

# Strontium-90 Liquid Concentration Solubility Correlation in the Hanford Tank Waste Operations Simulator

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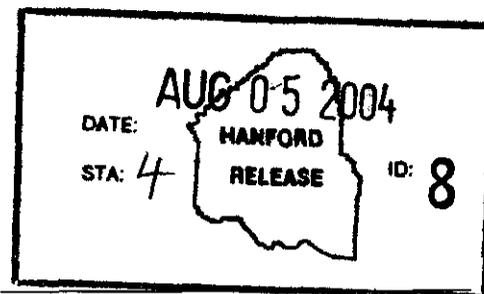
**Key Words:** Strontium, Strontium-90, Total Organic Carbon, TOC, HTWOS Sr, Sr-90, Solubility, Partitioning, Wash Factor, Low-Activity Waste, LAW Feed

**Abstract:** A new correlation was developed to estimate the concentration of strontium-90 in a waste solution based on total organic carbon. This correlation replaces the strontium-90 wash factors, and when applied in the Hanford Tank Waste Operations Simulator, significantly reduced the estimated quantity of strontium-90 in the delivered low-activity waste feed. This is thought to be a more realistic estimate of strontium-90 than using the wash-factor method.

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# **STRONTIUM-90 LIQUID CONCENTRATION SOLUBILITY CORRELATION IN THE HANFORD TANK WASTE OPERATIONS SIMULATOR**

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**LIST OF TERMS**

|        |  |
|--------|--|
| BBI    | Best-Basis Inventory                                       |
| DST    | Double-shell tank  |
| g/L    | gram per Liter   |
| HDW    | Hanford Defined Waste                                      |
| HLW    | High-level waste   |
| HTWOS  | Hanford Tank Waste Operations Simulator                    |
| LAW    | Low activity waste   |
| Sr-90  | Strontium-90   |
| SST    | Single-shell tank  |
| TCD    | Tank Characterization Database                             |
| TFCOUP | <i>Tank Farm Contractor Operation and Utilization Plan</i> |
| TIA    | Technical integration activity                             |
| TOC    | Total organic carbon                                       |
| μCi/mL | micro-Curies per milli-Liter                               |
| μg/mL  | micro-gram per milli-Liter                                 |
| WTP    | Waste Treatment and Immobilization Plant                   |

## 1.0 INTRODUCTION

This report presents a correlation for the concentration of strontium-90 (Sr-90) in the liquid phase as a function of total organic carbon (TOC) concentration for Hanford Site single-shell tank (SST) and double-shell tank (DST) wastes. This work was performed as a follow-up action to one of the recommendations made during an assessment of out-of-specification feed sanctioned by the Technical Integration Activity (TIA) Team. The TIA Team is comprised of members from the U.S. Department of Energy, Office of River Protection, Bechtel National, Inc., and CH2M HILL Hanford Group, Inc. The assessment found that the wash factor data for Sr-90 was "poor". The assessment also concluded that the Hanford Defined Waste (HDW) model (LA-UR-96-3860, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4*) solubility creates unrealistically high Sr-90 liquid concentrations. The Sr-90 correlation was developed to take the place of water wash factors for Sr-90 since the use of water wash factors for strontium was incorrectly predicting that >20% of the feed delivered to the Waste Treatment and Immobilization Plant (WTP) would require strontium removal (D-03-DESIGN-005 2003, *Evaluation of Tank Waste Wash and Leach Factors*).

The correlation is based on 51 pairs of liquid-phase Sr-90 and TOC data. Two models were developed based on this data. The first model correlation (Model 1) fit well but had some unacceptable drawbacks. The second model correlation (Model 2) was also a good fit and did not have the same drawbacks as the Model 1 correlation. Therefore, the Model 2 correlation was chosen to be the preferred equation. More details of the derivation of the Sr-90 to TOC correlation is documented in Section 2.0.

Sr-90 concentrations in low-activity waste (LAW) and high-level waste (HLW) feed liquids are tracked using the Hanford Tank Waste Operations Simulator (HTWOS) to see if they meet WTP contract limits. The description of how the correlation is integrated into the HTWOS model and demonstration of its successful incorporation is presented in Section 3.0.

## 2.0 DERIVATION OF THE STRONTIUM-90 SOLUBILITY CORRELATION

Correlations between the Sr-90 concentrations in solution and the liquid phase TOC concentrations were established using sample-based data from the Best-Basis Calculation Detail Reports (TWINS 2004a). The Best-Basis Inventory (BBI) data are traceable to sample data reported in the Tank Characterization Database (TCD) (TWINS 2004b).

## 2.1 CRITERIA FOR SOLUBILITY ESTIMATES

The criteria for the Sr-90 solubility correlation evolved during development. The following points summarize the results of several discussions:

- The correlation must be simple and easy to implement in HTWOS. Iterative or logical branching calculations are to be avoided whenever possible. A single equation describing a continuous curve is preferred.
- Estimates are to be best estimate (Best-Basis) as opposed to conservative, bounding limits.
- Dependencies must rely on analytes that are already included in the standard BBI analyte list (24 chemicals and 46 radionuclides).
- Equations should be tied to solubility theory or postulated behavior in as far as is practical.
- Equations must not result in abnormal behavior, such as negative concentrations or regions where the solubility moves opposite to the expected direction (e.g. reductions in metal/radionuclide solubility with increasing TOC).
- Existing data sources to be used whenever possible.

## 2.2 ASSUMPTIONS

A number of assumptions are necessary to establish a correlation for Sr-90 solubility with TOC.

1. Strontium solubility behavior during retrieval and feed staging will be similar to that currently exhibited in the stored tanks wastes.
2. The concentrations of organic complexants and the solution pH are the primary factors influencing strontium solubility.
3. Wastes will be retrieved to DSTs prior to feed delivery to the WTP. Since corrosion specifications for the DSTs require a minimum of 0.01 molar free hydroxide, pH will not significantly influence strontium solubility after waste retrieval.
4. The TOC concentration is assumed to be a suitable surrogate for the unknown organic species which are forming the actual soluble complex with strontium.
5. The Sr-90 liquid concentration is assumed to be an acceptable substitute for the total chemical strontium concentration (which is actually the controlling factor for solubility). This assumption is required as chemical strontium is not accurately measured in the Hanford tank waste liquids. Approximately 99% of the strontium Inductively Coupled Plasma "ICP" analyses for liquids available in the TCD (TWINS 2004b) are below detection limits, "R" qualified (data not usable) or "J" qualified (estimates). The remaining data are likely to contain a large percentage of outliers due to the proximity to the analytical detection limits.
6. Chemical strontium will partition identically to Sr-90 when subjected to water washing. The fraction of the chemical strontium transferred between phases during dissolution or precipitation will match that of Sr-90 (i.e. no isotopic depletion or enrichment for material transferred between phases).

7. Decay of Sr-90 from the January 1, 2001 BBI radionuclide baseline date will be ignored as accurate measurements of chemical strontium are unavailable. Consequently the strontium isotopic distribution can not be established.

## 2.3 DATA SOURCES

The Sr-90 and TOC concentrations summarized by the Best-Basis Calculation Report (TWINS 2004a) were selected as the data source for developing the Sr-90 solubility correlation since an adequate number of sample-based data points is readily available without extensive data manipulation and evaluation. The initial query of TOC and Sr-90 data was made in December 2003, and updated in March 2004. Fifty-three data pairs were available for liquid phases, most representing low Sr-90 and TOC concentrations. Two data sources were excluded from the data evaluation: tank 241-C-103 and tank 241-U-106.

The tank 241-C-103 data represented a solution that was below pH 10. Sr-90 solubility is known to increase with reduced pH. The effects of TOC (if any) would be masked by the pH effects.

The TOC in the 241-U-106 liquid phase appears to be totally different than for any other high TOC waste (the Sr-90 concentration would be expected to be much higher than that measured). The raw data supporting the BBI concentrations were examined and appear to be valid. There is a significant difference between the mean TOC concentrations measured by persulfate oxidation and furnace oxidation analytical methods ( $3.38\text{E}+04$   $\mu\text{g/mL}$  versus  $4.28\text{E}+04$   $\mu\text{g/mL}$  respectively). This difference suggests that the TOC in the tank 241-U-106 liquid phase is resistant to oxidation since furnace oxidation generally results in more complete oxidation than persulfate oxidation method when a "rugged" organic is present. The tank 241-U-106 data were excluded from curve fitting as no reasonable relationship between Sr-90 and TOC concentrations can accommodate this divergent result.

## 2.4 DEVELOPMENT OF THE STRONTIUM-90 SOLUBILITY CORRELATION

### 2.4.1 Model 1

The first model developed was of the form  $y=A+(B-A)/(1+\exp(-\lambda*(x-C)))$  which assumes upper and lower asymptotes (constants B and A respectively). The lower asymptote was set at the average of all Sr-90 concentrations corresponding to less than 10 g/L TOC, and the upper asymptote was set slightly above the highest Sr-90 concentration reported. The anomalous tank 241-U-106 data was excluded from the curve fitting. The remaining two constants (C and  $\lambda$ ) were optimized using the Solver function in an Excel spreadsheet by minimizing the sum of the squared deviations between predicted and measured Sr-90 concentrations. Weighting factors of 10 were applied to squared deviations for TOC concentrations of greater than 10 g/L to keep the numerous data points with low TOC and Sr-90 concentrations from controlling the curve fit at higher TOC concentrations.

The resulting data fit was excellent (see Figure 2-1). However, the model has three drawbacks: 1) there was no assurance that an upper solubility limit actually exists, 2) there is no tie-in to solubility theory or postulated Sr-90 behavior, and 3) the excellent fit is misleading since four constants were used to achieve this fit.

#### 2.4.2 Model 2

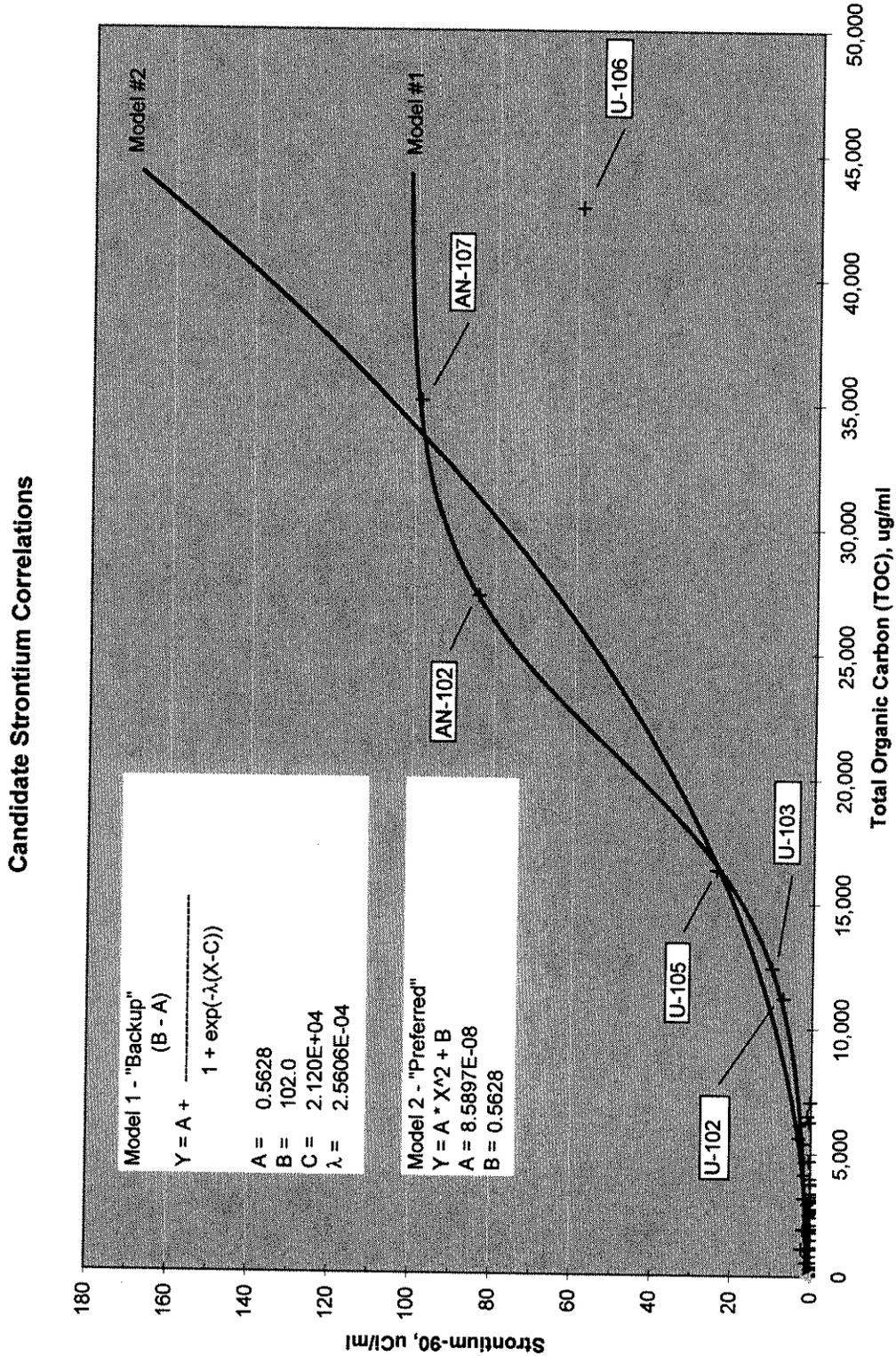
With the exclusion of the data for tank 241-U-106, the data are fit reasonably well by a quadratic equation of the form  $AX^2+BX+C$  (correlation coefficient of 97%); however, the result dips below zero Sr-90 concentration and includes a region of negative slope with increasing TOC. The second order dependence on the TOC concentration suggests that two molecules of the unknown organic chelating agent are required to complex each mole of strontium (which has a +2 valence). Additionally, the Sr-90 solubility was thought to consist of two components: a low baseline solubility representing sparingly soluble metal compounds and the additive effects of chelation at higher TOC concentrations.

Therefore, a truncated equation of the form  $AX^2 + B$  was adopted, for which the variable B was set at the average Sr-90 concentration for all data points having less than 10 g/L TOC. Weighting factors of 10 were again applied to squared deviations for TOC concentrations of greater than 10 to improve the fit at higher TOC concentrations. The resulting correlation is not quite as good as with Model 1, but it is still excellent (correlation coefficient of 97%). The Model 2 correlation did not assume an upper-bounding Sr-90 solubility limit for highly complexed waste and the correlation exhibits a postulated solubility behavior for Sr-90 (see Figure 2-1).

### 2.5 RECOMMENDED CORRELATION FOR STRONTIUM-90 SOLUBILITY

Model 2 [ $^{90}\text{Sr}$  Concentration =  $8.5897\text{E-}08 \times (\text{TOC})^2 + 0.5628$  in units of  $\mu\text{Ci/mL}$  and  $\mu\text{g/mL}$ ] is the preferred equation describing Sr-90 solubility as a function of TOC as it is simpler, has fewer constants and better fits postulated behavior.

Figure 2-1. Strontium Concentration to Total Organic Carbon Concentration Correlations.



### 3.0 IMPLEMENTATION IN THE HANFORD TANK WASTE OPERATIONS SIMULATOR

#### 3.1 INCORPORATION OF STRONTIUM SOLUBILITY MODEL INTO THE HANFORD TANK WASTE OPERATIONS SIMULATOR

A test case was run in HTWOS to test the implementation of a strontium solubility model using the preferred correlation developed in Section 2. The detailed assumptions used in this model are contained in Appendix A. For this test case it is assumed that the partitioning of all strontium between solid and liquid is determined by Model 2, which is described in the previous section. The partitioning for all components other than strontium is calculated once in the HTWOS model by applying water wash factors (HNF-3157, Rev. 0A, *Best-Basis Wash and Leach Factor Analysis*). Given the TOC partitioning determined from the wash factors, the concentration limit for the Sr-90 is set from the relationship

$$C_{\text{Sr-90}} = A C_{\text{TOC}}^2 + B , \quad (3-1)$$

where  $A = 8.5897 \times 10^{-8} (\mu\text{Ci/mL})/(\mu\text{g/mL})^2$ ,  $B = 0.5628 \mu\text{Ci/mL}$  and  $C_{\text{TOC}}$  is the TOC concentration. To satisfy Equation (1) in HTWOS, the strontium concentration is recalculated for any mixing operation. For the receiver tank, the calculation is performed after every transfer time step. The concentrations in the sending tank are normally unchanged during a transfer. Since the relationship [Equation (3-1)] is specified for the Sr-90 concentration alone, an assumption for handling the remainder of the chemical strontium (non Sr-90) is necessary. To avoid isotopic selectivity for the strontium partitioning it was assumed that the Sr-90/strontium ratio of the phase losing material is preserved. Therefore, the precipitating strontium adds to the existing solids in the same Sr-90/Sr-total ratio  $r$  that it has in the liquid; likewise, the dissolving strontium solids adds to the liquid in the same ratio as in the solids. It should be noted that the simple form of Equation (3-1) can be treated explicitly in HTWOS. This is true only because the density calculation is linear. Indirectly the mass of strontium affects the total volume and therefore the concentration of TOC. In this case the allowed mass change of Sr-total ( $\Delta M_{\text{Sr}}$ ) at the limit of Equation (3-1) is the solution of the quadratic equation

$$\left[ r \frac{\partial V_L}{\partial M_{\text{Sr}}} - B \left( \frac{\partial V_L}{\partial M_{\text{Sr}}} \right)^2 \right] \Delta M_{\text{Sr}}^2 + \left( r V_L + \frac{\partial V_L}{\partial M_{\text{Sr}}} M_{\text{Sr-90}} - 2B V_L \frac{\partial V_L}{\partial M_{\text{Sr}}} \right) \Delta M_{\text{Sr}} + M_{\text{Sr-90}} V_L - A M_{\text{TOC}}^2 - B V_L^2 = 0 , \quad (3-2)$$

where:

|                    |   |  |
|--------------------|---|--|
| $r$                | = | “losing” phase Sr-90/Sr-total mass ratio                     |
| $V_L$              | = | initial total liquid volume                                  |
| $M_{\text{Sr}}$    | = | initial Sr-total mass  |
| $B$                | = | 0.5628 $\mu\text{Ci/mL}$                                     |
| $M_{\text{Sr-90}}$ | = | initial Sr-90 mass   |
| $A$                | = | $8.5897 \times 10^{-8} (\mu\text{Ci/mL})/(\mu\text{g/mL})^2$ |
| $M_{\text{TOC}}$   | = | initial TOC mass   |

For more complicated solubility models a closed expression such as Equation (3-2) will not be practical. To allow for more general models in future runs, it was shown that an implicit calculation using a fixed point iteration method rapidly converges to the same result typically after five iterations.

As a test of the HTWOS application of Equation (3-1), a hand calculation for the Sr-90 concentration for each HLW and LAW feed batch was performed and compared with the HTWOS result. Table 3-1 shows selected results from the test using HTWOS reported values good to four significant figures. In each batch the Sr-90 concentration was equal to the Equation (3-1) limit within the expected precision.

**Table 3-1. Independent Check of Hanford Tank Waste Operations Simulator  
Calculated Strontium-90 Concentrations.**

| Batch | Type | TOC<br>Aqueous <sup>a</sup> | Liquid<br>Volume <sup>b</sup> | Sr-90<br>Aqueous <sup>c</sup> | Sr-90<br>Solid <sup>d</sup> | TOC <sup>e</sup> | HTWOS<br>Sr-90 <sup>f</sup> | Calculated<br>Sr-90 <sup>g</sup> | Difference <sup>h</sup> |
|-------|------|-----------------------------|-------------------------------|-------------------------------|-----------------------------|------------------|-----------------------------|----------------------------------|-------------------------|
|       |      | (kg-mol)                    | (gal)                         | (kg-mol)                      | (kg-mol)                    | (µg/ml)          | (µCi/ml)                    | (µCi/ml)                         |                         |
| 1     | LAW  | 5.49E+02                    | 7.12E+05                      | 2.40E-04                      | 5.80E-02                    | 2448.2           | 1.0776                      | 1.0776                           | 6.72E-09                |
| 3     | HLW  | 4.45E+01                    | 1.51E+05                      | 3.02E-05                      | 6.63E-02                    | 934.6            | 0.6378                      | 0.6378                           | 2.58E-09                |
| 4     | HLW  | 4.45E+01                    | 1.51E+05                      | 3.02E-05                      | 6.63E-02                    | 934.6            | 0.6378                      | 0.6378                           | -1.85E-08               |
| 7     | LAW  | 9.72E+02                    | 1.21E+06                      | 4.25E-04                      | 1.15E-04                    | 2554.5           | 1.1233                      | 1.1233                           | -3.15E-09               |
| 8     | HLW  | 2.34E+01                    | 1.55E+05                      | 2.83E-05                      | 5.76E-02                    | 478.2            | 0.5824                      | 0.5824                           | -1.51E-08               |
| 9     | HLW  | 2.34E+01                    | 1.55E+05                      | 2.83E-05                      | 5.76E-02                    | 478.2            | 0.5824                      | 0.5824                           | -1.51E-08               |
| 11    | HLW  | 2.34E+01                    | 1.55E+05                      | 2.83E-05                      | 5.76E-02                    | 478.2            | 0.5824                      | 0.5824                           | -1.51E-08               |
| 12    | HLW  | 2.30E+01                    | 1.53E+05                      | 2.78E-05                      | 5.66E-02                    | 478.2            | 0.5824                      | 0.5824                           | 1.73E-09                |
| 13    | HLW  | 1.68E+02                    | 1.57E+05                      | 7.64E-05                      | 2.67E-02                    | 3401.6           | 1.5567                      | 1.5567                           | 1.52E-08                |
| 15    | HLW  | 1.68E+02                    | 1.57E+05                      | 7.64E-05                      | 2.63E-02                    | 3401.7           | 1.5568                      | 1.5568                           | 5.28E-08                |
| 19    | HLW  | 1.33E+02                    | 1.24E+05                      | 6.06E-05                      | 2.10E-02                    | 3401.3           | 1.5565                      | 1.5565                           | 4.74E-08                |
| 28    | HLW  | 1.01E+02                    | 1.48E+05                      | 4.46E-05                      | 1.96E-02                    | 2163.1           | 0.9647                      | 0.9647                           | -2.47E-08               |
| 29    | HLW  | 1.51E+01                    | 2.23E+04                      | 6.70E-06                      | 2.99E-03                    | 2156.6           | 0.9623                      | 0.9623                           | -3.58E-09               |
| 30    | HLW  | 4.89E+01                    | 1.43E+05                      | 2.98E-05                      | 2.08E-02                    | 1081.9           | 0.6633                      | 0.6633                           | 9.61E-09                |
| 31    | LAW  | 4.32E+02                    | 6.82E+05                      | 1.94E-04                      | 9.58E-04                    | 2011.6           | 0.9104                      | 0.9104                           | 9.28E-09                |
| 32    | HLW  | 4.89E+01                    | 1.43E+05                      | 2.98E-05                      | 2.07E-02                    | 1081.9           | 0.6633                      | 0.6633                           | -3.79E-09               |
| 33    | HLW  | 4.89E+01                    | 1.43E+05                      | 2.98E-05                      | 2.07E-02                    | 1081.9           | 0.6633                      | 0.6633                           | 1.26E-08                |
| 35    | LAW  | 4.81E+02                    | 7.65E+05                      | 2.17E-04                      | 1.61E-03                    | 1995.6           | 0.9049                      | 0.9049                           | 1.63E-08                |
| 229   | HLW  | 4.97E+01                    | 1.55E+05                      | 3.17E-05                      | 4.44E-03                    | 1015.6           | 0.6514                      | 0.6514                           | 5.68E-09                |
| 230   | HLW  | 3.42E+01                    | 1.56E+05                      | 2.95E-05                      | 5.82E-03                    | 697.7            | 0.6046                      | 0.6046                           | -3.27E-09               |
| 231   | HLW  | 3.42E+01                    | 1.56E+05                      | 2.95E-05                      | 5.81E-03                    | 697.2            | 0.6046                      | 0.6046                           | -1.34E-08               |
| 232   | HLW  | 3.42E+01                    | 1.56E+05                      | 2.95E-05                      | 5.81E-03                    | 696.7            | 0.6045                      | 0.6045                           | 2.06E-08                |
| 233   | HLW  | 3.42E+01                    | 1.56E+05                      | 2.95E-05                      | 5.80E-03                    | 696.0            | 0.6044                      | 0.6044                           | -2.14E-09               |
| 234   | HLW  | 3.41E+01                    | 1.56E+05                      | 2.95E-05                      | 5.79E-03                    | 695.0            | 0.6043                      | 0.6043                           | -7.91E-09               |
| 235   | HLW  | 3.40E+01                    | 1.56E+05                      | 2.95E-05                      | 5.78E-03                    | 693.2            | 0.6041                      | 0.6041                           | 2.17E-08                |
| 236   | HLW  | 2.10E+01                    | 1.50E+05                      | 2.72E-05                      | 4.57E-03                    | 445.5            | 0.5798                      | 0.5798                           | 2.79E-08                |
| 237   | HLW  | 2.10E+01                    | 1.50E+05                      | 2.72E-05                      | 4.57E-03                    | 445.2            | 0.5798                      | 0.5798                           | 1.90E-09                |
| 238   | HLW  | 2.10E+01                    | 1.50E+05                      | 2.72E-05                      | 4.57E-03                    | 444.8            | 0.5798                      | 0.5798                           | -1.55E-08               |
| 239   | HLW  | 2.10E+01                    | 1.50E+05                      | 2.72E-05                      | 4.56E-03                    | 444.4            | 0.5798                      | 0.5798                           | 1.25E-08                |
| 240   | HLW  | 2.10E+01                    | 1.50E+05                      | 2.72E-05                      | 4.56E-03                    | 443.7            | 0.5797                      | 0.5797                           | 1.16E-08                |

## Notes:

LAW = Low-activity waste

HLW = High-level waste

HTWOS = Hanford Tank Waste Operations Simulator

Sr-90 = Strontium-90

TOC = Total Organic Carbon

<sup>a</sup>Inventories of TOC in the aqueous phase (from HTWOS)<sup>b</sup>Liquid volume in batch (from HTWOS)<sup>c</sup>Inventories of Sr-90 in the aqueous phase (from HTWOS)<sup>d</sup>Inventories of Sr-90 in the solid phase (from HTWOS)<sup>e</sup>Concentration of TOC in the aqueous phase (from HTWOS)<sup>f</sup>Concentration of Sr-90 in the aqueous phase (calculated from within HTWOS using TOC correlation)<sup>g</sup>Concentration of Sr-90 in the aqueous phase (calculated externally by hand using TOC correlation)<sup>h</sup>Difference between internal HTWOS calculation and external hand calculation (small difference indicates agreement)

## 3.2 EFFECT OF STRONTIUM CORRELATION ON RESULTS

As stated before, the Sr-90 correlation was developed to take the place of water wash factors for Sr-90 since the use of water wash factors for strontium was incorrectly predicting that a significant portion of the feed delivered to the WTP would require strontium removal. In incorporating this correlation into HTWOS some impacts are expected to model results that are dependent on strontium solubility while other factors are expected to remain unchanged when compared with a model scenario based on wash factors for Sr-90 solubility.

### 3.2.1 Strontium-90 to Sodium Ratio Distribution

A comparison was made of the distribution of Sr-90 to sodium prior to and after application of the Sr-90 correlation. The initial condition is based on the scenario documented in HNF-SD-WM-SP-012, Rev. 5A, *Tank Farm Contractor Operation and Utilization Plan* (TFCOUP) and is identified as TFCOUP Rev 5. The initial scenario utilized the strontium wash factors and the comparison scenario used the Sr-90 correlation instead of the strontium wash factors. This comparison is shown in Figure 3-1 and is on a percent of delivered sodium basis.

The figure shows that prior to application of the Sr-90 correlation (TFCOUP Rev. 5A), 69% of the modeled feed met Envelopes A and B with the remaining 31% requiring additional pretreatment to remove strontium. Additionally, 3% of the feed would be out of specification for Sr-90 per *WTP Contract*, DE-AC27-01RV14136.

When the Sr-90 correlation is applied, 96% of the modeled feed met Envelopes A and B. Therefore only 4% of the liquid feed would require additional pretreatment to remove strontium. Additionally, none of the liquid feed would be out of specification for Sr-90 per the WTP contract (DE-AC27-01RV14136).

### 3.2.2 Overall Strontium Mass Balance

The overall Sr-90 and elemental strontium is tracked during an HTWOS model run. Regardless of which method is used to calculate the quantity of strontium in solution, the total overall mass balance of strontium should not differ. To show that the overall strontium mass balance is not affected by replacement of the wash factors with the Sr-90 correlation, a complete model run was performed and the final Sr-90 and elemental strontium inventories were compiled. For this exercise, inventories are defined to include Sr-90 and elemental strontium in DSTs and SSTs, as well as, in vitrified and other immobilized waste forms. These inventories were compared with the TFCOUP Rev. 5 run using strontium wash factors and also with the initial starting inventory, accounting for radiological decay of Sr-90. The result was that all three inventories (initial, TFCOUP Rev 5 run-based, and Sr-90 correlation based) were equal; verifying that the overall strontium mass balance was maintained.

### 3.2.3 Impact to High-Level Waste and Low-Activity Waste Glass

The effect of the Sr-90 correlation was also assessed on its impact to HLW and LAW glass production. For HLW glass, the TFCOUP Rev. 5 run produced 9,429 canisters and was completed by September 15, 2027. After applying the correlation, 9,584 canisters of HLW glass were produced and HLW glass production was completed by January 23, 2028. The additional 155 canisters and four months additional time required to complete HLW vitrification is acceptable for this comparison. The reason for its acceptability is that the single model run with the Sr-90 correlation has variations in the incidental blending of waste well within the expected run-to-run variability when compared to the TFCOUP Rev. 5 run. The TFCOUP Rev. 5 run was optimized over several iterations to minimize plant outages and glass volume. If time was spent optimizing the model scenario using the Sr-90 correlation in the same manner as the TFCOUP Rev. 5 run, the quantity of HLW glass could be similarly reduced and completion of the HLW vitrification mission would be accomplished at an earlier date. Figure 3-2 shows the HLW glass production relationship between the TFCOUP Rev. 5 run and the scenario with the Sr-90 correlation.

The LAW glass production comparison was slightly affected. For LAW glass, the TFCOUP Rev. 5 run produced 27,850 packages and was completed by September 20, 2027. After applying the correlation, 27,854 packages of LAW glass were produced and LAW glass production was completed by January 23, 2028. The number of packages is essentially unchanged from the TFCOUP Rev. 5 run and the additional four months to complete processing is directly related to the delay in HLW glass mentioned previously. Figure 3-3 shows the LAW glass production relationship between the TFCOUP Rev. 5 run and the scenario with the Sr-90 correlation.

Figure 3-1. Strontium-90 to Sodium Distributions Using Strontium Wash Factors and Correlation.

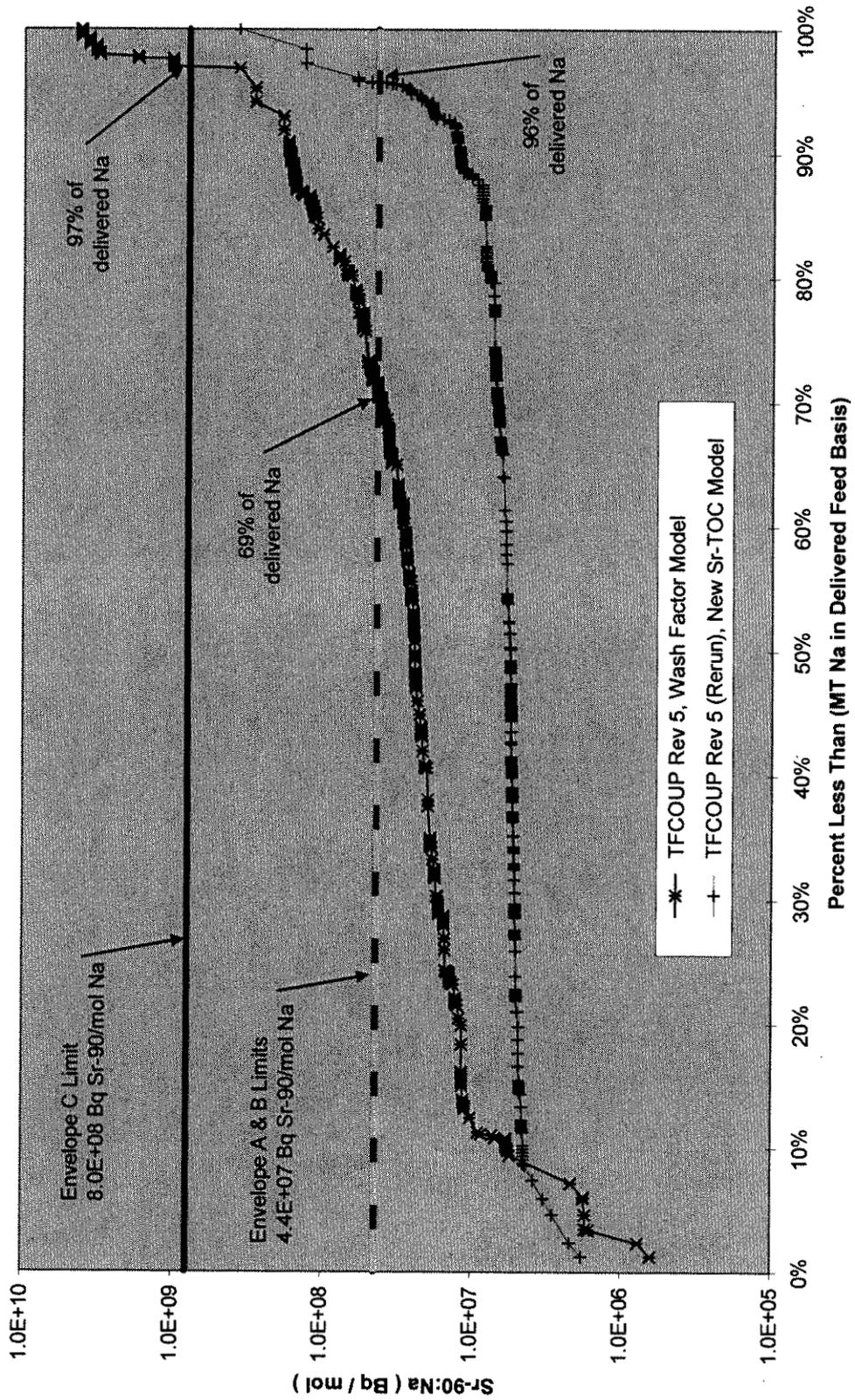


Figure 3-2. High-Level Glass Production Using Strontium Wash Factors and Correlation.

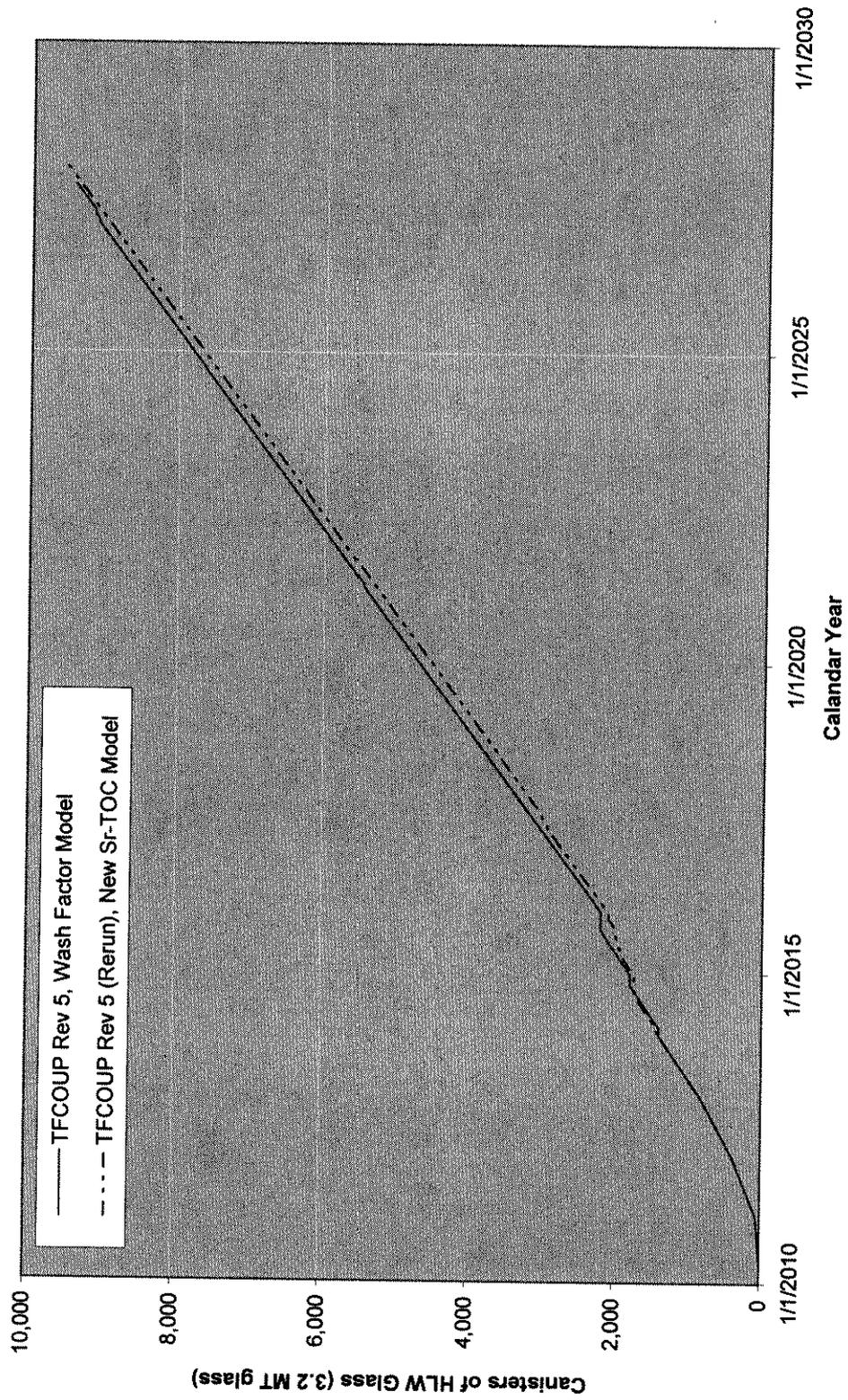
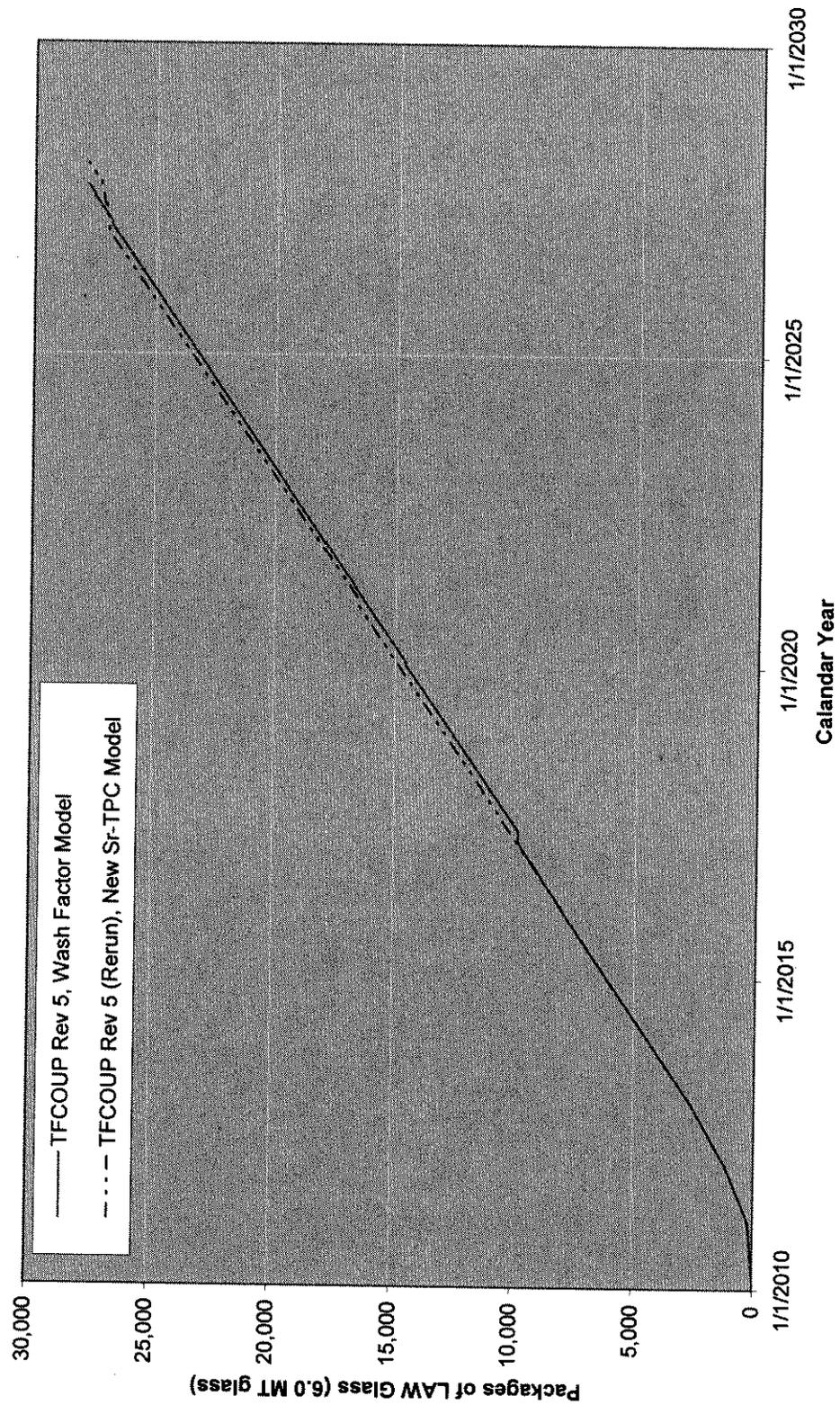


Figure 3-3. Low-Activity Glass Production Using Strontium Wash Factors and Correlation.



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#### 4.0 REFERENCES

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**APPENDIX A**

**HANFORD TANK WASTE OPERATIONS SIMULATOR  
MODEL ASSUMPTIONS MATRIX**

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## HTWOS Model Change Summary Form

|  |  |
|--|--|
| <b>Case Name</b>   | Sr Solubility Model Test                           |
| <b>Objective:</b> The purpose of this case is to test that a simple solubility model can be implemented in HTWOS to provide more realistic estimates of Sr in the WTP feed. This test is being performed as a follow-up action to one of the recommendations made during a joint ORP-BNI/WGI-CH2MHILL assessment of out-of-specification feed. The recommendation from the assessment was to develop and implement a simple Sr solubility model to take the place of water wash factors for Sr since the use of water wash factors for Sr was incorrectly predicting that > 20 % of the feed delivered to the WTP would require Sr removal.  |  |
| <b>Scenario Change Summary</b> - This section is focused on changes in key assumptions or key inputs to the model.<br>The scenario described and documented in HNF-SD-WM-SP-012, Rev 5A, "Tank Farm Contractor Operation and Utilization Plan" will be maintained, except as needed to implement the Sr solubility model.  |  |
| <b>Software Change Summary</b> - This section is focused on changes in the HTWOS model functionality and includes references to the Scenario Change Summary section where appropriate.<br>Incorporate and test the "Preferred" Sr solubility in HTWOS. If there are difficulties with the use of the "Preferred" model or anomalous results are seen, incorporate and test the "Backup" model, with the concurrence of the requestor. The two Sr models are shown on Figure A-2.<br><br>The solubility model should be applied to repartitioning the starting inventory and each time waste streams of two different compositions are mixed within the tank farm system. The Sr solubility model should not be used as part of the caustic leaching in the WTP or as part of any supplemental treatment. |  |
| <b>Requestor or Point of Contact:</b>  | Paul Certa, 376-5429                               |
| <small>For reporting modeling status and resolving issues.</small>   |  |
| <b>Supplemental Information:</b><br>For all WTP feed deliveries (HLW and LAW), assess compliance with the Envelope A, B and C feed specifications by plotting Sr:Na ratio versus delivery date and versus feed batch. Prepare a Sr:Na distribution plot, on a sodium basis, and compare with similar plot created from TFCOUP Rev 5A data. See requestor for examples of these plots.<br><br>Confirm that overall Sr mass balance is maintained.<br><br>Identify and investigate any changes between this case and the TFCOUP Rev 5A with respect to LAW glass production curves, HLW glass production curves, treatment end date and simplified mass balance figure.  |  |
| <b>Change Approval</b>   |  |
| <b>Team Lead:</b> R. A. Kirkbride <i>Randy A Kirkbride 9/3/04</i>  | <b>Manager:</b> N. W. Kirch <i>Shelby 8/3/2004</i> |
| <b>Customer:</b> P. J. Certa <i>Paul J Certa 8/3/04</i>  | <b>Customer:</b> N/A                               |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test   |  | Involves Model Change That Needs to be Verified? |
|---|--|--|
| <b>A1.1. Brief Description of Case</b>  |  |  |
| Test the incorporation of a simple Sr solubility model into HTWOS. A simple schematic of the overall process is shown in Figure 1.<br><br>A simple schematic of the overall process is shown in Figure A-1. |  | Yes  |
| <b>A2.0. Major Facilities</b>   |  |  |
| <b>A2.1. New Waste Generation</b>   |  |  |
| <b>A2.1.1. New Waste Introduced Via 200 East Area</b>   |  |  |
| PUREX – yearly rate   | 5 Kgal/year  | No   |
| B-Plant – yearly rate   | No waste anticipated   | No   |
| WESF – yearly rate  | No waste anticipated   | No   |
| 300 Area – yearly rate<br>Flush for misc. waste<br>RF   | 0 to 30 Kgal/year<br>44%<br>94%  | No   |
| 400 Area  | No wastes anticipated  | No   |
| WSCF  | No wastes anticipated  | No   |
| 100 Area  | No wastes anticipated from 100 N, 100-K Basin, 105-F Basin, or 105-H Basin   | No   |
| <b>A2.1.2. New Waste Introduced Via 200 West Area</b>   |  |  |
| 222-S Laboratory – yearly rate<br>Flush for misc. waste<br>WVRF   | 10 Kgal/year<br>22%<br>99%   | No   |
| T-Plant<br>Yearly rate (FY 2003)<br>Yearly rate (FY 2004 on)<br>Flush for misc. waste<br>WVRF   | 17 Kgal/year<br>3 to 14 Kgal/year<br>22%<br>99%  | No   |
| PFM stabilization – not calculated in yearly average dates<br>Total volume<br>Flush<br>WVRF   | 2003-2005<br>37 Kgal total<br>22%<br>81%   | No   |
| <b>Tank Farm Waste Generations</b>  |  |  |
| Tank Farms<br>Yearly Rate<br>WVRF   | 120 Kgal/year<br>99%   | No   |
| <b>A2.2. Waste Treatment Plant</b>  |  |  |
| <b>A2.2.1. Low-Activity Waste Processing</b>  |  |  |
| LAW feed delivery dates   | Start delivery of the first LAW feed batch on 12/1/2009 and deliver remaining LAW feed as needed to keep the WTP operating within model constraints. The first LAW feed batch will be provided by a decant transfer of all supernatant in AY-102 (less ten-inches above the HLW solids) to the LAW feed receipt tanks. | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test           |  | Involves Model Change That Needs to be Verified? |
|---|--|--|
| LAW Pretreatment Ramp Up                      | From - To MT Na /year (net rate)<br>12/1/2009 – 1/31/2011 based on LAW melter <sup>1</sup><br>2/1/2011 – 9/30/2027 2950  | No   |
| LAW Vitrification Ramp Up <sup>2</sup>        | From - To MTG/d (net rate)<br>3/1/2010 – 1/31/11 3.4<br>2/1/2011 – 12/31/2011 18.0<br>1/1/2012 – 12/31/2012 24.0<br>1/1/2013 – 9/30/2027 28.8  | No   |
| Complete Waste Processing                     | Goal is to complete waste processing by 9/30/2027.   | No   |
| <b>A2.2.2. LAW Feed Receipt Tanks</b>         |  |  |
| LAW Feed Receipt Tank Use                     | 1.5 Mgal Total Capacity; be capable of receiving 1 Mgal without interruption while feeding out of the remaining 0.5 Mgal   | No   |
| <b>A2.2.3. LAW Pre-Treatment Process</b>      |  |  |
| LAW WTP Process Model                         | <ul style="list-style-type: none"> <li>Na is added to the effluent of the radionuclide separation block as non-waste Na to account for all sources of non-waste sodium added by BNI/WGI's WTP model. The amount added is 3.63% of the amount in the stream so that non-waste sodium is about 3.5% of the total Na in the LAW glass.</li> <li>80% of the sulfate in the feed to the melter is retained in the glass product and 20% is volatilized. After 1/31/2011, the off-gas stream, containing the volatilized sulfate, is sent to the WTP Supplemental LAW Process for treatment. Prior to that date, the volatilized sulfate will be assumed to be recycled into the source batch.</li> <li>The addition of NaMnO<sub>4</sub>, Sr(NO<sub>3</sub>)<sub>2</sub>, and NaOH used during the pretreatment of Envelope C waste will be approximated as: <ul style="list-style-type: none"> <li>0.01 mole Mn per Mole Na in the LAW feed.</li> <li>0.015 mole Sr per mole Na in the LAW feed.</li> <li>0.00 mole Na per mole Na in the LAW feed.</li> </ul> </li> </ul> | No   |
| <b>A2.2.4. ILAW Formulation and Packaging</b> |  |  |
| ILAW Na <sub>2</sub> O Loading                | Gimpel Rule Rev. 4   | No   |
| ILAW Glass Density                            | 2.6 MT/m <sup>3</sup>  | No   |
| ILAW Package Net Mass                         | 6.0 MT   | No   |
| <b>A2.2.5. ILAW Interim Storage Capacity</b>  |  |  |
| ILAW Interim Storage Capacity                 | No lag storage of ILAW in WTP.   | No   |

<sup>1</sup> LAW pretreatment will provide sufficient feed at the rate needed to operate the LAW melter.

<sup>2</sup> RPP System Plan, Rev. 2 (ORP-11242).

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test        |  | Involves Model Change That Needs to be Verified? |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
|--|--|--|----|----------------------|-----------|-----------|------|----------|------------|-----|----------|------------|-----|----------|-----------|------------------|----|
| <b>A2.2.6. High-Level Waste Processing</b> |  |  |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| HLW feed delivery dates                    | Start delivery of the first batch group of HLW feed on 12/15/2009 and deliver remaining HLW feed as needed to keep the WTP operating within model constraints. The first batch group of HLW feed will be provided from AY-102 by adding sufficient water to the decanted solids to yield a solids loading between 10 and 200 grams solids per liter of slurry (150 g/liter nominal).   | No   |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| HLW Vitrification Ramp-up <sup>3</sup>     | <table border="1"> <thead> <tr> <th>From</th> <th>To</th> <th>HLW MTG/d (net rate)</th> </tr> </thead> <tbody> <tr> <td>5/17/2010</td> <td>1/31/2011</td> <td>0.69</td> </tr> <tr> <td>2/1/2011</td> <td>12/31/2011</td> <td>3.0</td> </tr> <tr> <td>1/1/2012</td> <td>12/31/2012</td> <td>4.0</td> </tr> <tr> <td>1/1/2013</td> <td>9/30/2027</td> <td>5.4<sup>4</sup></td> </tr> </tbody> </table>   | From   | To | HLW MTG/d (net rate) | 5/17/2010 | 1/31/2011 | 0.69 | 2/1/2011 | 12/31/2011 | 3.0 | 1/1/2012 | 12/31/2012 | 4.0 | 1/1/2013 | 9/30/2027 | 5.4 <sup>4</sup> | No |
| From                                       | To   | HLW MTG/d (net rate)                             |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| 5/17/2010                                  | 1/31/2011  | 0.69   |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| 2/1/2011                                   | 12/31/2011   | 3.0  |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| 1/1/2012                                   | 12/31/2012   | 4.0  |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| 1/1/2013                                   | 9/30/2027  | 5.4 <sup>4</sup>                                 |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| <b>A2.2.7. HLW Feed Receipt Tanks</b>      |  |  |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |
| HLW Feed Receipt Tank Usage                | <ul style="list-style-type: none"> <li>Sufficient space to hold feed for 60 days of operation and receive 160,000 gallons (600 m<sup>3</sup>) without interruption.</li> <li>HLW feed deliveries will be suspended when the LAW feed receipt tanks contain waste from either AN-102 or AN-107 to segregate the LAW liquids until the Sr and TRU is removed.</li> <li>All HLW batches delivered after 3/1/2018 must be at least 130,000 gallons total volume and contain more than 2 wt% solids.</li> </ul> | No   |    |                      |           |           |      |          |            |     |          |            |     |          |           |                  |    |

<sup>3</sup> River Protection Project System Plan, Rev. 2 (ORP-11242).

<sup>4</sup> This is the capacity estimated to be needed to complete processing all HLW into glass by 9/30/2027. This capacity may be adjusted at the modeler's discretion to complete the processing of all waste by 9/30/2027.

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test           |  | Involves Model Change That Needs to be Verified? |
|---|--|--|
| <b>A2.2.8. HLW Pre-Treatment Process</b>      |  |  |
| HLW WTP Process Model                         | <ul style="list-style-type: none"> <li>• The water wash factors in the TWINS on 5/14/2003 (or Sr model in the case of Sr) will be used for partitioning waste into solid and liquid phases during retrieval and staging.</li> <li>• The caustic leach factors in the TWINS on 5/14/2003 will be used as the basis for computing the caustic leach factors associated with each delivered batch of HLW solids and for the entrained solids.</li> <li>• All HLW solids batches and entrained solids will be leached. One exception is that AN-102 or AN-107 solids will not be leached if those wastes are delivered as distinct LAW batches.<sup>5</sup></li> <li>• The amount of caustic added to the waste during the caustic leach will be determined as follows: <ul style="list-style-type: none"> <li>– Concentrate the HLW slurry to 20 wt% solids.</li> <li>– Water wash.</li> <li>– Add sufficient 19 M NaOH to result in an initial [OH<sup>-</sup>] concentration of 3.0 M, excluding all [OH<sup>-</sup>] in the water-washed slurry.</li> <li>– Perform caustic-leaching reactions.</li> </ul> </li> <li>• The post-leach wash is performed with 22,000 gallons of water.</li> </ul> | Yes  |
| <b>A2.2.9. IHLW Formulation and Packaging</b> |  |  |
| Method for Estimating HLW Waste Oxide Loading | <p>Glass Properties Model modified as follows.</p> <ul style="list-style-type: none"> <li>• Increase the spinel liquidus temperature constraint from 1050 °C to 1100 °C.</li> <li>• Increase the viscosity constraint from 5.5 Pa•s to 10 Pa•s.</li> <li>• Increase the Cr<sub>2</sub>O<sub>3</sub> constraint from 0.5 wt% to 1.0 wt%.</li> </ul>   | No   |
| IHLW Glass Density                            | 2.7 MT/m <sup>3</sup>  | No   |
| IHLW Canister Net Mass                        | 3.2 MT (thin-walled canister)  | No   |
| <b>A2.2.10. IHLW Interim Storage</b>          |  |  |
| IHLW Interim Storage Capacity                 | 22 canisters of IHLW can be stored in the WTP before having to ship canisters to an interim storage site on the Hanford Site.  | No   |

<sup>5</sup> When AN-102 or AN-107 wastes delivered as distinct LAW batches, the entrained solids are not leached because of the Sr/TRU precipitation step.

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test        |  | Involves Model Change That Needs to be Verified? |
|--|--|--|
| <b>A2.2.11. Supplemental LAW Treatment</b> |  |  |
| Supplemental LAW Processing Ramp-up        | From - To MT Na/year<br>1/31/2011 - 9/30/2027 (2950 - LAW Vit rate) <sup>6</sup>   | No   |
| Product and Packaging                      | <p>Two sets of product assumptions will be used outside of the HTWOS model to estimate product mass, volume and package count.</p> <p><u>Bulk-Vitrification</u></p> <ul style="list-style-type: none"> <li>Assume a 20 wt% waste Na<sub>2</sub>O loading.</li> <li>Glass density is 2.74 MT/m<sup>3</sup>.</li> <li>Packaged in 35 m<sup>3</sup> roll-off boxes, each filled with 58 MT glass. External volume of box is 1,920 ft<sup>3</sup> (8 ft by 10 ft by 24 ft, ~ 54.4 m<sup>3</sup>).</li> </ul> <p><u>Steam Reformer</u></p> <ul style="list-style-type: none"> <li>Assume a 19.8 wt% Na<sub>2</sub>O loading</li> <li>Bulk product density is 1.0 MT/m<sup>3</sup></li> <li>Packaged in 2.3 m<sup>3</sup> (standard ILAW) containers. External volume of package is 1.162 times the volume of glass contained in the package.</li> </ul> | No   |

<sup>6</sup> The WTP Supplemental LAW process capacity is calculated as the difference between the LAW pretreatment capacity (2950 MT Na per yr) and the LAW melter capacity expressed in MT Na per yr, and depends on the glass formulation for specific LAW batches.

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test     | Involves Model Change That Needs to be Verified?   |
|---|--|
| <b>A2.3. Supplemental Treatment</b>     |  |
| <b>A2.3.1. TRU/LLW Sludge Packaging</b> |  |
| Contact-Handled Sludge Packaging        | <ul style="list-style-type: none"> <li>• The TRU packaging facility will be available and begin packaging operations will begin on 10/28/2004. The nameplate capacity of the facility is 7,200 gallons of SST waste per day.<sup>7</sup></li> <li>• Wastes will be retrieved from the B-200 series SSTs to support operation at 40% of the nameplate capacity.</li> <li>• There will be a 30 day break in operation to redeploy the facility in the 200 West Area; then wastes from the T-200 series SSTs will be retrieved and delivered to the facility to support operation at 40% of the nameplate capacity.</li> <li>• Then waste from tanks T-111, T-112, T-104, and T-110 will be retrieved, according to the schedule in Table A-14 in Section A3.3 and delivered to the facility to support operation at 50% of the nameplate capacity.</li> <li>• There will be a 30 day break in operation to redeploy the facility in the 200 East Area; then wastes from tanks B-110 and B-111 will be retrieved and delivered to the facility to support operation at 50% of the nameplate capacity.</li> <li>• All the waste from the B-200 and T-200 series SSTs, T-110, and T-111 will be retrieved without impact to DST space.</li> <li>• It is assumed that all the SST wastes can be packaged as contact-handled TRU or disposed of via the TRU packaging system.</li> <li>• There will be no water or waste sent to the DST system.</li> </ul> |

<sup>7</sup> This volumetric processing rate is equivalent to an estimated mass processing rate of 20.4 MT solids/day assuming 25 volume % solids and a solids density of 3 MT/m<sup>3</sup>. HTWOS will use the mass processing rate and the modeler has the discretion to adjust the mass processing rate to match processing durations based on the volumetric processing rate.

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test                          | Involves Model Change That Needs to be Verified?   |
|--|--|
| Remote-Handled Sludge Packaging – AW-103, AW-105, and SY-102 | <ul style="list-style-type: none"> <li>• A remote TRU sludge packaging facility will begin operation on 7/1/2012 and be sized to complete the packaging of waste from tanks AW-103, AW-105, and SY-102 by 3/31/2015.</li> <li>• Supernatant liquid will be decanted from tank AW-103 in August 2011. The waste solids in tank AW-103 will be washed four times over a nine month period starting 9/1/2011 using 273,000 gallons of 0.01 M NaOH solution each time. After each wash, the solids are settled to 40 wt% before decanting the wash solution for feed to the evaporator. The first wash of AW-103 waste solids is assumed to dissolve the saltcake portion. Existing water wash factors (or Sr model in the case of Sr) will be applied to estimate the overall wash effectiveness.</li> <li>• Supernatant liquid will be decanted from tank AW-105 in September 2012. The waste solids in tank AW-105 will be washed four times over a nine-month period starting 10/1/2012 using 263,000 gallons of 0.01 M NaOH solution each time. After each wash, the solids are settled to 40 wt% before decanting the wash solution for feed to the evaporator. The first wash of AW-105 waste solids is assumed to dissolve the saltcake portion. Existing water wash factors (or Sr model in the case of Sr) will be applied to estimate the overall wash effectiveness.</li> <li>• Supernatant liquid will be decanted from tank SY-102 by 10/30/2013. The SY-102 solids will be washed three times over a nine month period starting by 11/1/2013 using 290,000 gallons of 0.01 M NaOH solution each time. After each wash, the solids are settled to 40 wt% before decanting the wash solution for feed to the evaporator. The first wash of SY-102 waste solids is assumed to dissolve the saltcake portion. Existing water wash factors (or Sr model in the case of Sr) will be applied to estimate the overall wash effectiveness. (Note: The solids in SY-102 may be moved to AW-103 for washing, after the washed AW-103 solids are delivered for packaging, if the cross-site transfer does not delay operation of the packaging facility.)</li> <li>• Carrier liquids will be separated from the solids in the packaging facility and transferred to the DST system for concentration and eventual delivery as LAW feed.<sup>8</sup></li> <li>• The washed solids are assumed to be remote handled for packaging.</li> </ul> |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test                | Involves Model Change That Needs to be Verified?  |    |
|--|---|----|
| <b>A2.3.2. Non-WTP Supplemental LAW Processing</b> |   |    |
| Process and Ramp-Up                                | <ul style="list-style-type: none"> <li>• A demonstration facility will be located in the 200 West Area (west of S-Farm) and be operated for 18 months starting on 10/1/2004 to process 300 MT of Na from tank S-109.</li> <li>• The demonstration facility will be fed directly from S-109 with no solids entrained out of S-109. The feed will be delivered at 5 M Na. The S-109 waste retrieval will be controlled to limit the total activity in the retrieved waste to 0.0062 Ci per liter (at the 5 M Na feed concentration).</li> <li>• The production process will be located in the 200 East Area.</li> <li>• The production facility starts operating after 1/31/2011 and operates at the rate needed to process at least 4500 MT of Na by 9/30/2027.</li> <li>• Low-Cs waste in the 200 West Area will be moved cross-site to feed the process when dedicated DST space is available to transfer low-Cs waste without contamination (through SY-101 in to an East Area DST used as a feed tank).</li> </ul> | No |
| Feed Staging and Solids Return                     | <ul style="list-style-type: none"> <li>• The low-Cs tanks that are candidates for feed are identified in Table A-14 in Section A3.3. Other low-Cs tanks may be substituted with the concurrence of the Requestor.</li> <li>• All entrained solids are separated from the waste liquids in the supplemental treatment facility (in a way to minimize the Na returned to the DST system) before treatment of the liquids and are returned directly to an appropriate DST (AN-106 or AY-101) as 20-wt% slurry.</li> <li>• Details concerning feed batch size and process control strategy have not been established. Therefore, for simplicity, assume that the process operates as a continuous process.</li> </ul>   | No |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test                          |  | Involves Model Change That Needs to be Verified? |
|--|--|--|
| Product and Packaging  | <p>Three sets of product assumptions will be used outside of the HTWOS model to estimate product mass, volume and package count.</p> <p><u>Bulk-Vitrification</u></p> <ul style="list-style-type: none"> <li>Assume a 20 wt% waste Na<sub>2</sub>O loading.</li> <li>Glass density is 2.74 MT/m<sup>3</sup>.</li> <li>Packaged in 35 m<sup>3</sup> roll-off boxes, each filled with 58 MT glass. External volume of box is 1,920 ft<sup>3</sup> (8 ft by 10 ft by 24 ft, ~ 54.4 m<sup>3</sup>).</li> </ul> <p><u>Steam Reformer</u></p> <ul style="list-style-type: none"> <li>Assume a 19.8 wt% Na<sub>2</sub>O loading</li> <li>Bulk product density is 1.0 MT/m<sup>3</sup></li> <li>Packaged in 2.3 m<sup>3</sup> (standard ILAW) containers. External volume of package is 1.162 times the volume of glass contained in the package.</li> </ul> | No   |
| <b>A2.4. Waste Disposal Sites</b>                            |  |  |
| ILAW Facility Need Dates (Integrated Disposal Facility; IDF) | To be determined from production schedule assuming no WTP lag storage of ILAW. This assumes that the ILAW produced by the Supplemental Treatment demonstration can be stored until the IDF is available.   | No   |
| IHLW Facility Need Dates (Project W-464)                     | 0 The need date for IHLW interim storage facility (the Canister Storage Building) will be the date on which the 1 <sup>st</sup> IHLW is produced (5/17/2010). The demand for interim storage space will be established assuming that 22 canisters of WTP-provided IHLW is used. The shipping date of IHLW to Yucca will be the date on which the Canister Storage Building is full (880 canisters + 22 canisters in WTP-provided lag storage), but no earlier than September 30, 2012. Assume shipping keeps up with production once shipping begins.  | No   |
| <b>A2.5. Cesium and Strontium Capsule Processing</b>         |  |  |
| Cesium and Strontium Capsules                                | Cesium and strontium capsules are disposed separately by RL and not incorporated into HLW glass in the WTP   | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test   |  | Involves Model Change That Needs to be Verified? |
|---|--|--|
| <b>A3.0. Retrieval and Closure</b>  |  |  |
| <b>A3.1. SST Interim Stabilization</b>  |  |  |
| Saltwell liquid pumping<br>Volume remaining on 10/1/2003<br>West Area receiver tank<br>Pumping completion<br>Dilution/flush for pumping | ~ 56 Kgal<br>SY-101 or SY-102<br>FY 2004<br>28-275%  | No   |
| <b>A3.2. SST Tri-Party Agreement Milestones</b>   |  |  |
| SST TPA Milestone Dates   | See Table A-14 in Section A3.3.  | No   |
| <b>A3.3. SST Retrieval Sequence Basis</b>   |  |  |
| Retrieval sequence basis  | Table A-14 in Section A3.3 provides the sequence and schedule for SST retrievals out through the end of FY 2008. This sequence and schedule was developed with considerations of risk reduction. The sequence and schedule for retrieval of waste from the remaining SSTs will be determined by the model based on algorithms that consider risk measures, DST space availability, and WTP feed requirements.<br><br>Estimates for the as-retrieved volume of SST wastes from selected tanks are also given in Table A-14. | No   |
| <b>A3.4. Waste Retrieval Facilities</b>   |  |  |
| Waste Retrieval Facility Availability Dates   | B-Complex WRF: 6/1/2018<br>T-Complex WRF: 6/1/2018<br><br>Wastes retrieved from tanks in the B or T complexes before the WRFs are available will be at lower insoluble solids loadings as defined in the Retrieved Waste Composition assumptions (see Section A3.8).   | No   |
| <b>A3.5. SST Farm Upgrades</b>  |  |  |
| Availability Dates for Tank Farms Upgrades  | Any SST farm upgrades needed to support the retrieval of SST waste will be completed before the retrieval dates projected by the HTWOS model.  | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test                 |   | Involves Model Change That Needs to be Verified? |
|---|---|--|
| <b>A3.6. Constraints on Simultaneous Retrievals</b> |   |  |
| Simultaneous retrieval                              | <ul style="list-style-type: none"> <li>• The most limiting condition(s) resulting from application of the following constraints:<sup>9</sup></li> <li>• Retrieval and transfer systems in the NE and NW quadrants can support a maximum of 6 simultaneous retrievals in each tank farm and a total of six simultaneous retrievals in each quadrant (after the WRFs are constructed).</li> <li>• Retrieval and transfer systems in the SE and SW quadrants can support a maximum of 2 simultaneous retrievals in each tank farm and a total of two simultaneous retrievals in that quadrant.<br/><br/>SE - A, AX, and C farms<br/>NE - B, BX, and BY farms<br/>SW - S, SX, and U farms<br/>NW - T, TX, and TY farms</li> <li>• A maximum of 7 total simultaneous retrievals can be performed at one time. (This assumes that labor resources are available.)</li> <li>• The waste from up to two SSTs may be retrieved to one DST at one time.</li> <li>• The waste from one only SST may be retrieved into one WRF tank at a time.</li> <li>• Constraints also apply to retrievals going directly from SSTs to supplemental treatment processes.</li> </ul> | No   |
| <b>A3.7. Retrieval Rates</b>                        |   |  |
| SST Waste Retrieval Rates                           | <ul style="list-style-type: none"> <li>• Minimum retrieval durations are given in Section A3.7 and based on proposed project schedules or technologies to be used to retrieve the waste.</li> </ul>   | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test      |   | Involves Model Change That Needs to be Verified? |
|--|---|--|
| <b>A3.8. Retrieved Waste Composition</b> |   |  |
| Retrieval Solution Requirements          | <ul style="list-style-type: none"> <li>The amount of retrieval solution needed to retrieve the waste from SSTs listed in Table A-14 in Section A3.3 will be determined as the amount need to achieve the total retrieved volume given in the table after the application of water wash factors (or Sr model in the case of Sr).</li> <li>The amount of retrieval solution needed to retrieve wastes from the S, SX, and U farm SSTs not listed in Table A-14 will be determined as the amount needed to result in a Na concentration <math>\leq 5 \text{ M}</math> and an insoluble solids concentration <math>\leq 5 \text{ wt\%}</math> (3.5 volume %) after the application of wash factors (or Sr model in the case of Sr).</li> <li>The amount of retrieval solution needed to retrieve wastes from SSTs in the B or T farm complex before the WRFs are available will be determined as the amount needed to result in a Na concentration <math>\leq 5 \text{ M}</math> and an insoluble solids concentration <math>\leq 5 \text{ wt\%}</math> after the application of wash factors (or Sr model in the case of Sr).</li> <li>The amount of retrieval solution needed to retrieve wastes from SSTs in the B or T farm complex after the WRFs are available will be determined as the amount needed to result in a Na concentration <math>\leq 5 \text{ M}</math> and an insoluble solids concentration <math>\leq 10 \text{ wt\%}</math> after the application of wash factors (or Sr model in the case of Sr).</li> <li>The amount of retrieval solution needed to retrieve wastes from all other SSTs will be determined as the amount needed to result in a Na concentration <math>\leq 5 \text{ M}</math> and an insoluble solids concentration <math>\leq 10 \text{ wt\%}</math> after the application of wash factors (or Sr model in the case of Sr).</li> </ul> | Yes  |
| <b>A3.9. Retrieval System Reuse</b>      |   |  |
| Retrieval System Availability            | <ul style="list-style-type: none"> <li>A sufficient number of retrieval systems are available.</li> <li>Retrieval systems will be reused when cost effective.</li> </ul>  | No   |
| <b>A4.0. Waste Feed Operations</b>       |   |  |
| <b>A4.1. Waste Inventory</b>             |   |  |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test  |  | Involves Model Change That Needs to be Verified? |
|--|--|--|
| <b>A4.1.1. Initial Inventory</b>   |  |  |
| Date that BBI quarterly update was issued  | Starting tank inventory represents waste inventory as of 6/30/2003. This will be referred to as the FY 2004 inventory (or as the October 2003 inventory) and is based on BBI data downloaded from TWINS on about 10/22/2003. Adjustments were made in the HTWOS model for historical transfers through 9/30/2003.  | No   |
| IMUST waste Total volume (2011-15)   | 500 Kgal total   | No   |
| <b>A4.2. DST Operations</b>  |  |  |
| <b>A4.2.1. Sodium Hydroxide Additions</b>  |  |  |
| Caustic addition <ul style="list-style-type: none"> <li>Planned Additions</li> <li>Caustic Rules for SST Retrievals</li> </ul> | <ul style="list-style-type: none"> <li>No near-term additions are planned. Future evaluations may show the need for caustic additions.</li> <li>Liquids associated with sludge retrievals need to have at least 0.05 M free OH. Saltcake retrievals do not require NaOH addition because waste in DSTs contains sufficient OH as a buffer.</li> </ul>  | No   |
| <b>A4.2.2. Flush Volumes</b>   |  |  |
|  | Table A-16 in Section A4.2.2 provides the flush volumes used in the HTWOS model.   | No   |
| <b>A4.2.3. Minimum DST Level</b>   |  |  |
|  | <ul style="list-style-type: none"> <li>Liquids or slurries can be removed down to within 12 inches above the bottom of a DST.</li> <li>Wastes can be removed down to the bottom of a DST during final cleanout.</li> <li>Supernatants can be pumped down to within 10 inches of a settled solids layer.</li> <li>SY-101 can only be pumped down to 100 inches (275 Kgal) between now and 10/1/2013. After that date, the transfer pump will be replaced and the waste can be pumped down to 12 inches.</li> <li>SY-102 can only be pumped down to 200 inches (550 Kgal) until the solids are washed before delivery for TRU packaging. After the solids are washed the waste can be pumped down to within 12 inches.</li> <li>The AZ/AY farm tanks can be pumped down below 64 inches if the annulus ventilation is shut down. The annulus ventilation will be shut down when necessary to deliver feed to the WTP allowing the waste to be pumped down within 12 inches of the bottom.</li> </ul> | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

|                                      |  |  |
|--------------------------------------|--|--|
| Case name: Sr Solubility Model Test  |  | Involves Model Change That Needs to be Verified? |
| <b>A4.2.4. Maximum DST Level</b>     |  |  |
| Maximum DST Levels                   | Raise the DST fill limits according to the schedule given in Table A-18 in Section A4.2.3 of these assumptions.  | No   |
| <b>A4.2.5. Tank Solids Level</b>     |  |  |
| Solids Settling Endpoint             | Insoluble solids can be settled to 40 wt% within 30 days.  | No   |
| <b>A4.2.6. Tank Space Allocation</b> |  |  |
| Space Allocation Categories          | Use the categories and reasoning given in Table A-19 in Section A4.2.6 to allocate and track head space above the waste in the DSTs.   | No   |
| DST Usage                            | <p><b>WTP Feed Staging tanks:</b> <sup>10</sup><br/>AN-101, AN-102, AN-103, AN-104, AN-105, AN-107, AP-101, AP-102, AP-103, AP-104, AP-105, AP-106, AP-108, AW-101, AY-101, AY-102, AZ-101, and AZ-102</p> <p><b>WTP Alternative (Back-up) HLW Feed Staging tanks:</b><br/>AN-103, AN-104 (cross-site receiver), and AN-105. At the modelers' discretion, other DSTs equipped with dual mixer pumps can be used to store and stage HLW feed.</p> <p><b>Slurry Transfer Limitations:</b><br/>Use AZ, AY, and AN farms, primarily for staging HLW solids. Try to avoid staging solids through AP or AW farms after retrieving the solids currently in those farms.</p> <p><b>Supplemental Sludge Treatment Process Feed Staging Tanks:</b><br/>AW-103, AW-105, and SY-102</p> <p><b>Non-WTP Supplemental LAW Treatment DST Usage:</b><br/>Provide feed directly from East Area SSTs to the treatment process. Transfer low-Cs wastes from the West Area when sufficient DST space is available transfer cross-site without contamination and to provide a dedicated feed tank. Entrained solids separated in the process are returned to AN-106 or AY-101 depending on space availability.</p> | No   |

**Table A-1. Assumptions Matrix. (19 Sheets)**

| <b>Case name: Sr Solubility Model Test</b>   |   | <b>Involves Model Change That Needs to be Verified?</b> |
|--|---|---|
| Emergency Space and LAW or HLW Waste Return Space <ul style="list-style-type: none"> <li>• TFC Emergency Space and Emergency Returns from WTP</li> <li>• LAW or HLW Non-Emergency Process Returns from WTP</li> <li>• Contingency space</li> </ul> | Emergency Space and Emergency Returns will be raised from 1.14 Mgal to 1.235 Mgal on 6/30/2004, and will be allocated as shown below: <ul style="list-style-type: none"> <li>• 1.235 Mgal total</li> <li>• None</li> <li>• None</li> </ul>  | No  |
| WTP Returns (to the DST system)  | No waste streams or wastewaters are returned to DST system from the WTP.  | No  |
| <b>A4.2.7. Waste Segregation or Blending</b>   |   |   |
| Waste Segregation <ul style="list-style-type: none"> <li>• Store concentrated waste on NCRW solids</li> <li>• Store concentrated waste on NCAW solids</li> <li>• High-organic Content Wastes</li> </ul>  | <ul style="list-style-type: none"> <li>• No wastes may be added to AW-103 and AW-105 until sludge is removed for delivery to a packaging facility.</li> <li>• AZ-102 supernatant blended with other wastes, concentrated waste stored on top of AZ-102 solids.</li> <li>• AN-102 and AN-107 have been identified as high-organic wastes (Envelope C); avoid creating more Envelope C waste where possible.</li> </ul>   | No  |
| Blending   | <ul style="list-style-type: none"> <li>• There is no deliberate blending of waste to optimize WTP feeds other than the blending of AZ-102 supernatant to reduce sulfate, and the consolidation of AP-101 into AY-102. Incidental blending that occurs as waste is moved through the system is relied on to provide benefits such as a significant reduction in HLW glass quantities.</li> <li>• Constrain the blending of AZ-102 supernate to start after 11/1/04 and complete the blending by 12/31/05, if possible.</li> <li>• Remove the supernatant from AY-102, concentrate the waste in AP-101, and place the concentrated AP-101 waste on top of AY-102 solids.</li> </ul> | No  |
| <b>A4.2.8. Availability of DST Space</b>   |   |   |
| DST Integrity  | No DST failures or replacements are assumed.  | No  |
| <b>A4.2.9. Space Optimization</b>  |   |   |
| Tank Space Options Incorporated (M-46-21 options)  | <ul style="list-style-type: none"> <li>• Concentrate waste to save space.</li> <li>• Release the ORP restriction on the use of the WTP feed restricted space.</li> <li>• Allocate only 1.235 Mgal as emergency space.</li> <li>• Implement tank level increases detailed in Section A4.2.4.</li> </ul>  | No  |
| <b>A4.2.10. Aging Waste Farm Condensates</b>   |   |   |
|  | HTWOS does not account for in-tank evaporation from or the recycle back to the aging waste tanks.   | No  |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test  |   | Involves Model Change That Needs to be Verified? |
|--|---|--|
| <b>A4.2.11. Common Use of Transfer Lines</b>   |   |  |
|  | There are no restrictions on the subsequent use of transfer lines based on waste types (HLW, LAW, TRU, and LLW) and chemistries.  | No   |
| <b>A4.2.12. Waste Transfer Routes</b>  |   |  |
| Essential Drawings for DST Waste Transfer System   | <ul style="list-style-type: none"> <li>H-14-104175, Rev. 18</li> <li>H-14-104176, Rev. 12</li> </ul>  | No   |
| <b>A4.2.13. Waste Transfers</b>  |   |  |
| Cross-site Transfer Rate   | <ul style="list-style-type: none"> <li>Wastes transferred cross-site through the supernatant line can be transferred at rates between 50 and 60 gallons per minute.</li> <li>Wastes transferred cross-site through the slurry line can be transferred at rates between 100 and 120 gallons per minute.</li> </ul> | No   |
| SST Retrievals   | Wastes retrieved from the SSTs will be retrieved at the capacity of the retrieval system as defined by the minimum durations when DST space is available.   | No   |
| DST Transfer Rate  | Wastes can be transferred between DSTs or to the WTP at a rate of 140 gallons per minute (excluding cross-site transfers).  | No   |
| Transfer Durations   | Waste transfer durations will be calculated by dividing the total volume being transferred by the transfer rate.  | No   |
| Transfer System Set-up Time  | There is a 5-day delay between subsequent uses of transfer routes having common components starting on 11/1/2007 to account for the closeout of one transfer route and the establishment of another route.  | No   |
| <b>A4.3. 242-A Evaporator</b>  |   |  |
| <b>A4.3.1. Evaporator Availability</b>   |   |  |
| 242-A Evaporator Shutdown & New Evaporator Availability  | <ul style="list-style-type: none"> <li>242-A Evaporator is available until 9/30/2018</li> <li>No tank farm evaporator is available after 10/1/2018 to support DST space management.</li> </ul>  | No   |
| Outage Schedule [FY(Duration in months)]   | <ul style="list-style-type: none"> <li>2003(3), 2004(4), 2005(6), and 2006(3).</li> </ul>   |  |
| <b>A4.3.2. Evaporator Operation</b>  |   |  |
| <ul style="list-style-type: none"> <li>Training Volume</li> <li>Average Evaporation Rate</li> <li>Bottoms Set Point (g/mL)</li> <li>Feed Staging Duration</li> <li>Yearly Evaporation of Waste</li> <li>SST wastes evaporated</li> </ul> | <ul style="list-style-type: none"> <li>50 Kgal of water is evaporated every 2 years to train personnel</li> <li>500 Kgal/month</li> <li>1.47<sup>11</sup></li> <li>3 months minimum;<sup>12</sup></li> <li>Yes</li> <li>Evaporate retrieved waste as needed to manage DST space until the WTP starts.</li> </ul>  | No   |

**Table A-1. Assumptions Matrix. (19 Sheets)**

| Case name: Sr Solubility Model Test  |   | Involves Model Change That Needs to be Verified? |
|--|---|--|
| <b>A4.3.3. Waste Volume Reduction</b>  |   |  |
| Waste Volume Reduction Factor  | Water is removed until the specific gravity set point is reached (as calculated by algorithms within the model).  |  |
| <b>A4.3.4. ETF and LERF</b>  |   |  |
| <ul style="list-style-type: none"> <li>• Effluent Treatment Facility               <ul style="list-style-type: none"> <li>○ Total treatment capacity</li> <li>○ Rate for evaporator condensate</li> </ul> </li> <li>• LERF Capacity</li> </ul> | <ul style="list-style-type: none"> <li>○ 24 Mgal/year</li> <li>○ 5 Mgal/year</li> </ul> <ul style="list-style-type: none"> <li>• 7.8 Mgal</li> </ul>  | No   |
| <b>A4.4. Waste Feed Delivery</b>   |   |  |
| <b>A4.4.1. LAW Feed Delivery Plans</b>   |   |  |
| LAW Feed Delivery Sequence and Envelope Designation <sup>13</sup> .  | <u>Source Tank (Envelope)</u><br>AY-102 (containing concentrated AP-101; A/D)<br>1-3 tanks from AP-Farm (A)<br>AN-104 (A)<br>AN-102 (C)<br>AN-105 (A)<br>AN-107 (C)<br>SY-101 (A)<br>AN-103 (A)<br>AW-101 (A)<br>Continue with liquid wastes made available from SST retrieval. | No   |
| <b>A4.4.2. LAW Feed Specifications</b>   |   |  |
|  | Delivered LAW feed compositions are compared to BNI contract Specification 7 to assess envelope compliance.   | No   |
| <b>A4.4.3. LAW Entrained Solids</b>  |   |  |
| Entrained Solids Quantity  | <ul style="list-style-type: none"> <li>• 0.5 wt% solids are entrained in decanted supernatants.</li> <li>• Supernatant liquids from dissolving salts will entrain the same solids concentration as exists in the tank after dissolution up to a maximum of 2 wt%.</li> </ul>    | No   |
| Entrained Solids Composition   | Entrained solids have the same composition as the average composition of solids in the tank.  | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test                                  |   | Involves Model Change That Needs to be Verified? |                      |                               |     |        |     |        |     |                      |           |    |
|--|---|--|----------------------|-------------------------------|-----|--------|-----|--------|-----|----------------------|-----------|----|
| <b>A4.4.4. HLW Feed Delivery Plans</b>                               |   |  |                      |                               |     |        |     |        |     |                      |           |    |
| HLW Feed Delivery Sequence and Retrieval Efficiency <sup>14</sup>    | <table border="1"> <thead> <tr> <th>Source Tank</th> <th>Retrieval Efficiency</th> </tr> </thead> <tbody> <tr> <td>AY-102 (AP-101)<sup>15</sup></td> <td>90%</td> </tr> <tr> <td>AZ-101</td> <td>90%</td> </tr> <tr> <td>AZ-102</td> <td>80%</td> </tr> <tr> <td>C-Farm Solids/AY-101</td> <td>100%/100%</td> </tr> </tbody> </table> Continue with HLW solids made available from SST retrieval.   | Source Tank                                      | Retrieval Efficiency | AY-102 (AP-101) <sup>15</sup> | 90% | AZ-101 | 90% | AZ-102 | 80% | C-Farm Solids/AY-101 | 100%/100% | No |
| Source Tank  | Retrieval Efficiency  |  |                      |                               |     |        |     |        |     |                      |           |    |
| AY-102 (AP-101) <sup>15</sup>  | 90%   |  |                      |                               |     |        |     |        |     |                      |           |    |
| AZ-101   | 90%   |  |                      |                               |     |        |     |        |     |                      |           |    |
| AZ-102   | 80%   |  |                      |                               |     |        |     |        |     |                      |           |    |
| C-Farm Solids/AY-101   | 100%/100%   |  |                      |                               |     |        |     |        |     |                      |           |    |
| <b>A4.4.5. HLW Feed Specifications</b>                               |   |  |                      |                               |     |        |     |        |     |                      |           |    |
|  | Delivered HLW feed compositions are compared to BNI contract Specification 8 to assess envelope compliance.   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| <b>A4.4.6. Feed Compliance Verification</b>                          |   |  |                      |                               |     |        |     |        |     |                      |           |    |
| Compliance Verification Sampling                                     | Allow 210 days to complete feed compliance verification starting from when each staging tank (DST) is first filled with feed.   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| <b>A5.0. Project Delivery</b>  |   |  |                      |                               |     |        |     |        |     |                      |           |    |
| <b>A5.1. Project Impacts on DST System Availability<sup>16</sup></b> |   |  |                      |                               |     |        |     |        |     |                      |           |    |
| AN-101-01A Pit work (W-314)  | 6/1/2001 – 10/1/2004  | No   |                      |                               |     |        |     |        |     |                      |           |    |
| 241-A-A Pit work outage (W-314)                                      | 3/1/2004 – 10/1/2004  | No   |                      |                               |     |        |     |        |     |                      |           |    |
| AN Farm Outage (W-314)   | 6/1/2004 – 10/1/2004  | No   |                      |                               |     |        |     |        |     |                      |           |    |
| AP Farm Outage (W-314)   | 7/1/2004 – 10/1/2004  | No   |                      |                               |     |        |     |        |     |                      |           |    |
| Cross-site line outage connects cross-site to AN farm (W-314)        | 5/15/2004 – 11/1/2004   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| Cross-site to AP farm (W-211)  | 5/15/2004 – 11/1/2004   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| AW Farm Outage (W-314)   | 7/1/2004 – 10/1/2004  | No   |                      |                               |     |        |     |        |     |                      |           |    |
| SY Farm Outage (W-314)   | 7/1/2004 – 10/1/2004  | No   |                      |                               |     |        |     |        |     |                      |           |    |
| 244-S Outage (W-314)   | 4/10/2003 – 1/15/2004<br>222-S direct routed to SY farm after 6/30/2005<br>PFP can no longer use 244-TX after 6/30/2005   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| AY Farm Electrical Upgrades  | 12/23/2002 – 12/31/2003   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| AZ Farm Electrical Upgrades  | 1/9/2003 – 12/31/2003   | No   |                      |                               |     |        |     |        |     |                      |           |    |
| <b>A5.2. Feed Staging Tank Upgrades</b>                              |   |  |                      |                               |     |        |     |        |     |                      |           |    |
|  | <ul style="list-style-type: none"> <li>The necessary equipment will be available in time to support all planned waste transfers.</li> <li>The DSTs will need a mixer pump, and, a decant/transfer pump (if solids entrainment is a concern) or a fixed intake transfer pump (if solids entrainment is not a problem).</li> <li>The following DSTs have been identified as requiring expense or capital project work before use as feed staging tanks; AN-101, AN-102, AN-103, AN-104, AN-105, AN-107, AP-101, AP-102, AP-104, AW-101, AY-101, AY-102, AZ-101, and AZ-102</li> </ul> | No   |                      |                               |     |        |     |        |     |                      |           |    |

Table A-1. Assumptions Matrix. (19 Sheets)

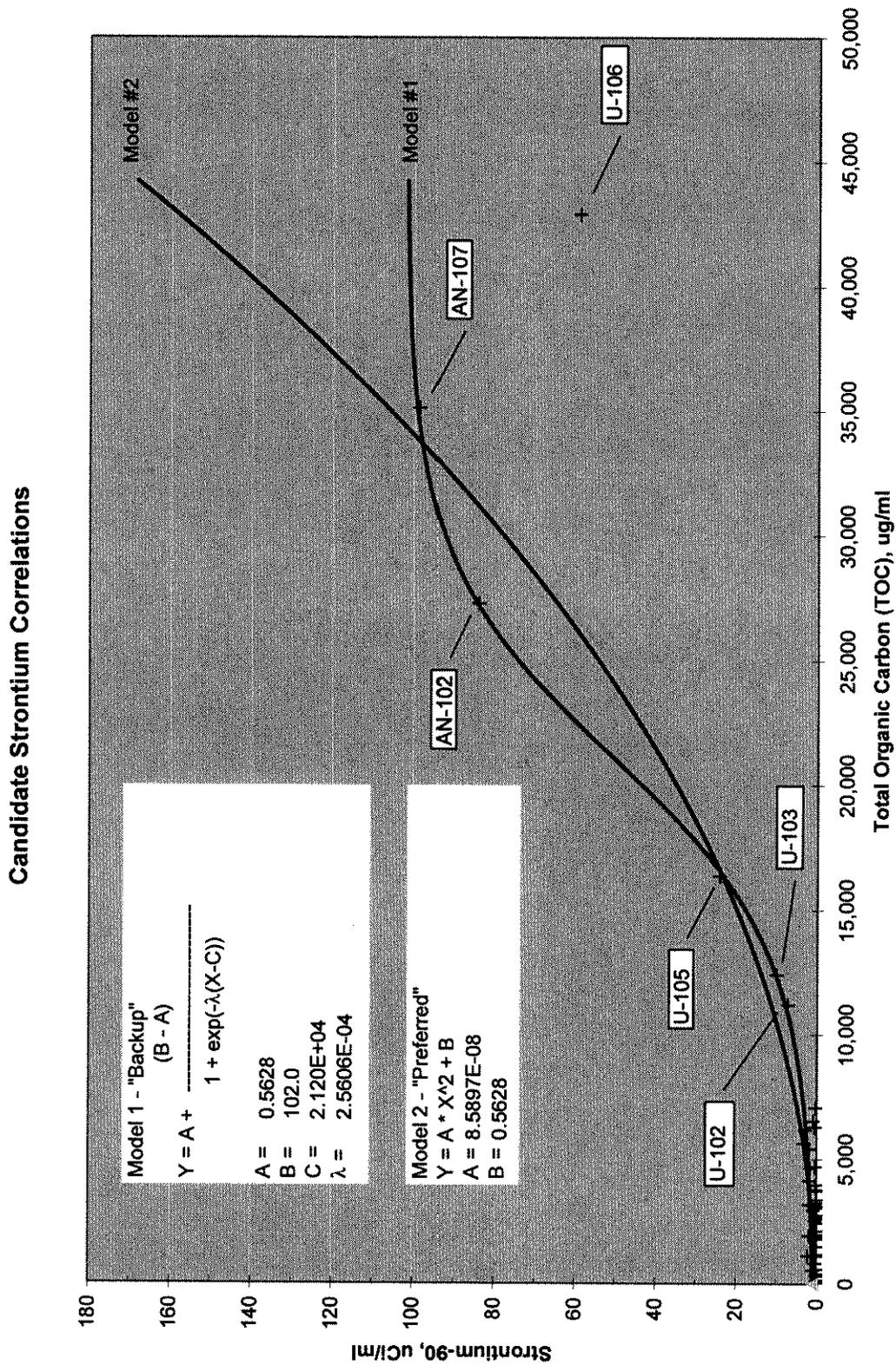
| Case name: Sr Solubility Model Test                   |  | Involves Model Change That Needs to be Verified? |
|---|--|--|
| <b>A6.0. HTWOS Model or Data Analysis Assumptions</b> |  |  |
| <b>A6.1. Estimating Waste Compositions</b>            |  |  |
|   | Wastes are homogenized when mixed.   | No   |
| <b>A6.2. Water Content of Initial Inventory</b>       |  |  |
|   | The water content of initial inventory is determined by calculating a stream density and total stream mass (including water), the total stream mass excluding water, and then obtaining water content by difference.   | No   |
| <b>A6.3. Volume of In-Process Streams</b>             |  |  |
|   | Volumes of waste streams are calculated from mass using density correlations for liquids and a solid density of 3 g/mL.  | No   |
| <b>A6.4. Transuranic Content Accounting</b>           |  |  |
|   | TRU quantities for LAW and ILAW are based on Specification 2 and 7 definitions.  | No   |
| <b>A6.5. Radionuclide Decay</b>                       |  |  |
|   | <ul style="list-style-type: none"> <li>The BBI reference decay date of 1/1/2001 is used as the reference decay date in the model.</li> <li>Radionuclides are decayed to the date of delivery for feed specification compliance assessment.</li> <li>Half-life values for decay calculations are taken from the Chart of Nuclides, 15<sup>th</sup> Edition.</li> </ul>  | No   |
| <b>A6.6. Waste Chemistry and Mass Balances</b>        |  |  |
|   | <ul style="list-style-type: none"> <li>Dissolution of solids is predicted by the application of wash factors (or Sr model in the case of Sr).</li> <li>Chemical charges are balanced when washing solids by the adjustment of bound OH<sup>-</sup> and then by adjustment of CO<sub>3</sub><sup>2-</sup>.</li> <li>HTWOS does not account for solids formation, except for repartitioning of Sr using the Sr model.</li> </ul> | Yes  |
| <b>A6.7. ILAW Package Production</b>                  |  |  |
|   | ILAW package production rates are based on the glass production rates, glass density, and package fill assumptions.  | No   |
| <b>A6.8. IHLW Canister Production</b>                 |  |  |
|   | IHLW canister production rates are based on the glass production rates, glass density, and package fill assumptions.   | No   |

Table A-1. Assumptions Matrix. (19 Sheets)

| Case name: Sr Solubility Model Test   |   | Involves Model Change That Needs to be Verified? |
|---|---|--|
| <b>A6.9. Mission Summary Diagram</b>  |   |  |
| Mission Summary Diagram   | <ul style="list-style-type: none"> <li>Handled external to the model. When possible, allocate 6 months float on either side of feed compliance verification activities for the 1<sup>st</sup> batch of LAW and the 1<sup>st</sup> batch of HLW. All other schedule float and project strategy will be developed with guidance from Projects.</li> <li>Two months</li> </ul> | No   |
| <ul style="list-style-type: none"> <li>Schedule float</li> <li>Transfer window</li> </ul>   |   |  |
| <p>Notes:</p> <p>BBI = Best Basis Inventory<br/> BNI = Bechtel National, Inc.<br/> BNI/WGI = Bechtel National-Washington Group<br/> DST = Double-Shell Tank<br/> ETF = Effluent Treatment Facility<br/> FY = fiscal year<br/> HLW = high-level waste<br/> IDF = Integrated Disposal Facility<br/> IHLW = immobilized high-level waste<br/> ILAW = immobilized low-activity waste<br/> IMUST = inactive miscellaneous underground storage tanks<br/> LAW = low-activity waste<br/> LERF = Liquid Effluent Retention Facility<br/> LLW = low-level waste<br/> MSD = Mission Summary Diagram<br/> NCAW = neutralized current acid waste<br/> NCRW = neutralized cladding removal waste<br/> ORP = U.S. Department of Energy, Office of River Protection<br/> PFP = Plutonium Finishing Plant<br/> PUREX = Plutonium-Uranium Extraction Plant<br/> RL = U.S. Department of Energy, Richland Operations Office<br/> SST = Single-Shell Tank<br/> TPA = Tri-Party Agreement (<i>Hanford Federal Facility Agreement and Consent Order</i>)<br/> TRU = transuranic<br/> TWINS = Tank Waste Information Network System<br/> WSCF = Waste Sampling and Characterization Facility<br/> WESF = Waste Encapsulation and Storage Facility<br/> WRF = Waste Retrieval Facility<br/> WTP = Waste Treatment and Immobilization Plant<br/> WVRF = waste volume reduction factor</p> |   |  |



Figure A-2. Strontium Concentration to TOC Concentration Correlations.



**HTWOS Model Modification Form**

|   |
|---|
| <p><b>Modification Title:</b><br/>Implementation of a strontium solubility model.</p>   |
| <p><b>Description of Modification:</b><br/>The HTWOS liquid-solid partitioning of Sr-90 was determined from a concentration limit of <math>C_{Sr-90} = A C_{TOC}^2 + B</math>, where <math>A = 8.5897 \times 10^{-8} (\mu\text{Ci/ml})/(\mu\text{g/ml})^2</math>, <math>B = 0.5628 \mu\text{Ci/ml}</math> and <math>C_{TOC}</math> is the TOC concentration. Other Sr isotopes were assumed to partition with Sr-90 to keep the isotopic fractions in the source phase unchanged.</p> |
| <p><b>Method Used to Check Modification:</b><br/>A test of the HTWOS calculation was performed by a hand calculation for the Sr-90 concentration for each HLW and LAW feed batch.</p>   |
| <p><b>Result of Checking Modification:</b><br/>Results from the test using HTWOS reported values good to better than four significant figures. In each batch the Sr-90 concentration was less than or equal to the concentration limit within the expected precision.</p>   |
| <p><b>Modeler Name:</b> R.S. Wittman <i>[Signature]</i> 8/3/2004<br/><b>Verifier Name:</b> T.M. Hohl <i>[Signature]</i> 8/3/2004</p>  |