AE6.'

3.) Copy NH3 maximum from the spreadsheet 'CB05all Tab_5mc RGS Forecast Values 030823 .xls' cell 'O40' in tab NH3 to this spreadsheet in tab "6- Gas Forecast Data" cell 'AE60.'

4. Sort the raw data as given below

a. For H2 - sort range a5:c424 with sort keys: 1 -- column A ascending; 2 -- NONE; 3 -- NONE.

b. For N2O - sort range J5:L424 with sort keys: 1 -- column L ascending; 2 -- NONE; 3 -- NONE.

c. For CH4 - sort range S5:U424 with sort keys: 1 -- column S ascending; 2 -- NONE; 3 -- NONE.

d. For NH3 - sort range AB5:AD424 with sort keys: 1 -- column AB ascending; 2 -- NONE; 3 -- NONE.

Calculate the "CH4 Ratio" and "N2O Ratio" distributions

5. Calculate distributions for "CH4 Ratio" and "N2O Ratio."

a. Create Assumption Distributions for H2, N2O, CH4, and NH3 in cells H6, Q6, Z6, and AI6.
   1.) Use the Continuous Linear function.
      a). Select Create Assumption.
      b.) Select Custom Distribution.
      c.) Select Data.
      d.) Enter range of data I.e., d6:e60 for H2 and make sure the "cumulative data" selection is selected.
      e). Select "OK" to create the distribution.

b. Create forecasts for "N2", "CH4 Ratio" and "N2O Ratio" values.
   1.) The formulas behind the forecasts are:
      a.) For N2: 100 - [H2] - {N2O] - [CH4] - [NH3].
      b.) For "CH4 Ratio": [CH4] / ([CH4] + [H2]).
      c.) For "N2O Ratio": [N2O] / ([N2O] + [CH4] + [H2]).
   2.) Extract data for "CH4 Ratio" and "N2O Ratio" and copy to TAB "7-OverallDistributions."

TAB "7-OverallDistributions"

1. Use Crystal Ball to fit 1,000 trails of data into distribution for "CH4 Ratio" and "N2O Ratio."
   a. Create a distribution using Crystal Ball to fit the data by:
      1.) Create Assumption.
      2.) Select fit Data.
      3.) Enter range of data.
         a.) For "CH4 Ratio" use the range B8:B1007.
         b.) For "N2O Ratio" use the range C8:C1007.
      4.) Allow Crystal Ball to fit the data to the regression curves.

G2.5 REFORMAT RESULTS TO FIT DATABASE

Tab "8-RPP-10006 DB values"

1. For RGS Tanks copy data values from tab "4-Gas comp by tanks" range AQ7:AW178 to tab "8-RPP-10006 DB values" cell A4.
2. Remove blank lines and sort by tank name.
3. When positioned as given in tab "8-RPP-10006 DB values" the numbers will automatically be rearranged to fit the database format by the embedded formulas.

4. The same procedure is used for the values for the default gas composition specifications.

G3.0 RESULTS

Table G.3.1 presents the distributions obtained by the methodology explained in Section G2.0. Included in the results are the gas concentration distributions for all 16 RGS tanks as well as the gas concentration distributions for non-RGS tanks, which are labeled "DEFAULT". Following Table G.3.1 are three figures illustrating the distributions overlaying the frequency bins for the DEFAULT distributions, demonstrating the closeness of fit achieved Crystal Ball by its regression algorithm.

Table G.3.1. Retained Gas Concentration Distribution Results. (2 sheets)

Tank	Gas	Mean	Std Dev	Min	Max	Distribution Type
A-101	CH4 Ratio	0.0206	0.0010	0.0177	0.0236	Normal
A-101	N2	19.0006	2.3255	11.3516	26.5940	Normal
A-101	N2O Ratio	0.0710	0.0053	0.0577	0.0844	Normal
A-101	NH3	2.4569	0.2953	1.2415	3.3466	Normal
AN-103	CH4 Ratio	0.0860	0.0356	0.0215	0.1639	Normal
AN-103	N2	28.6602	5.1532	14.9119	42.8042	Normal
AN-103	N2O Ratio	0.0534	0.0071	0.0374	0.0768	Normal
AN-103	NH3	0.5966	0.0661	0.4003	0.7819	Normal
AN-104	CH4 Ratio	0.0588	0.0139	0.0266	0.0987	Normal
AN-104	N2	29.1727	4.9184	14.3337	41.4358	Normal
AN-104	N2O Ratio	0.3081	0.0321	0.2231	0.4011	Normal
AN-104	NH3	0.8820	0.1337	0.3767	1.2932	Normal
AN-105	CH4 Ratio	0.0223	0.0056	0.0108	0.0359	Normal
AN-105	N2	24.5713	3.6349	14.1664	34.3390	Normal
AN-105	N2O Ratio	0.1690	0.0178	0.1246	0.2198	Normal
AN-105	NH3	0.5001	0.0649	0.3029	0.7618	Normal
AW-101	CH4 Ratio	0.2136	0.0210	0.1565	0.2751	Normal
AW-101	N2	53.5503	2.7074	45.4532	62.0123	Normal
AW-101	N2O Ratio	0.1256	0.0205	0.0779	0.1739	Normal
AW-101	NH3	0.5706	0.0999	0.2715	0.9587	Normal
AX-101	CH4 Ratio	0.0568883	0.0072603	0.040168	0.0763907	Normal
AX-101	N2	16.682515	4.2840712	4.6480254	27.391705	Normal
AX-101	N2O Ratio	0.1417203	0.0080401	0.1219057	0.1632994	Normal
AX-101	NH3	6.5851237	1.769175	3.094251	10.784005	Normal

Table G.3.1. Retained Gas Concentration Distribution Results. (2 sheets)

Tank	Gas	Mean	Std Dev	Min	Max	Distribution Type
BY-109	CH4 Ratio	0.0857066	0.0312712	0.0277509	0.1608994	Normal
BY-109	N2	29.044525	4.4366125	16.677941	42.376593	Normal
BY-109	N2O Ratio	0.2362124	0.0213373	0.1780785	0.3050799	Normal
BY-109	NH3	0.1912388	0.0337871	0.081167	0.3206144	Normal
S-102	CH4 Ratio	0.0198833	0.0040362	0.0116416	0.0306858	Normal
S-102	N2	32.246089	3.0735677	23.973682	40.719438	Normal
S-102	N2O Ratio	0.4810489	0.0220261	0.4138286	0.5485435	Normal
S-102	NH3	0.9317253	0.2880169	0.3470069	1.6237296	Normal
S-106	CH4 Ratio	0.0134833	0.0062037	0.000211	0.0296648	Normal
S-106	N2	25.216722	3.7891284	15.249227	34.922471	Normal
S-106	N2O Ratio	0.1309545	0.0150095	0.0981745	0.1694995	Normal
S-106	NH3	0.2988262	0.0672631	0.0941543	0.5200336	Normal
S-111	CH4 Ratio	0.0136002	0.0015555	0.0097731	0.0192358	Normal
S-111	N2	20.990104	5.9531917	4.5555037	34.751033	Normal
S-111	N2O Ratio	0.1345261	0.0166708	0.0924325	0.1900213	Normal
S-111	NH3	0.9286594	0.2851553	0.354503	1.6034667	Normal
SX-106	CH4 Ratio	0.0170592	0.0069497	0.0046007	0.0339737	Normal
SX-106	N2	20.202874	3.4462161	10.197908	29.550656	Normal
SX-106	N2O Ratio	0.3154821	0.0150306	0.2752638	0.3600094	Normal
SX-106	NH3	4.2022214	1.2553005	1.7899067	6.8047356	Normal
SY-101	CH4 Ratio	0.0650518	0.0257035	0.0145888	0.1498403	Normal
SY-101	N2	33.874694	6.7839154	13.359652	53.313162	Normal
SY-101	N2O Ratio	0.360501	0.0490851	0.226125	0.5012775	Normal
SY-101	NH3	9.1721	2.9868881	3.2737398	15.767285	Normal
U-103	CH4 Ratio	0.0572362	0.0110623	0.0339797	0.0820054	Normal
U-103	N2	36.711397	2.0175933	30.945456	42.560795	Normal
U-103	N2O Ratio	0.6032003	0.015214	0.5608941	0.644936	Normal
U-103	NH3	0.5959713	0.1560355	0.2463287	0.9627055	Normal
U-109	CH4 Ratio	0.0489471	0.0133258	0.0238921	0.0873525	Normal
U-109	N2	46.777093	3.1883437	36.853937	56.618098	Normal
U-109	N2O Ratio	0.4889364	0.0306199	0.4021244	0.5769073	Normal
U-109	NH3	1.0070756	0.3279163	0.3542088	1.8118107	Normal
DEFAULT	CH4 Ratio	0.0529	0.0563	0.0010	0.3178	LogNorm
DEFAULT	N2	29.84	12.01	4.5000	80.0000	LogNorm
DEFAULT	N2O Ratio	0.2533	0.1758	0.0010	0.6189	LogNorm

Figure G.3.1. Distribution fit of CH_4 Ratio

R_CH4	0.03526
Mean	5.2890E-02
Std Dev	5.6280E-02
Log Mean	-3.3182E+00
Log Std De	8.7019E-01
Min	1.0000E-03
Max	0.3178

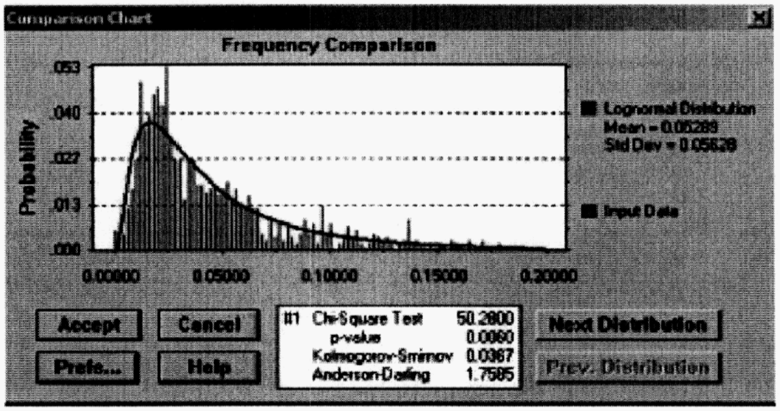


Figure G.3.2. Distribution fit of N_2O Ratio

R_N2O	2.3960E-01
Mean	2.53E-01
Std Dev	1.76E-01
Log Mean	-1.57E+00
Log Std De	6.27E-01
Min	1.0000E-03
Max	0.6189

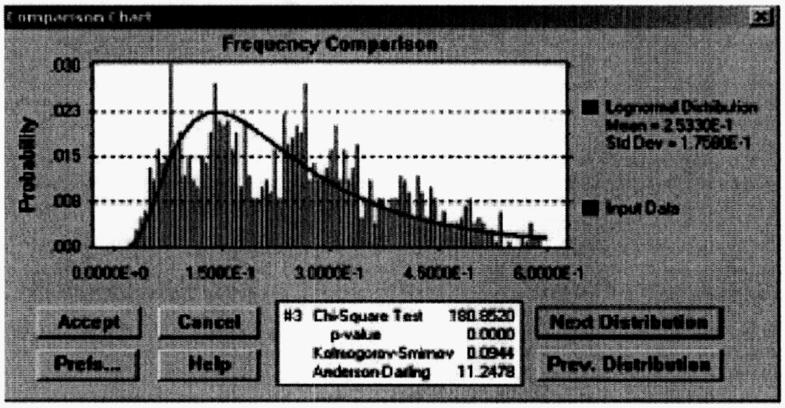
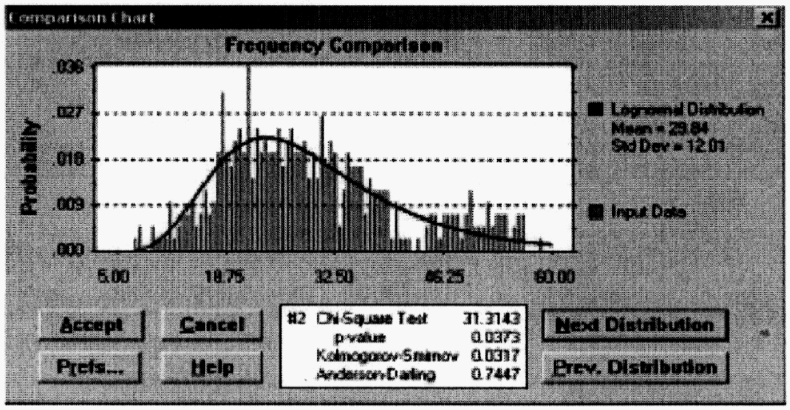


Figure G.3.3. Distribution fit of N_2 Concentration

N2 Distribu	50	d8:s427
LogNormal		
Mean	29.84	
StdDev	12.01	
Min	4.5	
Max	80	



G4.0 REFERENCES

PNNL-13317, 2000, "*Ammonia Results Review for Retained Gas Sampling*", Pacific Northwest National Laboratory, Richland, Washington.

APPENDIX H

INPUT DATA

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CONTENTS

LIST OF TERMS

DST	double-shell tank
LIQ	liquid waste form
MIX-LIQ	mixed waste form with ≥ 1 m liquid over solids
MIX-NL	mixed waste form with < 1 m liquid over solids
n/a	not applicable
OSD	operating specifications documents
PCSACS ILL	Personal Computer Surveillance Analysis Computer System Interstitial Liquid Level
SC/SS	saltcake/salt slurry
SC/SS-LIQ	saltcake/salt slurry waste form with ≥ 1 m liquid over solids
SC/SS-NL	saltcake/salt slurry waste form with < 1 m liquid over solids
SL	sludge
SL-LIQ	sludge waste form with ≥ 1 m liquid over solids
SL-NL	sludge waste form with < 1 m liquid over solids
SST	single shell tank
vol%	volume percent

Peer Review Checklist (Calculation Review Checklist)

Calculation Reviewed: RPP-10006, Rev 5, Appendix H INPUT DATA
Scope of Review: Appendix H text and tables
(e.g., document section or portion of calculation)

Engineer/Analyst: V. S. Anda [signature] Date: 7/25/06

Organizational Manager: M. A. Knight [signature] Date: 7/25/06

This document consists of 36 pages and the following attachments (if applicable):
n/a

Yes	No	NA*		
[X]	[]	[]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[X]	[]	[]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[X]	[]	[]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[X]	[]	[]	4.	Input data were checked for consistency with original source information.
[]	[]	[X]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[]	[]	[X]	6.	Mathematical derivations were checked, including dimensional consistency of results.
[]	[]	[X]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[X]	[]	[]	8.	Software verification and validation are addressed adequately.
[X]	[]	[]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[X]	[]	[]	10.	Conclusions are consistent with analytical results and applicable limits.
[X]	[]	[]	11.	Results and conclusions address all points in the purpose.
[X]	[]	[]	12.	Referenced documents are retrievable or otherwise available.
[X]	[]	[]	13.	The version or revision of each reference is cited.
[]	[]	[X]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[]	[]	[X]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
[X]	[]	[]	16.	All checker comments have been dispositioned and the design media matches the calculations.

K. D. Fowler [signature] 7/25/06
Checker (printed name and signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.
This appendix is not a calculation and does not directly contain mathematical equations or input data with associated uncertainties. It presents a summary of the input data that is used in the calculations for tank flammable gas waste groups. The spreadsheet used to derive and compile the data is documented in the cited reference RPP-29167.
This appendix does not establish or alter any existing requirement or necessitate revisions to other documents.

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APPENDIX H

INPUT DATA

H1.0 PURPOSE

This appendix presents the input data used to perform the flammable gas waste group assignment calculations. The calculation methodology is discussed in Section 3.0 of the main text with the waste group assignment calculation results presented in Section 5.0.

H2.0 INPUT DATA

The input data is presented in spreadsheet format on pages H-2 through H-33. Input data sources are included in the "Reference" row. The information in the input data table is from the "MC_Data" worksheet in the data rebuild spreadsheet: RPP-10006 Rev 5 Data Rebuild 060306.xls. The data rebuild spreadsheet is documented to have been verified by SVF-1118, *Spreadsheet Verification & Release Form for Spreadsheet RPP-10006 Rev 5 Data Rebuild 060306.xls*. The worksheets used and assumptions applied to generate the "MC_Data" sheet are described in RPP-29167, *Spreadsheet Description Document for RPP-10006 Rev 5 Data Rebuild 060306.xls*. Spreadsheet inputs used to generate RPP-10006 Rev 5 Data Rebuild 060306.xls are depicted in the Figure 3-1 hierarchy in the main text.

1	2	3	4	5	6	7	8	9	10	11	12	13
Tank #	Tank type	Total waste depth (m)	Total waste depth uncertainty (m)	Total non-convective waste depth (m)	Total non-convective waste depth uncertainty (m)	Total non-convective waste depth lower bound (m)	Wetted non-convective waste depth (m)	Wetted non-convective waste depth uncertainty (m)	Wetted non-convective waste depth lower bound (m)	Mean Crust depth (m)	Convective Waste Density Mean (kg/m3)	Convective Waste Density Std Dev (kg/m3)
References:	n/a	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	RPP-7625, Rev 6	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	RPP-7625, Rev 6, or RPP-10006, Rev 5, Appendix C	RPP-10006, Rev 5, Appendix C	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E, or PCSACS ILL	RPP-7625, Rev 6, or RPP-10006, Rev 5, Appendix C	RPP-10006, Rev 5, Appendix C	RPP-6655, Rev 0	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B
A-101	SST	2.95	0.292	2.95	0.292	0.010	2.95	0.292	0.010	0.00	1490	88
A-102	SST	0.37	0.006	0.34	0.292	0.010	0.34	0.292	0.010	0.00	1570	93
A-103	SST	3.50	0.006	3.46	0.292	0.010	3.46	0.292	0.010	0.00	1510	89
A-104	SST	0.26	0.292	0.26	0.292	0.010	0.26	0.292	0.000	0.00	1640	97
A-105	SST	0.34	0.292	0.34	0.292	0.000	0.34	0.292	0.000	0.00	1100	65
A-106	SST	0.73	0.292	0.73	0.292	0.010	0.49	0.024	0.010	0.00	1100	65
AN-101	DST	8.84	0.006	0.47	0.223	0.010	0.47	0.223	0.010	0.00	1410	115
AN-102	DST	9.89	0.006	1.58	0.348	0.010	1.58	0.348	0.010	0.00	1410	115
AN-103	DST	8.85	0.080	3.78	0.290	0.010	3.78	0.290	0.010	0.89	1480	121
AN-104	DST	9.72	0.035	4.14	0.310	0.010	4.14	0.310	0.010	0.41	1400	114
AN-105	DST	10.40	0.050	4.50	0.154	0.010	4.50	0.154	0.010	0.45	1420	116
AN-106	DST	8.61	0.006	0.88	0.130	0.010	0.88	0.130	0.010	0.00	1110	91
AN-107	DST	10.17	0.006	2.28	0.105	0.010	2.28	0.105	0.010	0.00	1430	117
AP-101	DST	10.29	0.006	0.00	na	0.000	0.00	na	0.000	0.00	1300	106
AP-102	DST	10.10	0.006	0.39	0.223	0.010	0.39	0.223	0.010	0.00	1390	113
AP-103	DST	8.26	0.006	0.38	0.018	0.010	0.38	0.018	0.010	0.00	1350	110
AP-104	DST	10.16	0.006	0.35	0.223	0.010	0.35	0.223	0.010	0.00	1280	104
AP-105	DST	10.52	0.006	1.21	0.076	0.010	1.21	0.076	0.010	0.00	1270	104
AP-106	DST	10.49	0.006	0.00	na	0.000	0.00	na	0.000	0.00	1210	99
AP-107	DST	1.94	0.006	0.32	0.223	0.010	0.32	0.223	0.010	0.00	1280	104
AP-108	DST	10.56	0.006	1.37	0.487	0.010	1.37	0.487	0.010	0.00	1430	117
AW-101	DST	10.41	0.100	2.84	0.287	0.010	2.84	0.287	0.010	0.80	1470	120
AW-102	DST	5.12	0.006	0.23	0.223	0.010	0.23	0.223	0.010	0.00	1260	103
AW-103	DST	10.16	0.006	3.20	0.223	0.010	3.20	0.223	0.010	0.00	1240	101
AW-104	DST	9.92	0.006	2.06	0.223	0.010	2.06	0.223	0.010	0.00	1350	110
AW-105	DST	3.88	0.006	2.44	0.223	0.010	2.44	0.223	0.010	0.00	1060	86
AW-106	DST	8.31	0.006	2.77	0.342	0.010	2.77	0.342	0.010	0.00	1300	106
AX-101	SST	3.30	0.292	3.30	0.292	0.010	1.71	0.024	0.000	0.00	1100	65
AX-102	SST	0.28	0.292	0.28	0.292	0.010	0.28	0.292	0.000	0.00	1100	65
AX-103	SST	0.98	0.292	0.98	0.292	0.010	0.84	0.024	0.010	0.00	1100	65
AX-104	SST	0.07	0.292	0.07	0.292	0.010	0.07	0.292	0.000	0.00	1100	65
AY-101	DST	1.68	0.006	1.07	0.067	0.010	1.07	0.067	0.010	0.00	1190	97
AY-102	DST	8.39	0.006	1.63	0.090	0.010	1.63	0.090	0.010	0.00	1,171	96
AZ-101	DST	8.32	0.006	0.65	0.107	0.010	0.65	0.107	0.010	0.00	1240	101
AZ-102	DST	9.06	0.006	1.13	0.223	0.010	1.13	0.223	0.010	0.00	1110	91
B-101	SST	1.19	0.292	1.19	0.292	0.010	1.19	0.292	0.010	0.00	1100	65
B-102	SST	0.48	0.006	0.45	0.292	0.010	0.45	0.292	0.010	0.00	1260	74
B-103	SST	0.70	0.292	0.70	0.292	0.010	0.70	0.292	0.000	0.00	1100	65
B-104	SST	3.65	0.292	3.65	0.292	0.010	3.60	0.024	0.010	0.00	1100	65
B-105	SST	2.87	0.292	2.87	0.292	0.010	1.19	0.024	0.010	0.00	1100	65
B-106	SST	1.32	0.006	1.31	0.292	0.010	1.31	0.292	0.010	0.00	1260	74
B-107	SST	1.68	0.292	1.68	0.292	0.010	1.65	0.024	0.010	0.00	1100	65

1	14	15	16	17	18	19	20	21	22	23	24
Tank #	Convective Waste Density Min (kg/m3)	Convective Waste Density Max (kg/m3)	Convective Waste Density Dist (kg/m3)	Non-Convective Waste Density Mean (kg/m3)	Non-Convective Waste Density Std Dev (kg/m3)	Non-Convective Waste Density Min (kg/m3)	Non-Convective Waste Density Max (kg/m3)	Non-Convective Waste Density Dist (kg/m3)	Non-Convective Waste Average Temperature (K)	Tank Vapor Space Average Temperature (K)	Tank type group
References:	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-10006, Rev 5, Appendix B	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	n/a
A-101	1318	1662	normal	1,700	128	1,449	1,952	normal	321	307	a
A-102	1388	1752	normal	1,669	126	1,422	1,916	normal	307	306	a
A-103	1335	1685	normal	1,750	132	1,491	2,009	normal	312	302	a
A-104	1450	1830	normal	1,750	132	1,491	2,009	normal	347	307	a
A-105	1000	1227	normal	1,540	116	1,312	1,768	normal	347	307	a
A-106	1000	1227	normal	1,700	128	1,448	1,952	normal	327	312	a
AN-101	1184	1636	normal	1,549	101	1,352	1,747	normal	300	298	an
AN-102	1184	1636	normal	1,530	99	1,335	1,725	normal	305	304	an
AN-103	1243	1717	normal	1,720	112	1,501	1,939	normal	311	305	an
AN-104	1176	1624	normal	1,590	103	1,387	1,793	normal	312	305	an
AN-105	1193	1647	normal	1,570	102	1,370	1,770	normal	308	303	an
AN-106	1000	1288	normal	1,547	101	1,350	1,745	normal	299	295	an
AN-107	1201	1659	normal	1,480	96	1,291	1,669	normal	307	304	an
AP-101	1092	1508	normal	1,750	114	1,527	1,973	normal	294	295	ap
AP-102	1168	1612	normal	1,750	114	1,527	1,973	normal	297	293	ap
AP-103	1134	1566	normal	1,610	105	1,405	1,815	normal	294	294	ap
AP-104	1075	1485	normal	1,610	105	1,405	1,815	normal	298	295	ap
AP-105	1067	1473	normal	1,610	105	1,405	1,815	normal	293	291	ap
AP-106	1016	1404	normal	1,750	114	1,527	1,973	normal	297	293	ap
AP-107	1075	1485	normal	1,610	105	1,405	1,815	normal	293	292	ap
AP-108	1201	1659	normal	1,610	105	1,405	1,815	normal	299	299	ap
AW-101	1235	1705	normal	1,590	103	1,387	1,793	normal	305	294	aw
AW-102	1058	1462	normal	1,320	86	1,152	1,488	normal	301	295	aw
AW-103	1042	1438	normal	1,491	97	1,301	1,681	normal	294	294	aw
AW-104	1134	1566	normal	1,485	96	1,295	1,674	normal	302	298	aw
AW-105	1000	1230	normal	1,364	89	1,190	1,538	normal	292	293	aw
AW-106	1092	1508	normal	1,610	105	1,405	1,815	normal	306	298	aw
AX-101	1000	1227	normal	1,702	128	1,450	1,954	normal	308	302	ax
AX-102	1000	1227	normal	1,578	119	1,344	1,811	normal	297	298	ax
AX-103	1000	1227	normal	1,580	119	1,346	1,814	normal	311	305	ax
AX-104	1000	1227	normal	1,800	136	1,534	2,066	normal	305	305	ax
AY-101	1000	1380	normal	1,683	109	1,469	1,898	normal	315	307	ay
AY-102	1000	1358	normal	1,545	100	1,348	1,742	normal	337	313	ay
AZ-101	1042	1438	normal	1,610	105	1,405	1,815	normal	352	346	az
AZ-102	1000	1288	normal	1,410	92	1,230	1,590	normal	330	322	az
B-101	1000	1227	normal	1,489	112	1,269	1,709	normal	313	307	b
B-102	1114	1406	normal	1,612	122	1,373	1,850	normal	291	294	b
B-103	1000	1227	normal	1,613	122	1,374	1,851	normal	290	293	b
B-104	1000	1227	normal	1,385	105	1,180	1,590	normal	294	295	b
B-105	1000	1227	normal	1,653	125	1,408	1,898	normal	293	292	b
B-106	1114	1406	normal	1,381	104	1,177	1,586	normal	296	293	b
B-107	1000	1227	normal	1,626	123	1,385	1,867	normal	289	294	b

1	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Tank #	**Total tank volume (m3)**	**OSD Maximum *Operating Limit (m)***	**Dish type**	**Dish height *(m)***	**Dish volume *(kL)***	**Dish Radius *(m)***	**Knuckle height *(m)***	**Knuckle volume *(M3)***	**Knuckle Radius *(m)***	**Body height *(m)***	**Body volume *(M3)***	**Body Operating Capacity (m3/m)**	**Body Radius *(m)***	**Dome Arc height *(m)***
References:	RPP-13019, Rev 0	OSD-T-151-00007, Rev J-0, or OSD-T-151-00013, Rev F-2	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0
A-101	4,988	9.27	flat	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	9.855	4,053.92	411.35	11.443	0.0000
A-102	4,988	9.27	flat	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	9.855	4,053.92	411.35	11.443	0.0000
A-103	4,988	9.27	flat	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	9.855	4,053.92	411.35	11.443	0.0000
A-104	4,988	9.27	flat	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	9.855	4,053.92	411.35	11.443	0.0000
A-105	4,988	9.27	flat	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	9.855	4,053.92	411.35	11.443	0.0000
A-106	4,988	9.27	flat	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	9.855	4,053.92	411.35	11.443	0.0000
AN-101	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AN-102	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AN-103	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AN-104	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AN-105	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AN-106	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AN-107	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AP-101	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-102	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-103	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-104	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-105	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-106	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-107	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AP-108	5,324	11.68	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.422	0.9668
AW-101	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AW-102	5,324	10.39	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AW-103	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AW-104	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AW-105	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AW-106	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AX-101	5,046	9.27	flat	0.0008	0.0000	0.0000	0.1524	62.2477	0.1524	9.754	4,005.45	410.66	11.433	0.0000
AX-102	5,046	9.27	flat	0.0008	0.0000	0.0000	0.1524	62.2477	0.1524	9.754	4,005.45	410.66	11.433	0.0000
AX-103	5,046	9.27	flat	0.0008	0.0000	0.0000	0.1524	62.2477	0.1524	9.754	4,005.45	410.66	11.433	0.0000
AX-104	5,046	9.27	flat	0.0008	0.0000	0.0000	0.1524	62.2477	0.1524	9.754	4,005.45	410.66	11.433	0.0000
AY-101	5,325	9.42	flat	0.0127	4.1559	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.430	0.9668
AY-102	5,325	9.42	flat	0.0127	4.1559	0.0000	0.3048	123.4357	0.3048	10.422	4,263.35	409.07	11.430	0.9668
AZ-101	5,324	9.42	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
AZ-102	5,324	9.42	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
B-101	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-102	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-103	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-104	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-105	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-106	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-107	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000

1	39	40	41	42	43	44	45	46
Tank #	Dome Arc volume (M3)	Dome Arc Radius (m)	Tank capacity (kL/m)	Void Fraction or Maximum Wetted Solids Void Fraction Mean (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Uncertainty (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Minimum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Maximum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Dist Type (Dimension-less)
References:	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-13019, Rev 0	RPP-10006, Rev 5, Appendix D	RPP-10006, Rev 5, Appendix D	RPP-10006, Rev 5, Appendix D	RPP-10006, Rev 5, Appendix D	RPP-10006, Rev 5, Appendix D
A-101	0.000	0.0000	411.35	8.838	7.1328	0.01	40	normal
A-102	0.000	0.0000	411.35	8.838	7.1328	0.01	40	normal
A-103	0.000	0.0000	411.35	0.400	0.2	0.01	40	normal
A-104	0.000	0.0000	411.35	2.437	2.4869	0.01	26.5	Lognorm
A-105	0.000	0.0000	411.35	2.437	2.4869	0.01	26.5	Lognorm
A-106	0.000	0.0000	411.35	8.838	7.1328	0.01	40	normal
AN-101	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
AN-102	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
AN-103	379.417	1.2192	409.04	10.700	5.35	0.01	15.11	normal
AN-104	379.417	1.2192	409.04	6.200	3.1	0.01	15.11	normal
AN-105	379.417	1.2192	409.04	4.200	2.1	0.01	15.11	normal
AN-106	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
AN-107	379.417	1.2192	409.04	1.100	0.5500	0.0100	15.1100	normal
AP-101	379.417	1.2192	409.07	0.015	0.001	0.01	0.02	normal
AP-102	379.417	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AP-103	379.417	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AP-104	379.417	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AP-105	379.417	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AP-106	379.417	1.2192	409.07	0.015	0.001	0.01	0.02	normal
AP-107	379.417	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AP-108	379.417	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AW-101	379.417	1.2192	409.04	4.700	2.35	0.01	15.11	normal
AW-102	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
AW-103	379.417	1.2192	409.04	0.900	0.45	0.01	15.11	normal
AW-104	379.417	1.2192	409.04	5.800	2.9	0.001	15.11	normal
AW-105	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
AW-106	379.417	1.2192	409.04	3.200	1.6	0.01	15.11	normal
AX-101	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
AX-102	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
AX-103	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
AX-104	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
AY-101	378.216	1.2192	409.07	4.200	2.1	0.001	26.5	normal
AY-102	378.216	1.2192	409.07	6.371	2.734436	0.01	15.11	normal
AZ-101	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
AZ-102	379.417	1.2192	409.04	6.371	2.734436	0.01	15.11	normal
B-101	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
B-102	0.000	0.0000	410.44	2.700	1.35	0.01	40	normal
B-103	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
B-104	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
B-105	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
B-106	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
B-107	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal

1	47	48	49	50	51	52	53	54	55
Tank #	non-convective waste yield stress mean (Pa)	non-convective waste yield stress std dev (Pa)	non-convective waste yield stress min (Pa)	non-convective waste yield stress max (Pa)	non-convective waste yield stress dist type (Pa)	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 std dev	Headspace gas ratio CH4 min
References:	RPP-10006, Rev 5, Appendix F	RPP-10006, Rev 5, Appendix F	RPP-10006, Rev 5, Appendix F	RPP-10006, Rev 5, Appendix F	RPP-10006, Rev 5, Appendix F	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G
A-101	631.25	260.88	109.49	1674.77	Normal	0.021	0.021	0.001	0.018
A-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
A-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
A-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
A-105	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
A-106	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
AN-101	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AN-102	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AN-103	144	13.87	88.52	199.48	Normal	0.086	0.086	0.036	0.022
AN-104	144	13.87	88.52	199.48	Normal	0.059	0.059	0.014	0.027
AN-105	144	13.87	88.52	199.48	Normal	0.022	0.022	0.006	0.011
AN-106	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AN-107	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-101	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-102	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
AP-103	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-104	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-105	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-106	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-107	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AP-108	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AW-101	144	13.87	88.52	199.48	Normal	0.214	0.214	0.021	0.156
AW-102	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
AW-103	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
AW-104	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AW-105	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
AW-106	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
AX-101	631.25	260.88	109.49	1674.77	Normal	0.057	0.057	0.007	0.040
AX-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
AX-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
AX-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
AY-101	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
AY-102	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
AZ-101	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
AZ-102	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
B-101	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-106	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-107	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001

1	56	57	58	59	60	61	62	63	64	65
Tank #	**Headspace gas ratio CH4 max**	**Headspace gas ratio CH4 type**	**Headspace gas ratio N2O mean**	**Headspace gas ratio N2O mean**	**Headspace gas ratio N2O std dev**	**Headspace gas ratio N2O min**	**Headspace gas ratio N2O max**	**Headspace gas ratio N2O type**	**Retained gas composition N2 mean**	**Retained gas composition N2 mean**
References:	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G
A-101	0.024	Normal	0.071	0.071	0.005	0.058	0.084	Normal	19.001	19.001
A-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
A-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
A-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
A-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
A-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AN-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AN-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AN-103	0.164	Normal	0.053	0.053	0.007	0.037	0.077	Normal	28.660	28.660
AN-104	0.099	Normal	0.308	0.308	0.032	0.223	0.401	Normal	29.173	29.173
AN-105	0.036	Normal	0.169	0.169	0.018	0.125	0.220	Normal	24.571	24.571
AN-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AN-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AP-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AW-101	0.275	Normal	0.126	0.126	0.021	0.078	0.174	Normal	53.550	53.550
AW-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AW-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AW-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AW-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AW-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AX-101	0.076	Normal	0.142	0.142	0.008	0.122	0.163	Normal	16.683	16.683
AX-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AX-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AX-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AY-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AY-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AZ-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
AZ-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840

1	66	67	68	69	70	71	72	73	74	75
Tank #	Retained gas composition N2 std dev	Retained gas composition N2 min	Retained gas composition N2 max	Retained gas composition N2 type	Retained gas composition NH3 mean	Retained gas composition NH3 mean	Retained gas composition NH3 std dev	Retained gas composition NH3 min	Retained gas composition NH3 max	Retained gas composition NH3 type
References:	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G	RPP-10006, Rev 5, Appendix G
A-101	2.326	11.352	26.594	Normal	2.457	2.457	0.295	1.242	3.347	Normal
A-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
A-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
A-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
A-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
A-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AN-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AN-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AN-103	5.153	14.912	42.804	Normal	0.597	0.597	0.066	0.400	0.782	Normal
AN-104	4.918	14.334	41.436	Normal	0.882	0.882	0.134	0.377	1.293	Normal
AN-105	3.635	14.166	34.339	Normal	0.500	0.500	0.065	0.303	0.762	Normal
AN-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AN-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AP-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AW-101	2.707	45.453	62.012	Normal	0.571	0.571	0.100	0.272	0.959	Normal
AW-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AW-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AW-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AW-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AW-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AX-101	4.284	4.648	27.392	Normal	6.585	6.585	1.769	3.094	10.784	Normal
AX-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AX-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AX-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AY-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AY-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AZ-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
AZ-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin

1	76	77	78	79	80	81
Tank #	Hydrogen Generation Rate in Non-Convective Waste (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Min (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Max (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Dist Type (moles/m3/day)	Cross sectional area of tank (m2)	Waste Type
References:	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	RPP-5926, Rev 5, or RPP-10006, Rev 5, Appendix E	RPP-10006, Rev 5, Appendix E	n/a	RPP-10006, Rev 5, Appendix A
A-101	2.29E-03	1.14E-03	3.43E-03	triangular	411.35	SC/SS-NL
A-102	9.08E-03	4.54E-03	1.73E-02	triangular	411.35	SC/SS-NL
A-103	1.74E-03	5.80E-04	1.91E-03	triangular	411.35	SC/SS-NL
A-104	3.50E-03	1.75E-03	6.64E-03	triangular	411.35	SL-NL
A-105	2.70E-03	1.35E-03	5.13E-03	triangular	411.35	SL-NL
A-106	1.01E-02	3.36E-03	1.11E-02	triangular	411.35	MIX-NL
AN-101	1.09E-03	3.64E-04	1.20E-03	triangular	409.91	SC/SS-LIQ
AN-102	4.39E-03	1.46E-03	4.83E-03	triangular	409.91	SC/SS-LIQ
AN-103	1.10E-03	3.65E-04	1.21E-03	triangular	409.91	SC/SS-LIQ
AN-104	1.71E-03	5.71E-04	1.88E-03	triangular	409.91	SC/SS-LIQ
AN-105	1.07E-03	3.57E-04	1.18E-03	triangular	409.91	SC/SS-LIQ
AN-106	1.35E-02	4.50E-03	1.49E-02	triangular	409.91	MIX-LIQ
AN-107	4.10E-03	1.37E-03	4.51E-03	triangular	409.91	SC/SS-LIQ
AP-101	3.34E-04	1.67E-04	6.35E-04	triangular	409.88	LIQ
AP-102	8.34E-04	4.17E-04	1.25E-03	triangular	409.88	SL-LIQ
AP-103	1.13E-03	5.65E-04	1.69E-03	triangular	409.88	SC/SS-LIQ
AP-104	1.13E-03	5.66E-04	1.70E-03	triangular	409.88	SC/SS-LIQ
AP-105	6.95E-04	3.47E-04	1.32E-03	triangular	409.88	SC/SS-LIQ
AP-106	6.32E-04	2.11E-04	6.95E-04	triangular	409.88	LIQ
AP-107	9.76E-04	4.88E-04	1.85E-03	triangular	409.88	SC/SS-LIQ
AP-108	6.79E-04	2.26E-04	7.46E-04	triangular	409.88	SC/SS-LIQ
AW-101	9.29E-04	3.10E-04	1.02E-03	triangular	409.91	SC/SS-LIQ
AW-102	2.26E-03	1.13E-03	4.30E-03	triangular	409.91	SL-LIQ
AW-103	3.15E-04	1.58E-04	5.99E-04	triangular	409.91	SL-LIQ
AW-104	7.22E-04	2.41E-04	7.94E-04	triangular	409.91	SC/SS-LIQ
AW-105	4.29E-04	2.15E-04	8.15E-04	triangular	409.91	SL-LIQ
AW-106	7.06E-04	3.53E-04	1.06E-03	triangular	409.91	SC/SS-LIQ
AX-101	1.23E-03	6.15E-04	1.85E-03	triangular	410.66	SC/SS-NL
AX-102	7.90E-03	3.95E-03	1.50E-02	triangular	410.66	SC/SS-NL
AX-103	3.52E-03	1.76E-03	6.69E-03	triangular	410.66	SC/SS-NL
AX-104	4.47E-02	2.24E-02	8.50E-02	triangular	410.66	SL-NL
AY-101	2.19E-02	7.30E-03	2.41E-02	triangular	410.43	SL-NL
AY-102	7.20E-02	2.40E-02	0.079213732	triangular	410.43	SL-LIQ
AZ-101	6.64E-02	2.21E-02	7.31E-02	triangular	409.91	SL-LIQ
AZ-102	6.84E-02	2.28E-02	7.53E-02	triangular	409.91	SL-LIQ
B-101	1.54E-03	7.69E-04	2.92E-03	triangular	410.43	SC/SS-NL
B-102	3.50E-03	1.75E-03	6.65E-03	triangular	410.43	SC/SS-NL
B-103	1.84E-03	9.22E-04	3.50E-03	triangular	410.43	SC/SS-NL
B-104	4.15E-04	2.07E-04	7.88E-04	triangular	410.43	SL-NL
B-105	4.80E-04	2.40E-04	9.11E-04	triangular	410.43	SC/SS-NL
B-106	1.07E-03	5.33E-04	2.03E-03	triangular	410.43	SL-NL
B-107	7.48E-04	3.74E-04	1.42E-03	triangular	410.43	MIX-NL

1	2	3	4	5	6	7	8	9	10	11	12	13
Tank #	Tank type	Total waste depth (m)	Total waste depth uncertainty (m)	Total non-convective waste depth (m)	Total non-convective waste depth uncertainty (m)	Total non-convective waste depth lower bound (m)	Wetted non-convective waste depth (m)	Wetted non-convective waste depth uncertainty (m)	Wetted non-convective waste depth lower bound (m)	Mean Crust depth (m)	Convective Waste Density Mean (kg/m3)	Convective Waste Density Std Dev (kg/m3)
B-108	SST	1.04	0.292	1.04	0.292	0.010	0.89	0.024	0.010	0.00	1100	65
B-109	SST	1.34	0.292	1.34	0.292	0.010	1.07	0.024	0.010	0.00	1100	65
B-110	SST	2.46	0.006	2.45	0.292	0.010	2.41	0.024	0.010	0.00	1190	70
B-111	SST	2.42	0.006	2.41	0.292	0.010	2.22	0.024	0.010	0.00	1190	70
B-112	SST	0.51	0.006	0.48	0.292	0.010	0.48	0.292	0.010	0.00	1510	89
B-201	SST	4.02	0.292	4.02	0.292	0.010	4.02	0.292	0.000	0.00	1100	65
B-202	SST	3.92	0.292	3.92	0.292	0.010	3.92	0.292	0.000	0.00	1100	65
B-203	SST	6.73	0.006	6.66	0.292	0.010	6.66	0.292	0.010	0.00	1050	62
B-204	SST	6.62	0.006	6.52	0.292	0.010	6.52	0.292	0.010	0.00	1050	62
BX-101	SST	0.63	0.292	0.63	0.292	0.010	0.63	0.292	0.000	0.00	1100	65
BX-102	SST	0.92	0.292	0.92	0.292	0.010	0.92	0.292	0.000	0.00	1100	65
BX-103	SST	0.88	0.006	0.76	0.292	0.010	0.76	0.292	0.010	0.00	1070	63
BX-104	SST	1.12	0.006	1.09	0.292	0.010	1.09	0.292	0.010	0.00	1280	76
BX-105	SST	0.85	0.006	0.81	0.292	0.010	0.81	0.292	0.010	0.00	1290	76
BX-106	SST	0.54	0.292	0.54	0.292	0.010	0.54	0.292	0.000	0.00	1100	65
BX-107	SST	3.39	0.292	3.39	0.292	0.010	3.39	0.292	0.000	0.00	1100	65
BX-108	SST	0.48	0.292	0.48	0.292	0.010	0.48	0.292	0.000	0.00	1100	65
BX-109	SST	1.97	0.292	1.97	0.292	0.010	1.97	0.292	0.010	0.00	1100	65
BX-110	SST	2.17	0.006	2.16	0.292	0.010	2.16	0.292	0.010	0.00	1440	85
BX-111	SST	1.93	0.292	1.93	0.292	0.010	1.11	0.024	0.010	0.00	1100	65
BX-112	SST	1.71	0.006	1.69	0.292	0.010	1.69	0.292	0.010	0.00	1180	70
BY-101	SST	3.61	0.292	3.61	0.292	0.010	2.44	0.024	0.010	0.00	1100	65
BY-102	SST	2.76	0.292	2.76	0.292	0.010	1.73	0.024	0.010	0.00	1100	65
BY-103	SST	4.01	0.292	4.01	0.292	0.010	3.14	0.024	0.010	0.00	1100	65
BY-104	SST	3.93	0.292	3.93	0.292	0.010	2.25	0.024	0.010	0.00	1100	65
BY-105	SST	4.63	0.292	4.63	0.292	0.010	2.79	0.024	0.010	0.00	1100	65
BY-106	SST	4.46	0.292	4.46	0.292	0.010	1.90	0.024	0.010	0.00	1100	65
BY-107	SST	2.70	0.292	2.70	0.292	0.010	1.79	0.024	0.010	0.00	1100	65
BY-108	SST	2.24	0.292	2.24	0.292	0.010	1.70	0.024	0.010	0.00	1100	65
BY-109	SST	2.84	0.292	2.84	0.292	0.010	2.73	0.024	0.010	0.00	1100	65
BY-110	SST	3.57	0.292	3.57	0.292	0.010	2.52	0.024	0.010	0.00	1100	65
BY-111	SST	3.91	0.292	3.91	0.292	0.010	1.81	0.024	0.010	0.00	1100	65
BY-112	SST	2.83	0.292	2.83	0.292	0.010	0.74	0.024	0.010	0.00	1100	65
C-101	SST	1.00	0.292	1.00	0.292	0.010	1.00	0.292	0.000	0.00	1100	65
C-102	SST	3.11	0.292	3.11	0.292	0.010	3.11	0.292	0.000	0.00	1100	65
C-103	SST	0.86	0.006	0.85	0.292	0.010	0.85	0.292	0.010	0.00	1070	63
C-104	SST	2.58	0.292	2.58	0.292	0.010	2.58	0.292	0.000	0.00	1100	65
C-105	SST	1.41	0.292	1.41	0.292	0.010	1.41	0.292	0.000	0.00	1100	65
C-106	SST	0.14	0.006	0.14	0.292	0.010	0.14	0.292	0.010	0.00	1020	60
C-107	SST	2.47	0.292	2.47	0.292	0.010	2.47	0.292	0.000	0.00	1100	65
C-108	SST	0.80	0.292	0.80	0.292	0.010	0.80	0.292	0.000	0.00	1100	65
C-109	SST	0.77	0.292	0.77	0.292	0.010	0.77	0.292	0.000	0.00	1100	65
C-110	SST	1.83	0.006	1.82	0.292	0.010	1.82	0.292	0.010	0.00	1100	65
C-111	SST	0.72	0.292	0.72	0.292	0.010	0.72	0.292	0.000	0.00	1100	65
C-112	SST	1.15	0.292	1.15	0.292	0.010	1.15	0.292	0.000	0.00	1100	65
C-201	SST	0.26	0.292	0.26	0.292	0.010	0.26	0.292	0.000	0.00	1100	65
C-202	SST	0.10	0.006	0.10	0.292	0.010	0.10	0.292	0.000	0.00	1100	65

1	14	15	16	17	18	19	20	21	22	23	24
Tank #	Convective Waste Density Min (kg/m3)	Convective Waste Density Max (kg/m3)	Convective Waste Density Dist (kg/m3)	Non-Convective Waste Density Mean (kg/m3)	Non-Convective Waste Density Std Dev (kg/m3)	Non-Convective Waste Density Min (kg/m3)	Non-Convective Waste Density Max (kg/m3)	Non-Convective Waste Density Dist (kg/m3)	Non-Convective Waste Average Temperature (K)	Tank Vapor Space Average Temperature (K)	Tank type group
B-108	1000	1227	normal	1,676	127	1,428	1,924	normal	294	293	b
B-109	1000	1227	normal	1,783	135	1,520	2,047	normal	293	294	b
B-110	1052	1328	normal	1,360	103	1,159	1,561	normal	295	298	b
B-111	1052	1328	normal	1,270	96	1,082	1,458	normal	299	299	b
B-112	1335	1685	normal	1,750	132	1,491	2,009	normal	294	294	b
B-201	1000	1227	normal	1,260	95	1,074	1,446	normal	291	292	b2
B-202	1000	1227	normal	1,220	92	1,039	1,401	normal	292	292	b2
B-203	1000	1171	normal	1,190	90	1,014	1,366	normal	292	285	b2
B-204	1000	1171	normal	1,190	90	1,014	1,366	normal	292	293	b2
BX-101	1000	1227	normal	1,680	127	1,431	1,929	normal	296	296	bx
BX-102	1000	1227	normal	1,750	132	1,491	2,009	normal	293	294	bx
BX-103	1000	1194	normal	1,661	125	1,415	1,907	normal	294	295	bx
BX-104	1132	1428	normal	1,680	127	1,431	1,929	normal	303	298	bx
BX-105	1141	1439	normal	1,694	128	1,443	1,945	normal	293	294	bx
BX-106	1000	1227	normal	1,617	122	1,378	1,857	normal	294	294	bx
BX-107	1000	1227	normal	1,440	109	1,227	1,653	normal	293	294	bx
BX-108	1000	1227	normal	1,457	110	1,242	1,673	normal	293	293	bx
BX-109	1000	1227	normal	1,520	115	1,295	1,745	normal	294	295	bx
BX-110	1273	1607	normal	1,667	126	1,420	1,913	normal	293	294	bx
BX-111	1000	1227	normal	1,447	109	1,233	1,661	normal	293	292	bx
BX-112	1044	1316	normal	1,310	99	1,116	1,504	normal	293	293	bx
BY-101	1000	1227	normal	1,830	138	1,559	2,100	normal	298	297	by
BY-102	1000	1227	normal	1,571	119	1,338	1,803	normal	295	295	by
BY-103	1000	1227	normal	1,660	125	1,415	1,906	normal	296	293	by
BY-104	1000	1227	normal	1,714	129	1,460	1,967	normal	312	299	by
BY-105	1000	1227	normal	1,801	136	1,534	2,067	normal	307	300	by
BY-106	1000	1227	normal	1,673	126	1,426	1,921	normal	306	306	by
BY-107	1000	1227	normal	1,687	127	1,438	1,937	normal	304	298	by
BY-108	1000	1227	normal	1,485	112	1,265	1,704	normal	307	300	by
BY-109	1000	1227	normal	1,706	129	1,453	1,958	normal	292	290	by
BY-110	1000	1227	normal	1,565	118	1,334	1,797	normal	309	299	by
BY-111	1000	1227	normal	1,673	126	1,426	1,921	normal	299	296	by
BY-112	1000	1227	normal	1,740	131	1,482	1,997	normal	303	297	by
C-101	1000	1227	normal	1,780	134	1,517	2,043	normal	305	306	c
C-102	1000	1227	normal	1,681	127	1,432	1,930	normal	302	299	c
C-103	1000	1194	normal	1,594	120	1,358	1,830	normal	316	312	c
C-104	1000	1227	normal	1,680	127	1,431	1,929	normal	309	306	c
C-105	1000	1227	normal	1,550	117	1,321	1,779	normal	321	316	c
C-106	1000	1138	normal	1,560	118	1,329	1,791	normal	303	299	c
C-107	1000	1227	normal	1,550	117	1,321	1,779	normal	316	314	c
C-108	1000	1227	normal	1,480	112	1,261	1,699	normal	300	300	c
C-109	1000	1227	normal	1,548	117	1,319	1,777	normal	299	299	c
C-110	1000	1227	normal	1,340	101	1,142	1,538	normal	294	296	c
C-111	1000	1227	normal	1,552	117	1,322	1,781	normal	298	298	c
C-112	1000	1227	normal	1,597	121	1,361	1,833	normal	301	301	c
C-201	1000	1227	normal	1,440	109	1,227	1,653	normal	289	293	c2
C-202	1000	1227	normal	1,440	109	1,227	1,653	normal	289	292	c2

1	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Tank #	Total tank volume (m3)	OSD Maximum Operating Limit (m)	Dish type	Dish height (m)	Dish volume (kL)	Dish Radius (m)	Knuckle height (m)	Knuckle volume (M3)	Knuckle Radius (m)	Body height (m)	Body volume (M3)	Body Operating Capacity (m3/m)	Body Radius (m)	Dome Arc height (m)
B-108	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-109	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-110	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-111	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-112	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
B-201	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
B-202	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
B-203	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
B-204	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
BX-101	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-102	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-103	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-104	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-105	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-106	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-107	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-108	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-109	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-110	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-111	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BX-112	3,215	4.80	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	4.276	1,754.89	410.44	11.430	0.0000
BY-101	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-102	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-103	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-104	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-105	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-106	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-107	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-108	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-109	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-110	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-111	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
BY-112	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
C-101	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-102	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-103	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-104	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-105	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-106	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-107	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-108	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-109	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-110	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-111	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-112	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
C-201	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
C-202	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000

1	39	40	41	42	43	44	45	46
Tank #	Dome Arc volume (M3)	Dome Arc Radius (m)	Tank capacity (kL/m)	Void Fraction or Maximum Wetted Solids Void Fraction Mean (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Uncertainty (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Minimum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Maximum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Dist Type (Dimension-less)
B-108	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
B-109	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
B-110	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
B-111	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
B-112	0.000	0.0000	410.44	2.500	1.25	0.01	40	normal
B-201	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
B-202	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
B-203	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
B-204	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
BX-101	0.000	0.0000	410.44	2.000	1	0.001	26.5	normal
BX-102	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
BX-103	0.000	0.0000	410.44	1.200	0.6	0.001	26.5	normal
BX-104	0.000	0.0000	410.44	7.500	3.75	0.001	26.5	normal
BX-105	0.000	0.0000	410.44	1.600	0.8	0.01	40	normal
BX-106	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BX-107	0.000	0.0000	410.44	2.500	1.25	0.001	26.5	normal
BX-108	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
BX-109	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
BX-110	0.000	0.0000	410.44	4.000	2	0.01	40	normal
BX-111	0.000	0.0000	410.44	0.500	0.25	0.01	40	normal
BX-112	0.000	0.0000	410.44	0.500	0.25	0.001	26.5	normal
BY-101	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-102	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-103	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-104	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-105	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-106	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-107	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-108	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-109	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-110	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-111	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
BY-112	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
C-101	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-102	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-103	0.000	0.0000	410.44	0.600	0.3	0.001	26.5	normal
C-104	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-105	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-106	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-107	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-108	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-109	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-110	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-111	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-112	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
C-201	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
C-202	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm

1	47	48	49	50	51	52	53	54	55
Tank #	non-convective waste yield stress mean (Pa)	non-convective waste yield stress std dev (Pa)	non-convective waste yield stress min (Pa)	non-convective waste yield stress max (Pa)	non-convective waste yield stress dist type (Pa)	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 std dev	Headspace gas ratio CH4 min
B-108	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-109	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-110	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-111	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-112	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
B-201	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-202	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-203	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
B-204	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-101	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-102	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-103	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BX-106	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BX-107	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-108	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-109	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BX-110	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BX-111	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BX-112	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
BY-101	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-104	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-106	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-107	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-108	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-109	631.25	260.88	109.49	1674.77	Normal	0.086	0.086	0.031	0.028
BY-110	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-111	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
BY-112	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
C-101	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-102	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-103	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-105	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-106	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-107	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-108	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-109	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-110	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-111	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-112	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-201	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-202	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001

1	56	57	58	59	60	61	62	63	64	65
Tank #	Headspace gas ratio CH4 max	Headspace gas ratio CH4 type	Headspace gas ratio N2O mean	Headspace gas ratio N2O mean	Headspace gas ratio N2O std dev	Headspace gas ratio N2O min	Headspace gas ratio N2O max	Headspace gas ratio N2O type	Retained gas composition N2 mean	Retained gas composition N2 mean
B-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-201	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-202	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-203	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
B-204	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BX-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-109	0.161	Normal	0.236	0.236	0.021	0.178	0.305	Normal	29.045	29.045
BY-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
BY-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-201	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-202	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840

1	66	67	68	69	70	71	72	73	74	75
Tank #	Retained gas composition N2 std dev	Retained gas composition N2 min	Retained gas composition N2 max	Retained gas composition N2 type	Retained gas composition NH3 mean	Retained gas composition NH3 mean	Retained gas composition NH3 std dev	Retained gas composition NH3 min	Retained gas composition NH3 max	Retained gas composition NH3 type
B-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-201	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-202	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-203	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
B-204	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BX-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-109	4.437	16.678	42.377	Normal	0.191	0.191	0.034	0.081	0.321	Normal
BY-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
BY-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-201	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-202	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin

1	76	77	78	79	80	81
Tank #	Hydrogen Generation Rate in Non-Convective Waste (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Min (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Max (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Dist Type (moles/m3/day)	Cross sectional area of tank (m2)	Waste Type
B-108	1.18E-03	5.88E-04	2.23E-03	triangular	410.43	SC/SS-NL
B-109	9.05E-04	4.52E-04	1.72E-03	triangular	410.43	MIX-NL
B-110	9.49E-04	4.74E-04	1.80E-03	triangular	410.43	SL-NL
B-111	1.41E-03	7.04E-04	2.67E-03	triangular	410.43	SL-NL
B-112	3.51E-03	1.75E-03	6.66E-03	triangular	410.43	MIX-NL
B-201	8.76E-04	4.38E-04	1.66E-03	triangular	29.19	SL-NL
B-202	8.49E-04	4.24E-04	1.61E-03	triangular	29.19	SL-NL
B-203	1.78E-03	8.89E-04	3.38E-03	triangular	29.19	SL-NL
B-204	1.79E-03	8.95E-04	3.40E-03	triangular	29.19	SL-NL
BX-101	2.41E-03	1.20E-03	4.58E-03	triangular	410.43	SL-NL
BX-102	1.43E-03	7.14E-04	2.71E-03	triangular	410.43	SL-NL
BX-103	2.11E-03	1.05E-03	4.00E-03	triangular	410.43	SL-NL
BX-104	1.61E-03	8.03E-04	3.05E-03	triangular	410.43	SL-NL
BX-105	1.78E-03	8.92E-04	3.39E-03	triangular	410.43	MIX-NL
BX-106	3.13E-03	1.56E-03	5.94E-03	triangular	410.43	SC/SS-NL
BX-107	5.10E-04	2.55E-04	9.69E-04	triangular	410.43	SL-NL
BX-108	3.32E-03	1.66E-03	6.31E-03	triangular	410.43	SL-NL
BX-109	1.13E-03	5.63E-04	2.14E-03	triangular	410.43	SL-NL
BX-110	7.80E-04	3.90E-04	1.48E-03	triangular	410.43	MIX-NL
BX-111	6.62E-04	3.31E-04	1.26E-03	triangular	410.43	SC/SS-NL
BX-112	8.84E-04	4.42E-04	1.68E-03	triangular	410.43	SL-NL
BY-101	7.89E-04	3.94E-04	1.50E-03	triangular	410.43	SC/SS-NL
BY-102	5.37E-04	2.69E-04	1.02E-03	triangular	410.43	SC/SS-NL
BY-103	4.48E-04	2.24E-04	8.50E-04	triangular	410.43	SC/SS-NL
BY-104	6.75E-04	3.37E-04	1.28E-03	triangular	410.43	SC/SS-NL
BY-105	5.15E-04	2.57E-04	9.78E-04	triangular	410.43	SC/SS-NL
BY-106	6.60E-04	3.30E-04	1.25E-03	triangular	410.43	SC/SS-NL
BY-107	7.22E-04	3.61E-04	1.37E-03	triangular	410.43	SC/SS-NL
BY-108	8.06E-04	4.03E-04	1.53E-03	triangular	410.43	SC/SS-NL
BY-109	5.23E-04	2.62E-04	9.94E-04	triangular	410.43	SC/SS-NL
BY-110	1.42E-03	7.08E-04	2.13E-03	triangular	410.43	SC/SS-NL
BY-111	4.07E-04	2.03E-04	7.72E-04	triangular	410.43	SC/SS-NL
BY-112	5.11E-04	2.55E-04	9.70E-04	triangular	410.43	SC/SS-NL
C-101	1.53E-03	7.63E-04	2.90E-03	triangular	410.43	SL-NL
C-102	6.50E-04	3.25E-04	1.24E-03	triangular	410.43	SL-NL
C-103	5.52E-02	1.84E-02	6.07E-02	triangular	410.43	SL-NL
C-104	2.61E-03	8.70E-04	2.87E-03	triangular	410.43	SL-NL
C-105	2.61E-03	1.30E-03	4.96E-03	triangular	410.43	SL-NL
C-106	1.58E-01	7.92E-02	3.01E-01	triangular	410.43	SL-NL
C-107	4.75E-03	1.58E-03	5.23E-03	triangular	410.43	SL-NL
C-108	2.10E-03	1.05E-03	3.98E-03	triangular	410.43	SL-NL
C-109	4.74E-03	2.37E-03	9.00E-03	triangular	410.43	SL-NL
C-110	1.77E-03	8.85E-04	3.36E-03	triangular	410.43	SL-NL
C-111	1.09E-02	5.43E-03	1.63E-02	triangular	410.43	SL-NL
C-112	6.12E-03	3.06E-03	9.19E-03	triangular	410.43	SL-NL
C-201	1.23E-02	6.15E-03	2.34E-02	triangular	29.19	SL-NL
C-202	5.95E-03	2.97E-03	1.13E-02	triangular	29.19	SL-NL

1	2	3	4	5	6	7	8	9	10	11	12	13
Tank #	Tank type	Total waste depth (m)	Total waste depth uncertainty (m)	Total non-convective waste depth (m)	Total non-convective waste depth uncertainty (m)	Total non-convective waste depth lower bound (m)	Wetted non-convective waste depth (m)	Wetted non-convective waste depth uncertainty (m)	Wetted non-convective waste depth lower bound (m)	Mean Crust depth (m)	Convective Waste Density Mean (kg/m3)	Convective Waste Density Std Dev (kg/m3)
C-203	SST	0.10	0.006	0.09	0.292	0.010	0.09	0.292	0.000	0.00	1000	59
C-204	SST	0.37	0.292	0.37	0.292	0.010	0.37	0.292	0.000	0.00	1100	65
S-101	SST	3.44	0.292	3.44	0.292	0.010	3.20	0.024	0.010	0.00	1100	65
S-102	SST	1.53	0.292	1.53	0.292	0.010	0.00	0.292	0.010	0.00	1100	65
S-103	SST	2.38	0.006	2.37	0.292	0.010	2.34	0.024	0.010	0.00	1450	86
S-104	SST	2.85	0.292	2.85	0.292	0.010	2.83	0.024	0.010	0.00	1100	65
S-105	SST	3.94	0.292	3.94	0.292	0.010	1.40	0.024	0.010	0.00	1100	65
S-106	SST	4.39	0.292	4.39	0.292	0.010	1.48	0.024	0.010	0.00	1100	65
S-107	SST	3.50	0.292	3.50	0.292	0.010	3.10	0.024	0.010	0.00	1310	77
S-108	SST	5.27	0.292	5.27	0.292	0.010	1.67	0.024	0.010	0.00	1100	65
S-109	SST	5.11	0.292	5.11	0.292	0.010	1.85	0.024	0.010	0.00	1100	65
S-110	SST	3.78	0.292	3.78	0.292	0.010	3.32	0.024	0.010	0.00	1100	65
S-111	SST	3.99	0.292	3.99	0.292	0.010	2.25	0.024	0.010	0.00	1450	86
S-112	SST	0.41	0.292	0.41	0.292	0.010	0.00	0.292	0.010	0.00	1100	65
SX-101	SST	4.07	0.292	4.07	0.292	0.010	3.05	0.024	0.010	0.00	1100	65
SX-102	SST	3.36	0.292	3.36	0.292	0.010	3.36	0.292	0.000	0.00	1100	65
SX-103	SST	4.91	0.292	4.91	0.292	0.010	2.46	0.024	0.010	0.00	1470	87
SX-104	SST	4.33	0.292	4.33	0.292	0.010	2.40	0.024	0.010	0.00	1100	65
SX-105	SST	3.68	0.292	3.68	0.292	0.010	2.46	0.024	0.010	0.00	1100	65
SX-106	SST	3.87	0.292	3.87	0.292	0.010	2.02	0.024	0.010	0.00	1100	65
SX-107	SST	1.08	0.292	1.08	0.292	0.010	1.08	0.292	0.000	0.00	1100	65
SX-108	SST	0.89	0.292	0.89	0.292	0.010	0.89	0.292	0.000	0.00	1100	65
SX-109	SST	2.44	0.292	2.44	0.292	0.010	2.44	0.292	0.000	0.00	1100	65
SX-110	SST	0.72	0.292	0.72	0.292	0.010	0.72	0.292	0.000	0.00	1100	65
SX-111	SST	1.27	0.292	1.27	0.292	0.010	0.34	0.024	0.010	0.00	1100	65
SX-112	SST	0.90	0.292	0.90	0.292	0.010	0.51	0.024	0.000	0.00	1100	65
SX-113	SST	0.38	0.292	0.38	0.292	0.010	0.38	0.292	0.000	0.00	1100	65
SX-114	SST	1.64	0.292	1.64	0.292	0.010	1.64	0.292	0.000	0.00	1100	65
SX-115	SST	0.17	0.292	0.17	0.292	0.010	0.17	0.292	0.000	0.00	1100	65
SY-101	DST	3.69	0.006	2.67	0.239	0.010	2.67	0.239	0.010	0.00	1300	106
SY-102	DST	9.52	0.006	1.59	0.223	0.010	1.59	0.223	0.010	0.00	1270	104
SY-103	DST	6.82	0.065	3.07	0.395	0.010	3.07	0.395	0.010	0.58	1470	120
T-101	SST	1.11	0.292	1.11	0.292	0.010	1.09	0.024	0.000	0.00	1100	65
T-102	SST	0.48	0.006	0.37	0.292	0.010	0.37	0.292	0.010	0.00	1140	67
T-103	SST	0.44	0.006	0.40	0.292	0.010	0.40	0.292	0.010	0.00	1190	70
T-104	SST	3.11	0.292	3.11	0.292	0.010	2.73	0.024	0.010	0.00	1100	65
T-105	SST	1.09	0.292	1.09	0.292	0.010	1.09	0.292	0.000	0.00	1100	65
T-106	SST	0.39	0.292	0.39	0.292	0.010	0.39	0.292	0.000	0.00	1100	65
T-107	SST	1.79	0.292	1.79	0.292	0.010	1.79	0.292	0.000	0.00	1100	65
T-108	SST	0.34	0.292	0.34	0.292	0.010	0.34	0.292	0.000	0.00	1100	65
T-109	SST	0.76	0.292	0.76	0.292	0.010	0.57	0.024	0.010	0.00	1100	65
T-110	SST	3.61	0.006	3.60	0.292	0.010	3.60	0.292	0.010	0.00	1050	62
T-111	SST	4.32	0.292	4.32	0.292	0.010	4.24	0.024	0.010	0.00	1100	65
T-112	SST	0.80	0.006	0.74	0.292	0.010	0.74	0.292	0.010	0.00	1100	65
T-201	SST	4.16	0.006	3.88	0.292	0.010	3.88	0.292	0.010	0.00	1060	63
T-202	SST	2.85	0.292	2.85	0.292	0.010	2.85	0.292	0.000	0.00	1100	65
T-203	SST	4.88	0.292	4.88	0.292	0.010	4.88	0.292	0.000	0.00	1100	65

1	14	15	16	17	18	19	20	21	22	23	24
Tank #	Convective Waste Density Min (kg/m3)	Convective Waste Density Max (kg/m3)	Convective Waste Density Dist (kg/m3)	Non-Convective Waste Density Mean (kg/m3)	Non-Convective Waste Density Std Dev (kg/m3)	Non-Convective Waste Density Min (kg/m3)	Non-Convective Waste Density Max (kg/m3)	Non-Convective Waste Density Dist (kg/m3)	Non-Convective Waste Average Temperature (K)	Tank Vapor Space Average Temperature (K)	Tank type group
C-203	1000	1116	normal	1,620	122	1,380	1,860	normal	288	292	c2
C-204	1000	1227	normal	1,620	122	1,380	1,860	normal	291	289	c2
S-101	1000	1227	normal	1,652	125	1,407	1,896	normal	313	305	s
S-102	1000	1227	normal	1,700	128	1,449	1,952	normal	309	306	s
S-103	1282	1618	normal	1,612	122	1,374	1,851	normal	300	297	s
S-104	1000	1227	normal	1,668	126	1,421	1,914	normal	310	303	s
S-105	1000	1227	normal	1,657	125	1,412	1,902	normal	297	296	s
S-106	1000	1227	normal	1,722	130	1,467	1,977	normal	297	297	s
S-107	1159	1461	normal	1,775	134	1,513	2,038	normal	307	299	s
S-108	1000	1227	normal	1,677	127	1,429	1,926	normal	300	296	s
S-109	1000	1227	normal	1,657	125	1,412	1,903	normal	300	297	s
S-110	1000	1227	normal	1,662	126	1,416	1,908	normal	314	302	s
S-111	1282	1618	normal	1,544	117	1,315	1,772	normal	301	294	s
S-112	1000	1227	normal	1,711	129	1,458	1,964	normal	296	301	s
SX-101	1000	1227	normal	1,679	127	1,431	1,928	normal	324	312	sx
SX-102	1000	1227	normal	1,697	128	1,446	1,948	normal	326	309	sx
SX-103	1300	1640	normal	1,729	131	1,473	1,985	normal	333	305	sx
SX-104	1000	1227	normal	1,695	128	1,444	1,946	normal	329	308	sx
SX-105	1000	1227	normal	1,630	123	1,389	1,872	normal	333	307	sx
SX-106	1000	1227	normal	1,578	119	1,345	1,812	normal	307	299	sx
SX-107	1000	1227	normal	1,770	134	1,508	2,032	normal	343	326	sx
SX-108	1000	1227	normal	1,770	134	1,508	2,032	normal	350	332	sx
SX-109	1000	1227	normal	1,734	131	1,477	1,990	normal	326	321	sx
SX-110	1000	1227	normal	1,763	133	1,502	2,024	normal	342	320	sx
SX-111	1000	1227	normal	1,762	133	1,502	2,023	normal	347	330	sx
SX-112	1000	1227	normal	1,770	134	1,508	2,032	normal	333	323	sx
SX-113	1000	1227	normal	1,750	132	1,491	2,009	normal	301	301	sx
SX-114	1000	1227	normal	1,751	132	1,492	2,010	normal	346	325	sx
SX-115	1000	1227	normal	1,770	134	1,508	2,032	normal	299	298	sx
SY-101	1092	1508	normal	1,520	99	1,326	1,714	normal	297	293	sy
SY-102	1067	1473	normal	1,560	101	1,362	1,759	normal	299	299	sy
SY-103	1235	1705	normal	1,610	105	1,405	1,815	normal	305	298	sy
T-101	1000	1227	normal	1,544	117	1,316	1,773	normal	295	294	t
T-102	1008	1272	normal	1,797	136	1,531	2,063	normal	291	291	t
T-103	1052	1328	normal	1,714	129	1,460	1,968	normal	292	293	t
T-104	1000	1227	normal	1,290	97	1,099	1,481	normal	293	295	t
T-105	1000	1227	normal	1,460	110	1,244	1,676	normal	290	289	t
T-106	1000	1227	normal	1,587	120	1,352	1,822	normal	293	294	t
T-107	1000	1227	normal	1,560	118	1,329	1,791	normal	292	295	t
T-108	1000	1227	normal	1,547	117	1,318	1,776	normal	289	294	t
T-109	1000	1227	normal	1,646	124	1,402	1,889	normal	292	293	t
T-110	1000	1171	normal	1,250	94	1,065	1,435	normal	291	293	t
T-111	1000	1227	normal	1,240	94	1,057	1,423	normal	292	295	t
T-112	1000	1227	normal	1,280	97	1,091	1,469	normal	292	294	t
T-201	1000	1183	normal	1,310	99	1,116	1,504	normal	290	293	t2
T-202	1000	1227	normal	1,180	89	1,005	1,355	normal	290	293	t2
T-203	1000	1227	normal	1,220	92	1,039	1,401	normal	290	293	t2

1	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Tank #	**Total tank volume (m3)**	**OSD Maximum Operating Limit (m)**	**Dish type**	**Dish height (m)**	**Dish volume (kL)**	**Dish Radius (m)**	**Knuckle height (m)**	**Knuckle volume (M3)**	**Knuckle Radius (m)**	**Body height (m)**	**Body volume (M3)**	**Body Operating Capacity (m3/m)**	**Body Radius (m)**	**Dome Arc height (m)**
C-203	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
C-204	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
S-101	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-102	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-103	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-104	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-105	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-106	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-107	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-108	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-109	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-110	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-111	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
S-112	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
SX-101	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-102	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-103	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-104	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-105	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-106	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-107	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-108	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-109	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-110	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-111	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-112	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-113	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-114	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SX-115	4,903	9.35	dished	0.3778	77.8029	173.6110	0.0000	0.0000	0.0000	9.474	3,890.71	410.66	11.433	0.0000
SY-101	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
SY-102	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
SY-103	5,324	10.72	flat	0.0095	3.1170	0.0000	0.3048	123.4357	0.3048	10.422	4,262.95	409.04	11.423	0.9668
T-101	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-102	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-103	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-104	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-105	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-106	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-107	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-108	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-109	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-110	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-111	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-112	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
T-201	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
T-202	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
T-203	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000

1	39	40	41	42	43	44	45	46
Tank #	Dome Arc volume (M3)	Dome Arc Radius (m)	Tank capacity (kL/m)	Void Fraction or Maximum Wetted Solids Void Fraction Mean (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Uncertainty (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Minimum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Maximum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Dist Type (Dimension-less)
C-203	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
C-204	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
S-101	0.000	0.0000	410.44	4.300	2.15	0.01	40	normal
S-102	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
S-103	0.000	0.0000	410.44	14.700	7.35	0.01	40	normal
S-104	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
S-105	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
S-106	0.000	0.0000	410.44	8.200	4.1	0.01	40	normal
S-107	0.000	0.0000	410.44	2.400	1.2	0.01	26.5	normal
S-108	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
S-109	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
S-110	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
S-111	0.000	0.0000	410.44	11.900	5.95	0.01	40	normal
S-112	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
SX-101	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
SX-102	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
SX-103	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
SX-104	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
SX-105	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
SX-106	0.000	0.0000	410.66	14.000	7	0.01	40	normal
SX-107	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-108	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-109	0.000	0.0000	410.66	8.838	7.1328	0.01	40	normal
SX-110	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-111	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-112	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-113	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-114	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SX-115	0.000	0.0000	410.66	2.437	2.4869	0.01	26.5	Lognorm
SY-101	379.417	1.2192	409.04	8.500	4.25	0.001	15.11	normal
SY-102	379.417	1.2192	409.04	0.900	0.45	0.01	15.11	normal
SY-103	379.417	1.2192	409.04	6.000	3	0.001	15.11	normal
T-101	0.000	0.0000	410.44	0.700	0.35	0.01	40	normal
T-102	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-103	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-104	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-105	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-106	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-107	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-108	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
T-109	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
T-110	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-111	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-112	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
T-201	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
T-202	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
T-203	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm

1	47	48	49	50	51	52	53	54	55
Tank #	non-convective waste yield stress mean (Pa)	non-convective waste yield stress std dev (Pa)	non-convective waste yield stress min (Pa)	non-convective waste yield stress max (Pa)	non-convective waste yield stress dist type (Pa)	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 std dev	Headspace gas ratio CH4 min
C-203	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
C-204	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
S-101	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-102	631.25	260.88	109.49	1674.77	Normal	0.020	0.020	0.004	0.012
S-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-104	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-106	631.25	260.88	109.49	1674.77	Normal	0.013	0.013	0.006	0.000
S-107	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
S-108	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-109	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-110	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
S-111	631.25	260.88	109.49	1674.77	Normal	0.014	0.014	0.002	0.010
S-112	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-101	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-104	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-106	631.25	260.88	109.49	1674.77	Normal	0.017	0.017	0.007	0.005
SX-107	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-108	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-109	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
SX-110	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-111	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-112	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-113	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-114	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SX-115	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
SY-101	144	13.87	88.52	199.48	Normal	0.065	0.065	0.026	0.015
SY-102	829.55	218.64	173.63	1704.11	LogNorm	0.053	0.053	0.056	0.001
SY-103	144	13.87	88.52	199.48	Normal	0.053	0.053	0.056	0.001
T-101	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
T-102	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-103	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-105	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-106	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-107	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-108	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
T-109	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
T-110	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-111	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-112	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-201	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-202	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
T-203	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001

1	56	57	58	59	60	61	62	63	64	65
Tank #	Headspace gas ratio CH4 max	Headspace gas ratio CH4 type	Headspace gas ratio N2O mean	Headspace gas ratio N2O mean	Headspace gas ratio N2O std dev	Headspace gas ratio N2O min	Headspace gas ratio N2O max	Headspace gas ratio N2O type	Retained gas composition N2 mean	Retained gas composition N2 mean
C-203	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
C-204	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-102	0.031	Normal	0.481	0.481	0.022	0.414	0.549	Normal	32.246	32.246
S-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-106	0.030	Normal	0.131	0.131	0.015	0.098	0.169	Normal	25.217	25.217
S-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
S-111	0.019	Normal	0.135	0.135	0.017	0.092	0.190	Normal	20.990	20.990
S-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-106	0.034	Normal	0.315	0.315	0.015	0.275	0.360	Normal	20.203	20.203
SX-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-113	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-114	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SX-115	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SY-101	0.150	Normal	0.361	0.361	0.049	0.226	0.501	Normal	33.875	33.875
SY-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
SY-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-201	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-202	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
T-203	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840

1	66	67	68	69	70	71	72	73	74	75
Tank #	Retained gas composition N2 std dev	Retained gas composition N2 min	Retained gas composition N2 max	Retained gas composition N2 type	Retained gas composition NH3 mean	Retained gas composition NH3 mean	Retained gas composition NH3 std dev	Retained gas composition NH3 min	Retained gas composition NH3 max	Retained gas composition NH3 type
C-203	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
C-204	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-102	3.074	23.974	40.719	Normal	0.932	0.932	0.288	0.347	1.624	Normal
S-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-106	3.789	15.249	34.922	Normal	0.299	0.299	0.067	0.094	0.520	Normal
S-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
S-111	5.953	4.556	34.751	Normal	0.929	0.929	0.285	0.355	1.603	Normal
S-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-106	3.446	10.198	29.551	Normal	4.202	4.202	1.255	1.790	6.805	Normal
SX-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-113	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-114	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SX-115	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SY-101	6.784	13.360	53.313	Normal	9.172	9.172	2.987	3.274	15.767	Normal
SY-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
SY-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-201	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-202	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
T-203	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin

1	76	77	78	79	80	81
Tank #	Hydrogen Generation Rate in Non-Convective Waste (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Min (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Max (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Dist Type (moles/m3/day)	Cross sectional area of tank (m2)	Waste Type
C-203	1.34E-01	6.71E-02	2.55E-01	triangular	29.19	SL-NL
C-204	4.57E-03	2.28E-03	8.68E-03	triangular	29.19	SL-NL
S-101	1.22E-03	6.12E-04	1.84E-03	triangular	410.43	MIX-NL
S-102	1.06E-03	5.29E-04	2.01E-03	triangular	410.43	SC/SS-NL
S-103	9.16E-04	4.58E-04	1.74E-03	triangular	410.43	SC/SS-NL
S-104	8.91E-04	4.45E-04	1.69E-03	triangular	410.43	MIX-NL
S-105	3.92E-04	1.96E-04	7.45E-04	triangular	410.43	SC/SS-NL
S-106	4.98E-04	2.49E-04	9.46E-04	triangular	410.43	SC/SS-NL
S-107	8.48E-04	4.24E-04	1.61E-03	triangular	410.43	SL-NL
S-108	3.33E-04	1.66E-04	6.33E-04	triangular	410.43	SC/SS-NL
S-109	3.48E-04	1.74E-04	6.62E-04	triangular	410.43	SC/SS-NL
S-110	6.08E-04	3.04E-04	1.15E-03	triangular	410.43	SC/SS-NL
S-111	7.49E-04	3.74E-04	1.42E-03	triangular	410.43	SC/SS-NL
S-112	4.99E-03	2.50E-03	9.49E-03	triangular	410.43	SC/SS-NL
SX-101	7.14E-04	3.57E-04	1.36E-03	triangular	410.66	MIX-NL
SX-102	1.97E-03	6.56E-04	2.16E-03	triangular	410.66	SC/SS-NL
SX-103	4.94E-03	1.65E-03	5.44E-03	triangular	410.66	SC/SS-NL
SX-104	2.15E-03	7.17E-04	2.37E-03	triangular	410.66	MIX-NL
SX-105	5.85E-03	1.95E-03	6.44E-03	triangular	410.66	SC/SS-NL
SX-106	8.67E-04	4.33E-04	1.65E-03	triangular	410.66	SC/SS-NL
SX-107	5.68E-03	2.84E-03	8.52E-03	triangular	410.66	SL-NL
SX-108	2.69E-03	1.34E-03	5.11E-03	triangular	410.66	SL-NL
SX-109	3.67E-03	1.22E-03	4.03E-03	triangular	410.66	SC/SS-NL
SX-110	1.76E-02	5.87E-03	1.94E-02	triangular	410.66	SL-NL
SX-111	7.52E-03	2.51E-03	8.27E-03	triangular	410.66	SL-NL
SX-112	5.08E-03	2.54E-03	9.65E-03	triangular	410.66	SL-NL
SX-113	5.32E-03	2.66E-03	1.01E-02	triangular	410.66	SL-NL
SX-114	6.30E-03	2.10E-03	6.93E-03	triangular	410.66	SL-NL
SX-115	3.51E-02	1.75E-02	6.67E-02	triangular	410.66	SL-NL
SY-101	5.90E-04	2.95E-04	1.12E-03	triangular	409.91	SC/SS-LIQ
SY-102	2.32E-03	1.16E-03	3.48E-03	triangular	409.91	SL-LIQ
SY-103	1.60E-03	5.34E-04	1.76E-03	triangular	409.91	SC/SS-LIQ
T-101	1.27E-03	6.36E-04	2.42E-03	triangular	410.43	MIX-NL
T-102	1.30E-02	6.51E-03	2.47E-02	triangular	410.43	SL-NL
T-103	4.29E-03	2.14E-03	8.15E-03	triangular	410.43	SL-NL
T-104	4.89E-04	2.45E-04	9.30E-04	triangular	410.43	SL-NL
T-105	1.41E-03	7.03E-04	2.67E-03	triangular	410.43	SL-NL
T-106	4.51E-03	2.25E-03	8.56E-03	triangular	410.43	SL-NL
T-107	1.05E-03	5.27E-04	2.00E-03	triangular	410.43	SL-NL
T-108	6.07E-03	3.04E-03	1.15E-02	triangular	410.43	MIX-NL
T-109	1.66E-03	8.32E-04	3.16E-03	triangular	410.43	SC/SS-NL
T-110	1.02E-03	5.12E-04	1.95E-03	triangular	410.43	SL-NL
T-111	4.10E-04	2.05E-04	7.79E-04	triangular	410.43	SL-NL
T-112	1.75E-03	8.77E-04	3.33E-03	triangular	410.43	SL-NL
T-201	2.08E-03	1.04E-03	3.95E-03	triangular	29.19	SL-NL
T-202	9.28E-04	4.64E-04	1.76E-03	triangular	29.19	SL-NL
T-203	7.89E-04	3.95E-04	1.50E-03	triangular	29.19	SL-NL

1	2	3	4	5	6	7	8	9	10	11	12	13
Tank #	Tank type	Total waste depth (m)	Total waste depth uncertainty (m)	Total non-convective waste depth (m)	Total non-convective waste depth uncertainty (m)	Total non-convective waste depth lower bound (m)	Wetted non-convective waste depth (m)	Wetted non-convective waste depth uncertainty (m)	Wetted non-convective waste depth lower bound (m)	Mean Crust depth (m)	Convective Waste Density Mean (kg/m3)	Convective Waste Density Std Dev (kg/m3)
T-204	SST	4.88	0.292	4.88	0.292	0.010	4.88	0.292	0.000	0.00	1100	65
TX-101	SST	1.03	0.292	1.03	0.292	0.010	1.03	0.292	0.000	0.00	1100	65
TX-102	SST	2.19	0.292	2.19	0.292	0.010	1.52	0.024	0.010	0.00	1100	65
TX-103	SST	1.53	0.292	1.53	0.292	0.010	1.17	0.024	0.000	0.00	1100	65
TX-104	SST	0.83	0.006	0.81	0.292	0.010	0.81	0.292	0.010	0.00	1440	85
TX-105	SST	5.51	0.292	5.51	0.292	0.010	1.44	0.024	0.010	0.00	1100	65
TX-106	SST	3.41	0.292	3.41	0.292	0.010	2.42	0.024	0.010	0.00	1100	65
TX-107	SST	0.46	0.292	0.46	0.292	0.010	0.46	0.292	0.000	0.00	1100	65
TX-108	SST	1.36	0.292	1.36	0.292	0.010	1.36	0.292	0.000	0.00	1100	65
TX-109	SST	3.54	0.292	3.54	0.292	0.010	3.21	0.024	0.010	0.00	1100	65
TX-110	SST	4.51	0.292	4.51	0.292	0.010	1.48	0.024	0.010	0.00	1100	65
TX-111	SST	3.56	0.292	3.56	0.292	0.010	1.83	0.024	0.010	0.00	1100	65
TX-112	SST	6.04	0.292	6.04	0.292	0.010	3.42	0.024	0.010	0.00	1100	65
TX-113	SST	6.08	0.292	6.08	0.292	0.010	1.90	0.024	0.010	0.00	1100	65
TX-114	SST	5.10	0.292	5.10	0.292	0.010	2.00	0.024	0.010	0.00	1100	65
TX-115	SST	5.30	0.292	5.30	0.292	0.010	2.56	0.024	0.010	0.00	1100	65
TX-116	SST	5.71	0.292	5.71	0.292	0.010	1.39	0.024	0.000	0.00	1100	65
TX-117	SST	4.62	0.292	4.62	0.292	0.010	1.13	0.024	0.010	0.00	1100	65
TX-118	SST	2.47	0.292	2.47	0.292	0.010	2.08	0.024	0.010	0.00	1100	65
TY-101	SST	1.28	0.292	1.28	0.292	0.010	1.28	0.292	0.000	0.00	1100	65
TY-102	SST	0.83	0.292	0.83	0.292	0.010	0.83	0.292	0.000	0.00	1100	65
TY-103	SST	1.62	0.292	1.62	0.292	0.010	1.60	0.024	0.010	0.00	1100	65
TY-104	SST	0.60	0.006	0.59	0.292	0.010	0.59	0.292	0.010	0.00	1180	70
TY-105	SST	2.32	0.292	2.32	0.292	0.010	1.65	0.024	0.010	0.00	1100	65
TY-106	SST	0.34	0.292	0.34	0.292	0.010	0.34	0.292	0.000	0.00	1100	65
U-101	SST	0.40	0.292	0.40	0.292	0.010	0.40	0.292	0.000	0.00	1100	65
U-102	SST	3.21	0.292	3.21	0.292	0.010	2.01	0.024	0.010	0.00	1480	87
U-103	SST	4.04	0.292	4.04	0.292	0.010	1.53	0.024	0.010	0.00	1440	85
U-104	SST	1.32	0.292	1.32	0.292	0.010	1.32	0.292	0.000	0.00	1100	65
U-105	SST	3.45	0.292	3.45	0.292	0.010	2.58	0.024	0.010	0.00	1100	65
U-106	SST	1.76	0.006	1.75	0.292	0.010	1.75	0.292	0.010	0.00	1340	79
U-107	SST	2.91	0.292	2.91	0.292	0.010	1.92	0.024	0.010	0.00	1390	82
U-108	SST	4.23	0.292	4.23	0.292	0.010	2.96	0.024	0.010	0.00	1400	83
U-109	SST	3.89	0.292	3.89	0.292	0.010	2.00	0.024	0.010	0.00	1100	65
U-110	SST	1.81	0.292	1.81	0.292	0.010	0.81	0.024	0.010	0.00	1100	65
U-111	SST	2.24	0.292	2.24	0.292	0.010	1.84	0.024	0.010	0.00	1100	65
U-112	SST	0.61	0.292	0.61	0.292	0.010	0.61	0.292	0.000	0.00	1100	65
U-201	SST	0.73	0.006	0.58	0.292	0.010	0.58	0.292	0.010	0.00	1260	74
U-202	SST	0.69	0.006	0.54	0.292	0.010	0.54	0.292	0.010	0.00	1280	76
U-203	SST	0.65	0.006	0.50	0.292	0.010	0.50	0.292	0.010	0.00	1280	76
U-204	SST	0.58	0.006	0.42	0.292	0.010	0.42	0.292	0.010	0.00	1110	65

1	14	15	16	17	18	19	20	21	22	23	24
Tank #	Convective Waste Density Min (kg/m3)	Convective Waste Density Max (kg/m3)	Convective Waste Density Dist (kg/m3)	Non-Convective Waste Density Mean (kg/m3)	Non-Convective Waste Density Std Dev (kg/m3)	Non-Convective Waste Density Min (kg/m3)	Non-Convective Waste Density Max (kg/m3)	Non-Convective Waste Density Dist (kg/m3)	Non-Convective Waste Average Temperature (K)	Tank Vapor Space Average Temperature (K)	Tank type group
T-204	1000	1227	normal	1,180	89	1,005	1,355	normal	290	294	t2
TX-101	1000	1227	normal	1,740	131	1,482	1,997	normal	298	297	tx
TX-102	1000	1227	normal	1,614	122	1,375	1,853	normal	300	298	tx
TX-103	1000	1227	normal	1,611	122	1,372	1,849	normal	295	295	tx
TX-104	1273	1607	normal	1,737	131	1,480	1,994	normal	294	294	tx
TX-105	1000	1227	normal	1,634	123	1,392	1,876	normal	307	297	tx
TX-106	1000	1227	normal	1,620	122	1,380	1,860	normal	299	299	tx
TX-107	1000	1227	normal	1,782	135	1,518	2,046	normal	295	295	tx
TX-108	1000	1227	normal	1,622	122	1,382	1,862	normal	294	294	tx
TX-109	1000	1227	normal	1,430	108	1,218	1,642	normal	308	312	tx
TX-110	1000	1227	normal	1,618	122	1,379	1,858	normal	301	295	tx
TX-111	1000	1227	normal	1,612	122	1,373	1,850	normal	298	296	tx
TX-112	1000	1227	normal	1,633	123	1,391	1,874	normal	295	296	tx
TX-113	1000	1227	normal	1,608	121	1,370	1,846	normal	294	291	tx
TX-114	1000	1227	normal	1,634	123	1,392	1,876	normal	294	291	tx
TX-115	1000	1227	normal	1,628	123	1,387	1,869	normal	295	294	tx
TX-116	1000	1227	normal	1,658	125	1,412	1,903	normal	294	293	tx
TX-117	1000	1227	normal	1,581	119	1,347	1,816	normal	294	293	tx
TX-118	1000	1227	normal	1,692	128	1,441	1,942	normal	297	294	tx
TY-101	1000	1227	normal	1,627	123	1,386	1,868	normal	292	293	ty
TY-102	1000	1227	normal	1,756	133	1,496	2,015	normal	289	293	ty
TY-103	1000	1227	normal	1,681	127	1,432	1,929	normal	294	293	ty
TY-104	1044	1316	normal	1,650	125	1,406	1,894	normal	293	293	ty
TY-105	1000	1227	normal	1,530	116	1,304	1,756	normal	298	295	ty
TY-106	1000	1227	normal	1,400	106	1,193	1,607	normal	289	293	ty
U-101	1000	1227	normal	1,770	134	1,508	2,032	normal	294	295	u
U-102	1309	1651	normal	1,673	126	1,425	1,920	normal	299	301	u
U-103	1273	1607	normal	1,702	128	1,450	1,954	normal	301	299	u
U-104	1000	1227	normal	1,427	108	1,216	1,638	normal	301	298	u
U-105	1000	1227	normal	1,670	126	1,423	1,918	normal	301	296	u
U-106	1185	1495	normal	1,552	117	1,323	1,782	normal	300	295	u
U-107	1229	1551	normal	1,738	131	1,481	1,995	normal	297	297	u
U-108	1238	1562	normal	1,681	127	1,432	1,929	normal	303	300	u
U-109	1000	1227	normal	1,653	125	1,408	1,897	normal	303	298	u
U-110	1000	1227	normal	1,715	130	1,462	1,969	normal	298	298	u
U-111	1000	1227	normal	1,609	121	1,371	1,847	normal	298	298	u
U-112	1000	1227	normal	1,743	132	1,485	2,000	normal	294	294	u
U-201	1114	1406	normal	1,630	123	1,389	1,871	normal	290	290	u2
U-202	1132	1428	normal	1,510	114	1,287	1,733	normal	292	292	u2
U-203	1132	1428	normal	1,590	120	1,355	1,825	normal	292	292	u2
U-204	1000	1238	normal	1,470	111	1,252	1,688	normal	291	292	u2

1	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Tank #	Total tank volume (m3)	OSD Maximum Operating Limit (m)	Dish type	Dish height (m)	Dish volume (kL)	Dish Radius (m)	Knuckle height (m)	Knuckle volume (M3)	Knuckle Radius (m)	Body height (m)	Body volume (M3)	Body Operating Capacity (m3/m)	Body Radius (m)	Dome Arc height (m)
T-204	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
TX-101	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-102	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-103	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-104	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-105	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-106	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-107	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-108	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-109	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-110	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-111	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-112	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-113	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-114	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-115	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-116	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-117	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TX-118	3,967	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.079	2,495.07	410.44	11.430	0.0000
TY-101	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
TY-102	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
TY-103	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
TY-104	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
TY-105	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
TY-106	3,975	7.14	dished	0.3048	50.6413	173.6110	1.2171	477.3316	1.2192	6.098	2,502.89	410.44	11.430	0.0000
U-101	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-102	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-103	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-104	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-105	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-106	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-107	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-108	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-109	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-110	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-111	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-112	3,215	4.80	dished	0.3048	50.6778	173.7360	1.2171	477.6507	1.2192	4.269	1,752.29	410.44	11.430	0.0000
U-201	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
U-202	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
U-203	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000
U-204	225	7.24	dished	0.1524	1.2214	16.7894	0.9065	23.3622	0.9144	6.866	200.39	29.19	3.048	0.0000

1	39	40	41	42	43	44	45	46
Tank #	Dome Arc volume (M3)	Dome Arc Radius (m)	Tank capacity (kL/m)	Void Fraction or Maximum Wetted Solids Void Fraction Mean (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Uncertainty (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Minimum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Maximum (Dimension-less)	Void Fraction or Maximum Wetted Solids Void Fraction Dist Type (Dimension-less)
T-204	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
TX-101	0.000	0.0000	410.44	0.900	0.45	0.01	26.5	normal
TX-102	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-103	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-104	0.000	0.0000	410.44	1.200	0.6	0.01	40	normal
TX-105	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-106	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-107	0.000	0.0000	410.44	2.100	1.05	0.01	40	normal
TX-108	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-109	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
TX-110	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-111	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-112	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-113	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-114	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-115	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-116	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-117	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TX-118	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TY-101	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TY-102	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TY-103	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
TY-104	0.000	0.0000	410.44	1.700	0.85	0.01	26.5	normal
TY-105	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
TY-106	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
U-101	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
U-102	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
U-103	0.000	0.0000	410.44	8.000	4	0.01	40	normal
U-104	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
U-105	0.000	0.0000	410.44	7.300	3.65	0.01	40	normal
U-106	0.000	0.0000	410.44	1.500	0.75	0.01	40	normal
U-107	0.000	0.0000	410.44	7.600	3.8	0.01	40	normal
U-108	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
U-109	0.000	0.0000	410.44	4.100	2.05	0.01	40	normal
U-110	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
U-111	0.000	0.0000	410.44	8.838	7.1328	0.01	40	normal
U-112	0.000	0.0000	410.44	2.437	2.4869	0.01	26.5	Lognorm
U-201	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
U-202	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
U-203	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm
U-204	0.000	0.0000	29.19	2.437	2.4869	0.01	26.5	Lognorm

1	47	48	49	50	51	52	53	54	55
Tank #	non-convective waste yield stress mean (Pa)	non-convective waste yield stress std dev (Pa)	non-convective waste yield stress min (Pa)	non-convective waste yield stress max (Pa)	non-convective waste yield stress dist type (Pa)	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 mean	Headspace gas ratio CH4 std dev	Headspace gas ratio CH4 min
T-204	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
TX-101	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
TX-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-104	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-106	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-107	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-108	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-109	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
TX-110	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-111	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-112	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-113	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-114	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-115	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-116	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-117	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TX-118	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TY-101	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TY-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TY-103	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
TY-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
TY-105	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
TY-106	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-101	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-102	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
U-103	631.25	260.88	109.49	1674.77	Normal	0.057	0.057	0.011	0.034
U-104	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-105	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
U-106	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
U-107	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
U-108	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
U-109	631.25	260.88	109.49	1674.77	Normal	0.049	0.049	0.013	0.024
U-110	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-111	631.25	260.88	109.49	1674.77	Normal	0.053	0.053	0.056	0.001
U-112	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-201	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-202	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-203	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001
U-204	1143.27	272.08	327.03	2231.59	LogNorm	0.053	0.053	0.056	0.001

1	56	57	58	59	60	61	62	63	64	65
Tank #	Headspace gas ratio CH4 max	Headspace gas ratio CH4 type	Headspace gas ratio N2O mean	Headspace gas ratio N2O mean	Headspace gas ratio N2O std dev	Headspace gas ratio N2O min	Headspace gas ratio N2O max	Headspace gas ratio N2O type	Retained gas composition N2 mean	Retained gas composition N2 mean
T-204	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-109	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-113	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-114	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-115	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-116	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-117	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TX-118	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TY-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TY-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TY-103	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TY-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TY-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
TY-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-101	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-102	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-103	0.082	Normal	0.603	0.603	0.015	0.561	0.645	Normal	36.711	36.711
U-104	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-105	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-106	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-107	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-108	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-109	0.087	Normal	0.489	0.489	0.031	0.402	0.577	Normal	46.777	46.777
U-110	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-111	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-112	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-201	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-202	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-203	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840
U-204	0.318	LogNorm	0.253	0.253	0.176	0.001	0.619	LogNorm	29.840	29.840

1	66	67	68	69	70	71	72	73	74	75
Tank #	Retained gas composition N2 std dev	Retained gas composition N2 min	Retained gas composition N2 max	Retained gas composition N2 type	Retained gas composition NH3 mean	Retained gas composition NH3 mean	Retained gas composition NH3 std dev	Retained gas composition NH3 min	Retained gas composition NH3 max	Retained gas composition NH3 type
T-204	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-109	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-113	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-114	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-115	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-116	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-117	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TX-118	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TY-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TY-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TY-103	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TY-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TY-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
TY-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-101	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-102	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-103	2.018	30.945	42.561	Normal	0.596	0.596	0.156	0.246	0.963	Normal
U-104	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-105	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-106	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-107	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-108	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-109	3.188	36.854	56.618	Normal	1.007	1.007	0.328	0.354	1.812	Normal
U-110	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-111	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-112	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-201	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-202	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-203	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin
U-204	12.010	4.500	80.000	LogNorm	0.250	0.250		0.010	18.318	ContLin

1	76	77	78	79	80	81
Tank #	Hydrogen Generation Rate in Non-Convective Waste (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Min (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Max (moles/m3/day)	Hydrogen Generation Rate in Non-Convective Waste Dist Type (moles/m3/day)	Cross sectional area of tank (m2)	Waste Type
T-204	7.88E-04	3.94E-04	1.50E-03	triangular	29.19	SL-NL
TX-101	1.74E-03	8.71E-04	3.31E-03	triangular	410.43	SL-NL
TX-102	6.57E-04	3.28E-04	1.25E-03	triangular	410.43	SC/SS-NL
TX-103	8.77E-04	4.39E-04	1.67E-03	triangular	410.43	SC/SS-NL
TX-104	1.96E-03	9.81E-04	3.73E-03	triangular	410.43	MIX-NL
TX-105	3.54E-04	1.77E-04	6.72E-04	triangular	410.43	SC/SS-NL
TX-106	5.12E-04	2.56E-04	9.72E-04	triangular	410.43	SC/SS-NL
TX-107	3.55E-03	1.77E-03	6.74E-03	triangular	410.43	SC/SS-NL
TX-108	9.30E-04	4.65E-04	1.77E-03	triangular	410.43	SC/SS-NL
TX-109	6.04E-04	3.02E-04	1.15E-03	triangular	410.43	SL-NL
TX-110	3.82E-04	1.91E-04	7.26E-04	triangular	410.43	SC/SS-NL
TX-111	4.37E-04	2.18E-04	8.30E-04	triangular	410.43	SC/SS-NL
TX-112	3.28E-04	1.64E-04	6.23E-04	triangular	410.43	SC/SS-NL
TX-113	3.04E-04	1.52E-04	5.77E-04	triangular	410.43	SC/SS-NL
TX-114	3.39E-04	1.69E-04	6.44E-04	triangular	410.43	SC/SS-NL
TX-115	3.39E-04	1.70E-04	6.45E-04	triangular	410.43	SC/SS-NL
TX-116	3.12E-04	1.56E-04	5.93E-04	triangular	410.43	SC/SS-NL
TX-117	3.51E-04	1.75E-04	6.67E-04	triangular	410.43	SC/SS-NL
TX-118	8.02E-04	4.01E-04	1.52E-03	triangular	410.43	SC/SS-NL
TY-101	9.50E-04	4.75E-04	1.80E-03	triangular	410.43	MIX-NL
TY-102	1.55E-03	7.77E-04	2.95E-03	triangular	410.43	SC/SS-NL
TY-103	9.37E-04	4.69E-04	1.78E-03	triangular	410.43	MIX-NL
TY-104	2.76E-03	1.38E-03	5.24E-03	triangular	410.43	SL-NL
TY-105	9.30E-04	4.65E-04	1.77E-03	triangular	410.43	SL-NL
TY-106	6.31E-03	3.15E-03	1.20E-02	triangular	410.43	SL-NL
U-101	5.32E-03	2.66E-03	1.01E-02	triangular	410.43	SL-NL
U-102	1.20E-03	5.98E-04	2.27E-03	triangular	410.43	SC/SS-NL
U-103	1.24E-03	6.19E-04	1.86E-03	triangular	410.43	SC/SS-NL
U-104	1.64E-03	8.22E-04	3.12E-03	triangular	410.43	SL-NL
U-105	1.15E-03	5.77E-04	2.19E-03	triangular	410.43	SC/SS-NL
U-106	2.27E-03	1.13E-03	4.31E-03	triangular	410.43	SC/SS-NL
U-107	7.47E-04	3.74E-04	1.42E-03	triangular	410.43	SC/SS-NL
U-108	9.28E-04	4.64E-04	1.76E-03	triangular	410.43	SC/SS-NL
U-109	7.82E-04	3.91E-04	1.49E-03	triangular	410.43	SC/SS-NL
U-110	1.19E-03	5.96E-04	2.26E-03	triangular	410.43	SL-NL
U-111	9.08E-04	4.54E-04	1.72E-03	triangular	410.43	SC/SS-NL
U-112	2.76E-03	1.38E-03	5.23E-03	triangular	410.43	SL-NL
U-201	2.86E-03	1.43E-03	5.44E-03	triangular	29.19	SL-NL
U-202	3.09E-03	1.55E-03	5.87E-03	triangular	29.19	SL-NL
U-203	3.37E-03	1.69E-03	6.41E-03	triangular	29.19	SL-NL
U-204	1.04E-02	5.22E-03	1.98E-02	triangular	29.19	SL-NL

H3.0 USE OF COMPUTER SOFTWARE

The input data shown from the "MC_Data" worksheet are included in the RPP-10006 Rev 5 Data Rebuild 060306.xls spreadsheet. Additional spreadsheet information follows below.

Spreadsheet Verification Form Number: SVF-1118

Base Software: Microsoft Excel[1] 2003

Spreadsheet Title: RPP-10006 Rev 5 Data Rebuild 060306.xls.

Document: RPP-29167

Author: V. S. Anda

Purpose: Compilation of tank property data and source of data for RPP-10006 database

H4.0 REFERENCES

OSD-T-151-00007, 2005, *Operating Specifications for the Double-Shell Storage Tanks*, Rev. J-0, CH2M HILL Hanford Group, Inc., Richland, Washington.

OSD-T-151-00013, 2005, *Operating Specifications for Single-Shell Waste Storage Tanks*, Rev. F-2, CH2M HILL Hanford Group, Inc., Richland, Washington.

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RPP-5926, 2005, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-6655, 2000, *Data Observations on Double-Shell Flammable Gas Watch List Tank Behavior*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-7625, 2006, *Best-Basis Inventory Process Requirements*, Rev. 6, CH2M HILL Hanford Group, Inc., Richland, Washington.

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[1] Excel is a registered trademark of Microsoft Corporation, Redmond, Washington.

RPP-10006, 2006, *Methodology and Calculations for the Waste Groups for Large Underground Waste Storage Tanks at the Hanford Site*, Rev. 5, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13019, 2003, *Determination of Hanford Waste Tank Volumes*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-29167, 2006, *Spreadsheet Description Document for RPP-10006 Rev 5 Data Rebuild 060306.xls*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

SVF-1118, 2006, *Spreadsheet Verification & Release Form for Spreadsheet RPP-10006 Rev 5 Data Rebuild 060306.xls*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

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APPENDIX I

PEER REVIEW CHECKLIST

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APPENDIX I

PEER REVIEW CHECKLIST

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

Scope of Review: complete document
(e.g., document section or portion of calculation)

Engineer/Analyst: S. A. Barker [signature] Date: 7/25/2006

Organizational Mgr: M. A. Knight [signature] Date: 7/25/2006

This document consists of _____ pages and the following attachments (if applicable):

Yes	No	NA*		
[X]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[X]	[ ]	[ ]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[X]	[ ]	[ ]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[X]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[X]	[ ]	[ ]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[X]	[ ]	[ ]	6.	Mathematical derivations were checked including dimensional consistency of results.
[X]	[ ]	[ ]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[X]	[ ]	[ ]	8.	Software verification and validation are addressed adequately.
[X]	[ ]	[ ]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[X]	[ ]	[ ]	10.	Conclusions are consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	11.	Results and conclusions address all points in the purpose.
[ ]	[ ]	[X]	12.	Referenced documents are retrievable or otherwise available.
[ ]	[ ]	[X]	13.	The version or revision of each reference is cited.
[ ]	[ ]	[X]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[X]	[ ]	[ ]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents as appropriate.
[ ]	[ ]	[X]	16.	All checker comments have been dispositioned and the design media matches the calculations.

T. A. Hu [signature] 7/25/2006
Checker (Printed Name and Signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

	Items 12, 13, 14, & 16 are separately reviewed by
	the technical editor

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

Scope of Review: complete document
(e.g., document section or portion of calculation)

Engineer/Analyst: S. A. Barker [signature] Date: 7/25/2006

Organizational Mgr: M. A. Knight [signature] Date: 7/25/2006

This document consists of _____ pages and the following attachments (if applicable):

Yes	No	NA*		
[✓]	[ ]	[ ]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[✓]	[ ]	[ ]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[ ]	[ ]	[✓]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[✓]	[ ]	[ ]	4.	Input data were checked for consistency with original source information.
[✓]	[ ]	[ ]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[ ]	[✓]	[ ]	6.	Mathematical derivations were checked including dimensional consistency of results.
[✓]	[ ]	[ ]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[✓]	[ ]	[ ]	8.	Software verification and validation are addressed adequately.
[✓]	[ ]	[ ]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[✓]	[ ]	[ ]	10.	Conclusions are consistent with analytical results and applicable limits.
[✓]	[ ]	[ ]	11.	Results and conclusions address all points in the purpose.
[✓]	[ ]	[ ]	12.	Referenced documents are retrievable or otherwise available.
[✓]	[ ]	[ ]	13.	The version or revision of each reference is cited.
[✓]	[ ]	[ ]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[ ]	[✓]	[ ]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents as appropriate.
[✓]	[ ]	[ ]	16.	All checker comments have been dispositioned and the design media matches the calculations.

V. Anda [signature] 7/25/2006
Checker (Printed Name and Signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

3	Calculations are performed separately
	and summarized in this document,
6	Mathematical derivations were checked by

the other reviewer, T.A. Hu.

15 Paperwork will be initiated to revise appropriate documentation following document release.

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

Scope of Review: complete document
(e.g., document section or portion of calculation)

Engineer/Analyst: S. A. Barker [signature] Date: 7/25/2006

Organizational Mgr: M. A. Knight [signature] Date: 7/25/2006

This document consists of ____ pages and the following attachments (if applicable):

Yes	No	NA*		
[]	[]	[X]	1.	Analytical and technical approaches and results are reasonable and appropriate.
[]	[]	[X]	2.	Necessary assumptions are reasonable, explicitly stated, and supported.
[]	[]	[X]	3.	Ensure calculations that use software include a paper printout, microfiche, CD ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
[]	[]	[X]	4.	Input data were checked for consistency with original source information.
[]	[]	[X]	5.	For both qualitative and quantitative data, uncertainties are recognized and discussed.
[]	[]	[X]	6.	Mathematical derivations were checked including dimensional consistency of results.
[]	[]	[X]	7.	Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
[]	[]	[X]	8.	Software verification and validation are addressed adequately.
[]	[]	[X]	9.	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[]	[]	[X]	10.	Conclusions are consistent with analytical results and applicable limits.
[]	[]	[X]	11.	Results and conclusions address all points in the purpose.
[X]	[]	[]	12.	Referenced documents are retrievable or otherwise available.
[X]	[]	[]	13.	The version or revision of each reference is cited.
[X]	[]	[]	14.	The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
[]	[]	[X]	15.	Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents as appropriate.
[X]	[]	[]	16.	All checker comments have been dispositioned and the design media matches the calculations.

L. M.. Germain [signature] 7/25/2006
Checker (Printed Name and Signature) Date

* If No or NA is chosen, an explanation must be provided on or attached to this form.

Calculation Reviewed: RPP-10006, Rev. 5, *Methodology and Calculations for the Assignment of Waste Groups for the Large Underground Waste Storage Tanks at the Hanford Site*

All NA	Technical editing and text editing only