ENCLOSURE 4

Non-Proprietary Polestar Calculation No. PSAT 05653A.04, Rev. 1

CALCULATION TITLE PAGE

CALCULATION NUMBER: PSAT 05653A.04

CALCULATION TITLE: Formulation of a Once-Through Steam Generator DF for Radioiodine (as I_2) to be Credited for TMI-1 MSLB w/ AIS/PAS

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REASON FOR REVISION:	Nonconformance Rpt
0 - Initial Issue	N/A
1 - Change in Attachment 1 spread-sheet to reflect 0.25 ppm Li instead of 0.25 ppm LiOH (change in Reference 3) Minor correction to Attachment 2 spread-sheet Addition of pre-accident spike case (note title change), including Attachments 3 and 4	N/A
2	
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4	

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Purpose

The purpose of this calculation is to calculate the overall radioiodine DF for the affected (and, if necessary, the unaffected) TMI-1 Once-Through Steam Generator (OTSG) as a function of time for a Main Steam Line Break (MSLB) with primary-to-secondary leakage of 2.5 lbm/sec (corresponding to 3228 gallons of reactor coolant at operating conditions leaked over two hours). This calculation considers both an Accident-Induced Spike (AIS) of radioiodine in the reactor coolant and a Pre-Accident Spike (PAS) of radioiodine in the reactor coolant.

Methodology

The overall approach is to apply the Reference 1 assumption that the radioiodine released from the affected OTSG is equal to the flashing fraction of the reactor coolant being released (in this case to the affected OTSG), but not less than a fixed percentage. For the unaffected OTSG the intact path to the main condenser and the condenser, itself, is credited which makes its contribution to offsite dose negligible (see Assumption 1).

The calculation also neglects the contribution to radioiodine release of liquid carryover (release of entrained liquid with radioiodine in solution). This is based on the very small entrained liquid release fractions expected after blowdown (see Assumption 2). The radioiodine release would, instead, be controlled by the release of I_2.

I_2 is a volatile substance which has moderate solubility in water and exhibits a propensity for adsorption onto metal surfaces (see Appendix B). Thus, when considering the transport of radioiodine into and through the OTSG as a result of primary-to-secondary leakage following a MSLB, the following need to be evaluated:

1. I_2 appearance as the result of partitioning as liquid flashes,

2. I_2 appearance as the result of evaporation-to-dryness of unflashed liquid,

3. I_2 appearance as the result of stripping of liquid remaining in the steam generator,

4. I_2 deposition in the steam generator, primarily on the Inconel-600 tubes.

The first two items dominate the behavior of radioiodine in the affected OTSG throughout most of the cooldown. The third item is important only if water begins to accumulate in the affected OTSG. This is not expected (see Assumption 3). However, the discussion of Item 3 is relevant to the behavior in the unaffected OTSG and the main condenser (see Assumption 1). Item 4 is important late in the cooldown; i.e., once the tube surface temperature drops below about 300 F, significant I_2 deposition on the tube surfaces will occur.

Assumptions

Assumption 1: The contribution of the unaffected OTSG to offsite dose is negligible.

Justification: This assumption is based on the fact that I_2 is moderately soluble, its solubility is inversely proportional to temperature, it has an affinity for cold, metal surfaces, and once deposited, it can be once again dissolved in surface condensate (as I^-) and washed away (Reference 2). There are two places where this behavior can be effective as a retention mechanism: in the unaffected OTSG and in the main condenser.

In the unaffected OTSG the Emergency Feedwater (EFW) and leakage will be entering the OTSG and collecting near the bottom of the secondary side. The operator will maintain a level of approximately 30" above the tubesheet (Reference 3, Item 2.2). This level will vary both as decay power drops and primary coolant temperature drops; however, since both are dropping together, it will be assumed that this volume is a constant. Because of the quantity of liquid entering at the top of the OTSG and the fact that most of the heat transfer is occurring at the bottom (where tubes are covered) it can be further assumed that whatever radioiodine does not escape with the flash will eventually be deposited in this water. The question is "how much will remain"?

Consider the situation near the end of the first day for the AIS case (which bounds the PAS case in terms of maximum iodine concentration in the coolant). Consider that the I-131 source rate into the primary coolant is about 162 Ci/min (Reference 3, Item 4.6) so that the I-131 activity in the primary system is increasing at a rate of about = 500 μCi/L-min for a primary system volume of about 11,500 ft^3 or 3.25×10^5 L (Reference 3, Item 3.1). Since there are about 3×10^{-10} g of iodine/μCi of I-131 (Reference 3, Item 4.7), the coolant iodine mass concentration is increasing at about 1.5×10^{-7} g/L-min or about 1.15×10^{-9} g-atom/L-min. This means that at the end of 24 hours, the coolant iodine concentration would be about 1.7×10^{-6} g-atom/L.

To be very conservative, assume that the unaffected OTSG steaming rate at this time is 1% power or about 26 Mw. This yields a steam flow of about 26 lbm/sec, most of which is coming from EFW. This would result in a volumetric steam flow out of the OTSG of about 20,000 L/sec. Meanwhile, a volumetric primary coolant leak of about 1.1 L/sec is bringing iodine into the OTSG at a rate of about 1.7×10^{-6} g-atom/sec. If the DF were unity, the g-atoms of iodine leaving would have to equal those entering, so the iodine concentration in the steam leaving the unaffected OTSG would have to be about 17,000 times less than that entering. If the iodine concentration in the exiting steam flow were 34,000 times less, the DF would be two, and so on.

The <u>relative</u> iodine concentration of the steam flow exiting the unaffected OTSG and the water remaining in the unaffected OTSG is dependent on two things, the pH and absolute iodine concentration in the water. Let us assume that no iodine has left that system and that the water in the unaffected OTSG has a pH of 7 (Reference 3, Item 5.6). The amount of iodine in the OTSG would be equal to the average iodine concentration leaving the primary system over the first day (about 8.5×10^{-7} g-atom/L) times the 1.1 L/sec leak rate times 86,400 seconds, or about 0.081 g-atoms. Since 30" of level in the OTSG corresponds to about 3,000 L

(Reference 3, Item 2.3), the concentration in the liquid would be about 2.7 x 10^{-5} g-atom/L, for the most part as I^-.

The iodine in the steam would be in the form of I_2, and the ratio of I_2 in the gas phase to I^- in the liquid phase has two parts. First, the I_2 concentration in the liquid phase will about 5.4 times greater than that in the gas phase (Reference 3, Item 5.7); and secondly the ratio of I^- in the liquid phase to I_2 in the liquid phase would be about (see Reference 2):

$$(I^-/I_2) = \{6.05 \times 10^{-14} + 1.47 \times 10^{-9}(10^{-pH})\}/\{(10^{-pH})^2(I^- \text{ concentration})\}$$

$$= 2.25 \times 10^5$$

Taken together the I^- concentration in the liquid phase would be more than 600,000 times greater than the concentration of iodine in the gas phase, even taking into account that there are two g-atoms of I for each g-mole of I_2. This means that the DF for the OTSG under these conditions (not including the flash) would be at least 35, and in reality, a good deal more. The effect of flashing would certainly decrease this value somewhat, but that, in turn, does not take into account the effect of the main condenser.

Assuming that all of the flow from the unaffected OTSG makes its way to the main condenser, the main condenser will greatly attenuate the release. It must be remembered that the tube surfaces will remain relatively cold (at a temperature near that of the Susquehanna River) and the condenser will be maintained at a vacuum. One would expect a DF in the main condenser at least as great as that in the unaffected OTSG. Therefore, one would expect that not more than one percent of the radioiodine passing into the unaffected OTSG would be released to the environment. In comparison to the release from the affected OTSG, this is negligible.

Assumption 2: Only a very small entrained liquid release is expected after blowdown.

Justification: There are a number of reasons to expect negligible liquid entrainment after blowdown. The most important of these is that the leak path from the primary side to the secondary side of the OTSG is by way of a very small (sub-mm) annulus between the tube and the tube sheet. Thermal and mechanical fragmentation at the point of pressure reduction (the actual leak through the tube) will be attenuated by boundary impaction and droplet agglomeration effects within this extremely confined annulus. Therefore, the droplets are not expected to be within the 10-100 μm range normally expected from a primary system blowdown; rather 100 μm would be expected to be at the lower end of the droplet spectrum. Since the cross-sectional area of the OTSG riser is about 43 ft^2 (Reference 3, Item 2.1) and the volumetric steam flow coming up from the bottom of the OTSG (assuming all of the liquid is settling) would be about 63 cfs (corresponding to 2.5 lbm/sec), the average updraft would be about 1.5 fps or about 46 cm/sec. This is the settling velocity of a 150 μm water droplet. Therefore, since one would expect the mass fraction less than 150 μm to be minimal, the droplet carryover contribution would be expected to be minimal, as well.

Assumption 3: Water accumulation in the affected OTSG is not expected prior to near-completion of the cooldown.

Justification: The tube surface in the affected OTSG during cooldown will be well above saturation temperature at atmospheric pressure, and since the leak rate is small relative to the decay power of the core (2.5 lbm/sec boiloff corresponds roughly to 2.5 Mw or about 0.1% of full core power), one would not expect water accumulation in the affected OTSG until cooldown is virtually complete.

References

Reference 1: NUREG-0800, NRC Standard Review Plan, Section 15.6.5, Appendix B, "Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Engineered Safety Features Components Outside Containment"

Reference 2: Weber, C.F., Beahm, E.C., and Kress, T.S., "Models of Iodine Behavior in Reactor Containments", ORNL/TM-12202, October 1992

Reference 3: PSAT 05653A.03, "Project Data Base for the Calculation of Steam Generator DFs for a Main Steam Line Break at Three Mile Island Unit 1", Revision 1

Reference 4: NUREG/CR-5950, "Iodine Evolution and pH Control", November 1992

Reference 5: Chang, R, Chemistry, Random House, New York, 1981 (Second Edition)

Reference 6: NUREG/CR-5732, "Iodine Chemical Forms in LWR Severe Accidents", April 1992

Calculation

Flashing and Evaporation to Dryness

This is the first of two calculational sections. This calculational section deals with the model for iodine release to the OTSG gas phase that results from the initial flash, and then further from the evaporation to dryness that is assumed to occur on the OTSG tubes (Assumption 3). Key in this model is the question of what happens to the pH of leaked coolant as evaporation to dryness occurs on the OTSG tubes. This last point is the subject of a spread-sheet which is partially displayed as Attachment 1 (for the AIS case) and Attachment 3 (for the PAS case) and which is discussed further below.

The model for the initial flash is based on the fact that the post-MSLB OTSG pressure (i.e., in the affected OTSG) will be near atmospheric. Therefore, in the course of the flash a fraction "x" of the coolant will become steam (where "x" is the flashing fraction) and it will have a volume (relative to the unflashed liquid) of:

$$Vol_x/Vol_{(1-x)} = x(Sp\ Vol_{gas}/Sp\ Vol_{liquid})_{atmospheric}/(1-x) = 1603x/(1-x)$$

On a concentration basis the iodine entering the OTSG can be defined as $[I]_A$ where the units are g-atoms/L. Most of this iodine will be I^-, but some will be I_2. By definition:

$$[I]_A = [I^-]_A + 2[I_2]_A$$

After the flash the concentration of iodine remaining in the unflashed liquid may be defined as $[I]_B$ and that leaving the affected OTSG with the steam as $[I]_C$. The iodine "balance" is:

$$[I]_A = (1-x)[I]_B + 1603x[I]_C$$

And the DF for the system is:

$$DF = [I]_A/1603x[I]_C = [I]_A/3206x[I_2]_C$$

Therefore, the DF is a function only of the flashing fraction and the ratio of the concentration in the liquid phase prior to the flash to that in the gas phase after the flash. As the cooldown progresses, the pressure and the temperature are decreasing, decreasing the flashing fraction and the ratio of the I_2 concentration in the gas phase to that in the liquid phase ($[I_2]_C/[I_2]_B$) which is the inverse of the partition coefficient (PC). Both of these effects tend to improve the DF. However, as time goes on, $[I]_A$ is increasing, and the increasing $[I]_A$ also increases the ratio of $[I_2]_B$ to $[I]_B$. This effect tends to worsen the DF.

The PC may be obtained from Reference 4 as:

$$PC = 10^{6.29 - 0.0149T(K)} = [I_2]_B/[I_2]_C$$

Substituting this into the equation for DF,

$$DF = [I]_A/3206x[I_2]_C = 10^{2.78 - 0.0149T(K)}[I]_A/x[I_2]_B \qquad \text{Equation 1}$$

This means that the DF during the flash is a function of the flashing fraction, the iodine concentration in the pre-flash liquid, the temperature of the post-flash liquid, and the I_2 concentration in the post-flash liquid. The first three variables are known; but the I_2 concentration in the post-flash liquid is a function of pH and overall iodine concentration in the post-flash liquid. While the pH is known (being primarily a function of the post-flash boric acid concentration), the post-flash liquid iodine concentration is reduced by conversion and release of I_2.

The functional relationship between I_2 concentration and overall iodine concentration in the post-flash liquid can be derived from the following expression given in Reference 4:

$$[I_2] = [H^+]^2[I^-]^2/(6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+])$$

Rewriting:

$$[I_2]/[I^-] = [H^+]^2[I^-]/(6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+])$$

Or:

$$[I^-]/[I_2] = (6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+])/([H^+]^2[I^-]) = ([I] - 2[I_2])/ [I_2] = [I]/[I_2] - 2$$

So that:

$$[I]/[I_2] = 2 + (6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+])/([H^+]^2[I^-])$$

$$= \{2 [H^+]^2[I^-] + (6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+])\}/([H^+]^2[I^-])$$

And:

$$\frac{[I_2]}{[I]} = \frac{[H^+]^2([I] - 2[I_2])}{2[H^+]^2([I] - 2[I_2]) + 6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+]}$$

If one applies this to the post-flash liquid (subscript "B") and assumes that $[I]_B = [I^-]_B + 2[I_2]_B$, then:

$$[I_2]_B = \frac{[H^+]_B^2[I]_B^2 - 2[H^+]_B^2 [I_2]_B[I]_B}{2[H^+]_B^2[I]_B - 4[H^+]_B^2[I_2]_B + 6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+]_B} \qquad \text{Equation 2}$$

To solve this equation, it is necessary to know the hydrogen ion concentration in the post-flash liquid. From Reference 3 (Item 3.5) it is known that the maximum boron concentration in the coolant (as H_3BO_3 or orthoboric acid) is 1900 ppm or about 0.176 g-atoms/L which corresponds to 0.176 g-moles/L of H_3BO_3, as well. Orthoboric acid is known to be a Lewis acid which dissociates in water to form H^+ and $B(OH)^-_4$ with an acid ionization constant of about 7.3×10^{-10} (Reference 5). Therefore, the H^+ concentration corresponding to 0.176 g-moles/L of H_3BO_3 would be about $\sqrt{1.3 \times 10^{-10}} = 1.14 \times 10^{-5}$ g-atoms/L or a pH of about 4.94. However, the post-flash H^+ concentration would be greater. To obtain this concentration, the following expression may be used:

$[H^+]_B = \sqrt{(7.3 \times 10^{-10} \{0.176/(1-x)\}}$ Equation 3

Even knowing x, $[I]_A$, and $[H^+]_B$, one must iterate on $[I]_B$, $[I_2]_B$, and DF in order to obtain a final result for DF. Since there are three unknowns, an additional independent relationship among $[I]_B$, $[I_2]_B$, and DF (in addition to Equations 1 and 2) is needed to solve the equation set. That relationship is the following:

$[I]_B = [I]_A\{1-1/DF\}\{1/(1-x)\}$ Equation 4

This equation states that the iodine concentration in the unflashed liquid will be related to that in the pre-flashed liquid in the following way: it will be reduced by that which leaves with the steam ({1-1/DF}) and it will be increased by the reduction of liquid volume ({1/(1-x)}). This relationship suggests an iterative scheme to solve the equation set with a spread-sheet.

Let it first be assumed that the DF is large enough that $1-1/DF \approx 1$. This means that Equation 4 becomes:

$[I]_{B1} = [I]_A\{1/(1-x)\}$ Equation 4a

where $[I]_{B1}$ represents the first estimate of $[I]_B$.

Then, assume that $[I_2]_B$ is very small relative to $[I]_B$. Using that assumption and $[I]_{B1}$ from Equation 4a, Equation 2 becomes:

$$[I_2]_{B1} = \frac{[H^+]_B^2[I]_{B1}^2}{2[H^+]_B^2[I]_{B1} + 6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+]_B} \qquad \text{Equation 2a}$$

where $[I_2]_{B1}$ represents the first estimate of $[I_2]_B$.

Similarly, DF_1 can be calculated as follows:

$DF_1 = 10^{2.78 - 0.0149T(K)}[I]_A/x[I_2]_{B1}$ Equation 1a

With a preliminary estimate of DF (as DF_1) Equation 4 can be recalculated in an unsimplified form:

$[I]_{B2} = [I]_A\{1-1/DF_1\}\{1/(1-x)\}$ Equation 4b

where $[I]_{B2}$ represents the second estimate of $[I]_B$.

With a refined estimate of $[I]_B$ (as $[I]_{B2}$) Equation 4 can be recalculated in an unsimplified form:

$$[I_2]_{B2} = \frac{[H^+]_B^2[I]_{B2}^2 - 2[H^+]_B^2[I_2]_{B1}[I]_{B2}}{2[H^+]_B^2[I]_{B2} - 4[H^+]_B^2[I_2]_{B1} + 6.05 \times 10^{-14} + 1.47 \times 10^{-9}[H^+]_B} \qquad \text{Equation 2b}$$

where $[I_2]_{B2}$ represents the second estimate of $[I_2]_B$.

Using $[I_2]_{B2}$, DF_2 is calculated:

$$DF_2 = 10^{2.78 - 0.0149T(K)}[I]_A/x[I_2]_{B2} \qquad \text{Equation 1b}$$

The need for additional iterations can be assessed by comparing DF_1 and DF_2. If these DFs are close, then DF_2 may be considered the final result, and the release fraction associated with the flash may be taken to be $1/DF_2$.

Before a spread-sheet can be prepared to solve the equation set described above for I_2 released during the flash, it is necessary to consider the subsequent evaporation-to-dryness of the unflashed liquid and the I_2 resulting from that source, as well.

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The iodine release process is now completely described. First, a variable amount will be released during the flash (depending on pH, flashing fraction, post-flash temperature, and overall iodine concentration), followed by a release during evaporation to dryness of not more than 22% of that remaining in the unflashed liquid.

I_2 Deposition on Steam Generator Tubes

I_2 released during the time that the OTSG tubes exceed 300 F will most likely escape that steam generator. This is because the residence time of the I_2 relative to the time-constant corresponding to the rate of I_2 deposition on the tubes is simply too short. Once the temperature of the tubes falls below 300 F, however, the situation changes dramatically.

Appendix B establishes the following expression for the OTSG DF for I_2 deposition:

$$DF_{depo} = \exp\left[\frac{\rho_g V_d A}{\dot{m}}\right]$$

The mass flow rate of vapor, $\dot{m}$, (assuming the entire leak either flashes or evaporates to dryness) is equal to approximately 2.5 lbm/sec or 1.13 Kg/sec. The total tube surface area can be obtained from the OTSG data sheet (Reference 3, Item 2.1). It can be calculated as follows:

$$A = \pi d L n$$

where d is the tube OD, L its length, and n the number of tubes.

Since d = 2 x 0.3125 inches = 1.59 x 10^{-2} m, L = 52 ft = 15.85 m, and n = 15531:

$$A = \pi(1.59E\text{-}2)(15.85)(15531) = 1.23E4\ m^2$$

And

$$DF_{depo} = \exp[1.09E4\rho_g V_d] \text{ for } \rho_g V_d \text{ in units of kg/m}^2\text{-sec.} \quad \text{Equation 5}$$

The following expression for V_d is also developed in Appendix B:

$$V_d = (3.6E\text{-}10)e^{(13800/RT(K))} \text{ in cm/sec} = (3.6E\text{-}12)e^{(13800/RT(K))} \text{ in m/sec} \quad \text{Equation 6}$$

where R = 2 cal/g-mole-K and T(K) = temperature, K

Appendix B also provides the following expression for ρ_g (where the units are kg/m^3):

$$\rho_g = 219.2/T(K) \quad \text{Equation 7}$$

Equations 5, 6, and 7 completely define DF_{depo}.

Results

The spread-sheet shown as Attachment 2 (for the AIS case) and Attachment 4 (for the PAS case) contains the final results of this calculation. This spread-sheet is eight pages long, and all eight pages are presented. Pages 1-4 contain the first nine columns, and Pages 5-8 contain the last nine columns.

The first column is time (in hours) expressed as 10 minute time-steps between t = 0 and t = 23.33 hours. The next two columns of this spread-sheet are the percentage flash and time data (corresponding to Column 1 times, but in seconds) from Reference 3, Item 1.4, followed by the primary system pressure (psia) and the primary system temperature (F) from Reference 3, Item 1.3. Column 6 is the percentage flash converted to a fraction.

The next two columns are the fractional release of iodine (as I2) to the OTSG and the overall release fraction to the environment, respectively. These represent the results of the calculation and will be discussed further below.

The last column on Pages 1-4 is the hydrogen ion concentration in the post-flash liquid. It corresponds to the pH in the first column on Pages 5-8. This pH, in turn, is calculated from the ppm B (as orthoboric acid) on Page 1. The 1978 ppm value appearing on Page 1 is assumed to be constant based on the initial 1900 ppm B in the primary coolant and the 2500 ppm in the BWST (Reference 3, Item 3.5). During the first 10 minutes of the accident the total injection is approximately 12840 gallons (see Page 1 of Attachment 1) or 13% of the total volume of the primary system (volume = 85820 gallons, Reference 3, Item 3.1). Therefore, the ppm B at the end of the first 10 minutes is 1978 ppm. The water volume injected beyond the first 10 minutes would not be expected to have significant effect on the results.

The hydrogen ion concentration is equal to the ppm B divided by (1-flashing fraction) to obtain the post-flash ppm B concentration, divided by the atomic weight of boron (to obtain g-moles of orthoboric acid per 10^6 grams of water), divided by 1000 to convert to g-moles of orthoboric acid per liter, multiplied by the orthoboric acid ionization constant 7.3×10^{-10}, and finally taken to the 1/2 power. The corresponding pH is shown on the next column, as noted above.

The pre-flash iodine concentration is shown on the second column of Pages 5-8. It is equal to the initial concentration plus the rate of addition associated with the spiking. The initial concentration (Attachment 2 or 4, AIS and PAS cases, respectively, Page 1, in g-atoms/L) is obtained from the initial μCi/g of I131 (see spread-sheet Attachment 1 or 3, AIS and PAS cases, respectively, Page 29) multiplied by 3×10^{-10} grams of iodine/μCi I131, divided by 129 (the assumed atomic weight of fission product iodine), and multiplied by 1000 grams of water/liter (to obtain the pre-flash concentration after being cooled to the post-flash temperature). The iodine addition rate is calculated by dividing this initial "equilibrium" concentration by the removal rate. The removal rate, in turn, is the letdown rate (Reference 3, Item 3.2) divided by the volume of the primary system (Reference 3, Item 3.1) in units of /min. Both the removal rate and the addition rate are shown on Page 1 of Attachment 2 or 4.

The next six columns on Pages 5-8 (i.e., the third through eighth columns on Pages 5-8 which are Columns 12 through 17 for the spread-sheet) are Equations 4a, 2a, 1a, 4b, 2b, and 1b. Inputs to these equations are shown on top of Page 1 of Attachment 2 or 4 (the volume ratio of steam to liquid at the assumed post-flash temperature of 373 K). A comparison of Columns 14 and 17 (DF1 and DF2) shows the effectiveness of the single iteration, and in no case is difference more than about 15% of DF2.

The last column on the spread-sheet (Column 18) is the deposition DF calculated using Equations 5, 6, and 7. Inputs to these equations are shown on top Page 5 of Attachment 2 or 4 (the tube length, deposition area per foot of tube, the mass leak rate, and the specific volume of the flashed steam). These have already been discussed in the main body of the calculation, although the spread-sheet uses English units while those used for illustration in the calculation are SI.

The final results are shown on Columns 7 and 8. Column 7 is simply the inverse of DF2 (Column 17) and represents the fraction of the iodine in the leaked coolant which becomes airborne post-flash. Column 8 is that quantity plus 22% of one minus that quantity (which represents the addition of the ETD contribution) divided by the deposition DF of Column 18. This is the final result.

Figure 1 shows the primary system ("Reactor Coolant System" or "RCS") pressure and temperature, the flashing fraction, and the total release fraction as functions of time for the AIS case. Figure 2 provides that same information for the PAS case. Note that for the AIS case the total release fraction briefly exceeds 25% between about 7000 seconds (about 2 hours) and about 30000 seconds (about 8.5 hours), but never exceeds 27%. Therefore, using 25% for the AIS case release fraction for both the 0-2 hour period and the 2-23.33 hour period is demonstrably conservative. For additional conservatism (and to cover any question regarding liquid carryover during the first 10 minutes), a release fraction equal to or greater than the flashing fraction will be used during the first 10 minutes for the AIS case.

For the PAS case the total release fraction exceeds 25% for only the first ten minutes, and during that time the total release fraction is considerably less than the flashing fraction. Therefore, using 25% for the PAS case release fraction for both the 0-2 hour period and the 2-23.33 hour period is demonstrably conservative as long as the first ten minutes is covered. For additional conservatism (and to cover any question regarding liquid carryover during the first 10 minutes), a release fraction equal to or greater than the flashing fraction will be used during the first 10 minutes for the PAS case as well as for the AIS case.

Conclusions

- The iodine release fraction to be used for the affected OTSG for the TMI-1 MSLB with AIS should be the flashing fraction (or greater), but not less than 25%.
- The iodine release fraction to be used for the affected OTSG for the TMI-1 MSLB with PAS should be the flashing fraction (or greater), but not less than 25%.
- The unaffected OTSG may be neglected in terms of its contribution to the iodine release. The conservatism applied to the affected OTSG release fraction more than covers the >1% release fraction expected for the unaffected OTSG.

Figure 1 - MSLB-AIS - Cooldown and Release

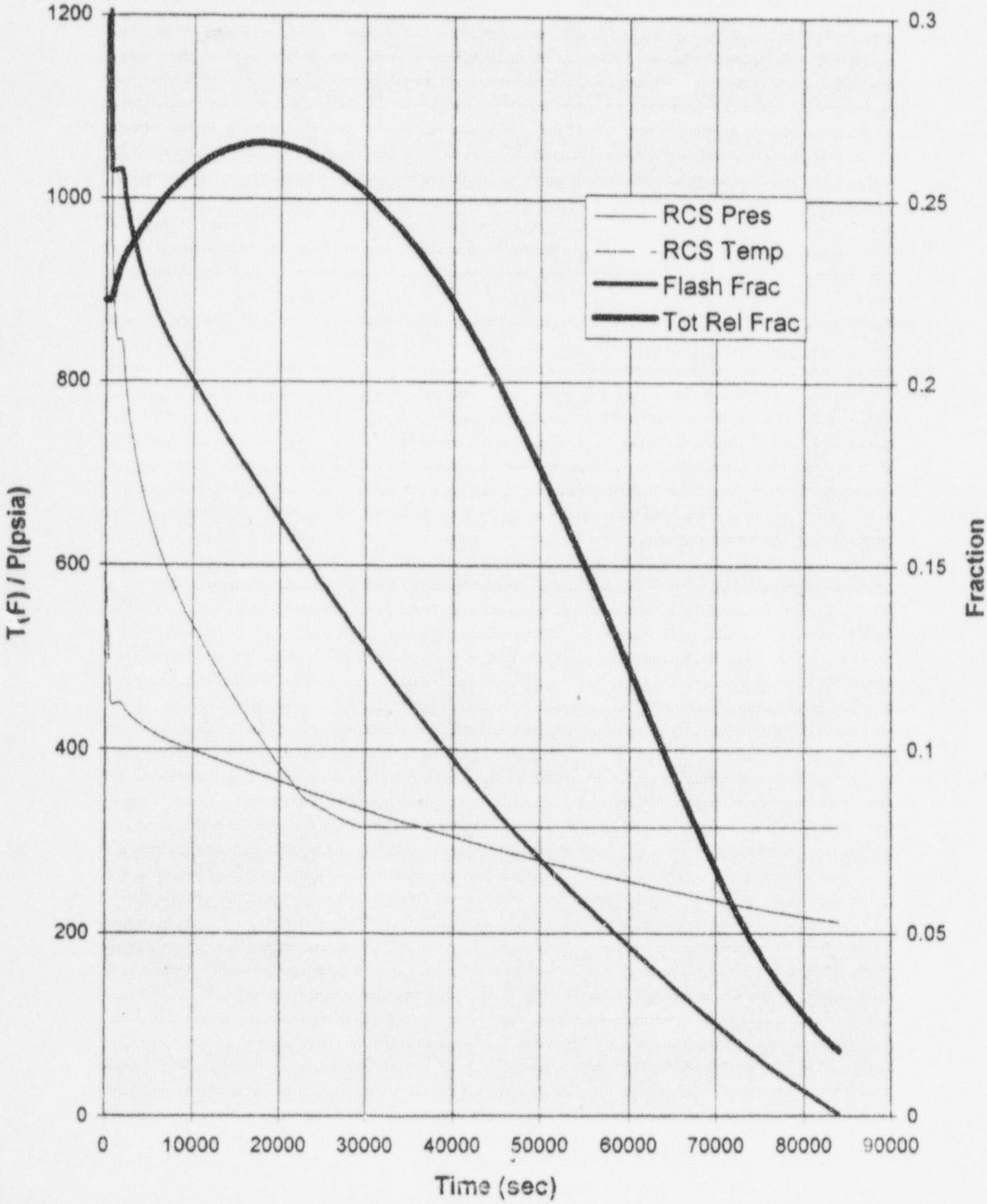
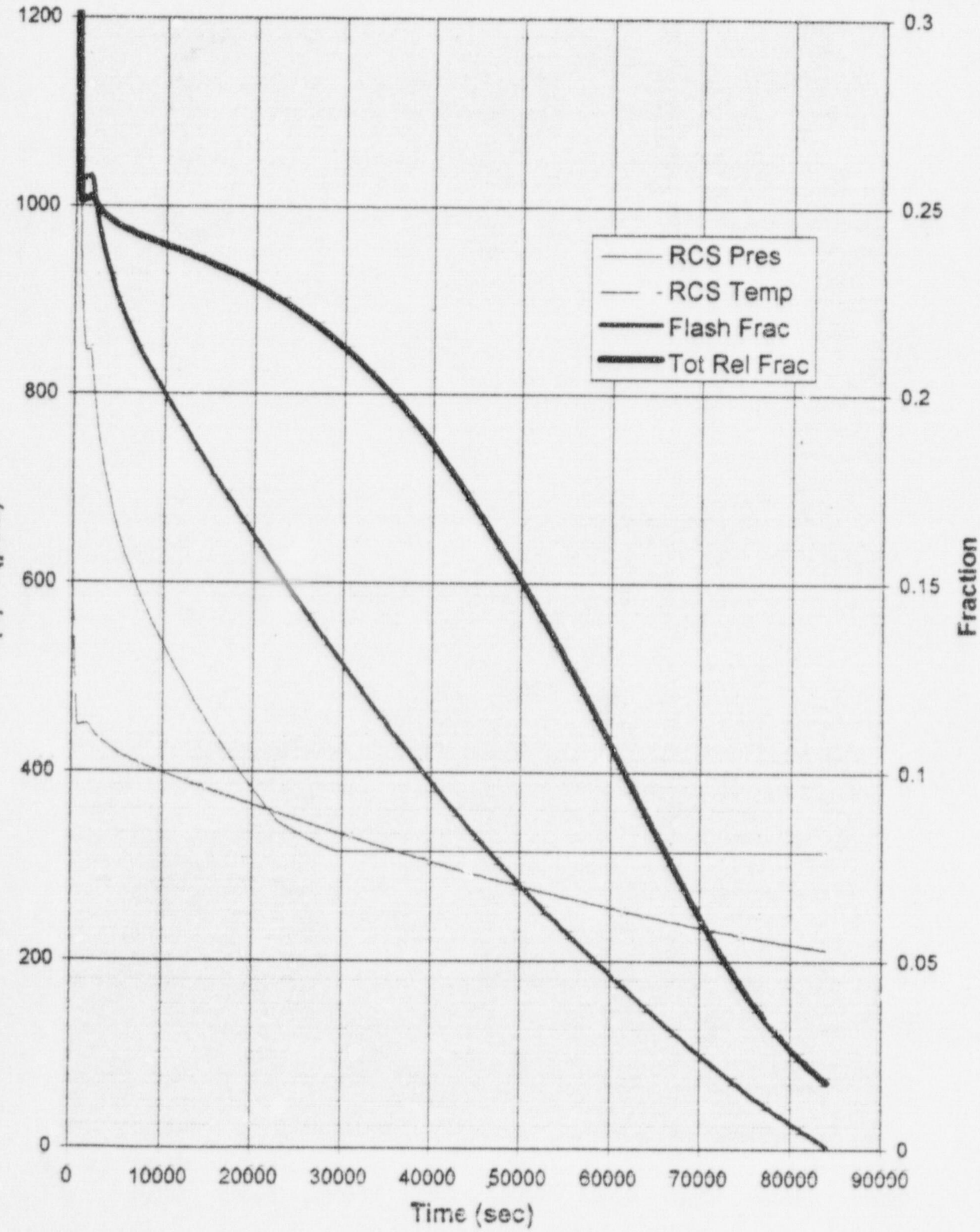


Figure 2 - MSLB-PAS - Cooldown and Release



APPENDIX A

APPENDIX TITLE: HNO_3 Production as a Result of Nitrogenated Water Injected into the RCS

CALCULATION TITLE: Formulation of a Once-Through Steam Generator DF for Radioiodine (as I_2) to be Credited for TMI-1 MSLB w/ AIS

Table of Contents

Purpose

The purpose of this appendix is to re-analyze test data reported on in Reference 1 to establish the relationship among the rate of HNO_3 production, the concentration of dissolved N_2 in water, and absorbed radiation dose.

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References

Reference 1: Beahm E.C., et al., "Iodine Chemical Forms in LWR Severe Accidents - Final Report", NUREG/CR-5732, April 1992

Reference 2: *Handbook of Chemistry and Physics*, 51st Edition, The Chemical Rubber Company, Cleveland Ohio, 1970-1971

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APPENDIX B

APPENDIX TITLE: I_2 Deposition on OTSG Tubes as a Function of Tube Temperature and Mass Leak Rate

CALCULATION TITLE: Formulation of a Once-Through Steam Generator DF for Radioiodine (as I_2) to be Credited for TMI-1 MSLB w/ AIS

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Introduction

As I_2 vapor is convected with a gas flow through a once-through steam generator (OTSG), diffusion will bring the I_2 molecules in contact with the metal surfaces along the flow path (primarily the Inconel-600 tubes). Chemical and physical reactions will then occur at the contact surface between I_2 and the metal, resulting in a removal of I_2 from the flow. The rates of reaction determine the rate of removal of I_2 vapor, which is what is to be obtained from the model.

Methodology

Based on the fact that, on average, the residence time of all the I_2 molecules in the flow system under consideration is the same, the problem to be solved can be considered as equivalent to the following:

A certain amount of the I_2 vapor is placed in a volume for a certain period of time that equals the residence time (the average time a flow element travels from the inlet to the outlet of the steam generator). During this period, the I_2 vapor is experiencing deposition so that the amount of the I_2 vapor in the volume is decreasing. At the end of the residence time, the I_2 vapor that remains suspended in the volume is assumed to be immediately released.

Using this description, the differential equation for the change of the I_2 vapor in this volume is:

$$\frac{d(m)}{dt} = -\frac{m}{V} V_d A \tag{1}$$

where m = the mass of the I_2 vapor in the volume under consideration
A = the deposition area in the volume under consideration
V = the volume of the system under consideration
V_d = the deposition velocity of the I_2 vapor

By integration over the residence time (τ), equation (1) becomes:

$$\frac{m_0}{m_1} = \exp\left[\frac{V_d A}{V} \tau\right] \tag{2}$$

where m_0 and m_1 are, respectively, the I_2 vapor mass in this volume at the beginning and the end of the residence time. The ratio on the left-hand-side of the equation is often referred to as the decontamination factor (DF).

Derivation of I_2 Vapor Deposition Velocity

The I_2 vapor deposition velocity correlation with system temperature is based on Reference 1 data. Much of the data for I_2 in Reference 1 (including all of the Inconel-600 data) is for high temperature; i.e, 1000/T(K) $\leq$ 1.75. However, Table 2 of Reference 1 shows that at 1000/T(K) = 0.71, the I_2 deposition velocity for stainless steel and Inconel-600 are about the same, at 1000/T(K) = 0.85, stainless steel is about three times greater, at 1000/T(K) = 1.15, stainless steel is about two times greater, and at 1000/T(K) = 1.75, the stainless steel is at least an order of magnitude less. Therefore, the general trend is that as temperature decreases (and 1000/T(K) increases), Inconel-600 exhibits greater I_2 deposition velocity than stainless steel. Use of stainless steel data, therefore, for values of 1000/T(K) greater than 1.75 is conservative.

For values of 1000/T(K) corresponding to high temperature, the air environment data appears to be generally comparable to the steam environment data. However, at low temperatures, the air data is consistently below the steam data. Since the OTSG is steam-filled, only the steam data will be considered in the range of temperatures seen in this analysis ($1.8 < 1000/T(K) < 2.7$).

Over this range, the data is lower-bounded by the expression:

$$I_2 \text{ Deposition Velocity} = (3.6E\text{-}10)e^{(13800/RT(K))} \qquad (3)$$

where R = 2 cal/g-mole-K and T(K) = temperature, K

This expression is used to determine the I_2 deposition velocity. The curve of this expression is shown on Figure 1 along with all of the data from I_2 deposition velocity data from Reference [1].

Derivation of the Residence Time and DF Expression

The residence time (τ) in a steam generator should be obtained from the length or height (L) of the steam generator and the average flow velocity (U) in the steam generator. The latter is, on the other hand, obtained from the total gas flow rate ($\dot{W}$) into the steam generator, the gas density (ρ_g) in the steam generator and the average flow area of the steam generator (A_c). The ultimate expression for the residence time is:

$$\tau = \frac{\rho_g A_c L}{\dot{W}} \qquad (4)$$

Substituting Equation (4) into Equation (2), we obtain the expression for DF, i.e.,

$$DF = \exp\left[\frac{\rho_g V_d A L A_c}{V \dot{W}}\right] \qquad (5)$$

Calculation

From Reference [2], we obtain the following geometry data for the steam generator under consideration:

Leak rate = 2.5 lbm/sec (= 1.13398 kg/sec),
Tube outer diameter (d) = 0.625 in (= 0.0159 m),
Tube length (L) = 52 ft (= 15.85 m),
Number of tubes (n) = 15531,
Tube bundle inner diameter (D) = 118.375 in (= 3.007 m).

Based on the geometric data above, we can calculate the flow area (A_c), the deposition area (A) and the volume (V).

$$A_c = \frac{\pi}{4}D^2 - n\frac{\pi}{4}d^2 \tag{6}$$

$$A = n\pi dL \tag{7}$$

$$V = A_c L \tag{8}$$

A_c is calculated to be 4.026 m^2, A to be 12277 m^2 and V to be 63.814 m^3.

To present some typical DF values as a function of primary system temperature, the following assumptions are made:

1. The gas in the secondary side of the steam generator (superheated steam) is assumed to be an ideal gas, and
2. The pressure in the secondary side of the steam generator is atmospheric and the temperature is that of the primary side.

Based on the ideal gas law, the steam density in the secondary side of the steam generator can be calculated by the following expression:

$$\rho_g = \frac{p\hat{M}}{\Re T} \tag{9}$$

where p and T are the bulk pressure and temperature in the secondary side of the steam generator, $\hat{M}$ and $\Re$ are the molecular weight of steam and the universal gas constant. In SI units, p = 101325 Pa, $\hat{M}$ = 18 kg/kgmole, $\Re$ = [illegible]17 J/kgmole•K. Since the steam flow rate into the steam generator is 1.134 kg/sec and V_d = (3.6E-10)e$^{(13800/RT(K))}$ cm/sec = (3.6E-12)e$^{(13800/RT(K))}$ m/sec, the following spread-sheet table can be prepared:

Table 1 - Typical I_2 DF in the OTSG

Time (hrs)	Temp (F)	Temp (K)	1000/T(K)	Vd (m/sec)	rho (kg/m3)	Typical DF
0	601	589.4444	1.696513	4.36643E-07	0.372152	1.001761
0.17	450	505.5556	1.978022	3.04583E-06	0.433905	1.014411
11.5	300	422.2222	2.368421	4.5039E-05	0.519544	1.288307
24	212	373.3333	2.678571	0.00038282	0.58758	11.41817

Results

In Table 1, the time is given in hours in Column 1, the temperature on the primary side of the steam generator as a function of time is shown in °F and °K in, respectively, Columns 2 and 3. Column 5 is embedded with the Equation (3) to calculate the vapor deposition in meters per second. Column 6 contains calculations of the steam density using Equation (9). Finally, Equation (5) is used to calculate typical I_2 vapor DFs in Column 7.

Conclusions

It can be concluded that the I_2 vapor DF is almost negligible until the temperature drops below 300 F.

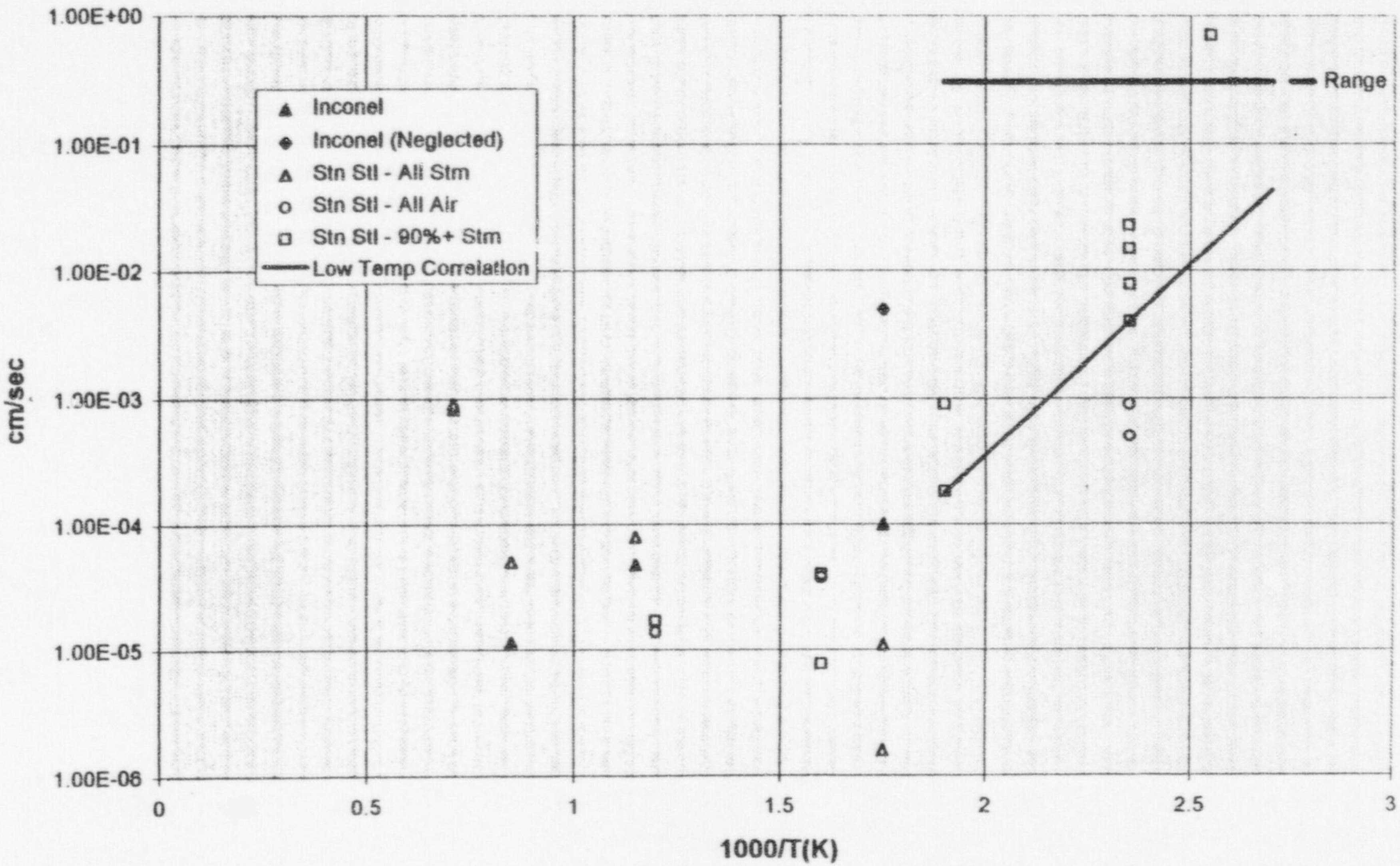
The above model is used in the spread-sheet in the main body of the calculation to obtain a DF for I_2 vapor deposition on the OTSG tubes.

References

1. NUREG/CR-2713, "Vapor Deposition Velocity Measurements and Correlations for I_2 and CsI", May 1982

2. PSAT 05653A.03, "Data Base for the Formulation of Once-Through Steam Generator DFs for Radioiodine (as I_2) to be Credited for TMI-1 MSLB Analyses", Revision 0

Figure 1 - Comparison of I2 Deposition Velocity



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FLASH2

XL Spread Sheet for TMI MSLB with Accident-Induced Spike - Final Release Fractions

Initial I conc	1.32E-09 g-atom/L.		Rem rate =	1.630E-03 per minute.			Vratio =	1604
ppm B =	1978		Add rate =	1.076E-09 g-atom/L-m			Post-fl T(K)	373

Time (hrs)	% flash	Time (sec)	Press (psia)	Temp (F)	Flash frac	Flash rel	Rel frac	[H+]B
0	44.85	0	2160	601	0.4485	0.0033303	0.2221937	1.557E-05
0.1666667	25.77	600	961.05	449.71	0.2577	0.0074028	0.2224477	1.342E-05
0.3333333	25.76	1200	846.16	449.71	0.2576	0.0137962	0.2273611	1.342E-05
0.5	25.76	1800	846.16	449.71	0.2576	0.0200185	0.232143	1.342E-05
0.6666667	24.8	2400	787.33	441.37	0.248	0.0242836	0.2349141	1.333E-05
0.8333333	24.06	3000	743.93	434.92	0.2406	0.0282008	0.237464	1.327E-05
1	23.49	3600	711.21	429.86	0.2349	0.0319212	0.2399109	1.322E-05
1.1666667	22.99	4200	684.07	425.52	0.2299	0.0353694	0.2421664	1.318E-05
1.3333333	22.56	4800	660.56	421.66	0.2256	0.0386343	0.2442892	1.314E-05
1.5	22.18	5400	640.79	418.33	0.2218	0.0417309	0.2463051	1.311E-05
1.6666667	21.83	6000	622.95	415.26	0.2183	0.044648	0.2481851	1.308E-05
1.8333333	21.51	6600	606.72	412.4	0.2151	0.0474223	0.2499555	1.305E-05
2	21.21	7200	591.88	409.74	0.2121	0.0500494	0.2516153	1.303E-05
2.1666667	20.93	7800	578.29	407.26	0.2093	0.0525534	0.2531834	1.300E-05
2.3333333	20.67	8400	565.46	404.87	0.2067	0.0549558	0.2546665	1.298E-05
2.5	20.41	9000	553.17	402.55	0.2041	0.0571926	0.2560144	1.296E-05
2.6666667	20.16	9600	541.67	400.33	0.2016	0.059316	0.2572723	1.294E-05
2.8333333	19.92	10200	530.61	398.17	0.1992	0.0613386	0.2584445	1.292E-05
3	19.68	10800	519.79	396.03	0.1968	0.0632256	0.2594989	1.290E-05
3.1666667	19.44	11400	509.13	393.88	0.1944	0.0649839	0.2604351	1.288E-05
3.3333333	19.21	12000	499.07	391.82	0.1921	0.0666684	0.2613124	1.286E-05
3.5	18.99	12600	489.2	389.77	0.1899	0.0682681	0.2621234	1.285E-05
3.6666667	18.75	13200	479.28	387.67	0.1875	0.0696999	0.2627479	1.283E-05
3.8333333	18.53	13800	469.7	385.61	0.1853	0.071109	0.2633573	1.281E-05
4	18.3	14400	460.5	383.61	0.183	0.0723684	0.2638466	1.279E-05
4.1666667	18.08	15000	451.46	381.61	0.1808	0.0735864	0.2642837	1.278E-05
4.3333333	17.86	15600	442.59	379.62	0.1786	0.0747156	0.2646347	1.276E-05
4.5	17.65	16200	433.96	377.65	0.1765	0.0758149	0.2649457	1.274E-05
4.6666667	17.43	16800	425.36	375.66	0.1743	0.0767781	0.265127	1.272E-05
4.8333333	17.21	17400	416.82	373.65	0.1721	0.0776629	0.26522	1.271E-05
5	16.99	18000	408.58	371.68	0.1699	0.0784723	0.2652433	1.269E-05
5.1666667	16.77	18600	400.39	369.69	0.1677	0.0792093	0.265181	1.267E-05
5.3333333	16.56	19200	392.4	367.73	0.1656	0.0799358	0.2650932	1.266E-05
5.5	16.34	19800	384.41	365.73	0.1634	0.0805365	0.2648721	1.264E-05
5.6666667	16.12	20400	376.68	363.76	0.1612	0.0810723	0.2645843	1.263E-05
5.8333333	15.91	21000	369.14	361.81	0.1591	0.0816067	0.2642728	1.261E-05
6	15.7	21600	361.8	359.89	0.157	0.0820818	0.263899	1.259E-05
6.1666667	15.49	22200	354.43	357.92	0.1549	0.0824995	0.2634328	1.258E-05
6.3333333	15.28	22800	347.37	356.01	0.1528	0.0828615	0.2629177	1.256E-05
6.5	15.07	23400	343.49	354.09	0.1507	0.0831695	0.2623266	1.255E-05
6.6666667	14.86	24000	340.3	352.18	0.1486	0.083425	0.2616681	1.253E-05

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6.3333333	14.65	24600	337.08	350.25	0.1465	0.0836295	0.2609286	1.252E-05
7	14.45	25200	333.96	348.37	0.1445	0.0838503	0.2601878	1.250E-05
7.1666667	14.24	25800	330.75	346.45	0.1424	0.0839572	0.2593092	1.249E-05
7.3333333	14.04	26400	327.61	344.57	0.1404	0.0840841	0.2584264	1.247E-05
7.5	13.84	27000	324.6	342.7	0.1384	0.084166	0.257478	1.246E-05
7.6666667	13.63	27600	322.08	340.81	0.1363	0.0841353	0.2563989	1.244E-05
7.8333333	13.43	28200	319.6	338.95	0.1343	0.0841295	0.2553128	1.243E-05
8	13.23	28800	317.12	337.09	0.1323	0.0840816	0.2541547	1.241E-05
8.1666667	13.03	29400	314.7	335.26	0.1303	0.0839922	0.2529431	1.240E-05
8.3333333	12.84	30000	314.7	333.44	0.1284	0.0839334	0.2517151	1.239E-05
8.5	12.64	30600	314.7	331.61	0.1264	0.083764	0.2503592	1.237E-05
8.6666667	12.45	31200	314.7	329.8	0.1245	0.0836278	0.2489933	1.236E-05
8.8333333	12.26	31800	314.7	328	0.1226	0.0834541	0.2475617	1.234E-05
9	12.07	32400	314.7	326.23	0.1207	0.0832435	0.2460798	1.233E-05
9.1666667	11.88	33000	314.7	324.44	0.1188	0.0829965	0.244509	1.232E-05
9.3333333	11.69	33600	314.7	322.68	0.1169	0.0827136	0.2428882	1.230E-05
9.5	11.5	34200	314.7	320.94	0.115	0.0823951	0.2412104	1.229E-05
9.6666667	11.32	34800	314.7	319.2	0.1132	0.082118	0.239509	1.228E-05
9.8333333	11.13	35400	314.7	317.5	0.1113	0.0817303	0.2377192	1.227E-05
10	10.95	36000	314.7	315.75	0.1095	0.081386	0.2358591	1.225E-05
10.166667	10.76	36600	314.7	314.01	0.1076	0.0809303	0.2338808	1.224E-05
10.333333	10.58	37200	314.7	312.27	0.1058	0.08052	0.2318753	1.223E-05
10.5	10.4	37800	314.7	310.57	0.104	0.0800775	0.229833	1.222E-05
10.666667	10.22	38400	314.7	308.88	0.1022	0.0796028	0.2277244	1.220E-05
10.833333	10.04	39000	314.7	307.21	0.1004	0.0790963	0.225561	1.219E-05
11	9.86	39600	314.7	305.53	0.0986	0.0785582	0.223309	1.218E-05
11.166667	9.69	40200	314.7	303.86	0.0969	0.0780715	0.2210416	1.217E-05
11.333333	9.51	40800	314.7	302.19	0.0951	0.0774711	0.2186445	1.216E-05
11.5	9.33	41400	314.7	300.55	0.0933	0.0768394	0.2162062	1.214E-05
11.666667	9.16	42000	314.7	298.92	0.0916	0.0762818	0.2137541	1.213E-05
11.833333	8.99	42600	314.7	297.33	0.0899	0.0756546	0.2112781	1.212E-05
12	8.82	43200	314.7	295.73	0.0882	0.0750179	0.2087129	1.211E-05
12.166667	8.66	43800	314.7	294.13	0.0866	0.0744394	0.2061218	1.210E-05
12.333333	8.49	44400	314.7	292.53	0.0849	0.0737446	0.2034028	1.209E-05
12.5	8.32	45000	314.7	290.97	0.0832	0.0730204	0.2006667	1.208E-05
12.666667	8.16	45600	314.7	289.42	0.0816	0.0723569	0.197922	1.207E-05
12.833333	7.99	46200	314.7	287.84	0.0799	0.0715748	0.1950053	1.205E-05
13	7.83	46800	314.7	286.32	0.0783	0.070855	0.1921602	1.204E-05
13.166667	7.67	47400	314.7	284.81	0.0767	0.0701075	0.1892601	1.203E-05
13.333333	7.52	48000	314.7	283.35	0.0752	0.0694255	0.1864244	1.202E-05
13.5	7.36	48600	314.7	281.9	0.0736	0.0686233	0.1834901	1.201E-05
13.666667	7.21	49200	314.7	280.45	0.0721	0.0678883	0.1805395	1.200E-05
13.833333	7.06	49800	314.7	279.01	0.0706	0.0671271	0.1775419	1.199E-05
14	6.91	50400	314.7	277.6	0.0691	0.0663398	0.1745364	1.198E-05
14.166667	6.76	51000	314.7	276.17	0.0676	0.0655262	0.171432	1.197E-05

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14.333333	6.61	51600	314.7	274.76	0.0661	0.0646864	0.1683049	1.196E-05
14.5	6.47	52200	314.7	273.35	0.0647	0.0639195	0.1651662	1.196E-05
14.666667	6.32	52800	314.7	271.98	0.0632	0.0630279	0.1620025	1.195E-05
14.833333	6.18	53400	314.7	270.61	0.0618	0.0622108	0.1588317	1.194E-05
15	6.04	54000	314.7	269.25	0.0604	0.0613691	0.1556286	1.193E-05
15.166667	5.89	54600	314.7	267.89	0.0589	0.0603997	0.1523288	1.192E-05
15.333333	5.75	55200	314.7	266.55	0.0575	0.0595074	0.1490688	1.191E-05
15.5	5.61	55800	314.7	265.22	0.0561	0.0585901	0.1457843	1.190E-05
15.666667	5.47	56400	314.7	263.88	0.0547	0.0576479	0.1424338	1.189E-05
15.833333	5.33	57000	314.7	262.56	0.0533	0.0566805	0.1390859	1.188E-05
16	5.2	57600	314.7	261.24	0.052	0.0557952	0.135742	1.188E-05
16.166667	5.06	58200	314.7	259.93	0.0506	0.0547783	0.1323408	1.187E-05
16.333333	4.92	58800	314.7	258.63	0.0492	0.053736	0.1289292	1.186E-05
16.5	4.79	59400	314.7	257.34	0.0479	0.0527783	0.1255518	1.185E-05
16.666667	4.65	60000	314.7	256.06	0.0465	0.0516859	0.1221289	1.184E-05
16.833333	4.52	60600	314.7	254.78	0.0452	0.0506798	0.1187219	1.183E-05
17	4.39	61200	314.7	253.51	0.0439	0.0496497	0.1153165	1.183E-05
17.166667	4.26	61800	314.7	252.25	0.0426	0.0485957	0.1119165	1.182E-05
17.333333	4.13	62400	314.7	251	0.0413	0.0475176	0.1085253	1.181E-05
17.5	4	63000	314.7	249.75	0.04	0.0464153	0.1051223	1.180E-05
17.666667	3.87	63600	314.7	248.51	0.0387	0.0452888	0.1017355	1.179E-05
17.833333	3.74	64200	314.7	247.28	0.0374	0.0441377	0.0983685	1.179E-05
18	3.61	64800	314.7	246.05	0.0361	0.0429622	0.0950006	1.178E-05
18.166667	3.48	65400	314.7	244.83	0.0348	0.041762	0.0916601	1.177E-05
18.333333	3.35	66000	314.7	243.61	0.0335	0.0405371	0.0883262	1.176E-05
18.5	3.23	66600	314.7	242.4	0.0323	0.0394089	0.0850596	1.175E-05
18.666667	3.1	67200	314.7	241.21	0.031	0.0381351	0.081823	1.175E-05
18.833333	2.98	67800	314.7	240.02	0.0298	0.0369597	0.078635	1.174E-05
19	2.86	68400	314.7	238.83	0.0286	0.0357611	0.075467	1.173E-05
19.166667	2.73	69000	314.7	237.65	0.0273	0.0344136	0.0723185	1.172E-05
19.333333	2.61	69600	314.7	236.47	0.0261	0.0331671	0.0692274	1.172E-05
19.5	2.49	70200	314.7	235.29	0.0249	0.0318971	0.0661681	1.171E-05
19.666667	2.37	70800	314.7	234.13	0.0237	0.0306034	0.0631911	1.170E-05
19.833333	2.25	71400	314.7	232.97	0.0225	0.0292858	0.0602529	1.170E-05
20	2.13	72000	314.7	231.81	0.0213	0.0279443	0.0573572	1.169E-05
20.166667	2.01	72600	314.7	230.66	0.0201	0.0265787	0.0545303	1.168E-05
20.333333	1.89	73200	314.7	229.53	0.0189	0.0251888	0.0517966	1.167E-05
20.5	1.77	73800	314.7	228.41	0.0177	0.0237747	0.0491359	1.167E-05
20.666667	1.66	74400	314.7	227.32	0.0166	0.022471	0.0466131	1.166E-05
20.833333	1.55	75000	314.7	226.25	0.0155	0.021145	0.0441845	1.165E-05
21	1.44	75600	314.7	225.2	0.0144	0.0197963	0.0418502	1.165E-05
21.166667	1.33	76200	314.7	224.2	0.0133	0.0184249	0.0396693	1.164E-05
21.333333	1.23	76800	314.7	223.21	0.0123	0.01717	0.0375775	1.163E-05
21.5	1.13	77400	314.7	222.24	0.0113	0.0158943	0.0355752	1.163E-05
21.666667	1.03	78000	314.7	221.27	0.0103	0.0145977	0.0336247	1.162E-05

21.833333	0.93	78600	314.7	220.32	0.0093	0.0132801	0.0317634	1.162E-05
22	0.84	79200	314.7	219.39	0.0084	0.012085	0.0300043	1.161E-05
22.166667	0.74	79800	314.7	218.45	0.0074	0.0107261	0.0282653	1.161E-05
22.333333	0.64	80400	314.7	217.53	0.0064	0.0093459	0.0266134	1.160E-05
22.5	0.55	81000	314.7	216.61	0.0055	0.0080913	0.0250276	1.159E-05
22.666667	0.45	81600	314.7	215.7	0.0045	0.0066692	0.023498	1.159E-05
22.833333	0.36	82200	314.7	214.78	0.0036	0.0053746	0.022019	1.158E-05
23	0.26	82800	314.7	213.87	0.0026	0.0039102	0.0205977	1.158E-05
23.166667	0.17	83400	314.7	212.96	0.0017	0.0025754	0.0192417	1.157E-05
23.333333	0.07	84000	314.7	212.05	0.0007	0.0010682	0.0179303	1.157E-05

FLASH2

			Ltube =	52 ft		Mdot =	2.5 lbm/sec	
			Adep/ft =	2541.25 ft		Spvolsat =	26.8 ft3/lbm	
Post-fl pH	[I]a (g-at/L)	[I]b1	[I2]b1	DF1	[I]b2	[I2]b2	DF2	DF (depo)
4.8077101	1.320E-09	2.393E-09	1.646E-14	298.2579	2.385E-09	1.635E-14	300.27213	1.0018182
4.872227	1.208E-08	1.627E-08	5.877E-13	133.05202	1.615E-08	5.789E-13	135.08455	1.014954
4.8722563	2.284E-08	3.076E-08	2.1E-12	70.430569	3.032E-08	2.04E-12	72.483883	1.014954
4.8722563	3.359E-08	4.525E-08	4.544E-12	47.879262	4.431E-08	4.356E-12	49.953747	1.014954
4.8750462	4.435E-08	5.898E-08	7.633E-12	39.089886	5.747E-08	7.246E-12	41.179999	1.017143
4.8771726	5.511E-08	7.257E-08	1.146E-11	33.355093	7.039E-08	1.078E-11	35.459973	1.0190876
4.8787964	6.587E-08	8.609E-08	1.602E-11	29.207817	8.314E-08	1.493E-11	31.327094	1.0207898
4.8802109	7.663E-08	9.95E-08	2.127E-11	26.140011	9.569E-08	1.967E-11	28.273028	1.0223884
4.88142	8.738E-08	1.128E-07	2.722E-11	23.737383	1.081E-07	2.497E-11	25.883766	1.0239285
4.8824829	9.814E-08	1.261E-07	3.386E-11	21.803658	1.203E-07	3.081E-11	23.963063	1.0253547
4.8834574	1.089E-07	1.393E-07	4.115E-11	20.225391	1.324E-07	3.716E-11	22.397398	1.0267557
4.8843445	1.197E-07	1.524E-07	4.91E-11	18.902817	1.444E-07	4.401E-11	21.087123	1.0281407
4.8851729	1.304E-07	1.655E-07	5.768E-11	17.783994	1.562E-07	5.134E-11	19.980249	1.0295026
4.8859432	1.412E-07	1.785E-07	6.69E-11	16.820343	1.679E-07	5.914E-11	19.028272	1.0308402
4.886656	1.519E-07	1.915E-07	7.676E-11	15.977037	1.795E-07	6.739E-11	18.196437	1.0321951
4.8873866	1.627E-07	2.044E-07	8.718E-11	15.254424	1.91E-07	7.606E-11	17.484778	1.0335755
4.8880476	1.734E-07	2.172E-07	9.82E-11	14.617853	2.024E-07	8.514E-11	16.858849	1.03496
4.8886993	1.842E-07	2.3E-07	1.098E-10	14.051597	2.137E-07	9.463E-11	16.302959	1.0363698
4.8893492	1.950E-07	2.427E-07	1.219E-10	13.555119	2.248E-07	1.045E-10	15.816378	1.0378308
4.889997	2.057E-07	2.554E-07	1.346E-10	13.11773	2.359E-07	1.147E-10	15.388419	1.0393665
4.8906161	2.165E-07	2.68E-07	1.478E-10	12.719718	2.469E-07	1.253E-10	14.999621	1.0409049
4.8912066	2.272E-07	2.805E-07	1.616E-10	12.354899	2.578E-07	1.363E-10	14.643832	1.0425044
4.891849	2.380E-07	2.929E-07	1.757E-10	12.050222	2.686E-07	1.476E-10	14.347226	1.0442173
4.8924362	2.488E-07	3.053E-07	1.905E-10	11.757733	2.794E-07	1.593E-10	14.062909	1.0459747
4.8930483	2.595E-07	3.176E-07	2.056E-10	11.505552	2.9E-07	1.712E-10	13.818194	1.0477576
4.8936323	2.703E-07	3.299E-07	2.213E-10	11.269485	3.006E-07	1.835E-10	13.589462	1.0496199
4.8942147	2.810E-07	3.421E-07	2.374E-10	11.057185	3.112E-07	1.961E-10	13.384085	1.0515559
4.8947691	2.918E-07	3.543E-07	2.541E-10	10.856277	3.217E-07	2.091E-10	13.190013	1.0535579
4.8953484	3.025E-07	3.664E-07	2.71E-10	10.684686	3.321E-07	2.223E-10	13.024544	1.0556711
4.8959262	3.133E-07	3.784E-07	2.884E-10	10.530581	3.425E-07	2.359E-10	12.876163	1.057903
4.8965025	3.241E-07	3.904E-07	3.062E-10	10.392436	3.528E-07	2.497E-10	12.743345	1.0601906
4.8970773	3.348E-07	4.023E-07	3.244E-10	10.268931	3.631E-07	2.638E-10	12.624777	1.0626071
4.8976245	3.456E-07	4.142E-07	3.43E-10	10.149287	3.734E-07	2.783E-10	12.510043	1.0650966
4.8981962	3.563E-07	4.259E-07	3.62E-10	10.051801	3.836E-07	2.93E-10	12.416735	1.0677548
4.8987665	3.671E-07	4.376E-07	3.812E-10	9.9659402	3.937E-07	3.08E-10	12.334676	1.0704956
4.8993095	3.779E-07	4.493E-07	4.01E-10	9.8813519	4.039E-07	3.234E-10	12.253901	1.0733348
4.8998511	3.886E-07	4.61E-07	4.211E-10	9.8069612	4.14E-07	3.39E-10	12.182973	1.0762595
4.9003914	3.994E-07	4.726E-07	4.415E-10	9.742163	4.241E-07	3.549E-10	12.121291	1.0794009
4.9009303	4.101E-07	4.841E-07	4.623E-10	9.6864273	4.341E-07	3.711E-10	12.068332	1.0825896
4.9014679	4.209E-07	4.956E-07	4.834E-10	9.6392907	4.442E-07	3.875E-10	12.023637	1.0859447
4.9020041	4.316E-07	5.07E-07	5.048E-10	9.6003485	4.542E-07	4.043E-10	11.986808	1.0894393

FLASH2

4.9025391	4.424E-07	5.183E-07	5.265E-10	9.569249	4.642E-07	4.213E-10	11.9575	1.0931382
4.9030473	4.532E-07	5.297E-07	5.487E-10	9.5358727	4.741E-07	4.387E-10	11.92602	1.0969123
4.9035797	4.639E-07	5.409E-07	5.71E-10	9.5195152	4.841E-07	4.563E-10	11.910832	1.1009504
4.9040855	4.747E-07	5.522E-07	5.937E-10	9.5002464	4.941E-07	4.743E-10	11.89286	1.1050944
4.9045901	4.854E-07	5.634E-07	6.168E-10	9.4876652	5.04E-07	4.925E-10	11.881286	1.1094132
4.9051188	4.962E-07	5.745E-07	6.399E-10	9.4917078	5.14E-07	5.11E-10	11.885615	1.1139888
4.905621	5.069E-07	5.856E-07	6.635E-10	9.4920786	5.239E-07	5.298E-10	11.88643	1.1187103
4.9061221	5.177E-07	5.966E-07	6.873E-10	9.4986854	5.338E-07	5.489E-10	11.893211	1.1236607
4.906622	5.285E-07	6.076E-07	7.114E-10	9.51143	5.438E-07	5.683E-10	11.905866	1.1287674
4.9070959	5.392E-07	6.187E-07	7.36E-10	9.5196725	5.537E-07	5.881E-10	11.914213	1.1340917
4.9075936	5.500E-07	6.296E-07	7.606E-10	9.5443593	5.636E-07	6.081E-10	11.938304	1.1397061
4.9080654	5.607E-07	6.405E-07	7.857E-10	9.5641883	5.735E-07	6.284E-10	11.95775	1.1455314
4.9085361	5.715E-07	6.513E-07	8.11E-10	9.5896898	5.834E-07	6.49E-10	11.982634	1.1516065
4.9090058	5.823E-07	6.622E-07	8.365E-10	9.6208472	5.933E-07	6.7E-10	12.012946	1.1578764
4.9094745	5.930E-07	6.73E-07	8.623E-10	9.6576641	6.033E-07	6.912E-10	12.048696	1.1645267
4.9099422	6.038E-07	6.837E-07	8.883E-10	9.7001636	6.132E-07	7.127E-10	12.089913	1.1713891
4.9104089	6.145E-07	6.944E-07	9.146E-10	9.7483883	6.231E-07	7.346E-10	12.136644	1.1785072
4.9108501	6.253E-07	7.051E-07	9.413E-10	9.7905624	6.331E-07	7.568E-10	12.177592	1.1859766
4.9113149	6.360E-07	7.157E-07	9.679E-10	9.8502302	6.43E-07	7.792E-10	12.235366	1.1936335
4.9117543	6.468E-07	7.263E-07	9.951E-10	9.9035977	6.53E-07	8.021E-10	12.287121	1.2019086
4.9122171	6.576E-07	7.368E-07	1.022E-09	9.9750601	6.63E-07	8.252E-10	12.356313	1.2105553
4.9126546	6.683E-07	7.474E-07	1.05E-09	10.039996	6.729E-07	8.486E-10	12.419273	1.2196455
4.9130913	6.791E-07	7.579E-07	1.077E-09	10.110781	6.829E-07	8.724E-10	12.48791	1.2289812
4.9135271	6.898E-07	7.684E-07	1.105E-09	10.187553	6.929E-07	8.964E-10	12.562367	1.2387349
4.913962	7.006E-07	7.788E-07	1.134E-09	10.270471	7.03E-07	9.208E-10	12.642809	1.2488647
4.9143961	7.113E-07	7.892E-07	1.162E-09	10.359715	7.13E-07	9.456E-10	12.729422	1.2595789
4.9148052	7.221E-07	7.996E-07	1.191E-09	10.441369	7.23E-07	9.707E-10	12.808772	1.2707825
4.9152376	7.329E-07	8.099E-07	1.219E-09	10.543561	7.331E-07	9.961E-10	12.90804	1.2825725
4.9156691	7.436E-07	8.201E-07	1.248E-09	10.652742	7.432E-07	1.022E-09	13.014159	1.294758
4.9160759	7.544E-07	8.304E-07	1.278E-09	10.754026	7.532E-07	1.048E-09	13.112724	1.3075036
4.9164819	7.651E-07	8.407E-07	1.307E-09	10.862112	7.633E-07	1.074E-09	13.217962	1.3205847
4.9168871	7.759E-07	8.509E-07	1.337E-09	10.977267	7.734E-07	1.101E-09	13.330148	1.3344359
4.9172678	7.867E-07	8.612E-07	1.367E-09	11.083475	7.835E-07	1.128E-09	13.433743	1.3490217
4.9176716	7.974E-07	8.714E-07	1.397E-09	11.213242	7.937E-07	1.156E-09	13.560313	1.3643905
4.9180746	8.082E-07	8.815E-07	1.428E-09	11.351031	8.039E-07	1.183E-09	13.694799	1.3801787
4.9184532	8.189E-07	8.917E-07	1.459E-09	11.479545	8.14E-07	1.212E-09	13.820378	1.3967037
4.9188548	8.297E-07	9.017E-07	1.489E-09	11.63406	8.242E-07	1.24E-09	13.971395	1.4144659
4.9192321	8.404E-07	9.118E-07	1.52E-09	11.779112	8.344E-07	1.269E-09	14.113325	1.4324867
4.9196087	8.512E-07	9.219E-07	1.552E-09	11.932806	8.447E-07	1.298E-09	14.263811	1.4513563
4.9199612	8.620E-07	9.321E-07	1.584E-09	12.075749	8.549E-07	1.328E-09	14.403924	1.4705794
4.9203366	8.727E-07	9.421E-07	1.615E-09	12.247498	8.651E-07	1.358E-09	14.572307	1.4906865
4.9206879	8.835E-07	9.521E-07	1.648E-09	12.408254	8.754E-07	1.388E-09	14.730082	1.5118736
4.9210386	8.942E-07	9.622E-07	1.68E-09	12.578332	8.857E-07	1.419E-09	14.897111	1.5340558
4.9213888	9.050E-07	9.722E-07	1.713E-09	12.758249	8.96E-07	1.45E-09	15.073916	1.5569529
4.9217384	9.158E-07	9.821E-07	1.745E-09	12.948572	9.063E-07	1.481E-09	15.26107	1.581446

FLASH2

4.9220875	9.265E-07	9.921E-07	1.778E-09	13.149924	9.166E-07	1.513E-09	15.459201	1.6069371
4.9224128	9.373E-07	1.002E-06	1.812E-09	13.338227	9.27E-07	1.545E-09	15.644676	1.633853
4.9227607	9.480E-07	1.012E-06	1.845E-09	13.562848	9.374E-07	1.577E-09	15.865988	1.6614664
4.923085	9.588E-07	1.022E-06	1.879E-09	13.774139	9.477E-07	1.61E-09	16.074368	1.6906221
4.9234088	9.695E-07	1.032E-06	1.913E-09	13.997575	9.581E-07	1.644E-09	16.294859	1.7211989
4.9237552	9.803E-07	1.042E-06	1.947E-09	14.262471	9.686E-07	1.677E-09	16.556362	1.7535214
4.924078	9.911E-07	1.052E-06	1.981E-09	14.513728	9.791E-07	1.711E-09	16.80463	1.7872003
4.9244003	1.002E-06	1.061E-06	2.016E-09	14.779818	9.895E-07	1.746E-09	17.067718	1.8225577
4.9247221	1.013E-06	1.071E-06	2.051E-09	15.061806	1E-06	1.78E-09	17.346697	1.8602699
4.9250435	1.023E-06	1.081E-06	2.085E-09	15.36087	1.011E-06	1.816E-09	17.642756	1.8996235
4.9253415	1.034E-06	1.091E-06	2.121E-09	15.643418	1.021E-06	1.851E-09	17.922699	1.9413316
4.9256619	1.045E-06	1.101E-06	2.156E-09	15.979117	1.032E-06	1.887E-09	18.255416	1.9852309
4.9259819	1.056E-06	1.11E-06	2.191E-09	16.336152	1.042E-06	1.924E-09	18.6095	2.0314567
4.9262786	1.066E-06	1.12E-06	2.227E-09	16.676386	1.053E-06	1.96E-09	18.94719	2.0801538
4.9265977	1.077E-06	1.13E-06	2.263E-09	17.079694	1.064E-06	1.997E-09	19.347631	2.1314779
4.9268935	1.088E-06	1.139E-06	2.299E-09	17.466255	1.074E-06	2.035E-09	19.731738	2.1860356
4.927189	1.099E-06	1.149E-06	2.335E-09	17.878004	1.085E-06	2.073E-09	20.14109	2.2436229
4.927484	1.109E-06	1.159E-06	2.372E-09	18.317177	1.095E-06	2.111E-09	20.577939	2.304439
4.9277787	1.120E-06	1.168E-06	2.409E-09	18.786297	1.106E-06	2.15E-09	21.044819	2.3686985
4.9280729	1.131E-06	1.178E-06	2.446E-09	19.288216	1.117E-06	2.189E-09	21.5446	2.437198
4.9283668	1.142E-06	1.188E-06	2.483E-09	19.826171	1.128E-06	2.229E-09	22.080538	2.5096969
4.9286602	1.152E-06	1.197E-06	2.52E-09	20.403855	1.139E-06	2.269E-09	22.656344	2.5864726
4.9289533	1.163E-06	1.207E-06	2.557E-09	21.025492	1.149E-06	2.31E-09	23.276265	2.6685148
4.929246	1.174E-06	1.216E-06	2.594E-09	21.695941	1.16E-06	2.35E-09	23.945188	2.7555546
4.9295382	1.185E-06	1.226E-06	2.632E-09	22.420819	1.171E-06	2.392E-09	24.668758	2.8487453
4.9298077	1.195E-06	1.235E-06	2.67E-09	23.127919	1.182E-06	2.433E-09	25.374982	2.9478037
4.9300992	1.206E-06	1.245E-06	2.708E-09	23.976318	1.193E-06	2.476E-09	26.222589	3.0522619
4.9303879	1.217E-06	1.254E-06	2.746E-09	24.810549	1.204E-06	2.518E-09	27.056483	3.164351
4.9306364	1.228E-06	1.264E-06	2.785E-09	25.717399	1.215E-06	2.561E-09	27.963314	3.2847943
4.9309268	1.238E-06	1.273E-06	2.823E-09	26.812101	1.226E-06	2.605E-09	29.058315	3.4132697
4.9311945	1.249E-06	1.283E-06	2.862E-09	27.903295	1.237E-06	2.649E-09	30.150327	3.551634
4.9314619	1.260E-06	1.292E-06	2.901E-09	29.102442	1.248E-06	2.693E-09	31.350791	3.7008732
4.9317289	1.271E-06	1.302E-06	2.94E-09	30.425865	1.259E-06	2.738E-09	32.676116	3.8592548
4.9319957	1.282E-06	1.311E-06	2.979E-09	31.893374	1.27E-06	2.783E-09	34.146212	4.0303959
4.9322621	1.292E-06	1.32E-06	3.019E-09	33.529244	1.281E-06	2.829E-09	35.785479	4.2156246
4.9325282	1.303E-06	1.33E-06	3.058E-09	35.363551	1.292E-06	2.875E-09	37.624144	4.4146357
4.9327939	1.314E-06	1.339E-06	3.098E-09	37.434012	1.303E-06	2.921E-09	39.700117	4.6266996
4.9330594	1.325E-06	1.348E-06	3.138E-09	39.788575	1.315E-06	2.968E-09	42.061587	4.8547848
4.9333024	1.335E-06	1.358E-06	3.179E-09	42.220815	1.326E-06	3.016E-09	44.501708	5.0957218
4.9335452	1.346E-06	1.367E-06	3.22E-09	45.002085	1.337E-06	3.064E-09	47.292599	5.3524027
4.9337877	1.357E-06	1.377E-06	3.261E-09	48.212274	1.348E-06	3.112E-09	50.514557	5.625808
4.9340299	1.368E-06	1.386E-06	3.302E-09	51.957704	1.359E-06	3.161E-09	54.274445	5.9081372
4.9342498	1.378E-06	1.396E-06	3.344E-09	55.908344	1.371E-06	3.21E-09	58.241224	6.2109724
4.9344696	1.389E-06	1.405E-06	3.386E-09	60.563169	1.382E-06	3.26E-09	62.915767	6.532576
4.9346891	1.400E-06	1.414E-06	3.429E-09	66.127155	1.393E-06	3.31E-09	68.504102	6.8814307

FLASH2

4.9349084	1.411E-06	1.424E-06	3.472E-09	72.893445	1.404E-06	3.361E-09	75.300878	7.2523282
4.9351056	1.421E-06	1.433E-06	3.515E-09	80.305324	1.416E-06	3.412E-09	82.747298	7.6464475
4.9353244	1.432E-06	1.443E-06	3.558E-09	90.738986	1.427E-06	3.463E-09	93.230235	8.0793759
4.9355431	1.443E-06	1.452E-06	3.601E-09	104.44097	1.438E-06	3.515E-09	106.99824	8.5404163
4.9357397	1.454E-06	1.462E-06	3.646E-09	120.95128	1.45E-06	3.568E-09	123.58989	9.0424649
4.9359579	1.464E-06	1.471E-06	3.689E-09	147.17408	1.461E-06	3.621E-09	149.94302	9.5838985
4.9361542	1.475E-06	1.48E-06	3.734E-09	183.10856	1.472E-06	3.674E-09	186.05884	10.181772
4.936372	1.486E-06	1.49E-06	3.777E-09	252.43674	1.484E-06	3.728E-09	255.73898	10.828856
4.9365678	1.497E-06	1.499E-06	3.822E-09	384.31553	1.495E-06	3.783E-09	388.29313	11.53787
4.9367852	1.507E-06	1.508E-06	3.866E-09	929.38641	1.507E-06	3.838E-09	936.16346	12.316222

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FLASH2

XL Spread Sheet for TMI MSLB with Pre-Accident Spike - Final Release Fractions

Initial I conc	7.92E-08	g-atom/L.	Rem rate =	1.630E-03	per minute.		Vratio =	1604
ppm B =	1978		Add rate =	1.291E-10	g-atom/L-m		Post-fl T(K)	373
Time (hrs)	% flash	Time (sec)	Press (psia)	Temp (F)	Flash frac	Flash rel	Rel frac	[H+]B
0	44.85	0	2160	601	0.4485	0.1282091	0.3194223	1.557E-05
0.1666667	25.77	600	961.05	449.71	0.2577	0.0451574	0.2514624	1.342E-05
0.3333333	25.76	1200	846.16	449.71	0.2576	0.0457718	0.2519346	1.342E-05
0.5	25.76	1800	846.16	449.71	0.2576	0.0464151	0.2524289	1.342E-05
0.6666667	24.8	2400	787.33	441.37	0.248	0.0440093	0.2500408	1.333E-05
0.8333333	24.06	3000	743.93	434.92	0.2406	0.0423282	0.248277	1.327E-05
1	23.49	3600	711.21	429.86	0.2349	0.0411761	0.2469826	1.322E-05
1.1666667	22.99	4200	684.07	425.52	0.2299	0.0402343	0.2458779	1.318E-05
1.3333333	22.56	4800	660.56	421.66	0.2256	0.0394958	0.2449455	1.314E-05
1.5	22.18	5400	640.79	418.33	0.2218	0.0388974	0.2441497	1.311E-05
1.6666667	21.83	6000	622.95	415.26	0.2183	0.038379	0.2434227	1.308E-05
1.8333333	21.51	6600	606.72	412.4	0.2151	0.0379394	0.2427612	1.305E-05
2	21.21	7200	591.88	409.74	0.2121	0.0375492	0.2421445	1.303E-05
2.1666667	20.93	7800	578.29	407.26	0.2093	0.0372081	0.2415722	1.300E-05
2.3333333	20.67	8400	565.46	404.87	0.2067	0.0369162	0.2410345	1.298E-05
2.5	20.41	9000	553.17	402.55	0.2041	0.0366161	0.2404861	1.296E-05
2.6666667	20.16	9600	541.67	400.33	0.2016	0.0363366	0.2399538	1.294E-05
2.8333333	19.92	10200	530.61	398.17	0.1992	0.0360779	0.2394327	1.292E-05
3	19.68	10800	519.79	396.03	0.1968	0.0358116	0.2388954	1.290E-05
3.1666667	19.44	11400	509.13	393.88	0.1944	0.0355378	0.238337	1.288E-05
3.3333333	19.21	12000	499.07	391.82	0.1921	0.0352852	0.2377954	1.286E-05
3.5	18.99	12600	489.2	389.77	0.1899	0.0350539	0.2372575	1.285E-05
3.6666667	18.75	13200	479.28	387.67	0.1875	0.0347587	0.2366479	1.283E-05
3.8333333	18.53	13800	469.7	385.61	0.1853	0.0345136	0.2360675	1.281E-05
4	18.3	14400	460.5	383.61	0.183	0.0342334	0.2354572	1.279E-05
4.1666667	18.08	15000	451.46	381.61	0.1808	0.0339751	0.2348475	1.278E-05
4.3333333	17.86	15600	442.59	379.62	0.1786	0.0337105	0.2342188	1.276E-05
4.5	17.65	16200	433.96	377.65	0.1765	0.0334679	0.2335942	1.274E-05
4.6666667	17.43	16800	425.36	375.66	0.1743	0.0331909	0.2329219	1.272E-05
4.8333333	17.21	17400	416.82	373.65	0.1721	0.0329078	0.2322218	1.271E-05
5	16.99	18000	408.58	371.68	0.1699	0.032619	0.2315082	1.269E-05
5.1666667	16.77	18600	400.39	369.69	0.1677	0.0323244	0.2307655	1.267E-05
5.3333333	16.56	19200	392.4	367.73	0.1656	0.0320525	0.230027	1.266E-05
5.5	16.34	19800	384.41	365.73	0.1634	0.0317468	0.229231	1.264E-05
5.6666667	16.12	20400	376.68	363.76	0.1612	0.0314358	0.2284175	1.263E-05
5.8333333	15.91	21000	369.14	361.81	0.1591	0.0311478	0.227604	1.261E-05
6	15.7	21600	361.8	359.89	0.157	0.0308545	0.2267729	1.259E-05
6.1666667	15.49	22200	354.43	357.92	0.1549	0.0305562	0.2258974	1.258E-05
6.3333333	15.28	22800	347.37	356.01	0.1528	0.030253	0.2250135	1.256E-05
6.5	15.07	23400	343.49	354.09	0.1507	0.0299448	0.224097	1.255E-05
6.6666667	14.86	24000	340.3	352.18	0.1486	0.029632	0.2231542	1.253E-05

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6.8333333	14.65	24600	337.08	350.25	0.1465	0.0293145	0.2221725	1.252E-05
7	14.45	25200	333.96	348.37	0.1445	0.0290203	0.221199	1.250E-05
7.1666667	14.24	25800	330.75	346.45	0.1424	0.0286937	0.2201563	1.249E-05
7.3333333	14.04	26400	327.61	344.57	0.1404	0.0283907	0.2191168	1.247E-05
7.5	13.84	27000	324.6	342.7	0.1384	0.0280833	0.2180477	1.246E-05
7.6666667	13.63	27600	322.08	340.81	0.1363	0.0277438	0.2169143	1.244E-05
7.8333333	13.43	28200	319.6	338.95	0.1343	0.0274279	0.2157787	1.243E-05
8	13.23	28800	317.12	337.09	0.1323	0.027108	0.2146059	1.241E-05
8.1666667	13.03	29400	314.7	335.26	0.1303	0.0267841	0.2134112	1.240E-05
8.3333333	12.84	30000	314.7	333.44	0.1284	0.0264839	0.2122028	1.239E-05
8.5	12.64	30600	314.7	331.61	0.1264	0.0261521	0.2109304	1.237E-05
8.6666667	12.45	31200	314.7	329.8	0.1245	0.0258442	0.2096481	1.236E-05
8.8333333	12.26	31800	314.7	328	0.1226	0.0255325	0.2083306	1.234E-05
9	12.07	32400	314.7	326.23	0.1207	0.025217	0.2069904	1.233E-05
9.1666667	11.88	33000	314.7	324.44	0.1188	0.024898	0.2055946	1.232E-05
9.3333333	11.69	33600	314.7	322.68	0.1169	0.0245753	0.2041753	1.230E-05
9.5	11.5	34200	314.7	320.94	0.115	0.0242492	0.2027263	1.229E-05
9.6666667	11.32	34800	314.7	319.2	0.1132	0.023947	0.2012508	1.228E-05
9.8333333	11.13	35400	314.7	317.5	0.1113	0.023614	0.1997422	1.227E-05
10	10.95	36000	314.7	315.75	0.1095	0.0233051	0.1981665	1.225E-05
10.166667	10.76	36600	314.7	314.01	0.1076	0.0229655	0.1965322	1.224E-05
10.333333	10.58	37200	314.7	312.27	0.1058	0.0226499	0.1948656	1.223E-05
10.5	10.4	37800	314.7	310.57	0.104	0.0223312	0.193183[illegible]	1.222E-05
10.666667	10.22	38400	314.7	308.88	0.1022	0.0220093	0.191459[illegible]	[illegible].220E-05
10.833333	10.04	39000	314.7	307.21	0.1004	0.0216844	0.1897033	1.219E-05
11	9.86	39600	314.7	305.53	0.0986	0.0213564	0.1878866	1.218E-05
11.166667	9.69	40200	314.7	303.86	0.0969	0.0210525	0.1860436	1.217E-05
11.333333	9.51	40800	314.7	302.19	0.0951	0.0207185	0.1841303	1.216E-05
11.5	9.33	41400	314.7	300.55	0.0933	0.0203816	0.1821944	1.214E-05
11.666667	9.16	42000	314.7	298.92	0.0916	0.020069	0.1802319	1.213E-05
11.833333	8.99	42600	314.7	297.33	0.0899	0.0197534	0.17[illegible]2602	1.212E-05
12	8.82	43200	314.7	295.73	0.0882	0.0194351	0.1762238	1.211E-05
12.166667	8.66	43800	314.7	294.13	0.0866	0.019141	0.1741484	1.210E-05
12.333333	8.49	44400	314.7	292.53	0.0849	0.0188172	0.1720016	1.209E-05
12.5	8.32	45000	314.7	290.97	0.0832	0.0184906	0.1698495	1.208E-05
12.666667	8.16	45600	314.7	289.42	0.0816	0.0181884	0.1676712	1.207E-05
12.833333	7.99	46200	314.7	287.84	0.0799	0.0178566	0.1653827	1.205E-05
13	7.83	46800	314.7	286.32	0.0783	0.0175491	0.1631347	1.204E-05
13.166667	7.67	47400	314.7	284.81	0.0767	0.0172391	0.1608471	1.203E-05
13.333333	7.52	48000	314.7	283.35	0.0752	0.0169533	0.158593	1.202E-05
13.5	7.36	48600	314.7	281.9	0.0736	0.0166382	0.1562889	1.201E-05
13.666667	7.21	49200	314.7	280.45	0.0721	0.0163474	0.1539487	1.200E-05
13.833333	7.06	49800	314.7	279.01	0.0706	0.0160542	0.1515735	1.199E-05
14	6.91	50400	314.7	277.6	0.0691	0.0157585	0.1491963	1.198E-05
14.166667	6.76	51000	314.7	276.17	0.0676	0.0154605	0.1467386	1.197E-05

FLASH2

14.333333	6.61	51600	314.7	274.76	0.0661	0.01516	0.144265	1.196E-05
14.5	6.47	52200	314.7	273.35	0.0647	0.014884	0.1417567	1.196E-05
14.666667	6.32	52800	314.7	271.98	0.0632	0.0145789	0.1392574	1.195E-05
14.833333	6.18	53400	314.7	270.61	0.0618	0.0142983	0.1367264	1.194E-05
15	6.04	54000	314.7	269.25	0.0604	0.0140154	0.1341693	1.193E-05
15.166667	5.89	54600	314.7	267.89	0.0589	0.0137035	0.1315574	1.192E-05
15.333333	5.75	55200	314.7	266.55	0.0575	0.0134162	0.1289529	1.191E-05
15.5	5.61	55800	314.7	265.22	0.0561	0.0131266	0.1263273	1.190E-05
15.666667	5.47	56400	314.7	263.88	0.0547	0.0128349	0.123644	1.189E-05
15.833333	5.33	57000	314.7	262.56	0.0533	0.012541	0.1209619	1.188E-05
16	5.2	57600	314.7	261.24	0.052	0.0122717	0.1182549	1.188E-05
16.166667	5.06	58200	314.7	259.93	0.0506	0.0119737	0.1155228	1.187E-05
16.333333	4.92	58800	314.7	258.63	0.0492	0.0116736	0.1127789	1.186E-05
16.5	4.79	59400	314.7	257.34	0.0479	0.011398	0.1100354	1.185E-05
16.666667	4.65	60000	314.7	256.06	0.0465	0.0110938	0.1072745	1.184E-05
16.833333	4.52	60600	314.7	254.78	0.0452	0.0108143	0.1044974	1.183E-05
17	4.39	61200	314.7	253.51	0.0439	0.0105327	0.1017174	1.183E-05
17.166667	4.26	61800	314.7	252.25	0.0426	0.0102492	0.098937	1.182E-05
17.333333	4.13	62400	314.7	251	0.0413	0.0099637	0.096159	1.181E-05
17.5	4	63000	314.7	249.75	0.04	0.0096764	0.0933644	1.180E-05
17.666667	3.87	63600	314.7	248.51	0.0387	0.0093871	0.0905774	1.179E-05
17.833333	3.74	64200	314.7	247.28	0.0374	0.0090959	0.087801	1.179E-05
18	3.61	64800	314.7	246.05	0.0361	0.0088029	0.0850159	1.178E-05
18.166667	3.48	65400	314.7	244.83	0.0348	0.0085081	0.0822471	1.177E-05
18.333333	3.35	66000	314.7	243.61	0.0335	0.0082114	0.0794753	1.176E-05
18.5	3.23	66600	314.7	242.4	0.0323	0.0079394	0.0767326	1.175E-05
18.666667	3.1	67200	314.7	241.21	0.031	0.0076392	0.0740299	1.175E-05
18.833333	2.98	67800	314.7	240.02	0.0298	0.0073637	0.0713396	1.174E-05
19	2.86	68400	314.7	238.83	0.0286	0.0070864	0.068658	1.173E-05
19.166667	2.73	69000	314.7	237.65	0.0273	0.0067809	0.0660039	1.172E-05
19.333333	2.61	69600	314.7	236.47	0.0261	0.0065002	0.0633709	1.172E-05
19.5	2.49	70200	314.7	235.29	0.0249	0.0062177	0.0607559	1.171E-05
19.666667	2.37	70800	314.7	234.13	0.0237	0.0059336	0.0582051	1.170E-05
19.833333	2.25	71400	314.7	232.97	0.0225	0.0056478	0.0556782	1.170E-05
20	2.13	72000	314.7	231.81	0.0213	0.0053604	0.0531786	1.169E-05
20.166667	2.01	72600	314.7	230.66	0.0201	0.0050713	0.0507303	1.168E-05
20.333333	1.89	73200	314.7	229.53	0.0189	0.0047806	0.048356	1.167E-05
20.5	1.77	73800	314.7	228.41	0.0177	0.0044883	0.0460372	1.167E-05
20.666667	1.66	74400	314.7	227.32	0.0166	0.0042208	0.0438195	1.166E-05
20.833333	1.55	75000	314.7	226.25	0.0155	0.0039517	0.0416789	1.165E-05
21	1.44	75600	314.7	225.2	0.0144	0.0036811	0.0396159	1.165E-05
21.166667	1.33	76200	314.7	224.2	0.0133	0.0034089	0.0376868	1.164E-05
21.333333	1.23	76800	314.7	223.21	0.0123	0.0031617	0.0358182	1.163E-05
21.5	1.13	77400	314.7	222.24	0.0113	0.0029129	0.0340252	1.163E-05
21.666667	1.03	78000	314.7	221.27	0.0103	0.0026626	0.0322719	1.162E-05

FLASH2

21.833333	0.93	78600	314.7	220.32	0.0093	0.0024109	0.0305944	1.162E-05
22	0.84	79200	314.7	219.39	0.0084	0.0021841	0.0289943	1.161E-05
22.166667	0.74	79800	314.7	218.45	0.0074	0.0019294	0.0274161	1.161E-05
22.333333	0.64	80400	314.7	217.53	0.0064	0.0016733	0.0259127	1.160E-05
22.5	0.55	81000	314.7	216.61	0.0055	0.0014422	0.0244541	1.159E-05
22.666667	0.45	81600	314.7	215.7	0.0045	0.0011832	0.0230515	1.159E-05
22.833333	0.36	82200	314.7	214.78	0.0036	0.0009493	0.02168	1.158E-05
23	0.26	82800	314.7	213.87	0.0026	0.0006874	0.0203656	1.158E-05
23.166667	0.17	83400	314.7	212.96	0.0017	0.0004508	0.0190981	1.157E-05
23.333333	0.07	34000	314.7	212.05	0.0007	0.0001861	0.0178744	1.157E-05

FLASH2

			Ltube =	52 ft		Mdot =	2.5 lbm/sec	
			Adep/ft =	2541.25 ft		Spvolsat =	26.8 ft3/lbm	
Post-fl pH	[I]a (g-at/L)	[I]b1	[I2]b1	DF1	[I]b2	[I2]b2	DF2	DF (depo)
4.8077101	7.920E-08	1.436E-07	5.922E-11	4.9749997	1.147E-07	3.777E-11	7.7997593	1.0018182
4.872227	8.049E-08	1.084E-07	2.609E-11	19.973173	1.03E-07	2.353E-11	22.144748	1.014954
4.8722563	8.178E-08	1.102E-07	2.692E-11	19.673289	1.046E-07	2.424E-11	21.847518	1.014954
4.8722563	8.307E-08	1.119E-07	2.778E-11	19.367714	1.061E-07	2.497E-11	21.54473	1.014954
4.8750462	8.436E-08	1.122E-07	2.761E-11	20.555246	1.067E-07	2.498E-11	22.72248	1.017143
4.8771726	8.565E-08	1.128E-07	2.767E-11	21.464306	1.075E-07	2.514E-11	23.624904	1.0190876
4.8787964	8.695E-08	1.136E-07	2.791E-11	22.129769	1.085E-07	2.543E-11	24.285936	1.0207898
4.8802109	8.824E-08	1.146E-07	2.821E-11	22.701822	1.095E-07	2.576E-11	24.854438	1.0223884
4.88142	8.953E-08	1.156E-07	2.858E-11	23.169282	1.106E-07	2.615E-11	25.319174	1.0239285
4.8824829	9.082E-08	1.167E-07	2.899E-11	23.5609	1.118E-07	2.657E-11	25.708631	1.0253547
4.8834574	9.211E-08	1.178E-07	2.944E-11	23.910042	1.129E-07	2.702E-11	26.055933	1.0267557
4.8843445	9.340E-08	1.19E-07	2.992E-11	24.213491	1.141E-07	2.749E-11	26.357853	1.0281407
4.8851729	9.469E-08	1.202E-07	3.042E-11	24.488725	1.153E-07	2.797E-11	26.631755	1.0295026
4.8859432	9.598E-08	1.214E-07	3.093E-11	24.733945	1.165E-07	2.847E-11	26.875836	1.0308402
4.886656	9.727E-08	1.226E-07	3.147E-11	24.94744	1.177E-07	2.898E-11	27.08838	1.0321951
4.8873666	9.856E-08	1.238E-07	3.201E-11	25.170425	1.189E-07	2.95E-11	27.310389	1.0335755
4.8880476	9.986E-08	1.251E-07	3.256E-11	25.381361	1.201E-07	3.003E-11	27.520432	1.03496
4.8886993	1.011E-07	1.263E-07	3.312E-11	25.57952	1.214E-07	3.056E-11	27.717779	1.0363698
4.8893492	1.024E-07	1.275E-07	3.368E-11	25.786512	1.226E-07	3.11E-11	27.923936	1.0378308
4.889997	1.037E-07	1.288E-07	3.424E-11	26.002516	1.238E-07	3.164E-11	28.139083	1.0393665
4.8906161	1.050E-07	1.3E-07	3.481E-11	26.204737	1.25E-07	3.218E-11	28.340528	1.0409049
4.8912066	1.063E-07	1.312E-07	3.539E-11	26.392409	1.263E-07	3.274E-11	28.527506	1.0425044
4.891849	1.076E-07	1.324E-07	3.595E-11	26.63559	1.275E-07	3.328E-11	28.769769	1.0442173
4.8924362	1.089E-07	1.337E-07	3.653E-11	26.840623	1.287E-07	3.384E-11	28.974069	1.0459747
4.8930483	1.102E-07	1.349E-07	3.71E-11	27.078616	1.299E-07	3.439E-11	29.211208	1.0477576
4.8936323	1.115E-07	1.361E-07	3.768E-11	27.30146	1.311E-07	3.495E-11	29.433282	1.0496199
4.8942147	1.128E-07	1.373E-07	3.826E-11	27.533343	1.323E-07	3.551E-11	29.664377	1.0515559
4.8947691	1.141E-07	1.385E-07	3.885E-11	27.749042	1.335E-07	3.608E-11	29.879371	1.0535579
4.8953484	1.153E-07	1.397E-07	3.943E-11	27.999271	1.347E-07	3.665E-11	30.12878	1.0556711
4.8959262	1.166E-07	1.409E-07	4.001E-11	28.259228	1.359E-07	3.721E-11	30.387902	1.057903
4.8965025	1.179E-07	1.421E-07	4.059E-11	28.529182	1.371E-07	3.777E-11	30.657008	1.0601906
4.8970773	1.192E-07	1.432E-07	4.117E-11	28.809423	1.383E-07	3.834E-11	30.936388	1.0626071
4.8976245	1.205E-07	1.444E-07	4.176E-11	29.072649	1.395E-07	3.892E-11	31.198838	1.06509[illegible]
4.8981962	1.218E-07	1.456E-07	4.234E-11	29.373909	1.406E-07	3.948E-11	31.499215	1.0677548
4.8987665	1.231E-07	1.467E-07	4.292E-11	29.686424	1.418E-07	4.005E-11	31.810836	1.0704956
4.8993095	1.244E-07	1.479E-07	4.351E-11	29.981434	1.43E-07	4.063E-11	32.105035	1.0733348
4.8998511	1.257E-07	1.491E-07	4.409E-11	30.287376	1.442E-07	4.121E-11	32.410159	1.0762595
4.9003914	1.270E-07	1.502E-07	4.468E-11	30.604606	1.453E-07	4.179E-11	32.72656	1.0794009
4.9009303	1.283E-07	1.514E-07	4.527E-11	30.933498	1.465E-07	4.237E-11	33.054615	1.0825896
4.9014679	1.295E-07	1.525E-07	4.586E-11	31.274453	1.477E-07	4.295E-11	33.394727	1.0859447
4.9020041	1.308E-07	1.537E-07	4.645E-11	31.627899	1.488E-07	4.353E-11	33.747323	1.0894393

FLASH2

4.9025391	1.321E-07	1.548E-07	4.703E-11	31.99429	1.5E-07	4.411E-11	34.112858	1.0931382
4.9030473	1.334E-07	1.56E-07	4.763E-11	32.340812	1.511E-07	4.471E-11	34.458609	1.0969123
4.9035797	1.347E-07	1.571E-07	4.822E-11	32.733865	1.523E-07	4.529E-11	34.850797	1.1009504
4.9040855	1.360E-07	1.582E-07	4.882E-11	33.106676	1.534E-07	4.588E-11	35.222827	1.1050944
4.9045901	1.373E-07	1.593E-07	4.941E-11	33.493031	1.546E-07	4.648E-11	35.608398	1.1094132
4.9051188	1.386E-07	1.605E-07	5E-11	33.929636	1.557E-07	4.706E-11	36.044131	1.1139888
4.905621	1.399E-07	1.616E-07	5.059E-11	34.345464	1.569E-07	4.766E-11	36.459169	1.1187103
4.9061221	1.412E-07	1.627E-07	5.119E-11	34.776534	1.58E-07	4.826E-11	36.88945	1.1236607
4.906622	1.425E-07	1.638E-07	5.179E-11	35.223477	1.591E-07	4.886E-11	37.335603	1.1287674
4.9070959	1.437E-07	1.649E-07	5.24E-11	35.647383	1.603E-07	4.947E-11	37.7588	1.1340917
4.9075936	1.450E-07	1.66E-07	5.299E-11	36.127182	1.614E-07	5.007E-11	38.23781	1.1397061
4.9080654	1.463E-07	1.671E-07	5.36E-11	36.583501	1.626E-07	5.068E-11	38.693421	1.1455314
4.9085361	1.476E-07	1.682E-07	5.421E-11	37.056601	1.637E-07	5.129E-11	39.165815	1.1516085
4.9090058	1.489E-07	1.694E-07	5.482E-11	37.547207	1.648E-07	5.191E-11	39.655717	1.1578764
4.9094745	1.502E-07	1.705E-07	5.543E-11	38.056092	1.66E-07	5.252E-11	40.163902	1.1645267
4.9099422	1.515E-07	1.715E-07	5.604E-11	38.584083	1.671E-07	5.313E-11	40.691197	1.1713891
4.9104089	1.528E-07	1.726E-07	5.664E-11	39.132062	1.682E-07	5.375E-11	41.238485	1.1785072
4.9108501	1.541E-07	1.737E-07	5.727E-11	39.65301	1.694E-07	5.438E-11	41.758822	1.1859766
4.9113149	1.554E-07	1.748E-07	5.787E-11	40.242572	1.705E-07	5.5E-11	42.347706	1.1936335
4.9117543	1.567E-07	1.759E-07	5.85E-11	40.804572	1.716E-07	5.563E-11	42.909107	1.2019086
4.9122171	1.579E-07	1.77E-07	5.91E-11	41.439784	1.727E-07	5.624E-11	43.543658	1.2105553
4.9126546	1.592E-07	1.781E-07	5.972E-11	42.046929	1.738E-07	5.688E-11	44.15022	1.2196455
4.9130913	1.605E-07	1.792E-07	6.034E-11	42.677635	1.75E-07	5.751E-11	44.780353	1.2289812
4.9135271	1.618E-07	1.802E-07	6.096E-11	43.333086	1.761E-07	5.814E-11	45.435242	1.2387349
4.913962	1.631E-07	1.813E-07	6.158E-11	44.014553	1.772E-07	5.878E-11	46.116159	1.2488647
4.9143961	1.644E-07	1.824E-07	6.22E-11	44.723404	1.783E-07	5.941E-11	46.824474	1.2595789
4.9148052	1.657E-07	1.835E-07	6.284E-11	45.399695	1.794E-07	6.006E-11	47.500302	1.2707825
4.9152376	1.670E-07	1.845E-07	6.346E-11	46.165923	1.805E-07	6.07E-11	48.266024	1.2825725
4.9156691	1.683E-07	1.856E-07	6.407E-11	46.964185	1.816E-07	6.133E-11	49.063797	1.294758
4.9160759	1.696E-07	1.867E-07	6.471E-11	47.728983	1.828E-07	6.198E-11	49.82818	1.3075036
4.9164819	1.709E-07	1.877E-07	6.534E-11	48.525277	1.839E-07	6.264E-11	50.624077	1.3205847
4.9168871	1.721E-07	1.888E-07	6.598E-11	49.354831	1.85E-07	6.329E-11	51.453253	1.3344359
4.9172678	1.734E-07	1.899E-07	6.663E-11	50.145725	1.861E-07	6.396E-11	52.243838	1.3490217
4.9176716	1.747E-07	1.909E-07	6.727E-11	51.045188	1.872E-07	6.461E-11	53.142966	1.3643905
4.9180746	1.760E-07	1.92E-07	6.79E-11	51.983953	1.883E-07	6.527E-11	54.08142	1.3801787
4.9184532	1.773E-07	1.931E-07	6.855E-11	52.882908	1.894E-07	6.594E-11	54.980133	1.3967037
4.9188548	1.786E-07	1.941E-07	6.919E-11	53.904743	1.905E-07	6.66E-11	56.001712	1.4144659
4.9192321	1.799E-07	1.952E-07	6.984E-11	54.886158	1.916E-07	6.727E-11	56.98294	1.4324867
4.9196087	1.812E-07	1.962E-07	7.049E-11	55.911186	1.927E-07	6.794E-11	58.00781	1.4513563
4.9199612	1.825E-07	1.973E-07	7.116E-11	56.889037	1.938E-07	6.863E-11	58.985566	1.4705794
4.9203366	1.838E-07	1.984E-07	7.182E-11	58.006236	1.949E-07	6.931E-11	60.10267	1.4906865
4.9206879	1.851E-07	1.994E-07	7.249E-11	59.075314	1.961E-07	7E-11	61.171716	1.5118736
4.9210386	1.863E-07	2.005E-07	7.316E-11	60.192629	1.972E-07	7.07E-11	62.289033	1.5340558
4.9213888	1.876E-07	2.016E-07	7.383E-11	61.361263	1.983E-07	7.139E-11	63.457706	1.5569529
4.9217384	1.889E-07	2.026E-07	7.451E-11	62.584576	1.994E-07	7.209E-11	64.681097	1.581446

FLASH2

4.9220875	1.902E-07	2.037E-07	7.518E-11	63.866232	2.005E-07	7.279E-11	65.962874	1.6069371
4.9224128	1.915E-07	2.048E-07	7.587E-11	65.08937	2.016E-07	7.35E-11	67.18619	1.633853
4.9227607	1.928E-07	2.058E-07	7.654E-11	66.495092	2.027E-07	7.42E-11	68.592125	1.6614664
4.923085	1.941E-07	2.069E-07	7.724E-11	67.841159	2.038E-07	7.492E-11	69.938461	1.6906221
4.9234088	1.954E-07	2.079E-07	7.793E-11	69.252638	2.049E-07	7.564E-11	71.350259	1.7211989
4.9237552	1.967E-07	2.09E-07	7.86E-11	70.875943	2.06E-07	7.634E-11	72.973945	1.7535214
4.924078	1.980E-07	2.1E-07	7.93E-11	72.43856	2.071E-07	7.706E-11	74.536998	1.7872003
4.9244003	1.993E-07	2.111E-07	7.999E-11	74.082228	2.083E-07	7.779E-11	76.181166	1.8225577
4.9247221	2.006E-07	2.122E-07	8.068E-11	75.813112	2.094E-07	7.851E-11	77.912618	1.8602699
4.9250435	2.018E-07	2.132E-07	8.138E-11	77.638023	2.105E-07	7.923E-11	79.738174	1.8996235
4.9253415	2.031E-07	2.143E-07	8.21E-11	79.387338	2.116E-07	7.998E-11	81.488177	1.9413316
4.9256619	2.044E-07	2.153E-07	8.279E-11	81.414955	2.127E-07	8.071E-11	83.516601	1.9852309
4.9259819	2.057E-07	2.164E-07	8.348E-11	83.561139	2.138E-07	8.143E-11	85.663688	2.0314567
4.9262786	2.070E-07	2.174E-07	8.42E-11	85.631092	2.149E-07	8.218E-11	87.734591	2.0801538
4.9265977	2.083E-07	2.185E-07	8.489E-11	88.035456	2.16E-07	8.291E-11	90.14007	2.1314779
4.9268935	2.096E-07	2.195E-07	8.561E-11	90.364627	2.171E-07	8.366E-11	92.470405	2.1860356
4.927189	2.109E-07	2.206E-07	8.633E-11	92.835244	2.182E-07	8.441E-11	94.942303	2.2436229
4.927484	2.122E-07	2.216E-07	8.705E-11	95.460191	2.193E-07	8.517E-11	97.56866	2.304439
4.9277787	2.135E-07	2.227E-07	8.776E-11	98.253977	2.204E-07	8.592E-11	100.364	2.3686985
4.9280729	2.148E-07	2.237E-07	8.848E-11	101.233	2.215E-07	8.667E-11	103.34472	2.437198
4.9283368	2.160E-07	2.247E-07	8.92E-11	104.41585	2.226E-07	8.743E-11	106.52946	2.5096969
4.9286602	2.173E-07	2.258E-07	8.992E-11	107.82373	2.237E-07	8.819E-11	109.93941	2.5864726
4.9289533	2.186E-07	2.268E-07	9.063E-11	111.48088	2.248E-07	8.894E-11	113.59884	2.6685148
4.929246	2.199E-07	2.278E-07	9.135E-11	115.41516	2.259E-07	8.97E-11	117.53564	2.7555546
4.9295382	2.212E-07	2.289E-07	9.207E-11	119.65877	2.27E-07	9.046E-11	121.78203	2.8487453
4.9298077	2.225E-07	2.299E-07	9.281E-11	123.82749	2.281E-07	9.125E-11	125.95359	2.9478037
4.9300992	2.238E-07	2.309E-07	9.353E-11	128.7748	2.292E-07	9.201E-11	130.90409	3.0522619
4.9303879	2.251E-07	2.32E-07	9.427E-11	133.6691	2.303E-07	9.279E-11	135.80205	3.164351
4.9306364	2.264E-07	2.33E-07	9.502E-11	138.97894	2.314E-07	9.358E-11	141.11572	3.2847943
4.9309268	2.277E-07	2.34E-07	9.573E-11	145.332	2.324E-07	9.434E-11	147.47338	3.4132697
4.9311945	2.290E-07	2.351E-07	9.648E-11	151.69641	2.335E-07	9.513E-11	153.84253	3.551634
4.9314619	2.302E-07	2.361E-07	9.722E-11	158.6793	2.346E-07	9.592E-11	160.83071	3.7008732
4.9317289	2.315E-07	2.372E-07	9.797E-11	166.37455	2.357E-07	9.671E-11	168.53185	3.8592548
4.9319957	2.328E-07	2.382E-07	9.871E-11	174.89603	2.368E-07	9.75E-11	177.05996	4.0303959
4.9322621	2.341E-07	2.392E-07	9.946E-11	184.3833	2.379E-07	9.83E-11	186.55469	4.2156246
4.9325282	2.354E-07	2.402E-07	1.002E-10	195.00924	2.39E-07	9.909E-11	197.18909	4.4146357
4.9327939	2.367E-07	2.413E-07	1.009E-10	206.99064	2.401E-07	9.989E-11	209.18013	4.6266996
4.9330594	2.380E-07	2.423E-07	1.017E-10	220.60308	2.412E-07	1.007E-10	222.80364	4.8547848
4.9333024	2.393E-07	2.433E-07	1.025E-10	234.7105	2.423E-07	1.015E-10	236.92273	5.0957218
4.9335452	2.406E-07	2.444E-07	1.032E-10	250.82785	2.434E-07	1.023E-10	253.05352	5.3524027
4.9337877	2.419E-07	2.454E-07	1.04E-10	269.41582	2.445E-07	1.032E-10	271.65691	5.625808
4.9340299	2.432E-07	2.464E-07	1.048E-10	291.08663	2.456E-07	1.04E-10	293.34625	5.9081372
4.9342498	2.444E-07	2.475E-07	1.056E-10	314.00835	2.467E-07	1.048E-10	316.28761	6.2109724
4.9344696	2.457E-07	2.485E-07	1.064E-10	340.99743	2.478E-07	1.057E-10	343.29994	6.532576
4.9346891	2.470E-07	2.496E-07	1.072E-10	373.23836	2.489E-07	1.065E-10	375.56878	6.8814307

FLASH2

4.9349084	2.483E-07	2.506E-07	1.08E-10	412.42511	2.5E-07	1.074E-10	414.7896	7.2523282
4.9351056	2.496E-07	2.517E-07	1.089E-10	455.44647	2.512E-07	1.083E-10	457.84871	7.6464475
4.9353244	2.509E-07	2.528E-07	1.097E-10	515.83453	2.523E-07	1.091E-10	518.28968	8.0793759
4.9355431	2.522E-07	2.538E-07	1.105E-10	595.11089	2.534E-07	1.1E-10	597.83573	8.5404163
4.9357397	2.535E-07	2.549E-07	1.113E-10	690.77238	2.545E-07	1.109E-10	693.38184	9.0424649
4.9359579	2.548E-07	2.559E-07	1.121E-10	842.44419	2.556E-07	1.118E-10	845.18769	9.5838985
4.9361542	2.561E-07	2.57E-07	1.13E-10	1050.4883	2.567E-07	1.127E-10	1053.4164	10.181772
4.936372	2.574E-07	2.58E-07	1.138E-10	1451.4303	2.578E-07	1.135E-10	1454.7141	10.828856
4.9365678	2.586E-07	2.591E-07	1.146E-10	2214.5245	2.59E-07	1.144E-10	2218.4871	11.53787
4.9367852	2.599E-07	2.601E-07	1.154E-10	5368.9377	2.601E-07	1.153E-10	5373.7036	12.316222

ENCLOSURE 3

Proprietary Polestar Calculation No. PSAT 05653A.04, Rev. 1