ADDITIONAL ATTACHMENTS TO
10-10-05 Letter: Supplement to Request for LAR Application of AST

Attachment 002 AST – LM-0642 Rev 1 pH.

ATTACHMENT 1
Design Analysis Cover Sheet

Design Analysis (Major Revision)		**Last Page No.** [6]	16 / Att. H-1
Analysis No.: [1]	LM-0642	**Revision:** [2]	1
Title: [3]	Suppression Pool pH Calculation for Alternative Source Terms		
EC/ECR No.: [4]	04-00003	**Revision:** [5]	0

Station(s): [7]	Limerick	**Component(s):** [14]	
Unit No.: [8]	1 & 2	N/A	
Discipline: [9]	MEDC		
Descrip. Code/Keyword: [10]	H84 /AST, LOCA		
Safety/QA Class: [11]	SR		
System Code: [12]	912		
Structure: [13]	N/A		

CONTROLLED DOCUMENT REFERENCES [15]

Document No.:	From/To	Document No.:	From/To
LGS UFSAR	From/To	LGS Unit 1 & 2 Tech. Specs.	From/To
LGS Dwg No.M-213	From	LGS Unit 1 & 2 Tech. Spec. Bases	From/To
LGS Dwg No.M-108	From		
LGS Procedure CH-C-105-3	From		

Is this Design Analysis Safeguards Information? [16] Yes ☐ No ☒ If yes, see SY-AA-101-106

Does this Design Analysis contain Unverified Assumptions? [17] Yes ☐ No ☒ If yes, ATI/AR#:

This Design Analysis SUPERCEDES: [18] LM-0642, Rev. 0 in its entirety.

Description of Revision (list affected pages for partials): [19]

This revision incorporates clarifications regarding the conservatism of use of maximum Suppression Pool volumes for determination of both minimum sodium pentaborate quantity required and minimum time after the LOCA before its injection is completed. It also incorporates responses to pertinent NRC Requests for Additional Information (RAIs) with respect to all Exelon Nuclear Station Alternative Source Term License Amendment Applications

	Print Name	Sign Name	Date
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Method of Review: [21] Detailed Review ☒ Alternate Calculations (attached) ☐ Testing ☐

	Print Name	Sign Name	Date
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Review Notes: [23] Independent review ☒ Peer review ☐

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	Print Name	Sign Name	Date
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Is a Supplemental Review Required? [26] Yes ☐ No ☒ If yes, complete Attachment 3

	Print Name	Sign Name	Date
Exelon Approver: [27]	Elliott Flick	Elliott Flick	9/27/05

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1. Purpose and Objective

In order to prevent iodine re-evolution following an accident, the pH of the Suppression Pool should be maintained above 7.0. The chemistry of this phenomenon and methods of pH control are discussed in References 5.1 and 5.5.

The Objective of this calculation is to determine the pH of the Suppression Pool following a Loss of Coolant Accident (LOCA) based on the use of Alternative Source Terms (AST) as defined in References 5.4 and 5.6. The pH values are determined, as a function of time, with and without the addition of the sodium pentaborate in the Standby Liquid Control System. The minimum quantity of sodium pentaborate required to maintain the Suppression Pool at a pH above 7.0 is determined and compared to the current Technical Specifications (TS) limit.

2. Methodology and Acceptance Criteria

This calculation is based on the methodology developed for the equivalent calculation done for the Grand Gulf Nuclear Station, Unit 1 as revised December 2000. [Ref. 5.1 & 5.2]. These references are included in this calculation as Attachments F and G. The Grand Gulf calculation was provided to the Nuclear Regulatory Commission (NRC) and the associated AST application was approved by the NRC. The calculation formulas developed in these Ref. 5.1 and 5.2 documents were reviewed by an experienced Washington Group International Chemical Engineer and used by him to develop the spreadsheets included herein in Attachments C and D. The accuracy of translation of the equations in these documents into spreadsheet cell formulas is verified by duplicating the Grand Gulf calculation. This verification is presented as Attachment E and accurately duplicates all of the Grand Gulf results.

As noted in this calculation, injection of sodium pentaborate solution by the Standby Liquid Control System (SLCS) is a required function in order to control post-LOCA pH in the Suppression Pool, and prevent iodine re-evolution. Based on the worst case beginning of cycle, injection should be completed within 13 hours after the start of the Design Basis Accident (DBA) LOCA. Therefore, manual initiation is acceptable. Manual initiation of SBLCS is expected early in a DBA-LOCA as a result of emergency operating procedures and severe accident guidelines, particularly for events resulting in fuel damage that would be consistent with AST source terms.

Per the guidance of Appendix A of Regulatory Guide 1.183 [Ref. 5.6], the Suppression Pool pH should be controlled at values of 7 or greater, following loss of coolant accidents.

3. Assumptions/Engineering Judgements

- The Suppression Pool is assumed to be well mixed so that the pH at any time can be represented by a single value.
- As a worst case for determination of both the minimum sodium pentaborate quantity required and the minimum time after the LOCA before its injection is completed, the maximum Suppression Pool volume condition (to maximally dilute the initial Cesium from the core release and the sodium pentaborate addition) is utilized.
- For cable parameters, the cable data presented in Attachment A is used. It provides the lengths and outside diameters of all cables located in raceways in the drywell, all considered as exposed to Post-LOCA environment. As a conservative estimate of the cable lengths in free air, an additional 10% of the totals are assumed to be in free air. A 10% contingency on the cable surface area, reported in Attachment A is also included. Radiolysis of surface coatings on the steel and concrete surfaces in the Drywell and Containment would not be significant contributors, since the coatings utilize non-chlorinated polymers.

4. Design Input

4.1 Cable Data

Cable lengths, diameters, and average jacket thickness are developed separately and presented in Attachment A.

4.2 Temperature

Suppression Pool temperatures are taken from SIL-636 results, as contained in Attachment E of the Limerick Generating Station (LGS) Calculation LM-0646 (Ref. 5.16). This data only extends to 100,000 seconds, but as indicated in UFSAR Figure 6.2-9A, Suppression Pool temperatures are going down with time by 100,000 seconds, and there is no mechanism for the temperatures to rise between 100,000 seconds and 720 hours. Therefore, the Suppression Pool temperature at 100,000 seconds is used from then until 720 hours, as this is conservative (higher temperatures give lower calculated pH values).

4.3 Sodium Pentaborate Mass in SBLC Tank

The minimum quantity of sodium pentaborate required to maintain the Suppression Pool at a pH above 7.0 is determined and compared to the current minimum available volume of sodium pentaborate solution stored in the SBLC tank of 3160 gallons, as per LGS Technical Specification section 4.1.5. Per the LGS TS Figure 3.1.5-1 [Ref. 5.7], a 10% solution concentration, by weight, is chosen to conservatively bound the acceptable operable range. As per reference 5.11 (Table CH-C-105-3) and Attachment C, a specific gravity of 1.0485 gm/cm^3 corresponds to this $Na_2B_{10}O_{16}\bullet 10H_2O$ concentration. Based on the TS 3160 gallon volume and this specific gravity, the total solution mass equals 27,651 lbs. and, at 10wt% the total mass of $Na_2B_{10}O_{16}\bullet 10H_2O$ in solution is 2765 lbs.

Although references 5.3, 5.8, and 5.11 indicate that artificially enriched Boron is used in the SBLC sodium pentaborate, for this calculation, the natural ^{10}B enrichment of Boron, 19.9%, is assumed in order to conservatively minimize its available gm-moles. Because ^{10}B has an atomic weight of 10.0129 gm/mole, and ^{11}B has an atomic weight of 11.0093 gm/mole, the calculated naturally occurring molar mass of Boron is 10.811 gm/mole. This value agrees with the periodic table value. The total molar mass of $Na_2B_{10}O_{16}\bullet 10H_2O$ is 590.23 gm/mole. Based on the 10.811 gm/mole mass of Boron, the percentage of total Boron in $Na_2B_{10}O_{16}\bullet 10H_2O$ is 18.3165%. Taking 18.3% of the 2765 lbs. total mass of $Na_2B_{10}O_{16}\bullet 10H_2O$ for the TS 3160 gallon volume gives a total of 506 lbs., or 21,249 gm-atoms of total available Boron for the TS 3160 gallon volume.

Attachment C page C-6 provides the corresponding derivation of the minimum quantities in gallons of sodium pentaborate solution stored in the SBLC tank and resulting lbs. and gm-atoms of total available Boron required to maintain the Suppression Pool at a pH just above 7.0.

4.4 Suppression Pool and Drywell + Suppression Pool Airspace Volume

In order to determine the minimum quantity of sodium pentaborate required to maintain the Suppression Pool at a pH above 7.0 for the purposes of this calculation, the maximum Suppression Pool volume and corresponding minimum Drywell + Suppression Pool Airspace volume is required. Initially, for maximal conservatism in this calculation, the entire 200,000 gal. (26,736 cu. ft.) Condensate Storage Tank capacity provided in Design Baseline Document L-S-41 (Ref. 5.14) was considered as added to the maximum Suppression Pool volume as derived from the UFSAR Table 6.2-4A High Water Level volume of 134,600 cu. ft. plus a maximum Reactor Coolant System liquid and applicable piping volume for a total of approximately 185,000 cu. ft. However, the Condensate Storage Tank volume would not be applicable to large break DBA-LOCA conditions considered herein, where low-pressure Emergency Core Cooling Systems would be utilized. Considering this, an approximately 154,000 cu. ft. maximum Suppression Pool volume is derived, as shown in the Exelon e-mail included in Attachment C. However, to increase the conservatism, a 175,000 cu. ft. maximum Suppression Pool volume is used.

For the corresponding minimum Drywell + Suppression Pool Airspace volume, the 403,120 cu. ft. value from ST-4-LLR-001-1 [Ref. 5.15] is used minus the above 175,000 cu. ft. conservative maximum Suppression Pool volume and plus the 122,120 nominal minimum Suppression Pool volume provided in TS 3/4.5.3 for a value of 350,240 cu. ft.

4.5 Adequacy of Mixing

The Emergency Core Cooling System (ECCS) takes water from the Suppression Pool and pumps it into the core region of the reactor vessel. Additionally, the SBLC System will pump from the SBLC Tank into the reactor vessel, above the core, so that it mixes with the ECCS water in the core region. This mixed ECCS water and SBLC solution

will refill the reactor pressure vessel under post-LOCA conditions, and eventually spill out of the break into the Suppression Pool. To illustrate the adequacy of the SBLC solution mixing in the Suppression Pool, a minimum spillage and bounding maximum volume of the Suppression Pool are considered. The minimum spillage is taken as just one core spray loop at its minimum allowed run-out flow condition of 6250 gpm, as per LGS UFSAR Table 6.3-1 on Significant Input Variables Used in the SAFER/GESTR-LOCA Analysis. This flow rate is significantly less than any of the LGS UFSAR Table 6.3-3 Single Failure Evaluation conditions, including the assumed failure of the Division 2 dc source or of the Diesel Generator. The maximum post-LOCA volume of the Suppression Pool of 175,000 cu. ft from Section 4.4 above is also utilized for additional conservatism. A two-hour delay before ECCS and SBLC initiation to refill the reactor pressure vessel is also conservatively assumed, consistent with the event timing in Regulatory Guide 1.183. After two hours, simultaneous injection of SBLC solution and ECCS fill of the reactor pressure vessel takes place. However, no consideration of the filling rate from SBLC is conservatively considered. Using these assumptions, the reactor pressure vessel volume of 19,090 cu ft (including piping) indicated on Attachment C page C-7 would be flooded in

[(19,090 cu ft) x 7.4805 gallon / cu ft] / 6250 gallon / minute = 22.8 minutes, or by 2.38 hours after the LOCA.

The minimum Suppression Pool volume turnover rate is then calculated as:

[175,000 cu ft x 7.4805 gallon / cu ft] / 6250 gallon / minute = 209 minutes = 3.49 hours.

Thus, the initial turnover of one Suppression Pool volume containing essentially 100% of the SBLC injection is calculated to be completed by 2.38 + 3.49 = 5.87 hours after the LOCA, with subsequent Suppression Pool turnover of the full Suppression Pool volume taking place every 3.49 hours, with approximately 6 Suppression Pool volume turnovers per day. Thus, adequate mixing of the Suppression Pool with the SBLC Sodium Pentaborate is assured.

5. References

5.1. GGNS-98-0039, Rev. 3, "Entergy Operations Engineering Report for Suppression Pool pH and Iodine Re-Evolution Methodology", Applicable Site: Grand Gulf Nuclear Station, 12/20/00.

5.2. XC-Q1111-98013, Rev. 2, Grand Gulf Design Engineering Calculation "Suppression Pool pH Analysis", 12/20/00.

5.3. LGS Units 1 & 2 UFSAR, Rev. 12.

5.4. NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants", February 1995.

5.5. NUREG/CR-5950, "Iodine Evolution and pH Control", December 1992.

5.6. USNRC Regulatory Guide 1.183, "Alternative Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", July 2000.

5.7. LGS Unit 1 Technical Specification, Rev. 177, and LGS Unit 2 Technical Specification, Rev. 139.

5.8. LGS Units 1 & 2 Technical Specification Bases, Rev. 0.

5.9. LGS Design Analysis LM-0645, "Re-analysis of Fuel Handling Accident (FHA) Using Alternate Source Terms", Rev. 0.

5.10. GE Report NEDC-32963A, "Prediction of the Onset of fission Gas Release From Fuel in Generic BWR", March 2000 (Allows a 121-second delay in timing of fission product release following design basis accidents).

5.11. LGS Procedure CH-C-105, Rev. 5, "Boron Analysis by Automatic Titration".

5.12. Radioactive Decay Data Tables by David C. Kocher, Report DOE/TIC-11026 Technical Information Center U.S. DOE, Washington, D.C., 1981

5.13. LGS Units 1 & 2 Drawing No. M-108 Rev. 7, "General Arrangement Section C-C".

5.14. L-S-41, Condensate Storage & Transfer System Design Baseline Document, Rev. 6.

5.15. ST-4-LLR-001-1, "The LLRT Program and Accountability Test", Rev. 8.

5.16. LGS Design Analysis LM-0646, "Re-analysis of Loss of Cooling Accident (LOCA) Using Alternative Source Terms", Rev. 1.

6. Calculations

pH - Fundamental Relationships

$$pH = -\log_{10}[H^+] \qquad 6\text{-}1$$

$$[H^+]\cdot[OH^-] = K_W(T) \qquad 6\text{-}2$$

where:

$[H^+]$ = concentration of hydrogen ions in moles/liter
$[OH^-]$ = concentration of hydroxyl ions in moles/liter
$K_W(T)$ = ionization constant for water as a function of temperature T

The data for K_W for T between 77 and 212 °F can be represented by the following correlation developed in Section 3.0 of Reference 5.1:

$$-\text{Log}_{10}K_W(T) = 15.5129 - 2.24E\text{-}2 * T + 3.352E\text{-}5 * T^2 \qquad 6\text{-}3$$

Hydriodic Acid Production

Iodine, accompanied by Cesium, is released during the Gap Release and Early In-Vessel Release phases.

The following equation, valid during the Early Vessel Release Phase, includes the release during the Gap Release Phase. See analysis in Reference 5.1 (Section 3.1 and Equation 3-1d).

Iodine and cesium core inventories are calculated for both beginning and end of cycle (BOC and EOC) conditions (See Attachment B for a discussion of the assumed BOC conditions). Since EOC conditions result in increased inventory of both acidic (iodine) and basic (cesium) compounds, pH values are calculated for both conditions. For conservatism, the EOC radiation doses are used for the BOC calculation.

The hydriodic acid concentration is governed by the following equation:

$$[HI](t) = m_I / (120 * V_{POOL}) * [t - (0.5 + t_{gap})] + m_I / (400 * V_{POOL}) \qquad 6\text{-}4$$

where:

$[HI](t)$ = concentration of Hydriodic Acid at time t (moles/liter)
m_I = core iodine inventory (gram-moles)
V_{POOL} = Suppression Pool volume (liters)
t = time after start of accident (hrs) (includes t_{gap} + Gap Release [0.5 hrs] + Early In-Vessel Release [1.5 hrs] duration for a t_{max} = 2.0336 hrs) [Ref. 5.6, Table 4, page 1.183-15]
t_{gap} = time of onset of gap release = 121 seconds = 0.0336 hrs [Ref. 5.6 and 5.10]
t_{max} = 2.0336 hrs = end of Early In-Vessel Release

[See Attachment C Spreadsheet: Sheets 1 (EOC) and 5 (BOC), Col H]

Nitric Acid Production

Nitric Acid is produced by radiolysis of the water in the Suppression Pool with a G value of 0.007 molecules HNO_3 / 100 eV absorbed dose or 7.3E-6 g moles / megarad- liter [Ref. 5.1, Section 3.2, Equation 3-2b].

The nitric acid concentration is governed by the following equation:

$[HNO_3](t) = 7.3E\text{-}6 * D(t)_{pool}$ 6-5

[See Spreadsheet Col. I]

where:

$[HNO_3](t)$ = nitric acid concentration at time t (moles/liter)
$D(t)_{pool}$ = Total accumulated dose in Suppression Pool at time t (megarad)

Hydrochloric Acid Production

Hydrochloric Acid is produced by radiolysis of chlorinated polymer cable jacketing. Radiolysis of surface coatings on the steel and concrete surfaces in the Drywell and Containment would not be significant contributors, since the coatings utilize nonchlorinated polymers.

The calculation of the resulting concentration in the Suppression Pool is based on the equations in Section 3.3 of Reference 5.1 [see Ref. 5.2, Equations 5-1, 5-2, and 5-3]. These equations are in turn based on the following G value for HCl production in Hypalon chlorinated polymer given in Reference 5.5.

G_{HCl} = 2.115 molecules/100eV = 3.512E-20 g moles HCl / MeV

The hydrochloric acid concentration is governed by the following equations:

Doses from beta and gamma radiation are calculated separately.

$$[HCl]_\beta(t) = G_{HCl} / V_{POOL} * (S_{tray} / 2 + S_{fa}) / \mu_{\beta\ air} * D_\beta(t) \qquad 6\text{-}6$$

where the effective cable surface area for β dose is:
$$S_{tray} / 2 + S_{fa} = \pi * D_0 * (L_{tray} / 2 + L_{fa})$$

[See Spreadsheet Cols J & L]

$$[HCl]_\gamma(t) = G_{HCl} / V_{POOL} * (S_{tray} + S_{fa}) * (1 - e^{-\mu\lambda\ air * r\lambda}) / \mu_{\gamma\ air}$$

$$* (1 - e^{-\mu\lambda\ hypalon * th}) * D_\gamma(t) \qquad 6\text{-}7$$

where: $S_{tray} + S_{fa} = \pi * D_0 * (L_{tray} + L_{fa})$

[See Spreadsheet Cols K & M]

where:

$[HCl]_\beta(t)$ = HCl concentration from Beta radiation at time t (g moles/liter)
$[HCl]_\gamma(t)$ = HCl concentration from Gamma radiation at time t (g moles/liter)
D_0 = cable diameter (cm)
L_{tray} = cable length in trays (raceways) (cm)
L_{fa} = cable length in free air (cm)
$\mu_{\beta\ air}$ = linear beta absorption coefficient in air (1/cm)
$\mu_{\lambda\ air}$ = linear gamma absorption coefficient in air (1/cm)
r_λ = gamma free path (cm)
$\mu_{\lambda\ hypalon}$ = linear gamma absorption coefficient in Hypalon (1/cm)

th = Hypalon jacket thickness (cm)

$D_\beta(t)$ = accumulated beta dose per unit volume at time t (MeV/cm^3)
$D_\gamma(t)$ = accumulated gamma dose per unit volume at time t (MeV/cm^3)
G_{HCl} = 3.512E-20 (g moles HCl / MeV)
V_{POOL} = Suppression Pool volume (Liters)
S_{tray} = Cable surface area in trays (cm^2)
S_{fa} = Cable surface area in free air (cm^2)

Cesium Hydroxide Production

Cesium, accompanied by Iodine, is released during the Gap Release and Early In-Vessel Release phases. The following equation, valid during the Early Vessel Release Phase, includes the release during the Gap Release Phase. See analysis in Reference 5.1 (Section 3.4 and Equation 3-4d).

Iodine and cesium core inventories are calculated for both beginning and end of cycle (BOC and EOC) conditions (See Attachment B for a discussion of the assumed conditions). Since EOC conditions result in increased inventory of both acidic (iodine) and basic (cesium) compounds, pH values are calculated for both conditions. For conservatism, the EOC radiation doses are used for the BOC calculation.

The cesium hydroxide concentration is governed by the following equation:

$$[CsOH](t) = (0.4 * m_{Cs} - 0.475 * m_I) / 3 * V_{POOL}) * [t - (0.5 + t_{gap})] + (0.05 * m_{Cs} - 0.0475 * m_I) / V_{POOL} \qquad 6\text{-}8$$

[See Spreadsheet: Sheets 1 (EOC) and 5 (BOC), Col O]

[CsOH](t) = concentration of Cesium Hydroxide at time t (g moles/liter)
m_I = core Iodine inventory (gram-moles)
m_{Cs} = core Cesium inventory (gram-moles)
V_{POOL} = Suppression Pool volume (liters)
t = time after start of accident (hrs) (includes t_{gap} + Gap Release [0.5 hrs] + Early In-Vessel Release [1.5 hrs] duration for a t_{max} = 2.0336 hrs) [Ref. 5.6, Table 4, page 1.183-15]
t_{gap} = time of onset of gap release = 121 seconds = 0.0336 hrs [Ref. 5.6]
t_{max} = 2.0336 hrs = end of Early In-Vessel Release

Final Pool pH Calculation (No SBLC Addition)

The net Suppression Pool pH can be calculated from the total of the [H^+] and [OH^-] concentrations using the following equations developed in Reference 5.1, Section 3.5.

$$[H^+](t) = [H^+](t=0) + [HI](t) + [HNO_3](t) + [HCl](t)$$
$$[H^+](t) = 10^{-pH}(t=0) + [HI](t) + [HNO_3](t) + [HCl](t) \qquad 6\text{-}9$$

[See Spreadsheet Col N]

$$[OH^-](t) = [OH^-](t=0) + [CsOH](t)$$

$$[OH^-](t) = 10^{-14}/10^{-pH}(t=0) + [CsOH](t) \qquad 6\text{-}10$$

[See Spreadsheet Col P]

Accounting for the concentration of neutralized ions [x]:

$([H^+] - [x]) * ([OH^-] - [x]) = K_W(T)$

$[x] = \{ [H^+] + [OH^-] - \{([H^+]+[OH^-])^2 - 4*([H^+]*[OH^-]-K_W)\}^{1/2} \} / 2$ 6-11

[See Spreadsheet Col R]

note: $K_W = 10^{-(-\text{Log } K_W)}$ [See Equation 6-3 and Spreadsheet Col Q]

The equation for the net $[H^+]$ becomes:

$[H^+]_{net} = [H^+] - [x]$ 6-12

[See Spreadsheet Col S]

and

$pH = -\log_{10}([H^+]_{net})$ 6-13

[See Spreadsheet Col T]

Effect of Sodium Pentaborate (SBLC) Addition

The pH of the Suppression Pool is increased by the addition of Sodium Pentaborate from the Standby Liquid Control (SBLC) System.

As per Section 4.3 of this calculation, a limiting value (minimum weight) of Boron is used. The limiting value is used since it minimizes the number of moles available for buffering.

Addition of Sodium Pentaborate introduces a buffer into the Suppression Pool, which will maintain the pool at a pH corresponding to the following equation: [Ref. 5.1, Sec. 6.1, p. 21].

$pH = pK_a + \log_{10}\left([\text{anion}] / [\text{acid}] \right)$ 6-14

with data for K_a fitted by the equation

$K_a = (0.0585 * T + 1.309)E\text{-}10$ 6-15

[See Spreadsheet Col U]

where:
K_a = boric acid dissociation constant
pK_a = negative of the log of the boric acid dissociation constant [See Spreadsheet Col Z]
T = °F
[anion] = borate concentration of $[2B(OH)_4^-]$
[acid] = boric acid concentration of $[8H_3BO_3]$

based on the equation

$Na_2B_{10}O_{16} + 16H_2O \leftrightarrow 2Na^+ + 2B(OH)_4^- + 8H_3BO_3$

Therefore,

Borate (g-equivalents) = 2 * $Na_2B_{10}O_{16} \bullet 10\ H_20$ (g-moles)

Boric acid (g-equivalents) = 8 * $Na_2B_{10}O_{16} \bullet 10\ H_20$ (g-moles)

Using the methodology of reference 5.1, the net strong acid equivalents $[H^+]_{net}$ calculated in Equation 5-12 are neutralized by the borate and the above equations become:

Borate (g-equivalents) = 2 * $Na_2B_{10}O_{16}$ (g-moles) – $[H^+]_{net}$ * V_{pool} 6-16

[See Spreadsheet Col X]

Boric acid (g-equivalents) = 8 * $Na_2B_{10}O_{16}$ (g-moles) + $[H^+]_{net}$ * V_{pool} 6-17

[See Spreadsheet Col Y]

And equation 6-14 becomes:

$$pH = -\log_{10}K_a + \log_{10} \frac{\left(2 * Na_2B_{10}O_{16}\ (\text{g-moles}) - [H^+]_{net} * V_{pool}\right) / V_{pool}}{\left(8 * Na_2B_{10}O_{16}\ (\text{g-moles}) + [H^+]_{net} * V_{pool}\right) / V_{pool}} \qquad 6\text{-}18$$

[See Spreadsheet Col AA]

7. Summary of Results and Conclusions

The post accident Suppression Pool pH is calculated as a function of time after accident initiation. The results are shown below in Figures 7-1 and 7-2 for Beginning of Cycle (BOC) and End of Cycle (EOC) conditions respectively. These graphs are based on Excel spreadsheet calculations presented in Attachment C (Sheets 1 and 5). The inputs to the pH calculation of radiation doses (based on the Source Term data from Reference 5.9) and the Iodine and Cesium inventories are presented in Attachment B.

The BOC (actually early cycle) condition produces the lowest pH and is therefore the limiting case.

Without addition of sodium pentaborate from the Standby Liquid Control (SBLC) System, the pH in the Suppression Pool could drop below pH 7 after about 13 hours. Therefore, SBLC addition is required to prevent iodine re-evolution.

With SBLC addition of only 1500 gallons (of the TS 4.1.5 3160 gallons available), the Suppression Pool remains above pH 7 at 30 days (720 hours). This equates to 240 lbs. total Boron or 1313 lbs. sodium pentaborate.

Figure 7-1

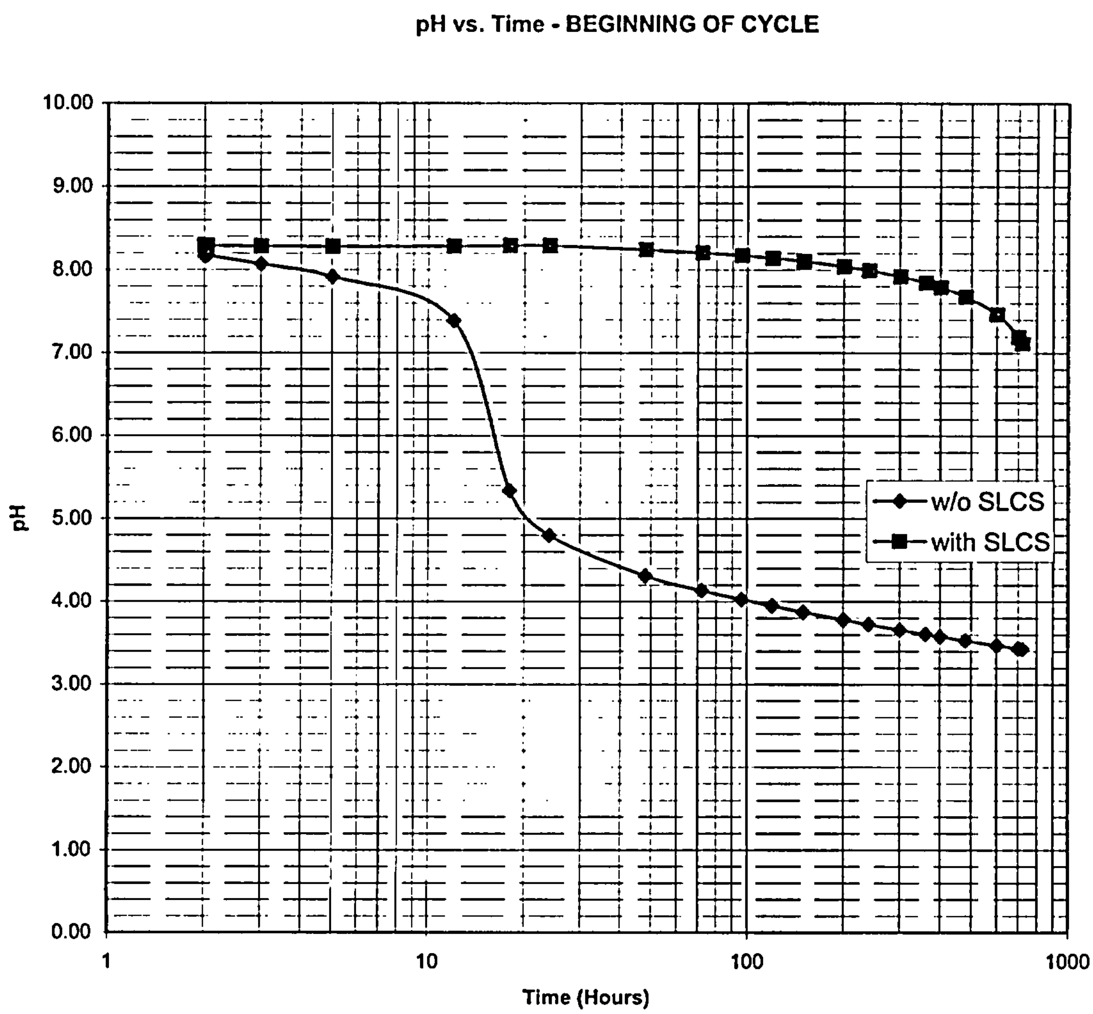
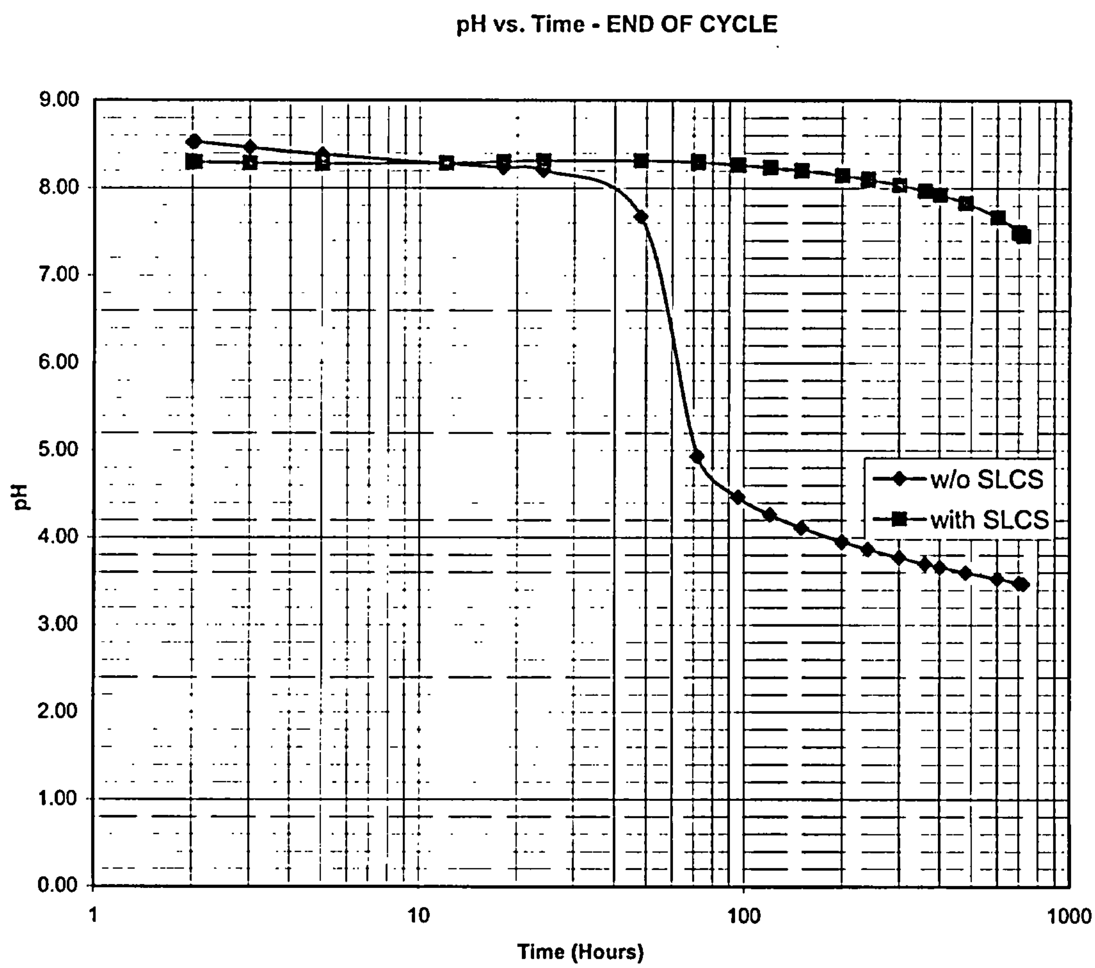

pH vs. Time - BEGINNING OF CYCLE
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
1
10
100
1000
Time (Hours)
w/o SLCS
with SLCS

Figure 7-2


pH vs. Time - END OF CYCLE
pH
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1
10
100
1000
Time (Hours)
w/o SLCS
with SLCS

8. OWNER'S ACCEPTANCE REVIEW CHECKLIST FOR EXTERNAL DESIGN ANALYSIS

DESIGN ANALYSIS NO. LM-0642 REV: 1

		Yes	No	N/A
1.	Do assumptions have sufficient rationale?	☑	☐	☐
2.	Are assumptions compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
3.	Do the design inputs have sufficient rationale?	☑	☐	☐
4.	Are design inputs correct and reasonable?	☑	☐	☐
5.	Are design inputs compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
6.	Are Engineering Judgments clearly documented and justified?	☑	☐	☐
7.	Are Engineering Judgments compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
8.	Do the results and conclusions satisfy the purpose and objective of the Design Analysis?	☑	☐	☐
9.	Are the results and conclusions compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
10.	Does the Design Analysis include the applicable design basis documentation?	☑	☐	☐
11.	Have any limitations on the use of the results been identified and transmitted to the appropriate organizations?	☑	☐	☐
12.	Are there any unverified assumptions?	☐	☑	☐
13.	Do all unverified assumptions have a tracking and closure mechanism in place?	☐	☐	☑
14.	Have all affected design analyses been documented on the Affected Documents List (ADL) for the associated Configuration Change?	☑	☐	☐
15.	Do the sources of inputs and analysis methodology used meet current technical requirements and regulatory commitments? (If the input sources or analysis methodology are based on an out-of-date methodology or code, additional reconciliation may be required if the site has since committed to a more recent code)	☑	☐	☐
16.	Have vendor supporting technical documents and references (including GE DRFs) been reviewed when necessary?	☑	☐	☐

EXELON REVIEWER: T. J. Mscisz / [signature] DATE: 9/27/05

Print / Sign

9. Attachments

(Unless noted, Attachments are Calculated By and Checked By the same individuals as the Calculation)

SPREADSHEET (ATT. D) INPUTS:	CALC. BY:	CHECKED BY
Attachment A – Determination of Total Exposed Cable Quantities Inside Containment	Stewart Cleaver/ Harold Rothstein Harold Rothstein	Sahar Elkenani [signature]
Attachment B – Dose Assessment, Core Cs & I Inventory, and Gamma Mean Free Path Determination	Aleem Boatright Harold Rothstein Harold Rothstein for Aleem Boatright	Paul Reichert Paul Reichert

Attachment C – pH Transient Spreadsheet

Attachment D – pH Transient Spreadsheet Cell Formulas

Attachment E – pH Transient – Grand Gulf Reference Data

Attachment F – Reference 5.1

Attachment G – Reference 5.2

Attachment H – Computer Disclosure Sheet

"Suppression Pool pH Calculation for Alternative Source Term"
Attachment A
Determination of Total Exposed Cable Quantities Inside Containment
for Assessment of Impact of Radiolytic Chlorine Releases on Suppression Pool pH

1. Purpose

The purpose of this attachment is to provide a conservative basis for the calculation of Hydrochloric Acid addition to the suppression pool from radiolysis of exposed chloride-bearing materials inside the drywell during post-Loss of Coolant Accident (LOCA) conditions. The primary exposed chloride-bearing materials are the DuPont Hypalon (or Hypalon-like chlorosulfonated polyethylene rubbers from other manufacturers, such as Okonite) jackets typically used on containment power and control cable. Post-LOCA in-containment radioactivity exposure to these materials can lead to radiolytic breakdown with free chlorine radicals available for carryover as hydrochloric acid to the suppression pool by containment sprays or condensation, with resulting decreases in suppression pool pH. Cables in sealed metal conduits can be excluded from consideration, as there is no mechanism for any significant HCl produced to be released through the conduit (even if connections are assumed to leak, the HCl vapor formed is so chemically reactive that no significant amount would remain unreacted and available for release).

2. Background and Approach

LGS Station Electrical Engineer Stewart Cleaver developed a listing of the total drywell exposed cable inventory from the INDMS database. The resulting data on cable types and codes, location and length were tabulated and provided to WGI by e-mail on May 7, 2003. These data for each unit are listed in the following spreadsheets as Columns A, B, C, and D, with the formulas added by WGI shown on the last 2 pages (corresponding to the first and last page of the spreadsheets for each unit). In WGI discussions of the data with Mr. Cleaver, he confirmed the data would be a conservative approximation if an additional 10% of cable area is used to account for any missed cable and if a 10% free air addition is made.

Mr. Cleaver also indicated that there is no cabling outside of conduits underwater or in the air space of the suppression pool.

Hypalon may be used not only as an external cable jacket material, but also as a filler inside the jacket. Therefore, to conservatively account for such Hypalon use and in accordance with the equivalent assumptions used by Grand Gulf in Reference 5.2 of Calculation LM-0642, an equivalent chlorine-containing material thickness of 80% of the cable radius is used, considered as 100% Hypalon. Additional conservatism is provided by inclusion of all cable types as if they are all Hypalon or Hypalon-equivalent jacketed.

3. Results

The data were used to develop individual and total cable volumes and the resulting volume-average cable radius [derived as the square root of the quantity (Total Cable Volume divided by pi and the Total Cable Length)]. The Hypalon thickness was then derived as 80% of this average cable radius. The data indicate that Unit 1 has the greater surface area of 2,425,858 square centimeters, with both units having the same Hypalon average thickness of 0.6299 centimeters. For conservatism, the Unit 1 values are used.

	A	B	C	D	E	F	G	H
1	LGS UNIT 1 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
6	W16	1MIPS001A	66	0.62	1.57	10.71	9952.5	3918.3
7								
8	W16	1MIPS002A	66	0.62	1.57	10.71	9952.5	3918.3
9								
10	W16	1MIPS003A	66	0.62	1.57	10.71	9952.5	3918.3
11								
12	W16	1MIPS004A	66	0.62	1.57	10.71	9952.5	3918.3
13								
14	W16	1MIPS005A	66	0.62	1.57	10.71	9952.5	3918.3
15								
16	W16	1MIPS006A	66	0.62	1.57	10.71	9952.5	3918.3
17								
18	W16	1MIPS007A	66	0.62	1.57	10.71	9952.5	3918.3
19								
20	W16	1MIPS008A	66	0.62	1.57	10.71	9952.5	3918.3
21								
22	W16	1MIPS009A	66	0.62	1.57	10.71	9952.5	3918.3
23								
24	W16	1MIPS010A	66	0.62	1.57	10.71	9952.5	3918.3
25								
26	W16	1MIPS011A	66	0.62	1.57	10.71	9952.5	3918.3
27								
28	W16	1MIPS012A	66	0.62	1.57	10.71	9952.5	3918.3
29								
30	W16	1MIPS013A	66	0.62	1.57	10.71	9952.5	3918.3
31								
32	W16	1MIPS014A	66	0.62	1.57	10.71	9952.5	3918.3
33								
34	W16	1MIPS015A	66	0.62	1.57	10.71	9952.5	3918.3
35								
36	W16	1MIPS016A	66	0.62	1.57	10.71	9952.5	3918.3
37								
38	W16	1MIPS017A	66	0.62	1.57	10.71	9952.5	3918.3
39								
40	W16	1MIPS018A	66	0.62	1.57	10.71	9952.5	3918.3
41								
42	W16	1MIPS019A	66	0.62	1.57	10.71	9952.5	3918.3
43								
44	W16	1MIPS020A	66	0.62	1.57	10.71	9952.5	3918.3
45								
46	W16	1MIPS021A	66	0.62	1.57	10.71	9952.5	3918.3
47								
48	W16	1MIPS022A	66	0.62	1.57	10.71	9952.5	3918.3
49								
50	W16	1MIPS023A	66	0.62	1.57	10.71	9952.5	3918.3
51								
52	W16	1MIPS024A	66	0.62	1.57	10.71	9952.5	3918.3

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
53								
54	W16	1MIPS025A	66	0.62	1.57	10.71	9952.5	3918.3
55								
56	W16	1MIPS026A	66	0.62	1.57	10.71	9952.5	3918.3
57								
58	W16	1MIPS027A	66	0.62	1.57	10.71	9952.5	3918.3
59								
60	W16	1MIPS028A	66	0.62	1.57	10.71	9952.5	3918.3
61								
62	W16	1MIPS029A	66	0.62	1.57	10.71	9952.5	3918.3
63								
64	W16	1MIPS030A	66	0.62	1.57	10.71	9952.5	3918.3
65								
66	W16	1MIPS031A	66	0.62	1.57	10.71	9952.5	3918.3
67								
68	W16	1MIPS032A	66	0.62	1.57	10.71	9952.5	3918.3
69								
70	W16	1MIPS033A	66	0.62	1.57	10.71	9952.5	3918.3
71								
72	W16	1MIPS034A	66	0.62	1.57	10.71	9952.5	3918.3
73								
74	W16	1MIPS035A	66	0.62	1.57	10.71	9952.5	3918.3
75								
76	W16	1MIPS036A	66	0.62	1.57	10.71	9952.5	3918.3
77								
78	W16	1MIPS037A	66	0.62	1.57	10.71	9952.5	3918.3
79								
80	W16	1MIPS038A	66	0.62	1.57	10.71	9952.5	3918.3
81								
82	W16	1MIPS039A	66	0.62	1.57	10.71	9952.5	3918.3
83								
84	W16	1MIPS040A	66	0.62	1.57	10.71	9952.5	3918.3
85								
86	W16	1MIPS041A	66	0.62	1.57	10.71	9952.5	3918.3
87								
88	W16	1MIPS042A	66	0.62	1.57	10.71	9952.5	3918.3
89								
90	W16	1MIPS043A	66	0.62	1.57	10.71	9952.5	3918.3
91								
92	W16	1MIPS044A	66	0.62	1.57	10.71	9952.5	3918.3
93								
94	W16	1MIPS045A	66	0.62	1.57	10.71	9952.5	3918.3
95								
96	W16	1MIPS046A	66	0.62	1.57	10.71	9952.5	3918.3
97								
98	W16	1MIPS047A	66	0.62	1.57	10.71	9952.5	3918.3
99								
100	W16	1MIPS048A	66	0.62	1.57	10.71	9952.5	3918.3
101								

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
102	W16	1MIPS049A	66	0.62	1.57	10.71	9952.5	3918.3
103								
104	W16	1MIPS050A	66	0.62	1.57	10.71	9952.5	3918.3
105								
106	W16	1MIPS051A	66	0.62	1.57	10.71	9952.5	3918.3
107								
108	W16	1MIPS052A	66	0.62	1.57	10.71	9952.5	3918.3
109								
110	W16	1MIPS053A	66	0.62	1.57	10.71	9952.5	3918.3
111								
112	W16	1MIPS054A	66	0.62	1.57	10.71	9952.5	3918.3
113								
114	W16	1MIPS055A	66	0.62	1.57	10.71	9952.5	3918.3
115								
116	W16	1MIPS056A	66	0.62	1.57	10.71	9952.5	3918.3
117								
118	W16	1MIPS057A	66	0.62	1.57	10.71	9952.5	3918.3
119								
120	W16	1MIPS058A	66	0.62	1.57	10.71	9952.5	3918.3
121								
122	W16	1MIPS059A	66	0.62	1.57	10.71	9952.5	3918.3
123								
124	W16	1MIPS060A	66	0.62	1.57	10.71	9952.5	3918.3
125								
126	W16	1MIPS061A	66	0.62	1.57	10.71	9952.5	3918.3
127								
128	W16	1MIPS062A	66	0.62	1.57	10.71	9952.5	3918.3
129								
130	W16	1MIPS063A	66	0.62	1.57	10.71	9952.5	3918.3
131								
132	W16	1MIPS064A	66	0.62	1.57	10.71	9952.5	3918.3
133								
134	W16	1MIPS065A	66	0.62	1.57	10.71	9952.5	3918.3
135								
136	W16	1MIPS066A	66	0.62	1.57	10.71	9952.5	3918.3
137								
138	W16	1MIPS067A	66	0.62	1.57	10.71	9952.5	3918.3
139								
140	W16	1MIPS068A	66	0.62	1.57	10.71	9952.5	3918.3
141								
142	W16	1MIPS069A	66	0.62	1.57	10.71	9952.5	3918.3
143								
144	W16	1MIPS070A	66	0.62	1.57	10.71	9952.5	3918.3
145								
146	W16	1MIPS071A	66	0.62	1.57	10.71	9952.5	3918.3
147								
148	W16	1MIPS072A	66	0.62	1.57	10.71	9952.5	3918.3
149								
150	W16	1MIPS073A	66	0.62	1.57	10.71	9952.5	3918.3

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
151								
152	W16	1MIPS074A	66	0.62	1.57	10.71	9952.5	3918.3
153								
154	W16	1MIPS075A	66	0.62	1.57	10.71	9952.5	3918.3
155								
156	W16	1MIPS076A	66	0.62	1.57	10.71	9952.5	3918.3
157								
158	W16	1MIPS077A	66	0.62	1.57	10.71	9952.5	3918.3
159								
160	W16	1MIPS078A	66	0.62	1.57	10.71	9952.5	3918.3
161								
162	W16	1MIPS079A	66	0.62	1.57	10.71	9952.5	3918.3
163								
164	W16	1MIPS080A	66	0.62	1.57	10.71	9952.5	3918.3
165								
166	W16	1MIPS081A	66	0.62	1.57	10.71	9952.5	3918.3
167								
168	W16	1MIPS082A	66	0.62	1.57	10.71	9952.5	3918.3
169								
170	W16	1MIPS083A	66	0.62	1.57	10.71	9952.5	3918.3
171								
172	W16	1MIPS084A	66	0.62	1.57	10.71	9952.5	3918.3
173								
174	W16	1MIPS085A	66	0.62	1.57	10.71	9952.5	3918.3
175								
176	W16	1MIPS086A	66	0.62	1.57	10.71	9952.5	3918.3
177								
178	W16	1MIPS087A	66	0.62	1.57	10.71	9952.5	3918.3
179								
180	W16	1MIPS088A	66	0.62	1.57	10.71	9952.5	3918.3
181								
182	W16	1MIPS089A	66	0.62	1.57	10.71	9952.5	3918.3
183								
184	W16	1MIPS090A	66	0.62	1.57	10.71	9952.5	3918.3
185								
186	W16	1MIPS091A	66	0.62	1.57	10.71	9952.5	3918.3
187								
188	W16	1MIPS092A	66	0.62	1.57	10.71	9952.5	3918.3
189								
190	W16	1MIPS093A	66	0.62	1.57	10.71	9952.5	3918.3
191								
192	W16	1MIPS001A	13	0.62	1.57	2.11	1960.3	771.8
193								
194	W16	1MIPS002A	13	0.62	1.57	2.11	1960.3	771.8
195								
196	W16	1MIPS003A	13	0.62	1.57	2.11	1960.3	771.8
197								
198	W16	1MIPS004A	13	0.62	1.57	2.11	1960.3	771.8
199								

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
200	W16	1MIPS005A	13	0.62	1.57	2.11	1960.3	771.8
201								
202	W16	1MIPS006A	13	0.62	1.57	2.11	1960.3	771.8
203								
204	W16	1MIPS007A	13	0.62	1.57	2.11	1960.3	771.8
205								
206	W16	1MIPS008A	13	0.62	1.57	2.11	1960.3	771.8
207								
208	W16	1MIPS009A	13	0.62	1.57	2.11	1960.3	771.8
209								
210	W16	1MIPS010A	13	0.62	1.57	2.11	1960.3	771.8
211								
212	W16	1MIPS011A	13	0.62	1.57	2.11	1960.3	771.8
213								
214	W16	1MIPS012A	13	0.62	1.57	2.11	1960.3	771.8
215								
216	W16	1MIPS013A	13	0.62	1.57	2.11	1960.3	771.8
217								
218	W16	1MIPS014A	13	0.62	1.57	2.11	1960.3	771.8
219								
220	W16	1MIPS015A	13	0.62	1.57	2.11	1960.3	771.8
221								
222	W16	1MIPS016A	13	0.62	1.57	2.11	1960.3	771.8
223								
224	W16	1MIPS017A	13	0.62	1.57	2.11	1960.3	771.8
225								
226	W16	1MIPS018A	13	0.62	1.57	2.11	1960.3	771.8
227								
228	W16	1MIPS019A	13	0.62	1.57	2.11	1960.3	771.8
229								
230	W16	1MIPS020A	13	0.62	1.57	2.11	1960.3	771.8
231								
232	W16	1MIPS021A	13	0.62	1.57	2.11	1960.3	771.8
233								
234	W16	1MIPS022A	13	0.62	1.57	2.11	1960.3	771.8
235								
236	W16	1MIPS023A	13	0.62	1.57	2.11	1960.3	771.8
237								
238	W16	1MIPS024A	13	0.62	1.57	2.11	1960.3	771.8
239								
240	W16	1MIPS025A	13	0.62	1.57	2.11	1960.3	771.8
241								
242	W16	1MIPS026A	13	0.62	1.57	2.11	1960.3	771.8
243								
244	W16	1MIPS027A	13	0.62	1.57	2.11	1960.3	771.8
245								
246	W16	1MIPS028A	13	0.62	1.57	2.11	1960.3	771.8
247								
248	W16	1MIPS029A	13	0.62	1.57	2.11	1960.3	771.8

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
249								
250	W16	1MIPS030A	13	0.62	1.57	2.11	1960.3	771.8
251								
252	W16	1MIPS031A	13	0.62	1.57	2.11	1960.3	771.8
253								
254	W16	1MIPS032A	13	0.62	1.57	2.11	1960.3	771.8
255								
256	W16	1MIPS033A	13	0.62	1.57	2.11	1960.3	771.8
257								
258	W16	1MIPS034A	13	0.62	1.57	2.11	1960.3	771.8
259								
260	W16	1MIPS035A	13	0.62	1.57	2.11	1960.3	771.8
261								
262	W16	1MIPS036A	13	0.62	1.57	2.11	1960.3	771.8
263								
264	W16	1MIPS037A	13	0.62	1.57	2.11	1960.3	771.8
265								
266	W16	1MIPS038A	13	0.62	1.57	2.11	1960.3	771.8
267								
268	W16	1MIPS039A	13	0.62	1.57	2.11	1960.3	771.8
269								
270	W16	1MIPS040A	13	0.62	1.57	2.11	1960.3	771.8
271								
272	W16	1MIPS041A	13	0.62	1.57	2.11	1960.3	771.8
273								
274	W16	1MIPS042A	13	0.62	1.57	2.11	1960.3	771.8
275								
276	W16	1MIPS043A	13	0.62	1.57	2.11	1960.3	771.8
277								
278	W16	1MIPS044A	13	0.62	1.57	2.11	1960.3	771.8
279								
280	W16	1MIPS045A	13	0.62	1.57	2.11	1960.3	771.8
281								
282	W16	1MIPS046A	13	0.62	1.57	2.11	1960.3	771.8
283								
284	W16	1MIPS047A	13	0.62	1.57	2.11	1960.3	771.8
285								
286	W16	1MIPS048A	13	0.62	1.57	2.11	1960.3	771.8
287								
288	W16	1MIPS049A	13	0.62	1.57	2.11	1960.3	771.8
289								
290	W16	1MIPS050A	13	0.62	1.57	2.11	1960.3	771.8
291								
292	W16	1MIPS051A	13	0.62	1.57	2.11	1960.3	771.8
293								
294	W16	1MIPS052A	13	0.62	1.57	2.11	1960.3	771.8
295								
296	W16	1MIPS053A	13	0.62	1.57	2.11	1960.3	771.8
297								

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
298	W16	1MIPS054A	13	0.62	1.57	2.11	1960.3	771.8
299								
300	W16	1MIPS055A	13	0.62	1.57	2.11	1960.3	771.8
301								
302	W16	1MIPS056A	13	0.62	1.57	2.11	1960.3	771.8
303								
304	W16	1MIPS057A	13	0.62	1.57	2.11	1960.3	771.8
305								
306	W16	1MIPS058A	13	0.62	1.57	2.11	1960.3	771.8
307								
308	W16	1MIPS059A	13	0.62	1.57	2.11	1960.3	771.8
309								
310	W16	1MIPS060A	13	0.62	1.57	2.11	1960.3	771.8
311								
312	W16	1MIPS061A	13	0.62	1.57	2.11	1960.3	771.8
313								
314	W16	1MIPS062A	13	0.62	1.57	2.11	1960.3	771.8
315								
316	W16	1MIPS063A	13	0.62	1.57	2.11	1960.3	771.8
317								
318	W16	1MIPS064A	13	0.62	1.57	2.11	1960.3	771.8
319								
320	W16	1MIPS065A	13	0.62	1.57	2.11	1960.3	771.8
321								
322	W16	1MIPS066A	13	0.62	1.57	2.11	1960.3	771.8
323								
324	W16	1MIPS067A	13	0.62	1.57	2.11	1960.3	771.8
325								
326	W16	1MIPS068A	13	0.62	1.57	2.11	1960.3	771.8
327								
328	W16	1MIPS069A	13	0.62	1.57	2.11	1960.3	771.8
329								
330	W16	1MIPS070A	13	0.62	1.57	2.11	1960.3	771.8
331								
332	W16	1MIPS071A	13	0.62	1.57	2.11	1960.3	771.8
333								
334	W16	1MIPS072A	13	0.62	1.57	2.11	1960.3	771.8
335								
336	W16	1MIPS073A	13	0.62	1.57	2.11	1960.3	771.8
337								
338	W16	1MIPS074A	13	0.62	1.57	2.11	1960.3	771.8
339								
340	W16	1MIPS075A	13	0.62	1.57	2.11	1960.3	771.8
341								
342	W16	1MIPS076A	13	0.62	1.57	2.11	1960.3	771.8
343								
344	W16	1MIPS077A	13	0.62	1.57	2.11	1960.3	771.8
345								
346	W16	1MIPS078A	13	0.62	1.57	2.11	1960.3	771.8

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
347								
348	W16	1MIPS079A	13	0.62	1.57	2.11	1960.3	771.8
349								
350	W16	1MIPS080A	13	0.62	1.57	2.11	1960.3	771.8
351								
352	W16	1MIPS081A	13	0.62	1.57	2.11	1960.3	771.8
353								
354	W16	1MIPS082A	13	0.62	1.57	2.11	1960.3	771.8
355								
356	W16	1MIPS083A	13	0.62	1.57	2.11	1960.3	771.8
357								
358	W16	1MIPS084A	13	0.62	1.57	2.11	1960.3	771.8
359								
360	W16	1MIPS085A	13	0.62	1.57	2.11	1960.3	771.8
361								
362	W16	1MIPS086A	13	0.62	1.57	2.11	1960.3	771.8
363								
364	W16	1MIPS087A	13	0.62	1.57	2.11	1960.3	771.8
365								
366	W16	1MIPS088A	13	0.62	1.57	2.11	1960.3	771.8
367								
368	W16	1MIPS089A	13	0.62	1.57	2.11	1960.3	771.8
369								
370	W16	1MIPS090A	13	0.62	1.57	2.11	1960.3	771.8
371								
372	W16	1MIPS091A	13	0.62	1.57	2.11	1960.3	771.8
373								
374	W16	1MIPS092A	13	0.62	1.57	2.11	1960.3	771.8
375								
376	W16	1MIPS093A	13	0.62	1.57	2.11	1960.3	771.8
377								
378	W16	1MIPS094A	95	0.62	1.57	15.42	14325.6	5640.0
379								
380	W16	1MIPS095A	95	0.62	1.57	15.42	14325.6	5640.0
381								
382	W16	1MIPS096A	95	0.62	1.57	15.42	14325.6	5640.0
383								
384	W16	1MIPS097A	95	0.62	1.57	15.42	14325.6	5640.0
385								
386	W16	1MIPS098A	95	0.62	1.57	15.42	14325.6	5640.0
387								
388	W16	1MIPS099A	95	0.62	1.57	15.42	14325.6	5640.0
389								
390	W16	1MIPS100A	95	0.62	1.57	15.42	14325.6	5640.0
391								
392	W16	1MIPS101A	95	0.62	1.57	15.42	14325.6	5640.0
393								
394	W16	1MIPS102A	95	0.62	1.57	15.42	14325.6	5640.0
395								

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
396	W16	1MIPS103A	95	0.62	1.57	15.42	14325.6	5640.0
397								
398	W16	1MIPS104A	95	0.62	1.57	15.42	14325.6	5640.0
399								
400	W16	1MIPS105A	95	0.62	1.57	15.42	14325.6	5640.0
401								
402	W16	1MIPS106A	95	0.62	1.57	15.42	14325.6	5640.0
403								
404	W16	1MIPS107A	95	0.62	1.57	15.42	14325.6	5640.0
405								
406	W16	1MIPS108A	95	0.62	1.57	15.42	14325.6	5640.0
407								
408	W16	1MIPS109A	95	0.62	1.57	15.42	14325.6	5640.0
409								
410	W16	1MIPS110A	95	0.62	1.57	15.42	14325.6	5640.0
411								
412	W16	1MIPS111A	95	0.62	1.57	15.42	14325.6	5640.0
413								
414	W16	1MIPS112A	95	0.62	1.57	15.42	14325.6	5640.0
415								
416	W16	1MIPS113A	95	0.62	1.57	15.42	14325.6	5640.0
417								
418	W16	1MIPS114A	95	0.62	1.57	15.42	14325.6	5640.0
419								
420	W16	1MIPS115A	95	0.62	1.57	15.42	14325.6	5640.0
421								
422	W16	1MIPS116A	95	0.62	1.57	15.42	14325.6	5640.0
423								
424	W16	1MIPS117A	95	0.62	1.57	15.42	14325.6	5640.0
425								
426	W16	1MIPS118A	95	0.62	1.57	15.42	14325.6	5640.0
427								
428	W16	1MIPS119A	95	0.62	1.57	15.42	14325.6	5640.0
429								
430	W16	1MIPS120A	95	0.62	1.57	15.42	14325.6	5640.0
431								
432	W16	1MIPS121A	95	0.62	1.57	15.42	14325.6	5640.0
433								
434	W16	1MIPS122A	95	0.62	1.57	15.42	14325.6	5640.0
435								
436	W16	1MIPS123A	95	0.62	1.57	15.42	14325.6	5640.0
437								
438	W16	1MIPS124A	95	0.62	1.57	15.42	14325.6	5640.0
439								
440	W16	1MIPS125A	95	0.62	1.57	15.42	14325.6	5640.0
441								
442	W16	1MIPS126A	95	0.62	1.57	15.42	14325.6	5640.0
443								
444	W16	1MIPS127A	95	0.62	1.57	15.42	14325.6	5640.0

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
445								
446	W16	1MIPS128A	95	0.62	1.57	15.42	14325.6	5640.0
447								
448	W16	1MIPS129A	95	0.62	1.57	15.42	14325.6	5640.0
449								
450	W16	1MIPS130A	95	0.62	1.57	15.42	14325.6	5640.0
451								
452	W16	1MIPS131A	95	0.62	1.57	15.42	14325.6	5640.0
453								
454	W16	1MIPS132A	95	0.62	1.57	15.42	14325.6	5640.0
455								
456	W16	1MIPS133A	95	0.62	1.57	15.42	14325.6	5640.0
457								
458	W16	1MIPS134A	95	0.62	1.57	15.42	14325.6	5640.0
459								
460	W16	1MIPS135A	95	0.62	1.57	15.42	14325.6	5640.0
461								
462	W16	1MIPS136A	95	0.62	1.57	15.42	14325.6	5640.0
463								
464	W16	1MIPS137A	95	0.62	1.57	15.42	14325.6	5640.0
465								
466	W16	1MIPS138A	95	0.62	1.57	15.42	14325.6	5640.0
467								
468	W16	1MIPS139A	95	0.62	1.57	15.42	14325.6	5640.0
469								
470	W16	1MIPS140A	95	0.62	1.57	15.42	14325.6	5640.0
471								
472	W16	1MIPS141A	95	0.62	1.57	15.42	14325.6	5640.0
473								
474	W16	1MIPS142A	95	0.62	1.57	15.42	14325.6	5640.0
475								
476	W16	1MIPS143A	95	0.62	1.57	15.42	14325.6	5640.0
477								
478	W16	1MIPS144A	95	0.62	1.57	15.42	14325.6	5640.0
479								
480	W16	1MIPS145A	95	0.62	1.57	15.42	14325.6	5640.0
481								
482	W16	1MIPS146A	95	0.62	1.57	15.42	14325.6	5640.0
483								
484	W16	1MIPS147A	95	0.62	1.57	15.42	14325.6	5640.0
485								
486	W16	1MIPS148A	95	0.62	1.57	15.42	14325.6	5640.0
487								
488	W16	1MIPS149A	95	0.62	1.57	15.42	14325.6	5640.0
489								
490	W16	1MIPS150A	95	0.62	1.57	15.42	14325.6	5640.0
491								
492	W16	1MIPS151A	95	0.62	1.57	15.42	14325.6	5640.0
493								

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
494	W16	1MIPS152A	95	0.62	1.57	15.42	14325.6	5640.0
495								
496	W16	1MIPS153A	95	0.62	1.57	15.42	14325.6	5640.0
497								
498	W16	1MIPS154A	95	0.62	1.57	15.42	14325.6	5640.0
499								
500	W16	1MIPS155A	95	0.62	1.57	15.42	14325.6	5640.0
501								
502	W16	1MIPS156A	95	0.62	1.57	15.42	14325.6	5640.0
503								
504	W16	1MIPS157A	95	0.62	1.57	15.42	14325.6	5640.0
505								
506	W16	1MIPS158A	95	0.62	1.57	15.42	14325.6	5640.0
507								
508	W16	1MIPS159A	95	0.62	1.57	15.42	14325.6	5640.0
509								
510	W16	1MIPS160A	95	0.62	1.57	15.42	14325.6	5640.0
511								
512	W16	1MIPS161A	95	0.62	1.57	15.42	14325.6	5640.0
513								
514	W16	1MIPS162A	95	0.62	1.57	15.42	14325.6	5640.0
515								
516	W16	1MIPS163A	95	0.62	1.57	15.42	14325.6	5640.0
517								
518	W16	1MIPS164A	95	0.62	1.57	15.42	14325.6	5640.0
519								
520	W16	1MIPS165A	95	0.62	1.57	15.42	14325.6	5640.0
521								
522	W16	1MIPS166A	95	0.62	1.57	15.42	14325.6	5640.0
523								
524	W16	1MIPS167A	95	0.62	1.57	15.42	14325.6	5640.0
525								
526	W16	1MIPS168A	95	0.62	1.57	15.42	14325.6	5640.0
527								
528	W16	1MIPS169A	95	0.62	1.57	15.42	14325.6	5640.0
529								
530	W16	1MIPS170A	95	0.62	1.57	15.42	14325.6	5640.0
531								
532	W16	1MIPS171A	95	0.62	1.57	15.42	14325.6	5640.0
533								
534	W16	1MIPS172A	95	0.62	1.57	15.42	14325.6	5640.0
535								
536	W16	1MIPS173A	95	0.62	1.57	15.42	14325.6	5640.0
537								
538	W16	1MIPS174A	95	0.62	1.57	15.42	14325.6	5640.0
539								
540	W16	1MIPS175A	95	0.62	1.57	15.42	14325.6	5640.0
541								
542	W16	1MIPS176A	95	0.62	1.57	15.42	14325.6	5640.0

	A	B	C	D	E	F	G	H
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
543								
544	W16	1MIPS177A	95	0.62	1.57	15.42	14325.6	5640.0
545								
546	W16	1MIPS178A	95	0.62	1.57	15.42	14325.6	5640.0
547								
548	W16	1MIPS179A	95	0.62	1.57	15.42	14325.6	5640.0
549								
550	W16	1MIPS180A	95	0.62	1.57	15.42	14325.6	5640.0
551								
552	W16	1MIPS181A	95	0.62	1.57	15.42	14325.6	5640.0
553								
554	W16	1MIPS182A	95	0.62	1.57	15.42	14325.6	5640.0
555								
556	W16	1MIPS183A	95	0.62	1.57	15.42	14325.6	5640.0
557								
558	W16	1MIPS184A	95	0.62	1.57	15.42	14325.6	5640.0
559								
560	W16	1MIPS185A	95	0.62	1.57	15.42	14325.6	5640.0
561								
562								
563	SUM - OVERALL		16087			2611.17	2425857.6	955060.1
564								
565	VOLUME AVERAGED CABLE RADIUS (CM)							0.78740
566								
567	HYPALON AVERAGE THICKNESS AT 80%							
568	OF VOLUME AVERAGED CABLE RADIUS (CM)							0.62992

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
6	W16	2MIPS001A	60	0.62	1.57	9.74	9,047.77	3,562.11
7								
8	W16	2MIPS002A	60	0.62	1.57	9.74	9,047.77	3,562.11
9								
10	W16	2MIPS003A	60	0.62	1.57	9.74	9,047.77	3,562.11
11								
12	W16	2MIPS004A	60	0.62	1.57	9.74	9,047.77	3,562.11
13								
14	W16	2MIPS005A	60	0.62	1.57	9.74	9,047.77	3,562.11
15								
16	W16	2MIPS006A	60	0.62	1.57	9.74	9,047.77	3,562.11
17								
18	W16	2MIPS007A	60	0.62	1.57	9.74	9,047.77	3,562.11
19								
20	W16	2MIPS008A	60	0.62	1.57	9.74	9,047.77	3,562.11
21								
22	W16	2MIPS009A	60	0.62	1.57	9.74	9,047.77	3,562.11
23								
24	W16	2MIPS010A	60	0.62	1.57	9.74	9,047.77	3,562.11
25								
26	W16	2MIPS011A	60	0.62	1.57	9.74	9,047.77	3,562.11
27								
28	W16	2MIPS012A	60	0.62	1.57	9.74	9,047.77	3,562.11
29								
30	W16	2MIPS013A	60	0.62	1.57	9.74	9,047.77	3,562.11
31								
32	W16	2MIPS014A	60	0.62	1.57	9.74	9,047.77	3,562.11
33								
34	W16	2MIPS015A	60	0.62	1.57	9.74	9,047.77	3,562.11
35								
36	W16	2MIPS016A	60	0.62	1.57	9.74	9,047.77	3,562.11
37								
38	W16	2MIPS017A	60	0.62	1.57	9.74	9,047.77	3,562.11
39								
40	W16	2MIPS018A	60	0.62	1.57	9.74	9,047.77	3,562.11
41								
42	W16	2MIPS019A	60	0.62	1.57	9.74	9,047.77	3,562.11
43								
44	W16	2MIPS020A	60	0.62	1.57	9.74	9,047.77	3,562.11
45								
46	W16	2MIPS021A	60	0.62	1.57	9.74	9,047.77	3,562.11
47								
48	W16	2MIPS022A	60	0.62	1.57	9.74	9,047.77	3,562.11
49								
50	W16	2MIPS023A	60	0.62	1.57	9.74	9,047.77	3,562.11

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
51								
52	W16	2MIPS024A	60	0.62	1.57	9.74	9,047.77	3,562.11
53								
54	W16	2MIPS025A	60	0.62	1.57	9.74	9,047.77	3,562.11
55								
56	W16	2MIPS026A	60	0.62	1.57	9.74	9,047.77	3,562.11
57								
58	W16	2MIPS027A	60	0.62	1.57	9.74	9,047.77	3,562.11
59								
60	W16	2MIPS028A	60	0.62	1.57	9.74	9,047.77	3,562.11
61								
62	W16	2MIPS029A	60	0.62	1.57	9.74	9,047.77	3,562.11
63								
64	W16	2MIPS030A	60	0.62	1.57	9.74	9,047.77	3,562.11
65								
66	W16	2MIPS031A	60	0.62	1.57	9.74	9,047.77	3,562.11
67								
68	W16	2MIPS032A	60	0.62	1.57	9.74	9,047.77	3,562.11
69								
70	W16	2MIPS033A	60	0.62	1.57	9.74	9,047.77	3,562.11
71								
72	W16	2MIPS034A	60	0.62	1.57	9.74	9,047.77	3,562.11
73								
74	W16	2MIPS035A	60	0.62	1.57	9.74	9,047.77	3,562.11
75								
76	W16	2MIPS036A	60	0.62	1.57	9.74	9,047.77	3,562.11
77								
78	W16	2MIPS037A	60	0.62	1.57	9.74	9,047.77	3,562.11
79								
80	W16	2MIPS038A	60	0.62	1.57	9.74	9,047.77	3,562.11
81								
82	W16	2MIPS039A	60	0.62	1.57	9.74	9,047.77	3,562.11
83								
84	W16	2MIPS040A	60	0.62	1.57	9.74	9,047.77	3,562.11
85								
86	W16	2MIPS041A	60	0.62	1.57	9.74	9,047.77	3,562.11
87								
88	W16	2MIPS042A	60	0.62	1.57	9.74	9,047.77	3,562.11
89								
90	W16	2MIPS043A	60	0.62	1.57	9.74	9,047.77	3,562.11
91								
92	W16	2MIPS044A	60	0.62	1.57	9.74	9,047.77	3,562.11
93								
94	W16	2MIPS045A	60	0.62	1.57	9.74	9,047.77	3,562.11
95								

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
96	W16	2MIPS046A	60	0.62	1.57	9.74	9,047.77	3,562.11
97								
98	W16	2MIPS047A	60	0.62	1.57	9.74	9,047.77	3,562.11
99								
100	W16	2MIPS048A	60	0.62	1.57	9.74	9,047.77	3,562.11
101								
102	W16	2MIPS049A	60	0.62	1.57	9.74	9,047.77	3,562.11
103								
104	W16	2MIPS050A	60	0.62	1.57	9.74	9,047.77	3,562.11
105								
106	W16	2MIPS051A	60	0.62	1.57	9.74	9,047.77	3,562.11
107								
108	W16	2MIPS052A	60	0.62	1.57	9.74	9,047.77	3,562.11
109								
110	W16	2MIPS053A	60	0.62	1.57	9.74	9,047.77	3,562.11
111								
112	W16	2MIPS054A	60	0.62	1.57	9.74	9,047.77	3,562.11
113								
114	W16	2MIPS055A	60	0.62	1.57	9.74	9,047.77	3,562.11
115								
116	W16	2MIPS056A	60	0.62	1.57	9.74	9,047.77	3,562.11
117								
118	W16	2MIPS057A	60	0.62	1.57	9.74	9,047.77	3,562.11
119								
120	W16	2MIPS058A	60	0.62	1.57	9.74	9,047.77	3,562.11
121								
122	W16	2MIPS059A	60	0.62	1.57	9.74	9,047.77	3,562.11
123								
124	W16	2MIPS060A	60	0.62	1.57	9.74	9,047.77	3,562.11
125								
126	W16	2MIPS061A	60	0.62	1.57	9.74	9,047.77	3,562.11
127								
128	W16	2MIPS062A	60	0.62	1.57	9.74	9,047.77	3,562.11
129								
130	W16	2MIPS063A	60	0.62	1.57	9.74	9,047.77	3,562.11
131								
132	W16	2MIPS064A	60	0.62	1.57	9.74	9,047.77	3,562.11
133								
134	W16	2MIPS065A	60	0.62	1.57	9.74	9,047.77	3,562.11
135								
136	W16	2MIPS066A	60	0.62	1.57	9.74	9,047.77	3,562.11
137								
138	W16	2MIPS067A	60	0.62	1.57	9.74	9,047.77	3,562.11
139								
140	W16	2MIPS068A	60	0.62	1.57	9.74	9,047.77	3,562.11
141								

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
142	W16	2MIPS069A	60	0.62	1.57	9.74	9,047.77	3,562.11
143								
144	W16	2MIPS070A	60	0.62	1.57	9.74	9,047.77	3,562.11
145								
146	W16	2MIPS071A	60	0.62	1.57	9.74	9,047.77	3,562.11
147								
148	W16	2MIPS072A	60	0.62	1.57	9.74	9,047.77	3,562.11
149								
150	W16	2MIPS073A	60	0.62	1.57	9.74	9,047.77	3,562.11
151								
152	W16	2MIPS074A	60	0.62	1.57	9.74	9,047.77	3,562.11
153								
154	W16	2MIPS075A	60	0.62	1.57	9.74	9,047.77	3,562.11
155								
156	W16	2MIPS076A	60	0.62	1.57	9.74	9,047.77	3,562.11
157								
158	W16	2MIPS077A	60	0.62	1.57	9.74	9,047.77	3,562.11
159								
160	W16	2MIPS078A	60	0.62	1.57	9.74	9,047.77	3,562.11
161								
162	W16	2MIPS079A	60	0.62	1.57	9.74	9,047.77	3,562.11
163								
164	W16	2MIPS080A	60	0.62	1.57	9.74	9,047.77	3,562.11
165								
166	W16	2MIPS081A	60	0.62	1.57	9.74	9,047.77	3,562.11
167								
168	W16	2MIPS082A	60	0.62	1.57	9.74	9,047.77	3,562.11
169								
170	W16	2MIPS083A	60	0.62	1.57	9.74	9,047.77	3,562.11
171								
172	W16	2MIPS084A	60	0.62	1.57	9.74	9,047.77	3,562.11
173								
174	W16	2MIPS085A	60	0.62	1.57	9.74	9,047.77	3,562.11
175								
176	W16	2MIPS086A	60	0.62	1.57	9.74	9,047.77	3,562.11
177								
178	W16	2MIPS087A	60	0.62	1.57	9.74	9,047.77	3,562.11
179								
180	W16	2MIPS088A	60	0.62	1.57	9.74	9,047.77	3,562.11
181								
182	W16	2MIPS089A	60	0.62	1.57	9.74	9,047.77	3,562.11
183								
184	W16	2MIPS090A	60	0.62	1.57	9.74	9,047.77	3,562.11
185								
186	W16	2MIPS091A	60	0.62	1.57	9.74	9,047.77	3,562.11

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
187								
188	W16	2MIPS092A	60	0.62	1.57	9.74	9,047.77	3,562.11
189								
190	W16	2MIPS093A	60	0.62	1.57	9.74	9,047.77	3,562.11
191								
192	W16	2MIPS001A	10	0.62	1.57	1.62	1,507.96	593.68
193								
194	W16	2MIPS002A	10	0.62	1.57	1.62	1,507.96	593.68
195								
196	W16	2MIPS003A	10	0.62	1.57	1.62	1,507.96	593.68
197								
198	W16	2MIPS004A	10	0.62	1.57	1.62	1,507.96	593.68
199								
200	W16	2MIPS005A	10	0.62	1.57	1.62	1,507.96	593.68
201								
202	W16	2MIPS006A	10	0.62	1.57	1.62	1,507.96	593.68
203								
204	W16	2MIPS007A	10	0.62	1.57	1.62	1,507.96	593.68
205								
206	W16	2MIPS008A	10	0.62	1.57	1.62	1,507.96	593.68
207								
208	W16	2MIPS009A	10	0.62	1.57	1.62	1,507.96	593.68
209								
210	W16	2MIPS010A	10	0.62	1.57	1.62	1,507.96	593.68
211								
212	W16	2MIPS011A	10	0.62	1.57	1.62	1,507.96	593.68
213								
214	W16	2MIPS012A	10	0.62	1.57	1.62	1,507.96	593.68
215								
216	W16	2MIPS013A	10	0.62	1.57	1.62	1,507.96	593.68
217								
218	W16	2MIPS014A	10	0.62	1.57	1.62	1,507.96	593.68
219								
220	W16	2MIPS015A	10	0.62	1.57	1.62	1,507.96	593.68
221								
222	W16	2MIPS016A	10	0.62	1.57	1.62	1,507.96	593.68
223								
224	W16	2MIPS017A	10	0.62	1.57	1.62	1,507.96	593.68
225								
226	W16	2MIPS018A	10	0.62	1.57	1.62	1,507.96	593.68
227								
228	W16	2MIPS019A	10	0.62	1.57	1.62	1,507.96	593.68
229								
230	W16	2MIPS020A	10	0.62	1.57	1.62	1,507.96	593.68
231								
232	W16	2MIPS021A	10	0.62	1.57	1.62	1,507.96	593.68

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
233								
234	W16	2MIPS022A	10	0.62	1.57	1.62	1,507.96	593.68
235								
236	W16	2MIPS023A	10	0.62	1.57	1.62	1,507.96	593.68
237								
238	W16	2MIPS024A	10	0.62	1.57	1.62	1,507.96	593.68
239								
240	W16	2MIPS025A	10	0.62	1.57	1.62	1,507.96	593.68
241								
242	W16	2MIPS026A	10	0.62	1.57	1.62	1,507.96	593.68
243								
244	W16	2MIPS027A	10	0.62	1.57	1.62	1,507.96	593.68
245								
246	W16	2MIPS028A	10	0.62	1.57	1.62	1,507.96	593.68
247								
248	W16	2MIPS029A	10	0.62	1.57	1.62	1,507.96	593.68
249								
250	W16	2MIPS030A	10	0.62	1.57	1.62	1,507.96	593.68
251								
252	W16	2MIPS031A	10	0.62	1.57	1.62	1,507.96	593.68
253								
254	W16	2MIPS032A	10	0.62	1.57	1.62	1,507.96	593.68
255								
256	W16	2MIPS033A	10	0.62	1.57	1.62	1,507.96	593.68
257								
258	W16	2MIPS034A	10	0.62	1.57	1.62	1,507.96	593.68
259								
260	W16	2MIPS035A	10	0.62	1.57	1.62	1,507.96	593.68
261								
262	W16	2MIPS036A	10	0.62	1.57	1.62	1,507.96	593.68
263								
264	W16	2MIPS037A	10	0.62	1.57	1.62	1,507.96	593.68
265								
266	W16	2MIPS038A	10	0.62	1.57	1.62	1,507.96	593.68
267								
268	W16	2MIPS039A	10	0.62	1.57	1.62	1,507.96	593.68
269								
270	W16	2MIPS040A	10	0.62	1.57	1.62	1,507.96	593.68
271								
272	W16	2MIPS041A	10	0.62	1.57	1.62	1,507.96	593.68
273								
274	W16	2MIPS042A	10	0.62	1.57	1.62	1,507.96	593.68
275								
276	W16	2MIPS043A	10	0.62	1.57	1.62	1,507.96	593.68
277								
278	W16	2MIPS044A	10	0.62	1.57	1.62	1,507.96	593.68
279								
280	W16	2MIPS045A	10	0.62	1.57	1.62	1,507.96	593.68
281								
282	W16	2MIPS046A	10	0.62	1.57	1.62	1,507.96	593.68
283								
284	W16	2MIPS047A	10	0.62	1.57	1.62	1,507.96	593.68
285								

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
286	W16	2MIPS048A	10	0.62	1.57	1.62	1,507.96	593.68
287								
288	W16	2MIPS049A	10	0.62	1.57	1.62	1,507.96	593.68
289								
290	W16	2MIPS050A	10	0.62	1.57	1.62	1,507.96	593.68
291								
292	W16	2MIPS051A	10	0.62	1.57	1.62	1,507.96	593.68
293								
294	W16	2MIPS052A	10	0.62	1.57	1.62	1,507.96	593.68
295								
296	W16	2MIPS053A	10	0.62	1.57	1.62	1,507.96	593.68
297								
298	W16	2MIPS054A	10	0.62	1.57	1.62	1,507.96	593.68
299								
300	W16	2MIPS055A	10	0.62	1.57	1.62	1,507.96	593.68
301								
302	W16	2MIPS056A	10	0.62	1.57	1.62	1,507.96	593.68
303								
304	W16	2MIPS057A	10	0.62	1.57	1.62	1,507.96	593.68
305								
306	W16	2MIPS058A	10	0.62	1.57	1.62	1,507.96	593.68
307								
308	W16	2MIPS059A	10	0.62	1.57	1.62	1,507.96	593.68
309								
310	W16	2MIPS060A	10	0.62	1.57	1.62	1,507.96	593.68
311								
312	W16	2MIPS061A	10	0.62	1.57	1.62	1,507.96	593.68
313								
314	W16	2MIPS062A	10	0.62	1.57	1.62	1,507.96	593.68
315								
316	W16	2MIPS063A	10	0.62	1.57	1.62	1,507.96	593.68
317								
318	W16	2MIPS064A	10	0.62	1.57	1.62	1,507.96	593.68
319								
320	W16	2MIPS065A	10	0.62	1.57	1.62	1,507.96	593.68
321								
322	W16	2MIPS066A	10	0.62	1.57	1.62	1,507.96	593.68

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
323								
324	W16	2MIPS067A	10	0.62	1.57	1.62	1,507.96	593.68
325								
326	W16	2MIPS068A	10	0.62	1.57	1.62	1,507.96	593.68
327								
328	W16	2MIPS069A	10	0.62	1.57	1.62	1,507.96	593.68
329								
330	W16	2MIPS070A	10	0.62	1.57	1.62	1,507.96	593.68
331								
332	W16	2MIPS071A	10	0.62	1.57	1.62	1,507.96	593.68
333								
334	W16	2MIPS072A	10	0.62	1.57	1.62	1,507.96	593.68
335								
336	W16	2MIPS073A	10	0.62	1.57	1.62	1,507.96	593.68
337								
338	W16	2MIPS074A	10	0.62	1.57	1.62	1,507.96	593.68
339								
340	W16	2MIPS075A	10	0.62	1.57	1.62	1,507.96	593.68
341								
342	W16	2MIPS076A	10	0.62	1.57	1.62	1,507.96	593.68
343								
344	W16	2MIPS077A	10	0.62	1.57	1.62	1,507.96	593.68
345								
346	W16	2MIPS078A	10	0.62	1.57	1.62	1,507.96	593.68
347								
348	W16	2MIPS079A	10	0.62	1.57	1.62	1,507.96	593.68
349								
350	W16	2MIPS080A	10	0.62	1.57	1.62	1,507.96	593.68
351								
352	W16	2MIPS081A	10	0.62	1.57	1.62	1,507.96	593.68
353								
354	W16	2MIPS082A	10	0.62	1.57	1.62	1,507.96	593.68
355								
356	W16	2MIPS083A	10	0.62	1.57	1.62	1,507.96	593.68
357								
358	W16	2MIPS084A	10	0.62	1.57	1.62	1,507.96	593.68
359								
360	W16	2MIPS085A	10	0.62	1.57	1.62	1,507.96	593.68
361								
362	W16	2MIPS086A	10	0.62	1.57	1.62	1,507.96	593.68
363								
364	W16	2MIPS087A	10	0.62	1.57	1.62	1,507.96	593.68
365								
366	W16	2MIPS088A	10	0.62	1.57	1.62	1,507.96	593.68
367								
368	W16	2MIPS089A	10	0.62	1.57	1.62	1,507.96	593.68

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
369								
370	W16	2MIPS090A	10	0.62	1.57	1.62	1,507.96	593.68
371								
372	W16	2MIPS091A	10	0.62	1.57	1.62	1,507.96	593.68
373								
374	W16	2MIPS092A	10	0.62	1.57	1.62	1,507.96	593.68
375								
376	W16	2MIPS093A	10	0.62	1.57	1.62	1,507.96	593.68
377								
378	W16	2MIPS094A	67	0.62	1.57	10.88	10,103.34	3,977.69
379								
380	W16	2MIPS095A	67	0.62	1.57	10.88	10,103.34	3,977.69
381								
382	W16	2MIPS096A	67	0.62	1.57	10.88	10,103.34	3,977.69
383								
384	W16	2MIPS097A	67	0.62	1.57	10.88	10,103.34	3,977.69
385								
386	W16	2MIPS098A	67	0.62	1.57	10.88	10,103.34	3,977.69
387								
388	W16	2MIPS099A	67	0.62	1.57	10.88	10,103.34	3,977.69
389								
390	W16	2MIPS100A	67	0.62	1.57	10.88	10,103.34	3,977.69
391								
392	W16	2MIPS101A	67	0.62	1.57	10.88	10,103.34	3,977.69
393								
394	W16	2MIPS102A	67	0.62	1.57	10.88	10,103.34	3,977.69
395								
396	W16	2MIPS103A	67	0.62	1.57	10.88	10,103.34	3,977.69
397								
398	W16	2MIPS104A	67	0.62	1.57	10.88	10,103.34	3,977.69
399								
400	W16	2MIPS105A	67	0.62	1.57	10.88	10,103.34	3,977.69
401								
402	W16	2MIPS106A	67	0.62	1.57	10.88	10,103.34	3,977.69
403								
404	W16	2MIPS107A	67	0.62	1.57	10.88	10,103.34	3,977.69
405								
406	W16	2MIPS108A	67	0.62	1.57	10.88	10,103.34	3,977.69
407								
408	W16	2MIPS109A	67	0.62	1.57	10.88	10,103.34	3,977.69
409								
410	W16	2MIPS110A	67	0.62	1.57	10.88	10,103.34	3,977.69
411								
412	W16	2MIPS111A	67	0.62	1.57	10.88	10,103.34	3,977.69
413								

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
414	W16	2MIPS112A	67	0.62	1.57	10.88	10,103.34	3,977.69
415								
416	W16	2MIPS113A	67	0.62	1.57	10.88	10,103.34	3,977.69
417								
418	W16	2MIPS114A	67	0.62	1.57	10.88	10,103.34	3,977.69
419								
420	W16	2MIPS115A	67	0.62	1.57	10.88	10,103.34	3,977.69
421								
422	W16	2MIPS116A	67	0.62	1.57	10.88	10,103.34	3,977.69
423								
424	W16	2MIPS117A	67	0.62	1.57	10.88	10,103.34	3,977.69
425								
426	W16	2MIPS118A	67	0.62	1.57	10.88	10,103.34	3,977.69
427								
428	W16	2MIPS119A	67	0.62	1.57	10.88	10,103.34	3,977.69
429								
430	W16	2MIPS120A	67	0.62	1.57	10.88	10,103.34	3,977.69
431								
432	W16	2MIPS121A	67	0.62	1.57	10.88	10,103.34	3,977.69
433								
434	W16	2MIPS122A	67	0.62	1.57	10.88	10,103.34	3,977.69
435								
436	W16	2MIPS123A	67	0.62	1.57	10.88	10,103.34	3,977.69
437								
438	W16	2MIPS124A	67	0.62	1.57	10.88	10,103.34	3,977.69
439								
440	W16	2MIPS125A	67	0.62	1.57	10.88	10,103.34	3,977.69
441								
442	W16	2MIPS126A	67	0.62	1.57	10.88	10,103.34	3,977.69
443								
444	W16	2MIPS127A	67	0.62	1.57	10.88	10,103.34	3,977.69
445								
446	W16	2MIPS128A	67	0.62	1.57	10.88	10,103.34	3,977.69
447								
448	W16	2MIPS129A	67	0.62	1.57	10.88	10,103.34	3,977.69
449								
450	W16	2MIPS130A	67	0.62	1.57	10.88	10,103.34	3,977.69
451								
452	W16	2MIPS131A	67	0.62	1.57	10.88	10,103.34	3,977.69
453								
454	W16	2MIPS132A	67	0.62	1.57	10.88	10,103.34	3,977.69
455								
456	W16	2MIPS133A	67	0.62	1.57	10.88	10,103.34	3,977.69
457								
458	W16	2MIPS134A	67	0.62	1.57	10.88	10,103.34	3,977.69

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
459								
460	W16	2MIPS135A	67	0.62	1.57	10.88	10,103.34	3,977.69
461								
462	W16	2MIPS136A	67	0.62	1.57	10.88	10,103.34	3,977.69
463								
464	W16	2MIPS137A	67	0.62	1.57	10.88	10,103.34	3,977.69
465								
466	W16	2MIPS138A	67	0.62	1.57	10.88	10,103.34	3,977.69
467								
468	W16	2MIPS139A	67	0.62	1.57	10.88	10,103.34	3,977.69
469								
470	W16	2MIPS140A	67	0.62	1.57	10.88	10,103.34	3,977.69
471								
472	W16	2MIPS141A	67	0.62	1.57	10.88	10,103.34	3,977.69
473								
474	W16	2MIPS142A	67	0.62	1.57	10.88	10,103.34	3,977.69
475								
476	W16	2MIPS143A	67	0.62	1.57	10.88	10,103.34	3,977.69
477								
478	W16	2MIPS144A	67	0.62	1.57	10.88	10,103.34	3,977.69
479								
480	W16	2MIPS145A	67	0.62	1.57	10.88	10,103.34	3,977.69
481								
482	W16	2MIPS146A	67	0.62	1.57	10.88	10,103.34	3,977.69
483								
484	W16	2MIPS147A	67	0.62	1.57	10.88	10,103.34	3,977.69
485								
486	W16	2MIPS148A	67	0.62	1.57	10.88	10,103.34	3,977.69
487								
488	W16	2MIPS149A	67	0.62	1.57	10.88	10,103.34	3,977.69
489								
490	W16	2MIPS150A	67	0.62	1.57	10.88	10,103.34	3,977.69
491								
492	W16	2MIPS151A	67	0.62	1.57	10.88	10,103.34	3,977.69
493								
494	W16	2MIPS152A	67	0.62	1.57	10.88	10,103.34	3,977.69
495								
496	W16	2MIPS153A	67	0.62	1.57	10.88	10,103.34	3,977.69
497								
498	W16	2MIPS154A	67	0.62	1.57	10.88	10,103.34	3,977.69
499								
500	W16	2MIPS155A	67	0.62	1.57	10.88	10,103.34	3,977.69
501								
502	W16	2MIPS156A	67	0.62	1.57	10.88	10,103.34	3,977.69
503								

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
504	W16	2MIPS157A	67	0.62	1.57	10.88	10,103.34	3,977.69
505								
506	W16	2MIPS158A	67	0.62	1.57	10.88	10,103.34	3,977.69
507								
508	W16	2MIPS159A	67	0.62	1.57	10.88	10,103.34	3,977.69
509								
510	W16	2MIPS160A	67	0.62	1.57	10.88	10,103.34	3,977.69
511								
512	W16	2MIPS161A	67	0.62	1.57	10.88	10,103.34	3,977.69
513								
514	W16	2MIPS162A	67	0.62	1.57	10.88	10,103.34	3,977.69
515								
516	W16	2MIPS163A	67	0.62	1.57	10.88	10,103.34	3,977.69
517								
518	W16	2MIPS164A	67	0.62	1.57	10.88	10,103.34	3,977.69
519								
520	W16	2MIPS165A	67	0.62	1.57	10.88	10,103.34	3,977.69
521								
522	W16	2MIPS166A	67	0.62	1.57	10.88	10,103.34	3,977.69
523								
524	W16	2MIPS167A	67	0.62	1.57	10.88	10,103.34	3,977.69
525								
526	W16	2MIPS168A	67	0.62	1.57	10.88	10,103.34	3,977.69
527								
528	W16	2MIPS169A	67	0.62	1.57	10.88	10,103.34	3,977.69
529								
530	W16	2MIPS170A	67	0.62	1.57	10.88	10,103.34	3,977.69
531								
532	W16	2MIPS171A	67	0.62	1.57	10.88	10,103.34	3,977.69
533								
534	W16	2MIPS172A	67	0.62	1.57	10.88	10,103.34	3,977.69
535								
536	W16	2MIPS173A	67	0.62	1.57	10.88	10,103.34	3,977.69
537								
538	W16	2MIPS174A	67	0.62	1.57	10.88	10,103.34	3,977.69
539								
540	W16	2MIPS175A	67	0.62	1.57	10.88	10,103.34	3,977.69
541								
542	W16	2MIPS176A	67	0.62	1.57	10.88	10,103.34	3,977.69
543								
544	W16	2MIPS177A	67	0.62	1.57	10.88	10,103.34	3,977.69
545								
546	W16	2MIPS178A	67	0.62	1.57	10.88	10,103.34	3,977.69
547								
548	W16	2MIPS179A	67	0.62	1.57	10.88	10,103.34	3,977.69

	A	B	C	D	E	F	G	H
1	LGS UNIT 2 DRYWELL CABLES							
2								
3	CABLE		CABLE	CABLE	CABLE	CABLE	CABLE	CABLE
4	CODE	CABLE	LENGTH	O.D.	O.D.	SURFACE	SURFACE	VOLUME
5			(FT)	(INCHES)	(CM)	AREA (SQ FT)	AREA (SQ CM)	(CU CM)
549								
550	W16	2MIPS180A	67	0.62	1.57	10.88	10,103.34	3,977.69
551								
552	W16	2MIPS181A	67	0.62	1.57	10.88	10,103.34	3,977.69
553								
554	W16	2MIPS182A	67	0.62	1.57	10.88	10,103.34	3,977.69
555								
556	W16	2MIPS183A	67	0.62	1.57	10.88	10,103.34	3,977.69
557								
558	W16	2MIPS184A	67	0.62	1.57	10.88	10,103.34	3,977.69
559								
560	W16	2MIPS185A	67	0.62	1.57	10.88	10,103.34	3,977.69
561								
562	SUM - OVERALL		12,674.00			2057.19	1911190.4	752435.6
563								
564	VOLUME AVERAGED CABLE RADIUS (CM)							0.78740
565								
566	HYPALON AVERAGE THICKNESS AT 80%							
567	OF VOLUME AVERAGED CABLE RADIUS (CM)							0.62992

LGS

CAE COE	CA	CABLE LENGTH (FT)	CABI O.D. (INCI	CABLE O.D. (CM)	CABLE SURFACE AREA (SQ FT)	CABLE SURFACE AREA (SQ CM)	CABLE VOLUME (CU CM)
W16PS(		66	0.62	=D6*2.54	=(D6/12)*PI()*C6	=F6*929.0304	=PI()*C6*30.48*(E6/2)^2
W16PS(		66	0.62	=D8*2.54	=(D8/12)*PI()*C8	=F8*929.0304	=PI()*C8*30.48*(E8/2)^2
W16PS(		66	0.62	=D10*2.54	=(D10/12)*PI()*C10	=F10*929.0304	=PI()*C10*30.48*(E10/2)^2
W16PS(		66	0.62	=D12*2.54	=(D12/12)*PI()*C12	=F12*929.0304	=PI()*C12*30.48*(E12/2)^2
W16PS(		66	0.62	=D14*2.54	=(D14/12)*PI()*C14	=F14*929.0304	=PI()*C14*30.48*(E14/2)^2
W16PS(		66	0.62	=D16*2.54	=(D16/12)*PI()*C16	=F16*929.0304	=PI()*C16*30.48*(E16/2)^2
W16PS(		66	0.62	=D18*2.54	=(D18/12)*PI()*C18	=F18*929.0304	=PI()*C18*30.48*(E18/2)^2
W16PS(		66	0.62	=D20*2.54	=(D20/12)*PI()*C20	=F20*929.0304	=PI()*C20*30.48*(E20/2)^2
W16PS(		66	0.62	=D22*2.54	=(D22/12)*PI()*C22	=F22*929.0304	=PI()*C22*30.48*(E22/2)^2
W16PS(		66	0.62	=D24*2.54	=(D24/12)*PI()*C24	=F24*929.0304	=PI()*C24*30.48*(E24/2)^2
W16PS(		66	0.62	=D26*2.54	=(D26/12)*PI()*C26	=F26*929.0304	=PI()*C26*30.48*(E26/2)^2
W16PS(		66	0.62	=D28*2.54	=(D28/12)*PI()*C28	=F28*929.0304	=PI()*C28*30.48*(E28/2)^2
W16PS(		66	0.62	=D30*2.54	=(D30/12)*PI()*C30	=F30*929.0304	=PI()*C30*30.48*(E30/2)^2
W16PS(		66	0.62	=D32*2.54	=(D32/12)*PI()*C32	=F32*929.0304	=PI()*C32*30.48*(E32/2)^2
W16PS(		66	0.62	=D34*2.54	=(D34/12)*PI()*C34	=F34*929.0304	=PI()*C34*30.48*(E34/2)^2
W16PS(		66	0.62	=D36*2.54	=(D36/12)*PI()*C36	=F36*929.0304	=PI()*C36*30.48*(E36/2)^2
W16PS(		66	0.62	=D38*2.54	=(D38/12)*PI()*C38	=F38*929.0304	=PI()*C38*30.48*(E38/2)^2
W16PS(		66	0.62	=D40*2.54	=(D40/12)*PI()*C40	=F40*929.0304	=PI()*C40*30.48*(E40/2)^2
W16PS(		66	0.62	=D42*2.54	=(D42/12)*PI()*C42	=F42*929.0304	=PI()*C42*30.48*(E42/2)^2
W16PS(		66	0.62	=D44*2.54	=(D44/12)*PI()*C44	=F44*929.0304	=PI()*C44*30.48*(E44/2)^2
W16PS(		66	0.62	=D46*2.54	=(D46/12)*PI()*C46	=F46*929.0304	=PI()*C46*30.48*(E46/2)^2
W16PS(		66	0.62	=D48*2.54	=(D48/12)*PI()*C48	=F48*929.0304	=PI()*C48*30.48*(E48/2)^2
W16PS(		66	0.62	=D50*2.54	=(D50/12)*PI()*C50	=F50*929.0304	=PI()*C50*30.48*(E50/2)^2
W16PS(		66	0.62	=D52*2.54	=(D52/12)*PI()*C52	=F52*929.0304	=PI()*C52*30.48*(E52/2)^2

W16PS195		0.62	=D54*2.54	=(D54/12)*PI()*C54	=F54*929.0304	=PI()*C54*30.48*(E54/2)^2
W16PS195		0.62	=D56*2.54	=(D56/12)*PI()*C56	=F56*929.0304	=PI()*C56*30.48*(E56/2)^2
W16PS195		0.62	=D58*2.54	=(D58/12)*PI()*C58	=F58*929.0304	=PI()*C58*30.48*(E58/2)^2
W16PS195		0.62	=D60*2.54	=(D60/12)*PI()*C60	=F60*929.0304	=PI()*C60*30.48*(E60/2)^2
W16PS195		0.62	=D62*2.54	=(D62/12)*PI()*C62	=F62*929.0304	=PI()*C62*30.48*(E62/2)^2
W16PS195		0.62	=D64*2.54	=(D64/12)*PI()*C64	=F64*929.0304	=PI()*C64*30.48*(E64/2)^2
W16PS195		0.62	=D66*2.54	=(D66/12)*PI()*C66	=F66*929.0304	=PI()*C66*30.48*(E66/2)^2
W16PS195		0.62	=D68*2.54	=(D68/12)*PI()*C68	=F68*929.0304	=PI()*C68*30.48*(E68/2)^2
W16PS195		0.62	=D70*2.54	=(D70/12)*PI()*C70	=F70*929.0304	=PI()*C70*30.48*(E70/2)^2
SUN	=SUM(C6:C70)			=SUM(F6:F70)	=SUM(G6:G70)	=SUM(H6:H70)
VOL						=(H73/(C73*30.48*PI()))^0.5
**HYP OF **						=H75*0.8

LGS pH Calc., Rev. 1
Attachment B
Part 1: Determination of Post-LOCA Drywell/Torus and Suppression Pool Integrated γ and β Energy, and Suppression Pool Integrated Doses for Suppression Pool pH Determination
&
Part 2: Core Cesium and Iodine Determination
&
Part 3: Drywell and Torus Gamma Mean Free Path Determination

1. Part 1 Purpose

The purpose of this analysis is to determine Post-LOCA Drywell/Containment and Suppression Pool Integrated γ and β energies, and Suppression Pool Integrated Doses for Suppression Pool pH Determination. This data is used in Attachment C of this calculation to determine the radiolytic generation of acid input to the suppression pool.

During a DBA-LOCA, analyzed using Alternative Source Terms (AST), radioactivity is released from the reactor, first during a 1/2 hour gap release period, and then during an early in-vessel release period. Activity is then removed from containment by decay only for conservatism and simplicity.

2. Approach

This attachment calculates the total integrated γ and β energy released into drywell/containment at specific points in time, and total γ plus β Dose in the Suppression Pool water. For conservatism in this calculation, all activity is instantly distributed into the drywell and containment airspaces. The data is then used by the spreadsheets in Attachment C to calculate the change in the pH of the pool water as a function of time.

Initial activity in the core is taken from Reference 5.11. Release fractions and timing are per R.G. 1.183, Table 1. For simplicity, and because of its negligible effect, no credit is taken for the 121-second minimum anticipated time before the start of gap activity. No credit is taken for natural deposition or suppression pool scrubbing. This maintains aerosols airborne to conservatively simulate theoretical plateout contributions. In general, significant amounts of plated-out material are likely to be washed into the suppression pool by condensed vapor flow or containment spray. Simultaneously, all non-noble gas releases are assumed to be instantly transported to, and uniformly mixed in, the suppression pool water.

The calculation of the dose in the pool water, and the integrated energies from radiation in drywell/containment, parallel each other, up to the point of determining the total integrated γ and β energy released into containment at the specific time-steps used by Entergy in their GGNS Suppression Pool pH Analysis Calculation (No. XC-Q1111-98013); the basis for this part of the Limerick Generating Station (LGS) AST analysis. First, for each isotope the following list of parameters must be calculated or acquired:

Parameter	Origin
Decay Constant	RadTrad Standard Library Values
Release Fractions from 0 to 0.5 hours and 0.5 to 2 hours	Reg. Guide 1.183, Table 1

Initial Core Activity	Reg. Guide 1.183
Activity in Drywell/Containment due to Gap Release at 0.5 hours	Calculated Herein, see below
Time Integrated Activity through 0.5 hours of Gap Release	Calculated Herein, see below
Activity in Drywell/Containment due to Early In-vessel Release at 2 hours	Calculated Herein, see below
Time Integrated Activity through 2 hours of Early In-vessel Release	Calculated Herein, see below
Total Time Integrated Activity Released through 2 hours	Calculated Herein, see below
Total Activity in Drywell/Containment at 2 hours	Calculated Herein, see below
Gamma (Photon) Emission Energy	Radioactive Decay Data Tables, by David C. Kocher [Ref. 5.12] as compiled in RadDecay program
Beta Particle Emission Energy	Radioactive Decay Data Tables, by David C. Kocher [Ref. 5.12] as compiled in RadDecay program

<u>Calculated Values</u>

In order to evaluate the activity in containment, and subsequently the concentration of activity, it was necessary to develop functions that took into account the LGS conditions, while providing the necessary inputs for the analysis model of GGNS.

- <u>Activity in Drywell/Containment up through 0.5 Hours (Due to Gap Release)</u>

$$\alpha_G(.5) = f_{0-.5} \times \frac{0.5}{0.5}\alpha_o e^{-\lambda 0.5} = f_{0-0.5} \times \alpha_o e^{-\lambda 0.5}$$

$$\alpha_G(t) = f_{0-t} \times \frac{t}{0.5}\alpha_o e^{-\lambda t}$$

$f_{0\text{-}0.5}$= activity release fraction at 30 minutes, variable depending on isotope
α_o= initial core activity, variable depending on isotope (Ci)
e= constant
λ= decay constant, variable depending on isotope (hours^{-1})
t= time (hours)
($^t/_{0.5}$)= release fraction buildup over 0.5 hours related linearly (as done in RadTrad)

- <u>Activity in Drywell/Containment up through 2 Hours (Due to Early In-vessel Release)</u>

$$\alpha_E(2) = f_{.5-2} \times \frac{2-0.5}{1.5} \times \alpha_o e^{-\lambda 0.5} \times e^{-\lambda 1.5} = f_{.5-2} \times \alpha_o e^{-\lambda 2}$$

$$\alpha_E(2) = f_{.5-t} \times \frac{t}{1.5} \times \alpha_o e^{-\lambda t}$$

$f_{0.5-2}$= activity release fraction at 2 hours, variable depending on isotope
α_o= initial core activity, variable depending on isotope (Ci)
e= constant
λ= decay constant, variable depending on isotope (hours^{-1})
t= time (hours)
($^t/_{1.5}$)= release fraction buildup over 1.5 hours related linearly (as done in RadTrad)

- <u>Time Integrated Activity through 0.5 Hours (from Gap Release)</u>

$$\alpha_G(t) = \alpha_o \times f_{0-0.5} \times \left(\frac{t}{0.5}\right) \times e^{-\lambda 0.5}$$

$$A_{G0-0.5} = \int_0^{0.5} \alpha_G(t)dt = \frac{\alpha_o \times f_{0-0.5}}{0.5} \int_0^{0.5} te^{-\lambda t}dt$$

$$A_{G0-0.5} = \frac{\alpha_o \times f_{0-.5}}{0.5\lambda^2}\left[1 - e^{-0.5\lambda}(0.5\lambda + 1)\right]$$

$f_{0-0.5}$= activity release fraction at 2 hours, variable depending on isotope
($^t/_{0.5}$)= release fraction buildup over 0.5 hours related linearly (as done in RadTrad)
α_o= initial core activity, variable depending on isotope (Ci)
e= constant
λ= decay constant, variable depending on isotope (hours^{-1})
t= time (hours)
$\alpha_G(t)$= activity in containment as a function of time, due to gap release (Ci)
$A_{G0-0.5}$= time integrated activity though 0.5 hours due to gap release (Ci-hours)

- <u>Time Integrated Activity through 2 Hours (from Early In-vessel Release)</u>

$$\alpha_E(t) = \alpha_o e^{-\lambda 0.5} \times f_{0.5-2} \times \left(\frac{t}{1.5}\right) \times e^{-\lambda 1.5}$$ [Note: Here, t starts after 0.5 hour]

$$A_{E0-1.5} = \int_0^{1.5} \alpha_E(t)dt = \frac{\alpha_o e^{-0.5\lambda} \times f_{0.5-2}}{1.5} \int_0^{1.5} te^{-\lambda t}dt$$

$$A_{E0-1.5} = \frac{\alpha_o e^{-0.5\lambda} \times f_{0.5-2}}{1.5\lambda^2}\left[1 - e^{-1.5\lambda}(1.5\lambda + 1)\right]$$

$f_{0-0.5}$= activity release fraction at 2 hours, variable depending on isotope
($^t/_{1.5}$)= release fraction buildup over 1.5 hours related linearly (as done in RadTrad)
α_o= initial core activity, variable depending on isotope (Ci)
e= constant
λ= decay constant, variable depending on isotope (hours^{-1})
t= time (hours)
$\alpha_E(t)$= activity in containment as a function of time, due to early in-vessel release (Ci)
$A_{E0-1.5}$= time integrated activity from 0.5 to 2 hours due to early in-vessel release (Ci-hours), after shutdown

- <u>Total Time Integrated Activity Released in Drywell/Containment through 2 Hours</u>

$$A_{2_{total}} = A_{G0-0.5} + A_{E0-1.5}$$

$A_{G0\text{-}0.5}$= time integrated activity though 0.5 hours due to gap release (Ci-hours)
$A_{E0\text{-}1.5}$= time integrated activity from 0.5 to 2 hours due to early in-vessel release (Ci-hours), after shutdown

- Total Activity in Drywell/Containment at 2 Hours

$$\alpha(2)_{total} = \alpha(2) + \alpha(0.5) \times e^{-1.5\lambda}$$

$\alpha(0.5)$= activity present in containment at 0.5 hours
e= constant
λ= decay constant, variable depending on isotope ($hours^{-1}$)
t= time (hours)

When the above values are obtained for each isotope, the Activity in Containment can be calculated at given times, and subsequently the energy from the activity can be calculated in the following manner:

- Total Time Integrated Activity in Drywell/Containment at Specific Times (t hours)

$$\alpha_{time} = \left(\frac{\alpha(2)_{total}}{\lambda}\right) \times \left(1 - e^{-\lambda(t-2)}\right) + A_{2_{total}}$$

$\alpha(2)_{total}$= total activity in containment at 2 hours (Ci)
$\alpha_{2_{total}}$= total time integrated activity released through 2 hours (Ci-hours)
λ= decay constant, variable depending on isotope ($hours^{-1}$)
t= time (hours)

At this point, the above equation is used to calculate the activity at the given timesteps, due to γ and β radiation and the values are summed for all contributing sources, as used in the GGNS analysis model. Finally, the activity's radiation energy concentration is calculated by dividing over the airspace volume of containment. Subsequently, this data is input into the spreadsheet of Attachment C to calculate the concentration of HCl that results in the pool (due to the release of chlorine from the radiolysis of cables in primary containment), and its contribution to the pH transient.

Of additional concern is the formation of Nitric Acid (HNO_3), which contributes to the transient calculated in Attachment C, by serving to lower the pH in the pool. Any activity from sources found immediately in the pool water is a factor in this acid's formation; therefore a dose to the water must also be calculated. Because the noble gas sources stay gaseous and do not mix with the pool water, we need only to consider non-noble gas sources in this calculation. As stated earlier, up to the point of determining the total integrated γ and β energy released into containment at the specific time-steps, the calculation of the dose in the pool water, and the integrated energies from radiation in containment parallel each other.

As before, the activities at given timesteps are summed for all contributing sources and the radiation energy concentration is calculated. However, the Entergy designed spreadsheet used in Attachment C uses a dose value for its calculation directly to HNO_3 concentration, so it was necessary to convert the energy concentration (MeV/cm^3) to dose (Mrad). The conversion factor

was determined to equal 1.60209E-14 (Mrad/(MeV/cm^3)). When all concentrations were converted to doses, the γ and β values were summed and input into Attachment C to calculate the concentration of HNO_3 formed, and its contribution to the pH transient.

Part 2: Core Cesium and Iodine Determination

Cesium and Iodine released from the core during the DBA-LOCA have an impact on suppression pool pH. Iodines can contribute to the formation of hydriodic acid, HI, and cesiums contribute to formation of Cesium Hydroxide, CsOH. There is significantly more Cesium available and released from the core than Iodine. Therefore, these materials lead the suppression pool to be basic essentially from the beginning of fission product release. The quantities of Cesium and Iodine, tabulated on page B-14, were taken from Attachment A of Design Analysis LM-0645, Rev. 1, the LGS Fuel Handling Accident (FHA) calculation.

Part 3: Drywell and Containment Gamma Mean Free Path Determination

Gamma mean free paths in the drywell and containment are used to conservatively assess the size of the contained cloud that will irradiate cable. These values were scaled off of LGS Units 1 & 2 Drawing No. M-213. To conservatively account for uncertainty, the maximum distance from the reactor vessel center to the containment wall was used for both the Drywell and Containment gamma mean free path. This value was approximately equal to 1310.42 cm.

8. OWNER'S ACCEPTANCE REVIEW CHECKLIST FOR EXTERNAL DESIGN ANALYSIS

DESIGN ANALYSIS NO. LM-0642 REV: 1

#	Question	Yes	No	N/A
1.	Do assumptions have sufficient rationale?	☑	☐	☐
2.	Are assumptions compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
3.	Do the design inputs have sufficient rationale?	☑	☐	☐
4.	Are design inputs correct and reasonable?	☑	☐	☐
5.	Are design inputs compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
6.	Are Engineering Judgments clearly documented and justified?	☑	☐	☐
7.	Are Engineering Judgments compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
8.	Do the results and conclusions satisfy the purpose and objective of the Design Analysis?	☑	☐	☐
9.	Are the results and conclusions compatible with the way the plant is operated and with the licensing basis? (For AST)	☑	☐	☐
10.	Does the Design Analysis include the applicable design basis documentation?	☑	☐	☐
11.	Have any limitations on the use of the results been identified and transmitted to the appropriate organizations?	☑	☐	☐
12.	Are there any unverified assumptions?	☐	☑	☐
13.	Do all unverified assumptions have a tracking and closure mechanism in place?	☐	☐	☑
14.	Have all affected design analyses been documented on the Affected Documents List (ADL) for the associated Configuration Change?	☑	☐	☐
15.	Do the sources of inputs and analysis methodology used meet current technical requirements and regulatory commitments? (If the input sources or analysis methodology are based on an out-of-date methodology or code, additional reconciliation may be required if the site has since committed to a more recent code)	☑	☐	☐
16.	Have vendor supporting technical documents and references (including GE DRFs) been reviewed when necessary?	☑	☐	☐

EXELON REVIEWER: T.J. Mscisz / [signature] DATE: 9/27/05

Print / Sign

Class	Isotopic Nuclide	Decay Constant $(hours)^{-1}$	Release Fractions 0-0.5 hours	Release Fractions 0.5-2 hours	Initial Core Activity (Ci)	Gap Release Activity in Containment at 0.5 hours (Ci)	Gap Release Time Integrated Activity in Containment through 0.5 hours (Ci-hours)	Early In-vessel Release Activity in Containment at 2.0 hours (Ci)	Early In-vessel Release Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Activity in Containment at 2.0 hours (Ci)	Gamma (Photon) Emission Energy (MeV/decay)	Gamma (Photon) Emission Energy per Unit of Activity (MeV/Ci-hour)	Beta Particle Emission Energy (MeV/decay)	Beta Particle Emission Energy per Unit of Activity (MeV/Ci-hour)
1	Kr-85	7.376E-06	0.05	0.95	1.392E+06	6.96E+04	1.74E+04	1.32E+06	9.92E+05	1.01E+06	1.39E+06	2.23E-03	2.97E+11	2.51E-01	3.34E+13
1	Kr-85m	1.547E-01	0.05	0.95	2.933E+07	1.36E+06	3.48E+05	2.04E+07	1.66E+07	1.89E+07	2.15E+07	1.58E-01	2.10E+13	2.29E-01	3.05E+13
1	Kr-87	5.451E-01	0.05	0.95	5.760E+07	2.19E+06	6.02E+05	1.84E+07	1.85E+07	1.91E+07	1.94E+07	7.93E-01	1.06E+14	1.32E+00	1.76E+14
1	Kr-88	2.441E-01	0.05	0.95	8.126E+07	3.60E+06	9.37E+05	4.74E+07	4.03E+07	4.12E+07	4.99E+07	1.95E+00	2.60E+14	3.60E-01	4.79E+13
1	Xe-133	5.506E-03	0.05	0.95	1.937E+08	9.66E+06	2.42E+06	1.82E+08	1.37E+08	1.39E+08	1.92E+08	4.53E-02	6.03E+12	1.00E-01	1.34E+13
1	Xe-135	7.625E-02	0.05	0.95	7.861E+07	3.78E+06	9.58E+05	6.41E+07	5.00E+07	5.09E+07	6.75E+07	2.48E-01	3.30E+13	3.03E-01	4.03E+13
2	I-131	3.592E-03	0.05	0.25	9.479E+07	4.73E+06	1.18E+06	2.35E+07	1.77E+07	1.89E+07	2.82E+07	3.81E-01	5.08E+13	1.81E-01	2.42E+13
2	I-132	3.014E-01	0.05	0.25	1.369E+08	5.89E+06	1.55E+06	1.87E+07	1.64E+07	1.80E+07	2.25E+07	2.29E+00	3.05E+14	4.86E-01	6.47E+13
2	I-133	3.332E-02	0.05	0.25	1.960E+08	9.64E+06	2.42E+06	4.58E+07	3.50E+07	3.74E+07	5.50E+07	6.07E-01	8.08E+13	4.07E-01	5.42E+13
2	I-134	7.907E-01	0.05	0.25	2.175E+08	7.32E+06	2.10E+06	1.12E+07	1.30E+07	1.51E+07	1.34E+07	2.63E+00	3.50E+14	6.03E-01	8.03E+13
2	I-135	1.049E-01	0.05	0.25	1.832E+08	8.89E+06	2.21E+06	3.71E+07	2.94E+07	3.16E+07	4.46E+07	1.58E+00	2.10E+14	3.68E-01	4.91E+13
3	Rb-86	1.548E-03	0.05	0.20	2.300E+05	1.15E+04	2.87E+03	4.58E+04	3.44E+04	3.73E+04	5.73E+04	9.45E-02	1.26E+13	6.67E-01	8.89E+13
3	Cs-134	3.835E-05	0.05	0.20	2.569E+07	1.28E+06	3.21E+05	5.14E+06	3.85E+06	4.17E+06	6.42E+06	1.56E+00	2.07E+14	1.57E-01	2.09E+13
3	Cs-136	2.205E-03	0.05	0.20	7.150E+06	3.57E+05	8.93E+04	1.42E+06	1.07E+06	1.16E+06	1.78E+06	2.17E+00	2.89E+14	1.00E-01	1.33E+13
3	Cs-137	2.636E-06	0.05	0.20	1.601E+07	8.00E+05	2.00E+05	3.20E+06	2.40E+06	2.60E+06	4.00E+06	0.00E+00	0.00E+00	1.71E-01	2.27E+13
4	Sb-127	7.502E-03	0.00	0.05	1.022E+07	0.00E+00	0.00E+00	5.03E+05	3.79E+05	3.79E+05	5.03E+05	6.62E-01	8.82E+13	3.11E-01	4.14E+13
4	Sb-129	1.605E-01	0.00	0.05	3.047E+07	0.00E+00	0.00E+00	1.11E+06	9.00E+05	9.00E+05	1.11E+06	1.43E+00	1.90E+14	3.58E-01	4.76E+13
4	Te-127	7.413E-02	0.00	0.05	1.014E+07	0.00E+00	0.00E+00	4.37E+05	3.40E+05	3.40E+05	4.37E+05	4.84E-03	6.44E+11	2.23E-01	2.97E+13
4	Te-127m	2.650E-04	0.00	0.05	1.360E+06	0.00E+00	0.00E+00	6.80E+04	5.10E+04	5.10E+04	6.80E+04	1.12E-02	1.50E+12	4.61E-03	6.13E+11
4	Te-129	5.975E-01	0.00	0.05	2.999E+07	0.00E+00	0.00E+00	4.54E+05	4.70E+05	4.70E+05	4.54E+05	5.77E-02	7.68E+12	5.25E-01	6.99E+13
4	Te-129m	8.596E-04	0.00	0.05	4.470E+06	0.00E+00	0.00E+00	2.23E+05	1.67E+05	1.67E+05	2.23E+05	3.94E-02	5.25E+12	2.12E-01	2.82E+13
4	Te-131m	2.310E-02	0.00	0.05	1.365E+07	0.00E+00	0.00E+00	6.52E+05	4.94E+05	4.94E+05	6.52E+05	1.43E+00	1.90E+14	1.45E-01	1.92E+13
4	Te-132	8.864E-03	0.00	0.05	1.348E+08	0.00E+00	0.00E+00	6.62E+06	4.99E+06	4.99E+06	6.62E+06	2.31E-01	3.07E+13	5.94E-02	7.91E+12
5	Sr-89	5.719E-04	0.00	0.02	9.873E+07	0.00E+00	0.00E+00	1.97E+06	1.48E+06	1.48E+06	1.97E+06	1.36E-04	1.82E+10	5.83E-01	7.76E+13
5	Sr-90	2.715E-06	0.00	0.02	1.121E+07	0.00E+00	0.00E+00	2.24E+05	1.68E+05	1.68E+05	2.24E+05	0.00E+00	0.00E+00	1.96E-01	2.61E+13
5	Sr-91	7.296E-02	0.00	0.02	1.341E+08	0.00E+00	0.00E+00	2.32E+06	1.80E+06	1.80E+06	2.32E+06	6.87E-01	9.15E+13	6.53E-01	8.70E+13
5	Sr-92	2.558E-01	0.00	0.02	1.417E+08	0.00E+00	0.00E+00	1.70E+06	1.45E+06	1.45E+06	1.70E+06	1.34E+00	1.78E+14	2.00E-01	2.66E+13
6	Ba-139	5.029E-01	0.00	0.02	1.794E+08	0.00E+00	0.00E+00	1.31E+06	1.29E+06	1.29E+06	1.31E+06	3.53E-02	4.70E+12	8.97E-01	1.19E+14
6	Ba-140	2.267E-03	0.00	0.02	1.727E+08	0.00E+00	0.00E+00	3.44E+06	2.58E+06	2.58E+06	3.44E+06	1.91E-01	2.54E+13	2.71E-01	3.61E+13
7	Co-58	4.079E-04	0.00	0.0025	5.394E+06	0.00E+00	0.00E+00	1.35E+04	1.01E+04	1.01E+04	1.35E+04	9.76E-01	1.30E+14	0.00E+00	0.00E+00
7	Co-60	1.500E-05	0.00	0.0025	6.361E+06	0.00E+00	0.00E+00	1.59E+04	1.19E+04	1.19E+04	1.59E+04	2.51E+00	3.34E+14	9.58E-02	1.28E+13
7	Mo-99	1.050E-02	0.00	0.0025	1.792E+08	0.00E+00	0.00E+00	4.39E+05	3.31E+05	3.31E+05	4.39E+05	1.55E-01	2.06E+13	3.93E-01	5.24E+13
7	Tc-99m	1.151E-01	0.00	0.0025	1.509E+08	0.00E+00	0.00E+00	3.12E+05	2.48E+05	2.48E+05	3.12E+05	1.27E-01	1.69E+13	0.00E+00	0.00E+00
7	Ru-103	7.353E-04	0.00	0.0025	1.483E+08	0.00E+00	0.00E+00	3.70E+05	2.78E+05	2.78E+05	3.70E+05	4.84E-01	6.44E+13	6.75E-02	9.00E+12
7	Ru-105	1.561E-01	0.00	0.0025	1.026E+08	0.00E+00	0.00E+00	1.88E+05	1.52E+05	1.52E+05	1.88E+05	7.84E-01	1.04E+14	4.03E-01	5.36E+13
7	Ru-106	7.844E-05	0.00	0.0025	8.104E+07	0.00E+00	0.00E+00	1.53E+05	1.14E+05	1.14E+05	1.53E+05	0.00E+00	0.00E+00	1.00E-02	1.34E+12
7	Rh-105	1.960E-02	0.00	0.0025	9.709E+07	0.00E+00	0.00E+00	2.33E+05	1.77E+05	1.77E+05	2.33E+05	7.76E-02	1.03E+13	1.52E-01	2.03E+13
8	Ce-141	8.886E-04	0.00	0.0005	1.585E+08	0.00E+00	0.00E+00	7.91E+04	5.94E+04	5.94E+04	7.91E+04	7.89E-02	1.02E+13	1.45E-01	1.93E+13
8	Ce-143	2.100E-02	0.00	0.0005	1.562E+08	0.00E+00	0.00E+00	7.49E+04	5.68E+04	5.68E+04	7.49E+04	2.73E-01	3.64E+13	4.10E-01	5.46E+13
8	Ce-144	1.016E-04	0.00	0.0005	1.209E+08	0.00E+00	0.00E+00	6.34E+04	4.76E+04	4.76E+04	6.34E+04	1.93E-02	2.57E+12	8.33E-02	1.11E+13
8	Np-239	1.226E-02	0.00	0.0005	1.904E+09	0.00E+00	0.00E+00	9.29E+05	7.01E+05	7.01E+05	9.29E+05	1.72E-01	2.29E+13	1.15E-01	1.53E+13
8	Pu-238	9.012E-07	0.00	0.0005	6.336E+05	0.00E+00	0.00E+00	3.17E+02	2.38E+02	2.38E+02	3.17E+02	1.60E-03	2.13E+11	0.00E+00	0.00E+00
8	Pu-239	3.288E-09	0.00	0.0005	4.234E+04	0.00E+00	0.00E+00	2.12E+01	1.45E+02	1.45E+02	2.12E+01	6.54E-04	8.71E+10	0.00E+00	0.00E+00
8	Pu-240	1.210E-08	0.00	0.0005	4.543E+04	0.00E+00	0.00E+00	2.27E+01	1.15E+01	1.15E+01	2.27E+01	1.53E-03	2.03E+11	0.00E+00	0.00E+00
8	Pu-241	5.491E-06	0.00	0.0005	2.181E+07	0.00E+00	0.00E+00	1.09E+04	8.18E+03	8.18E+03	1.09E+04	0.00E+00	0.00E+00	5.23E-03	6.97E+11
9	Y-90	1.083E-02	0.00	0.0002	1.154E+07	0.00E+00	0.00E+00	2.26E+03	1.70E+03	1.70E+03	2.26E+03	0.00E+00	0.00E+00	9.35E-01	1.25E+14
9	Y-91	4.936E-04	0.00	0.0002	1.217E+08	0.00E+00	0.00E+00	2.43E+04	1.82E+04	1.82E+04	2.43E+04	3.61E-03	4.81E+11	6.02E-01	8.02E+13
9	Y-92	1.958E-01	0.00	0.0002	1.421E+08	0.00E+00	0.00E+00	1.92E+04	1.59E+04	1.59E+04	1.92E+04	2.52E-01	3.35E+13	1.44E+00	1.92E+14
9	Y-93	6.863E-02	0.00	0.0002	1.597E+08	0.00E+00	0.00E+00	2.78E+04	2.16E+04	2.16E+04	2.78E+04	8.91E-02	1.19E+13	1.17E+00	1.56E+14
9	Zr-95	4.514E-04	0.00	0.0002	1.584E+08	0.00E+00	0.00E+00	3.16E+04	2.37E+04	2.37E+04	3.16E+04	7.35E-01	9.79E+13	1.16E-01	1.55E+13
9	Zr-97	4.101E-02	0.00	0.0002	1.643E+08	0.00E+00	0.00E+00	3.03E+04	2.32E+04	2.32E+04	3.03E+04	1.81E-01	2.41E+13	6.97E-01	9.29E+13
9	Nb-95	8.217E-04	0.00	0.0002	1.592E+08	0.00E+00	0.00E+00	3.18E+04	2.38E+04	2.38E+04	3.18E+04	7.64E-01	1.02E+14	4.34E-02	5.79E+12
9	La-140	1.721E-02	0.00	0.0002	1.771E+08	0.00E+00	0.00E+00	3.42E+04	2.59E+04	2.59E+04	3.42E+04	2.32E+00	3.09E+14	5.27E-01	7.03E+13
9	La-141	1.764E-01	0.00	0.0002	1.637E+08	0.00E+00	0.00E+00	2.30E+04	1.89E+04	1.89E+04	2.30E+04	4.27E-02	5.69E+12	9.48E-01	1.26E+14
9	La-142	4.496E-01	0.00	0.0002	1.599E+08	0.00E+00	0.00E+00	1.30E+04	1.24E+04	1.24E+04	1.30E+04	2.72E+00	3.62E+14	8.46E-01	1.13E+14
9	Pr-143	2.130E-03	0.00	0.0002	1.515E+08	0.00E+00	0.00E+00	3.02E+04	2.26E+04	2.26E+04	3.02E+04	0.00E+00	0.00E+00	3.16E-01	4.20E+13
9	Nd-147	2.630E-03	0.00	0.0002	6.483E+07	0.00E+00	0.00E+00	1.29E+04	9.89E+03	9.89E+03	1.29E+04	1.41E-01	1.87E+13	2.33E-01	3.11E+13
9	Am-241	1.830E-07	0.00	0.0002	3.361E+04	0.00E+00	0.00E+00	8.72E+00	5.05E+00	5.05E+00	8.72E+00	2.81E-02	3.74E+12	0.00E+00	0.00E+00
9	Cm-242	1.774E-04	0.00	0.0002	8.424E+06	0.00E+00	0.00E+00	1.68E+03	1.26E+03	1.26E+03	1.68E+03	1.67E-03	2.23E+11	0.00E+00	0.00E+00
9	Cm-244	4.366E-06	0.00	0.0002	9.181E+05	0.00E+00	0.00E+00	1.84E+02	1.38E+02	1.38E+02	1.84E+02	1.49E-03	1.98E+11	0.00E+00	0.00E+00

Disintegrations per Curie-hour 1.3320E+14

Drywell (Drywell + Supp. Pool Airspace) cm^3= 9.9177E+09

Activity in Containment at Given Timesteps (Ci-hours)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	1.01E+06	1.06E+06	2.40E+06	5.19E+06	1.49E+07	2.33E+07	3.16E+07	8.50E+07	9.84E+07	1.32E+08	1.65E+08	2.07E+08	2.78E+08	3.32E+08	4.15E+08	4.99E+08	5.54E+08	6.65E+08	8.32E+08	9.70E+08	9.98E+08
	1.69E+07	1.77E+07	3.69E+07	6.86E+07	1.26E+08	1.44E+08	1.51E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08
	1.91E+07	1.97E+07	3.40E+07	4.77E+07	5.44E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07
	4.12E+07	4.29E+07	8.55E+07	1.47E+08	2.28E+08	2.41E+08	2.45E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08
	1.39E+08	1.46E+08	3.30E+08	7.09E+08	2.00E+09	3.07E+09	4.11E+09	7.93E+09	1.13E+10	1.42E+10	1.68E+10	1.95E+10	2.32E+10	2.56E+10	2.82E+10	3.01E+10	3.10E+10	3.24E+10	3.36E+10	3.42E+10	3.43E+10
	5.09E+07	5.32E+07	1.16E+08	2.32E+08	5.23E+08	6.75E+08	7.71E+08	9.10E+08	9.32E+08	9.35E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08
	1.89E+07	1.98E+07	4.70E+07	1.03E+08	2.96E+08	4.58E+08	6.16E+08	1.22E+09	1.77E+09	2.27E+09	2.73E+09	3.26E+09	4.02E+09	4.54E+09	5.18E+09	5.71E+09	6.00E+09	6.47E+09	6.96E+09	7.24E+09	7.28E+09
	1.80E+07	1.87E+07	3.74E+07	6.24E+07	8.89E+07	9.20E+07	9.25E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07
	3.74E+07	3.92E+07	9.15E+07	1.94E+08	5.05E+08	7.20E+08	8.95E+08	1.33E+09	1.53E+09	1.62E+09	1.66E+09	1.68E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09
	1.51E+07	1.55E+07	2.44E+07	3.05E+07	3.20E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07
	3.16E+07	3.31E+07	7.39E+07	1.46E+08	3.08E+08	3.77E+08	4.14E+08	4.53E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08
	3.73E+04	3.92E+04	9.46E+04	2.09E+05	6.06E+05	9.43E+05	1.26E+06	2.56E+06	3.84E+06	5.05E+06	6.22E+06	7.62E+06	9.81E+06	1.14E+07	1.37E+07	1.58E+07	1.71E+07	1.94E+07	2.24E+07	2.45E+07	2.49E+07
	4.17E+06	4.39E+06	1.06E+07	2.34E+07	6.84E+07	1.07E+08	1.45E+08	2.99E+08	4.53E+08	6.07E+08	7.60E+08	9.52E+08	1.27E+09	1.53E+09	1.91E+09	2.29E+09	2.54E+09	3.05E+09	3.80E+09	4.43E+09	4.55E+09
	1.16E+06	1.22E+06	2.94E+06	6.48E+06	1.86E+07	2.91E+07	3.94E+07	7.90E+07	1.17E+08	1.52E+08	1.86E+08	2.26E+08	2.87E+08	3.31E+08	3.90E+08	4.42E+08	4.73E+08	5.27E+08	5.92E+08	6.35E+08	6.43E+08
	2.60E+06	2.74E+06	6.60E+06	1.46E+07	4.26E+07	6.66E+07	9.07E+07	1.87E+08	2.83E+08	3.79E+08	4.75E+08	5.95E+08	7.95E+08	9.55E+08	1.19E+09	1.43E+09	1.59E+09	1.91E+09	2.39E+09	2.79E+09	2.87E+09
	3.79E+05	3.96E+05	8.80E+05	1.87E+06	5.23E+06	7.97E+06	1.06E+07	2.00E+07	2.78E+07	3.43E+07	3.98E+07	4.54E+07	5.23E+07	5.62E+07	6.03E+07	6.29E+07	6.41E+07	6.56E+07	6.67E+07	6.71E+07	6.72E+07
	9.00E+05	9.37E+05	1.92E+06	3.53E+06	6.40E+06	7.26E+06	7.59E+06	7.78E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06
	3.40E+05	3.55E+05	7.81E+05	1.52E+06	3.43E+06	4.44E+06	5.08E+06	6.04E+06	6.20E+06	6.23E+06	6.23E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06
	5.10E+04	5.33E+04	1.19E+05	2.55E+05	7.30E+05	1.14E+06	1.54E+06	3.16E+06	4.76E+06	6.36E+06	7.95E+06	9.92E+06	1.32E+07	1.57E+07	1.95E+07	2.33E+07	2.57E+07	3.06E+07	3.76E+07	4.34E+07	4.45E+07
	4.70E+05	4.85E+05	8.11E+05	1.10E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06
	1.67E+05	1.75E+05	3.90E+05	8.36E+05	2.39E+06	3.71E+06	5.03E+06	1.02E+07	1.53E+07	2.03E+07	2.52E+07	3.12E+07	4.06E+07	4.82E+07	5.88E+07	6.89E+07	7.54E+07	8.76E+07	1.04E+08	1.17E+08	1.20E+08
	4.94E+05	5.16E+05	1.14E+06	2.38E+06	6.31E+06	9.21E+06	1.17E+07	1.90E+07	2.31E+07	2.55E+07	2.69E+07	2.78E+07	2.84E+07	2.86E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07
	4.99E+06	5.21E+06	1.16E+07	2.48E+07	6.84E+07	1.04E+08	1.37E+08	2.55E+08	3.50E+08	4.27E+08	4.90E+08	5.51E+08	6.23E+08	6.61E+08	6.99E+08	7.21E+08	7.30E+08	7.41E+08	7.48E+08	7.50E+08	7.51E+08
	1.48E+06	1.55E+06	3.45E+06	7.39E+06	2.11E+07	3.29E+07	4.46E+07	9.10E+07	1.37E+08	1.82E+08	2.27E+08	2.81E+08	3.71E+08	4.40E+08	5.42E+08	6.40E+08	7.04E+08	8.26E+08	1.00E+09	1.14E+09	1.16E+09
	1.68E+05	1.76E+05	3.92E+05	8.41E+05	2.41E+06	3.76E+06	5.10E+06	1.05E+07	1.59E+07	2.12E+07	2.66E+07	3.33E+07	4.46E+07	5.35E+07	6.70E+07	8.04E+07	8.94E+07	1.07E+08	1.34E+08	1.57E+08	1.61E+08
	1.80E+06	1.88E+06	4.04E+06	8.05E+06	1.83E+07	2.37E+07	2.72E+07	3.25E+07	3.34E+07	3.35E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07
	1.45E+06	1.51E+06	2.95E+06	5.01E+06	7.58E+06	7.99E+06	8.08E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06
	1.29E+06	1.33E+06	2.32E+06	3.32E+06	3.88E+06	3.89E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06
	2.58E+06	2.70E+06	6.02E+06	1.29E+07	3.66E+07	5.66E+07	7.64E+07	1.53E+08	2.25E+08	2.94E+08	3.59E+08	4.35E+08	5.51E+08	6.35E+08	7.48E+08	8.46E+08	9.04E+08	1.01E+09	1.13E+09	1.21E+09	1.22E+09
	1.01E+04	1.06E+04	2.36E+04	5.05E+04	1.45E+05	2.25E+05	3.05E+05	6.24E+05	9.40E+05	1.25E+06	1.56E+06	1.95E+06	2.57E+06	3.07E+06	3.79E+06	4.50E+06	4.96E+06	5.86E+06	7.16E+06	8.20E+06	8.40E+06
	1.19E+04	1.25E+04	2.78E+04	5.96E+04	1.71E+05	2.66E+05	3.62E+05	7.43E+05	1.12E+06	1.51E+06	1.89E+06	2.36E+06	3.16E+06	3.79E+06	4.74E+06	5.69E+06	6.32E+06	7.59E+06	9.48E+06	1.11E+07	1.14E+07
	3.31E+05	3.45E+05	7.87E+05	1.63E+06	4.49E+06	6.79E+06	8.95E+06	1.63E+07	2.21E+07	2.65E+07	3.00E+07	3.33E+07	3.69E+07	3.87E+07	4.03E+07	4.11E+07	4.15E+07	4.18E+07	4.20E+07	4.21E+07	4.21E+07
	2.48E+05	2.58E+05	5.42E+05	1.04E+06	2.10E+06	2.52E+06	2.74E+06	2.94E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06
	2.78E+05	2.90E+05	6.48E+05	1.39E+06	3.96E+06	6.16E+06	8.35E+06	1.70E+07	2.55E+07	3.39E+07	4.21E+07	5.22E+07	6.85E+07	8.11E+07	9.93E+07	1.17E+08	1.28E+08	1.49E+08	1.79E+08	2.02E+08	2.07E+08
	1.52E+05	1.59E+05	3.26E+05	6.02E+05	1.10E+06	1.26E+06	1.32E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06
	1.14E+05	1.20E+05	2.67E+05	5.72E+05	1.64E+06	2.55E+06	3.47E+06	7.12E+06	1.06E+07	1.44E+07	1.80E+07	2.26E+07	3.01E+07	3.61E+07	4.51E+07	5.40E+07	5.99E+07	7.17E+07	8.92E+07	1.04E+08	1.07E+08
	1.77E+05	1.85E+05	4.06E+05	8.67E+05	2.30E+06	3.38E+06	4.35E+06	7.25E+06	9.06E+06	1.02E+07	1.09E+07	1.14E+07	1.18E+07	1.20E+07	1.20E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07
	5.94E+04	6.20E+04	1.38E+05	2.96E+05	8.47E+05	1.32E+06	1.78E+06	3.62E+06	5.43E+06	7.19E+06	8.92E+06	1.10E+07	1.44E+07	1.70E+07	2.06E+07	2.43E+07	2.66E+07	3.09E+07	3.68E+07	4.12E+07	4.20E+07
	5.68E+04	5.93E+04	1.31E+05	2.74E+05	7.32E+05	1.07E+06	1.38E+06	2.27E+06	2.80E+06	3.13E+06	3.32E+06	3.46E+06	3.57E+06	3.60E+06	3.61E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06
	4.76E+04	4.97E+04	1.11E+05	2.38E+05	6.81E+05	1.06E+06	1.44E+06	2.96E+06	4.47E+06	5.98E+06	7.49E+06	9.36E+06	1.25E+07	1.50E+07	1.87E+07	2.23E+07	2.48E+07	2.96E+07	3.66E+07	4.26E+07	4.40E+07
	7.01E+05	7.32E+05	1.62E+06	3.44E+06	9.44E+06	1.42E+07	1.86E+07	3.34E+07	4.43E+07	5.25E+07	5.86E+07	6.41E+07	6.98E+07	7.24E+07	7.45E+07	7.55E+07	7.59E+07	7.62E+07	7.64E+07	7.64E+07	7.64E+07
	2.36E+02	2.48E+02	5.54E+02	1.19E+03	3.41E+03	5.31E+03	7.21E+03	1.48E+04	2.24E+04	3.00E+04	3.76E+04	4.71E+04	6.30E+04	7.56E+04	9.46E+04	1.14E+05	1.26E+05	1.52E+05	1.90E+05	2.21E+05	2.28E+05
	1.45E+02	1.48E+02	1.66E+02	2.09E+02	3.57E+02	4.84E+02	6.11E+02	1.12E+03	1.63E+03	2.13E+03	2.64E+03	3.28E+03	4.34E+03	5.18E+03	6.45E+03	7.72E+03	8.57E+03	1.03E+04	1.28E+04	1.49E+04	1.53E+04
	1.15E+01	1.23E+01	3.42E+01	7.96E+01	2.39E+02	3.75E+02	5.11E+02	1.06E+03	1.60E+03	2.15E+03	2.69E+03	3.37E+03	4.51E+03	5.42E+03	6.78E+03	8.14E+03	9.05E+03	1.09E+04	1.36E+04	1.59E+04	1.63E+04
	6.18E+03	6.55E+03	1.91E+04	4.09E+04	1.17E+05	1.83E+05	2.48E+05	5.10E+05	7.71E+05	1.03E+06	1.29E+06	1.62E+06	2.17E+06	2.60E+06	3.26E+06	3.91E+06	4.34E+06	5.21E+06	6.52E+06	7.61E+06	7.82E+06
	1.70E+03	1.78E+03	3.95E+03	8.37E+03	2.31E+04	3.49E+04	4.59E+04	8.35E+04	1.13E+05	1.35E+05	1.52E+05	1.68E+05	1.86E+05	1.94E+05	2.02E+05	2.06E+05	2.07E+05	2.09E+05	2.10E+05	2.10E+05	2.10E+05
	1.82E+04	1.91E+04	4.25E+04	9.11E+04	2.61E+05	4.06E+05	5.50E+05	1.12E+06	1.69E+06	2.25E+06	2.80E+06	3.49E+06	4.60E+06	5.48E+06	6.75E+06	7.99E+06	8.80E+06	1.04E+07	1.26E+07	1.44E+07	1.47E+07
	1.59E+04	1.66E+04	3.34E+04	5.95E+04	1.00E+05	1.10E+05	1.13E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05
	2.16E+04	2.26E+04	4.85E+04	9.71E+04	2.23E+05	2.92E+05	3.38E+05	4.10E+05	4.24E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05
	2.37E+04	2.48E+04	5.54E+04	1.19E+05	3.40E+05	5.28E+05	7.17E+05	1.46E+06	2.20E+06	2.94E+06	3.66E+06	4.55E+06	6.02E+06	7.17E+06	8.85E+06	1.05E+07	1.16E+07	1.36E+07	1.66E+07	1.90E+07	1.94E+07
	2.32E+04	2.42E+04	5.26E+04	1.09E+05	2.72E+05	3.78E+05	4.62E+05	6.49E+05	7.19E+05	7.46E+05	7.55E+05	7.60E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05
	2.38E+04	2.49E+04	5.56E+04	1.19E+05	3.40E+05	5.29E+05	7.17E+05	1.46E+06	2.19E+06	2.90E+06	3.60E+06	4.45E+06	5.83E+06	6.90E+06	8.43E+06	9.88E+06	1.08E+07	1.26E+07	1.50E+07	1.69E+07	1.73E+07
	2.59E+04	2.70E+04	5.96E+04	1.26E+05	3.40E+05	5.04E+05	6.52E+05	1.11E+06	1.42E+06	1.62E+06	1.75E+06	1.86E+06	1.95E+06	1.98E+06	2.00E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06
	1.89E+04	1.97E+04	4.00E+04	7.25E+04	1.27E+05	1.42E+05	1.47E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05
	1.24E+04	1.28E+04	2.29E+04	3.38E+04	4.10E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04
	2.26E+04	2.37E+04	5.26E+04	1.13E+05	3.21E+05	4.97E+05	6.71E+05	1.34E+06	1.98E+06	2.59E+06	3.17E+06	3.85E+06	4.90E+06	5.65E+06	6.68E+06	7.58E+06	8.12E+06	9.07E+06	1.02E+07	1.10E+07	1.11E+07
	9.69E+03	1.01E+04	2.26E+04	4.82E+04	1.37E+05	2.12E+05	2.85E+05	5.69E+05	8.34E+05	1.08E+06	1.32E+06	1.59E+06	2.00E+06	2.29E+06	2.67E+06	3.00E+06	3.19E+06	3.52E+06	3.90E+06	4.13E+06	4.17E+06
	5.05E+00	5.28E+00	1.16E+01	2.52E+01	7.23E+01	1.13E+02	1.53E+02	3.14E+02	4.76E+02	6.37E+02	7.98E+02	1.00E+03	1.34E+03	1.61E+03	2.01E+03	2.41E+03	2.68E+03	3.22E+03	4.03E+03	4.70E+03	4.83E+03
	1.26E+03	1.32E+03	2.95E+03	6.31E+03	1.81E+04	2.82E+04	3.82E+04	7.84E+04	1.18E+05	1.58E+05	1.98E+05	2.47E+05	3.29E+05	3.94E+05	4.90E+05	5.85E+05	6.48E+05	7.73E+05	9.57E+05	1.11E+06	1.14E+06
	1.38E+02	1.44E+02	3.21E+02	6.89E+02	1.97E+03	3.08E+03	4.18E+03	8.58E+03	1.30E+04	1.74E+04	2.18E+04	2.73E+04	3.65E+04	4.38E+04	5.48E+04	6.58E+04	7.32E+04	8.78E+04	1.10E+05	1.28E+05	1.32E+05

Gamma (Photon) Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.8336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	3.00E+17	3.14E+17	7.14E+17	1.54E+18	4.44E+18	6.92E+18	9.40E+18	1.93E+19	2.92E+19	3.92E+19	4.91E+19	6.15E+19	8.21E+19	9.87E+19	1.23E+20	1.48E+20	1.65E+20	1.98E+20	2.47E+20	2.88E+20	2.97E+20
	3.56E+20	3.71E+20	7.75E+20	1.44E+21	2.66E+21	3.03E+21	3.18E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21
	2.01E+21	2.08E+21	3.59E+21	5.04E+21	5.75E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21
	1.07E+22	1.12E+22	2.23E+22	3.84E+22	5.93E+22	6.29E+22	6.37E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22
	8.40E+20	8.79E+20	1.99E+21	4.28E+21	1.21E+22	1.85E+22	2.48E+22	4.78E+22	6.80E+22	8.56E+22	1.01E+23	1.18E+23	1.40E+23	1.54E+23	1.70E+23	1.82E+23	1.87E+23	1.96E+23	2.03E+23	2.06E+23	2.07E+23
	1.68E+21	1.76E+21	3.83E+21	7.66E+21	1.73E+22	2.23E+22	2.55E+22	3.00E+22	3.08E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22
	9.58E+20	1.01E+21	2.39E+21	5.23E+21	1.50E+22	2.32E+22	3.13E+22	6.17E+22	8.97E+22	1.15E+23	1.39E+23	1.66E+23	2.04E+23	2.30E+23	2.63E+23	2.90E+23	3.04E+23	3.28E+23	3.53E+23	3.67E+23	3.70E+23
	5.49E+21	5.72E+21	1.14E+22	1.90E+22	2.71E+22	2.81E+22	2.82E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22
	3.02E+21	3.17E+21	7.39E+21	1.57E+22	4.08E+22	5.82E+22	7.23E+22	1.08E+23	1.23E+23	1.31E+23	1.34E+23	1.35E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23
	5.27E+21	5.43E+21	8.52E+21	1.07E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22
	6.63E+21	6.94E+21	1.55E+22	3.07E+22	6.45E+22	7.91E+22	8.69E+22	9.51E+22	9.57E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22
	4.69E+17	4.94E+17	1.19E+18	2.83E+18	7.63E+18	1.19E+19	1.61E+19	3.25E+19	4.83E+19	6.36E+19	7.83E+19	9.59E+19	1.24E+20	1.44E+20	1.73E+20	1.99E+20	2.15E+20	2.44E+20	2.82E+20	3.08E+20	3.13E+20
	8.65E+20	9.09E+20	2.19E+21	4.85E+21	1.42E+22	2.21E+22	3.01E+22	6.20E+22	9.36E+22	1.26E+23	1.57E+23	1.97E+23	2.63E+23	3.16E+23	3.95E+23	4.74E+23	5.26E+23	6.31E+23	7.87E+23	9.17E+23	9.43E+23
	3.34E+20	3.52E+20	8.48E+20	1.87E+21	5.42E+21	8.41E+21	1.14E+22	2.26E+22	3.37E+22	4.40E+22	5.37E+22	6.52E+22	8.28E+22	9.55E+22	1.13E+23	1.28E+23	1.37E+23	1.52E+23	1.71E+23	1.83E+23	1.86E+23
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.34E+19	3.49E+19	7.76E+19	1.65E+20	4.61E+20	7.02E+20	9.33E+20	1.76E+21	2.45E+21	3.03E+21	3.51E+21	4.00E+21	4.61E+21	4.98E+21	5.32E+21	5.55E+21	5.65E+21	5.78E+21	5.88E+21	5.92E+21	5.92E+21
	1.71E+20	1.78E+20	3.66E+20	6.73E+20	1.22E+21	1.38E+21	1.45E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21
	2.19E+17	2.29E+17	4.91E+17	9.77E+17	2.21E+18	2.86E+18	3.27E+18	3.89E+18	4.00E+18	4.01E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18
	7.62E+16	7.96E+16	1.78E+17	3.81E+17	1.09E+18	1.70E+18	2.31E+18	4.72E+18	7.12E+18	9.51E+18	1.19E+19	1.48E+19	1.97E+19	2.35E+19	2.92E+19	3.48E+19	3.85E+19	4.57E+19	5.63E+19	6.48E+19	6.65E+19
	3.61E+18	3.72E+18	6.23E+18	8.47E+18	9.43E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18
	8.79E+17	9.19E+17	2.05E+18	4.39E+18	1.25E+19	1.95E+19	2.64E+19	5.37E+19	8.05E+19	1.07E+20	1.32E+20	1.64E+20	2.14E+20	2.53E+20	3.09E+20	3.62E+20	3.98E+20	4.60E+20	5.49E+20	6.16E+20	6.29E+20
	8.39E+19	9.81E+19	2.16E+20	4.63E+20	1.20E+21	1.75E+21	2.22E+21	3.90E+21	4.39E+21	4.84E+21	5.10E+21	5.29E+21	5.40E+21	5.43E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21
	1.53E+20	1.60E+20	3.56E+20	7.56E+20	2.10E+21	3.19E+21	4.22E+21	7.84E+21	1.08E+22	1.31E+22	1.50E+22	1.69E+22	1.91E+22	2.03E+22	2.15E+22	2.21E+22	2.24E+22	2.27E+22	2.30E+22	2.31E+22	2.31E+22
	2.69E+16	2.81E+16	6.27E+16	1.34E+17	3.84E+17	5.97E+17	8.10E+17	1.65E+18	2.49E+18	3.31E+18	4.11E+18	5.11E+18	6.73E+18	8.00E+18	9.84E+18	1.16E+19	1.28E+19	1.50E+19	1.82E+19	2.08E+19	2.11E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.65E+20	1.72E+20	3.89E+20	7.36E+20	1.87E+21	2.17E+21	2.49E+21	2.97E+21	3.05E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21
	2.59E+20	2.70E+20	5.27E+20	8.94E+20	1.35E+21	1.42E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21
	6.04E+18	6.24E+18	1.09E+19	1.56E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	6.57E+19	6.86E+19	1.53E+20	3.27E+20	9.31E+20	1.44E+21	1.94E+21	3.99E+21	5.73E+21	7.47E+21	9.12E+21	1.11E+22	1.40E+22	1.62E+22	1.90E+22	2.15E+22	2.30E+22	2.56E+22	2.87E+22	3.07E+22	3.11E+22
	1.31E+18	1.37E+18	3.06E+18	6.56E+18	1.88E+19	2.92E+19	3.97E+19	8.11E+19	1.22E+20	1.63E+20	2.03E+20	2.53E+20	3.34E+20	3.99E+20	4.93E+20	5.85E+20	6.45E+20	7.62E+20	9.31E+20	1.07E+21	1.09E+21
	3.96E+19	4.16E+19	9.29E+19	1.99E+20	5.71E+20	8.89E+20	1.21E+21	2.48E+21	3.75E+21	5.03E+21	6.30E+21	7.89E+21	1.05E+22	1.26E+22	1.58E+22	1.90E+22	2.11E+22	2.53E+22	3.16E+22	3.69E+22	3.79E+22
	6.83E+18	7.13E+18	1.58E+19	3.36E+19	9.28E+19	1.40E+20	1.86E+20	3.37E+20	4.56E+20	5.46E+20	6.19E+20	6.87E+20	7.61E+20	7.96E+20	8.31E+20	8.49E+20	8.56E+20	8.63E+20	8.67E+20	8.68E+20	8.68E+20
	4.18E+18	4.35E+18	9.14E+18	1.75E+19	3.54E+19	4.26E+19	4.62E+19	4.96E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19
	1.79E+19	1.87E+19	4.17E+19	8.94E+19	2.56E+20	3.97E+20	5.38E+20	1.10E+21	1.65E+21	2.18E+21	2.71E+21	3.36E+21	4.41E+21	5.23E+21	6.40E+21	7.53E+21	8.25E+21	9.63E+21	1.16E+22	1.30E+22	1.33E+22
	1.59E+19	1.66E+19	3.41E+19	6.29E+19	1.15E+20	1.31E+20	1.37E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.83E+18	1.91E+18	4.22E+18	8.86E+18	2.37E+19	3.50E+19	4.50E+19	7.50E+19	9.38E+19	1.05E+20	1.13E+20	1.18E+20	1.22E+20	1.24E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20
	6.06E+17	6.35E+17	1.42E+18	3.03E+18	8.67E+18	1.35E+19	1.82E+19	3.71E+19	5.56E+19	7.36E+19	9.13E+19	1.13E+20	1.48E+20	1.74E+20	2.13E+20	2.49E+20	2.72E+20	3.16E+20	3.76E+20	4.22E+20	4.30E+20
	2.07E+18	2.16E+18	4.76E+18	9.99E+18	2.67E+19	3.91E+19	5.01E+19	8.25E+19	1.02E+20	1.14E+20	1.21E+20	1.26E+20	1.30E+20	1.31E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20
	1.22E+17	1.26E+17	2.85E+17	6.11E+17	1.75E+18	2.73E+18	3.70E+18	7.59E+18	1.15E+19	1.54E+19	1.92E+19	2.40E+19	3.20E+19	3.84E+19	4.79E+19	5.74E+19	6.36E+19	7.61E+19	9.46E+19	1.10E+20	1.13E+20
	1.61E+19	1.68E+19	3.72E+19	7.86E+19	2.16E+20	3.25E+20	4.27E+20	7.65E+20	1.02E+21	1.20E+21	1.34E+21	1.47E+21	1.60E+21	1.66E+21	1.71E+21	1.73E+21	1.74E+21	1.75E+21	1.75E+21	1.75E+21	1.75E+21
	5.06E+13	5.29E+13	1.18E+14	2.53E+14	7.26E+14	1.13E+15	1.54E+15	3.16E+15	4.78E+15	6.40E+15	8.02E+15	1.00E+16	1.34E+16	1.61E+16	2.02E+16	2.42E+16	2.69E+16	3.23E+16	4.04E+16	4.72E+16	4.85E+16
	1.26E+13	1.27E+13	1.45E+13	1.82E+13	3.11E+13	4.22E+13	5.32E+13	9.75E+13	1.42E+14	1.86E+14	2.30E+14	2.86E+14	3.78E+14	4.52E+14	5.62E+14	6.73E+14	7.47E+14	8.94E+14	1.12E+15	1.30E+15	1.34E+15
	2.34E+12	2.49E+12	5.95E+12	1.62E+13	4.85E+13	7.62E+13	1.04E+14	2.15E+14	3.26E+14	4.36E+14	5.47E+14	6.86E+14	9.17E+14	1.10E+15	1.38E+15	1.66E+15	1.84E+15	2.21E+15	2.76E+15	3.23E+15	3.32E+15
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.78E+15	9.17E+15	2.05E+16	4.39E+16	1.26E+17	1.95E+17	2.65E+17	5.41E+17	8.14E+17	1.08E+18	1.35E+18	1.68E+18	2.22E+18	2.64E+18	3.25E+18	3.85E+18	4.24E+18	4.99E+18	6.07E+18	6.92E+18	7.08E+18
	5.34E+17	5.56E+17	1.12E+18	2.00E+18	3.36E+18	3.68E+18	3.78E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18
	2.57E+17	2.68E+17	5.78E+17	1.15E+18	2.65E+18	3.47E+18	4.01E+18	4.87E+18	5.03E+18	5.06E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18
	2.32E+18	2.43E+18	5.42E+18	1.16E+19	3.32E+19	5.17E+19	7.01E+19	1.43E+20	2.16E+20	2.87E+20	3.58E+20	4.48E+20	5.89E+20	7.01E+20	8.66E+20	1.03E+21	1.13E+21	1.33E+21	1.63E+21	1.86E+21	1.90E+21
	5.57E+17	5.82E+17	1.27E+18	2.61E+18	6.53E+18	9.10E+18	1.11E+19	1.56E+19	1.73E+19	1.79E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	2.43E+18	2.54E+18	5.66E+18	1.21E+19	3.47E+19	5.39E+19	7.30E+19	1.49E+20	2.23E+20	2.95E+20	3.66E+20	4.53E+20	5.94E+20	7.02E+20	8.58E+20	1.01E+21	1.10E+21	1.28E+21	1.53E+21	1.72E+21	1.76E+21
	7.99E+18	8.34E+18	1.85E+19	3.88E+19	1.05E+20	1.56E+20	2.01E+20	3.43E+20	4.37E+20	5.00E+20	5.41E+20	5.73E+20	6.01E+20	6.11E+20	6.18E+20	6.20E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20
	1.07E+17	1.12E+17	2.27E+17	4.12E+17	7.22E+17	8.05E+17	8.34E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17
	4.48E+18	4.64E+18	8.28E+18	1.22E+19	1.48E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.82E+17	1.90E+17	4.23E+17	9.04E+17	2.57E+18	3.97E+18	5.35E+18	1.07E+19	1.56E+19	2.03E+19	2.47E+19	2.98E+19	3.75E+19	4.30E+19	5.01E+19	5.63E+19	5.98E+19	6.60E+19	7.30E+19	7.74E+19	7.82E+19
	1.89E+13	1.98E+13	4.41E+13	9.44E+13	2.71E+14	4.22E+14	5.73E+14	1.18E+15	1.78E+15	2.38E+15	2.99E+15	3.74E+15	5.00E+15	6.01E+15	7.52E+15	9.03E+15	1.00E+16	1.20E+16	1.51E+16	1.76E+16	1.81E+16
	2.82E+14	2.94E+14	6.57E+14	1.41E+15	4.03E+15	6.28E+15	8.53E+15	1.75E+16	2.64E+16	3.53E+16	4.41E+16	5.51E+16	7.33E+16	8.78E+16	1.09E+17	1.31E+17	1.45E+17	1.72E+17	2.13E+17	2.47E+17	2.53E+17
	2.73E+13	2.86E+13	6.38E+13	1.37E+14	3.92E+14	6.10E+14	8.29E+14	1.70E+15	2.58E+15	3.45E+15	4.33E+15	5.42E+15	7.24E+15	8.70E+15	1.09E+16	1.31E+16	1.45E+16	1.74E+16	2.16E+16	2.54E+16	2.62E+16
	3.92E+22	4.09E+22	8.30E+22	1.49E+23	2.85E+23	3.57E+23	4.11E+23	5.86E+23	6.82E+23	7.81E+23	8.71E+23	9.73E+23	1.13E+24	1.24E+24	1.39E+24	1.53E+24	1.61E+24	1.77E+24	1.98E+24	2.15E+24	2.18E+24

Total Integrated Gamma Energy in Containment at Given Timesteps (MeV/cm³)

	3.96E+12	4.12E+12	8.37E+12	1.51E+13	2.88E+13	3.59E+13	4.15E+13	5.71E+13	6.88E+13	7.88E+13	8.78E+13	9.81E+13	1.14E+14	1.25E+14	1.40E+14	1.54E+14	1.62E+14	1.78E+14	2.00E+14	2.17E+14	2.20E+14

Beta Particle Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.8336	3	6	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	3.37E+19	3.52E+19	8.01E+19	1.73E+20	4.98E+20	7.77E+20	1.08E+21	2.17E+21	3.28E+21	4.40E+21	5.51E+21	6.90E+21	9.22E+21	1.11E+22	1.39E+22	1.66E+22	1.85E+22	2.22E+22	2.78E+22	3.24E+22	3.33E+22
	5.17E+20	5.39E+20	1.12E+21	2.09E+21	3.88E+21	4.40E+21	4.62E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21
	3.30E+21	3.47E+21	5.99E+21	8.40E+21	9.59E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21
	1.98E+21	2.08E+21	4.10E+21	7.08E+21	1.09E+22	1.16E+22	1.17E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22
	1.86E+21	1.95E+21	4.42E+21	9.49E+21	2.68E+22	4.11E+22	6.50E+22	1.08E+23	1.51E+23	1.90E+23	2.24E+23	2.61E+23	3.11E+23	3.42E+23	3.77E+23	4.02E+23	4.15E+23	4.34E+23	4.50E+23	4.57E+23	4.58E+23
	2.05E+21	2.15E+21	4.68E+21	9.36E+21	2.11E+22	2.72E+22	3.11E+22	3.67E+22	3.76E+22	3.77E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22
	4.58E+20	4.79E+20	1.14E+21	2.49E+21	7.18E+21	1.11E+22	1.49E+22	2.94E+22	4.27E+22	5.49E+22	6.61E+22	7.88E+22	9.71E+22	1.10E+23	1.25E+23	1.38E+23	1.45E+23	1.56E+23	1.68E+23	1.75E+23	1.78E+23
	1.16E+21	1.21E+21	2.42E+21	4.04E+21	5.78E+21	5.95E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21
	2.03E+21	2.13E+21	4.98E+21	1.05E+22	2.74E+22	3.90E+22	4.85E+22	7.22E+22	8.28E+22	8.76E+22	8.97E+22	9.09E+22	9.14E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22
	1.21E+21	1.25E+21	1.98E+21	2.45E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21
	1.55E+21	1.62E+21	3.82E+21	7.17E+21	1.51E+22	1.85E+22	2.03E+22	2.22E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22
	3.31E+18	3.49E+18	8.41E+18	1.88E+19	5.39E+19	8.38E+19	1.14E+20	2.30E+20	3.41E+20	4.49E+20	5.53E+20	6.77E+20	8.72E+20	1.02E+21	1.22E+21	1.40E+21	1.52E+21	1.72E+21	1.99E+21	2.18E+21	2.21E+21
	8.72E+19	9.17E+19	2.21E+20	4.90E+20	1.43E+21	2.23E+21	3.04E+21	6.25E+21	9.46E+21	1.27E+22	1.59E+22	1.99E+22	2.65E+22	3.19E+22	3.98E+22	4.78E+22	5.31E+22	6.38E+22	7.94E+22	9.25E+22	9.51E+22
	1.54E+19	1.62E+19	3.91E+19	8.64E+19	2.50E+20	3.88E+20	5.25E+20	1.05E+21	1.55E+21	2.03E+21	2.48E+21	3.01E+21	3.82E+21	4.41E+21	5.20E+21	5.89E+21	6.30E+21	7.02E+21	7.90E+21	8.46E+21	8.56E+21
	5.92E+19	6.22E+19	1.50E+20	3.32E+20	9.69E+20	1.62E+21	2.06E+21	4.25E+21	6.43E+21	8.62E+21	1.08E+22	1.35E+22	1.81E+22	2.17E+22	2.72E+22	3.26E+22	3.63E+22	4.35E+22	5.45E+22	6.35E+22	6.54E+22
	1.57E+19	1.64E+19	3.65E+19	7.75E+19	2.17E+20	3.30E+20	4.39E+20	8.27E+20	1.15E+21	1.42E+21	1.65E+21	1.88E+21	2.17E+21	2.33E+21	2.50E+21	2.61E+21	2.65E+21	2.72E+21	2.76E+21	2.78E+21	2.78E+21
	4.29E+19	4.48E+19	9.15E+19	1.68E+20	3.05E+20	3.48E+20	3.61E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20
	1.01E+19	1.05E+19	2.28E+19	4.50E+19	1.02E+20	1.32E+20	1.51E+20	1.79E+20	1.84E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20
	3.13E+16	3.27E+16	7.30E+16	1.56E+17	4.48E+17	6.97E+17	9.46E+17	1.94E+18	2.92E+18	3.90E+18	4.87E+18	6.08E+18	8.07E+18	9.65E+18	1.20E+19	1.43E+19	1.58E+19	1.87E+19	2.31E+19	2.66E+19	2.73E+19
	3.28E+19	3.39E+19	5.67E+19	7.71E+19	8.58E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19
	4.72E+18	4.94E+18	1.10E+19	2.38E+19	6.74E+19	1.05E+20	1.42E+20	2.89E+20	4.33E+20	5.73E+20	7.11E+20	8.80E+20	1.15E+21	1.36E+21	1.66E+21	1.95E+21	2.13E+21	2.47E+21	2.95E+21	3.31E+21	3.38E+21
	9.52E+18	9.94E+18	2.19E+19	4.59E+19	1.22E+20	1.77E+20	2.26E+20	3.65E+20	4.45E+20	4.91E+20	5.17E+20	5.35E+20	5.47E+20	5.50E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20
	3.95E+19	4.12E+19	9.16E+19	1.95E+20	5.41E+20	8.21E+20	1.09E+21	2.02E+21	2.77E+21	3.38E+21	3.87E+21	4.36E+21	4.93E+21	5.23E+21	5.53E+21	5.70E+21	5.78E+21	5.86E+21	5.92E+21	5.94E+21	5.94E+21
	1.15E+20	1.20E+20	2.68E+20	5.74E+20	1.64E+21	2.55E+21	3.46E+21	7.07E+21	1.08E+22	1.41E+22	1.76E+22	2.18E+22	2.88E+22	3.42E+22	4.21E+22	4.97E+22	5.46E+22	6.42E+22	7.77E+22	8.82E+22	9.03E+22
	4.39E+18	4.58E+18	1.02E+19	2.19E+19	6.29E+19	9.80E+19	1.33E+20	2.73E+20	4.14E+20	5.54E+20	6.94E+20	8.70E+20	1.16E+21	1.40E+21	1.75E+21	2.10E+21	2.33E+21	2.80E+21	3.50E+21	4.08E+21	4.20E+21
	1.57E+20	1.64E+20	3.51E+20	7.00E+20	1.59E+21	2.08E+21	2.37E+21	2.82E+21	2.90E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21
	3.87E+19	4.03E+19	7.87E+19	1.34E+20	2.02E+20	2.13E+20	2.15E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20
	1.54E+20	1.59E+20	2.77E+20	3.96E+20	4.63E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20
	9.33E+19	9.75E+19	2.17E+20	4.65E+20	1.32E+21	2.05E+21	2.78E+21	5.52E+21	8.14E+21	1.06E+22	1.30E+22	1.57E+22	1.99E+22	2.29E+22	2.70E+22	3.08E+22	3.27E+22	3.64E+22	4.08E+22	4.36E+22	4.41E+22
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.52E+17	1.59E+17	3.55E+17	7.61E+17	2.18E+18	3.40E+18	4.62E+18	9.48E+18	1.43E+19	1.92E+19	2.41E+19	3.01E+19	4.03E+19	4.84E+19	6.05E+19	7.26E+19	8.07E+19	9.68E+19	1.21E+20	1.41E+20	1.45E+20
	1.73E+19	1.81E+19	4.02E+19	8.52E+19	2.35E+20	3.58E+20	4.69E+20	8.56E+20	1.16E+21	1.39E+21	1.57E+21	1.74E+21	1.93E+21	2.03E+21	2.11E+21	2.15E+21	2.17E+21	2.19E+21	2.20E+21	2.20E+21	2.20E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.50E+18	2.61E+18	5.83E+18	1.25E+19	3.57E+19	5.55E+19	7.52E+19	1.53E+20	2.30E+20	3.05E+20	3.79E+20	4.69E+20	6.16E+20	7.29E+20	8.93E+20	1.05E+21	1.15E+21	1.34E+21	1.61E+21	1.82E+21	1.86E+21
	6.17E+18	6.51E+18	1.75E+19	3.23E+19	5.91E+19	6.73E+19	7.06E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19
	1.53E+17	1.60E+17	3.57E+17	7.64E+17	2.19E+18	3.41E+18	4.63E+18	9.51E+18	1.44E+19	1.92E+19	2.41E+19	3.01E+19	4.02E+19	4.82E+19	6.02E+19	7.21E+19	8.00E+19	9.58E+19	1.19E+20	1.39E+20	1.42E+20
	3.58E+18	3.74E+18	8.27E+18	1.74E+19	4.85E+19	6.86E+19	8.81E+19	1.47E+20	1.84E+20	2.07E+20	2.21E+20	2.32E+20	2.40E+20	2.43E+20	2.44E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20
	1.14E+18	1.20E+18	2.67E+18	5.71E+18	1.63E+19	2.54E+19	3.44E+19	6.99E+19	1.05E+20	1.39E+20	1.72E+20	2.13E+20	2.78E+20	3.28E+20	4.00E+20	4.69E+20	5.12E+20	5.95E+20	7.08E+20	7.94E+20	8.10E+20
	3.10E+18	3.23E+18	7.14E+18	1.50E+19	4.00E+19	5.86E+19	7.51E+19	1.24E+20	1.53E+20	1.71E+20	1.81E+20	1.89E+20	1.95E+20	1.96E+20	1.97E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20
	5.28E+17	5.51E+17	1.23E+18	2.64E+18	7.58E+18	1.18E+19	1.60E+19	3.28E+19	4.98E+19	6.63E+19	8.30E+19	1.04E+20	1.38E+20	1.66E+20	2.07E+20	2.48E+20	2.75E+20	3.29E+20	4.09E+20	4.75E+20	4.88E+20
	1.07E+19	1.12E+19	2.49E+19	5.27E+19	1.45E+20	2.18E+20	2.85E+20	5.12E+20	6.80E+20	8.06E+20	8.99E+20	9.83E+20	1.07E+21	1.11E+21	1.14E+21	1.16E+21	1.16E+21	1.17E+21	1.17E+21	1.17E+21	1.17E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.70E+15	5.95E+15	1.33E+16	2.85E+16	8.17E+16	1.27E+17	1.73E+17	3.55E+17	5.37E+17	7.20E+17	9.02E+17	1.13E+18	1.51E+18	1.81E+18	2.27E+18	2.72E+18	3.03E+18	3.63E+18	4.54E+18	5.30E+18	5.45E+18
	2.12E+17	2.22E+17	4.92E+17	1.04E+18	2.88E+18	4.34E+18	5.72E+18	1.04E+19	1.40E+19	1.68E+19	1.89E+19	2.10E+19	2.31E+19	2.42E+19	2.52E+19	2.56E+19	2.58E+19	2.60E+19	2.61E+19	2.62E+19	2.62E+19
	1.46E+18	1.53E+18	3.41E+18	7.31E+18	2.09E+19	3.25E+19	4.41E+19	9.02E+19	1.36E+20	1.81E+20	2.25E+20	2.80E+20	3.69E+20	4.39E+20	5.42E+20	6.41E+20	7.06E+20	8.32E+20	1.01E+21	1.15E+21	1.18E+21
	3.07E+18	3.19E+18	6.42E+18	1.15E+19	1.93E+19	2.11E+19	2.17E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19
	3.38E+18	3.52E+18	7.58E+18	1.52E+19	3.49E+19	4.58E+19	5.28E+19	6.41E+19	6.62E+19	6.67E+19	6.67E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19
	3.67E+17	3.84E+17	8.57E+17	1.83E+18	5.25E+18	8.17E+18	1.11E+19	2.27E+19	3.41E+19	4.54E+19	5.68E+19	7.05E+19	9.31E+19	1.11E+20	1.37E+20	1.62E+20	1.79E+20	2.11E+20	2.57E+20	2.93E+20	3.01E+20
	2.15E+18	2.25E+18	4.91E+18	1.01E+19	2.52E+19	3.51E+19	4.29E+19	6.03E+19	6.68E+19	6.93E+19	7.02E+19	7.06E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19
	1.38E+17	1.44E+17	3.22E+17	6.89E+17	1.97E+18	3.06E+18	4.15E+18	8.44E+18	1.26E+19	1.68E+19	2.08E+19	2.58E+19	3.37E+19	3.99E+19	4.87E+19	5.72E+19	6.26E+19	7.26E+19	8.70E+19	9.78E+19	9.99E+19
	1.82E+18	1.90E+18	4.20E+18	8.85E+18	2.39E+19	3.54E+19	4.58E+19	7.82E+19	9.98E+19	1.14E+20	1.23E+20	1.31E+20	1.37E+20	1.39E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	2.39E+18	2.48E+18	5.05E+18	9.16E+18	1.60E+19	1.79E+19	1.85E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19
	1.39E+18	1.44E+18	2.57E+18	3.81E+18	4.62E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18
	9.52E+17	9.95E+17	2.22E+18	4.74E+18	1.35E+19	2.09E+19	2.82E+19	5.65E+19	8.34E+19	1.09E+20	1.33E+20	1.62E+20	2.06E+20	2.38E+20	2.81E+20	3.19E+20	3.41E+20	3.81E+20	4.30E+20	4.62E+20	4.67E+20
	3.01E+17	3.15E+17	7.02E+17	1.50E+18	4.28E+18	6.59E+18	8.88E+18	1.77E+19	2.59E+19	3.37E+19	4.10E+19	4.95E+19	6.22E+19	7.13E+19	8.32E+19	9.33E+19	9.93E+19	1.09E+20	1.21E+20	1.28E+20	1.30E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.72E+22	1.79E+22	3.86E+22	8.74E+22	1.41E+23	1.87E+23	2.24E+23	3.38E+23	4.23E+23	4.95E+23	5.57E+23	6.25E+23	7.21E+23	7.86E+23	8.68E+23	9.36E+23	9.75E+23	1.04E+24	1.12E+24	1.18E+24	1.19E+24

Total Integrated Beta Energy in Containment at Given Timesteps (MeV/cm²)

	1.73E+12	1.80E+12	3.69E+12	6.80E+12	1.42E+13	1.88E+13	2.26E+13	3.41E+13	4.27E+13	4.99E+13	5.61E+13	6.30E+13	7.27E+13	7.93E+13	8.75E+13	9.44E+13	9.83E+13	1.05E+14	1.13E+14	1.19E+14	1.20E+14

Class	Isotopic Nuclide	Decay Constant (hours)$^{-1}$	Release Fractions 0-0.5 hours	Release Fractions 0.5-2 hours	Initial Core Activity (Ci)	Gap Release Activity in Containment at 0.5 hours (Ci)	Gap Release Time Integrated Activity in Containment through 0.5 hours (Ci-hours)	Early In-vessel Release Activity in Containment at 2.0 hours (Ci)	Early In-vessel Release Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Activity in Containment at 2.0 hours (Ci)	Gamma (Photon) Emission Energy (MeV/decay)	Gamma (Photon) Emission Energy per Unit of Activity (MeV/Ci-hour)	Beta Particle Emission Energy (MeV/decay)	Beta Particle Emission Energy per Unit of Activity (MeV/Ci-hour)
2	I-131	3.592E-03	0.05	0.25	9.479E+07	4.73E+06	1.18E+06	2.35E+07	1.77E+07	1.89E+07	2.82E+07	3.81E-01	5.08E+13	1.81E-01	2.42E+13
2	I-132	3.014E-01	0.05	0.25	1.369E+08	5.89E+06	1.55E+06	1.87E+07	1.64E+07	1.80E+07	2.25E+07	2.29E+00	3.05E+14	4.86E-01	6.47E+13
2	I-133	3.332E-02	0.05	0.25	1.960E+08	9.64E+06	2.42E+06	4.58E+07	3.50E+07	3.74E+07	5.50E+07	6.07E-01	8.08E+13	4.07E-01	5.42E+13
2	I-134	7.907E-01	0.05	0.25	2.175E+08	7.32E+06	2.10E+06	1.12E+07	1.30E+07	1.51E+07	1.34E+07	2.63E+00	3.50E+14	6.03E-01	8.03E+13
2	I-135	1.049E-01	0.05	0.25	1.832E+08	8.69E+06	2.21E+06	3.71E+07	2.94E+07	3.16E+07	4.46E+07	1.58E+00	2.10E+14	3.68E-01	4.91E+13
3	Rb-86	1.548E-03	0.05	0.20	2.300E+05	1.15E+04	2.87E+03	4.58E+04	3.44E+04	3.73E+04	5.73E+04	9.45E-02	1.26E+13	6.67E-01	8.89E+13
3	Cs-134	3.835E-05	0.05	0.20	2.569E+07	1.28E+06	3.21E+05	5.14E+06	3.85E+06	4.17E+06	6.42E+06	1.56E+00	2.07E+14	1.57E-01	2.09E+13
3	Cs-136	2.206E-03	0.05	0.20	7.150E+06	3.57E+05	8.93E+04	1.42E+06	1.07E+06	1.16E+06	1.78E+06	2.17E+00	2.89E+14	1.00E-01	1.33E+13
3	Cs-137	2.636E-06	0.05	0.20	1.601E+07	8.00E+05	2.00E+05	3.20E+06	2.40E+06	2.60E+06	4.00E+06	0.00E+00	0.00E+00	1.71E-01	2.27E+13
4	Sb-127	7.502E-03	0.00	0.05	1.022E+07	0.00E+00	0.00E+00	5.03E+05	3.79E+05	3.79E+05	5.03E+05	6.62E-01	8.82E+13	3.11E-01	4.14E+13
4	Sb-129	1.605E-01	0.00	0.05	3.047E+07	0.00E+00	0.00E+00	1.11E+06	9.00E+05	9.00E+05	1.11E+06	1.43E+00	1.90E+14	3.58E-01	4.76E+13
4	Te-127	7.413E-02	0.00	0.05	1.014E+07	0.00E+00	0.00E+00	4.37E+05	3.40E+05	3.40E+05	4.37E+05	4.84E-03	6.44E+11	2.23E-01	2.97E+13
4	Te-127m	2.650E-04	0.00	0.05	1.360E+06	0.00E+00	0.00E+00	6.80E+04	5.10E+04	5.10E+04	6.80E+04	1.12E-02	1.50E+12	4.61E-03	6.13E+11
4	Te-129	5.875E-01	0.00	0.05	2.999E+07	0.00E+00	0.00E+00	4.54E+05	4.70E+05	4.70E+05	4.54E+05	5.77E-02	7.68E+12	5.25E-01	6.99E+13
4	Te-129m	8.596E-04	0.00	0.05	4.470E+06	0.00E+00	0.00E+00	2.23E+05	1.67E+05	1.67E+05	2.23E+05	3.94E-02	5.25E+12	2.12E-01	2.82E+13
4	Te-131m	2.310E-02	0.00	0.05	1.365E+07	0.00E+00	0.00E+00	6.52E+05	4.94E+05	4.94E+05	6.52E+05	1.43E+00	1.90E+14	1.45E-01	1.92E+13
4	Te-132	8.864E-03	0.00	0.05	1.348E+08	0.00E+00	0.00E+00	6.62E+06	4.99E+06	4.99E+06	6.62E+06	2.31E-01	3.07E+13	5.94E-02	7.91E+12
5	Sr-89	5.719E-04	0.00	0.02	9.873E+07	0.00E+00	0.00E+00	1.97E+06	1.48E+06	1.48E+06	1.97E+06	1.36E-04	1.82E+10	5.83E-01	7.76E+13
5	Sr-90	2.715E-06	0.00	0.02	1.121E+07	0.00E+00	0.00E+00	2.24E+05	1.68E+05	1.68E+05	2.24E+05	0.00E+00	0.00E+00	1.96E-01	2.61E+13
5	Sr-91	7.296E-02	0.00	0.02	1.341E+08	0.00E+00	0.00E+00	2.32E+06	1.80E+06	1.80E+06	2.32E+06	6.87E-01	9.15E+13	6.53E-01	8.70E+13
5	Sr-92	2.558E-01	0.00	0.02	1.417E+08	0.00E+00	0.00E+00	1.70E+06	1.45E+06	1.45E+06	1.70E+06	1.34E+00	1.78E+14	2.00E-01	2.66E+13
6	Ba-139	5.029E-01	0.00	0.02	1.794E+08	0.00E+00	0.00E+00	1.31E+06	1.29E+06	1.29E+06	1.31E+06	3.53E-02	4.70E+12	8.97E-01	1.19E+14
6	Ba-140	2.267E-03	0.00	0.02	1.727E+08	0.00E+00	0.00E+00	3.44E+06	2.56E+06	2.56E+06	3.44E+06	1.91E-01	2.54E+13	2.71E-01	3.61E+13
7	Co-58	4.079E-04	0.00	0.0025	5.394E+06	0.00E+00	0.00E+00	1.35E+04	1.01E+04	1.01E+04	1.35E+04	9.76E-01	1.30E+14	0.00E+00	0.00E+00
7	Co-60	1.500E-05	0.00	0.0025	6.361E+06	0.00E+00	0.00E+00	1.59E+04	1.19E+04	1.19E+04	1.59E+04	2.51E+00	3.34E+14	9.58E-02	1.28E+13
7	Mo-99	1.050E-02	0.00	0.0025	1.792E+08	0.00E+00	0.00E+00	4.39E+05	3.31E+05	3.31E+05	4.39E+05	1.55E-01	2.06E+13	3.93E-01	5.24E+13
7	Tc-99m	1.151E-01	0.00	0.0025	1.569E+08	0.00E+00	0.00E+00	3.12E+05	2.48E+05	2.48E+05	3.12E+05	1.27E-01	1.69E+13	0.00E+00	0.00E+00
7	Ru-103	7.353E-04	0.00	0.0025	1.483E+08	0.00E+00	0.00E+00	3.70E+05	2.78E+05	2.78E+05	3.70E+05	4.84E-01	6.44E+13	6.75E-02	9.00E+12
7	Ru-105	1.561E-01	0.00	0.0025	1.026E+08	0.00E+00	0.00E+00	1.88E+05	1.52E+05	1.52E+05	1.88E+05	7.84E-01	1.04E+14	4.03E-01	5.36E+13
7	Ru-106	7.844E-05	0.00	0.0025	6.104E+07	0.00E+00	0.00E+00	1.53E+05	1.14E+05	1.14E+05	1.53E+05	0.00E+00	0.00E+00	1.00E-02	1.34E+12
7	Rh-105	1.960E-02	0.00	0.0025	9.709E+07	0.00E+00	0.00E+00	2.33E+05	1.77E+05	1.77E+05	2.33E+05	7.76E-02	1.03E+13	1.52E-01	2.03E+13
8	Ce-141	8.886E-04	0.00	0.0005	1.585E+08	0.00E+00	0.00E+00	7.91E+04	5.94E+04	5.94E+04	7.91E+04	7.69E-02	1.02E+13	1.45E-01	1.93E+13
8	Ce-143	2.100E-02	0.00	0.0005	1.562E+08	0.00E+00	0.00E+00	7.49E+04	5.68E+04	5.68E+04	7.49E+04	2.73E-01	3.64E+13	4.10E-01	5.46E+13
8	Ce-144	1.016E-04	0.00	0.0005	1.269E+08	0.00E+00	0.00E+00	6.34E+04	4.76E+04	4.76E+04	6.34E+04	1.93E-02	2.57E+12	8.33E-02	1.11E+13
8	Np-239	1.226E-02	0.00	0.0005	1.904E+09	0.00E+00	0.00E+00	9.29E+05	7.01E+05	7.01E+05	9.29E+05	1.72E-01	2.29E+13	1.15E-01	1.53E+13
8	Pu-238	9.012E-07	0.00	0.0005	6.336E+05	0.00E+00	0.00E+00	3.17E+02	2.38E+02	2.38E+02	3.17E+02	1.60E-03	2.13E+11	0.00E+00	0.00E+00
8	Pu-239	3.286E-09	0.00	0.0005	4.234E+04	0.00E+00	0.00E+00	2.12E+01	1.45E+02	1.45E+02	2.12E+01	6.54E-04	8.71E+10	0.00E+00	0.00E+00
8	Pu-240	1.210E-08	0.00	0.0005	4.543E+04	0.00E+00	0.00E+00	2.27E+01	1.15E+01	1.15E+01	2.27E+01	1.53E-03	2.03E+11	0.00E+00	0.00E+00
8	Pu-241	5.491E-06	0.00	0.0005	2.181E+07	0.00E+00	0.00E+00	1.09E+04	8.18E+03	8.18E+03	1.09E+04	0.00E+00	0.00E+00	5.23E-03	6.97E+11
9	Y-90	1.083E-02	0.00	0.0002	1.154E+07	0.00E+00	0.00E+00	2.26E+03	1.70E+03	1.70E+03	2.26E+03	0.00E+00	0.00E+00	9.35E-01	1.25E+14
9	Y-91	4.938E-04	0.00	0.0002	1.217E+08	0.00E+00	0.00E+00	2.43E+04	1.82E+04	1.82E+04	2.43E+04	3.61E-03	4.81E+11	6.02E-01	8.02E+13
9	Y-92	1.958E-01	0.00	0.0002	1.421E+08	0.00E+00	0.00E+00	1.92E+04	1.59E+04	1.59E+04	1.92E+04	2.52E-01	3.35E+13	1.44E+00	1.92E+14
9	Y-93	6.863E-02	0.00	0.0002	1.597E+08	0.00E+00	0.00E+00	2.78E+04	2.16E+04	2.16E+04	2.78E+04	8.91E-02	1.19E+13	1.17E+00	1.56E+14
9	Zr-95	4.514E-04	0.00	0.0002	1.584E+08	0.00E+00	0.00E+00	3.16E+04	2.37E+04	2.37E+04	3.16E+04	7.35E-01	9.79E+13	1.16E-01	1.55E+13
9	Zr-97	4.101E-02	0.00	0.0002	1.643E+08	0.00E+00	0.00E+00	3.03E+04	2.32E+04	2.32E+04	3.03E+04	1.81E-01	2.41E+13	6.97E-01	9.29E+13
9	Nb-95	8.217E-04	0.00	0.0002	1.592E+08	0.00E+00	0.00E+00	3.18E+04	2.38E+04	2.38E+04	3.18E+04	7.64E-01	1.02E+14	4.34E-02	5.79E+12
9	La-140	1.721E-02	0.00	0.0002	1.771E+08	0.00E+00	0.00E+00	3.42E+04	2.59E+04	2.59E+04	3.42E+04	2.32E+00	3.09E+14	5.27E-01	7.03E+13
9	La-141	1.764E-01	0.00	0.0002	1.637E+08	0.00E+00	0.00E+00	2.30E+04	1.89E+04	1.89E+04	2.30E+04	4.27E-02	5.69E+12	9.48E-01	1.26E+14
9	La-142	4.498E-01	0.00	0.0002	1.599E+08	0.00E+00	0.00E+00	1.30E+04	1.24E+04	1.24E+04	1.30E+04	2.72E+00	3.62E+14	8.46E-01	1.13E+14
9	Pr-143	2.130E-03	0.00	0.0002	1.515E+08	0.00E+00	0.00E+00	3.02E+04	2.26E+04	2.26E+04	3.02E+04	0.00E+00	0.00E+00	3.16E-01	4.20E+13
9	Nd-147	2.630E-03	0.00	0.0002	6.483E+07	0.00E+00	0.00E+00	1.29E+04	9.69E+03	9.69E+03	1.29E+04	1.41E-01	1.87E+13	2.33E-01	3.11E+13
9	Am-241	1.830E-07	0.00	0.0002	3.361E+04	0.00E+00	0.00E+00	6.72E+00	5.05E+00	5.05E+00	6.72E+00	2.81E-02	3.74E+12	0.00E+00	0.00E+00
9	Cm-242	1.774E-04	0.00	0.0002	8.424E+06	0.00E+00	0.00E+00	1.68E+03	1.26E+03	1.26E+03	1.68E+03	1.67E-03	2.23E+11	0.00E+00	0.00E+00
9	Cm-244	4.366E-06	0.00	0.0002	9.181E+05	0.00E+00	0.00E+00	1.84E+02	1.38E+02	1.38E+02	1.84E+02	1.49E-03	1.98E+11	0.00E+00	0.00E+00

Disintegrations per Curie-hour= 1.3320E+14
Suppression Pool Water Volume cm^3= 4.9554E+09
MeV/cm^3 to Mrad Conversion Factor= 1.6021E-14

Activity in Containment at Given Timesteps (Ci-hours)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	1.89E+07	1.98E+07	4.70E+07	1.03E+08	2.96E+08	4.58E+08	6.16E+08	1.22E+09	1.77E+09	2.27E+09	2.73E+09	3.26E+09	4.02E+09	4.54E+09	5.18E+09	5.71E+09	6.00E+09	6.47E+09	6.96E+09	7.24E+09	7.28E+09
	1.80E+07	1.87E+07	3.74E+07	6.24E+07	8.89E+07	9.20E+07	9.25E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07
	3.74E+07	3.92E+07	9.15E+07	1.94E+08	5.05E+08	7.20E+08	8.95E+08	1.33E+09	1.53E+09	1.62E+09	1.66E+09	1.68E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09
	1.51E+07	1.55E+07	2.44E+07	3.05E+07	3.20E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07
	3.16E+07	3.31E+07	7.39E+07	1.46E+08	3.08E+08	3.77E+08	4.14E+08	4.53E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08
	3.73E+04	3.92E+04	9.46E+04	2.09E+05	6.06E+05	9.43E+05	1.28E+06	2.58E+06	3.84E+06	5.05E+06	6.22E+06	7.62E+06	9.81E+06	1.14E+07	1.37E+07	1.58E+07	1.71E+07	1.94E+07	2.24E+07	2.45E+07	2.49E+07
	4.17E+06	4.39E+06	1.06E+07	2.34E+07	6.84E+07	1.07E+08	1.45E+08	2.99E+08	4.53E+08	6.07E+08	7.60E+08	9.52E+08	1.27E+09	1.53E+09	1.91E+09	2.29E+09	2.64E+09	3.05E+09	3.80E+09	4.43E+09	4.55E+09
	1.16E+06	1.22E+06	2.94E+06	6.48E+06	1.88E+07	2.91E+07	3.94E+07	7.90E+07	1.17E+08	1.52E+08	1.86E+08	2.26E+08	2.87E+08	3.31E+08	3.90E+08	4.42E+08	4.73E+08	5.27E+08	5.92E+08	6.35E+08	6.43E+08
	2.60E+06	2.74E+06	6.60E+06	1.46E+07	4.26E+07	6.66E+07	9.07E+07	1.87E+08	2.83E+08	3.79E+08	4.75E+08	5.95E+08	7.95E+08	9.55E+08	1.19E+09	1.43E+09	1.59E+09	1.91E+09	2.39E+09	2.79E+09	2.87E+09
	3.79E+05	3.96E+05	8.80E+05	1.87E+06	5.23E+06	7.97E+06	1.06E+07	2.00E+07	2.78E+07	3.43E+07	3.98E+07	4.54E+07	5.23E+07	5.62E+07	6.03E+07	6.29E+07	6.41E+07	6.56E+07	6.67E+07	6.71E+07	6.72E+07
	9.00E+05	9.37E+05	1.92E+06	3.53E+06	6.40E+06	7.26E+06	7.59E+06	7.78E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06
	3.40E+05	3.55E+05	7.81E+05	1.52E+06	3.43E+06	4.44E+06	5.08E+06	6.04E+06	6.20E+06	6.23E+06	6.23E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06
	5.10E+04	5.33E+04	1.19E+05	2.55E+05	7.30E+05	1.14E+06	1.54E+06	3.16E+06	4.76E+06	6.36E+06	7.95E+06	9.92E+06	1.32E+07	1.57E+07	1.96E+07	2.33E+07	2.57E+07	3.06E+07	3.76E+07	4.34E+07	4.45E+07
	4.70E+05	4.85E+05	8.11E+05	1.10E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06
	1.67E+05	1.75E+05	3.90E+05	8.36E+05	2.39E+06	3.71E+06	5.03E+06	1.02E+07	1.53E+07	2.03E+07	2.52E+07	3.12E+07	4.08E+07	4.82E+07	5.88E+07	6.89E+07	7.54E+07	8.76E+07	1.04E+08	1.17E+08	1.20E+08
	4.94E+05	5.16E+05	1.14E+06	2.38E+06	6.31E+06	9.21E+06	1.17E+07	1.90E+07	2.31E+07	2.55E+07	2.69E+07	2.78E+07	2.84E+07	2.86E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07
	4.99E+06	5.21E+06	1.16E+07	2.46E+07	6.84E+07	1.04E+08	1.37E+08	2.55E+08	3.50E+08	4.27E+08	4.90E+08	5.51E+08	6.23E+08	6.61E+08	6.99E+08	7.21E+08	7.30E+08	7.41E+08	7.48E+08	7.50E+08	7.51E+08
	1.48E+06	1.55E+06	3.45E+06	7.39E+06	2.11E+07	3.29E+07	4.46E+07	9.10E+07	1.37E+08	1.82E+08	2.27E+08	2.81E+08	3.71E+08	4.40E+08	5.42E+08	6.40E+08	7.04E+08	8.26E+08	1.00E+09	1.14E+09	1.16E+09
	1.68E+05	1.76E+05	3.92E+05	8.41E+05	2.41E+06	3.76E+06	5.10E+06	1.05E+07	1.59E+07	2.12E+07	2.66E+07	3.33E+07	4.46E+07	5.35E+07	6.70E+07	8.04E+07	8.94E+07	1.07E+08	1.34E+08	1.57E+08	1.61E+08
	1.80E+06	1.88E+06	4.04E+06	8.05E+06	1.83E+07	2.37E+07	2.72E+07	3.25E+07	3.34E+07	3.35E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07
	1.45E+06	1.51E+06	2.95E+06	5.01E+06	7.58E+06	7.99E+06	8.08E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06
	1.29E+06	1.33E+06	2.32E+06	3.32E+06	3.88E+06	3.89E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06
	2.58E+06	2.70E+06	6.02E+06	1.29E+07	3.66E+07	5.66E+07	7.64E+07	1.53E+08	2.25E+08	2.94E+08	3.59E+08	4.35E+08	5.51E+08	6.35E+08	7.48E+08	8.46E+08	9.04E+08	1.01E+09	1.13E+09	1.21E+09	1.22E+09
	1.01E+04	1.06E+04	2.36E+04	5.05E+04	1.45E+05	2.25E+05	3.05E+05	6.24E+05	9.40E+05	1.25E+06	1.56E+06	1.95E+06	2.57E+06	3.07E+06	3.79E+06	4.50E+06	4.96E+06	5.86E+06	7.16E+06	8.20E+06	8.40E+06
	1.19E+04	1.25E+04	2.78E+04	5.96E+04	1.71E+05	2.66E+05	3.62E+05	7.43E+05	1.12E+06	1.51E+06	1.89E+06	2.36E+06	3.16E+06	3.79E+06	4.74E+06	5.69E+06	6.32E+06	7.59E+06	9.48E+06	1.11E+07	1.14E+07
	3.31E+05	3.45E+05	7.67E+05	1.63E+06	4.49E+06	6.79E+06	8.95E+06	1.63E+07	2.21E+07	2.65E+07	3.00E+07	3.33E+07	3.69E+07	3.87E+07	4.03E+07	4.11E+07	4.15E+07	4.18E+07	4.20E+07	4.21E+07	4.21E+07
	2.48E+05	2.58E+05	5.42E+05	1.04E+06	2.10E+06	2.52E+06	2.74E+06	2.94E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06
	2.78E+05	2.90E+05	6.48E+05	1.39E+06	3.96E+06	6.16E+06	8.35E+06	1.70E+07	2.55E+07	3.39E+07	4.21E+07	5.22E+07	6.85E+07	8.11E+07	9.93E+07	1.17E+08	1.28E+08	1.49E+08	1.79E+08	2.02E+08	2.07E+08
	1.52E+05	1.59E+05	3.26E+05	6.02E+05	1.10E+06	1.26E+06	1.32E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06
	1.14E+05	1.20E+05	2.67E+05	5.72E+05	1.64E+06	2.55E+06	3.47E+06	7.12E+06	1.08E+07	1.44E+07	1.80E+07	2.26E+07	3.01E+07	3.61E+07	4.51E+07	5.40E+07	5.99E+07	7.17E+07	8.92E+07	1.04E+08	1.07E+08
	1.77E+05	1.85E+05	4.06E+05	8.57E+05	2.30E+06	3.38E+06	4.35E+06	7.25E+06	9.06E+06	1.02E+07	1.09E+07	1.14E+07	1.18E+07	1.20E+07	1.20E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07
	5.94E+04	6.20E+04	1.36E+05	2.96E+05	8.47E+05	1.32E+06	1.78E+06	3.62E+06	5.43E+06	7.19E+06	8.92E+06	1.10E+07	1.44E+07	1.70E+07	2.08E+07	2.43E+07	2.66E+07	3.09E+07	3.68E+07	4.12E+07	4.20E+07
	5.68E+04	5.93E+04	1.31E+05	2.74E+05	7.32E+05	1.07E+06	1.36E+06	2.27E+06	2.80E+06	3.13E+06	3.32E+06	3.46E+06	3.57E+06	3.60E+06	3.61E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06
	4.76E+04	4.97E+04	1.11E+05	2.38E+05	6.81E+05	1.06E+06	1.44E+06	2.96E+06	4.47E+06	5.98E+06	7.49E+06	9.36E+06	1.25E+07	1.50E+07	1.87E+07	2.23E+07	2.48E+07	2.96E+07	3.68E+07	4.28E+07	4.40E+07
	7.01E+05	7.32E+05	1.62E+06	3.44E+06	9.44E+06	1.42E+07	1.86E+07	3.34E+07	4.43E+07	5.25E+07	5.86E+07	6.41E+07	6.98E+07	7.24E+07	7.45E+07	7.55E+07	7.59E+07	7.62E+07	7.64E+07	7.64E+07	7.64E+07
	2.30E+02	2.48E+02	5.54E+02	1.19E+03	3.41E+03	5.31E+03	7.21E+03	1.48E+04	2.24E+04	3.00E+04	3.76E+04	4.71E+04	6.30E+04	7.56E+04	9.46E+04	1.14E+05	1.26E+05	1.52E+05	1.90E+05	2.21E+05	2.28E+05
	1.45E+02	1.48E+02	1.66E+02	2.09E+02	3.57E+02	4.84E+02	6.11E+02	1.12E+03	1.63E+03	2.13E+03	2.64E+03	3.28E+03	4.34E+03	5.18E+03	6.45E+03	7.72E+03	8.57E+03	1.03E+04	1.28E+04	1.49E+04	1.53E+04
	1.15E+01	1.23E+01	3.42E+01	7.96E+01	2.39E+02	3.75E+02	6.11E+02	1.06E+03	1.60E+03	2.15E+03	2.69E+03	3.37E+03	4.51E+03	5.42E+03	6.78E+03	8.14E+03	9.05E+03	1.09E+04	1.36E+04	1.59E+04	1.63E+04
	8.18E+03	8.55E+03	1.91E+04	4.09E+04	1.17E+05	1.83E+05	2.48E+05	5.10E+05	7.71E+05	1.03E+06	1.29E+06	1.62E+06	2.17E+06	2.60E+06	3.26E+06	3.91E+06	4.34E+06	5.21E+06	6.52E+06	7.61E+06	7.82E+06
	1.70E+03	1.78E+03	3.95E+03	8.37E+03	2.31E+04	3.49E+04	4.59E+04	8.35E+04	1.13E+05	1.35E+05	1.52E+05	1.68E+05	1.86E+05	1.94E+05	2.02E+05	2.06E+05	2.07E+05	2.09E+05	2.10E+05	2.10E+05	2.10E+05
	1.82E+04	1.91E+04	4.25E+04	9.11E+04	2.61E+05	4.06E+05	5.50E+05	1.12E+06	1.69E+06	2.25E+06	2.80E+06	3.49E+06	4.60E+06	5.48E+06	6.75E+06	7.99E+06	8.80E+06	1.04E+07	1.26E+07	1.44E+07	1.47E+07
	1.59E+04	1.66E+04	3.34E+04	5.95E+04	1.00E+05	1.10E+05	1.13E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05
	2.16E+04	2.26E+04	4.85E+04	9.71E+04	2.23E+05	2.92E+05	3.38E+05	4.10E+05	4.24E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05
	2.37E+04	2.48E+04	5.54E+04	1.19E+05	3.40E+05	5.28E+05	7.17E+05	1.46E+06	2.20E+06	2.94E+06	3.68E+06	4.55E+06	6.02E+06	7.17E+06	8.85E+06	1.05E+07	1.16E+07	1.36E+07	1.66E+07	1.90E+07	1.94E+07
	2.32E+04	2.42E+04	5.28E+04	1.09E+05	2.72E+05	3.78E+05	4.62E+05	6.49E+05	7.19E+05	7.46E+05	7.55E+05	7.60E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05
	2.36E+04	2.49E+04	5.56E+04	1.19E+05	3.40E+05	5.29E+05	7.17E+05	1.46E+06	2.19E+06	2.90E+06	3.60E+06	4.45E+06	5.83E+06	6.90E+06	8.43E+06	9.88E+06	1.08E+07	1.26E+07	1.50E+07	1.69E+07	1.73E+07
	2.59E+04	2.70E+04	5.98E+04	1.26E+05	3.40E+05	5.04E+05	6.52E+05	1.11E+06	1.42E+06	1.62E+06	1.75E+06	1.86E+06	1.95E+06	1.98E+06	2.00E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06
	1.89E+04	1.97E+04	4.00E+04	7.25E+04	1.27E+05	1.42E+05	1.47E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05
	1.24E+04	1.28E+04	2.29E+04	3.38E+04	4.10E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04
	2.26E+04	2.37E+04	5.28E+04	1.13E+05	3.21E+05	4.97E+05	6.71E+05	1.34E+06	1.98E+06	2.59E+06	3.17E+06	3.85E+06	4.90E+06	5.65E+06	6.68E+06	7.58E+06	8.12E+06	9.07E+06	1.02E+07	1.10E+07	1.11E+07
	9.69E+03	1.01E+04	2.26E+04	4.82E+04	1.37E+05	2.12E+05	2.85E+05	5.69E+05	8.34E+05	1.06E+06	1.32E+06	1.59E+06	2.00E+06	2.29E+06	2.67E+06	3.00E+06	3.19E+06	3.52E+06	3.90E+06	4.13E+06	4.17E+06
	5.05E+00	5.28E+00	1.18E+01	2.52E+01	7.23E+01	1.13E+02	1.53E+02	3.14E+02	4.76E+02	6.37E+02	7.98E+02	1.00E+03	1.34E+03	1.61E+03	2.01E+03	2.41E+03	2.68E+03	3.22E+03	4.03E+03	4.70E+03	4.83E+03
	1.26E+03	1.32E+03	2.95E+03	6.31E+03	1.81E+04	2.82E+04	3.82E+04	7.84E+04	1.18E+05	1.58E+05	1.98E+05	2.47E+05	3.29E+05	3.94E+05	4.90E+05	5.85E+05	6.48E+05	7.73E+05	9.57E+05	1.11E+06	1.14E+06
	1.38E+02	1.44E+02	3.21E+02	6.89E+02	1.97E+03	3.06E+03	4.18E+03	8.56E+03	1.30E+04	1.74E+04	2.18E+04	2.73E+04	3.65E+04	4.38E+04	5.48E+04	6.56E+04	7.32E+04	8.78E+04	1.10E+05	1.28E+05	1.32E+05

Gamma (Photon) Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.0336	3	6	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	9.58E+20	1.01E+21	2.39E+21	6.23E+21	1.50E+22	2.32E+22	3.13E+22	6.17E+22	8.97E+22	1.15E+23	1.39E+23	1.66E+23	2.04E+23	2.30E+23	2.63E+23	2.90E+23	3.04E+23	3.28E+23	3.53E+23	3.67E+23	3.70E+23
	5.49E+21	6.72E+21	1.14E+22	1.90E+22	2.71E+22	2.81E+22	2.82E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22
	3.02E+21	3.17E+21	7.39E+21	1.57E+22	4.08E+22	5.82E+22	7.23E+22	1.08E+23	1.23E+23	1.31E+23	1.34E+23	1.35E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23
	6.27E+21	6.43E+21	8.52E+21	1.07E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22
	6.63E+21	6.94E+21	1.65E+22	3.07E+22	6.45E+22	7.91E+22	8.89E+22	9.51E+22	9.67E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22
	4.69E+17	4.94E+17	1.19E+18	2.63E+18	7.63E+18	1.19E+19	1.61E+19	3.25E+19	4.83E+19	6.36E+19	7.83E+19	9.59E+19	1.24E+20	1.44E+20	1.73E+20	1.99E+20	2.15E+20	2.44E+20	2.82E+20	3.08E+20	3.13E+20
	8.65E+20	9.09E+20	2.19E+21	4.85E+21	1.42E+22	2.21E+22	3.01E+22	6.20E+22	9.38E+22	1.26E+23	1.57E+23	1.97E+23	2.63E+23	3.16E+23	3.95E+23	4.74E+23	5.26E+23	6.31E+23	7.87E+23	9.17E+23	9.43E+23
	3.34E+20	3.52E+20	8.46E+20	1.87E+21	5.42E+21	8.41E+21	1.14E+22	2.28E+22	3.37E+22	4.40E+22	5.37E+22	6.52E+22	8.28E+22	9.55E+22	1.13E+23	1.28E+23	1.37E+23	1.52E+23	1.71E+23	1.83E+23	1.86E+23
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.34E+19	3.49E+19	7.76E+19	1.65E+20	4.61E+20	7.02E+20	9.33E+20	1.76E+21	2.45E+21	3.03E+21	3.51E+21	4.00E+21	4.61E+21	4.96E+21	5.32E+21	5.55E+21	5.65E+21	5.78E+21	5.88E+21	5.92E+21	5.92E+21
	1.71E+20	1.78E+20	3.86E+20	6.73E+20	1.22E+21	1.38E+21	1.45E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21
	2.19E+17	2.29E+17	4.91E+17	9.77E+17	2.21E+18	2.86E+18	3.27E+18	3.89E+18	4.00E+18	4.01E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18
	7.62E+16	7.96E+16	1.78E+17	3.81E+17	1.09E+18	1.70E+18	2.31E+18	4.72E+18	7.12E+18	9.51E+18	1.19E+19	1.48E+19	1.97E+19	2.35E+19	2.92E+19	3.48E+19	3.85E+19	4.57E+19	5.63E+19	6.48E+19	6.65E+19
	3.61E+18	3.72E+18	6.23E+18	8.47E+18	9.43E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18
	8.79E+17	9.19E+17	2.05E+18	4.39E+18	1.25E+19	1.95E+19	2.64E+19	5.37E+19	8.05E+19	1.07E+20	1.32E+20	1.64E+20	2.14E+20	2.53E+20	3.09E+20	3.82E+20	3.98E+20	4.80E+20	5.49E+20	6.16E+20	6.29E+20
	9.39E+19	9.81E+19	2.16E+20	4.53E+20	1.20E+21	1.75E+21	2.23E+21	3.60E+21	4.39E+21	4.84E+21	5.10E+21	5.28E+21	5.40E+21	5.43E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21
	1.53E+20	1.60E+20	3.56E+20	7.56E+20	2.10E+21	3.19E+21	4.22E+21	7.84E+21	1.06E+22	1.31E+22	1.50E+22	1.69E+22	1.91E+22	2.03E+22	2.15E+22	2.21E+22	2.24E+22	2.28E+22	2.30E+22	2.31E+22	2.31E+22
	2.69E+16	2.81E+16	6.27E+16	1.34E+17	3.84E+17	5.97E+17	8.10E+17	1.65E+18	2.49E+18	3.31E+18	4.11E+18	5.11E+18	6.73E+18	8.00E+18	9.84E+18	1.16E+19	1.28E+19	1.50E+19	1.82E+19	2.06E+19	2.11E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.65E+20	1.72E+20	3.69E+20	7.36E+20	1.67E+21	2.17E+21	2.49E+21	2.97E+21	3.05E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21
	2.59E+20	2.70E+20	5.27E+20	8.94E+20	1.35E+21	1.42E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21
	6.04E+18	6.24E+18	1.09E+19	1.56E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	6.57E+19	6.86E+19	1.53E+20	3.27E+20	9.31E+20	1.44E+21	1.94E+21	3.89E+21	5.73E+21	7.47E+21	9.12E+21	1.11E+22	1.40E+22	1.62E+22	1.90E+22	2.15E+22	2.30E+22	2.56E+22	2.87E+22	3.07E+22	3.11E+22
	1.31E+18	1.37E+18	3.06E+18	6.56E+18	1.88E+19	2.92E+19	3.97E+19	8.11E+19	1.22E+20	1.63E+20	2.03E+20	2.53E+20	3.34E+20	3.99E+20	4.93E+20	5.85E+20	6.45E+20	7.62E+20	9.31E+20	1.07E+21	1.09E+21
	3.94E+18	4.16E+18	9.29E+18	1.99E+19	5.71E+19	8.89E+19	1.21E+20	2.48E+20	3.75E+20	5.03E+20	6.30E+20	7.89E+20	1.05E+21	1.26E+21	1.58E+21	1.90E+21	2.11E+21	2.53E+21	3.16E+21	3.69E+21	3.79E+21
	6.83E+18	7.13E+18	1.58E+19	3.36E+19	9.28E+19	1.40E+20	1.85E+20	3.37E+20	4.56E+20	5.48E+20	6.19E+20	6.87E+20	7.61E+20	7.98E+20	8.31E+20	8.49E+20	8.56E+20	8.63E+20	8.67E+20	8.68E+20	8.68E+20
	4.18E+18	4.35E+18	9.14E+18	1.75E+19	3.54E+19	4.26E+19	4.62E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19	4.96E+19
	1.79E+19	1.87E+19	4.17E+19	8.94E+19	2.56E+20	3.97E+20	5.38E+20	1.10E+21	1.65E+21	2.18E+21	2.71E+21	3.36E+21	4.41E+21	5.23E+21	6.40E+21	7.53E+21	8.25E+21	9.63E+21	1.16E+22	1.30E+22	1.33E+22
	1.59E+19	1.66E+19	3.41E+19	6.29E+19	1.15E+20	1.31E+20	1.37E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.83E+18	1.91E+18	4.22E+18	8.86E+18	2.37E+19	3.50E+19	4.50E+19	7.50E+19	9.38E+19	1.05E+20	1.13E+20	1.18E+20	1.22E+20	1.24E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20
	6.08E+17	6.35E+17	1.42E+18	3.03E+18	8.67E+18	1.35E+19	1.82E+19	3.71E+19	5.56E+19	7.36E+19	9.13E+19	1.13E+20	1.48E+20	1.74E+20	2.13E+20	2.49E+20	2.72E+20	3.16E+20	3.76E+20	4.22E+20	4.30E+20
	2.07E+18	2.16E+18	4.78E+18	9.99E+18	2.67E+19	3.91E+19	5.01E+19	8.25E+19	1.02E+20	1.14E+20	1.21E+20	1.26E+20	1.30E+20	1.31E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20
	1.22E+17	1.28E+17	2.85E+17	6.11E+17	1.75E+18	2.73E+18	3.70E+18	7.59E+18	1.15E+19	1.54E+19	1.92E+19	2.40E+19	3.20E+19	3.84E+19	4.79E+19	5.74E+19	6.36E+19	7.61E+19	9.46E+19	1.10E+20	1.13E+20
	1.61E+19	1.68E+19	3.72E+19	7.88E+19	2.16E+20	3.25E+20	4.27E+20	7.65E+20	1.02E+21	1.20E+21	1.34E+21	1.47E+21	1.60E+21	1.66E+21	1.71E+21	1.73E+21	1.74E+21	1.75E+21	1.75E+21	1.75E+21	1.75E+21
	5.06E+13	5.29E+13	1.18E+14	2.53E+14	7.26E+14	1.13E+15	1.54E+15	3.16E+15	4.78E+15	6.40E+15	8.02E+15	1.00E+16	1.34E+16	1.61E+16	2.02E+16	2.42E+16	2.69E+16	3.23E+16	4.04E+16	4.72E+16	4.85E+16
	1.26E+13	1.27E+13	1.45E+13	1.82E+13	3.11E+13	4.22E+13	6.32E+13	9.75E+13	1.42E+14	1.86E+14	2.30E+14	2.86E+14	3.78E+14	4.52E+14	5.62E+14	6.73E+14	7.47E+14	8.94E+14	1.12E+15	1.30E+15	1.34E+15
	2.34E+12	2.49E+12	6.95E+12	1.62E+13	4.85E+13	7.62E+13	1.04E+14	2.15E+14	3.26E+14	4.36E+14	5.47E+14	6.86E+14	9.17E+14	1.10E+15	1.38E+15	1.66E+15	1.84E+15	2.21E+15	2.76E+15	3.23E+15	3.32E+15
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.78E+15	9.17E+15	2.05E+16	4.39E+16	1.26E+17	1.95E+17	2.65E+17	5.41E+17	8.14E+17	1.08E+18	1.35E+18	1.66E+18	2.22E+18	2.64E+18	3.25E+18	3.85E+18	4.24E+18	4.99E+18	6.07E+18	6.92E+18	7.06E+18
	5.34E+17	5.56E+17	1.12E+18	2.00E+18	3.36E+18	3.66E+18	3.78E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18
	2.57E+17	2.68E+17	5.76E+17	1.15E+18	2.65E+18	3.47E+18	4.01E+18	4.67E+18	5.03E+18	5.06E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18
	2.32E+18	2.43E+18	5.42E+18	1.16E+19	3.32E+19	5.17E+19	7.01E+19	1.43E+20	2.16E+20	2.87E+20	3.56E+20	4.46E+20	5.89E+20	7.01E+20	8.66E+20	1.03E+21	1.13E+21	1.33E+21	1.63E+21	1.86E+21	1.90E+21
	5.57E+17	5.82E+17	1.27E+18	2.81E+18	8.53E+18	9.10E+18	1.11E+19	1.56E+19	1.73E+19	1.79E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	2.43E+18	2.54E+18	5.66E+18	1.21E+19	3.47E+19	5.39E+19	7.30E+19	1.49E+20	2.23E+20	2.95E+20	3.66E+20	4.53E+20	5.94E+20	7.02E+20	8.58E+20	1.01E+21	1.10E+21	1.26E+21	1.53E+21	1.72E+21	1.76E+21
	7.99E+18	8.34E+18	1.85E+19	3.88E+19	1.05E+20	1.56E+20	2.01E+20	3.43E+20	4.37E+20	5.00E+20	5.41E+20	5.73E+20	6.01E+20	6.11E+20	6.18E+20	6.20E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20
	1.07E+17	1.12E+17	2.27E+17	4.12E+17	7.22E+17	8.05E+17	8.34E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17
	4.48E+18	4.64E+18	8.28E+18	1.22E+19	1.48E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.82E+17	1.90E+17	4.23E+17	9.04E+17	2.57E+18	3.97E+18	5.35E+18	1.07E+19	1.56E+19	2.03E+19	2.47E+19	2.98E+19	3.75E+19	4.30E+19	5.01E+19	5.83E+19	5.98E+19	6.80E+19	7.30E+19	7.74E+19	7.82E+19
	1.89E+13	1.98E+13	4.41E+13	9.44E+13	2.71E+14	4.22E+14	5.73E+14	1.18E+15	1.78E+15	2.38E+15	2.99E+15	3.74E+15	5.00E+15	6.01E+15	7.52E+15	9.03E+15	1.00E+16	1.20E+16	1.51E+16	1.76E+16	1.81E+16
	2.82E+14	2.94E+14	6.57E+14	1.41E+15	4.03E+15	6.28E+15	8.53E+15	1.75E+16	2.64E+16	3.53E+16	4.41E+16	5.51E+16	7.33E+16	8.78E+16	1.09E+17	1.31E+17	1.45E+17	1.72E+17	2.13E+17	2.47E+17	2.53E+17
	2.73E+13	2.86E+13	6.38E+13	1.37E+14	3.92E+14	6.10E+14	8.29E+14	1.70E+15	2.56E+15	3.45E+15	4.33E+15	5.42E+15	7.24E+15	8.70E+15	1.09E+16	1.31E+16	1.45E+16	1.74E+16	2.16E+16	2.54E+16	2.62E+16
	2.36E+22	2.46E+22	5.05E+22	9.25E+22	1.88E+23	2.44E+23	2.88E+23	4.15E+23	6.10E+23	6.92E+23	6.85E+23	7.51E+23	8.82E+23	9.79E+23	1.11E+24	1.24E+24	1.32E+24	1.47E+24	1.66E+24	1.84E+24	1.87E+24

TOTAL Integrated Gamma Energy in Suppression Pool Water at Given Timesteps (MeV/cm³)

4.76E+12	4.97E+12	1.02E+13	1.87E+13	3.80E+13	4.92E+13	5.82E+13	8.38E+13	1.03E+14	1.19E+14	1.34E+14	1.52E+14	1.78E+14	1.98E+14	2.25E+14	2.50E+14	2.66E+14	2.96E+14	3.38E+14	3.71E+14	3.77E+14

TOTAL Integrated Gamma Dose in Pool at Given Timesteps (Mrad)

7.83E-02	7.98E-02	1.63E-01	2.99E-01	6.09E-01	7.89E-01	9.32E-01	1.34E+00	1.65E+00	1.91E+00	2.15E+00	2.43E+00	2.85E+00	3.18E+00	3.60E+00	4.01E+00	4.27E+00	4.75E+00	5.42E+00	5.94E+00	6.04E+00

TOTAL Gamma + Beta Pool Dose (Mrad)

1.00E-01	1.04E-01	2.16E-01	3.99E-01	8.29E-01	1.09E+00	1.29E+00	1.86E+00	2.31E+00	2.68E+00	3.00E+00	3.37E+00	3.94E+00	4.36E+00	4.94E+00	5.47E+00	5.81E+00	6.44E+00	7.30E+00	7.97E+00	8.09E+00

Beta Particle Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.8336	3	6	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	4.56E+20	4.79E+20	1.14E+21	2.49E+21	7.16E+21	1.11E+22	1.49E+22	2.94E+22	4.27E+22	5.49E+22	6.61E+22	7.88E+22	9.71E+22	1.10E+23	1.25E+23	1.38E+23	1.45E+23	1.56E+23	1.68E+23	1.75E+23	1.78E+23
	1.16E+21	1.21E+21	2.42E+21	4.04E+21	5.76E+21	5.95E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21
	2.03E+21	2.13E+21	4.96E+21	1.05E+22	2.74E+22	3.90E+22	4.85E+22	7.22E+22	8.26E+22	8.76E+22	8.97E+22	9.09E+22	9.14E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22
	1.21E+21	1.25E+21	1.96E+21	2.45E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21
	1.55E+21	1.62E+21	3.62E+21	7.17E+21	1.61E+22	1.85E+22	2.03E+22	2.22E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22
	3.31E+18	3.49E+18	8.41E+18	1.86E+19	5.39E+19	8.36E+19	1.14E+20	2.30E+20	3.41E+20	4.49E+20	5.53E+20	6.77E+20	8.72E+20	1.02E+21	1.22E+21	1.40E+21	1.52E+21	1.72E+21	1.99E+21	2.18E+21	2.21E+21
	8.72E+19	9.17E+19	2.21E+20	4.90E+20	1.43E+21	2.23E+21	3.04E+21	6.25E+21	9.46E+21	1.27E+22	1.59E+22	1.99E+22	2.65E+22	3.19E+22	3.98E+22	4.78E+22	5.31E+22	6.36E+22	7.94E+22	9.25E+22	9.61E+22
	1.54E+19	1.62E+19	3.91E+19	8.64E+19	2.50E+20	3.88E+20	5.25E+20	1.05E+21	1.55E+21	2.03E+21	2.48E+21	3.01E+21	3.82E+21	4.41E+21	5.20E+21	5.89E+21	6.30E+21	7.02E+21	7.90E+21	8.46E+21	8.66E+21
	5.92E+19	6.22E+19	1.50E+20	3.32E+20	9.69E+20	1.52E+21	2.06E+21	4.25E+21	6.43E+21	8.62E+21	1.08E+22	1.35E+22	1.81E+22	2.17E+22	2.72E+22	3.26E+22	3.83E+22	4.35E+22	5.45E+22	6.35E+22	6.64E+22
	1.57E+19	1.64E+19	3.65E+19	7.75E+19	2.17E+20	3.30E+20	4.39E+20	8.27E+20	1.15E+21	1.42E+21	1.65E+21	1.88E+21	2.17E+21	2.33E+21	2.50E+21	2.61E+21	2.65E+21	2.72E+21	2.76E+21	2.78E+21	2.78E+21
	4.29E+19	4.48E+19	9.15E+19	1.68E+20	3.06E+20	3.46E+20	3.61E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20
	1.01E+19	1.05E+19	2.26E+19	4.50E+19	1.02E+20	1.32E+20	1.51E+20	1.79E+20	1.84E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20
	3.13E+16	3.27E+16	7.30E+16	1.56E+17	4.48E+17	6.97E+17	9.46E+17	1.94E+18	2.92E+18	3.90E+18	4.87E+18	6.08E+18	8.07E+18	9.65E+18	1.20E+19	1.43E+19	1.56E+19	1.87E+19	2.31E+19	2.66E+19	2.73E+19
	3.26E+19	3.39E+19	6.67E+19	7.71E+19	8.56E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19
	4.72E+18	4.94E+18	1.10E+19	2.36E+19	6.74E+19	1.05E+20	1.42E+20	2.89E+20	4.33E+20	5.73E+20	7.11E+20	8.80E+20	1.15E+21	1.36E+21	1.66E+21	1.95E+21	2.13E+21	2.47E+21	2.95E+21	3.31E+21	3.36E+21
	9.52E+18	9.94E+18	2.19E+19	4.59E+19	1.22E+20	1.77E+20	2.26E+20	3.65E+20	4.45E+20	4.91E+20	5.17E+20	5.35E+20	5.47E+20	5.50E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20
	3.95E+19	4.12E+19	9.16E+19	1.95E+20	5.41E+20	8.21E+20	1.09E+21	2.02E+21	2.77E+21	3.36E+21	3.87E+21	4.36E+21	4.93E+21	5.23E+21	5.53E+21	5.70E+21	5.78E+21	5.86E+21	5.92E+21	5.94E+21	5.94E+21
	1.15E+20	1.20E+20	2.66E+20	5.74E+20	1.64E+21	2.55E+21	3.46E+21	7.07E+21	1.06E+22	1.41E+22	1.76E+22	2.18E+22	2.88E+22	3.42E+22	4.21E+22	4.97E+22	5.46E+22	6.42E+22	7.77E+22	8.82E+22	9.03E+22
	4.39E+18	4.58E+18	1.02E+19	2.19E+19	6.29E+19	9.80E+19	1.33E+20	2.73E+20	4.14E+20	5.54E+20	6.94E+20	8.70E+20	1.16E+21	1.40E+21	1.75E+21	2.10E+21	2.33E+21	2.80E+21	3.50E+21	4.08E+21	4.20E+21
	1.57E+20	1.64E+20	3.51E+20	7.00E+20	1.59E+21	2.06E+21	2.37E+21	2.82E+21	2.90E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21
	3.87E+19	4.03E+19	7.87E+19	1.34E+20	2.02E+20	2.13E+20	2.15E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20
	1.54E+20	1.59E+20	2.77E+20	3.96E+20	4.63E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20
	9.33E+19	9.75E+19	2.17E+20	4.65E+20	1.32E+21	2.05E+21	2.76E+21	5.52E+21	8.14E+21	1.06E+22	1.30E+22	1.57E+22	1.99E+22	2.29E+22	2.70E+22	3.06E+22	3.27E+22	3.64E+22	4.06E+22	4.36E+22	4.41E+22
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.52E+17	1.59E+17	3.55E+17	7.61E+17	2.18E+18	3.40E+18	4.62E+18	9.48E+18	1.43E+19	1.92E+19	2.41E+19	3.01E+19	4.03E+19	4.84E+19	6.05E+19	7.26E+19	8.07E+19	9.68E+19	1.21E+20	1.41E+20	1.45E+20
	1.73E+19	1.81E+19	4.02E+19	8.52E+19	2.35E+20	3.56E+20	4.69E+20	8.56E+20	1.16E+21	1.39E+21	1.57E+21	1.74E+21	1.93E+21	2.03E+21	2.11E+21	2.15E+21	2.17E+21	2.19E+21	2.20E+21	2.20E+21	2.20E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.50E+18	2.61E+18	5.83E+18	1.25E+19	3.57E+19	5.55E+19	7.52E+19	1.53E+20	2.30E+20	3.05E+20	3.79E+20	4.69E+20	6.16E+20	7.29E+20	8.93E+20	1.05E+21	1.15E+21	1.34E+21	1.61E+21	1.82E+21	1.86E+21
	8.17E+18	8.51E+18	1.75E+19	3.23E+19	5.91E+19	6.73E+19	7.06E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19
	1.53E+17	1.60E+17	3.57E+17	7.64E+17	2.19E+18	3.41E+18	4.63E+18	9.51E+18	1.44E+19	1.92E+19	2.41E+19	3.01E+19	4.02E+19	4.82E+19	6.02E+19	7.21E+19	8.00E+19	9.58E+19	1.19E+20	1.39E+20	1.42E+20
	3.58E+18	3.74E+18	8.27E+18	1.74E+19	4.65E+19	6.66E+19	8.81E+19	1.47E+20	1.84E+20	2.07E+20	2.21E+20	2.32E+20	2.40E+20	2.43E+20	2.44E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20
	1.14E+18	1.20E+18	2.67E+18	5.71E+18	1.63E+19	2.54E+19	3.44E+19	6.99E+19	1.05E+20	1.39E+20	1.72E+20	2.13E+20	2.78E+20	3.28E+20	4.00E+20	4.69E+20	5.12E+20	5.95E+20	7.08E+20	7.94E+20	8.10E+20
	3.10E+18	3.23E+18	7.14E+18	1.50E+19	4.00E+19	5.66E+19	7.61E+19	1.24E+20	1.53E+20	1.71E+20	1.81E+20	1.89E+20	1.95E+20	1.96E+20	1.97E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20
	5.26E+17	5.51E+17	1.23E+18	2.64E+18	7.56E+18	1.18E+19	1.60E+19	3.28E+19	4.96E+19	6.63E+19	8.30E+19	1.04E+20	1.38E+20	1.66E+20	2.07E+20	2.48E+20	2.75E+20	3.29E+20	4.09E+20	4.75E+20	4.88E+20
	1.07E+19	1.12E+19	2.49E+19	5.27E+19	1.45E+20	2.18E+20	2.85E+20	5.12E+20	6.80E+20	8.06E+20	8.99E+20	9.83E+20	1.07E+21	1.11E+21	1.14E+21	1.16E+21	1.16E+21	1.17E+21	1.17E+21	1.17E+21	1.17E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.70E+15	5.95E+15	1.33E+16	2.85E+16	8.17E+16	1.27E+17	1.73E+17	3.55E+17	5.37E+17	7.20E+17	9.02E+17	1.13E+18	1.51E+18	1.81E+18	2.27E+18	2.72E+18	3.03E+18	3.63E+18	4.54E+18	5.30E+18	5.45E+18
	2.12E+17	2.22E+17	4.92E+17	1.04E+18	2.88E+18	4.34E+18	5.72E+18	1.04E+19	1.40E+19	1.68E+19	1.89E+19	2.10E+19	2.31E+19	2.42E+19	2.52E+19	2.58E+19	2.58E+19	2.60E+19	2.61E+19	2.62E+19	2.62E+19
	1.46E+18	1.53E+18	3.41E+18	7.31E+18	2.09E+19	3.25E+19	4.41E+19	9.02E+19	1.36E+20	1.81E+20	2.25E+20	2.80E+20	3.69E+20	4.39E+20	5.42E+20	6.41E+20	7.06E+20	8.32E+20	1.01E+21	1.15E+21	1.18E+21
	3.07E+18	3.19E+18	6.42E+18	1.15E+19	1.93E+19	2.11E+19	2.17E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19
	3.38E+18	3.52E+18	7.56E+18	1.52E+19	3.49E+19	4.56E+19	5.26E+19	6.41E+19	6.62E+19	6.67E+19	6.67E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19
	3.67E+17	3.84E+17	8.57E+17	1.83E+18	5.25E+18	8.17E+18	1.11E+19	2.27E+19	3.41E+19	4.54E+19	5.66E+19	7.05E+19	9.31E+19	1.11E+20	1.37E+20	1.62E+20	1.79E+20	2.11E+20	2.57E+20	2.93E+20	3.01E+20
	2.15E+18	2.25E+18	4.91E+18	1.01E+19	2.62E+19	3.51E+19	4.29E+19	6.03E+19	6.66E+19	6.93E+19	7.02E+19	7.06E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19
	1.38E+17	1.44E+17	3.22E+17	6.89E+17	1.97E+18	3.06E+18	4.15E+18	8.44E+18	1.26E+19	1.68E+19	2.08E+19	2.58E+19	3.37E+19	3.99E+19	4.87E+19	5.72E+19	6.26E+19	7.26E+19	8.70E+19	9.78E+19	9.99E+19
	1.82E+18	1.90E+18	4.20E+18	8.85E+18	2.38E+19	3.54E+19	4.58E+19	7.82E+19	9.96E+19	1.14E+20	1.23E+20	1.31E+20	1.37E+20	1.39E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	2.39E+18	2.48E+18	5.05E+18	9.18E+18	1.60E+19	1.79E+19	1.85E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19
	1.39E+18	1.44E+18	2.57E+18	3.81E+18	4.62E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18
	9.52E+17	9.95E+17	2.22E+18	4.74E+18	1.35E+19	2.09E+19	2.82E+19	5.65E+19	8.34E+19	1.09E+20	1.33E+20	1.62E+20	2.06E+20	2.38E+20	2.81E+20	3.19E+20	3.41E+20	3.81E+20	4.30E+20	4.62E+20	4.67E+20
	3.01E+17	3.15E+17	7.02E+17	1.50E+18	4.26E+18	6.59E+18	8.86E+18	1.77E+19	2.59E+19	3.37E+19	4.10E+19	4.95E+19	6.22E+19	7.13E+19	8.32E+19	9.33E+19	9.93E+19	1.09E+20	1.21E+20	1.28E+20	1.30E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	7.35E+21	7.87E+21	1.62E+22	3.08E+22	6.81E+22	9.19E+22	1.11E+23	1.67E+23	2.06E+23	2.37E+23	2.63E+23	2.93E+23	3.37E+23	3.70E+23	4.13E+23	4.53E+23	4.77E+23	5.22E+23	5.82E+23	6.27E+23	6.35E+23

Total Integrated Beta Energy in Suppression Pool Water at Given Timesteps (MeV/cm³)

1.48E+12	1.55E+12	3.27E+12	6.22E+12	1.38E+13	1.85E+13	2.25E+13	3.37E+13	4.15E+13	4.77E+13	5.31E+13	5.91E+13	6.81E+13	7.46E+13	8.34E+13	9.14E+13	9.63E+13	1.05E+14	1.17E+14	1.26E+14	1.28E+14

TOTAL Integrated Beta Dose in Pool at Given Timesteps (Mrad)

2.36E-02	2.48E-02	5.24E-02	9.97E-02	2.20E-01	2.97E-01	3.60E-01	5.40E-01	6.65E-01	7.65E-01	8.51E-01	9.47E-01	1.09E+00	1.19E+00	1.34E+00	1.46E+00	1.54E+00	1.69E+00	1.88E+00	2.03E+00	2.05E+00

Assessment of Core Iodines and Cesiums for Post-LOCA pH Determination

The inventories below are taken from Calculation LM-0645 (Ref. 5-9), Attachment A. For this analysis it is conservative to maximize Iodines, which form acids, and to minimize Cesiums, which provide neutralization before Standby Liquid Control System injection of sodium pentaborate. Both End-of-Cycle (EOC) and near Beginning-of-Cycle (BOC) conditions are modeled with the BOC conditions limiting for pH purposes. The rounding below is to provide additional conservatism.

	100 EFPD (grams)	EOC (grams)
I-127	4.533E+03	8.040E+03
I-129	1.571E+04	2.727E+04
I-131	7.369E+02	7.615E+02
I-132	1.296E+01	1.321E+01
I-133	1.723E+02	1.699E+02
I-134	8.118E+00	7.936E+00
I-135	5.195E+01	5.140E+01
Total	**2.123E+04**	**3.631E+04**
Cs-133	1.025E+05	1.678E+05
Cs-134	1.031E+04	1.977E+04
Cs-135	4.502E+04	7.841E+04
Cs-137	1.087E+05	1.832E+05
Total	**2.665E+05**	**4.492E+05**

	At. Mass	100 EFPD (gm-moles)	EOC (gm-moles)	Ratio
I-127	126.9045	3.572E+01	6.335E+01	0.564
I-129	128.9050	1.219E+02	2.116E+02	0.576
I-131	130.9061	5.629E+00	5.817E+00	0.968
I-132	131.9069	9.825E-02	1.001E-01	0.982
I-133	132.9078	1.296E+00	1.278E+00	1.014
I-134	133.9099	6.062E-02	5.926E-02	1.023
I-135	134.9100	3.851E-01	3.810E-01	1.011
Total		**1.651E+02**	**2.826E+02**	**0.584**
for conservatism, use		**170**	**290**	
Cs-133	132.9054	7.712E+02	1.263E+03	0.611
Cs-134	133.9067	7.699E+01	1.476E+02	0.522
Cs-135	134.9059	3.337E+02	5.812E+02	0.574
Cs-137	136.9071	7.940E+02	1.338E+03	0.593
Total		**1.976E+03**	**3.330E+03**	**0.593**
for conservatism, use		**1600**	**3200**	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	LIMERICK pH CALCULATION					pH TRANSIENT	BEGINNING OF CYCLE				Cable Data [22]				
2							Linear Absorption Coefficients [4]			$S_{A\ tray}$ [cm²]	2,668,443	Cable Surface [trays]- Drywell + 10% contingency			
3	V_{POOL}	4.955E+06	Liters [175,000 ft³] [13]				$U_{beta\ air}$	1.980E-02	1/cm	$S_{A\ fa}$ [cm²]	133,422	Cable Surface [free air]- Drywell + 10% contingency			
4	m_I	1.700E+02	Iodine inventory [g-atoms] BOC [19]				$U_{beta\ hypalon}$	52.08	1/cm	$S_{B\ tray}$ [cm²]	0	Cable Surface [trays] - Supp. Pool + 10% contingency			
5	m_{Cs}	1.600E+03	Cesium inventory [g-atoms] BOC [19]				$U_{gamma\ air}$	3.75E-05	1/cm	$S_{B\ fa}$ [cm²]	0	Cable Surface [free air] - Supp. Pool + 10% contingency			
6	t_{gap}	3.361E-02	Onset of Gap release [hrs] [20]				$U_{gamma\ hypalon}$	0.099	1/cm						
7							$r_{(gamma\ free\ path-DRYWELL)}$ [16]	1310.42	cm	th [cm]	0.62992	Hypalon Jacket Thickness [22]			
8							$r_{(gamma\ free\ path-SUPP\ POOL\ AIR)}$ [16]	1310.42	cm						
9				INTEGRATED DOSES											
10			Beta+Gamma [18]	Gamma [18]	Beta [18]	Gamma [18]	Beta [18]			From Beta	From Gamma	From Beta	From Gamma		
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp. Pool AIR	Supp. Pool AIR	[HI] [1]	[HNO_3] [2]	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]	[HCL] -CONTAIN [5]	[HCL] -CONTAIN [6]	Total [H+] [7]	[CsOH] [3]
12	Hours	Deg F [17]	Mrad	MeV/cm³	MeV/cm³	MeV/cm³	MeV/cm³	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-ions/liter	g-mols/liter
13	0	95						0.00E+00						5.012E-06	0 000E+00
14	1	187.2						2.191E-07						5.231E-06	3.206E-05
15	2	195.8	1.001E-01	3.956E+12	1.730E+12	3.956E+12	1.730E+12	5.050E-07	7.306E-07	8.675E-07	5.784E-06	0.000E+00	0.000E+00	1.290E-05	6.968E-05
16	2.0336	195.8	1.044E-01	4.121E+12	1.802E+12	4.121E+12	1.802E+12	5.146E-07	7.619E-07	9.037E-07	6.025E-06	0.000E+00	0.000E+00	1.322E-05	7.094E-05
17	3	199.9	2.158E-01	8.368E+12	3.689E+12	8.368E+12	3 689E+12	5.146E-07	1.575E-06	1.850E-06	1.223E-05	0.000E+00	0.000E+00	2.118E-05	7.094E-05
18	5	203.1	3.988E-01	1.505E+13	6.797E+12	1.505E+13	6.797E+12	5.146E-07	2.911E-06	3.408E-06	2.201E-05	0 000E+00	0.000E+00	3.385E-05	7.094E-05
19	12	199.5	8.293E-01	2.878E+13	1.421E+13	2.878E+13	1.421E+13	5.146E-07	6.054E-06	7.124E-06	4.208E-05	0.000E+00	0.000E+00	6.078E-05	7.094E-05
20	18	193.1	1.086E+00	3.595E+13	1.881E+13	3.595E+13	1.881E+13	5.146E-07	7.927E-06	9.432E-06	5.256E-05	0.000E+00	0.000E+00	7.544E-05	7.094E-05
21	24	186.6	1.292E+00	4.145E+13	2.263E+13	4.145E+13	2.263E+13	5.146E-07	9.429E-06	1.135E-05	6.060E-05	0.000E+00	0.000E+00	8.690E-05	7.094E-05
22	48	186 6	1.883E+00	5.709E+13	3.409E+13	5.709E+13	3.409E+13	5.146E-07	1.375E-05	1.709E-05	8.348E-05	0.000E+00	0.000E+00	1.198E-04	7.094E-05
23	72	186.6	2.315E+00	6.878E+13	4.269E+13	6.878E+13	4.269E+13	5.146E-07	1.690E-05	2.141E-05	1.006E-04	0.000E+00	0.000E+00	1.444E-04	7.094E-05
24	96	186.6	2.678E+00	7.877E+13	4.988E+13	7.877E+13	4.988E+13	5.146E-07	1.955E-05	2.501E-05	1.152E-04	0.000E+00	0.000E+00	1.653E-04	7.094E-05
25	120	186.6	3.002E+00	8.778E+13	5.615E+13	8.778E+13	5.615E+13	5.146E-07	2.192E-05	2.815E-05	1.283E-04	0.000E+00	0.000E+00	1.839E-04	7.094E-05
26	150	186.6	3.375E+00	9.807E+13	6.303E+13	9.807E+13	6.303E+13	5.146E-07	2.464E-05	3.160E-05	1.434E-04	0.000E+00	0.000E+00	2.051E-04	7.094E-05
27	200	186.6	3.942E+00	1.135E+14	7.274E+13	1.135E+14	7.274E+13	5.146E-07	2.877E-05	3.647E-05	1.660E-04	0.000E+00	0.000E+00	2.368E-04	7.094E-05
28	240	186.6	4.359E+00	1.247E+14	7.928E+13	1.247E+14	7.928E+13	5.146E-07	3.182E-05	3.975E-05	1.823E-04	0.000E+00	0.000E+00	2.594E-04	7.094E-05
29	300	186.6	4.939E+00	1.400E+14	8.754E+13	1.400E+14	8.754E+13	5.146E-07	3.605E-05	4.389E-05	2.047E-04	0.000E+00	0.000E+00	2.902E-04	7.094E-05
30	360	186.6	5.473E+00	1.538E+14	9.436E+13	1.538E+14	9.436E+13	5.146E-07	3.995E-05	4.732E-05	2.249E-04	0.000E+00	0.000E+00	3.177E-04	7.094E-05
31	400	186.6	5.809E+00	1.624E+14	9.830E+13	1.624E+14	9.830E+13	5.146E-07	4.240E-05	4.929E-05	2.375E-04	0.000E+00	0.000E+00	3.347E-04	7.094E-05
32	480	186.6	6.438E+00	1.784E+14	1.051E+14	1.784E+14	1.051E+14	5.146E-07	4.700E-05	5.269E-05	2.608E-04	0.000E+00	0.000E+00	3.660E-04	7.094E-05
33	600	186.6	7.301E+00	2.000E+14	1.133E+14	2.000E+14	1.133E+14	5.146E-07	5.330E-05	5.681E-05	2.924E-04	0.000E+00	0.000E+00	4.080E-04	7.094E-05
34	700	186.6	7.966E+00	2.166E+14	1.190E+14	2.166E+14	1.190E+14	5.146E-07	5.815E-05	5.967E-05	3.166E-04	0.000E+00	0.000E+00	4.400E-04	7.094E-05
35	720	186.6	8.094E+00	2.198E+14	1.201E+14	2.198E+14	1.201E+14	5.146E-07	5.909E-05	6.020E-05	3.213E-04	0.000E+00	0.000E+00	4.461E-04	7.094E-05
36															
37	NOTES:						14	Acid dissociation constant from: Entergy Eng. Report GGNS-98-0039 Rev.3, Sect 6.1,p.21							
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]					15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7							
39	2	Ibid, Equation 3-2b					16	See attachment B for gamma free paths							
40	3	Ibid, Equation 3-4d [30+90 min release duration]					17	ECR 01-01233 for SIL-636, extrpolated to times beyond 24 hours using the constant value at 24 hours							
41	4	Ibid, Table A-1					18	Attachment B							
42	5	Ibid, Equation 3-3a					19	Attachment B							
43	6	Ibid, Equation 3-3b					20	USNRC Reg. Guide 1.183							
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7					21	See page C-6 of this attachment.							
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					22	Cable Data from Attachment A.							
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7; Initial 5.3 pH value (before Cesium addition) from LGS UFSAR Sec. 6.1.1.2													
50	13	Max. Suppression Pool volume from Calc. body section 4.4, including													
51		UFSAR Table 6.2-4A HWL Suppression Pool volume of 134,600 cu ft, Reactor Coolant System Liquid Volume of 13,108 cu ft													
52		and low-pressure Emergency Core Cooling System sources, roundd up to 175,000 cu. Ft.													
53		(For Attachment B page B-6 minimization of Drywell + Suppression Pool Airspace volume, the LLRT Program													
54		403,120 cu ft value - 175,000 + 122,120 Tech Spec 3/4.5.3 nominal minimum Suppression Pool Volume is used)													

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1				pH TRANSIENT		BEGINNING OF CYCLE							
2	Cable Data [22]												
3	2,425,858	Cable Surface [Trays] - DRYWELL [cm2]											
4	121,293	Cable Surface [Free air] - DRYWELL [cm2]					1008 67	g. mols $Na_2B_{10}O_{16}\cdot 10H_2O$ Added[21]					
5	0	Cable Surface [Free air] - Supp. Pool [cm2]					10086.71	g.atoms total boron[21]					
6	0	Cable Surface [Trays] - Supp. Pool [cm2]											
7													
8						pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTION							
9													
10							Strong Acid						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}\cdot 10H_2O$	Borate	Boric Acid	pK_a	pH	
12	g-ions/liter			g-ions/liter	Before SLC	[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	[15]	
13	1.995E-09	1.369E+01	-2.101E-09	5.014E-06	5.30	6.867E-10	2.485E+01	1008.7	1992	8094	9.16	8.55	
14	3.206E-05	1.249E+01	5.219E-06	1.194E-08	7.92	1.226E-09	5.915E-02	1008.7	2017	8069	8.91	8.31	
15	6.968E-05	1.241E+01	1.289E-05	6.818E-09	8.17	1.276E-09	3.379E-02	1008.7	2017	8069	8.89	8.29	
16	7.094E-05	1.241E+01	1.321E-05	6.707E-09	8.17	1.276E-09	3.323E-02	1008.7	2017	8069	8.89	8.29	
17	7.094E-05	1.237E+01	2.118E-05	8.481E-09	8 07	1.300E-09	4.203E-02	1008.7	2017	8069	8.89	8.28	
18	7.094E-05	1.235E+01	3.384E-05	1.215E-08	7.92	1.319E-09	6.019E-02	1008.7	2017	8069	8 88	8.28	
19	7.094E-05	1.238E+01	6.074E-05	4.103E-08	7.39	1.298E-09	2.033E-01	1008.7	2017	8070	8.89	8.28	
20	7.094E-05	1.244E+01	7.086E-05	4.578E-06	5.34	1.261E-09	2.268E+01	1008.7	1995	8092	8.90	8.29	
21	7.094E-05	1.250E+01	7.092E-05	1.598E-05	4.80	1.223E-09	7.918E+01	1008.7	1938	8149	8.91	8.29	
22	7.094E-05	1.250E+01	7.094E-05	4.891E-05	4.31	1.223E-09	2.423E+02	1008.7	1775	8312	8.91	8.24	
23	7.094E-05	1.250E+01	7.094E-05	7.345E-05	4.13	1.223E-09	3.640E+02	1008.7	1653	8433	8.91	8.21	
24	7.094E-05	1.250E+01	7.094E-05	9.432E-05	4.03	1.223E-09	4.674E+02	1008.7	1550	8537	8.91	8.17	
25	7.094E-05	1.250E+01	7.094E-05	1.130E-04	3.95	1.223E-09	5.599E+02	1008.7	1457	8629	8.91	8.14	
26	7.094E-05	1.250E+01	7.094E-05	1.342E-04	3.87	1.223E-09	6.651E+02	1008.7	1352	8734	8.91	8.10	
27	7.094E-05	1.250E+01	7.094E-05	1.658E-04	3.78	1.223E-09	8.217E+02	1008.7	1196	8891	8.91	8.04	
28	7.094E-05	1.250E+01	7.094E-05	1.885E-04	3.72	1.223E-09	9.341E+02	1008.7	1083	9003	8.91	7.99	
29	7.094E-05	1.250E+01	7.094E-05	2.192E-04	3.66	1.223E-09	1.086E+03	1008.7	931	9156	8.91	7.92	
30	7.094E-05	1.250E+01	7.094E-05	2.468E-04	3.61	1.223E-09	1.223E+03	1008.7	795	9292	8.91	7.84	
31	7.094E-05	1.250E+01	7.094E-05	2.637E-04	3.58	1.223E-09	1.307E+03	1008.7	710	9376	8.91	7.79	
32	7.094E-05	1.250E+01	7.094E-05	2.950E-04	3.53	1.223E-09	1.462E+03	1008.7	555	9531	8.91	7.68	
33	7.094E-05	1.250E+01	7.094E-05	3.371E-04	3.47	1.223E-09	1.670E+03	1008.7	347	9740	8.91	7.46	
34	7.094E-05	1.250E+01	7.094E-05	3.690E-04	3.43	1.223E-09	1.829E+03	1008.7	189	9898	8.91	7.19	
35	7.094E-05	1.250E+01	7.094E-05	3.752E-04	3.43	1.223E-09	1.859E+03	1008.7	158	9928	8.91	7.12	
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**LIMERICK pH CALCULATION**					pH TRANSIENT	END OF CYCLE				**Cable Data [22]**				
2							Linear Absorption Coefficients [4]			$S_{A\,tray}$ [cm²]	2,668,443	Cable Surface [trays]- Drywell + 10% contingency			
3	V_{POOL}	4.955E+06	Liters [175,000 ft³] [13]				$u_{beta\ air}$	1.980E-02	1/cm	$S_{A\,fa}$ [cm²]	133,422	Cable Surface [free air]- Drywell + 10% contingency			
4	m_I	2.900E+02	Iodine Inventory [g-atoms] EOC [19]				$u_{beta\ hypalon}$	52.08	1/cm	$S_{B\,tray}$ [cm²]	0	Cable Surface [trays] - Supp. Pool + 10% contingency			
5	m_{Cs}	3.200E+03	Cesium inventory [g-atoms] EOC [19]				$u_{gamma\ air}$	3.75E-05	1/cm	$S_{B\,fa}$ [cm²]	0	Cable Surface [free air] - Supp. Pool + 10% contingency			
6	t_{gap}	3.361E-02	Onset of Gap release [hrs] [20]				$u_{gamma\ hypalon}$	0.099	1/cm						
7							$r_{[gamma\ free\ path-DRYWELL]}$ [18]	1310.42	cm	th [cm]	0.70514	Hypalon Jacket Thickness [22]			
8							$r_{[gamma\ free\ path-SUPP\ POOL\ AIR]}$ [18]	1310.42	cm						
9				INTEGRATED DOSES											
10			Beta+Gamma [18]	Gamma [18]	Beta [18]	Gamma [18]	Beta [18]			From Beta	From Gamma	From Beta	From Gamma		
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp. Pool AIR	Supp. Pool AIR	[HI] [1]	[HNO_3] [2]	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]	[HCL] -CONTAIN [5]	[HCL] -CONTAIN [6]	Total [H+] [7]	[CsOH] [3]
12	Hours	Deg F [17]	Mrad	MeV/cm³	MeV/cm³	MeV/cm³	MeV/cm³	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-ions/liter	g-mols/liter
13	0	95						0.00E+00						5.012E-06	0.000E+00
14	1	187.2						3.738E-07						5.386E-06	6.534E-05
15	2	195.8	1.001E-01	3.956E+12	1.730E+12	3.956E+12	1.730E+12	8.614E-07	7.306E-07	8.675E-07	6.451E-06	0.000E+00	0.000E+00	1.392E-05	1.422E-04
16	2.0336	195.8	1.044E-01	4.121E+12	1.802E+12	4.121E+12	1.802E+12	8.778E-07	7.619E-07	9.037E-07	6.719E-06	0.000E+00	0.000E+00	1.427E-05	1.448E-04
17	3	199.9	2.158E-01	8.368E+12	3.689E+12	8.368E+12	3.689E+12	8.778E-07	1.575E-06	1.850E-06	1.364E-05	0.000E+00	0.000E+00	2.296E-05	1.448E-04
18	5	203.1	3.988E-01	1.505E+13	6.797E+12	1.505E+13	6.797E+12	8.778E-07	2.911E-06	3.408E-06	2.454E-05	0.000E+00	0 000E+00	3.675E-05	1.448E-04
19	12	199.5	8.293E-01	2.878E+13	1.421E+13	2.878E+13	1.421E+13	8.778E-07	6.054E-06	7.124E-06	4.693E-05	0.000E+00	0.000E+00	6.600E-05	1.448E-04
20	18	193.1	1.086E+00	3.595E+13	1.881E+13	3.595E+13	1.881E+13	8.778E-07	7.927E-06	9 432E-06	5.862E-05	0.000E+00	0.000E+00	8.186E-05	1.448E-04
21	24	186.6	1.292E+00	4.145E+13	2.263E+13	4.145E+13	2.263E+13	8.778E-07	9.429E-06	1.135E-05	6.759E-05	0.000E+00	0.000E+00	9.425E-05	1.448E-04
22	48	186.6	1.883E+00	5.709E+13	3.409E+13	5.709E+13	3.409E+13	8.778E-07	1.375E-05	1.709E-05	9.310E-05	0.000E+00	0.000E+00	1.298E-04	1.448E-04
23	72	186.6	2.315E+00	6.878E+13	4.269E+13	6.878E+13	4.269E+13	8.778E-07	1.690E-05	2.141E-05	1.121E-04	0.000E+00	0.000E+00	1.563E-04	1.448E-04
24	96	186.6	2.678E+00	7.877E+13	4.988E+13	7.877E+13	4.988E+13	8.778E-07	1.955E-05	2.501E-05	1.285E-04	0.000E+00	0.000E+00	1.789E-04	1.448E-04
25	120	186.6	3.002E+00	8.778E+13	5.615E+13	8.778E+13	5.615E+13	8.778E-07	2.192E-05	2.815E-05	1.431E-04	0.000E+00	0.000E+00	1.991E-04	1.448E-04
26	150	186.6	3.375E+00	9.807E+13	6.303E+13	9.807E+13	6.303E+13	8.778E-07	2.464E-05	3.160E-05	1.599E-04	0.000E+00	0.000E+00	2.220E-04	1.448E-04
27	200	186.6	3.942E+00	1.135E+14	7.274E+13	1.135E+14	7.274E+13	8.778E-07	2.877E-05	3.647E-05	1.851E-04	0.000E+00	0.000E+00	2.563E-04	1.448E-04
28	240	186.6	4.359E+00	1.247E+14	7.928E+13	1.247E+14	7.928E+13	8.778E-07	3.182E-05	3.975E-05	2.034E-04	0.000E+00	0.000E+00	2.808E-04	1.448E-04
29	300	186.6	4.939E+00	1.400E+14	8.754E+13	1.400E+14	8.754E+13	8.778E-07	3.605E-05	4.389E-05	2.283E-04	0.000E+00	0.000E+00	3.141E-04	1.448E-04
30	360	186.6	5.473E+00	1.538E+14	9.436E+13	1.538E+14	9.436E+13	8.778E-07	3.995E-05	4.732E-05	2.508E-04	0.000E+00	0.000E+00	3.440E-04	1.448E-04
31	400	186.6	5.809E+00	1.624E+14	9.830E+13	1.624E+14	9.830E+13	8.778E-07	4.240E-05	4.929E-05	2.648E-04	0.000E+00	0.000E+00	3.624E-04	1.448E-04
32	480	186.6	6.438E+00	1.784E+14	1.051E+14	1.784E+14	1.051E+14	8.778E-07	4.700E-05	5.269E-05	2.908E-04	0.000E+00	0.000E+00	3.964E-04	1.448E-04
33	600	186.6	7.301E+00	2.000E+14	1.133E+14	2.000E+14	1.133E+14	8.778E-07	5.330E-05	5.681E-05	3.261E-04	0.000E+00	0.000E+00	4.421E-04	1.448E-04
34	700	186.6	7.966E+00	2.166E+14	1.190E+14	2.166E+14	1.190E+14	8.778E-07	5.815E-05	5.967E-05	3.531E-04	0.000E+00	0.000E+00	4.768E-04	1.448E-04
35	720	186.6	8.094E+00	2.198E+14	1.201E+14	2.198E+14	1.201E+14	8.778E-07	5.909E-05	6.020E-05	3.583E-04	0.000E+00	0.000E+00	4.835E-04	1.448E-04
36															
37	NOTES:						14	Acid dissociation constant from: Entergy Eng. Report GGNS-98-0039 Rev.3, Sect.6.1.p.21							
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]					15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7							
39	2	Ibid, Equation 3-2b					16	See attachment B for gamma free paths							
40	3	Ibid, Equation 3-4d [30+90 min release duration]					17	ECR 01-01233 for SIL-636, extrpolated to times beyond 24 hours using the constant value at 24 hours							
41	4	Ibid, Table A-1					18	Attachment B							
42	5	Ibid, Equation 3-3a					19	Attachment B							
43	6	Ibid, Equation 3-3b					20	USNRC Reg. Guide 1.183							
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7					21	Page C-6 of this attachment							
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					22	Cable Data from Attachment A.							
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7; initial 5.3 pH value (before Cesium addition) from LGS UFSAR Sec. 6.1.1.2													
50	13	Max. Suppression Pool volume from Calc. body section 4.4, including													
51		UFSAR Table 6.2-4A HWL Suppression Pool volume of 134,600 cu ft, Reactor Coolant System Liquid Volume of 13,108 cu ft													
52		and low-pressure Emergency Core Cooling System sources, roundd up to 175,000 cu. Ft.													
53		(For Attachment B page B-6 minimization of Drywell + Suppression Pool Airspace volume, the LLRT Program													
54		403,120 cu ft value - 175,000 + 122,120 Tech Spec 3/4.5.3 nominal minimum Suppression Pool Volume is used)													

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1				pH TRANSIENT		END OF CYCLE							
2	Cable Data [22]												
3	2,425,858	Cable Surface [Trays] - DRYWELL [cm2]											
4	121,293	Cable Surface [Free air] - DRYWELL [cm2]					1008.67	g. mols $Na_2B_{10}O_{16}$*$10H_2O$ Added[21]					
5	0	Cable Surface [Free air] - Supp. Pool [cm2]					10086.71	g.atoms total boron					
6	0	Cable Surface [Trays] - Supp. Pool [cm2]											
7													
8						pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTION							
9													
10							Strong Acid						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}$*$10H_2O$	Borate	Boric Acid	pK_a	pH	
12	g-ions/liter			g-ions/liter	Before SLC	[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	[15]	
13	1.995E-09	1.369E+01	-2.101E-09	5.014E-06	5.30	6.867E-10	2.485E+01	1008.7	1992	8094	9.16	8.55	
14	6.534E-05	1.249E+01	5.380E-06	5.343E-09	8.27	1.226E-09	2.648E-02	1008.7	2017	8069	8.91	8.31	
15	1.422E-04	1.241E+01	1.392E-05	3.019E-09	8.52	1.276E-09	1.496E-02	1008.7	2017	8069	8.89	8.29	
16	1.448E-04	1.241E+01	1.427E-05	2.967E-09	8.53	1.276E-09	1.470E-02	1008.7	2017	8069	8.89	8.29	
17	1.448E-04	1.237E+01	2.296E-05	3.465E-09	8.46	1.300E-09	1.717E-02	1008.7	2017	8069	8.89	8.28	
18	1.448E-04	1.235E+01	3.675E-05	4.172E-09	8.38	1.319E-09	2.068E-02	1008.7	2017	8069	8.88	8.28	
19	1.448E-04	1.238E+01	6.599E-05	5.314E-09	8.27	1.298E-09	2.633E-02	1008.7	2017	8069	8.89	8.28	
20	1.448E-04	1.244E+01	8.186E-05	5.807E-09	8.24	1.261E-09	2.878E-02	1008.7	2017	8069	8.90	8.30	
21	1.448E-04	1.250E+01	9.425E-05	6.257E-09	8.20	1.223E-09	3.101E-02	1008.7	2017	8069	8.91	8.31	
22	1.448E-04	1.250E+01	1.298E-04	2.114E-08	7.67	1.223E-09	1.047E-01	1008.7	2017	8069	8.91	8.31	
23	1.448E-04	1.250E+01	1.447E-04	1.161E-05	4.94	1.223E-09	5.753E+01	1008.7	1960	8127	8.91	8.30	
24	1.448E-04	1.250E+01	1.448E-04	3.415E-05	4.47	1.223E-09	1.692E+02	1008.7	1848	8239	8.91	8.26	
25	1.448E-04	1.250E+01	1.448E-04	5.433E-05	4.26	1.223E-09	2.692E+02	1008.7	1748	8339	8.91	8.23	
26	1.448E-04	1.250E+01	1.448E-04	7.729E-05	4.11	1.223E-09	3.830E+02	1008.7	1634	8452	8.91	8.20	
27	1.448E-04	1.250E+01	1.448E-04	1.115E-04	3.95	1.223E-09	5.525E+02	1008.7	1465	8622	8.91	8.14	
28	1.448E-04	1.250E+01	1.448E-04	1.361E-04	3.87	1.223E-09	6.743E+02	1008.7	1343	8744	8.91	8.10	
29	1.448E-04	1.250E+01	1.448E-04	1.694E-04	3.77	1.223E-09	8.392E+02	1008.7	1178	8909	8.91	8.03	
30	1.448E-04	1.250E+01	1.448E-04	1.992E-04	3.70	1.223E-09	9 873E+02	1008.7	1030	9057	8.91	7.97	
31	1.448E-04	1.250E+01	1.448E-04	2.177E-04	3 66	1.223E-09	1.079E+03	1008.7	939	9148	8.91	7.92	
32	1.448E-04	1.250E+01	1.448E-04	2.516E-04	3.60	1.223E-09	1.247E+03	1008.7	770	9316	8.91	7.83	
33	1.448E-04	1.250E+01	1.448E-04	2.973E-04	3.53	1.223E-09	1.473E+03	1008.7	544	9543	8.91	7.67	
34	1.448E-04	1.250E+01	1.448E-04	3.321E-04	3.48	1.223E-09	1.646E+03	1008.7	372	9715	8.91	7.50	
35	1.448E-04	1.250E+01	1.448E-04	3.388E-04	3.47	1.223E-09	1.679E+03	1008.7	339	9748	8.91	7.45	
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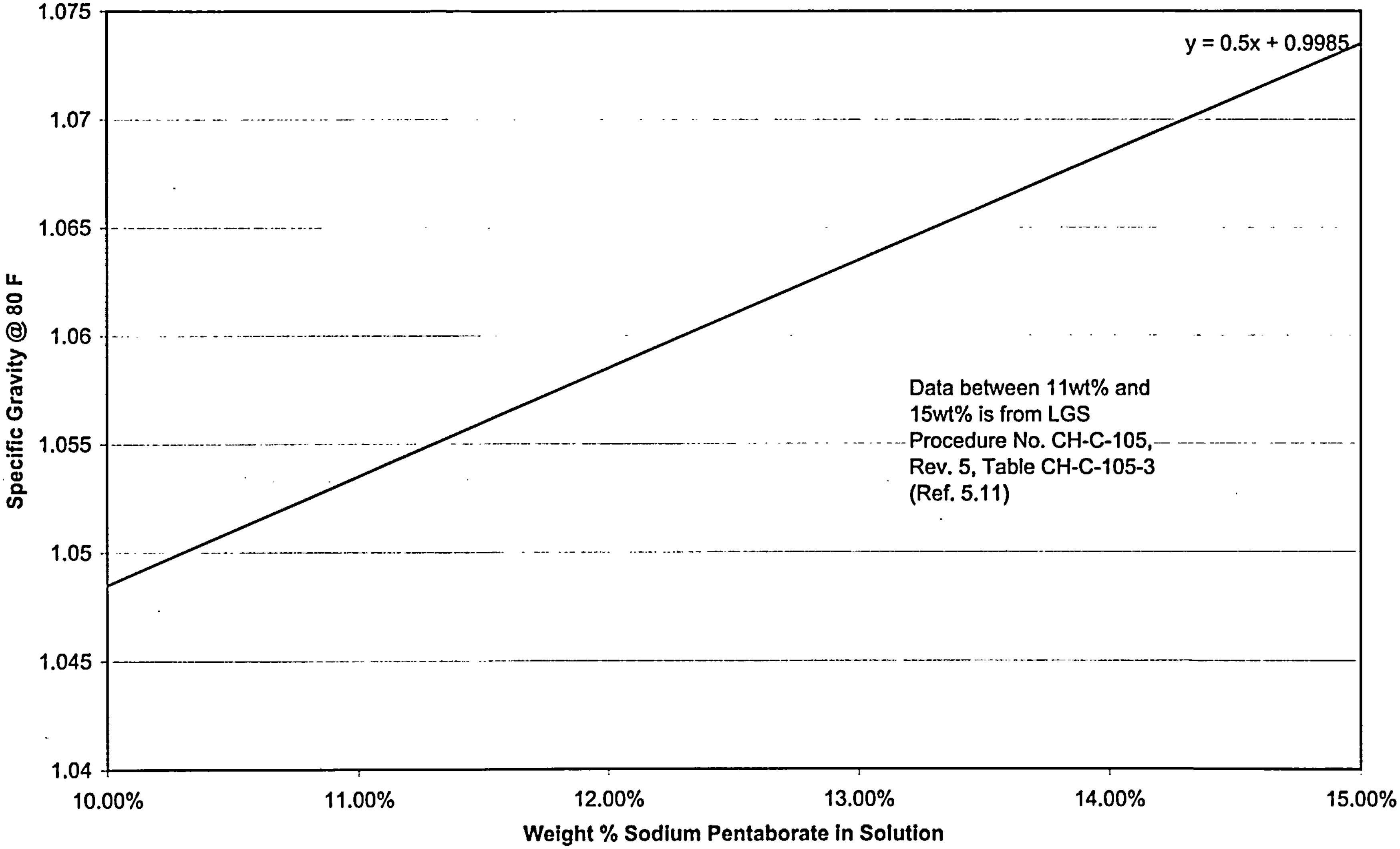
Weight % Sodium Pentaborate in Solution vs. Specific Gravity @ 80 F



LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D	E
1	**Available Boron Calculation**				
2					
3					
4	**Quantity**	**Value**	**Basis**		
5					
6	**Volume of Solution (gal)=**	1.5000E+03	Assumed Minimum (LGS Tech Spec Sect. 4.1.5		
7			indicates 3160 gallons)		
8	**wt% of $Na_2B_{10}O_{16}$*$10H_2O$=**	10%	LGS Technical Specification figure 3.1.5-1		
9	**Specific Gravity (gm/cm^3)=**	1.0485	Table CH-C-105-3		
10	**Conversion Factor (cm^3/gal)=**	3785.41			
11	**Conversion Factor (lbs/gm)=**	0.0022			
12					
13	**Total Mass of Solution (lbs)=**	1.3125E+04			
14	**Total $Na_2B_{10}O_{16}$*$10H_2O$ (lbs)=**	1.3125E+03			
15	**Total $Na_2B_{10}O_{16}$*$10H_2O$ (gm)=**	5.9535E+05			
16	**Total $Na_2B_{10}O_{16}$*$10H_2O$**				
17	**(gm-moles)=**	1.0087E+03			
18	**Total Boron (gm-atoms)=**	1.0087E+04			
19					
20					
21	***Total Available Boron (lbs)=***	***2.4041E+02***			
22	***l Available Boron (gm-atoms)=***	***1.0087E+04***			
23					
24	**B-10 Enrichment=**	**19.90%**			
25					
26		**Molar Mass**		**Total Molar Mass of**	
27		**(gm/mole)**		**$Na_2B_{10}O_{16}$ * $10H_2O$**	
28	Sodium	22.99		**590.2330**	
29	***Boron***	***10.8110***			
30	Oxygen	16.00			
31	Hydrogen	1.01			
32	Boron-10	10.0129			
33	Boron-11	11.0093			
34					
35	**Percentage of Total Boron=**	18.3165%			

2/23/04 e-mail from Francis Ray on assessment of maximum suppression pool fluid volume for use in AST project:

The volume of water assumed to require buffering with sodium pentaborate for pH control was initially estimated to be a maximum of approximately 185, 000 cu. ft. This was based on the combined volume of the suppression pool (HWL) of 134,600 cu. ft., the reactor coolant system liquid and applicable piping of approximately of 23,600 cu. ft. and the entire contents of condensate storage tank (CST) of 26,736 cu. ft. as documented in calculation LM-0642.

Further review indicates that the only accident for which pH control is credited is the large break LOCA. In this event, the contents of the CST will not normally be pumped into the primary containment. However, ECCS systems will be placed into service in response to the pipe break to maintain reactor level and remove decay heat from the suppression pool. While it is difficult to determine how many loops of the ECCS systems will be placed into service, it is reasonable to assume that the volume of water requiring pH control will be less than the above 185,000 cu. ft. used in calculation LM-0642. The best estimate of the water volume is the following:

Suppression pool (HWL)	134,600 cu. ft.	(UFSAR Table 6.2-4A)
Reactor lower plenum	3,887	(UFSAR Fig. 5.1-2)
RPV core region	2,054	(UFSAR Fig. 5.1-2)
RPV downcomer region	5,817	(UFSAR Fig. 5.1-2)
RPV upper plenum/separators	1,321	(UFSAR Fig. 5.1-2)
Recirc. loops & jet pumps	1,411	(UFSAR Fig. 5.1-2)
Suppression pool cooling (1 loop)	1,700	(estimated from iso dwgs)
LPCI (2 loops)	2,200	(estimated from iso dwgs)
Core spray (1 loop/2 pumps)	700	(estimated from iso dwgs)
Total	154,000 cu. ft.	

It should be noted that the volume estimates for core spray, LPCI, and suppression pool cooling are based on the primary flow loop volume with a 50% adder for the stagnant branch lines.

If all ECCS loops were to be placed in service, the volume could increase by 1,800 cu. ft. (1 LPCI loop and 1 CS loop) to an estimated 156,000 cu. ft.

Prepared by R. Hess

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D	E	F	G	H	I
1	**LIMERICK**					pH TRANSIENT	EGINNING OF CYCL		
2							Linear Absorption		
3	V_{POOL}	=175000*28.3168	Liters [175,000 ft^3] [13]				$U_{beta\ air}$	0.0198	1/cm
4	m_I	=170	Iodine inventory [g-atom				$U_{beta\ hypalon}$	52.08	1/cm
5	m_{Cs}	=1600	Cesium Inventory [g-ato				$U_{gamma\ air}$	0.0000375	1/cm
6	t_{gap}	=121/3600	Onset of Gap release [h				$U_{gamma\ hypalon}$	0.099	1/cm
7							$r_{[gamma\ free\ path\text{-}DRYWELL]}$	894.08	cm
8							$r_{[gamma\ free\ path\text{-}SUPP\ POO}$	894.08	cm
9				INTEGRATED					
10			Beta+Gamma [18]	Gamma [18]	Beta [18]	Gamma [18]	Beta [18]		
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp Pool AIR	Supp Pool AIR	[HI] [1]	[HNO_3] [2]
12	Hours	Deg F [17]	Mrad	MeV/cm^3	MeV/cm^3	MeV/cm^3	MeV/cm^3	g-mols/liter	g-mols/liter
13	0	95						0	
14	1	187.2						=$B$4/(120*$B$3)*($A14-(0.5+$B$6))+$B$4/(400*$B$3)	
15	2	195.8	0.100087111151012	3956052849546.56	1730013153896.35	3956052849546.56	1730013153896.35	=$B$4/(120*$B$3)*($A15-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C15
16	=0.5+1.5+B6	195.8	0.104365847573824	4120748284326.69	1802214752482.87	4120748284326.69	1802214752482.87	=$B$4/(120*$B$3)*($A16-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C16
17	3	199.9	0.215756878516613	8367522752309.87	3688722168022.81	8367522752309.87	3688722168022.81	=H$16	=0.0000073*$C17
18	5	203.1	0.398753951242835	15051283188018	6796717122483.9	15051283188018	6796717122483.9	=H$16	=0.0000073*$C18
19	12	199.5	0.829274158572949	28781202708989.2	14207462998066.7	28781202708989.2	14207462998066.7	=H$16	=0.0000073*$C19
20	18	193.1	1.08584565286588	35947219280802.3	18809856471831.5	35947219280802.3	18809856471831.5	=H$16	=0.0000073*$C20
21	24	186.6	1.29165941930598	41450203689486.6	22625236709381.3	41450203689486.6	22625236709381.3	=H$16	=0.0000073*$C21
22	48	186.6	1.88316646363286	57094527006647.7	34089477741320.3	57094527006647.7	34089477741320.3	=H$16	=0.0000073*$C22
23	72	186.6	2.31488045241861	68775684974726	42694278802823	68775684974726	42694278802823	=H$16	=0.0000073*$C23
24	96	186.6	2.67760819687578	78774903495935.1	49880534617235	78774903495935.1	49880534617235	=H$16	=0.0000073*$C24
25	120	186.6	3.0022610140995	87776415615034.7	56145093552860.5	87776415615034.7	56145093552860.5	=H$16	=0.0000073*$C25
26	150	186.6	3.37480313336637	98069389403685.5	63027129381434.4	98069389403685.5	63027129381434.4	=H$16	=0.0000073*$C26
27	200	186.6	3.94157016913884	113525022634318	72737793079027.3	113525022634318	72737793079027.3	=H$16	=0.0000073*$C27
28	240	186.6	4.35914715584886	124718856946027	79280404587774.5	124718856946027	79280404587774.5	=H$16	=0.0000073*$C28
29	300	186.6	4.93895422570735	139994683781518	87536763527759.8	139994683781518	87536763527759.8	=H$16	=0.0000073*$C29
30	360	186.6	5.47325714195057	153829094639737	94361689798228.1	153829094639737	94361689798228.1	=H$16	=0.0000073*$C30
31	400	186.6	5.80851378579049	162409963290567	98299968870279.8	162409963290567	98299968870279.8	=H$16	=0.0000073*$C31
32	480	186.6	6.43777056431354	178352381268313	105070419526278	178352381268313	105070419526278	=H$16	=0.0000073*$C32
33	600	186.6	7.30114927597588	199990905047147	113291889646017	199990905047147	113291889646017	=H$16	=0.0000073*$C33
34	700	186.6	7.96603186890977	216560042435043	119000318577454	216560042435043	119000318577454	=H$16	=0.0000073*$C34
35	720	186.6	8.09431558980373	219753186435482	120054170939062	219753186435482	120054170939062	=H$16	=0.0000073*$C35
36									
37	NOTES:						14	Acid dissociation constant from: Entergy Eng. Report GGNS-9	
38	1	Entergy Eng. Report					15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7	
39	2	Ibid, Equation 3-2b					16	See attachment B for gamma free paths	
40	3	Ibid, Equation 3-4d [					17	LGS UFSAR Rev. 11	
41	4	Ibid, Table A-1					18	Attachment B	
42	5	Ibid, Equation 3-3a					19	Attachment B	
43	6	Ibid, Equation 3-3b					20	USNRC Reg. Guide 1.183	
44	7	Ibid, Equation 3-5a;					21	See page C-6 of this attachment.	
45	8	Ibid, Equation 3-5b;					22	Cable Data from Attachment A.	
46	9	Ibid, Equation 3-0a;							
47	10	Ibid, Equation 3-5d;							
48	11	Ibid, Equation 3-5d;							
49	12	Ibid, Equation 3-5e;							
50	13	Max. Suppression P							
51		UFSAR Table 6.2-4A							
52		and low-pressure En							
53		(For Attachment B p							
54		403,120 cu ft value -							

	J	K	L
1		**Cable Data** [22]	
2	$S_{A\,tray}$ [cm^2]	=$P$3*1.1	Cable Surface [trays]- Drywell + 10% contingency
3	$S_{A\,fa}$ [cm^2]	=$P$4*1.1	Cable Surface [free air]- Drywell + 10% contingency
4	$S_{B\,tray}$ [cm^2]	=$P$6*0.95*1.1	Cable Surface [trays] - Supp. Pool + 10% contingency
5	$S_{B\,fa}$ [cm^2]	=P6*1.1*0.05	Cable Surface [free air] - Supp. Pool + 10% contingenc
6			
7	th [cm]	0.62992	Hypalon Jacket Thickness [22]
8			
9			
10	From Beta	From Gamma	From Beta
11	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]	[HCL] -CONTAIN [5]
12	g-mols/liter	g-mols/liter	g-mols/liter
13			
14			
15	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E15	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E15
16	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E16	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E16
17	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E17	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E17
18	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E18	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E18
19	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E19	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E19
20	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E20	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E20
21	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E21	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E21
22	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E22	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E22
23	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E23	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E23
24	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E24	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E24
25	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E25	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E25
26	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E26	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E26
27	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E27	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E27
28	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E28	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E28
29	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E29	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E29
30	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E30	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E30
31	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E31	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E31
32	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E32	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E32
33	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E33	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E33
34	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E34	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E34
35	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E35	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E35
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	M	N	O
1			
2			
3			
4			
5			
6			
7			
8			
9			
10	From Gamma		
11	[HCL] -CONTAIN[5]	Total [H+] [7]	[CsOH] [3]
12	g-mols/liter	g-ions/liter	g-mols/liter
13		=POWER(10,-$T$13)+$H13+$I13+$J13+$K13+$L13+$M13	0
14		=POWER(10,-$T$13)+$H14+$I14+$J14+$K14+$L14+$M14	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A14-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
15	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=POWER(10,-$T$13)+$H15+$I15+$J15+$K15+$L15+$M15	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A15-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
16	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=POWER(10,-$T$13)+$H16+$I16+$J16+$K16+$L16+$M16	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A16-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
17	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=POWER(10,-$T$13)+$H17+$I17+$J17+$K17+$L17+$M17	=$O$16
18	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=POWER(10,-$T$13)+$H18+$I18+$J18+$K18+$L18+$M18	=$O$16
19	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=POWER(10,-$T$13)+$H19+$I19+$J19+$K19+$L19+$M19	=$O$16
20	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=POWER(10,-$T$13)+$H20+$I20+$J20+$K20+$L20+$M20	=$O$16
21	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=POWER(10,-$T$13)+$H21+$I21+$J21+$K21+$L21+$M21	=$O$16
22	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=POWER(10,-$T$13)+$H22+$I22+$J22+$K22+$L22+$M22	=$O$16
23	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=POWER(10,-$T$13)+$H23+$I23+$J23+$K23+$L23+$M23	=$O$16
24	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=POWER(10,-$T$13)+$H24+$I24+$J24+$K24+$L24+$M24	=$O$16
25	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=POWER(10,-$T$13)+$H25+$I25+$J25+$K25+$L25+$M25	=$O$16
26	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=POWER(10,-$T$13)+$H26+$I26+$J26+$K26+$L26+$M26	=$O$16
27	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=POWER(10,-$T$13)+$H27+$I27+$J27+$K27+$L27+$M27	=$O$16
28	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=POWER(10,-$T$13)+$H28+$I28+$J28+$K28+$L28+$M28	=$O$16
29	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=POWER(10,-$T$13)+$H29+$I29+$J29+$K29+$L29+$M29	=$O$16
30	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=POWER(10,-$T$13)+$H30+$I30+$J30+$K30+$L30+$M30	=$O$16
31	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=POWER(10,-$T$13)+$H31+$I31+$J31+$K31+$L31+$M31	=$O$16
32	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=POWER(10,-$T$13)+$H32+$I32+$J32+$K32+$L32+$M32	=$O$16
33	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=POWER(10,-$T$13)+$H33+$I33+$J33+$K33+$L33+$M33	=$O$16
34	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=POWER(10,-$T$13)+$H34+$I34+$J34+$K34+$L34+$M34	=$O$16
35	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=POWER(10,-$T$13)+$H35+$I35+$J35+$K35+$L35+$M35	=$O$16
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	P	Q	R	S	T	U
1				pH TRANSIEN		BEGINNING OF CYCLE
2	**Cable Data** [22]					
3	2425857.59715346	Cable Surface [Trays] - DRYWELL [cm2]				
4	=$P$3*0.05	Cable Surface [Free air] - DRYWELL [cm2]				
5	=P6*0.05	Cable Surface [Free air] - Supp. Pool [cm2]				
6	0	Cable Surface [Trays] - Supp. Pool [cm2]				
7						
8						pH EFFECT
9						
10						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a
12	g-Ions/liter			g-Ions/liter	Before SLC	[14]
13	=POWER(10,-14)/POWER(10,-$T$13)+$O13	=15.5129-0.0224*$B13+0.00003352*POWER(B13,2)	=(N13+P13-SQRT(POWER(($N13+$P13),2)-(4*(N13*P13-POWER(10,-$Q13)))))/2	=$N13-$R13	5.3	=(0.0585*B13+1.309)/10000000000
14	=POWER(10,-14)/POWER(10,-$T$13)+$O14	=15.5129-0.0224*$B14+0.00003352*POWER(B14,2)	=(N14+P14-SQRT(POWER(($N14+$P14),2)-(4*(N14*P14-POWER(10,-$Q14)))))/2	=$N14-$R14	=-LOG10($S14)	=(0.0585*B14+1.309)/10000000000
15	=POWER(10,-14)/POWER(10,-$T$13)+$O15	=15.5129-0.0224*$B15+0.00003352*POWER(B15,2)	=(N15+P15-SQRT(POWER(($N15+$P15),2)-(4*(N15*P15-POWER(10,-$Q15)))))/2	=$N15-$R15	=-LOG10($S15)	=(0.0585*B15+1.309)/10000000000
16	=POWER(10,-14)/POWER(10,-$T$13)+$O16	=15.5129-0.0224*$B16+0.00003352*POWER(B16,2)	=(N16+P16-SQRT(POWER(($N16+$P16),2)-(4*(N16*P16-POWER(10,-$Q16)))))/2	=$N16-$R16	=-LOG10($S16)	=(0.0585*B16+1.309)/10000000000
17	=POWER(10,-14)/POWER(10,-$T$13)+$O17	=15.5129-0.0224*$B17+0.00003352*POWER(B17,2)	=(N17+P17-SQRT(POWER(($N17+$P17),2)-(4*(N17*P17-POWER(10,-$Q17)))))/2	=$N17-$R17	=-LOG10($S17)	=(0.0585*B17+1.309)/10000000000
18	=POWER(10,-14)/POWER(10,-$T$13)+$O18	=15.5129-0.0224*$B18+0.00003352*POWER(B18,2)	=(N18+P18-SQRT(POWER(($N18+$P18),2)-(4*(N18*P18-POWER(10,-$Q18)))))/2	=$N18-$R18	=-LOG10($S18)	=(0.0585*B18+1.309)/10000000000
19	=POWER(10,-14)/POWER(10,-$T$13)+$O19	=15.5129-0.0224*$B19+0.00003352*POWER(B19,2)	=(N19+P19-SQRT(POWER(($N19+$P19),2)-(4*(N19*P19-POWER(10,-$Q19)))))/2	=$N19-$R19	=-LOG10($S19)	=(0.0585*B19+1.309)/10000000000
20	=POWER(10,-14)/POWER(10,-$T$13)+$O20	=15.5129-0.0224*$B20+0.00003352*POWER(B20,2)	=(N20+P20-SQRT(POWER(($N20+$P20),2)-(4*(N20*P20-POWER(10,-$Q20)))))/2	=$N20-$R20	=-LOG10($S20)	=(0.0585*B20+1.309)/10000000000
21	=POWER(10,-14)/POWER(10,-$T$13)+$O21	=15.5129-0.0224*$B21+0.00003352*POWER(B21,2)	=(N21+P21-SQRT(POWER(($N21+$P21),2)-(4*(N21*P21-POWER(10,-$Q21)))))/2	=$N21-$R21	=-LOG10($S21)	=(0.0585*B21+1.309)/10000000000
22	=POWER(10,-14)/POWER(10,-$T$13)+$O22	=15.5129-0.0224*$B22+0.00003352*POWER(B22,2)	=(N22+P22-SQRT(POWER(($N22+$P22),2)-(4*(N22*P22-POWER(10,-$Q22)))))/2	=$N22-$R22	=-LOG10($S22)	=(0.0585*B22+1.309)/10000000000
23	=POWER(10,-14)/POWER(10,-$T$13)+$O23	=15.5129-0.0224*$B23+0.00003352*POWER(B23,2)	=(N23+P23-SQRT(POWER(($N23+$P23),2)-(4*(N23*P23-POWER(10,-$Q23)))))/2	=$N23-$R23	=-LOG10($S23)	=(0.0585*B23+1.309)/10000000000
24	=POWER(10,-14)/POWER(10,-$T$13)+$O24	=15.5129-0.0224*$B24+0.00003352*POWER(B24,2)	=(N24+P24-SQRT(POWER(($N24+$P24),2)-(4*(N24*P24-POWER(10,-$Q24)))))/2	=$N24-$R24	=-LOG10($S24)	=(0.0585*B24+1.309)/10000000000
25	=POWER(10,-14)/POWER(10,-$T$13)+$O25	=15.5129-0.0224*$B25+0.00003352*POWER(B25,2)	=(N25+P25-SQRT(POWER(($N25+$P25),2)-(4*(N25*P25-POWER(10,-$Q25)))))/2	=$N25-$R25	=-LOG10($S25)	=(0.0585*B25+1.309)/10000000000
26	=POWER(10,-14)/POWER(10,-$T$13)+$O26	=15.5129-0.0224*$B26+0.00003352*POWER(B26,2)	=(N26+P26-SQRT(POWER(($N26+$P26),2)-(4*(N26*P26-POWER(10,-$Q26)))))/2	=$N26-$R26	=-LOG10($S26)	=(0.0585*B26+1.309)/10000000000
27	=POWER(10,-14)/POWER(10,-$T$13)+$O27	=15.5129-0.0224*$B27+0.00003352*POWER(B27,2)	=(N27+P27-SQRT(POWER(($N27+$P27),2)-(4*(N27*P27-POWER(10,-$Q27)))))/2	=$N27-$R27	=-LOG10($S27)	=(0.0585*B27+1.309)/10000000000
28	=POWER(10,-14)/POWER(10,-$T$13)+$O28	=15.5129-0.0224*$B28+0.00003352*POWER(B28,2)	=(N28+P28-SQRT(POWER(($N28+$P28),2)-(4*(N28*P28-POWER(10,-$Q28)))))/2	=$N28-$R28	=-LOG10($S28)	=(0.0585*B28+1.309)/10000000000
29	=POWER(10,-14)/POWER(10,-$T$13)+$O29	=15.5129-0.0224*$B29+0.00003352*POWER(B29,2)	=(N29+P29-SQRT(POWER(($N29+$P29),2)-(4*(N29*P29-POWER(10,-$Q29)))))/2	=$N29-$R29	=-LOG10($S29)	=(0.0585*B29+1.309)/10000000000
30	=POWER(10,-14)/POWER(10,-$T$13)+$O30	=15.5129-0.0224*$B30+0.00003352*POWER(B30,2)	=(N30+P30-SQRT(POWER(($N30+$P30),2)-(4*(N30*P30-POWER(10,-$Q30)))))/2	=$N30-$R30	=-LOG10($S30)	=(0.0585*B30+1.309)/10000000000
31	=POWER(10,-14)/POWER(10,-$T$13)+$O31	=15.5129-0.0224*$B31+0.00003352*POWER(B31,2)	=(N31+P31-SQRT(POWER(($N31+$P31),2)-(4*(N31*P31-POWER(10,-$Q31)))))/2	=$N31-$R31	=-LOG10($S31)	=(0.0585*B31+1.309)/10000000000
32	=POWER(10,-14)/POWER(10,-$T$13)+$O32	=15.5129-0.0224*$B32+0.00003352*POWER(B32,2)	=(N32+P32-SQRT(POWER(($N32+$P32),2)-(4*(N32*P32-POWER(10,-$Q32)))))/2	=$N32-$R32	=-LOG10($S32)	=(0.0585*B32+1.309)/10000000000
33	=POWER(10,-14)/POWER(10,-$T$13)+$O33	=15.5129-0.0224*$B33+0.00003352*POWER(B33,2)	=(N33+P33-SQRT(POWER(($N33+$P33),2)-(4*(N33*P33-POWER(10,-$Q33)))))/2	=$N33-$R33	=-LOG10($S33)	=(0.0585*B33+1.309)/10000000000
34	=POWER(10,-14)/POWER(10,-$T$13)+$O34	=15.5129-0.0224*$B34+0.00003352*POWER(B34,2)	=(N34+P34-SQRT(POWER(($N34+$P34),2)-(4*(N34*P34-POWER(10,-$Q34)))))/2	=$N34-$R34	=-LOG10($S34)	=(0.0585*B34+1.309)/10000000000
35	=POWER(10,-14)/POWER(10,-$T$13)+$O35	=15.5129-0.0224*$B35+0.00003352*POWER(B35,2)	=(N35+P35-SQRT(POWER(($N35+$P35),2)-(4*(N35*P35-POWER(10,-$Q35)))))/2	=$N35-$R35	=-LOG10($S35)	=(0.0585*B35+1.309)/10000000000
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	V	W	X	Y	Z	AA
1						
2						
3						
4	='Available E	g. mols				
5	='Available E	g.atom:				
6						
7						
8	OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTIOI					
9						
10	Strong Acid					
11	g-equiv.	$_{10}O_{18}$*1(	Borate	Boric Acid	pK$_a$	pH
12	et [H+] * V$_{PO}$	g-mols	g-equiv.	g-equiv.	-log$_{10}$K$_a$	15
13	=S13*$B$3	=$V$4	=W13*2-V13	=W13*8+V13	=-LOG10(U13)	=Z13+LOG10((X13/$B$3)/(Y13/$B$3))
14	=S14*$B$3	=$V$4	=W14*2-V14	=W14*8+V14	=-LOG10(U14)	=Z14+LOG10((X14/$B$3)/(Y14/$B$3))
15	=S15*$B$3	=$V$4	=W15*2-V15	=W15*8+V15	=-LOG10(U15)	=Z15+LOG10((X15/$B$3)/(Y15/$B$3))
16	=S16*$B$3	=$V$4	=W16*2-V16	=W16*8+V16	=-LOG10(U16)	=Z16+LOG10((X16/$B$3)/(Y16/$B$3))
17	=S17*$B$3	=$V$4	=W17*2-V17	=W17*8+V17	=-LOG10(U17)	=Z17+LOG10((X17/$B$3)/(Y17/$B$3))
18	=S18*$B$3	=$V$4	=W18*2-V18	=W18*8+V18	=-LOG10(U18)	=Z18+LOG10((X18/$B$3)/(Y18/$B$3))
19	=S19*$B$3	=$V$4	=W19*2-V19	=W19*8+V19	=-LOG10(U19)	=Z19+LOG10((X19/$B$3)/(Y19/$B$3))
20	=S20*$B$3	=$V$4	=W20*2-V20	=W20*8+V20	=-LOG10(U20)	=Z20+LOG10((X20/$B$3)/(Y20/$B$3))
21	=S21*$B$3	=$V$4	=W21*2-V21	=W21*8+V21	=-LOG10(U21)	=Z21+LOG10((X21/$B$3)/(Y21/$B$3))
22	=S22*$B$3	=$V$4	=W22*2-V22	=W22*8+V22	=-LOG10(U22)	=Z22+LOG10((X22/$B$3)/(Y22/$B$3))
23	=S23*$B$3	=$V$4	=W23*2-V23	=W23*8+V23	=-LOG10(U23)	=Z23+LOG10((X23/$B$3)/(Y23/$B$3))
24	=S24*$B$3	=$V$4	=W24*2-V24	=W24*8+V24	=-LOG10(U24)	=Z24+LOG10((X24/$B$3)/(Y24/$B$3))
25	=S25*$B$3	=$V$4	=W25*2-V25	=W25*8+V25	=-LOG10(U25)	=Z25+LOG10((X25/$B$3)/(Y25/$B$3))
26	=S26*$B$3	=$V$4	=W26*2-V26	=W26*8+V26	=-LOG10(U26)	=Z26+LOG10((X26/$B$3)/(Y26/$B$3))
27	=S27*$B$3	=$V$4	=W27*2-V27	=W27*8+V27	=-LOG10(U27)	=Z27+LOG10((X27/$B$3)/(Y27/$B$3))
28	=S28*$B$3	=$V$4	=W28*2-V28	=W28*8+V28	=-LOG10(U28)	=Z28+LOG10((X28/$B$3)/(Y28/$B$3))
29	=S29*$B$3	=$V$4	=W29*2-V29	=W29*8+V29	=-LOG10(U29)	=Z29+LOG10((X29/$B$3)/(Y29/$B$3))
30	=S30*$B$3	=$V$4	=W30*2-V30	=W30*8+V30	=-LOG10(U30)	=Z30+LOG10((X30/$B$3)/(Y30/$B$3))
31	=S31*$B$3	=$V$4	=W31*2-V31	=W31*8+V31	=-LOG10(U31)	=Z31+LOG10((X31/$B$3)/(Y31/$B$3))
32	=S32*$B$3	=$V$4	=W32*2-V32	=W32*8+V32	=-LOG10(U32)	=Z32+LOG10((X32/$B$3)/(Y32/$B$3))
33	=S33*$B$3	=$V$4	=W33*2-V33	=W33*8+V33	=-LOG10(U33)	=Z33+LOG10((X33/$B$3)/(Y33/$B$3))
34	=S34*$B$3	=$V$4	=W34*2-V34	=W34*8+V34	=-LOG10(U34)	=Z34+LOG10((X34/$B$3)/(Y34/$B$3))
35	=S35*$B$3	=$V$4	=W35*2-V35	=W35*8+V35	=-LOG10(U35)	=Z35+LOG10((X35/$B$3)/(Y35/$B$3))
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D	E	F
1	**LIMERICK pH CALCULATION**					pH TRANSIENT
2						
3	V_{POOL}	=175000*28.3168	Liters [175,000 ft^3] [13]			
4	m_I	=290	Iodine inventory [g-atoms] EOC[19]			
5	m_{Cs}	=3200	Cesium inventory [g-atoms] EOC[19]			
6	t_{gap}	=121/3600	Onset of Gap release [hrs] [20]			
7						
8						
9				INTEGRATED DOSES		
10			Beta+Gamma[18]	Gamma[16]	Beta[18]	Gamma[18]
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp Pool AIR
12	Hours	Deg F [17]	Mrad	MeV/cm³	MeV/cm³	MeV/cm³
13	0	95				
14	1	187.2				
15	2	195.8	0.100087111151012	3956052849546.56	1730013153896.35	3956052849546.56
16	=0.5+1.5+B6	195.8	0.104365847573824	4120748284326.69	1802214752482.87	4120748284326.69
17	3	199.9	0.215756878516613	8367522752309.87	3688722168022.81	8367522752309.87
18	5	203.1	0.398753951242835	15051283188018	6796717122483.9	15051283188018
19	12	199.5	0.829274158572949	28781202708989.2	14207462998066.7	28781202708989.2
20	18	193.1	1.08584565286588	35947219280802.3	18809856471831.5	35947219280802.3
21	24	186.6	1.29165941930598	41450203689486.6	22625236709381.3	41450203689486.6
22	48	186.6	1.88316646363286	57094527006647.7	34089477741320.3	57094527006647.7
23	72	186.6	2.31488045241861	68775684974726	42694278802823	68775684974726
24	96	186.6	2.67760819687578	78774903495935.1	49880534617235	78774903495935.1
25	120	186.6	3.0022610140995	87776415615034.7	56145093552860.5	87776415615034.7
26	150	186.6	3.37480313336637	98069389403685.5	63027129381434.4	98069389403685.5
27	200	186.6	3.94157016913884	113525022634318	72737793079027.3	113525022634318
28	240	186.6	4.35914715584886	124718856946027	79280404587774.5	124718856946027
29	300	186.6	4.93895422570735	139994683781518	87536763527759.8	139994683781518
30	360	186.6	5.47325714195057	153829094639737	94361689798228.1	153829094639737
31	400	186.6	5.80851378579049	162409963290567	98299968870279.8	162409963290567
32	480	186.6	6.43777056431354	178352381268313	105070419526278	178352381268313
33	600	186.6	7.30114927597588	199990905047147	113291889646017	199990905047147
34	700	186.6	7.96603186890977	216560042435043	119000318577454	216560042435043
35	720	186.6	8.09431558980373	219753186435482	120054170939062	219753186435482
36						
37	NOTES:					
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]				
39	2	Ibid, Equation 3-2b				
40	3	Ibid, Equation 3-4d [30+90 min release duration]				
41	4	Ibid, Table A-1				
42	5	Ibid, Equation 3-3a				
43	6	Ibid, Equation 3-3b				
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7				
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7				
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7				
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7				
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7				
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7; initial 5.3 pH value (				
50	13	Max. Suppression Pool volume from Calc. body section 4.4, including				
51		UFSAR Table 6.2-4A HWL Suppression Pool volume of 134,600 cu ft, Reactor Coolant Syste				
52		and low-pressure Emergency Core Cooling System sources, roundd up to 175,000 cu. Ft.				
53		(For Attachment B page B-6 minimization of Drywell + Suppression Pool Airspace volume, th				
54		403,120 cu ft value - 175,000 + 122,120 Tech Spec 3/4.5.3 nominal minimum Suppression P				

	G
1	**END OF CYCLE**
2	Linear Absorption Coefficients [4]
3	$U_{beta\ air}$
4	$U_{beta\ hypalon}$
5	$U_{gamma\ air}$
6	$U_{gamma\ hypalon}$
7	$r_{(gamma\ free\ path-DRYWELL)}$ [15]
8	$r_{(gamma\ free\ path-SUPP\ POOL\ AIR)}$ [15]
9	
10	Beta [18]
11	Supp Pool AIR
12	MeV/cm^3
13	
14	
15	1730013153896.35
16	1802214752482.87
17	3688722168022.81
18	6796717122483.9
19	14207462998066.7
20	18809856471831.5
21	22625236709381.3
22	34089477741320.3
23	42694278802823
24	49880534617235
25	56145093552860.5
26	63027129381434.4
27	72737793079027.3
28	79280404587774.5
29	87536763527759.8
30	94361689798228.1
31	98299968870279.8
32	105070419526278
33	113291889646017
34	119000318577454
35	120054170939062
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	H	I	J	K
1				Cable Data [22]
2			$S_{A\,tray}$ [cm^2]	=$P$3*1.1
3	0.0198	1/cm	$S_{A\,fs}$ [cm^2]	=$P$4*1.1
4	52.08	1/cm	$S_{B\,tray}$ [cm^2]	=$P$6*0.95*1.1
5	0.0000375	1/cm	$S_{B\,fs}$ [cm^2]	=P6*1.1*0.05
6	0.099	1/cm		
7	894.08	cm	th [cm]	0.70514
8	894.08	cm		
9				
10			From Beta	From Gamma
11	[HI] [1]	[HNO_3] [2]	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]
12	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter
13	0			
14	=$B$4/(120*$B$3)*($A14-(0.5+$B$6))+$B$4/(400*$B$3)			
15	=$B$4/(120*$B$3)*($A15-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C15	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E15	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D15
16	=$B$4/(120*$B$3)*($A16-(0.5+$B$6))+$B$4/(400*$B$3)	=0 0000073*$C16	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E16	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D16
17	=H$16	=0.0000073*$C17	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E17	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D17
18	=H$16	=0.0000073*$C18	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E18	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D18
19	=H$16	=0.0000073*$C19	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E19	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D19
20	=H$16	=0.0000073*$C20	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E20	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D20
21	=H$16	=0.0000073*$C21	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E21	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D21
22	=H$16	=0.0000073*$C22	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E22	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D22
23	=H$16	=0 0000073*$C23	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E23	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D23
24	=H$16	=0.0000073*$C24	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E24	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D24
25	=H$16	=0.0000073*$C25	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E25	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D25
26	=H$16	=0.0000073*$C26	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E26	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D26
27	=H$16	=0.0000073*$C27	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E27	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D27
28	=H$16	=0.0000073*$C28	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E28	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D28
29	=H$16	=0.0000073*$C29	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E29	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D29
30	=H$16	=0.0000073*$C30	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E30	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D30
31	=H$16	=0.0000073*$C31	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E31	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D31
32	=H$16	=0.0000073*$C32	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E32	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D32
33	=H$16	=0.0000073*$C33	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E33	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D33
34	=H$16	=0.0000073*$C34	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E34	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D34
35	=H$16	=0.0000073*$C35	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E35	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D35
36				
37	Acid dissociation constant from: Entergy Eng. Report GGNS-98-0039 Rev.3, Sect.6.1,p.21			
38	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7			
39	See attachment B for gamma free paths			
40	LGS UFSAR Rev. 11)			
41	Attachment B			
42	Attachment B			
43	USNRC Reg. Guide 1.183			
44	Page C-6 of this attachment			
45	Cable Data from Attachment A.			
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	L	M	N
1			
2	Cable Surface [trays]- Drywell + 10% contingency		
3	Cable Surface [free air]- Drywell + 10% contingency		
4	Cable Surface [trays] - Supp. Pool + 10% contingency		
5	Cable Surface [free air] - Supp. Pool + 10% contingency		
6			
7	Hypalon Jacket Thickness [22]		
8			
9			
10	From Beta	From Gamma	
11	[HCL] -CONTAIN[5]	[HCL] -CONTAIN[6]	Total [H+] [7]
12	g-mols/liter	g-mols/liter	g-ions/liter
13			=POWER(10,-$T$13)+$H13+$I13+$J13+$K13+$L13+$M13
14			=POWER(10,-$T$13)+$H14+$I14+$J14+$K14+$L14+$M14
15	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E15	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=POWER(10,-$T$13)+$H15+$I15+$J15+$K15+$L15+$M15
16	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E16	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=POWER(10,-$T$13)+$H16+$I16+$J16+$K16+$L16+$M16
17	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E17	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=POWER(10,-$T$13)+$H17+$I17+$J17+$K17+$L17+$M17
18	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E18	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=POWER(10,-$T$13)+$H18+$I18+$J18+$K18+$L18+$M18
19	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E19	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=POWER(10,-$T$13)+$H19+$I19+$J19+$K19+$L19+$M19
20	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E20	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=POWER(10,-$T$13)+$H20+$I20+$J20+$K20+$L20+$M20
21	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E21	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=POWER(10,-$T$13)+$H21+$I21+$J21+$K21+$L21+$M21
22	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E22	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=POWER(10,-$T$13)+$H22+$I22+$J22+$K22+$L22+$M22
23	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E23	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=POWER(10,-$T$13)+$H23+$I23+$J23+$K23+$L23+$M23
24	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E24	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=POWER(10,-$T$13)+$H24+$I24+$J24+$K24+$L24+$M24
25	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E25	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=POWER(10,-$T$13)+$H25+$I25+$J25+$K25+$L25+$M25
26	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E26	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=POWER(10,-$T$13)+$H26+$I26+$J26+$K26+$L26+$M26
27	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E27	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=POWER(10,-$T$13)+$H27+$I27+$J27+$K27+$L27+$M27
28	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E28	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=POWER(10,-$T$13)+$H28+$I28+$J28+$K28+$L28+$M28
29	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E29	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=POWER(10,-$T$13)+$H29+$I29+$J29+$K29+$L29+$M29
30	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E30	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=POWER(10,-$T$13)+$H30+$I30+$J30+$K30+$L30+$M30
31	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E31	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=POWER(10,-$T$13)+$H31+$I31+$J31+$K31+$L31+$M31
32	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E32	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=POWER(10,-$T$13)+$H32+$I32+$J32+$K32+$L32+$M32
33	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E33	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=POWER(10,-$T$13)+$H33+$I33+$J33+$K33+$L33+$M33
34	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E34	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=POWER(10,-$T$13)+$H34+$I34+$J34+$K34+$L34+$M34
35	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E35	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=POWER(10,-$T$13)+$H35+$I35+$J35+$K35+$L35+$M35
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	O	P	Q
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2		**Cable Data** [22]	
3		2425857.59715346	Cable Surface [Trays] - DRYWELL [cm2]
4		=$P$3*0.05	Cable Surface [Free air] - DRYWELL [cm2]
5		=P6*0.05	Cable Surface [Free air] - TORUS [cm2]
6		0	Cable Surface [Trays] - TORUS [cm2]
7			
8			
9			
10			
11	[CsOH] [3]	Total [OH+] [9]	-LOG(Kw) [9]
12	g-mols/liter	g-ions/liter	
13	0	=POWER(10,-14)/POWER(10,-$T$13)+$O13	=15.5129-0.0224*$B13+0.00003352*POWER(B13,2)
14	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A14-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3	=POWER(10,-14)/POWER(10,-$T$13)+$O14	=15.5129-0.0224*$B14+0.00003352*POWER(B14,2)
15	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A15-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3	=POWER(10,-14)/POWER(10,-$T$13)+$O15	=15.5129-0.0224*$B15+0.00003352*POWER(B15,2)
16	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A16-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3	=POWER(10,-14)/POWER(10,-$T$13)+$O16	=15.5129-0.0224*$B16+0.00003352*POWER(B16,2)
17	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O17	=15.5129-0.0224*$B17+0.00003352*POWER(B17,2)
18	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O18	=15.5129-0.0224*$B18+0.00003352*POWER(B18,2)
19	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O19	=15.5129-0.0224*$B19+0.00003352*POWER(B19,2)
20	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O20	=15.5129-0.0224*$B20+0.00003352*POWER(B20,2)
21	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O21	=15.5129-0.0224*$B21+0.00003352*POWER(B21,2)
22	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O22	=15.5129-0.0224*$B22+0.00003352*POWER(B22,2)
23	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O23	=15.5129-0.0224*$B23+0.00003352*POWER(B23,2)
24	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O24	=15.5129-0.0224*$B24+0.00003352*POWER(B24,2)
25	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O25	=15.5129-0.0224*$B25+0.00003352*POWER(B25,2)
26	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O26	=15.5129-0.0224*$B26+0.00003352*POWER(B26,2)
27	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O27	=15.5129-0.0224*$B27+0.00003352*POWER(B27,2)
28	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O28	=15.5129-0.0224*$B28+0.00003352*POWER(B28,2)
29	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O29	=15.5129-0.0224*$B29+0.00003352*POWER(B29,2)
30	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O30	=15.5129-0.0224*$B30+0.00003352*POWER(B30,2)
31	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O31	=15.5129-0.0224*$B31+0.00003352*POWER(B31,2)
32	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O32	=15.5129-0.0224*$B32+0.00003352*POWER(B32,2)
33	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O33	=15.5129-0.0224*$B33+0.00003352*POWER(B33,2)
34	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O34	=15.5129-0.0224*$B34+0.00003352*POWER(B34,2)
35	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O35	=15.5129-0.0224*$B35+0.00003352*POWER(B35,2)
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	R	S	T	U	V	W	X	Y
1		pH TRANSIENT		END OF CYCLE				
2								
3								
4					='Available Boron'!B17	g. mols $Na_2B_{10}O_{16}*10H_2O$ Added		
5					='Available Boron'!B22	g.atoms total boron		
6								
7								
8				pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CO				
9								
10					Strong Acid			
11	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}*10H_2O$	Borate	Boric Acid
12		g-ions/liter	Before SLC	[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.
13	=(N13+P13-SQRT(POWER(($N13+$P13),2)-(4*(N13*P13-POWER(10,-$Q13)))))/2	=$N13-$R13	5.3	=(0.0585*B13+1.309)/10000000000	=S13*$B$3	=$V$4	=W13*2-V13	=W13*8+V13
14	=(N14+P14-SQRT(POWER(($N14+$P14),2)-(4*(N14*P14-POWER(10,-$Q14)))))/2	=$N14-$R14	=-LOG10($S14)	=(0.0585*B14+1.309)/10000000000	=S14*$B$3	=$V$4	=W14*2-V14	=W14*8+V14
15	=(N15+P15-SQRT(POWER(($N15+$P15),2)-(4*(N15*P15-POWER(10,-$Q15)))))/2	=$N15-$R15	=-LOG10($S15)	=(0.0585*B15+1.309)/10000000000	=S15*$B$3	=$V$4	=W15*2-V15	=W15*8+V15
16	=(N16+P16-SQRT(POWER(($N16+$P16),2)-(4*(N16*P16-POWER(10,-$Q16)))))/2	=$N16-$R16	=-LOG10($S16)	=(0.0585*B16+1.309)/10000000000	=S16*$B$3	=$V$4	=W16*2-V16	=W16*8+V16
17	=(N17+P17-SQRT(POWER(($N17+$P17),2)-(4*(N17*P17-POWER(10,-$Q17)))))/2	=$N17-$R17	=-LOG10($S17)	=(0.0585*B17+1.309)/10000000000	=S17*$B$3	=$V$4	=W17*2-V17	=W17*8+V17
18	=(N18+P18-SQRT(POWER(($N18+$P18),2)-(4*(N18*P18-POWER(10,-$Q18)))))/2	=$N18-$R18	=-LOG10($S18)	=(0.0585*B18+1.309)/10000000000	=S18*$B$3	=$V$4	=W18*2-V18	=W18*8+V18
19	=(N19+P19-SQRT(POWER(($N19+$P19),2)-(4*(N19*P19-POWER(10,-$Q19)))))/2	=$N19-$R19	=-LOG10($S19)	=(0.0585*B19+1.309)/10000000000	=S19*$B$3	=$V$4	=W19*2-V19	=W19*8+V19
20	=(N20+P20-SQRT(POWER(($N20+$P20),2)-(4*(N20*P20-POWER(10,-$Q20)))))/2	=$N20-$R20	=-LOG10($S20)	=(0.0585*B20+1.309)/10000000000	=S20*$B$3	=$V$4	=W20*2-V20	=W20*8+V20
21	=(N21+P21-SQRT(POWER(($N21+$P21),2)-(4*(N21*P21-POWER(10,-$Q21)))))/2	=$N21-$R21	=-LOG10($S21)	=(0.0585*B21+1.309)/10000000000	=S21*$B$3	=$V$4	=W21*2-V21	=W21*8+V21
22	=(N22+P22-SQRT(POWER(($N22+$P22),2)-(4*(N22*P22-POWER(10,-$Q22)))))/2	=$N22-$R22	=-LOG10($S22)	=(0.0585*B22+1.309)/10000000000	=S22*$B$3	=$V$4	=W22*2-V22	=W22*8+V22
23	=(N23+P23-SQRT(POWER(($N23+$P23),2)-(4*(N23*P23-POWER(10,-$Q23)))))/2	=$N23-$R23	=-LOG10($S23)	=(0.0585*B23+1.309)/10000000000	=S23*$B$3	=$V$4	=W23*2-V23	=W23*8+V23
24	=(N24+P24-SQRT(POWER(($N24+$P24),2)-(4*(N24*P24-POWER(10,-$Q24)))))/2	=$N24-$R24	=-LOG10($S24)	=(0.0585*B24+1.309)/10000000000	=S24*$B$3	=$V$4	=W24*2-V24	=W24*8+V24
25	=(N25+P25-SQRT(POWER(($N25+$P25),2)-(4*(N25*P25-POWER(10,-$Q25)))))/2	=$N25-$R25	=-LOG10($S25)	=(0.0585*B25+1.309)/10000000000	=S25*$B$3	=$V$4	=W25*2-V25	=W25*8+V25
26	=(N26+P26-SQRT(POWER(($N26+$P26),2)-(4*(N26*P26-POWER(10,-$Q26)))))/2	=$N26-$R26	=-LOG10($S26)	=(0.0585*B26+1.309)/10000000000	=S26*$B$3	=$V$4	=W26*2-V26	=W26*8+V26
27	=(N27+P27-SQRT(POWER(($N27+$P27),2)-(4*(N27*P27-POWER(10,-$Q27)))))/2	=$N27-$R27	=-LOG10($S27)	=(0.0585*B27+1.309)/10000000000	=S27*$B$3	=$V$4	=W27*2-V27	=W27*8+V27
28	=(N28+P28-SQRT(POWER(($N28+$P28),2)-(4*(N28*P28-POWER(10,-$Q28)))))/2	=$N28-$R28	=-LOG10($S28)	=(0.0585*B28+1.309)/10000000000	=S28*$B$3	=$V$4	=W28*2-V28	=W28*8+V28
29	=(N29+P29-SQRT(POWER(($N29+$P29),2)-(4*(N29*P29-POWER(10,-$Q29)))))/2	=$N29-$R29	=-LOG10($S29)	=(0.0585*B29+1.309)/10000000000	=S29*$B$3	=$V$4	=W29*2-V29	=W29*8+V29
30	=(N30+P30-SQRT(POWER(($N30+$P30),2)-(4*(N30*P30-POWER(10,-$Q30)))))/2	=$N30-$R30	=-LOG10($S30)	=(0.0585*B30+1.309)/10000000000	=S30*$B$3	=$V$4	=W30*2-V30	=W30*8+V30
31	=(N31+P31-SQRT(POWER(($N31+$P31),2)-(4*(N31*P31-POWER(10,-$Q31)))))/2	=$N31-$R31	=-LOG10($S31)	=(0.0585*B31+1.309)/10000000000	=S31*$B$3	=$V$4	=W31*2-V31	=W31*8+V31
32	=(N32+P32-SQRT(POWER(($N32+$P32),2)-(4*(N32*P32-POWER(10,-$Q32)))))/2	=$N32-$R32	=-LOG10($S32)	=(0.0585*B32+1.309)/10000000000	=S32*$B$3	=$V$4	=W32*2-V32	=W32*8+V32
33	=(N33+P33-SQRT(POWER(($N33+$P33),2)-(4*(N33*P33-POWER(10,-$Q33)))))/2	=$N33-$R33	=-LOG10($S33)	=(0.0585*B33+1.309)/10000000000	=S33*$B$3	=$V$4	=W33*2-V33	=W33*8+V33
34	=(N34+P34-SQRT(POWER(($N34+$P34),2)-(4*(N34*P34-POWER(10,-$Q34)))))/2	=$N34-$R34	=-LOG10($S34)	=(0.0585*B34+1.309)/10000000000	=S34*$B$3	=$V$4	=W34*2-V34	=W34*8+V34
35	=(N35+P35-SQRT(POWER(($N35+$P35),2)-(4*(N35*P35-POWER(10,-$Q35)))))/2	=$N35-$R35	=-LOG10($S35)	=(0.0585*B35+1.309)/10000000000	=S35*$B$3	=$V$4	=W35*2-V35	=W35*8+V35
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	Z	AA	AB
1			
2			
3			
4			
5			
6			
7			
8	TROL [SLC] SOLUTION		
9			
10			
11	pK_a	pH	
12	$-log_{10}K_a$	15	
13	=-LOG10(U13)	=Z13+LOG10((X13/$B$3)/(Y13/$B$3))	
14	=-LOG10(U14)	=Z14+LOG10((X14/$B$3)/(Y14/$B$3))	
15	=-LOG10(U15)	=Z15+LOG10((X15/$B$3)/(Y15/$B$3))	
16	=-LOG10(U16)	=Z16+LOG10((X16/$B$3)/(Y16/$B$3))	
17	=-LOG10(U17)	=Z17+LOG10((X17/$B$3)/(Y17/$B$3))	
18	=-LOG10(U18)	=Z18+LOG10((X18/$B$3)/(Y18/$B$3))	
19	=-LOG10(U19)	=Z19+LOG10((X19/$B$3)/(Y19/$B$3))	
20	=-LOG10(U20)	=Z20+LOG10((X20/$B$3)/(Y20/$B$3))	
21	=-LOG10(U21)	=Z21+LOG10((X21/$B$3)/(Y21/$B$3))	
22	=-LOG10(U22)	=Z22+LOG10((X22/$B$3)/(Y22/$B$3))	
23	=-LOG10(U23)	=Z23+LOG10((X23/$B$3)/(Y23/$B$3))	
24	=-LOG10(U24)	=Z24+LOG10((X24/$B$3)/(Y24/$B$3))	
25	=-LOG10(U25)	=Z25+LOG10((X25/$B$3)/(Y25/$B$3))	
26	=-LOG10(U26)	=Z26+LOG10((X26/$B$3)/(Y26/$B$3))	
27	=-LOG10(U27)	=Z27+LOG10((X27/$B$3)/(Y27/$B$3))	
28	=-LOG10(U28)	=Z28+LOG10((X28/$B$3)/(Y28/$B$3))	
29	=-LOG10(U29)	=Z29+LOG10((X29/$B$3)/(Y29/$B$3))	
30	=-LOG10(U30)	=Z30+LOG10((X30/$B$3)/(Y30/$B$3))	
31	=-LOG10(U31)	=Z31+LOG10((X31/$B$3)/(Y31/$B$3))	
32	=-LOG10(U32)	=Z32+LOG10((X32/$B$3)/(Y32/$B$3))	
33	=-LOG10(U33)	=Z33+LOG10((X33/$B$3)/(Y33/$B$3))	
34	=-LOG10(U34)	=Z34+LOG10((X34/$B$3)/(Y34/$B$3))	
35	=-LOG10(U35)	=Z35+LOG10((X35/$B$3)/(Y35/$B$3))	
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	A	B	C	D
1				
2	**Available Boron Calculation**			
3				
4	**Quantity**	**Value**	**Basis**	
5				
6	**Volume of Solution (gal)=**	1500	Assumed Minimum (LGS Tech Spec Sect. 4	
7			Indicates 3160 gallons)	
8	**wt% of Na2B10O16*10H2O=**	0.1	LGS Technical Specification figure 3.1.5-1	
9	**Specific Gravity (gm/cm3)=**	=0.5*($B$8)+0.9985	Table CH-C-105-3	
10	**Conversion Factor (cm3/gal)=**	3785.412		
11	**Conversion Factor (lbs/gm)=**	=(1/453.59)		
12				
13	**Total Mass of Solution (lbs)=**	=B6*B9*B10*B11		
14	**Total $Na_2B_{10}O_{16}$*$10H_2O$ (lbs)=**	=B13*B8		
15	**Total $Na_2B_{10}O_{16}$*$10H_2O$ (gm)=**	=B14/B11		
16	**Total $Na_2B_{10}O_{16}$*$10H_2O$**			
17	**(gm-moles)=**	=B15/D28		
18	**Total Boron (gm-atoms)=**	=10*B17		
19				
20				
21	***Total Available Boron (lbs)=***	=B14*B35		
22	***Total Available Boron (gm-atoms)=***	=(B21/B11)/B29		
23				
24	**B-10 Enrichment=**	0.199		
25				
26		Molar Mass		Total Molar Mass of
27		(gm/mole)		Na2B10O16 * 10H2O
28	**Sodium**	22.98977		=2*(B28)+10*(B29)+16*(B30)+10*((2*B31)+(1*(B30)))
29	**Boron**	=B32*(B24)+B33*(1-B24)		
30	**Oxygen**	15.9994		
31	**Hydrogen**	1.00794		
32	**Boron-10**	10.0129369		
33	**Boron-11**	11.0093054		
34				
35	**Percentage of Total Boron=**	=10*(B29)/D28		

GRAND GULF REFERENCE CALCULATION

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	CASE 1	GRAND GULF REFERENCE DATA			pH TRANSIENT											
2							Linear Absorption Coefficients [4]			$L_{A\,tray}$ [lb]	873.65	Cable Length [trays]- Zone A				SLC [lbs]
3	V_{POOL}	4.841E+06	Liters [Min.Tech Spec Basis B 3.6.2.2]				$U_{beta\ air}$	1.980E-02	1/cm	$L_{A\,fa}$ [lb]	873.65	Cable Length [free air]- Zone A				
4	m_I	325	Iodine inventory [g-atoms]				$U_{beta\ hypalon}$	52.08	1/cm	$L_{B\,tray}$ [lb]	14049.27	Cable Length [trays] - Zone B				
5	m_{Cs}	2400	Cesium Inventory [g-atoms]				$U_{gamma\ air}$	3.75E-05	1/cm	$L_{B\,fa}$ [lb]	1561.03	Cable Length [free air] - Zone B				
6	t_{gap}	0.0336	Onset of Gap release [hrs]				$U_{gamma\ hypalon}$	0.099	1/cm	R_0 [cm^2]/lb	800	Cable Area				
7							$r_{[gamma\ free\ path-A]}$	1112.5	cm	th [cm]	0.7112	Hypalon Jacket Thickness [13]				
8							$r_{[gamma\ free\ path-B]}$	1384	cm							
9				INTEGRATED DOSES						CONCENTRATIONS						
10			Beta+Gamma	Gamma	Beta	Gamma	Beta			From Beta	From Gamma	From Beta	From Gamma			
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	CONTAINMENT	CONTAINMENT	[HI] [1]	[HNO_3] [2]	[HCL] -A [5]	[HCL] -A [6]	[HCL] -B [5]	[HCL] -B [6]	Total [H+] [7]	[CsOH] [3]	Total [OH+] [8]
12	Hours	Deg F	Mrad	MeV/cm^3	MeV/cm^3	MeV/cm^3	MeV/cm^3	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-ions/liter	g-mols/liter	g-ions/liter
13	0	77						0.00E+00						5.012E-06	0.0000E+00	2.00E-09
14	1	160						4.288E-07						5.441E-06	4.7472E-05	4.75E-05
15	2	160	1.3645E-01	1.4200E+12	2.8733E+12	0.0000E+00	1.1220E+12	9.8825E-07	9.961E-07	1.104E-06	1.067E-06	2.824E-06	0.000E+00	1.199E-05	1.0295E-04	1.03E-04
16	2.0336	160	1.4229E-01	1.4506E+12	2.8784E+12	0.0000E+00	1.2148E+12	1.0071E-06	1.039E-06	1.106E-06	1.090E-06	3.057E-06	0.000E+00	1.231E-05	1.0481E-04	1.05E-04
17	3	159.1	2.9415E-01	2.1630E+12	3.0235E+12	6.6925E+10	1.2908E+12	1.0071E-06	2.147E-06	1.161E-06	1.625E-06	3.249E-06	5.560E-07	1.476E-05	1.0481E-04	1.05E-04
18	5	155.5	5.4364E-01	3.0991E+12	3.3208E+12	6.4671E+11	1.4468E+12	1.0071E-06	3.969E-06	1.276E-06	2.328E-06	3.641E-06	5.373E-06	2.261E-05	1.0481E-04	1.05E-04
19	12	149.2	1.1306E+00	4.7032E+12	4.3312E+12	1.6404E+12	1.9789E+12	1.0071E-06	8.253E-06	1.664E-06	3.533E-06	4.980E-06	1.363E-05	3.808E-05	1.0481E-04	1.05E-04
20	18	146.4	1.4804E+00	5.4462E+12	5.1609E+12	2.1006E+12	2.4183E+12	1.0071E-06	1.081E-05	1.982E-06	4.091E-06	6.086E-06	1.745E-05	4.644E-05	1.0481E-04	1.05E-04
21	24	144.3	1.7610E+00	5.9733E+12	5.9584E+12	2.4271E+12	2.8430E+12	1.0071E-06	1.286E-05	2.289E-06	4.487E-06	7.155E-06	2.016E-05	5.297E-05	1.0481E-04	1.05E-04
22	48	139.4	2.5674E+00	7.2434E+12	8.8503E+12	3.2138E+12	4.4038E+12	1.0071E-06	1.874E-05	3.400E-06	5.442E-06	1.108E-05	2.670E-05	7.138E-05	1.0481E-04	1.05E-04
23	72	136.5	3.1560E+00	7.9863E+12	1.1319E+13	3.6740E+12	5.7649E+12	1.0071E-06	2.304E-05	4.348E-06	6.000E-06	1.451E-05	3.052E-05	8.444E-05	1.0481E-04	1.05E-04
24	96	134.4	3.6505E+00	8.5135E+12	1.3425E+13	4.0005E+12	6.9521E+12	1.0071E-06	2.665E-05	5.157E-06	6.396E-06	1.750E-05	3.323E-05	9.495E-05	1.0481E-04	1.05E-04
25	120	132.8	4.0931E+00	8.9224E+12	1.5224E+13	4.2538E+12	7.9874E+12	1.0071E-06	2.988E-05	5.848E-06	6.703E-06	2.010E-05	3.534E-05	1.039E-04	1.0481E-04	1.05E-04
26	150	131.3	4.6010E+00	9.3312E+12	1.7105E+13	4.5071E+12	9.0975E+12	1.0071E-06	3.359E-05	6.571E-06	7.010E-06	2.290E-05	3.744E-05	1.135E-04	1.0481E-04	1.05E-04
27	200	129.2	5.3738E+00	9.8584E+12	1.9521E+13	4.8336E+12	1.0574E+13	1.0071E-06	3.923E-05	7.499E-06	7.406E-06	2.661E-05	4.016E-05	1.269E-04	1.0481E-04	1.05E-04
28	240	127.9	5.9431E+00	1.0192E+13	2.0955E+13	5.0405E+12	1.1486E+13	1.0071E-06	4.338E-05	8.050E-06	7.657E-06	2.891E-05	4.187E-05	1.359E-04	1.0481E-04	1.05E-04
29	300	126.3	6.7335E+00	1.0601E+13	2.2506E+13	5.2938E+12	1.2519E+13	1.0071E-06	4.915E-05	8.645E-06	7.964E-06	3.151E-05	4.398E-05	1.473E-04	1.0481E-04	1.05E-04
30	360	125	7.4620E+00	1.0935E+13	2.3551E+13	5.5007E+12	1.3252E+13	1.0071E-06	5.447E-05	9.047E-06	8.215E-06	3.335E-05	4.570E-05	1.568E-04	1.0481E-04	1.05E-04
31	400	124.3	7.9191E+00	1.1128E+13	2.4049E+13	5.6203E+12	1.3618E+13	1.0071E-06	5.781E-05	9.238E-06	8.360E-06	3.427E-05	4.669E-05	1.624E-04	1.0481E-04	1.05E-04
32	480	123	8.7770E+00	1.1463E+13	2.4727E+13	5.8272E+12	1.4143E+13	1.0071E-06	6.407E-05	9.499E-06	8.612E-06	3.559E-05	4.841E-05	1.722E-04	1.0481E-04	1.05E-04
33	600	121.4	9.9540E+00	1.1871E+13	2.5259E+13	6.0805E+12	1.4592E+13	1.0071E-06	7.266E-05	9.703E-06	8.918E-06	3.672E-05	5.051E-05	1.845E-04	1.0481E-04	1.05E-04
34	700	120.3	1.0861E+01	1.2154E+13	2.5472E+13	6.2555E+12	1.4791E+13	1.0071E-06	7.928E-05	9.785E-06	9.131E-06	3.722E-05	5.197E-05	1.934E-04	1.0481E-04	1.05E-04
35	720	120.1	1.1035E+01	1.2205E+13	2.5500E+13	6.2875E+12	1.4819E+13	1.0071E-06	8.056E-05	9.795E-06	9.169E-06	3.729E-05	5.223E-05	1.951E-04	1.0481E-04	1.05E-04
36																
37	NOTES															
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]						14	Acid dissociation constant from: Entergy Eng. Rep. GGNS-98-0039 Rev.3, Sect.6.1,p.21							
39	2	Ibid, Equation 3-2b						15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7							
40	3	Ibid, Equation 3-4d [30+90 min release duration]														
41	4	Ibid, Table A-1														
42	5	Ibid, Equation 3-3a; Entergy Calc. XC-Q11111-98013 Rev.2, Equation 5-1														
43	6	Ibid, Equation 3-3b; Entergy Calc. XC-Q11111-98013 Rev.2, Equation 5-2														
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
50	13	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.2.2														

GRAND GULF REFERENCE CALCULATION

	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1													
2	5800	$Na_2B_{10}O_{16}$ Added [MW=410]											
3													
4													
5													
6													
7													
8					pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTION								
9													
10						Strong Acid							
11	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}$	Borate	Boric Acid	pK_a	pH		
12			g-ions/liter		[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-\log_{10}K_a$			
13	1.399E+01	-6.1360E-11	5.0119E-06	5.300	5.8135E-10	2.4262E+01	6416.8	12809	51359	9.24	8.63		
14	1.279E+01	5.4368E-06	3.8846E-09	8.411	1.0669E-09	1.8805E-02	6416.8	12834	51334	8.97	8.37		
15	1.279E+01	1.1989E-05	1.7953E-09	8.746	1.0669E-09	8.6909E-03	6416.8	12834	51334	8.97	8.37		
16	1.279E+01	1.2309E-05	1.7653E-09	8.753	1.0669E-09	8.5458E-03	6416.8	12834	51334	8.97	8.37		
17	1.280E+01	1.4755E-05	1.7698E-09	8.752	1.0616E-09	8.5676E-03	6416.8	12834	51334	8.97	8.37		
18	1.284E+01	2.2603E-05	1.7573E-09	8.755	1.0406E-09	8.5071E-03	6416.8	12834	51334	8.98	8.38		
19	1.292E+01	3.8076E-05	1.8140E-09	8.741	1.0037E-09	8.7813E-03	6416.8	12834	51334	9.00	8.40		
20	1.295E+01	4.6435E-05	1.9133E-09	8.718	9.8734E-10	9.2620E-03	6416.8	12834	51334	9.01	8.40		
21	1.298E+01	5.2967E-05	2.0264E-09	8.693	9.7506E-10	9.8098E-03	6416.8	12834	51334	9.01	8.41		
22	1.304E+01	7.1382E-05	2.7173E-09	8.566	9.4639E-10	1.3154E-02	6416.8	12834	51334	9.02	8.42		
23	1.308E+01	8.4432E-05	4.0825E-09	8.389	9.2943E-10	1.9763E-02	6416.8	12834	51334	9.03	8.43		
24	1.311E+01	9.4943E-05	7.9048E-09	8.102	9.1714E-10	3.8266E-02	6416.8	12834	51334	9.04	8.44		
25	1.313E+01	1.0382E-04	7.4496E-08	7.128	9.0778E-10	3.6063E-01	6416.8	12833	51335	9.04	8.44		
26	1.315E+01	1.0480E-04	8.7215E-06	5.059	8.9901E-10	4.2220E+01	6416.8	12791	51376	9.05	8.44		
27	1.318E+01	1.0481E-04	2.2110E-05	4.655	8.8672E-10	1.0703E+02	6416.8	12727	51441	9.05	8.45		
28	1.320E+01	1.0481E-04	3.1080E-05	4.508	8.7912E-10	1.5045E+02	6416.8	12683	51485	9.06	8.45		
29	1.322E+01	1.0481E-04	4.2457E-05	4.372	8.6976E-10	2.0553E+02	6416.8	12628	51540	9.06	8.45		
30	1.324E+01	1.0481E-04	5.1990E-05	4.284	8.6215E-10	2.5168E+02	6416.8	12582	51586	9.06	8.45		
31	1.325E+01	1.0481E-04	5.7578E-05	4.240	8.5806E-10	2.7873E+02	6416.8	12555	51613	9.07	8.45		
32	1.326E+01	1.0481E-04	6.7392E-05	4.171	8.5045E-10	3.2624E+02	6416.8	12507	51660	9.07	8.45		
33	1.329E+01	1.0481E-04	7.9730E-05	4.098	8.4109E-10	3.8596E+02	6416.8	12448	51720	9.08	8.46		
34	1.330E+01	1.0481E-04	8.8596E-05	4.053	8.3466E-10	4.2888E+02	6416.8	12405	51763	9.08	8.46		
35	1.331E+01	1.0481E-04	9.0259E-05	4.045	8.3349E-10	4.3693E+02	6416.8	12397	51771	9.08	8.46		
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GRAND GULF REFERENCE CALCULATION

	A	B	C	D	E	F	G	H
1	CASE 1	GRAND GULF REFERE			pH TRANSIENT			
2							Linear Absorption Coeffici	
3	V_{POOL}	=170954*28.3168	Liters [Min.Tech Spec Basis E				$u_{beta\ air}$	0.0198
4	m_I	=325	Iodine Inventory [g-atoms]				$u_{beta\ hypalon}$	52.08
5	m_{Cs}	=2400	Cesium Inventory [g-atoms]				$u_{gamma\ air}$	0.0000375
6	t_{gap}	=121/3600	Onset of Gap release [hrs]				$u_{gamma\ hypalon}$	0.099
7							$r_{[gamma\ free\ path-A]}$	1112.5
8							$r_{[gamma\ free\ path-B]}$	1384
9				INTEGRATED DOSES				
10			Beta+Gamma	Gamma	Beta	Gamma	Beta	
11	TIME	POOL Temp	POOL	DRYWELL-A	DRYWELL-A	DRYWELL-B	DRYWELL-B	[HI] [1]
12	Hours	Deg F	Mrad	MeV/cm³	MeV/cm³	MeV/cm³	MeV/cm³	g-mols/liter
13	0	77						0
14	1	160						=$B$4/(120*$B$3)*($A14-(0.5+$B$6))+$B$4/(400*$B$3)
15	2	160	1.3783	1420000000000	2873300000000	0	1122000000000	=$B$4/(120*$B$3)*($A15-(0.5+$B$6))+$B$4/(400*$B$3)
16	=0.5+1.5+B6	160	1.3792	1450600000000	2878400000000	0	1214800000000	=$B$4/(120*$B$3)*($A16-(0.5+$B$6))+$B$4/(400*$B$3)
17	3	159.1	1.4049	2163000000000	3023500000000	66925000000	1290800000000	=H$16
18	5	155.5	1.4581	3099100000000	3320800000000	646710000000	1446800000000	=H$16
19	12	149.2	1.6425	4703200000000	4331200000000	1640400000000	1978900000000	=H$16
20	18	146.4	1.7985	5446200000000	5160900000000	2100600000000	2418300000000	=H$16
21	24	144.3	1.9526	5973300000000	5958400000000	2427100000000	2843000000000	=H$16
22	48	139.4	2.5509	7243400000000	8850300000000	3213800000000	4403800000000	=H$16
23	72	136.5	3.1213	7986300000000	11319000000000	3674000000000	5764900000000	=H$16
24	96	134.4	3.6648	8513500000000	13425000000000	4000500000000	6952100000000	=H$16
25	120	132.8	4.183	8922400000000	15224000000000	4253800000000	7987400000000	=H$16
26	150	131.3	4.7966	9331200000000	17105000000000	4507100000000	9097500000000	=H$16
27	200	129.2	5.7409	9858400000000	19521000000000	4833600000000	10574000000000	=H$16
28	240	127.9	6.4313	10192000000000	20955000000000	5040500000000	11486000000000	=H$16
29	300	126.3	7.3686	10601000000000	22506000000000	5293800000000	12519000000000	=H$16
30	360	125	8.1999	10935000000000	23551000000000	5500700000000	13252000000000	=H$16
31	400	124.3	8.7011	11128000000000	24049000000000	5620300000000	13618000000000	=H$16
32	480	123	9.5911	11463000000000	24727000000000	5827200000000	14143000000000	=H$16
33	600	121.4	10.685	11871000000000	25259000000000	6080500000000	14592000000000	=H$16
34	700	120.3	11.417	12154000000000	25472000000000	6255500000000	14791000000000	=H$16
35	720	120.1	11.546	12205000000000	25500000000000	6287500000000	14819000000000	=H$16
36								
37	NOTES							
38	1	Entergy Eng. Report GG						14
39	2	Ibid, Equation 3-2b						15
40	3	Ibid, Equation 3-4d [30+9						
41	4	Ibid, Table A-1						
42	5	Ibid, Equation 3-3a; Ente						
43	6	Ibid, Equation 3-3b; Ente						
44	7	Ibid, Equation 3-5a; Ente						
45	8	Ibid, Equation 3-5b; Ente						
46	9	Ibid, Equation 3-0a; Ente						
47	10	Ibid, Equation 3-5d; Ente						
48	11	Ibid, Equation 3-5d; Ente						
49	12	Ibid, Equation 3-5e; Ente						
50	13	Entergy Calc. XC-Q111						

GRAND GULF REFERENCE CALCULATION

	I	J	K	L
1				
2		$L_{A\,tray}$ [lb]	873.65	Cable Length [trays]- Zone A
3	1/cm	$L_{A\,fa}$ [lb]	873.65	Cable Length [free air]- Zone A
4	1/cm	$L_{B\,tray}$ [lb]	14049.27	Cable Length [trays] - Zone B
5	1/cm	$L_{B\,fa}$ [lb]	1561.03	Cable Length [free air] - Zone B
6	1/cm	R_0 [cm^2]/lb	800	Cable Area
7	cm	th [cm]	=0.28*2.54	Hypalon Jacket Thickness [13]
8	cm			
9		CONCENTRATIONS		
10		From Beta	From Gamma	From Beta
11	[HNO_3] [2]	[HCL] -A [5]	[HCL] -A [6]	[HCL] -B [5]
12	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter
13				
14				
15	=0.0000073*$C15	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E15	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G15
16	=0.0000073*$C16	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E16	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G16
17	=0.0000073*$C17	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E17	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G17
18	=0.0000073*$C18	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E18	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G18
19	=0.0000073*$C19	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E19	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G19
20	=0.0000073*$C20	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E20	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G20
21	=0.0000073*$C21	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E21	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G21
22	=0.0000073*$C22	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E22	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G22
23	=0.0000073*$C23	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E23	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G23
24	=0.0000073*$C24	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E24	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G24
25	=0.0000073*$C25	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E25	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G25
26	=0.0000073*$C26	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E26	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G26
27	=0.0000073*$C27	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E27	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G27
28	=0.0000073*$C28	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E28	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G28
29	=0.0000073*$C29	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E29	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G29
30	=0.0000073*$C30	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E30	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G30
31	=0.0000073*$C31	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E31	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G31
32	=0.0000073*$C32	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E32	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G32
33	=0.0000073*$C33	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E33	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G33
34	=0.0000073*$C34	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E34	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G34
35	=0.0000073*$C35	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E35	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G35
36				
37				
38	Acid dissociation consta			
39	Entergy Calc. XC-Q111			
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GRAND GULF REFERENCE CALCULATION

	M	N	O
1			
2			
3			
4			
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6			
7			
8			
9			
10	From Gamma		
11	[HCL] -B [8]	Total [H+] [7]	[CsOH] [3]
12	g-mols/liter	g-ions/liter	g-mols/liter
13		=POWER(10,-$T$13)+$H13+$I13+$J13+$K13+$L13+$M13	0
14		=POWER(10,-$T$13)+$H14+$I14+$J14+$K14+$L14+$M14	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A14-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
15	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F15	=POWER(10,-$T$13)+$H15+$I15+$J15+$K15+$L15+$M15	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A15-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
16	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F16	=POWER(10,-$T$13)+$H16+$I16+$J16+$K16+$L16+$M16	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A16-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
17	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F17	=POWER(10,-$T$13)+$H17+$I17+$J17+$K17+$L17+$M17	=$O$16
18	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F18	=POWER(10,-$T$13)+$H18+$I18+$J18+$K18+$L18+$M18	=$O$16
19	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F19	=POWER(10,-$T$13)+$H19+$I19+$J19+$K19+$L19+$M19	=$O$16
20	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F20	=POWER(10,-$T$13)+$H20+$I20+$J20+$K20+$L20+$M20	=$O$16
21	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F21	=POWER(10,-$T$13)+$H21+$I21+$J21+$K21+$L21+$M21	=$O$16
22	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F22	=POWER(10,-$T$13)+$H22+$I22+$J22+$K22+$L22+$M22	=$O$16
23	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F23	=POWER(10,-$T$13)+$H23+$I23+$J23+$K23+$L23+$M23	=$O$16
24	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F24	=POWER(10,-$T$13)+$H24+$I24+$J24+$K24+$L24+$M24	=$O$16
25	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F25	=POWER(10,-$T$13)+$H25+$I25+$J25+$K25+$L25+$M25	=$O$16
26	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F26	=POWER(10,-$T$13)+$H26+$I26+$J26+$K26+$L26+$M26	=$O$16
27	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F27	=POWER(10,-$T$13)+$H27+$I27+$J27+$K27+$L27+$M27	=$O$16
28	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F28	=POWER(10,-$T$13)+$H28+$I28+$J28+$K28+$L28+$M28	=$O$16
29	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F29	=POWER(10,-$T$13)+$H29+$I29+$J29+$K29+$L29+$M29	=$O$16
30	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F30	=POWER(10,-$T$13)+$H30+$I30+$J30+$K30+$L30+$M30	=$O$16
31	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F31	=POWER(10,-$T$13)+$H31+$I31+$J31+$K31+$L31+$M31	=$O$16
32	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F32	=POWER(10,-$T$13)+$H32+$I32+$J32+$K32+$L32+$M32	=$O$16
33	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F33	=POWER(10,-$T$13)+$H33+$I33+$J33+$K33+$L33+$M33	=$O$16
34	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F34	=POWER(10,-$T$13)+$H34+$I34+$J34+$K34+$L34+$M34	=$O$16
35	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F35	=POWER(10,-$T$13)+$H35+$I35+$J35+$K35+$L35+$M35	=$O$16
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	P	Q	R	S	T	U
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2	SLC [lbs]	5800	$Na_2B_4O_7 10H_2O$ Added [MW=410]			
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4						
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6						
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8						pH EFFECT OF ADDITION OF SODIU
9						
10						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a
12	g-Ions/liter			g-Ions/liter		[14]
13	=POWER(10,-14)/POWER(10,-$T$13)+$O13	=15.5129-0.0224*$B13+0.00003352*POWER(B13,2)	=(N13+P13-SQRT(POWER(($N13+$P13),2)-(4*(N13*P13-POWER(10,-$Q13)))))/2	=$N13-$R13	5.3	=(0.0585*B13+1.309)/10000000000
14	=POWER(10,-14)/POWER(10,-$T$13)+$O14	=15.5129-0.0224*$B14+0.00003352*POWER(B14,2)	=(N14+P14-SQRT(POWER(($N14+$P14),2)-(4*(N14*P14-POWER(10,-$Q14)))))/2	=$N14-$R14	=-LOG10($S14)	=(0.0585*B14+1.309)/10000000000
15	=POWER(10,-14)/POWER(10,-$T$13)+$O15	=15.5129-0.0224*$B15+0.00003352*POWER(B15,2)	=(N15+P15-SQRT(POWER(($N15+$P15),2)-(4*(N15*P15-POWER(10,-$Q15)))))/2	=$N15-$R15	=-LOG10($S15)	=(0.0585*B15+1.309)/10000000000
16	=POWER(10,-14)/POWER(10,-$T$13)+$O16	=15.5129-0.0224*$B16+0.00003352*POWER(B16,2)	=(N16+P16-SQRT(POWER(($N16+$P16),2)-(4*(N16*P16-POWER(10,-$Q16)))))/2	=$N16-$R16	=-LOG10($S16)	=(0.0585*B16+1.309)/10000000000
17	=POWER(10,-14)/POWER(10,-$T$13)+$O17	=15.5129-0.0224*$B17+0.00003352*POWER(B17,2)	=(N17+P17-SQRT(POWER(($N17+$P17),2)-(4*(N17*P17-POWER(10,-$Q17)))))/2	=$N17-$R17	=-LOG10($S17)	=(0.0585*B17+1.309)/10000000000
18	=POWER(10,-14)/POWER(10,-$T$13)+$O18	=15.5129-0.0224*$B18+0.00003352*POWER(B18,2)	=(N18+P18-SQRT(POWER(($N18+$P18),2)-(4*(N18*P18-POWER(10,-$Q18)))))/2	=$N18-$R18	=-LOG10($S18)	=(0.0585*B18+1.309)/10000000000
19	=POWER(10,-14)/POWER(10,-$T$13)+$O19	=15.5129-0.0224*$B19+0.00003352*POWER(B19,2)	=(N19+P19-SQRT(POWER(($N19+$P19),2)-(4*(N19*P19-POWER(10,-$Q19)))))/2	=$N19-$R19	=-LOG10($S19)	=(0.0585*B19+1.309)/10000000000
20	=POWER(10,-14)/POWER(10,-$T$13)+$O20	=15.5129-0.0224*$B20+0.00003352*POWER(B20,2)	=(N20+P20-SQRT(POWER(($N20+$P20),2)-(4*(N20*P20-POWER(10,-$Q20)))))/2	=$N20-$R20	=-LOG10($S20)	=(0.0585*B20+1.309)/10000000000
21	=POWER(10,-14)/POWER(10,-$T$13)+$O21	=15.5129-0.0224*$B21+0.00003352*POWER(B21,2)	=(N21+P21-SQRT(POWER(($N21+$P21),2)-(4*(N21*P21-POWER(10,-$Q21)))))/2	=$N21-$R21	=-LOG10($S21)	=(0.0585*B21+1.309)/10000000000
22	=POWER(10,-14)/POWER(10,-$T$13)+$O22	=15.5129-0.0224*$B22+0.00003352*POWER(B22,2)	=(N22+P22-SQRT(POWER(($N22+$P22),2)-(4*(N22*P22-POWER(10,-$Q22)))))/2	=$N22-$R22	=-LOG10($S22)	=(0.0585*B22+1.309)/10000000000
23	=POWER(10,-14)/POWER(10,-$T$13)+$O23	=15.5129-0.0224*$B23+0.00003352*POWER(B23,2)	=(N23+P23-SQRT(POWER(($N23+$P23),2)-(4*(N23*P23-POWER(10,-$Q23)))))/2	=$N23-$R23	=-LOG10($S23)	=(0.0585*B23+1.309)/10000000000
24	=POWER(10,-14)/POWER(10,-$T$13)+$O24	=15.5129-0.0224*$B24+0.00003352*POWER(B24,2)	=(N24+P24-SQRT(POWER(($N24+$P24),2)-(4*(N24*P24-POWER(10,-$Q24)))))/2	=$N24-$R24	=-LOG10($S24)	=(0.0585*B24+1.309)/10000000000
25	=POWER(10,-14)/POWER(10,-$T$13)+$O25	=15.5129-0.0224*$B25+0.00003352*POWER(B25,2)	=(N25+P25-SQRT(POWER(($N25+$P25),2)-(4*(N25*P25-POWER(10,-$Q25)))))/2	=$N25-$R25	=-LOG10($S25)	=(0.0585*B25+1.309)/10000000000
26	=POWER(10,-14)/POWER(10,-$T$13)+$O26	=15.5129-0.0224*$B26+0.00003352*POWER(B26,2)	=(N26+P26-SQRT(POWER(($N26+$P26),2)-(4*(N26*P26-POWER(10,-$Q26)))))/2	=$N26-$R26	=-LOG10($S26)	=(0.0585*B26+1.309)/10000000000
27	=POWER(10,-14)/POWER(10,-$T$13)+$O27	=15.5129-0.0224*$B27+0.00003352*POWER(B27,2)	=(N27+P27-SQRT(POWER(($N27+$P27),2)-(4*(N27*P27-POWER(10,-$Q27)))))/2	=$N27-$R27	=-LOG10($S27)	=(0.0585*B27+1.309)/10000000000
28	=POWER(10,-14)/POWER(10,-$T$13)+$O28	=15.5129-0.0224*$B28+0.00003352*POWER(B28,2)	=(N28+P28-SQRT(POWER(($N28+$P28),2)-(4*(N28*P28-POWER(10,-$Q28)))))/2	=$N28-$R28	=-LOG10($S28)	=(0.0585*B28+1.309)/10000000000
29	=POWER(10,-14)/POWER(10,-$T$13)+$O29	=15.5129-0.0224*$B29+0.00003352*POWER(B29,2)	=(N29+P29-SQRT(POWER(($N29+$P29),2)-(4*(N29*P29-POWER(10,-$Q29)))))/2	=$N29-$R29	=-LOG10($S29)	=(0.0585*B29+1.309)/10000000000
30	=POWER(10,-14)/POWER(10,-$T$13)+$O30	=15.5129-0.0224*$B30+0.00003352*POWER(B30,2)	=(N30+P30-SQRT(POWER(($N30+$P30),2)-(4*(N30*P30-POWER(10,-$Q30)))))/2	=$N30-$R30	=-LOG10($S30)	=(0.0585*B30+1.309)/10000000000
31	=POWER(10,-14)/POWER(10,-$T$13)+$O31	=15.5129-0.0224*$B31+0.00003352*POWER(B31,2)	=(N31+P31-SQRT(POWER(($N31+$P31),2)-(4*(N31*P31-POWER(10,-$Q31)))))/2	=$N31-$R31	=-LOG10($S31)	=(0.0585*B31+1.309)/10000000000
32	=POWER(10,-14)/POWER(10,-$T$13)+$O32	=15.5129-0.0224*$B32+0.00003352*POWER(B32,2)	=(N32+P32-SQRT(POWER(($N32+$P32),2)-(4*(N32*P32-POWER(10,-$Q32)))))/2	=$N32-$R32	=-LOG10($S32)	=(0.0585*B32+1.309)/10000000000
33	=POWER(10,-14)/POWER(10,-$T$13)+$O33	=15.5129-0.0224*$B33+0.00003352*POWER(B33,2)	=(N33+P33-SQRT(POWER(($N33+$P33),2)-(4*(N33*P33-POWER(10,-$Q33)))))/2	=$N33-$R33	=-LOG10($S33)	=(0.0585*B33+1.309)/10000000000
34	=POWER(10,-14)/POWER(10,-$T$13)+$O34	=15.5129-0.0224*$B34+0.00003352*POWER(B34,2)	=(N34+P34-SQRT(POWER(($N34+$P34),2)-(4*(N34*P34-POWER(10,-$Q34)))))/2	=$N34-$R34	=-LOG10($S34)	=(0.0585*B34+1.309)/10000000000
35	=POWER(10,-14)/POWER(10,-$T$13)+$O35	=15.5129-0.0224*$B35+0.00003352*POWER(B35,2)	=(N35+P35-SQRT(POWER(($N35+$P35),2)-(4*(N35*P35-POWER(10,-$Q35)))))/2	=$N35-$R35	=-LOG10($S35)	=(0.0585*B35+1.309)/10000000000
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GRAND GULF REFERENCE CALCULATION

	V	W	X	Y	Z	AA
1						
2						
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9						
10	Strong Acid					
11	g-equiv.	$Na_2B_4O_7 10H_2O$	Borate	Boric Acid	pK_a	pH
12	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	[15]
13	=S13*$B$3	=$Q$2*453.6/410	=W13*2-V13	=W13*8+V13	=-LOG10(U13)	=Z13+LOG10((X13/$B$3)/(Y13/$B$3))
14	=S14*$B$3	=$Q$2*453.6/410	=W14*2-V14	=W14*8+V14	=-LOG10(U14)	=Z14+LOG10((X14/$B$3)/(Y14/$B$3))
15	=S15*$B$3	=$Q$2*453.6/410	=W15*2-V15	=W15*8+V15	=-LOG10(U15)	=Z15+LOG10((X15/$B$3)/(Y15/$B$3))
16	=S16*$B$3	=$Q$2*453.6/410	=W16*2-V16	=W16*8+V16	=-LOG10(U16)	=Z16+LOG10((X16/$B$3)/(Y16/$B$3))
17	=S17*$B$3	=$Q$2*453.6/410	=W17*2-V17	=W17*8+V17	=-LOG10(U17)	=Z17+LOG10((X17/$B$3)/(Y17/$B$3))
18	=S18*$B$3	=$Q$2*453.6/410	=W18*2-V18	=W18*8+V18	=-LOG10(U18)	=Z18+LOG10((X18/$B$3)/(Y18/$B$3))
19	=S19*$B$3	=$Q$2*453.6/410	=W19*2-V19	=W19*8+V19	=-LOG10(U19)	=Z19+LOG10((X19/$B$3)/(Y19/$B$3))
20	=S20*$B$3	=$Q$2*453.6/410	=W20*2-V20	=W20*8+V20	=-LOG10(U20)	=Z20+LOG10((X20/$B$3)/(Y20/$B$3))
21	=S21*$B$3	=$Q$2*453.6/410	=W21*2-V21	=W21*8+V21	=-LOG10(U21)	=Z21+LOG10((X21/$B$3)/(Y21/$B$3))
22	=S22*$B$3	=$Q$2*453.6/410	=W22*2-V22	=W22*8+V22	=-LOG10(U22)	=Z22+LOG10((X22/$B$3)/(Y22/$B$3))
23	=S23*$B$3	=$Q$2*453.6/410	=W23*2-V23	=W23*8+V23	=-LOG10(U23)	=Z23+LOG10((X23/$B$3)/(Y23/$B$3))
24	=S24*$B$3	=$Q$2*453.6/410	=W24*2-V24	=W24*8+V24	=-LOG10(U24)	=Z24+LOG10((X24/$B$3)/(Y24/$B$3))
25	=S25*$B$3	=$Q$2*453.6/410	=W25*2-V25	=W25*8+V25	=-LOG10(U25)	=Z25+LOG10((X25/$B$3)/(Y25/$B$3))
26	=S26*$B$3	=$Q$2*453.6/410	=W26*2-V26	=W26*8+V26	=-LOG10(U26)	=Z26+LOG10((X26/$B$3)/(Y26/$B$3))
27	=S27*$B$3	=$Q$2*453.6/410	=W27*2-V27	=W27*8+V27	=-LOG10(U27)	=Z27+LOG10((X27/$B$3)/(Y27/$B$3))
28	=S28*$B$3	=$Q$2*453.6/410	=W28*2-V28	=W28*8+V28	=-LOG10(U28)	=Z28+LOG10((X28/$B$3)/(Y28/$B$3))
29	=S29*$B$3	=$Q$2*453.6/410	=W29*2-V29	=W29*8+V29	=-LOG10(U29)	=Z29+LOG10((X29/$B$3)/(Y29/$B$3))
30	=S30*$B$3	=$Q$2*453.6/410	=W30*2-V30	=W30*8+V30	=-LOG10(U30)	=Z30+LOG10((X30/$B$3)/(Y30/$B$3))
31	=S31*$B$3	=$Q$2*453.6/410	=W31*2-V31	=W31*8+V31	=-LOG10(U31)	=Z31+LOG10((X31/$B$3)/(Y31/$B$3))
32	=S32*$B$3	=$Q$2*453.6/410	=W32*2-V32	=W32*8+V32	=-LOG10(U32)	=Z32+LOG10((X32/$B$3)/(Y32/$B$3))
33	=S33*$B$3	=$Q$2*453.6/410	=W33*2-V33	=W33*8+V33	=-LOG10(U33)	=Z33+LOG10((X33/$B$3)/(Y33/$B$3))
34	=S34*$B$3	=$Q$2*453.6/410	=W34*2-V34	=W34*8+V34	=-LOG10(U34)	=Z34+LOG10((X34/$B$3)/(Y34/$B$3))
35	=S35*$B$3	=$Q$2*453.6/410	=W35*2-V35	=W35*8+V35	=-LOG10(U35)	=Z35+LOG10((X35/$B$3)/(Y35/$B$3))
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Calc. LM-0642, Rev. 0, Attachment F:

GGNS-98-0039, Rev. 3, "Entergy Operations Engineering Report for Suppression Pool pH and Iodine Re-Evolution Methodology" 12/20/00 (Grand Gulf Nuclear Station)

30 Pages

ENTERGY OPERATIONS

Engineering Report

For

SUPPRESSION POOL PH AND IODINE RE-EVOLUTION METHODOLOGY

APPLICABLE SITES

ANO Unit 1: ☐	GGNS: ☒	W-3: ☐
ANO Unit 2: ☐	RBS: ☐	ECH: ☐

Safety Related: X Yes
____ No

Prepared by: [signature] Date: 12/19/00
Responsible Engineer

Reviewed by: [signature] Date: 12/20/00
Reviewer

Reviewed by: [signature] Date: 12/20/00
Supervisor/Reviewer

Approved by: N/A Date: ____
Responsible CDE Manager
(for multiple site reports only)

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ATTACHMENT 1 - SAMPLE PH CASE RESULTS
APPENDIX A - HYDROCHLORIC ACID PRODUCTION MODEL

1.0 INTRODUCTION

Section 5.2 of NUREG-1465 [1] reports that the re-evolution of iodine can impact the plant radiological analyses if the suppression pool pH drops below a value of 7. Specifically, for those BWRs that credit the long-term retention of iodine in the suppression pool via sprays or pool scrubbing, NUREG-1465 suggests that the maintenance of a pH at or above a level of 7 should be demonstrated. Since BWRs generally do not have a requirement to control post-accident pool pH, the expected pool pH transient has not been evaluated. This report develops a methodology for calculating the suppression pool pH transient using the available NRC research results. This methodology explicitly considers the acids and bases expected to be available in BWR containments under post-accident conditions. Revision 2 adds the temperature dependence of the water ionization constant and bases the hydrochloric acid production term on an energy flux approach. Revision 3 adds methodology for considering standby liquid control (sodium pentaborate) as a pH buffer.

This methodology develops a reasonably bounding negative pH transient for application in radiological analyses in order to quantify (i) the timing requirements for pH control actions, (ii) the required inventories of pH control chemicals, and (iii) as input to the iodine re-evolution calculation in the event the pool pH is uncontrolled. In reality, the pool pH is not anticipated to experience this chemistry transient in the event of a recirculation line break since the EP actions directing operators to flood the containment with outside water sources would result in the significant dilution of any acids in the suppression pool.

Some background on pool pH issues is reported in Section 2. The GGNS model is developed in Section 3 and applied to a sample plant in Section 4. Section 5 develops a method for determining the amount of iodine re-evolution in the event the pool pH is calculated to drop below 7.0. Section 6 describes a pH control strategy while Section 7 lists the references applied in this report.

2.0 BACKGROUND

Unlike PWRs, BWRs currently do not have requirements to control post-accident suppression pool pH. PWRs include boric acid in the reactor coolant which introduces a negative pH transient at the onset of the accident and the PWR sump dose rates are an order of magnitude higher than in BWRs as reported in Section 2.2.4 of NUREG/CR-5950 [2] increasing the production rate of nitric acid (as discussed in Section 3.2). BWRs contain a much larger water inventory in the suppression pool since this volume is credited for condensation of the released reactor coolant, thereby suppressing the containment pressurization transient. As a result, the extent of iodine re-evolution can be significantly higher in PWRs. As illustrated in Figure 4.1 of NUREG/CR-5732 [3], an uncontrolled sump pH can result in the re-evolution of nearly 100% of the dissolved iodine in a PWR sump and as much as ~25% in BWR suppression pools. This figure also illustrates that essentially no iodine is re-evolved if the pool pH is controlled.

3.0 GGNS MODEL DESCRIPTION

Through basic chemistry relationships, the pH of a solution is directly related to the concentration of H^+ ions by the formulas:

$$pH = -\log([H^+])$$
$$[H^+]\cdot[OH^-] = K_w(T) \qquad (3\text{-}0a)$$
$$-\log K_w(T) = 15.5129 - 2.24E\text{-}2 * T + 3.352E\text{-}5 * T^2$$

where:

$[H^+]$ = concentration of H^+ ions in moles per liter,
$[OH^-]$ = concentration of OH^- ions in moles per liter,
K_w = ionization constant for water[1], and
T = pool temperature (°F) up to 212 °F

The temperature dependence of the ionization constant is taken from Reference 7 and the associated curve fit is documented in the following table.

Table 3-1 Water Ionization Constant Data Fit

Temp (°C)	Temp (°F)	-LOG(K_w)	Data Fit
25	77	13.995	13.987
30	86	13.836	13.834
35	95	13.685	13.687
40	104	13.542	13.546
45	113	13.405	13.410
50	122	13.275	13.279
55	131	13.152	13.154
60	140	13.034	13.034
65	149	12.921	12.919
70	158	12.814	12.810
75	167	12.712	12.707
80	176	12.613	12.609
85	185	12.520	12.516
90	194	12.428	12.429
95	203	12.345	12.347
100	212	12.265	12.271

A methodology to calculate the concentration of H^+ ions in the suppression pool will be developed in this section. Equation 3-0a can then be applied to determine the pool pH value.

[1] Although the impact of pool temperature on the ionization constant is small at the depressed pH values associated with iodine re-evolution, it's consideration is necessary to accurately characterize the pH values of alkaline solutions at elevated temperatures.

As discussed in Section 2 of NUREG/CR-5950, a variety of acids and bases are produced in containment during accidents. These chemicals are addressed individually below:

Boric Acid is an acid introduced from the reactor coolant system, refueling water storage tanks, and containment sprays. These sources are not borated in BWRs and are consequently not considered in this methodology.

Hydriodic Acid is a strong acid introduced into the containment with the release of iodine. As reported in Section 2.2.2 of NUREG/CR-5950 and Section 4.5 of NUREG-1465, no more than 5% of the core iodine inventory is expected to be released from the RCS in this chemical form. As such, the production of this acid is explicitly considered in this methodology.

Carbon Dioxide depresses the pH of pure water by absorption. Carbonic acid is a weak acid and is expected to be insignificant compared to other acids produced in containment during an accident. However, the initial pool pH may be depressed below 7.0 during normal operations by the absorption of CO_2. As such, the effects of carbon dioxide will be considered in the initial condition assumed for pool pH.

Nitric Acid is a strong acid produced by the irradiation of water and air during accidents. The production of this acid is explicitly considered in this methodology.

Hydrochloric Acid is a strong acid produced by the radiolysis of chloride-bearing insulation during accidents. The production of this acid is explicitly considered in this methodology. The pyrolysis of chloride-bearing insulation produces HCl at temperatures near 572 °F (per Section 2.2.5.3 of NUREG/CR-5950). Since drywell or containment temperatures above 330 °F are not postulated during accidents in BWRs, pyrolysis is not considered in this methodology.

Cesium Hydroxide is a strong base introduced into the containment with the release of cesium. The production of this base is explicitly considered in this methodology.

Core-Concrete Aerosols are basic materials produced from the interaction of the molten core materials with the concrete containment. Since SECY-94-302 [5] reports that the core damage may be assumed to be arrested after the in-vessel release phase, these chemicals are not considered in this methodology.

3.1 Hydriodic Acid Production

Iodine is released from the core as fuel failure occurs. Table 3.12 of NUREG-1465 indicates that 5% of the core halogen inventory is released during the gap release phase while an additional 25% is released during the early in-vessel phase. The core damage is assumed to be arrested after the in-vessel release phase in accordance with the NRC recommendation in SECY-94-302. Consistent with Section 4.5 of NUREG-1465, no more than 5% of the iodine exiting the reactor coolant system will be composed of I and HI. This methodology will conservatively assume that all 5% of this release is in the form of HI in order to maximize the acid generation. This release process is assumed to occur at a constant rate over the release period (*i.e.*, 30 and 90 minutes for the gap and early in-vessel release phases, respectively). The core iodine inventory includes the stable I^{127} species to maximize the amount of acid produced. The following equations describe this release.

$$\frac{d}{dt}[HI] = \frac{0.05 \cdot 0.05 m_I}{V_{pool} \cdot 0.5\ hr} \quad \text{(Gap Release Phase)} \qquad (3\text{-}1a)$$

$$\frac{d}{dt}[HI] = \frac{0.05 \cdot 0.25 m_I}{V_{pool} \cdot 1.5\ hr} \quad \text{(Early In-Vessel Release Phase)} \qquad (3\text{-}1b)$$

where:

m_I = core iodine inventory (gram-mols), and
V_{pool} = volume of the suppression pool (liters).

A conservatively small pool volume should be applied as generally used in the plant containment thermal-hydraulic analyses. In addition, any changes to the pool volume throughout the duration of the accident should be addressed such as losses due to humidity and ESF leakage and increases from the reactor coolant inventory and any expected pool water supplements. For example, at GGNS, the suppression pool makeup system would automatically transfer water from the upper containment pools into the suppression pool within 30 minutes in the event of a LOCA.

This release can be integrated considering the 1/2-hour BWR gap release duration to yield the following equations during the gap and in-vessel release periods.

$$[HI](t) = \frac{m_I}{200 \cdot V_{pool}} \cdot (t - t_{gap}) \quad \text{(Gap Release Phase)} \qquad (3\text{-}1c)$$

$$[HI](t) = \frac{m_I}{120 \cdot V_{pool}} \cdot \left[t - (0.5 + t_{gap})\right] + \frac{m_I}{400 \cdot V_{pool}} \quad \text{(Early In-Vessel Release Phase)} \qquad (3\text{-}1d)$$

where:

t = time into accident (hrs), and
t_{gap} = onset of gap release (hrs).

3.2 Nitric Acid Production

Section 2.2.4 of NUREG/CR-5950 and Section 3.3.1.1 of NUREG/CR-5732 report the experimental results of irradiation-assisted nitric acid production with the following constant (based on data at 86 °F):

$$\frac{0.007\ \text{molecules}\ HNO_3}{100\ \text{eV}}$$

This constant is assumed to be conservative for water temperatures above 86 °F considering the reduced solubility of nitrogen at elevated temperatures. For a water density of 1 g/cc, this constant can be calculated to be 7.3E-6 moles of nitric acid per liter per Megarad of absorbed energy which matches the reported generation term in Section 2.2.4 of NUREG/CR-5950.

$$\frac{0.007\ \text{molecules}}{100\ \text{eV}}\cdot\frac{\text{eV}}{1.60219\text{E}-12\ \text{erg}}\cdot\frac{\text{mole}}{6.022\text{E}23\ \text{molecules}}\cdot\frac{100\ \text{ergs}}{\text{rad}-\text{g}}\cdot\frac{10^6\ \text{rads}}{\text{Megarad}}\cdot\frac{1\ \text{g}}{\text{cc}}\cdot\frac{1000\ \text{cc}}{\text{liter}}$$

$$=7.3\text{E}-6\frac{\text{moles}}{\text{L}-\text{Megarad}}$$

Water densities less than 1 g/cc are applicable in post-accident suppression pools making the above constant conservative. Alternatively, an analysis considering the mass of water in the pool can be applied.

Since nitric acid is a strong acid, $[H^+]$ and $[NO_3^-]$ increase by 7.3E-6 for each Megarad received by the pool, the following formula can be developed.

$$\frac{d}{dt}[HNO_3]=7.3E-6\frac{mol\ HNO_3}{L-Megarad}\cdot\dot{X}(t)_{pool} \qquad (3\text{-}2a)$$

where:

$\dot{X}(t)_{pool}$ = the time-dependent dose rate[2] in the suppression pool (Megarads/hr).

The previous equation can be integrated to yield the nitric acid concentration throughout the accident.

$$[HNO_3](t)=7.3E-6\int_0^t\dot{X}(t)_{pool}\,dt \qquad (3\text{-}2b)$$

where:

t = time into accident (hrs).

Since the 30-day suppression pool dose rates generated with TID-14844 source terms have been shown to bound those generated with NUREG-1465 (per Figure 5 of SECY-98-154), EQ dose rates generated by the current TID methods are conservative and acceptable for determining the HNO_3 production rate.

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[2] Note that this dose rate represents an energy deposition to the pool water such that all decay mechanisms need to be considered including both gamma and beta emissions. Existing pool analyses may neglect beta decay if developed for calculated doses to equipment external to the pool.

3.3 Hydrochloric Acid Production

The radiolysis of chloride-bearing cable jacketing will result in the production of HCl vapor as reported in Section 2.2.5.2 of NUREG/CR-5950. A model for the production of HCl from cable jacketing is developed in Appendix A based on the approach in NUREG/CR-5950 and concludes the HCl produced from the radiolysis of a cable is predicted by the following formula.

From NUREG/CR 5950 page E3

Beta:

$$M_{HCl}(t) = 3.512E-20 \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{1}{\mu_\beta^{air}} \int_0^t \frac{E_\beta}{V} dt \qquad \text{(3-3a)}$$

G

Gamma:

$$M_{HCl}(t) = 3.512E-20 \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{\left(1-e^{-\mu_\gamma^{air} r}\right)}{\mu_\gamma^{air}} \cdot \left(1-e^{-\mu_\gamma^{H} th}\right) \int_0^t \frac{E_\gamma}{V} dt \qquad \text{(3-3b)}$$

where:

M_{HCl} = total HCl production (g mols).

$\frac{E_\beta}{V}$ = energy release rate per unit volume ($MeV/hr\text{-}cm^3$) for beta radiation,

$\frac{E_\gamma}{V}$ = energy release rate per unit volume ($MeV/hr\text{-}cm^3$) for gamma radiation,

μ_β^{air} = linear absorption coefficient of beta radiation in air (cm^{-1}),

μ_γ^{air} = linear absorption coefficient of gamma radiation in air (cm^{-1}),

μ_γ^{H} = linear absorption coefficient of gamma radiation in Hypalon (cm^{-1}),

ℓ = cable length (cm),

th = thickness of the Hypalon jacket (cm),

R_o = cable radius (cm), and

t = time into accident (hrs).

G = 3.512E-20 g moles HCl/MeV

Equations 3-3a and 3-3b can be applied to all cables in the containment to determine the total HCl generation in containment. Dose rates and the cable inventories may vary throughout containment such that local dose rates can be applied to local cable quantities. Although it is anticipated that a significant portion of the HCl produced from cable radiolysis would react with the plentiful metal surface areas in the containment (*e.g.*, gratings, etc.), the gaseous HCl will be conservatively assumed to be immediately dissolved in the suppression pool water. In the suppression pool, the HCl concentration is given by:

$$[HCl](t) = \frac{1}{V_{pool}} \sum_{\substack{all \\ cables}} M_{HCl}^{\gamma}(t) + M_{HCl}^{\beta}(t) \qquad \text{(3-3b)}$$

The following considerations may be used for determining the HCl production from chloride-bearing cable jackets.

1. Consistent with NUREG-0588 [4], Rev. 1, Section 1.4(9), the beta dose to cables arranged in cable trays is reduced by a factor of 2 due to localized shielding by other cables and the cable tray itself.

2. Cables in conduit or totally enclosed raceways will not contribute any HCl to the suppression pool. This assumption is consistent with Section 2.2 of NUREG-1081 and Table 2.2 of NUREG/CR-5950, which does not include the 15% of

cables at Fermi that are routed in conduit. These conduits are water-resistant and generally routed between sealed terminal boxes at which the cables terminate or are routed through other conduit. There is no significant driving force for source terms to enter this conduit and any potential diffusion of containment atmosphere into these conduits would be a long-term process occurring after a significant decay time and result in minimal dose rates.

In addition, these cables are shielded from any beta dose from the containment and drywell atmosphere outside the conduit due to the metal conduit structure. Although some HCl production may occur due to gamma radiation from the containment and drywell atmosphere outside the conduit, the limited amounts of gaseous HCl evolved from these cables would most likely react with the metal conduit structure considering the tortuous path out of the conduit and therefore is assumed to not enter the suppression pool.

3. Since the airborne dose rates generated with TID-14844 source terms have been shown to bound those generated with NUREG-1465 in SECY-98-154 [6], EQ dose rates generated by the current TID methods are acceptable in determining the HCl evolution rate.

3.4 Cesium Hydroxide Production

Cesium is released from the core as fuel failure occurs. Table 3.12 of NUREG-1465 indicates that 5% of the core alkali metal inventory (including cesium) is discharged during the gap release phase while an additional 20% is discharged during the early in-vessel phase. The core damage is assumed to be arrested after the in-vessel release phase in accordance with the NRC recommendation in SECY-94-302. For iodine, Table 3.12 of NUREG-1465 indicates that 5% of the core halogen inventory is discharged during the gap release phase while an additional 25% is discharged during the early in-vessel phase.

Consistent with Section 4.5 of NUREG-1465, the iodine exiting the reactor coolant system will be composed of at least 95% cesium iodide (CsI). These cesium and iodide inventories include the stable isotopes of I^{127} and Cs^{133}. The cesium that is not in the chemical form of CsI is assumed to exit the RCS in the form of *cesium hydroxide (CsOH) and be deposited into the* suppression pool[3]. This CsOH inventory is illustrated in Figure 3-1 below.

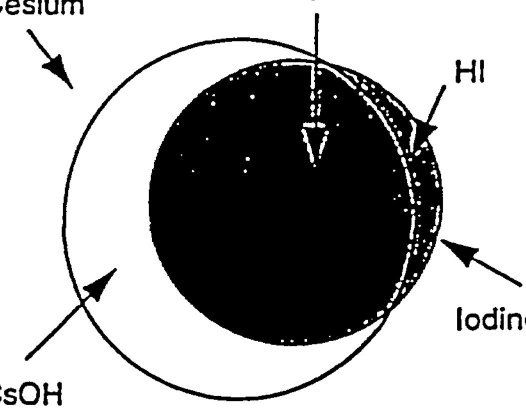

Figure 3-1 CsOH Inventory Assumption

Both the cesium and iodine core inventories grow throughout the cycle with the cesium inventory increasing significantly. Therefore, the EOC core exposure will result in the largest CsOH release. *Although a BOC exposure may result in a reduced CsOH release and lower* pool pH, the core source term inventory, pool iodine concentration, EQ dose rates, and core decay heat would all be lower at this BOC exposure. Since the radiological analyses are based on EOC conditions, the EOC core source terms for cesium and iodine are considered appropriate for the pool pH analysis.

This release process is assumed to occur at a constant rate over the release period (*i.e.*, 30 and 90 minutes for the gap and early in-vessel release phases, respectively). The following equations describe this release.

[3] Although, in reality, some CsOH may remain airborne in the containment, this assumption is expected to be sufficiently conservative when taken in conjunction with the assumption in Section 3.3 that all HCl evolved from cable radiolysis immediately enters the pool. Considering the hygroscopic nature of CsOH and its release in the vicinity of the suppression pool, the probability of CsOH migrating to the pool is considered higher than that of HCl produced from cable radiolysis in locations that may be some distance from the pool and are likely to contain large metal surface areas.

$$\frac{d}{dt}[CsOH]=\frac{0.05m_{Cs}-0.95 \cdot 0.05m_I}{V_{pool} \cdot 0.5\ hr} \quad \text{(Gap Release Phase)} \tag{3-4a}$$

$$\frac{d}{dt}[CsOH]=\frac{0.2m_{Cs}-0.95 \cdot 0.25m_I}{V_{pool} \cdot 1.5\ hr} \quad \text{(Early In-Vessel Release Phase)} \tag{3-4b}$$

where:

m_{Cs} = core cesium inventory (gram-mols)[4].

This release can be integrated considering the 1/2-hour BWR gap release duration to yield the following equations during the gap and in-vessel release periods.

Gap Release Phase:

$$[CsOH](t)=\frac{0.1m_{Cs}-0.095m_I}{V_{pool}} \cdot (t-t_{gap}) \tag{3-4c}$$

Early In-Vessel Release Phase:

$$[CsOH](t)=\frac{0.4m_{Cs}-0.475m_I}{3 \cdot V_{pool}} \cdot [t-(0.5+t_{gap})]+\frac{0.05m_{Cs}-0.0475m_I}{V_{pool}} \tag{3-4d}$$

4 Since cesium is being credited for a beneficial effect, a conservatively small cesium inventory should be applied.

3.5 Summary

The combined effects of the acids and bases that occur during BWR accidents can be calculated as a function of time and initial pool pH with the formulas in Equation 3-0a by separating the acid and base generation terms.

$$[\mathrm{H^+}](t) = [\mathrm{H^+}](t=0) + \int_0^t \frac{d}{dt}[\mathrm{HI}](t)dt + \int_0^t \frac{d}{dt}[\mathrm{HNO_3}](t)dt + \int_0^t \frac{d}{dt}[\mathrm{HCl}](t)dt$$

$$= 10^{-pH_0} + \int_0^t \frac{d}{dt}[\mathrm{HI}](t)dt + \int_0^t \frac{d}{dt}[\mathrm{HNO_3}](t)dt + \int_0^t \frac{d}{dt}[\mathrm{HCl}](t)dt \quad \text{(3-5a)}$$

$$[\mathrm{OH^-}](t) = [\mathrm{OH^-}](t=0) + \int_0^t \frac{d}{dt}[\mathrm{CsOH}](t)dt = \frac{10^{-14}}{10^{-pH_0}} + \int_0^t \frac{d}{dt}[\mathrm{CsOH}](t)dt \quad \text{(3-5b)}$$

where:

- pH_0 is the initial pool pH value,
- [HI](t) is given in Equations 3-1c and 3-1d,
- [HNO_3](t) is given is Equation 3-2b,
- [HCl](t) is given in Equation 3-3b, and
- [CsOH](t) is given in Equations 3-4c and 3-4d.

Some of the generated H^+ ions will be neutralized with the OH^- ions such that Equation 3-0a will be true at the final conditions.

$$([H^+]-x)\cdot([OH^-]-x) = K_w(T)$$
$$-\log K_w(T) = 15.5129 - 2.24E\text{-}2 * T + 3.352E\text{-}5 * T^2 \quad \text{(3-5c)}$$

Solving for x leads to the final H^+ concentration of:

$$[H^+]_{final} = [H^+] - x = [H^+] - \frac{[OH^-]+[H^+] - \sqrt{([OH^-]+[H^+])^2 - 4\cdot\left([OH^-]\cdot[H^+] - 10^{-(15.5129 - 2.24E\text{-}2 \cdot T + 3.352E\text{-}5 \cdot T^2)}\right)}}{2} \quad \text{(3-5d)}$$

The pool pH can then be directly calculated from Equation 3-0a as

$$pH = -\log([H^+]_{final}) \quad \text{(3-5e)}$$

4.0 SAMPLE PH CALCULATION

This section develops a sample calculation applying the methodologies developed in Sections 3 with the following input parameters.

Sample Case:
The pH transient for a BWR with a suppression pool water volume of 3.5E6 liters is evaluated based on an initial pH value of 6.0 (based on a normal pool temperature of 77 °F). This plant has 150,000 pounds of chloride-bearing cable insulation in containment, of which 50% is run in conduit and the remainder is in cable trays. All this cable is identical to the NRC model cable in Appendix A. The core inventories of cesium and iodine have been calculated to be 2500 (minimum) and 200 (maximum) gram mols, respectively. The BWR generic gap release time is 121 seconds. The containment has a radius of 63 feet (1920 cm) and the post-accident pool temperature drops linearly from 150 °F at 1 hour to 120 °F at 30 days. The 30-day integrated sump radiation dose is 10 Megarads while the 30-day containment gamma and beta integrated airborne energy depositions are 4E11 MeV/cc and 6E12 MeV/cc, respectively.

Solution:
This sample can be solved on a spreadsheet with the formulas summarized in Section 3.5. The results are illustrated in Figure 4-1 and reported in Attachment 1. The final results can be checked as follows. |

The initial H^+ concentration (in gram-mols per liter) can be determined from the initial pool pH as 1.0E-6 from Equation 3-0a. From Section 3.1, 5% of the released iodine is assumed to enter the pool as HI. With 30% of the core iodine inventory released, the HI concentration can be calculated as 8.5714E-7.

$$[HI]_{final} = \frac{0.05 \cdot 0.3 \cdot m_I}{V_{pool}} = \frac{0.05 \cdot 0.3 \cdot 200}{3.5E6} = 8.5714E-7$$

From Section 3.2, the final HNO_3 concentration can be calculated from the final integrated sump dose as 8.76E-5.

$$[HNO_3]_{final} = 7.3E-6 \cdot \int_0^{720} \dot{X}(t)_{pool}\,dt = 7.3E-6 \cdot 12 = 8.76E-5$$

The HCl concentration can then be calculated from the final integrated airborne dose. Neglecting the cable in conduit and reducing the beta dose by a factor of two for the 75,000 pounds of cable run in trays, the HCl concentration can be calculated to be 1.2069E-4.

$$[HCl]_{final} = \frac{3.512E-20\,\frac{g\cdot mol}{MeV} \cdot 973\,\frac{cm^3}{lb} \cdot M_{cable} \cdot \left[\frac{0.5}{\mu_\beta^{air}} \cdot \int_0^{720} \dot{X}_\beta(t)\,dt + \frac{\left(1-e^{[illegible]}\right)}{\mu_\gamma^{air}} \cdot \left(1-e^{[illegible]}\right) \cdot \int_0^{720} \dot{X}_\gamma(t)\,dt\right]}{3.5E6}$$

$$= \frac{3.512E-20 \cdot 973 \cdot 75{,}000 \cdot \left[\frac{0.5}{0.0198} \cdot 6E12 + \frac{0.069}{3.74E-5} \cdot 0.0179 \cdot 4E11\right]}{3.5E6} = 1.2069E-4$$

From Section 3.4, 95% of the released iodine is assumed to enter the pool as CsI with the remainder of the cesium as CsOH. With 25% of the core cesium inventory released, the CsOH concentration can be calculated as 1.62286E-4.

$$[\mathrm{CsOH}]_{final} = \frac{0.25 \cdot m_{Cs} - 0.95 \cdot 0.3 \cdot m_I}{V_{pool}} = \frac{0.25 \cdot 2500 - 0.95 \cdot 0.3 \cdot 200}{3.5E6} = 1.62286E-4$$

The total H^+ concentration is the sum of the previous results.

$$[\mathrm{H}^+]_{calc} = 1E-6 + 8.5714E-7 + 8.76E-5 + 1.2069E-4 = 2.10147E-4$$
$$[\mathrm{OH}^-]_{calc} = 1E-14/1E-6 + 1.62286E-4 = 1.62296E-4$$

The final pH is determined with the neutralized portion, x, calculated with Equation 3-5d to be 1.62295E-4. The final pH can then be calculated to be 4.32.

$$pH = -\log\left([\mathrm{H}^+]_{calc} - 1.62295E-4\right) = -\log(4.7851E-5) = 4.32$$

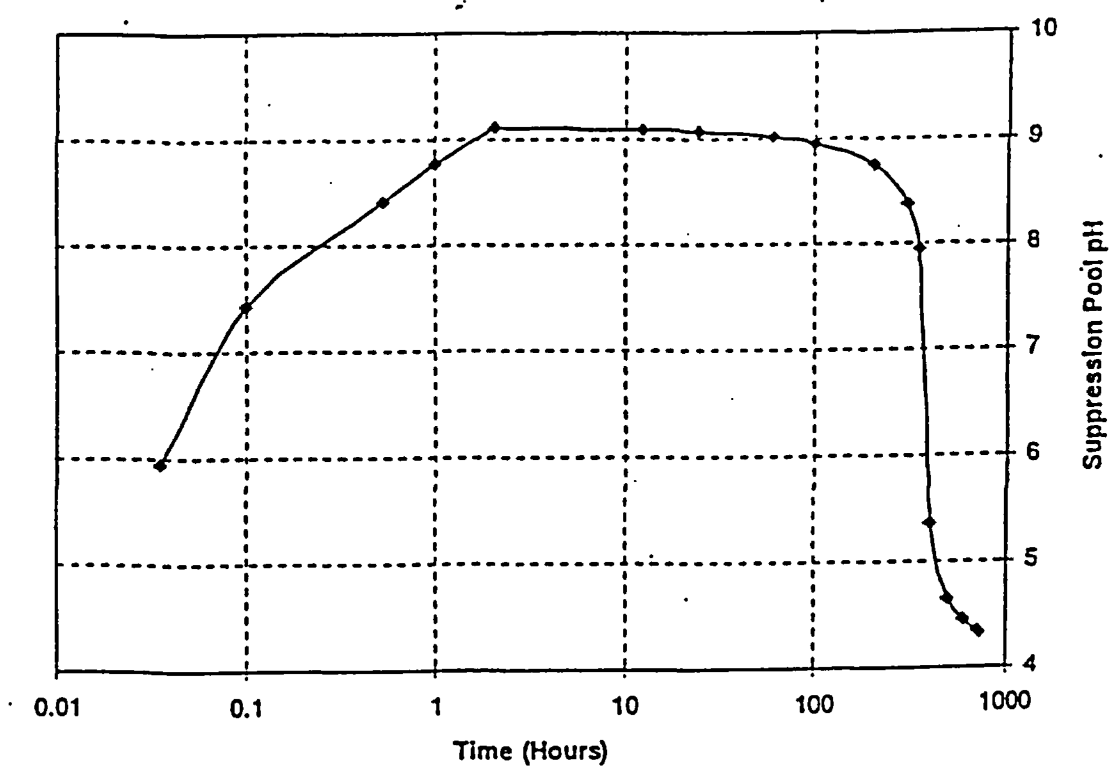

Figure 4-1 Sample Results

5.0 IODINE RE-EVOLUTION

As shown in Figure 4-1, the pool pH may drop below a value of 7 depending on plant-specific parameters such as the plant cable inventory or pool volume. This section develops a methodology for determining the amount of iodine that may evolve from a pool with a pH less than 7 based on the NRC research in NUREG/CR-5950. Specifically, an equation describing the equilibrium concentration of elemental iodine in the air volume above the pool is developed as a function of the pool pH, temperature, and iodine concentration.

5.1 Methodology

Aqueous iodine will exist in water pools in both I^- and I_2 species. Appendix C of NUREG/CR-5950 derives the following relationship between the dissolved iodine ions $[I^-]$ and the aqueous I_2 concentration.

$$[I_2]_{aq} = \frac{[H^+]^2[I^-]^2_{aq}}{d + e[H^+]} \qquad (5\text{-}1)$$

where:

$[I_2]$	=	concentration of elemental iodine (g-moles/liter)
d	=	6.05E-14 ± 1.83E-14
e	=	1.47E-09
$[H^+]$	=	concentration of H^+ ion (g-moles/liter)
$[I^-]$	=	concentration of ionic iodine (g-moles/liter)

In order to maximize the amount of I_2 in solution (and consequently the amount in the gas phase), the conservative value of the "d" parameter should be the lower of the specified range or 4.22E-14. Although these values are based experimental data at 25 °C, Appendix C of NUREG/CR-5950 indicates that this model conservatively over-predicts the conversion to I_2 at higher temperatures.

The total iodine concentration in the pool is given by the following expression per Section 3.2 of NUREG/CR-5950 and would include the non-radioactive isotope of iodine (*i.e.*, I^{127}).

$$[I]_{aq} = 2 \cdot [I_2]_{aq} + [I^-]_{aq} \qquad (5\text{-}2)$$

where:

$[I]_{aq}$ = total iodine concentration (g-atoms/liter)[5]

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[5] As described in Section 3.2 of Reference 5, it is convenient to use g-atom rather than mol in aqueous radioactive iodine concentrations because I_2 contains 2 g-atom I per mol while I^- contains only 1 g-atom. For each radioactive isotope of iodine, the total iodine concentration in g-atoms/liter can be calculated from the activity and pool volume as:

$$[I]_{aq} = \frac{A_i(Ci) \cdot 3.7E10 \dfrac{atoms}{Ci-s}}{\lambda_i(s^{-1}) \cdot 6.022E23 \dfrac{atoms}{g-atom} \cdot Vol(liters)}$$

Eliminating the variable for the ionic iodine parameter [I⁻] and considering that $[H^+]=10^{-pH}$, the following equation relates the aqueous I_2 concentration to the pool pH and the total iodine concentration [I].

$$[I_2]_{aq} = \frac{[I]_{aq}}{2} + \frac{d+e10^{-pH}}{8*10^{-2pH}} - \frac{1}{8*10^{-pH}}\sqrt{\frac{\left(d+e10^{-pH}\right)^2}{10^{-2pH}} + 8[I]_{aq}*\left(d+e10^{-pH}\right)} \qquad (5\text{-}3)$$

Applying the nominal value of the "d" parameter of 6.05E-14, the fraction of iodine in the I_2 species (*i.e.*, $2[I_2]/[I]$) can be determined as a function of pH for various total iodine concentrations, [I]. The results are plotted below and are identical to those presented in Figure 3.1 of NUREG/CR-5950.

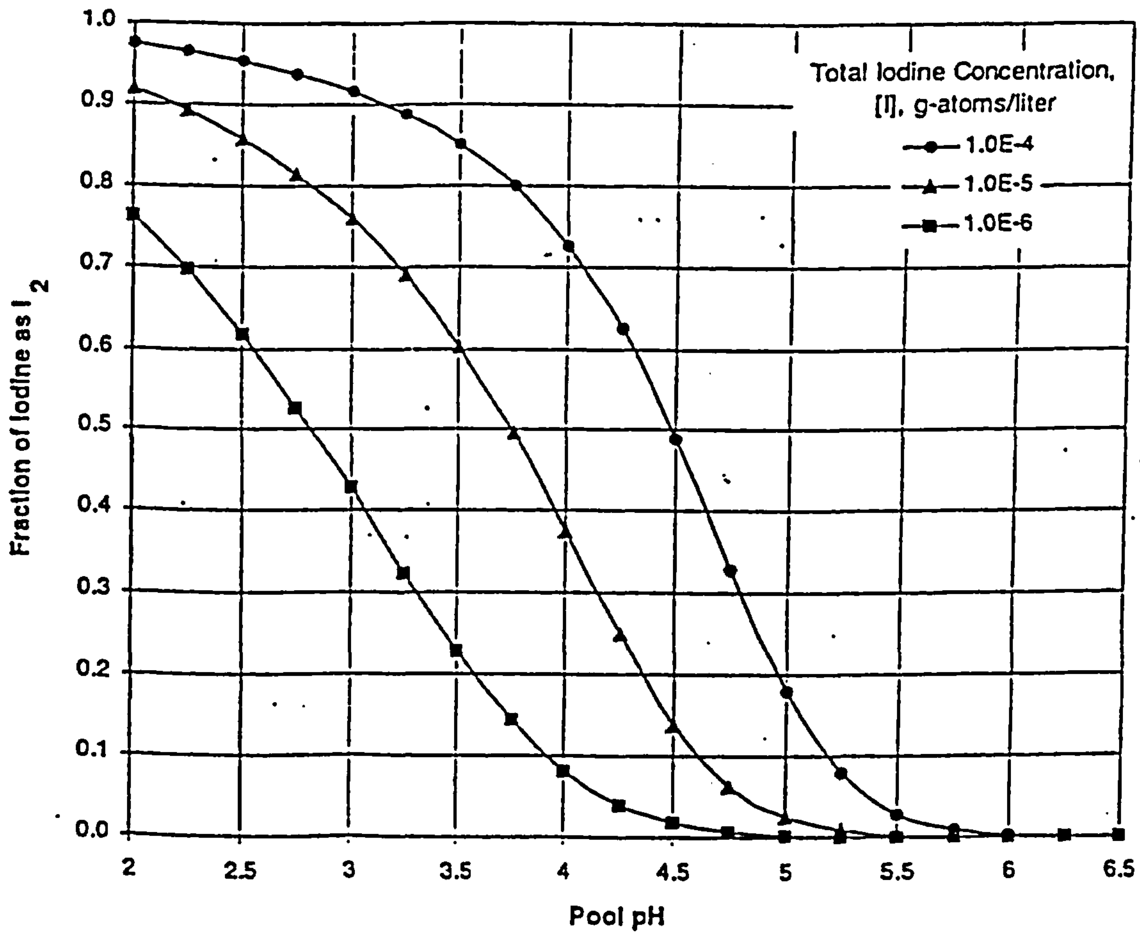

Figure 5-1 Benchmark Model Results for Aqueous Iodine

Considering the non-linear behavior of this Equation 5-3, the aqueous I_2 concentration for each isotope cannot merely be calculated individually for each isotope, but must be calculated based on the total iodine concentration. For example, the total aqueous iodine concentration for the isotopic concentrations reported in Table 5-1 is 8E-6 g-atoms/L. Based on this total iodine

concentration, Equation 5-3 predicts a total aqueous I_2 concentration of 3.63E-6 g-mols/L at a pool pH of 4 while, if this concentration were calculated for each isotope and summed, a total aqueous I_2 concentration of 3.417E-6 g-mols/L would be predicted as shown in Table 5-1.

Table 5-1 Example Isotopic Distribution

Isotope	Aqueous Concentration (g-atoms/L)	Isotopic I_2 Concentration based on Eq. 4-1 (g-mols/L) at pH of 4
I-131	5E-6	2.21E-6
I-132	1E-6	3.81E-7
I-133	2E-6	8.26E-7
Totals	8E-6	3.417E-6

Consequently, the total pool iodine concentration (including the stable isotope I-127) should be applied to calculate the total aqueous I_2 concentration. For the case above, since the I-131 is 62.5% of the pool iodine inventory, the I_2^{131} concentration in the pool would be 2.27E-6 g-mols/L (62.5% of 3.63E-6 g-mols/L) instead of the 2.21E-6 concentration based on only the I-131 concentration. The isotopic distribution for this example is listed in Table 5-2.

Table 5-2 Applied Aqueous Isotopic Distribution

Isotope	Percent of Pool Iodine	Isotopic I_2 Concentration (g-mols/L) at pH of 4
I-131	62.5	2.27E-6
I-132	12.5	4.54E-7
I-133	25	9.08E-7
Totals	100	3.63E-6

Section 3.1 of NUREG/CR-5950 cautions that the data at very low iodine concentrations (<~10^{-6} g-atom/L) are less reliable due to the formation of iodate. Fortunately, at these low concentrations, there is little iodine available for re-evolution.

5.2 Partition Coefficient

The gaseous concentration of iodine above the pool can be determined from the aqueous concentration of iodine in the pool via the partition coefficient (PC). The iodine partition coefficient is defined in Section 3.3.1 of NUREG/CR-5950 as:

$$PC = \frac{[I_2]_{aq}}{[I_2]_{gas}} = 10^{6.29-0.0149T} \tag{5-4}$$

where

T = pool temperature (Kelvin)

$[I_2]_{aq}$ = the iodine concentration in the pool (g-moles/liter)

$[I_2]_{gas}$ = the iodine concentration in the air (g-moles/liter)

The temperature dependence of the iodine partition factor is illustrated below. As the pool temperature increases the iodine partition factor decreases, driving the iodine into the airborne phase.

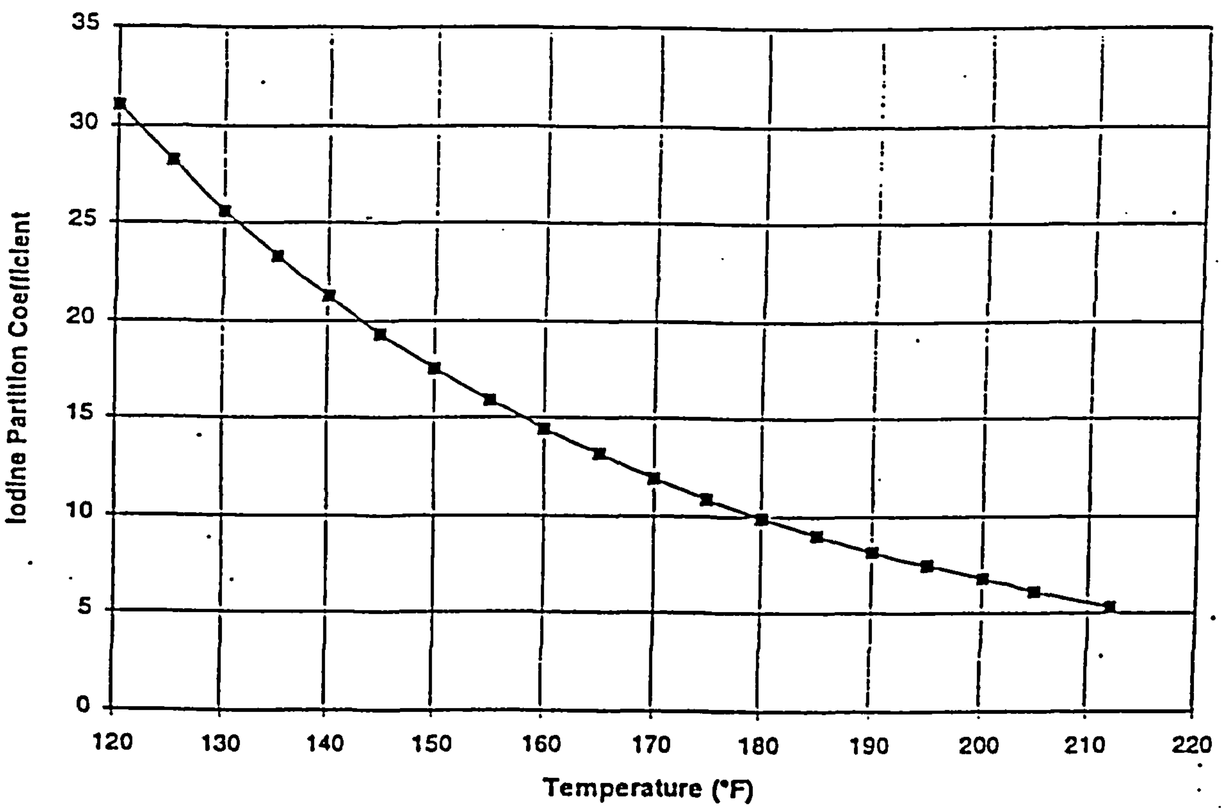

Figure 5-2 Iodine Partition Coefficient versus Temperature

5.3 Governing Formula

Combining Equations 5-3 and 5-4, the equilibrium concentration of iodine in the gaseous phase can be determined from the pool pH and temperature, and total aqueous iodine concentration as follows:

$$[I_2]_{gas} = \frac{[I_2]_{aq}}{PC} = \frac{\frac{[I]_{aq}}{2} + \frac{d+e10^{-pH}}{8 * 10^{-2pH}} - \frac{1}{8 * 10^{-pH}}\sqrt{\frac{\left(d+e10^{-pH}\right)^2}{10^{-2pH}} + 8[I]_{aq} * \left(d+e10^{-pH}\right)}}{10^{6.29-0.0149T}} \qquad (5\text{-}5)$$

where:

$[I_2]_{gas}$	=	iodine concentration in the air above the pool (g-moles/liter)
$[I]_{aq}$	=	total iodine concentration in the pool (g-atoms/liter)
pH	=	pool pH
d	=	4.22E-14
e	=	1.47E-09
T	=	pool temperature (K)

Any differences in vapor pressure among the iodine isotopes in the pool are assumed to be negligible based on the relatively small differences in atomic weight. This assumption is conservative since the iodine isotopes with the relatively lower weights are I-127 and I-129 which have little or no dose consequences. As such, the iodine isotopic distribution in the gaseous phase above the pool can be assumed to be identical to the isotopic distribution in the pool.

6.0 CONTROL STRATEGIES

There are a variety of potential strategies to control the post-accident pool pH in nuclear plants. PWRs utilize baskets of tri-sodium phosphate (TSP) that dissolve into the sump water when the containment sprays are initiated. Other PWRs may use sodium hydroxide. These systems, however, are already designed into these plants and are ensured to be operable via existing Technical Specifications. In BWRs, a supply of a buffering sodium pentaborate solution is available with the Standby Liquid Control (SLC) system for injection into the reactor vessel. This capability may also be provided with additional alternate injection procedures for mixing a batch of sodium pentaborate in an outdoor storage tank and injecting it into the vessel or suppression pool.

6.1 Standby Liquid Control

Standby Liquid Control was generally introduced into BWRs to address the Anticipated Transient Without Scram (ATWS) rule in 10CFR50.62. This system consists of a tank of a sodium pentaborate solution with redundant injection pumps that are manually operated from the control room. This system can be initiated in the event of an ATWS to inject this boron-rich solution into the reactor vessel and shut down the reactor core in place of the inoperable control rods. Some plants enhance this shutdown effect by using a solution enriched in the neutron-absorbing isotope, Boron-10, with a corresponding lower sodium pentaborate concentration.

The SLC solution is aqueous sodium pentaborate ($Na_2B_{10}O_{16}$) which is prepared from stoichiometric quantities of borax ($Na_2B_4O_7 \cdot 10H_2O$) and boric acid (H_3BO_3). This weak acid and its conjugate base will buffer the pool water at a pH corresponding to the following formula [10,11].

$$pH = pK_a + \log\frac{[anion]}{[acid]}$$

where:

- pK_a = negative of the log of the acid dissociation constant
- [anion] = borate concentration
- [acid] = acid concentration

The dissociation of sodium pentaborate is given by the following formula [11]. Hence, each mole of sodium pentaborate provides 2 equivalents of borate and 8 equivalents of boric acid. The acid and anion concentrations can then be determined from the amount of sodium pentaborate that reaches the pool and the amount of acid produced. The adequacy of this approach was confirmed via a laboratory experiment [12].

$$Na_2B_{10}O_{16} + 16\,H_2O \leftrightarrow 2Na^+ + 2B(OH)_4^- + 8B(OH)_3$$

The temperature dependence of the dissociation constant for boric acid is listed below [7]. As shown in this table, this constant increases with temperature; however, the slope decreases as the solution temperature is increased. Therefore, linear extrapolation of this data to temperatures above 50 °C is expected to result in conservatively high dissociation constants and correspondingly lower pool pH values. Fitting a linear regression line through this data and adjusting the constant term such that all data points are bounded leads to the following equation for the temperature dependence of the boric acid dissociation constant where T is the solution temperature in °F.

$$K_a \cdot 10^{10} = 0.0585 \cdot T + 1.309$$

Table 6-1 Temperature-Dependence of Boric Acid Dissociation Constant

Solution Temperature (°C)	Solution Temperature (°F)	Dissociation Constant ($K_a \cdot 10^{10}$)	Average Change in Dissociation Constant per °C	Fit of Dissociation Constant
5	41	3.63		3.71
10	50	4.17	0.108	4.23
15	59	4.72	0.11	4.76
20	68	5.25	0.108	5.29
25	77	5.79	0.106	5.81
30	86	6.34	0.11	6.34
35	95	6.86	0.104	6.87
40	104	7.38	0.104	7.39
50	122	8.32	0.094	8.45

As a test, the final pH of the sample calculation in Section 4 is calculated assuming that 5000 pounds of sodium pentaborate are injected into the suppression pool. At 30 days, this suppression pool is at 120 °F and the pK_a can be calculated as 9.08.

$$K_a \cdot 10^{10} = 0.0585 \cdot 120 + 1.309 = 8.33$$
$$pK_a = -\log(8.33E-10) = 9.08$$

This injected 5000 pounds of sodium pentaborate is equal to 5543 g-moles based on a molecular weight of 410. This 5543 moles will result 11,086 equivalents of borate and 44,344 equivalents of boric acid. The 11,086 equivalents of borate are neutralized by the 167 (4.785E-5 eq./liter*3.5E6 liters) equivalents of strong acid, leaving 10,919 (11,086-167) equivalents of borate ions and 44,511 (44,344+167) equivalents of boric acid. The pH of this solution would therefore be 8.47 instead of the un-buffered value of 4.32.

$$pH = 9.08 + \log\left[\frac{\left(\frac{10,919}{3.5E6}\right)}{\left(\frac{44,511}{3.5E6}\right)}\right] = 8.47$$

7.0 REFERENCES

1. NUREG-1465, Accident Source Terms for Light-Water Nuclear Power Plants, dated February 1995.
2. NUREG/CR-5950, Iodine Evolution and pH Control, dated December 1992.
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5. SECY-94-302, "Source Term-Related Technical and Licensing Issues Pertaining to Evolutionary and Passive Light-Water-Reactor Designs", dated December 19,1994.
6. SECY-98-154, "Results of the Revised (NUREG-1465) Source Term Rebaselining for Operating Reactors", dated June 30, 1998.
7. CRC Handbook and Chemistry and Physics, 73rd Edition, 1992-1993.
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9. NUREG/CR-1237, Best-Estimate LOCA Radiation Signature, dated January 1980.
10. S. Parker, McGraw Hill Encyclopedia of Chemistry, 1983
11. GEXI 2000-00157, M.A. Morris to G.E. Broadbent, "Suppression Pool pH", dated December 19, 2000.
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APPENDIX A - HYDROCHLORIC ACID PRODUCTION MODEL

The evolution of gaseous HCl from chloride-bearing cable is described in Section 2.2.5.2 of NUREG/CR-5950 [2]. Based on this description and the production model in Appendix B to NUREG/CR-5950, this appendix develops a generic methodology for calculating the HCl production rate for cables based on the individual cable dimensions.

A.1 Model Cable

The NRC's model for a cable is illustrated in Figure A-1. It is a 600-volt reactor power cable consisting of a copper core with ethylene-propylene rubber (EPR) elastomer insulation and a chloro-sulfonated polyethylene rubber (Hypalon) jacket. The dimensions are illustrated in Figure A-1 which is repeated from Section 4.2 of NUREG-1081 [8]. The material properties of the cable components and air are listed in Table A-1 as reported in Sections 2.1 and 4.2 of NUREG-1081. This model was originally reported in NUREG/CR-1237 [9] and has been referenced in NUREG-1081 and Appendix B to NUREG/CR-5950. The chloride-bearing component of this cable is the Hypalon jacket which is 27 weight percent chlorine per Section 2.2.5.1 of NUREG/CR-5950.

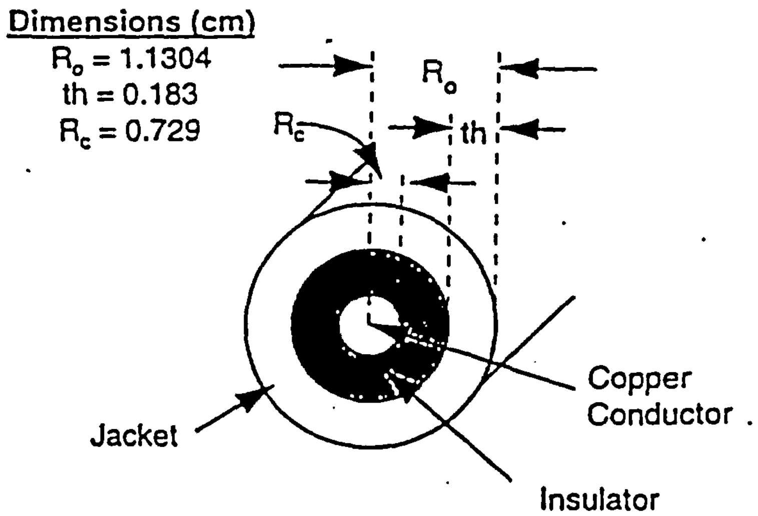

Figure A-1 NRC Cable Model

Table A-1 Cable and Air Material Properties

		Linear Absorption Coefficient (cm^{-1})	
Material	Density (g/cm^3)	Beta Radiation	Gamma Radiation
Hypalon	1.55	52.08	0.099
EPR	1.27	42.67	0.081
Air	5.88E-4	0.0198	3.74E-5

For the cable illustrated in Figure A-1, the absorption of a radiation flux at a radius, r, can be described from basic principles as:

$$\phi(r) = \phi(R_o)e^{-\mu(R_o-r)}$$

where:

μ = linear absorption coefficient (from Table A-1), and
R_o = outside cable radius.

Figure A-2 illustrates the beta and gamma radiation fluxes through the 78.7-mil (0.183-cm) Hypalon jacket of the NRC's model cable based on the linear absorption coefficients in Table A-1. Based on Figure A-2, the beta energy is completely absorbed by this Hypalon jacket in application while the gamma energy is only fractionally absorbed.

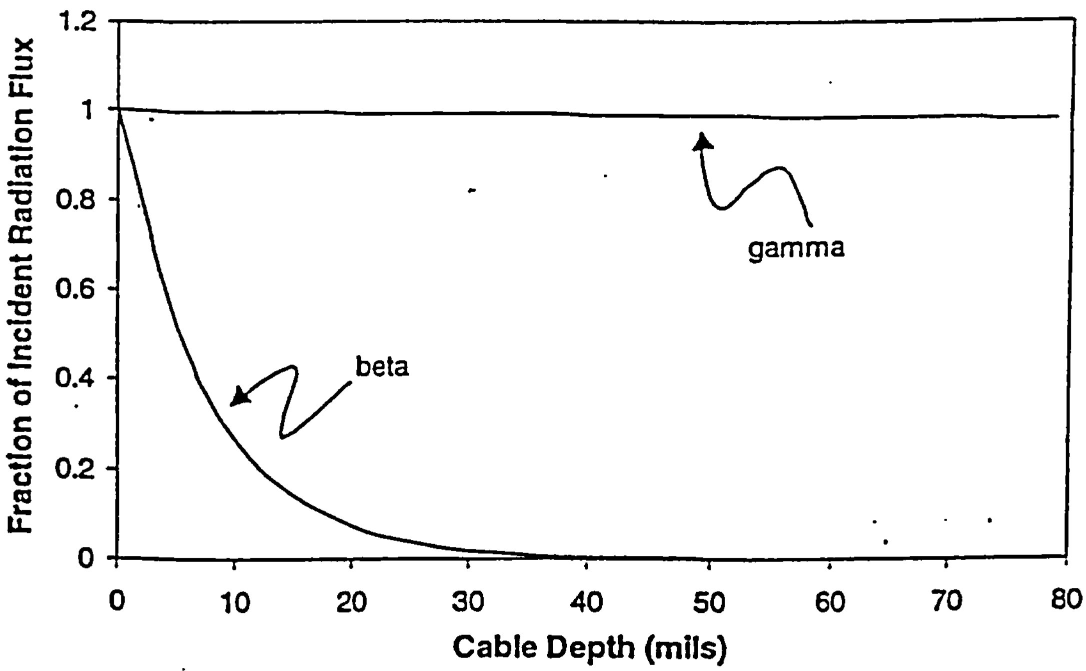

Figure A-2 Radiation Flux Profiles Through Hypalon Jacket of NRC's Model Cable

A.2 GGNS DETAILED MODEL

Similar to the approach in Appendix B to NUREG/CR-5950, the production of HCl from radiolysis can be given by the following formula.

$$R = G \cdot S \cdot \phi \cdot A \quad \text{(A-1)}$$

where:

R = HCl production rate
G = radiation G value for Hypalon,
S = surface area of cable,
ϕ = incident radiation energy flux, and
A = absorption fraction of energy flux in the Hypalon jacket[6].

[6] Energy absorption in the insulator need not be considered since this component does not contain chlorine.

Radiation G Value

The radiation G value for Hypalon adopted in Appendix B of NUREG/CR-5950 is 2.115 molecules HCl per 100 eV. This G value is based on the energy absorbed by the polymer consistent with the footnote to Table 3 of NUREG-1081. As described in the NUREG, this value represents a balance between the increased HCl production at elevated temperatures expected during accidents and the neutralization potential of fillers in the cable. This value corresponds to 3.512E-20 g-mols HCl/MeV.

$$G = \frac{2.115\text{ molecules}}{100\text{ eV}} \cdot \frac{\text{g-mol}}{6.022\text{E23 molecules}} \cdot \frac{10^6\text{ eV}}{\text{MeV}} = 3.512\text{E}-20\ \frac{\text{g-mols}}{\text{MeV}}$$

Cable Surface Area

The surface area of the cable depends on the cable radius and length.

$$S = 2\pi \cdot R_o \cdot \ell \tag{A-2}$$

where:

S = cable surface area (cm^2),
R_o = cable radius (cm), and
ℓ = cable length (cm).

Incident Energy Flux

Since the above HCl generation term is based on deposited energy in the cable jacket, the energy flux incident on the cable needs to be developed. Section 2 of NUREG-1081 develops an approach in which the radiation flux is integrated from the center of the containment to the wall at a radius r. This approach is subsequently applied to cable insulation in Section 2.2 of NUREG-1081. The energy flux on a surface area that is a distance, r, from the center of containment is calculated for each radiation type to be:

$$\phi = \frac{E}{V}\frac{\left(1-e^{-\mu \cdot r}\right)}{\mu} \tag{A-3}$$

where:

ϕ = energy flux (MeV/hr-cm^2)
$\frac{E}{V}$ = energy release rate per unit volume (MeV/hr-cm^3)
μ = linear absorption coefficient in air (1/cm), and
r = average distance of air to the cable (cm).

From Equation A-3 and the linear absorption coefficient in Table A-1, it can shown that the beta radiation energy flux can be conservatively approximated by the following equation due to the short range of beta radiation in air relative to the distances in containment.

$$\phi_\beta = \frac{E_\beta}{V}\frac{1}{\mu_\beta} \tag{A-4}$$

where:

ϕ_β = beta energy flux (MeV/hr-cm^2)

$\frac{E_\beta}{V}$ = beta energy release rate per unit volume (MeV/hr-cm^3), and

μ_β = beta radiation linear absorption coefficient in air (1/cm).

For the gamma radiation, a conservatively large distance that is characteristic of the plant containment should be applied in Equation A-3.

Absorption Fraction

The absorption fraction is the fraction of incident radiation energy flux absorbed by the Hypalon. As reported in Section 4 of NUREG-1081, this factor is calculated with the following equation for each radiation type.

$$A = 1 - e^{-\mu \cdot th} \qquad \text{(A-5)}$$

where:

A = absorption fraction,

th = thickness of the Hypalon jacket (cm), and

μ = linear absorption coefficient in Hypalon (1/cm).

From the above equation and the beta linear absorption coefficient in Table A-1, it can shown that the beta dose is completely absorbed by Hypalon jackets typically used in industry consistent with Figure A-2. This methodology will assume that the beta energy is completely absorbed in the Hypalon jacket. Equation A-5 above will be applied to explicitly calculate the absorption fraction for gamma radiation.

HCl Generation

The HCl generation rate can be calculated with the equations above as:

Beta:
$$R = G \cdot S \cdot \phi \cdot A = 3.512E-20 \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{E_\beta}{V} \frac{1}{\mu_\beta^{air}} \qquad \text{(A-6a)}$$

Gamma:
$$R = G \cdot S \cdot \phi \cdot A = 3.512E-20 \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{E_\gamma}{V} \frac{\left(1 - e^{-\mu_\gamma^{air} \cdot r}\right)}{\mu_\gamma^{air}} \cdot \left(1 - e^{-\mu_\gamma^{H} \cdot th}\right) \qquad \text{(A-6b)}$$

where:

R = HCl production rate (g-mol/hr),

$\frac{E_\beta}{V}$ = energy release rate per unit volume (MeV/hr-cm^3) for beta radiation,

$\frac{E_\gamma}{V}$ = energy release rate per unit volume (MeV/hr-cm^3) for gamma radiation,

μ_β^{air} = linear absorption coefficient of beta radiation in air (cm^{-1}),

μ_γ^{air} = linear absorption coefficient of gamma radiation in air (cm^{-1}),

μ_γ^{H} = linear absorption coefficient of gamma radiation in Hypalon (cm^{-1}),

r = containment radius (cm),

ℓ = cable length (cm),

th = thickness of the Hypalon jacket (cm), and

R_o = cable radius (cm).

Equations A-6a and A-6b can be integrated to determine the total HCl generated from an integrated energy release.

Beta:
$$M_{HCl}(t) = 3.512E-20 \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{1}{\mu_\beta^{air}} \int_0^t \frac{E_\beta}{V} dt \qquad \text{(A-7a)}$$

Gamma:
$$M_{HCl}(t) = 3.512E-20 \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{\left(1-e^{-\mu_\gamma^{air} \cdot r}\right)}{\mu_\gamma^{air}} \cdot \left(1-e^{-\mu_\gamma^{H} \cdot th}\right) \int_0^t \frac{E_\gamma}{V} dt \qquad \text{(A-7b)}$$

where:

M_{HCl} = total HCl production (g mols), and

t = time into accident (hrs).

A.3 SAMPLE CALCULATION

As a test of this methodology, the HCl production from a 1-cm segment of the NRC model cable is calculated from an integrated beta energy release of 3.67E11 MeV/cc in the containment.

Solution:

Applying Equation A-7a,

$$M_{HCl} = 3.512E-20 \frac{\text{g-mols}}{\text{MeV}} \cdot 2\pi \cdot (1.1304\ \text{cm}) \cdot (1\ \text{cm}) \cdot \frac{1}{0.0198\ \text{cm}^{-1}} \cdot 3.67E11 \frac{\text{MeV}}{\text{cc}} = 4.626E-6\ \text{g-mols HCl}$$

As a check, this result can be compared to that reported in NUREG/CR-05950. The weight of this section of cable can be calculated to be 1.85 grams of Hypalon and 1.46 g of EPR for a total mass of 7.3E-3 pounds.

Hypalon: $m_H = \rho \cdot \pi \left[R_o^2 - (R_o - th)^2\right] \cdot \ell = 1.55 \frac{\text{g}}{\text{cm}^3} \cdot 3.1416 \cdot \left[(1.1304\ \text{cm})^2 - (0.9474\ \text{cm})^2\right] \cdot 1\text{cm} = 1.85\ \text{g}$

EPR: $m_E = \rho \cdot \pi \left[R_o^2 - (R_o - th)^2\right] \cdot \ell = 1.27 \frac{\text{g}}{\text{cm}^3} \cdot 3.1416 \cdot \left[(0.9474\ \text{cm})^2 - (0.729\ \text{cm})^2\right] \cdot 1\text{cm} = 1.46\ \text{g}$

Total: $(1.85\ g + 1.46\ g)\cdot\left(\frac{kg}{1000\ g}\right)\cdot\left(\frac{2.205\ lbs}{kg}\right) = 7.30E-3\ lbs$

The total absorbed dose is calculated to be 1.14 Megarads below.

$$Dose = \frac{\dfrac{4.626E-6\ g-mols}{3.512E-20\ \dfrac{g-mols}{MeV}}}{10^6\dfrac{Rads}{Megarad}\cdot 100\dfrac{ergs}{Rad-g}\cdot 6.24146E5\dfrac{MeV}{erg}\cdot 1.85\ g} = 1.14\ Megarad$$

Considering that this segment is 7.3E-3 pounds of insulation, a rate constant of 5.55E-4 g-mols of HCl per pound of insulation per Megarad of absorbed dose can be calculated for the NRC model cable. This result compares well with (and is conservative with respect to) the 4.6E-4 value reported in Section 2.2.5.2 of NUREG/CR-5950.

$$\frac{4.626E-6\ mols}{(7.3E-3\ lbs)(1.14\ Megarad\ absorbed)} = \frac{5.55E-4\ mols\ HCl}{lb\ of\ insulation - Megarad\ absorbed\ dose}$$

ATTACHMENT 1 - SAMPLE CASE RESULTS

	Pool		Sump Intgrtd		CMT Int Dose (MeV/cc)								
Time (hr)	Temp (F)	[HI]	Dose (MRad)	[HNO3]	Gamma	Beta	[HCl]	Total [H+]	[CsOH]	Total [OH-]	x	Final [H+]	pH
0	150.0	0.0000E+00	0.00E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.00000E-06	0.00000E+00	1.00000E-08	-1.02352E-07	1.10235E-06	5.958
0.03361	150.0	0.0000E+00	1.56E-03	1.1362E-14	3.7584E+07	6.3584E+08	1.2672E-08	1.01267E-06	0.00000E+00	1.00000E-08	-1.01191E-07	1.11386E-06	5.953
0.1	150.0	1.8968E-08	4.63E-03	3.3601E-08	1.1175E+08	1.8916E+09	3.7700E-08	1.09047E-06	4.38167E-06	4.39167E-06	1.05337E-06	3.71001E-08	7.431
0.53361	150.0	1.4286E-07	2.47E-02	1.8023E-07	5.9603E+08	1.0088E+10	2.0105E-07	1.52414E-08	3.30000E-05	3.30100E-05	1.52021E-06	3.93306E-09	8.405
1	150.0	3.6496E-07	4.62E-02	3.3747E-07	1.1164E+09	1.8893E+10	3.7665E-07	2.07897E-06	7.31983E-05	7.32083E-05	2.07723E-06	1.74117E-09	8.759
2	150.0	8.4114E-07	9.23E-02	6.7375E-07	2.2303E+09	3.7736E+10	7.5209E-07	3.26697E-06	1.59389E-04	1.59399E-04	3.26618E-06	7.92303E-10	9.101
2.03361	150.0	8.5714E-07	9.38E-02	6.8503E-07	2.2677E+09	3.8367E+10	7.6469E-07	3.30687E-06	1.62286E-04	1.62296E-04	3.30609E-06	7.78034E-10	9.109
12	149.5	8.5714E-07	5.44E-01	3.9714E-06	1.3234E+10	2.2338E+11	4.4529E-06	1.02815E-05	1.62286E-04	1.62296E-04	1.02806E-05	8.04157E-10	9.095
24	149.0	8.5714E-07	1.07E+00	7.7766E-06	2.6117E+10	4.3963E+11	8.7655E-06	1.83992E-05	1.62286E-04	1.62296E-04	1.83984E-05	8.37472E-10	9.077
60	147.5	8.5714E-07	2.50E+00	1.8263E-05	6.2757E+10	1.0479E+12	2.0806E-05	4.10250E-05	1.62286E-04	1.62296E-04	4.10241E-05	9.51809E-10	9.021
100	145.9	8.5714E-07	3.90E+00	2.8441E-05	1.0015E+11	1.6678E+12	3.3093E-05	6.33919E-05	1.62286E-04	1.62296E-04	6.33908E-05	1.11204E-09	8.954
200	141.7	8.5714E-07	6.62E+00	4.8369E-05	1.8025E+11	2.9229E+12	5.8439E-05	1.08665E-04	1.62286E-04	1.62296E-04	1.08653E-04	1.81377E-09	8.741
300	137.5	8.5714E-07	8.54E+00	6.2307E-05	2.4430E+11	3.8886E+12	7.7853E-05	1.42017E-04	1.62286E-04	1.62296E-04	1.42013E-04	4.23207E-09	8.373
350	135.4	8.5714E-07	9.26E+00	6.7625E-05	2.7134E+11	4.2818E+12	8.5784E-05	1.55266E-04	1.62286E-04	1.62296E-04	1.55255E-04	1.14392E-08	7.942
400	133.4	8.5714E-07	9.87E+00	7.2075E-05	2.9562E+11	4.6253E+12	9.2726E-05	1.66658E-04	1.62286E-04	1.62296E-04	1.62278E-04	4.37994E-06	5.359
500	129.2	8.5714E-07	1.08E+01	7.8916E-05	3.3648E+11	5.1877E+12	1.0412E-04	1.84896E-04	1.62286E-04	1.62296E-04	1.62293E-04	2.26028E-05	4.646
600	125.0	8.5714E-07	1.15E+01	8.3706E-05	3.6923E+11	5.6169E+12	1.1286E-04	1.98420E-04	1.62286E-04	1.62296E-04	1.62294E-04	3.61259E-05	4.442
700	120.8	8.5714E-07	1.19E+01	8.7061E-05	3.9543E+11	5.9445E+12	1.1965E-04	2.08470E-04	1.62286E-04	1.62296E-04	1.62295E-04	4.61750E-05	4.336
720	120.0	8.5714E-07	1.20E+01	8.7600E-05	4.0000E+11	6.0000E+12	1.2069E-04	2.10147E-04	1.62286E-04	1.62296E-04	1.62295E-04	4.78524E-05	4.320

Calc. LM-0642, Rev. 0, Attachment G:

XC-Q1111-98013, Rev.2, Grand Gulf Design Engineering Calculation "Suppression Pool pH Analysis", 12/20/00

26 Pages

DESIGN ENGINEERING CALCULATION GRAND GULF NUCLEAR STATION UNIT ONE	CALC NO.: XC-Q1111-98013 REVISION: 2 PAGE i of iii

TITLE: Suppression Pool pH Analysis

REVISION STATUS	SUPERSEDED BY:	SUPERSEDES:	
☐ Pending	☒ N/A	☒ N/A	☒ Safety Related
☒ Final	Calc.	Calc.	☐ Non Safety Related
☐ Canceled	Rev.:	Rev.:	☐ Appendix B

ORG CODE: NPE-Safety Analysis | **CALC TYPE** NUCSAFE

KEYWORD(S):
ACCIDENT
DOSE

AFFECTED COMPONENT(S): (add sheets as needed)
N/A

SYSTEM(s): N/A

COMMENT(s): N/A

SOFTWARE USED FOR CALCULATION: ☐ Yes ☒ No

Software Manufacturer: | Software Name/ Program No: | Version/ Release No:

REVIEW AND APPROVAL

	Signature / Name	DATE
PREPARED BY:	G.E. Broadbent (signature) / G.E. Broadbent (Name)	12/19/00
CHECKED BY:	Scott Stanchfield (signature) / Scott Stanchfield (Name)	12/20/00
REVIEWED BY:	M.D. Withrow (Supervisor Signature) / M.D. Withrow (Name)	12/20/00
APPROVED BY:	M.D. Withrow (Responsible Manager Signature) / M.D. Withrow (Name)	12/20/00

REVISION STATUS SHEET

ENGINEERING CALCULATION REVISION SUMMARY

REVISION	DATE	DESCRIPTION
0	2/24/99	Issue for use
1	11/14/00	Revised to address changes to pH methodology documented in Revision 2 to Engineering Report GGNS-98-0039
2	12/20/00	Revised to address impact of SLC injection via the pH methodology documented in Revision 3 to Engineering Report GGNS-98-0039

****

SHEET REVISION STATUS

SHEET NO.	REVISION	SHEET NO.	REVISION	SHEET NO.	REVISION
i	2	5	1	13	1
ii	2	6	1	14	1
iii	2	7	1	15	2
1	2	8	1	16	2
2	1	9	1	17	2
3	1	10	1	18	2
4	2	11	1	19	2
		12	1	20	2

****

APPENDIX/ATTACHMENT REVISION STATUS

APPENDIX NO.	REVISION	ATTACHMENT NO.	REVISION
		1	1
		2	1
		3	1

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ENTERGY	CALCULATION SHEET	Sheet 1 Cont On 2
Calculation No. XC-Q1111-98013		Rev. 2
Prepared By G.E.B. Date 12/19/00	Checked By SLS	Date 12/20/00

1.0 PURPOSE

The purpose of this calculation is to develop the GGNS post-LOCA suppression pool pH transient based on the methodology reported in Engineering Report GGNS-98-0039 [1].

Revision 1 of this calculation applies the revised methodology documented in Revision 2 to GGNS-98-0039 and develops an HCl generation rate based on the energy flux to the cable surface. In addition, the GGNS suppression pool dose also considers the impact of beta radiation. Revision 2 addresses the buffering impact on the pool pH for the Standby Liquid Control system injection.

2.0 BACKGROUND

BWR suppression pools are credited in minimizing containment pressurization by condensing steam resulting from a loss of coolant accident (LOCA). At GGNS, the suppression pool is also credited for the long-term retention of iodine, which is washed into the pool by containment spray and by the scrubbing of airborne source term flows through the pool.

Standard Review Plan, NUREG-0800, Section 6.5.2 [15] addresses sump pH considerations for PWRs in Section II.C.1(g) stating:

> The pH of the aqueous solution collected in the containment sump after completion of injection of containment spray and ECCS water, and all additives for reactivity control, fission product removal, or other purposes, should be maintained at a level sufficiently high to provide assurance that significant long-term iodine re-evolution does not occur. Long-term iodine retention is calculated on the basis of the expected long-term partition coefficient. Long-term iodine retention may be assumed only when the equilibrium sump solution pH, after mixing and dilution with the primary coolant and ECCS injection, is above 7 (Ref. 5). This pH value should be achieved by the onset of the spray recirculation mode.

Section 5.2 of NUREG-1465 [2] applies these considerations to BWRs reporting that, although there is no current requirement for pH control of BWR suppression pools, there is a potential for these pools to scrub substantial amounts of iodine in the early phases of an accident only to re-evolve it later as elemental iodine. This NUREG also notes that the cesium hydroxide in the pool may well counteract any acid generation to ensure the pH is maintained sufficiently high that iodine re-evolution is precluded.

This calculation determines the GGNS post-accident pH transient based on the methodology reported in Engineering Report GGNS-98-0039, which was developed from NRC research reported in NUREG/CR-5950 [3]. These results may then be applied in the LOCA airborne dose calculation in the event iodine re-evolution is predicted.

3.0 GIVEN

3.1 Initial pH Values

The allowable suppression pool pH range is 5.3 to 8.6 consistent with the reactor water chemistry guidelines and SAR Section 9.3.6.1.2 and is confirmed quarterly per 08-S-03-10 [4] with temperature-corrected pH meters. This analysis will conservatively assume an initial suppression pool pH value of 5.3. Per SAR Table 5.2-6, the minimum allowable 24-hour reactor coolant chemistry during operation is 5.6 with a minimum pH of 5.3 when depressurized. As such, the reactor coolant pH will conservatively be modeled as 5.3 such that no suppression pool pH elevation need be considered due to the released reactor coolant mixing with the suppression pool inventory.

3.2 Pool Water Volume

The minimum suppression pool volume is 135,291 ft^3 based on Table 1 of ABD-4 [5] and Technical Specification Bases B3.6.2.2. Consistent with Calculation MC-Q1E30-90112 [6], a volume of 500 ft^3 is subtracted from this value for the new ECCS suction strainer installed in RFO9. The total suppression pool volume is therefore 134,791 ft^3 or 3.817E6 liters (based on 28.317 liters/ft^3).

In the event of a LOCA, the suppression pool makeup (SPMU) system is automatically initiated after a 30-minute timer starts on a LOCA signal (high drywell pressure or low-low reactor water level)[1]. The volume added to the suppression pool based on low water level in the upper pools is 36,163 ft^3 [6]. This volume will be added to the original suppression pool volume after 30 minutes for a total water volume of 170,954 ft^3 or 4.841E6 liters.

The reactor vessel will discharge a large quantity of reactor coolant to the suppression pool in the event of a DBA. A significant fraction of this inventory (~60%) will be discharged as a liquid while most of the resulting steam is quenched in the suppression pool. This reactor coolant inventory is reported as 6.815E5 lbs [5]. Also, some of the suppression pool inventory will vaporize to become humidity in the drywell and containment. Based on the total volume of both drywell and containment of 1.67E6 ft^3 [5] and bounding conditions of atmospheric pressure and 70° F, the total mass of air in the drywell and containment can be calculated to be 1.25E5 lbs (ρ=0.075 lbs/ft^3 [7]). At 100% humidity, a bounding low atmospheric pressure, and 185° F, the moisture content is 0.836 pounds of water vapor per pound of dry air [8]. Consequently, the 1.25E5 lbs of dry air will carry 1.045E5 lbs of water vapor, or significantly less than the 6.815E5 lbs released. Since the additional pool inventory from the reactor coolant release bounds the inventory loss due to evaporation, both of these components will be conservatively neglected in this analysis. The impact of ESF leakage is small compared to the large suppression pool volume and is consequently ignored.

1 An alternate SPMU initiation signal is low-low suppression pool level in association with a LOCA signal. Since, in the proposed core melt scenario, the ECCS pumps are not assumed to be injecting into the reactor vessel for approximately 2 hours, the potential immediate SPMU actuation on low-low suppression pool level (which is caused by the ECCS actuation) is not considered in this analysis.

3.3 Chloride-Bearing Cable Inventory

GGNS SAR Table 6.1-2 reports the containment and drywell weights of Hypalon, EPR or cross-linked polyethylene as 176,400 and 9835 lbs, respectively. These values are also reported in Table 2.2 of NUREG/CR-5950 and have been confirmed in EAR X-002-96 [9] to be bounding values based on the GGNS cable database.

A more detailed review of the GGNS chloride-bearing cable inventory in the containment and drywell was performed in EAR X-003-98 [10] based on the methodology reported in Engineering Report GGNS-98-0039. This review concluded that approximately 90% of the cable inventories in the GGNS containment and drywell are routed in conduit or totally enclosed raceways. Consistent with the methodology in Engineering Report GGNS-98-0039, these cable inventories are not included in the HCl generation calculation. The following exposed cable inventories were developed with significant conservatisms that would bound any additional cable lengths that may be added to the GGNS containment or drywell in future design changes.

Table 3-1 Total Combined Pounds of Exposed Cable Jacketing and Insulation

Drywell		Containment	
Free Air Drop	Routed in Trays	Free Air Drop	Routed in Trays
873.65	873.65	1,561.03	14,049.27

In addition to Hypalon, a limited number of cables in the GGNS containment are jacketed with neoprene with a chemical formula of $(C_4H_5Cl)_n$. Based on this formula, neoprene is 35 weight percent (w/o) chlorine relative to the 27 w/o value reported for Hypalon in Section 2.2.5.1 of NUREG/CR-5950. Based on the similar chemical composition of this material relative to Hypalon and the very small inventories in the plant, this material is treated identically to Hypalon in this calculation and is included in the above table.

3.4 Radiation Dose Profiles

The radiation doses that result in the production of acids are due to the presence of radioactive source terms in the containment atmosphere and suppression pool. Some of these source terms will be dissolved in the suppression pool generating nitric acid while others, such as the noble gases and organic species of halogens, will remain airborne irradiating exposed cabling and generating hydrochloric acid. To quantify the applicable radiation dose profiles for this event, this calculation evaluates two bounding profiles for the radiation doses.

1. The first profile assumes that all source terms (except noble gases) are deposited upon release into the suppression pool water. This profile maximizes the suppression pool dose and the generation of nitric acid. Noble gases in the drywell and containment atmosphere are modeled with the same flows as the LOCA dose analysis in which the drywell and lower containment nodes become well mixed after 2 hours.
2. The second profile emphasizes hydrochloric acid production from cable radiolysis by assuming the maximum airborne source term inventory. The lower-bound (10%) deposition constants and the elemental iodine plate-out coefficients

applied in the LOCA dose analysis [21] are also used in this case. Source terms calculated to deposit or plateout in the drywell are considered via a plate-out dose. Source terms removed from the containment atmosphere by containment spray are modeled to enter the suppression pool and generate nitric acid.

Since this analysis specifically considers the impact of daughter products such as Ba-137m, no adder to the gamma dose is required per Section 7 of R.G. 1.183. The RAPTOR code has been qualified to perform energy deposition calculations in Reference 16.

3.5 Source Term Inventories

The cesium and iodine inventories are considered in the suppression pool pH methodology in Engineering Report GGNS-98-0039. These inventories have been calculated for the GGNS core in Calculation XC-Q1J11-98010 [12] as 2400 and 325 g-atoms for cesium and iodine, respectively. These inventories are based on EOC core conditions and include the stable Cs^{133} and I^{127} species. The cesium inventory is a conservatively low estimate for the EOC conditions while the iodine inventory is a conservatively high estimate.

3.6 Standby Liquid Control (SLC) System

In the event of an unmitigated LOCA, the GGNS Severe Accident Procedures (SAPs) direct the operators to inject the SLC solution into the vessel in the early stages of the accident for both vessel inventory and re-criticality protection when the core is re-flooded. As required by Technical Specification 3.1.7, the associated Basis, and Reference 22, the GGNS SLC system is designed to inject at least 5800 pounds of sodium pentaborate into the reactor vessel at a minimum pump flow rate of 41.2 gpm for each of the two SLC pumps. As such, injection of the entire usable volume of the SLC tank would take approximately 2 hours to complete with a single pump. Considering the small flow out of the break until the core is re-flooded, no credit will be taken for the SLC system in the suppression pool for the first 2 hours, after which, the SLC solution will be assumed in the pool.

If the alternate SLC injection were used, 5,000 pounds each of anhydrous borax and boric acid (warehouse stock codes 82267132 and 82267131) would be mixed in the CST per the guidance in Attachment 28 of Reference 23. These fractions are a nearly stoichiometric mixture per Reference 22 making approximately 10,000 pounds of sodium pentaborate. Since the HPCS system can inject nearly all of this solution into the vessel or directly into the suppression pool, the limiting SLC case is via the injection from the SLC tank.

4.0 ASSUMPTIONS

4.1 Pool Mixing

After 2 hours, at least three ECCS pumps will be available to take suction from the pool. At approximately 7000 gpm per pump, at least 21,000 gpm will be circulating from the suppression pool to the reactor vessel or containment spray system. Based on the maximum pool inventory (including the upper containment pool) of 4.841E6 liters, this ECCS flow represents approximately one complete exchange of the pool volume per hour. On this basis, the suppression pool is assumed to be well-mixed such that a single pool pH value can be applied.

5.0 CALCULATION

5.1 Radiation Doses

The RAPTOR calculations are documented in Attachment 1. RAPTOR calculates an integrated suppression pool dose of 14.7 Mrad assuming all decay energy is absorbed in the water. Calculation XC-Q1111-98012 [14] performs a more detailed calculation of this dose considering the potential for some limited gamma release from the pool water with a result 11.54 Mrad. This calculation will apply the results of the detailed analysis in Reference 14. These integrated radiation doses are integrated in Attachment 2 via a fit to one of the following equations.

$$A \cdot (1 - B \cdot e^{-Ct}) \text{ or } A + B \cdot \ln(t)$$

5.2 Cable Model Calculations

There are many different types of cables in application at GGNS including single and multiple conductor. Some of these cables include interior Hypalon jackets on each individual conductor and some multiple-conductor cables have outer interstices filled with extruded Hypalon. The cable jacket/insulation inventories reported in Section 3.3 include all of these cable types. Some of these GGNS cable types are illustrated below.

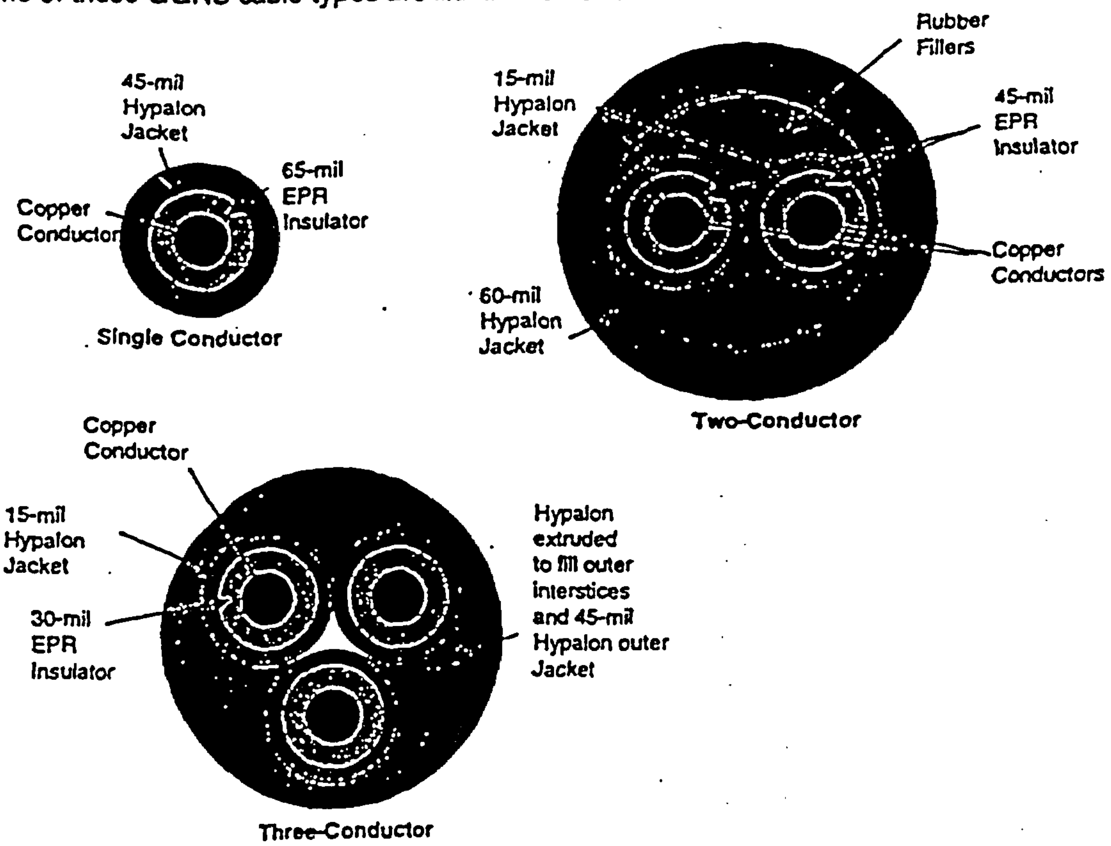

Figure 5-1 Sample GGNS Cable Types

The methodology in Engineering Report GGNS-98-0039, however, is based on simple single-conductor, single-jacketed cables like the NRC model cable in NUREG/CR-1237 [13]. Therefore, to simplify this analysis, the beta and gamma exposures are addressed separately as discussed in detail below.

5.2.1 Beta Radiation

As described in Engineering Report GGNS-98-0039, the beta dose is assumed to be completely absorbed by the cable in the chloride-bearing exterior jacket. Since the beta dose is completely absorbed in the first ~40 mils, the internals of the cable construction may be ignored for the beta calculation. As such, since the cable inventories are reported in terms of pounds, the specific GGNS cable types were reviewed to determine an appropriate surface area per unit mass for application in this calculation. The six cable types (B*6, B*7, C*2, C*4, C*7, and C*9) that make up over 85% of the exposed cables in the drywell and containment are listed below based on the data in Attachment 1 to EAR X-003-98.

Table 5-1 Primary Cable Types in GGNS Containment

EAR Att V Page #	Cable Type	Outer Diam (in)	Outer Radius (in)	Jacket Thickness (in)	Jacket Mass (lbs/ft)	Total Ins Mass (lbs/ft)	Surface Area (cm^2/lb)	GGNS Inventory (lbs)
	NRC Model	0.89	0.445	0.072	0.1237	0.2225	972.9	
3	B*6	0.678	0.3390	0.060	0.0779	0.2210	746.2	3396
4	B*7	0.639	0.3195	0.060	0.0729	0.2080	747.2	3496
16	C*2	0.522	0.2610	0.045	0.0451	0.1360	933.5	5427
17	C*4	0.634	0.3170	0.060	0.0723	0.1925	801.0	1847
19	C*7	0.745	0.3725	0.060	0.0863	0.2500	724.8	4480
20	C*9	1.024	0.5120	0.080	0.1586	0.4540	548.6	947

Based on the data in Table 5-1, the worst cable type is C*2 with a total surface area of 933.5 cm^2/lb. However, all other cable types have significantly less surface area per unit mass than this C*2 type due to their larger size. Considering the abundance of these larger cables, an appropriate value for this calculation would be 800 cm^2/lb since it bounds (or effectively equals) all but one cable type and is higher than the typical GGNS cable.

The HCl production rate is given by Equation 3-3a of Engineering Report GGNS-98-0039 below.

$$[HCl](t) = \frac{3.512E-20}{V_{pool}} \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{1}{\mu_\beta^{air}} \int_0^t \frac{E_\beta}{V} dt$$

$$= \frac{3.512E-20 \frac{\text{g-mols}}{\text{MeV}}}{4.841E6\ \text{liters}} \cdot 800 \frac{\text{cm}^2}{\text{lb}} \cdot \left(\frac{m_{tray}}{2} + m_{tu}\right) \cdot \frac{1}{0.0198\ \text{cm}^{-1}} \int_0^t \frac{E_\beta}{V} dt \qquad (5\text{-}1)$$

$$= 2.93E-22 \cdot \left(\frac{m_{tray}}{2} + m_{tu}\right) \cdot \int_0^t \frac{E_\beta}{V} dt$$

where:

m_{tray} = the mass of combined cable jacket and insulation routed in exposed cable trays (lbs),

m_{fa} = the mass of combined cable jacket and insulation in free air drops (lbs), and

$\frac{E_\beta(t)}{V}$ = energy release rate per unit volume (MeV/hr-cm^3) for beta radiation at time t (hours).

5.2.2 Gamma Radiation

Unlike beta radiation, gamma radiation can penetrate the cable interior and HCl may be generated from the interior Hypalon jackets or extruded Hypalon fillers in some of the GGNS cable types.

Absorption Faction

As illustrated in Figure 5-1, a cable type is needed to bound the various types routed in the GGNS containment. Considering that the worst-case cable would have a large radius and have the interstices between the interior cables are filled with Hypalon, a radius of 0.35 inches is taken to represent the typical GGNS cable. This radius bounds most of those cables in Table 5-1 and is larger than the average GGNS cable. Since the Hypalon depth could range from ~0.090 inches to the entire radius of the cable depending on angle, this calculation will conservatively assume, based on the GGNS cable drawings in Reference 10, an average Hypalon depth of 80% of the cable radius for an average Hypalon depth of 0.28 inches. For this cable, the absorption fraction, $\left(1-e^{-\mu \cdot n}\right)$, can be calculated with the linear absorption coefficient of 0.099 cm^{-1} from Table A-1 of Engineering Report GGNS-98-0039 to be 0.068, which is significantly higher than the 0.0179 value generated for the NRC's model in Section 4.2 of NUREG-1081.

Gamma Free Path

In the drywell, the largest radial distance would be approximately 20'2" based on the shield wall outer radius at 16'4" and the drywell wall inner radius of 36'6" per Reference 18. This calculation will conservatively apply a value of 36'6" (1112.5 cm) in the drywell. In the containment, the gamma free path in the annular region is severely restricted except in the large open area in the containment dome. Considering the compartments in the containment annulus, the free path in the annular region is taken to be 20'6" based on the 41'6" outer radius of the drywell and the 62' outer radius of the containment wall. In the containment dome, the containment radius of 62' is applied for the gamma distance. Although most cabling is in the annulus (where most of the containment equipment is located), the average containment gamma distance is conservatively taken as the volume-average of the above distances and calculated below to be 1384 cm. These volumes are calculated in the LOCA dose analysis [21] as 5.6E5 ft^3 for the unsprayed region and 8.4E5 ft^3 for the sprayed region.

$$\langle L \rangle = \frac{8.4E5\ ft^3}{1.4E6\ ft^3} \cdot 62' + \frac{5.6E5\ ft^3}{1.4E6\ ft^3} \cdot 20.5' = 45.4' = 1384\ cm$$

The HCl production rate is given by Equation 3-3b of Engineering Report GGNS-98-0039 and is reproduced below.

Drywell:

$$[HCl](t) = \frac{3.512E-20}{V_{pool}} \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{\left(1-e^{-\mu_\gamma^{air} \cdot r}\right)}{\mu_\gamma^{air}} \cdot \left(1-e^{-\mu_\gamma^{m} \cdot m}\right) \int_0^t \frac{E_\gamma}{V} dt$$

$$= \frac{3.512E-20 \frac{g-mols}{MeV}}{4.841E6 \text{ liters}} \cdot 800 \frac{cm^2}{lb} \cdot (m_{tray} + m_{fa}) \cdot \frac{\left(1-e^{-3.74E-5 cm^{-1} \cdot 1112.5 cm}\right)}{3.74E-5 cm^{-1}} \cdot 0.068 \cdot \int_0^t \frac{E_\gamma}{V} dt \quad (5\text{-}2)$$

$$= 4.3E-22 \cdot (m_{tray} + m_{fa}) \cdot \int_0^t \frac{E_\gamma}{V} dt$$

where:

m_{tray} = the mass of combined cable jacket and insulation routed in exposed cable trays (lbs),

m_{fa} = the mass of combined cable jacket and insulation in free air drops (lbs), and

$\frac{E_\gamma(t)}{V}$ = energy release rate per unit volume (MeV/hr-cm^3) for gamma radiation at time t (hours).

Containment:

$$[HCl](t) = \frac{3.512E-20}{V_{pool}} \cdot 2\pi \cdot R_o \cdot \ell \cdot \frac{\left(1-e^{-\mu_\gamma^{air} \cdot r}\right)}{\mu_\gamma^{air}} \cdot \left(1-e^{-\mu_\gamma^{m} \cdot m}\right) \int_0^t \frac{E_\gamma}{V} dt$$

$$= \frac{3.512E-20 \frac{g-mols}{MeV}}{4.841E6 \text{ liters}} \cdot 800 \frac{cm^2}{lb} \cdot (m_{tray} + m_{fa}) \cdot \frac{\left(1-e^{-3.74E-5 cm^{-1} \cdot 1384 cm}\right)}{3.74E-5 cm^{-1}} \cdot 0.068 \cdot \int_0^t \frac{E_\gamma}{V} dt \quad (5\text{-}3)$$

$$= 5.32E-22 \cdot (m_{tray} + m_{fa}) \cdot \int_0^t \frac{E_\gamma}{V} dt$$

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5.2.3 Deposition Doses

Case 1 involves no deposition since the only airborne source terms are noble gases[2] which do not plateout or deposit. For Case 2, the source terms that are removed by deposition and plate-out in the drywell, will result in additional energy absorption by the cables. The drywell plateout area is 181,608 ft^2 [20] or 1.69E8 cm^2. This area conservatively does not include the area of the cables.

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2 Some noble gases decay into radioactive daughters such as Rb-88 or Cs-135. These particulates are modeled to be removed from the atmosphere into the suppression pool with a large lambda.

The deposited source terms are conservatively assumed to be on the surface of the cable such that half of the released energy is in the direction of the affected cable. Similar to the airborne dose, the beta energy is assumed to be completely absorbed in the cable jacket while 6.8% of the gamma dose is absorbed.

$$[HCl](t) = \frac{3.512E-20}{V_{pool}} \cdot 2\pi \cdot R_c \cdot \ell \cdot \frac{1}{2} \cdot \left[0.068 \cdot \int_0^t \frac{E_{\gamma,dep}}{A}dt + \int_0^t \frac{E_{\beta,dep}}{A}dt\right]$$

$$= \frac{3.512E-20 \frac{g-mols}{MeV}}{4.841E6 \text{ liters}} \cdot 800 \frac{cm^2}{lb} \cdot \frac{1}{2} \cdot \left[(m_{tray} + m_{s}) \cdot 0.068 \cdot \int_0^t \frac{E_{\gamma,dep}}{A}dt + \left(\frac{m_{tray}}{2} + m_{s}\right) \cdot \int_0^t \frac{E_{\beta,dep}}{A}dt\right] \quad (5\text{-}4)$$

$$= 2.9E-24 \cdot \left[(m_{tray} + m_{s}) \cdot 0.068 \cdot \int_0^t \frac{E_{\gamma,dep}}{A}dt + \left(\frac{m_{tray}}{2} + m_{s}\right) \cdot \int_0^t \frac{E_{\beta,dep}}{A}dt\right]$$

where:

$\frac{E_{\gamma,dep}(t)}{A}$ = energy release rate per unit area ($MeV/hr\text{-}cm^2$) for gamma radiation at time t (hours) and

$\frac{E_{\beta,dep}(t)}{A}$ = energy release rate per unit area ($MeV/hr\text{-}cm^2$) for beta radiation at time t (hours).

5.3 Hydriodic Acid

The final hydriodic acid can be calculated from the iodine core inventory of 325 g-atoms reported in Section 3.5.

$$[HI](t) = \frac{m_I}{120 \cdot V_{pool}} \cdot [t - (0.5 + t_{gap})] + \frac{m_I}{400 \cdot V_{pool}}$$

where:

- m_I = core iodine inventory (gram-mols), and
- V_{pool} = volume of the suppression pool (liters).
- t = time into accident (hrs), and
- t_{gap} = onset of gap release (121/3600 hrs).

The final HI concentration at 7321 seconds is calculated below to be 1.0076E-6 moles per liter.

$$[HI](t = 7321s) = \frac{325}{120 \cdot 4.841E6} \cdot [7321/3600 - (0.5 + 121/3600)] + \frac{325}{400 \cdot 4.841E6} = 1.0070E-6$$

1 2 3

5.4 Nitric Acid

The nitric acid is calculated from the integrated pool dose. From Section 3.2 of Engineering Report GGNS-98-0039, the transient nitric acid concentration is given by:

$$[HNO_3](t) = 7.3E-6\int_0^t \dot{X}(t)_{pool}\,dt$$

where:

$\dot{X}(t)_{pool}$ = the time-dependent dose rate in the suppression pool (Megarads/hr)

The final HNO_3 concentration at 30 days is calculated below to be 8.424E-5 mols per liter.

$$[HNO_3](t = 30\text{ days}) = 7.3E-6 \cdot 11.54 = 8.424E-5$$

For Case 2, the nitric acid production is calculated to be 6.787E-5 mols per liter.

$$[HNO_3](t = 30\text{ days}) = \frac{\frac{0.007\text{ molecules}}{100\text{ eV}} \cdot 5.839E14\frac{\text{MeV}}{\text{cc}} \cdot 10^6\frac{\text{eV}}{\text{MeV}} \cdot 1000\frac{\text{cc}}{\text{liter}}}{6.022E23\frac{\text{molecules}}{\text{mol}}} = 6.787E-5\frac{\text{mols}}{\text{liter}}$$

5.5 Hydrochloric Acid

The hydrochloric acid transient can be calculated from the equations developed in Section 5.2. Since the containment and drywell contain different quantities of cable insulation and have different radiation profiles, the HCl generation in each of these regions is evaluated separately and then summed consistent with the well-mixed pool assumed in Section 4.1. The 30-day HCl concentrations are manually calculated below.

The 30-day drywell integrated beta and gamma dose results calculated in Attachment 1 are reported below. The containment doses are based on the volume-average of the sprayed and unsprayed regions.

	Drywell		Containment	
	Beta	Gamma	Beta	Gamma
Case 1	2.55E+13 MeV/cc	1.22E+13 MeV/cc	1.48E+13 MeV/cc	6.29E+12 MeV/cc
Case2 Airbome Dep/Plateout	2.91E+13 MeV/cc 3.75E+23 MeV	1.72E+13 MeV/cc 1.12E+24 MeV	1.57E+13 MeV/cc 7.17E+23 MeV	6.81E+12 MeV/cc 2.11E+24 MeV

Case 1:

Drywell Beta: $[HCl] = 2.93E-22 \cdot \left(\frac{873.65}{2} + 873.65\right) \cdot 2.55E+13 = 9.79E-6$

Containment Beta: $[HCl] = 2.93E-22 \cdot \left(\frac{14049.27}{2} + 1561.03\right) \cdot 1.48E+13 = 3.72E-5$

Drywell Gamma: $[HCl] = 4.3E-22 \cdot (873.65 + 873.65) \cdot 1.22E13 = 9.17E-6$

Containment Gamma: $[HCl] = 5.32E-22 \cdot (14049.27 + 1561.03) \cdot 6.29E12 = 5.22E-5$

Total HCl Concentration: 1.084E-4 mols/liter

Case 2:

Drywell Beta: $[HCl] = 2.93E-22 \cdot \left(\frac{873.65}{2} + 873.65\right) \cdot 2.91E+13 = 1.12E-5$

Containment Beta: $[HCl] = 2.93E-22 \cdot \left(\frac{14049.27}{2} + 1561.03\right) \cdot 1.57E+13 = 3.95E-5$

Drywell Gamma: $[HCl] = 4.3E-22 \cdot (873.65 + 873.65) \cdot 1.72E13 = 1.29E-5$

Containment Gamma: $[HCl] = 5.32E-22 \cdot (14049.27 + 1561.03) \cdot 6.81E12 = 5.66E-5$

Drywell Dep/Plateout:

$$[HCl] = 2.9E-24 \cdot \left[(873.65 + 873.65) \cdot 0.068 \cdot \frac{1.12E+24\ MeV}{1.69E+8\ cm^2} + \left(\frac{873.65}{2} + 873.65\right) \cdot \frac{3.75E+23\ MeV}{1.69E+8\ cm^2}\right] = 1.07E-5$$

Total HCl Concentration: 1.309E-4 mols/liter

5.6 Cesium Hydroxide

The final cesium hydroxide is calculated from the cesium and iodine core inventories reported in Section 3.5 of 2400 and 325 g-atoms for cesium and iodine respectively.

$$[CsOH](t) = \frac{0.4 m_{Cs} - 0.475 m_I}{3 \cdot V_{pool}} \cdot [t - (0.5 + t_{gap})] + \frac{0.05 m_{Cs} - 0.0475 m_I}{V_{pool}}$$

The final cesium hydroxide concentration at 7321 seconds is calculated below to be 1.0481E-4 moles per liter.

B = 5.55 E -5 C = .55

$$[CsOH](t = 7321s) = \frac{0.4 \cdot 2400 - 0.475 \cdot 325}{3 \cdot 4.841E6} \cdot [7321/3600 - (0.5 + 121/3600)]$$

$$+ \frac{0.05 \cdot 2400 - 0.0475 \cdot 325}{4.841E6} = 1.0481E-4 \text{ mols/liter}$$

A = 2.16 E -5

5.7 Final Pool pH Calculation

From the results of Sections 5.3-5.7, the pool pH at 30 days may be calculated for the limiting case (Case 2) with the methodology in Section 3.5 of Engineering Report GGNS-98-0039 where pH_0 is the initial pool pH value.

$$[H^+](t) = 10^{-pH_0} + \int_0^t \frac{d}{dt}[HI](t)dt + \int_0^t \frac{d}{dt}[HNO_3](t)dt + \int_0^t \frac{d}{dt}[HCl](t)dt$$

$$[H^+](t = 30\text{ days}) = 10^{-5.3} + 1.0070E-6 + 6.787E-5 + 1.309E-4 = 2.0479E-4$$

$$[OH^-](t) = \frac{10^{-14}}{10^{-pH_0}} + \int_0^t \frac{d}{dt}[CsOH](t)dt$$

$$[OH^-](t = 30\text{ days}) = \frac{10^{-14}}{10^{-5.3}} + 1.0481E-4 = 1.0481E-4$$

At 120 °F, the ionization constant of water is $10^{-13.31}$ per Equation 3-0a of Engineering Report GGNS-98-0039. The neutralized ions can then be calculated as 1.0481E-4 mols per liter.

$$x = \frac{[OH^-]+[H^+]-\sqrt{([OH^-]+[H^+])^2 - 4\cdot([OH^-]\cdot[H^+]-K_w)}}{2}$$

$$= \frac{1.0481E-4 + 2.0479E-4 - \sqrt{(1.0481E-4 + 2.0479E-4)^2 - 4\cdot(1.0481E-4\cdot 2.0479E-4 - 10^{-13.31})}}{2}$$

$$= 1.0481E-4$$

The final H^+ concentration can then be determined as 9.998E-5 mols per liter.

$$[H^+]_{final} = [H^+] - x = 9.998E-5$$

The final pool pH can then be calculated as 4.0. This value matches the result in Attachment 3 considering the slight round-off errors in the intermediate values.

$$pH = -\log([H^+]_{final}) = -\log(9.998E-5) = 4.0$$

The pool pH at intermediate points is calculated in Attachment 3.

The injection of 5,800 pounds of sodium pentaborate (or 6,416 g-mols based on a molecular weight of 410) from the SLC tank would introduce 12,832 equivalents of borate and 51,328 equivalents of boric acid into the suppression pool.

ENTERGY	CALCULATION SHEET	Sheet 16 Cont On 17
Calculation No. XC-Q1111-98013		Rev. 2
Prepared By J.E.B. Date 12/19/00	Checked By SES	Date 12/20/00

Col

$$\frac{(5800\ \text{lb})\cdot\left(453.6\ \frac{g}{lb}\right)}{410\ \frac{g}{g\text{-mol}}} = 6416\ g\text{-mol}$$

V

The number of strong acid equivalents in the pool after 30 days is 484 based on the 9.998E-5 mols per liter calculated above and the pool volume of 4.841E6 liters. The additional pool inventory associated with the SLC tank is conservatively neglected. Using the methodology in Reference 1, the resulting equivalents of borate and boric acid can then be calculated as 12,348 and 51,812 respectively.

Y

Equivalents Borate:	12,832 − 484 = 12,348
Equivalents Boric Acid:	51,328 + 484 = 51,812

The pool pH at 30 days can then be calculated to be 8.46 based on a temperature of 120 °F.

$$K_a \cdot 10^{10} = 0.0585 * 120 + 1.309 = 8.33$$
$$pK_a = -\log(8.33E-10) = 9.08$$
$$pH = 9.08 + \log\left[\frac{\left(\frac{12{,}348}{4.841E6}\right)}{\left(\frac{51{,}812}{4.841E6}\right)}\right] = 8.46$$

As a bounding sensitivity case, none of the cesium hydroxide and only 10% the sodium pentaborate are assumed to reach the pool, which is also conservatively assumed to be at the design temperature limit of 185 °F. In this case, the number of strong acid equivalents in the pool after 30 days is 991 based on the 2.0479E-4 mols per liter calculated above and the pool volume of 4.841E6 liters. The pool pH at 30 days can then be calculated to be 7.60.

Equivalents Borate:	12,832/10 − 991 = 292
Equivalents Boric Acid:	51,328/10 + 991 = 6124

$$K_a \cdot 10^{10} = 0.0585 * 185 + 1.309 = 12.13$$
$$pK_a = -\log(12.13E-10) = 8.92$$
$$pH = 8.92 + \log\left[\frac{\left(\frac{292}{4.841E6}\right)}{\left(\frac{6124}{4.841E6}\right)}\right] = 7.60$$

As such, the sodium pentaborate solution is a very effective buffer for the post-accident suppression pool chemistry transient and can ensure, with significant safety margin, that the suppression pool pH will remain above a value of 7.

6.0 RESULTS

The un-buffered GGNS post-accident suppression pool pH profile is calculated in Attachment 3 and illustrated in Figure 6-1 below. The pH rises steadily during the gap and in-vessel release due to the introduction of CsOH into the pool. The pH then begins to decrease after the vessel release terminates due to the continued formation of nitric acid in the suppression pool and hydrochloric acid from radiolysis of the Hypalon cable jacketing. As the pH approaches a value of 7, the slope becomes more negative due to the approaching complete neutralization and the logarithmic function of pH. After approximately 4 days, a pH transient is experienced and the pool becomes somewhat acidic.

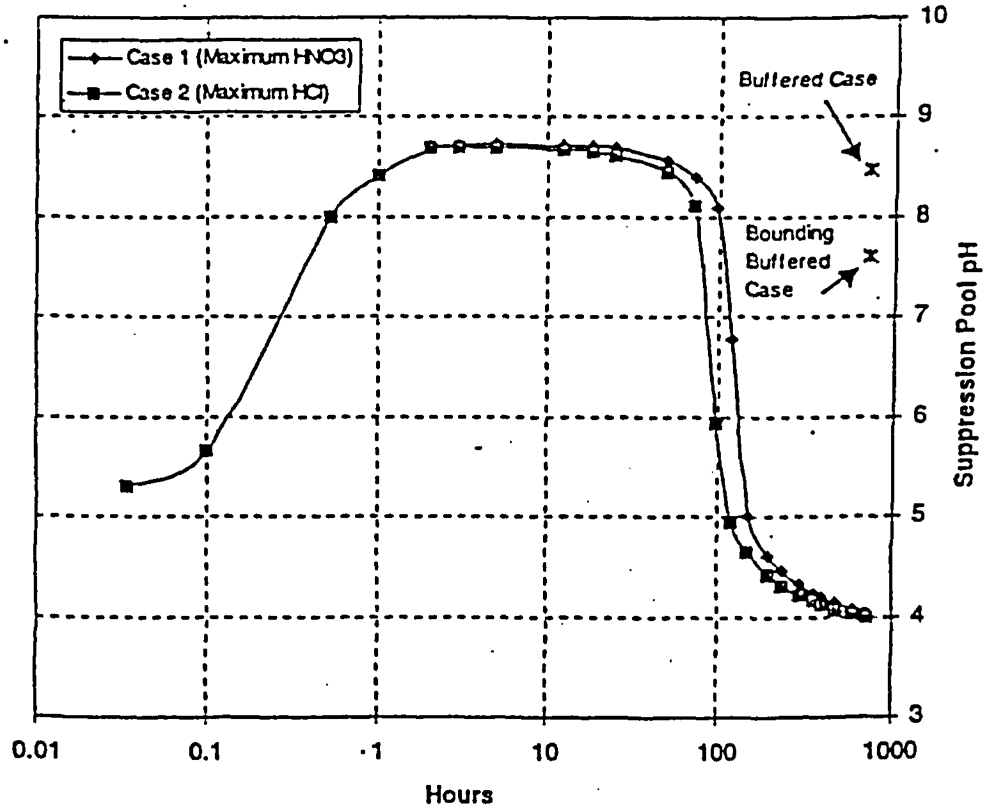


Figure 6-1 GGNS Pool pH Transient

As discussed in Section 3.6, the SLC system will be injected early in the event that such the SLC solution will reach the pool within 2 hours. With only a small credit for CsOH, the suppression pool pH will remain above 7 for the first 2 hours. After the SLC solution reaches the pool, the pH will remain above 7 for the 30-day duration of the accident even without credit for CsOH and assuming only a small fraction of the sodium pentaborate reaching the pool. This "bounding buffered case" is reported in the above figure as calculated in Section 5.7.

Therefore, with the injection of only small amounts of sodium pentaborate, the suppression pool pH will be maintained in an alkaline state such that iodine re-evolution need not be considered.

To evaluate the relative importance of each type of acid, a comparison of the origin of each acid is presented in Figure 6-2. The primary source of acid is from radiolysis of the cable insulation, particularly from the beta dose. The nitric acid generated from radiolysis of the suppression pool water is the second largest source of acid. The hydriodic acid is nearly insignificant in this analysis considering the large quantities of hydrochloric and nitric acids.

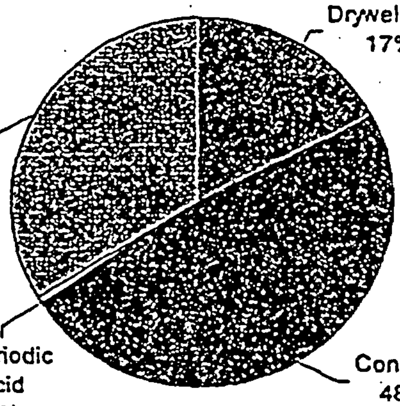


Figure 6-2 Acids by Contribution (after 30 days)

This calculation results in a more severe chemistry transient than the previous revision. The primary reasons for this change in results are described below.

1. The calculation includes beta dose in the pool dose calculation. This consideration will increase the nitric acid production.
2. This calculation uses simplified models for generating the energy flux into cables based on the volumetric energy release rate and a large gamma energy. The previous calculation applied the GGNS EQ results which are based on a complex shielding model and a time-varying gamma energy spectrum which is generally less than the 1 MeV applied in this calculation.
3. This calculation generates the containment volumetric energy release rate without credit for suppression pool scrubbing. The previous calculation took some credit for suppression pool scrubbing. This revision therefore results in higher source terms in the containment and a larger HCl generation rate.

7.0 REFERENCES

1. Engineering Report GGNS-98-0039, Rev. 3, Suppression Pool pH and Iodine Re-evolution Methodology.
2. NUREG-1465, Accident Source Terms for Light-Water Nuclear Power Plants, dated February 1995.
3. NUREG/CR-5950, Iodine Evolution and pH Control, dated December 1992.
4. Chemistry Procedure 08-S-03-10, Rev. 28, Chemistry Sampling Program.
5. Analysis Basis Document (ABD) 4, Rev. 0, Analytical Bases for Containment Performance.
6. Calculation MC-Q1E30-90112, Rev. 1, Calculation in Support of UFSAR Table 6.2-50 "Suppression Pool Geometry – GGNS" Values.
7. Crane Technical Paper 410, Flow of Fluids through Valves, Fittings, and Pipe, 25th Printing, 1991.
8. Cooling Tower Institute Code Tower Standard Specifications, "Acceptance Test Code for Water-Cooling Towers", CTI Code ATC-105, dated February 1990.
9. Engineering Assistance Request X-002-96, dated April 3, 1996.
10. Engineering Assistance Request X-003-98, dated November 30, 1998.
11. Bechtel Calculation 5.8.3, Rev. 5, NUREG-0588 Source Terms & Integrated Doses.
12. Calculation XC-Q1J11-98010, Rev. 0, Cesium and Iodine Inventories for Pool pH Calculation.
13. NUREG/CR-1237, Best-Estimate LOCA Radiation Signature, dated January 1980.
14. Calculation XC-Q1111-98012, Rev. 1, Suppression Pool Radiation Doses.
15. NUREG-0800, Standard Review Plan, Section 6.5.2, "Containment Spray As a Fission Product Cleanup System" Rev. 2, December 1988.
16. Engineering Report GGNS-00-0014, Rev. 0, RAPTOR Computer Code Validation: Phase I.
17. GGNS Technical Specifications and Bases, Amendment 136.
18. Drawing C-1000, Rev. 3, Unit 1 General Arrangement Plans and Sections.
19. Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, dated July 2000.
20. Calculation XC-Q1J11-97003, Rev. 0, NUREG-1465 Input Items for NRC Re-baselining.
21. Calculation XC-Q1111-98017, Rev. 1, LOCA Dose Analysis with Revised Source Term.
22. 22A7419AA, Rev. 5, GE Design Specification Data Sheet, Standby Liquid Control System.
23. Emergency Procedure 05-S-01-EP-2, Rev. 30, RPV Control.

Transient Pool pH Results

CASE 1

Time (Hours)	[HI]	Pool Int Dose (MRad)	[HNO3]	DRYWELL Int Gamma Dose (MeV/cc)	DRYWELL Int Beta Dose (MeV/cc)	DRYWELL [HCl]	CONTAINMENT Int Gamma Dose (MeV/cc)	CONTAINMENT Int Beta Dose (MeV/cc)	[HCl]	Total [H+]	[CsOH]	Total [OH-]	Pool Temp (F)	-LOG(Kw)	Root x	Final [H+]	pH
0	0.0000E+00					0.0000E+00			0.0000E+00	5.011872E-06	0.0000E+00	1.995282E-09	77.0	13.99	-6.136028E-11	5.011934E-06	5.300
0.03361	0.0000E+00					0.0000E+00			0.0000E+00	5.011872E-06	0.0000E+00	1.095282E-09	160.0	12.79	-3.030112E-08	5.042263E-06	5.297
0.1	2.2285E-08					0.0000E+00			0.0000E+00	5.034157E-06	2.8679E-06	2.869910E-06	160.0	12.79	2.796918E-06	2.237239E-06	5.650
0.53361	1.6784E-07					0.0000E+00			0.0000E+00	5.179710E-06	2.1599E-05	2.160135E-05	160.0	12.79	5.169771E-06	9.938219E-09	8.003
1	4.2876E-07					0.0000E+00			0.0000E+00	5.440634E-06	4.7471E-05	4.747304E-05	160.0	12.79	5.436750E-06	3.884754E-09	8.411
2	9.8622E-07	1.3783E+00	1.0061E-05	1.4201E+12	2.8733E+12	2.1702E-06	0.0000E+00	1.2122E+12	3.0493E-06	2.128101E-05	1.0294E-04	1.029454E-04	160.0	12.79	2.127902E-05	1.990607E-09	8.690
2.03361	1.0070E-06	1.3792E+00	1.0068E-05	1.4506E+12	2.8764E+12	2.1951E-06	0.0000E+00	1.2148E+12	3.0560E-06	2.133792E-05	1.0481E-04	1.048099E-04	160.0	12.79	2.133597E-05	1.956308E-09	8.709
3	1.0070E-06	1.4049E+00	1.0256E-05	2.1630E+12	3.0235E+12	2.7861E-06	6.6925E+10	1.2908E+12	3.6029E-06	2.286393E-05	1.0481E-04	1.048099E-04	159.1	12.80	2.286198E-05	1.946042E-09	8.711
5	1.0070E-06	1.4581E+00	1.0644E-05	3.0991E+12	3.3208E+12	3.6035E-06	6.4671E+11	1.4488E+12	9.0102E-06	2.927668E-05	1.0481E-04	1.048099E-04	155.5	12.84	2.927477E-05	1.911617E-09	8.719
12	1.0070E-06	1.6425E+00	1.1990E-05	4.7032E+12	4.3312E+12	5.1968E-06	1.6404E+12	1.9789E+12	1.8601E-05	4.180635E-05	1.0481E-04	1.048099E-04	149.2	12.92	4.180442E-05	1.923853E-09	8.716
18	1.0070E-06	1.7985E+00	1.3129E-05	5.4462E+12	5.1609E+12	6.0735E-06	2.1006E+12	2.4183E+12	2.3528E-05	4.874925E-05	1.0481E-04	1.048099E-04	146.4	12.95	4.874726E-05	1.989732E-09	8.701
24	1.0070E-06	1.9526E+00	1.4254E-05	5.9733E+12	5.9584E+12	6.7758E-06	2.4271E+12	2.8430E+12	2.7308E-05	5.435668E-05	1.0481E-04	1.048099E-04	144.3	12.98	5.435460E-05	2.082874E-09	8.681
48	1.0070E-06	2.5509E+00	1.8622E-05	7.2434E+12	8.8503E+12	8.8405E-06	3.2138E+12	4.4038E+12	3.7768E-05	7.124905E-05	1.0481E-04	1.048099E-04	139.4	13.04	7.124635E-05	2.703981E-09	8.568
72	1.0070E-06	3.1213E+00	2.2785E-05	7.9863E+12	1.1319E+13	1.0346E-05	3.6740E+12	5.7649E+12	4.5014E-05	8.416437E-05	1.0481E-04	1.048099E-04	136.5	13.08	8.416034E-05	4.026858E-09	8.395
96	1.0070E-06	3.6648E+00	2.6753E-05	8.5135E+12	1.3425E+13	1.1551E-05	4.0005E+12	6.9521E+12	5.0712E-05	9.503557E-05	1.0481E-04	1.048099E-04	134.4	13.11	9.502759E-05	7.982502E-09	8.098
120	1.0070E-06	4.1830E+00	3.0536E-05	8.9224E+12	1.5224E+13	1.2549E-05	4.2538E+12	7.9874E+12	5.5420E-05	1.045233E-04	1.0481E-04	1.048090E-04	132.8	13.13	1.043586E-04	1.647163E-07	6.783
150	1.0070E-06	4.7966E+00	3.5015E-05	9.3312E+12	1.7105E+13	1.3579E-05	4.5071E+12	9.0975E+12	6.0316E-05	1.149284E-04	1.0481E-04	1.048099E-04	131.3	13.15	1.048029E-04	1.012551E-05	4.995
200	1.0070E-06	5.7409E+00	4.1009E-05	9.8584E+12	1.9521E+13	1.4903E-05	4.8336E+12	1.0574E+13	6.6740E-05	1.295707E-04	1.0481E-04	1.048099E-04	129.2	13.18	1.048072E-04	2.476347E-05	4.606
240	1.0070E-06	6.4313E+00	4.6948E-05	1.0182E+13	2.0955E+13	1.5704E-05	5.0405E+12	1.1486E+13	7.0755E-05	1.394260E-04	1.0481E-04	1.048099E-04	127.9	13.20	1.048080E-04	3.461794E-05	4.461
300	1.0070E-06	7.3686E+00	5.3790E-05	1.0601E+13	2.2506E+13	1.6607E-05	5.2938E+12	1.2519E+13	7.5455E-05	1.518712E-04	1.0481E-04	1.048099E-04	126.3	13.22	1.048086E-04	4.706257E-05	4.327
360	1.0070E-06	8.1999E+00	5.9859E-05	1.0035E+13	2.3551E+13	1.7259E-05	5.5007E+12	1.3252E+13	7.9016E-05	1.621547E-04	1.0481E-04	1.048099E-04	125.0	13.24	1.048089E-04	5.734583E-05	4.241
400	1.0070E-06	8.7011E+00	6.3518E-05	1.1128E+13	2.4049E+13	1.7595E-05	5.6203E+12	1.3618E+13	8.0933E-05	1.680660E-04	1.0481E-04	1.048099E-04	124.3	13.25	1.048090E-04	6.325705E-05	4.199
480	1.0070E-06	9.5911E+00	7.0015E-05	1.1463E+13	2.4727E+13	1.8106E-05	5.8272E+12	1.4143E+13	8.3971E-05	1.781108E-04	1.0481E-04	1.048099E-04	123.0	13.27	1.048091E-04	7.330164E-05	4.135
600	1.0070E-06	1.0685E+01	7.8004E-05	1.1871E+13	2.5259E+13	1.8618E-05	6.0805E+12	1.4592E+13	8.7205E-05	1.898455E-04	1.0481E-04	1.048099E-04	121.4	13.29	1.048093E-04	8.503623E-05	4.070
700	1.0070E-06	1.1417E+01	8.3343E-05	1.2154E+13	2.5472E+13	1.8912E-05	6.2555E+12	1.4791E+13	8.9158E-05	1.974317E-04	1.0481E-04	1.048099E-04	120.3	13.30	1.048093E-04	9.262239E-05	4.033
720	1.0070E-06	1.1546E+01	8.4288E-05	1.2205E+13	2.5500E+13	1.8962E-05	6.2875E+12	1.4819E+13	8.9494E-05	1.987628E-04	1.0481E-04	1.048099E-04	120.1	13.31	1.048094E-04	9.395320E-05	4.027

CASE 2

				DRYWELL					CONTAINMENT								
Time (Hours)	[HI]	Pool Int Dose (MeV/cc)	[HNO3]	Int Air Gamma E (MeV/cc)	Int Air Beta E (MeV/cc)	Int Dep Gamma E (MeV/cm²)	Int Dep Beta E (MeV/cm²)	[HCl]	Int Gamma Dose (MeV/cc)	Int Beta Dose (MeV/cc)	[HCl]	Total [H+]	Pool [CsOH]	Total [OH-]	Temp (F)	Final [H+]	pH
0	0.0000E+00		0.0000E+00									5.011872E-06	0.0000E+00	1.995262E-09	77.0	5.011934E-06	5.300
0.03361	0.0000E+00		0.0000E+00									5.011872E-06	0.0000E+00	1.995262E-09	160.0	5.042263E-06	5.237
0.1	2.2285E-08		0.0000E+00									5.034157E-06	2.8679E-06	2.860910E-06	160.0	2.237239E-06	5.650
0.53361	1.6784E-07		0.0000E+00									5.179710E-06	2.1599E-05	2.160135E-05	160.0	9.938219E-09	8.003
1	4.2876E-07		0.0000E+00									5.440634E-06	4.7471E-05	4.747304E-05	160.0	3.884754E-09	8.411
2	9.8822E-07	3.0035E+13	3.4912E-06	6.2798E+12	8.4694E+12	2.6653E+14	1.1184E+14	7.7192E-06	2.5227E+11	1.4582E+12	5.7632E-06	2.297374E-05	1.0294E-04	1.029454E-04	160.0	2.041930E-09	8.690
2.03361	1.0070E-06	3.0098E+13	3.4986E-06	6.3106E+12	8.4743E+12	2.6725E+14	1.1214E+14	7.7456E-06	2.7084E+11	1.4613E+12	5.9253E-06	2.318841E-05	1.0481E-04	1.048099E-04	160.0	2.000658E-09	8.699
3	1.0070E-06	3.1912E+13	3.7094E-06	7.0285E+12	8.6157E+12	2.8803E+14	1.2076E+14	8.3792E-06	7.0402E+11	1.5515E+12	9.7497E-06	2.785721E-05	1.0481E-04	1.048099E-04	159.1	2.072309E-09	8.684
5	1.0070E-06	3.5648E+13	4.1438E-06	7.9717E+12	8.9055E+12	3.3064E+14	1.3850E+14	9.2813E-06	1.2732E+12	1.7365E+12	1.4941E-05	3.438540E-05	1.0481E-04	1.048009E-04	155.5	2.050281E-09	8.628
12	1.0070E-06	4.8552E+13	5.6438E-06	9.5681E+12	7.8910E+12	4.7868E+14	1.9948E+14	1.1157E-05	2.2488E+12	2.3651E+12	2.4823E-05	4.744288E-05	1.0481E-04	1.048099E-04	149.2	2.112865E-09	8.675
18	1.0070E-06	5.9399E+13	6.9048E-06	1.0337E+13	8.7013E+12	6.0292E+14	2.5041E+14	1.2267E-05	2.7003E+12	2.8817E+12	2.9674E-05	5.486476E-05	1.0481E-04	1.048099E-04	146.4	2.233343E-09	8.651
24	1.0070E-06	7.0053E+13	8.1430E-06	1.0668E+13	9.4810E+12	7.2496E+14	3.0013E+14	1.3196E-05	3.0208E+12	3.3785E+12	3.3586E-05	6.094419E-05	1.0481E-04	1.048099E-04	144.3	2.395407E-09	8.621
48	1.0070E-06	1.1080E+14	1.2879E-05	1.2148E+13	1.2317E+13	1.1918E+15	4.8750E+14	1.6120E-05	3.7831E+12	5.1828E+12	4.4538E-05	7.955844E-05	1.0481E-04	1.048099E-04	139.4	3.593262E-09	8.445
72	1.0070E-06	1.4872E+14	1.7287E-05	1.2896E+13	1.4750E+13	1.6261E+15	6.5772E+14	1.8413E-05	4.2448E+12	6.7264E+12	5.2173E-05	9.389173E-05	1.0481E-04	1.048099E-04	136.5	7.610703E-09	8.119
96	1.0070E-06	1.8400E+14	2.1388E-05	1.3428E+13	1.6836E+13	2.0303E+15	8.1236E+14	2.0340E-05	4.5654E+12	8.0472E+12	5.8157E-05	1.059041E-04	1.0481E-04	1.048099E-04	134.4	1.161486E-06	5.935
120	1.0070E-06	2.1683E+14	2.5204E-05	1.3840E+13	1.8625E+13	2.4064E+15	9.5264E+14	2.2000E-05	4.8140E+12	9.1771E+12	6.3064E-05	1.162876E-04	1.0481E-04	1.048099E-04	132.8	1.148415E-05	4.940
150	1.0070E-06	2.5468E+14	2.9604E-05	1.4252E+13	2.0507E+13	2.8400E+15	1.1105E+15	2.3781E-05	5.0626E+12	1.0363E+13	6.8112E-05	1.275158E-04	1.0481E-04	1.048099E-04	131.3	2.270903E-05	4.644
200	1.0070E-06	3.1066E+14	3.6112E-05	1.4783E+13	2.2942E+13	3.4814E+15	1.3347E+15	2.6188E-05	5.3831E+12	1.1891E+13	7.4618E-05	1.429384E-04	1.0481E-04	1.048009E-04	129.2	3.812823E-05	4.419
240	1.0070E-06	3.4978E+14	4.0659E-05	1.5119E+13	2.4401E+13	3.9295E+15	1.4844E+15	2.7724E-05	5.5863E+12	1.2802E+13	7.8507E-05	1.520984E-04	1.0481E-04	1.048099E-04	127.9	4.818987E-05	4.317
300	1.0070E-06	4.0032E+14	4.6534E-05	1.5531E+13	2.5995E+13	4.5065E+15	1.6664E+15	2.9545E-05	5.8349E+12	1.3793E+13	8.3154E-05	1.652513E-04	1.0481E-04	1.048099E-04	126.3	6.044246E-05	4.219
360	1.0070E-06	4.4254E+14	5.1441E-05	1.5868E+13	2.7061E+13	4.9921E+15	1.8132E+15	3.0932E-05	6.0380E+12	1.4484E+13	8.6528E-05	1.749199E-04	1.0481E-04	1.048099E-04	125.0	7.011083E-05	4.154
400	1.0070E-06	4.6875E+14	5.4265E-05	1.6063E+13	2.7605E+13	5.2694E+15	1.8922E+15	3.1674E-05	6.1554E+12	1.4786E+13	8.8313E-05	1.802613E-04	1.0481E-04	1.048099E-04	124.3	7.545214E-05	4.122
480	1.0070E-06	5.0726E+14	5.8964E-05	1.6399E+13	2.8324E+13	5.7335E+15	2.0168E+15	3.2837E-05	6.3585E+12	1.5225E+13	9.1106E-05	1.889257E-04	1.0481E-04	1.048099E-04	123.0	8.411650E-05	4.075
600	1.0070E-06	5.5241E+14	6.4212E-05	1.6811E+13	2.8901E+13	6.2507E+15	2.1427E+15	3.4025E-05	6.6071E+12	1.5574E+13	9.4049E-05	1.983049E-04	1.0481E-04	1.048099E-04	121.4	9.349558E-05	4.029
700	1.0070E-06	5.7941E+14	6.7351E-05	1.7096E+13	2.9137E+13	6.5601E+15	2.2101E+15	3.4692E-05	6.7769E+12	1.5716E+13	9.5831E-05	2.038928E-04	1.0481E-04	1.048009E-04	120.3	9.908342E-05	4.004
720	1.0070E-06	5.8391E+14	6.7874E-05	1.7148E+13	2.9168E+13	6.6116E+15	2.2206E+15	3.4801E-05	6.8103E+12	1.5735E+13	9.6139E-05	2.048323E-04	1.0481E-04	1.048099E-04	120.1	1.000229E-04	4.000

Computer Disclosure Sheet

Discipline Nuclear

Client:: Exelon Corporation
Project: Limerick Generating Station pH AST

Date: September 2005
Job No.

Program(s) used	Rev No.	Rev Date	Calculation No.: LM-0642, Rev. 1
Excel Spreadsheet included	N/A	N/A	

Status [ ] Prelim.
[X] Final
[ ] Void

WGI Prequalification [ ] Yes
[X] No, the Excel Spreadsheet qualification is included herein

Run No. N/A

Description: The Excel spreadsheet utilized is presented in Attachment C included with the Calculation. The cell formulae, presented in Attachment D of this Calculation, are based on the methodology developed for the equivalent calculations done for the Grand Gulf Nuclear Station, as described in Attachment F and G included with the Calculation. The accuracy of translation of these formulas is verified by duplicating the Grand Gulf calculation, as presented in Attachment E included with the Calculation.

Analysis Description: The Excel spreadsheet uses input values of pool volume, I and Cs inventory, onset of gap release, absorption coefficients, cable surface area and Hypalon jacket thickness, pool temperature as a function of time, and integrated drywell and containment air beta and gamma doses as a function of time. It calculates HI, Nitric acid, hydrochloric acid (from cable radiolysis), H+, CsOH, OH, and pH in the suppression pool as a function of time. This calculation is done with consideration of sodium pentaborate addition (as an input quantity).

The attached computer output has been reviewed, the input data checked,
And the results approved for release. Input criteria for this analysis were established.

By:

On: March 2004 – September 2005

Run by: Harold Rothstein *Harold Rothstein*

Checked by: Paul Reichert *Paul Reichert*

Approved by: Harold Rothstein *Harold Rothstein*

ADDITIONAL ATTACHMENTS TO
10-10-05 Letter: Supplement to Request for LAR Application of AST
Attachment 003 AST – LM-0642 Rev 1 pH Att B (Pages 6-9)

Class	Isotopic Nuclide	Decay Constant (hours)$^{-1}$	Release Fractions 0-0.5 hours	Release Fractions 0.5-2 hours	Initial Core Activity (Ci)	Gap Release Activity in Containment at 0.5 hours (Ci)	Gap Release Time Integrated Activity in Containment through 0.5 hours (Ci-hours)	Early In-vessel Release Activity in Containment at 2.0 hours (Ci)	Early In-vessel Release Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Activity in Containment at 2.0 hours (Ci)	Gamma *(Photon)* Emission Energy (MeV/decay)	Gamma *(Photon)* Emission Energy per Unit of Activity (MeV/Ci-hour)	Beta Particle Emission Energy (MeV/decay)	Beta Particle Emission Energy per Unit of Activity (MeV/Ci-hour)
1	Kr-85	7.376E-06	0.05	0.95	1.392E+06	6.96E+04	1.74E+04	1.32E+06	9.92E+05	1.01E+06	1.39E+06	2.23E-03	2.97E+11	2.51E-01	3.34E+13
1	Kr-85m	1.547E-01	0.05	0.95	2.933E+07	1.36E+06	3.48E+05	2.04E+07	1.66E+07	1.69E+07	2.15E+07	1.58E-01	2.10E+13	2.29E-01	3.05E+13
1	Kr-87	5.451E-01	0.05	0.95	5.760E+07	2.19E+06	6.02E+05	1.84E+07	1.85E+07	1.91E+07	1.94E+07	7.93E-01	1.06E+14	1.32E+00	1.76E+14
1	Kr-88	2.441E-01	0.05	0.95	8.126E+07	3.60E+06	9.37E+05	4.74E+07	4.03E+07	4.12E+07	4.99E+07	1.95E+00	2.60E+14	3.60E-01	4.79E+13
1	Xe-133	5.506E-03	0.05	0.95	1.937E+08	9.66E+06	2.42E+06	1.82E+08	1.37E+08	1.39E+08	1.92E+08	4.53E-02	6.03E+12	1.00E-01	1.34E+13
1	Xe-135	7.625E-02	0.05	0.95	7.861E+07	3.78E+06	9.58E+05	6.41E+07	5.00E+07	5.09E+07	6.75E+07	2.48E-01	3.30E+13	3.03E-01	4.03E+13
2	I-131	3.592E-03	0.05	0.25	9.479E+07	4.73E+06	1.18E+06	2.35E+07	1.77E+07	1.89E+07	2.82E+07	3.81E-01	5.08E+13	1.81E-01	2.42E+13
2	I-132	3.014E-01	0.05	0.25	1.369E+08	5.89E+06	1.55E+06	1.87E+07	1.64E+07	1.80E+07	2.25E+07	2.29E+00	3.05E+14	4.86E-01	6.47E+13
2	I-133	3.332E-02	0.05	0.25	1.960E+08	9.64E+06	2.42E+06	4.58E+07	3.50E+07	3.74E+07	5.50E+07	6.07E-01	8.08E+13	4.07E-01	5.42E+13
2	I-134	7.907E-01	0.05	0.25	2.175E+08	7.32E+06	2.10E+06	1.12E+07	1.30E+07	1.51E+07	1.34E+07	2.63E+00	3.50E+14	6.03E-01	8.03E+13
2	I-135	1.049E-01	0.05	0.25	1.832E+08	8.69E+06	2.21E+06	3.71E+07	2.94E+07	3.16E+07	4.46E+07	1.58E+00	2.10E+14	3.68E-01	4.91E+13
3	Rb-86	1.548E-03	0.05	0.20	2.300E+05	1.15E+04	2.87E+03	4.58E+04	3.44E+04	3.73E+04	5.73E+04	9.45E-02	1.26E+13	6.67E-01	8.89E+13
3	Cs-134	3.835E-05	0.05	0.20	2.569E+07	1.28E+06	3.21E+05	5.14E+06	3.85E+06	4.17E+06	6.42E+06	1.56E+00	2.07E+14	1.57E-01	2.09E+13
3	Cs-136	2.205E-03	0.05	0.20	7.150E+06	3.57E+05	8.93E+04	1.42E+06	1.07E+06	1.16E+06	1.78E+06	2.17E+00	2.89E+14	1.00E-01	1.33E+13
3	Cs-137	2.636E-06	0.05	0.20	1.601E+07	8.00E+05	2.00E+05	3.20E+06	2.40E+06	2.60E+06	4.00E+06	0.00E+00	0.00E+00	1.71E-01	2.27E+13
4	Sb-127	7.502E-03	0.00	0.05	1.022E+07	0.00E+00	0.00E+00	5.03E+05	3.79E+05	3.79E+05	5.03E+05	6.62E-01	8.82E+13	3.11E-01	4.14E+13
4	Sb-129	1.605E-01	0.00	0.05	3.047E+07	0.00E+00	0.00E+00	1.11E+06	9.00E+05	9.00E+05	1.11E+06	1.43E+00	1.90E+14	3.58E-01	4.76E+13
4	Te-127	7.413E-02	0.00	0.05	1.014E+07	0.00E+00	0.00E+00	4.37E+05	3.40E+05	3.40E+05	4.37E+05	4.84E-03	6.44E+11	2.23E-01	2.97E+13
4	Te-127m	2.650E-04	0.00	0.05	1.360E+06	0.00E+00	0.00E+00	6.80E+04	5.10E+04	5.10E+04	6.80E+04	1.12E-02	1.50E+12	4.61E-03	6.13E+11
4	Te-129	5.975E-01	0.00	0.05	2.999E+07	0.00E+00	0.00E+00	4.54E+05	4.70E+05	4.70E+05	4.54E+05	5.77E-02	7.68E+12	5.25E-01	6.99E+13
4	Te-129m	8.596E-04	0.00	0.05	4.470E+06	0.00E+00	0.00E+00	2.23E+05	1.67E+05	1.67E+05	2.23E+05	3.94E-02	5.25E+12	2.12E-01	2.82E+13
4	Te-131m	2.310E-02	0.00	0.05	1.365E+07	0.00E+00	0.00E+00	6.52E+05	4.94E+05	4.94E+05	6.52E+05	1.43E+00	1.90E+14	1.45E-01	1.92E+13
4	Te-132	8.864E-03	0.00	0.05	1.348E+08	0.00E+00	0.00E+00	6.62E+06	4.99E+06	4.99E+06	6.62E+06	2.31E-01	3.07E+13	5.94E-02	7.91E+12
5	Sr-89	5.719E-04	0.00	0.02	9.873E+07	0.00E+00	0.00E+00	1.97E+06	1.48E+06	1.48E+06	1.97E+06	1.36E-04	1.82E+10	5.83E-01	7.76E+13
5	Sr-90	2.715E-06	0.00	0.02	1.121E+07	0.00E+00	0.00E+00	2.24E+05	1.68E+05	1.68E+05	2.24E+05	0.00E+00	0.00E+00	1.96E-01	2.61E+13
5	Sr-91	7.296E-02	0.00	0.02	1.341E+08	0.00E+00	0.00E+00	2.32E+06	1.80E+06	1.80E+06	2.32E+06	6.87E-01	9.15E+13	6.53E-01	8.70E+13
5	Sr-92	2.558E-01	0.00	0.02	1.417E+08	0.00E+00	0.00E+00	1.70E+06	1.45E+06	1.45E+06	1.70E+06	1.34E+00	1.78E+14	2.00E-01	2.66E+13
6	Ba-139	5.029E-01	0.00	0.02	1.794E+08	0.00E+00	0.00E+00	1.31E+06	1.29E+06	1.29E+06	1.31E+06	3.53E-02	4.70E+12	8.97E-01	1.19E+14
6	Ba-140	2.267E-03	0.00	0.02	1.727E+08	0.00E+00	0.00E+00	3.44E+06	2.58E+06	2.58E+06	3.44E+06	1.91E-01	2.54E+13	2.71E-01	3.61E+13
7	Co-58	4.079E-04	0.00	0.0025	5.394E+06	0.00E+00	0.00E+00	1.35E+04	1.01E+04	1.01E+04	1.35E+04	9.76E-01	1.30E+14	0.00E+00	0.00E+00
7	Co-60	1.500E-05	0.00	0.0025	6.361E+06	0.00E+00	0.00E+00	1.59E+04	1.19E+04	1.19E+04	1.59E+04	2.51E+00	3.34E+14	9.58E-02	1.28E+13
7	Mo-99	1.050E-02	0.00	0.0025	1.792E+08	0.00E+00	0.00E+00	4.39E+05	3.31E+05	3.31E+05	4.39E+05	1.55E-01	2.06E+13	3.93E-01	5.24E+13
7	Tc-99m	1.151E-01	0.00	0.0025	1.569E+08	0.00E+00	0.00E+00	3.12E+05	2.48E+05	2.48E+05	3.12E+05	1.27E-01	1.69E+13	0.00E+00	0.00E+00
7	Ru-103	7.353E-04	0.00	0.0025	1.483E+08	0.00E+00	0.00E+00	3.70E+05	2.78E+05	2.78E+05	3.70E+05	4.84E-01	6.44E+13	6.75E-02	9.00E+12
7	Ru-105	1.561E-01	0.00	0.0025	1.026E+08	0.00E+00	0.00E+00	1.88E+05	1.52E+05	1.52E+05	1.88E+05	7.84E-01	1.04E+14	4.03E-01	5.36E+13
7	Ru-106	7.844E-05	0.00	0.0025	6.104E+07	0.00E+00	0.00E+00	1.53E+05	1.14E+05	1.14E+05	1.53E+05	0.00E+00	0.00E+00	1.00E-02	1.34E+12
7	Rh-105	1.960E-02	0.00	0.0025	9.709E+07	0.00E+00	0.00E+00	2.33E+05	1.77E+05	1.77E+05	2.33E+05	7.76E-02	1.03E+13	1.52E-01	2.03E+13
8	Ce-141	8.886E-04	0.00	0.0005	1.585E+08	0.00E+00	0.00E+00	7.91E+04	5.94E+04	5.94E+04	7.91E+04	7.69E-02	1.02E+13	1.45E-01	1.93E+13
8	Ce-143	2.100E-02	0.00	0.0005	1.562E+08	0.00E+00	0.00E+00	7.49E+04	5.68E+04	5.68E+04	7.49E+04	2.73E-01	3.64E+13	4.10E-01	5.46E+13
8	Ce-144	1.016E-04	0.00	0.0005	1.269E+08	0.00E+00	0.00E+00	6.34E+04	4.76E+04	4.76E+04	6.34E+04	1.93E-02	2.57E+12	8.33E-02	1.11E+13
8	Np-239	1.226E-02	0.00	0.0005	1.904E+09	0.00E+00	0.00E+00	9.29E+05	7.01E+05	7.01E+05	9.29E+05	1.72E-01	2.29E+13	1.15E-01	1.53E+13
8	Pu-238	9.012E-07	0.00	0.0005	6.336E+05	0.00E+00	0.00E+00	3.17E+02	2.38E+02	2.38E+02	3.17E+02	1.60E-03	2.13E+11	0.00E+00	0.00E+00
8	Pu-239	3.286E-09	0.00	0.0005	4.234E+04	0.00E+00	0.00E+00	2.12E+01	1.45E+02	1.45E+02	2.12E+01	6.54E-04	8.71E+10	0.00E+00	0.00E+00
8	Pu-240	1.210E-08	0.00	0.0005	4.543E+04	0.00E+00	0.00E+00	2.27E+01	1.15E+01	1.15E+01	2.27E+01	1.53E-03	2.03E+11	0.00E+00	0.00E+00
8	Pu-241	5.491E-06	0.00	0.0005	2.181E+07	0.00E+00	0.00E+00	1.09E+04	8.18E+03	8.18E+03	1.09E+04	0.00E+00	0.00E+00	5.23E-03	6.97E+11
9	Y-90	1.083E-02	0.00	0.0002	1.154E+07	0.00E+00	0.00E+00	2.26E+03	1.70E+03	1.70E+03	2.26E+03	0.00E+00	0.00E+00	9.35E-01	1.25E+14
9	Y-91	4.936E-04	0.00	0.0002	1.217E+08	0.00E+00	0.00E+00	2.43E+04	1.82E+04	1.82E+04	2.43E+04	3.61E-03	4.81E+11	6.02E-01	8.02E+13
9	Y-92	1.958E-01	0.00	0.0002	1.421E+08	0.00E+00	0.00E+00	1.92E+04	1.59E+04	1.59E+04	1.92E+04	2.52E-01	3.35E+13	1.44E+00	1.92E+14
9	Y-93	6.863E-02	0.00	0.0002	1.597E+08	0.00E+00	0.00E+00	2.78E+04	2.16E+04	2.16E+04	2.78E+04	8.91E-02	1.19E+13	1.17E+00	1.56E+14
9	Zr-95	4.514E-04	0.00	0.0002	1.584E+08	0.00E+00	0.00E+00	3.16E+04	2.37E+04	2.37E+04	3.16E+04	7.35E-01	9.79E+13	1.16E-01	1.55E+13
9	Zr-97	4.101E-02	0.00	0.0002	1.643E+08	0.00E+00	0.00E+00	3.03E+04	2.32E+04	2.32E+04	3.03E+04	1.81E-01	2.41E+13	6.97E-01	9.29E+13
9	Nb-95	8.217E-04	0.00	0.0002	1.592E+08	0.00E+00	0.00E+00	3.18E+04	2.38E+04	2.38E+04	3.18E+04	7.64E-01	1.02E+14	4.34E-02	5.79E+12
9	La-140	1.721E-02	0.00	0.0002	1.771E+08	0.00E+00	0.00E+00	3.42E+04	2.59E+04	2.59E+04	3.42E+04	2.32E+00	3.09E+14	5.27E-01	7.03E+13
9	La-141	1.764E-01	0.00	0.0002	1.637E+08	0.00E+00	0.00E+00	2.30E+04	1.89E+04	1.89E+04	2.30E+04	4.27E-02	5.69E+12	9.48E-01	1.26E+14
9	La-142	4.496E-01	0.00	0.0002	1.599E+08	0.00E+00	0.00E+00	1.30E+04	1.24E+04	1.24E+04	1.30E+04	2.72E+00	3.62E+14	8.46E-01	1.13E+14
9	Pr-143	2.130E-03	0.00	0.0002	1.515E+08	0.00E+00	0.00E+00	3.02E+04	2.26E+04	2.26E+04	3.02E+04	0.00E+00	0.00E+00	3.16E-01	4.20E+13
9	Nd-147	2.630E-03	0.00	0.0002	6.483E+07	0.00E+00	0.00E+00	1.29E+04	9.69E+03	9.69E+03	1.29E+04	1.41E-01	1.87E+13	2.33E-01	3.11E+13
9	Am-241	1.830E-07	0.00	0.0002	3.361E+04	0.00E+00	0.00E+00	6.72E+00	5.05E+00	5.05E+00	6.72E+00	2.81E-02	3.74E+12	0.00E+00	0.00E+00
9	Cm-242	1.774E-04	0.00	0.0002	8.424E+06	0.00E+00	0.00E+00	1.68E+03	1.26E+03	1.26E+03	1.68E+03	1.67E-03	2.23E+11	0.00E+00	0.00E+00
9	Cm-244	4.366E-06	0.00	0.0002	9.181E+05	0.00E+00	0.00E+00	1.84E+02	1.38E+02	1.38E+02	1.84E+02	1.49E-03	1.98E+11	0.00E+00	0.00E+00

Disintegrations per Curie-hour= 1.3320E+14

Drywell (Drywell + Supp. Pool Airspace) cm^3= 9.9177E+09

Activity in Containment at Given Timesteps (Ci-hours)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	1.01E+06	1.06E+06	2.40E+06	5.19E+06	1.49E+07	2.33E+07	3.16E+07	6.50E+07	9.84E+07	1.32E+08	1.65E+08	2.07E+08	2.76E+08	3.32E+08	4.15E+08	4.99E+08	5.54E+08	6.65E+08	8.32E+08	9.70E+08	9.98E+08
	1.69E+07	1.77E+07	3.69E+07	6.86E+07	1.26E+08	1.44E+08	1.51E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08	1.56E+08
	1.91E+07	1.97E+07	3.40E+07	4.77E+07	5.44E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07	5.46E+07
	4.12E+07	4.29E+07	8.55E+07	1.47E+08	2.28E+08	2.41E+08	2.45E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08	2.46E+08
	1.39E+08	1.46E+08	3.30E+08	7.09E+08	2.00E+09	3.07E+09	4.11E+09	7.93E+09	1.13E+10	1.42E+10	1.68E+10	1.95E+10	2.32E+10	2.56E+10	2.82E+10	3.01E+10	3.10E+10	3.24E+10	3.36E+10	3.42E+10	3.43E+10
	5.09E+07	5.32E+07	1.16E+08	2.32E+08	5.23E+08	6.75E+08	7.71E+08	9.10E+08	9.32E+08	9.35E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08	9.36E+08
	1.89E+07	1.98E+07	4.70E+07	1.03E+08	2.96E+08	4.58E+08	6.16E+08	1.22E+09	1.77E+09	2.27E+09	2.73E+09	3.26E+09	4.02E+09	4.54E+09	5.18E+09	5.71E+09	6.00E+09	6.47E+09	6.96E+09	7.24E+09	7.28E+09
	1.80E+07	1.87E+07	3.74E+07	6.24E+07	8.89E+07	9.20E+07	9.25E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07
	3.74E+07	3.92E+07	9.15E+07	1.94E+08	5.05E+08	7.20E+08	8.95E+08	1.33E+09	1.53E+09	1.62E+09	1.66E+09	1.68E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09
	1.51E+07	1.55E+07	2.44E+07	3.05E+07	3.20E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07
	3.16E+07	3.31E+07	7.39E+07	1.46E+08	3.08E+08	3.77E+08	4.14E+08	4.53E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08
	3.73E+04	3.92E+04	9.46E+04	2.09E+05	6.06E+05	9.43E+05	1.28E+06	2.58E+06	3.84E+06	5.05E+06	6.22E+06	7.62E+06	9.81E+06	1.14E+07	1.37E+07	1.58E+07	1.71E+07	1.94E+07	2.24E+07	2.45E+07	2.49E+07
	4.17E+06	4.39E+06	1.06E+07	2.34E+07	6.84E+07	1.07E+08	1.45E+08	2.99E+08	4.53E+08	6.07E+08	7.60E+08	9.52E+08	1.27E+09	1.53E+09	1.91E+09	2.29E+09	2.54E+09	3.05E+09	3.80E+09	4.43E+09	4.55E+09
	1.16E+06	1.22E+06	2.94E+06	6.48E+06	1.88E+07	2.91E+07	3.94E+07	7.90E+07	1.17E+08	1.52E+08	1.86E+08	2.26E+08	2.87E+08	3.31E+08	3.90E+08	4.42E+08	4.73E+08	5.27E+08	5.92E+08	6.35E+08	6.43E+08
	2.60E+06	2.74E+06	6.60E+06	1.46E+07	4.26E+07	6.66E+07	9.07E+07	1.87E+08	2.83E+08	3.79E+08	4.75E+08	5.95E+08	7.95E+08	9.55E+08	1.19E+09	1.43E+09	1.59E+09	1.91E+09	2.39E+09	2.79E+09	2.87E+09
	3.79E+05	3.96E+05	8.80E+05	1.87E+06	5.23E+06	7.97E+06	1.06E+07	2.00E+07	2.78E+07	3.43E+07	3.98E+07	4.54E+07	5.23E+07	5.62E+07	6.03E+07	6.29E+07	6.41E+07	6.56E+07	6.67E+07	6.71E+07	6.72E+07
	9.00E+05	9.37E+05	1.92E+06	3.53E+06	6.40E+06	7.26E+06	7.59E+06	7.78E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06
	3.40E+05	3.55E+05	7.61E+05	1.52E+06	3.43E+06	4.44E+06	5.08E+06	6.04E+06	6.20E+06	6.23E+06	6.23E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06
	5.10E+04	5.33E+04	1.19E+05	2.55E+05	7.30E+05	1.14E+06	1.54E+06	3.16E+06	4.76E+06	6.36E+06	7.95E+06	9.92E+06	1.32E+07	1.57E+07	1.95E+07	2.33E+07	2.57E+07	3.06E+07	3.76E+07	4.34E+07	4.45E+07
	4.70E+05	4.85E+05	8.11E+05	1.10E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06
	1.67E+05	1.75E+05	3.90E+05	8.36E+05	2.39E+06	3.71E+06	5.03E+06	1.02E+07	1.53E+07	2.03E+07	2.52E+07	3.12E+07	4.08E+07	4.82E+07	5.88E+07	6.89E+07	7.54E+07	8.76E+07	1.04E+08	1.17E+08	1.20E+08
	4.94E+05	5.16E+05	1.14E+06	2.38E+06	6.31E+06	9.21E+06	1.17E+07	1.90E+07	2.31E+07	2.55E+07	2.69E+07	2.78E+07	2.84E+07	2.86E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07
	4.99E+06	5.21E+06	1.16E+07	2.46E+07	6.84E+07	1.04E+08	1.37E+08	2.55E+08	3.50E+08	4.27E+08	4.90E+08	5.51E+08	6.23E+08	6.61E+08	6.99E+08	7.21E+08	7.30E+08	7.41E+08	7.48E+08	7.50E+08	7.51E+08
	1.48E+06	1.55E+06	3.45E+06	7.39E+06	2.11E+07	3.29E+07	4.46E+07	9.10E+07	1.37E+08	1.82E+08	2.27E+08	2.81E+08	3.71E+08	4.40E+08	5.42E+08	6.40E+08	7.04E+08	8.26E+08	1.00E+09	1.14E+09	1.16E+09
	1.68E+05	1.76E+05	3.92E+05	8.41E+05	2.41E+06	3.76E+06	5.10E+06	1.05E+07	1.59E+07	2.12E+07	2.66E+07	3.33E+07	4.46E+07	5.35E+07	6.70E+07	8.04E+07	8.94E+07	1.07E+08	1.34E+08	1.57E+08	1.61E+08
	1.80E+06	1.88E+06	4.04E+06	8.05E+06	1.83E+07	2.37E+07	2.72E+07	3.25E+07	3.34E+07	3.35E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07
	1.45E+06	1.51E+06	2.95E+06	5.01E+06	7.58E+06	7.99E+06	8.08E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06
	1.29E+06	1.33E+06	2.32E+06	3.32E+06	3.88E+06	3.89E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06
	2.58E+06	2.70E+06	6.02E+06	1.29E+07	3.66E+07	5.66E+07	7.64E+07	1.53E+08	2.25E+08	2.94E+08	3.59E+08	4.35E+08	5.51E+08	6.35E+08	7.48E+08	8.46E+08	9.04E+08	1.01E+09	1.13E+09	1.21E+09	1.22E+09
	1.01E+04	1.06E+04	2.36E+04	5.05E+04	1.45E+05	2.25E+05	3.05E+05	6.24E+05	9.40E+05	1.25E+06	1.56E+06	1.95E+06	2.57E+06	3.07E+06	3.79E+06	4.50E+06	4.96E+06	5.86E+06	7.16E+06	8.20E+06	8.40E+06
	1.19E+04	1.25E+04	2.78E+04	5.96E+04	1.71E+05	2.66E+05	3.62E+05	7.43E+05	1.12E+06	1.51E+06	1.89E+06	2.36E+06	3.16E+06	3.79E+06	4.74E+06	5.69E+06	6.32E+06	7.59E+06	9.48E+06	1.11E+07	1.14E+07
	3.31E+05	3.45E+05	7.67E+05	1.63E+06	4.49E+06	6.79E+06	8.95E+06	1.63E+07	2.21E+07	2.65E+07	3.00E+07	3.33E+07	3.69E+07	3.87E+07	4.03E+07	4.11E+07	4.15E+07	4.18E+07	4.20E+07	4.21E+07	4.21E+07
	2.48E+05	2.58E+05	5.42E+05	1.04E+06	2.10E+06	2.52E+06	2.74E+06	2.94E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06
	2.78E+05	2.90E+05	6.48E+05	1.39E+06	3.96E+06	6.16E+06	8.35E+06	1.70E+07	2.55E+07	3.39E+07	4.21E+07	5.22E+07	6.85E+07	8.11E+07	9.93E+07	1.17E+08	1.28E+08	1.49E+08	1.79E+08	2.02E+08	2.07E+08
	1.52E+05	1.59E+05	3.26E+05	6.02E+05	1.10E+06	1.26E+06	1.32E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06
	1.14E+05	1.20E+05	2.67E+05	5.72E+05	1.64E+06	2.55E+06	3.47E+06	7.12E+06	1.08E+07	1.44E+07	1.80E+07	2.26E+07	3.01E+07	3.61E+07	4.51E+07	5.40E+07	5.99E+07	7.17E+07	8.92E+07	1.04E+08	1.07E+08
	1.77E+05	1.85E+05	4.08E+05	8.57E+05	2.30E+06	3.38E+06	4.35E+06	7.25E+06	9.06E+06	1.02E+07	1.09E+07	1.14E+07	1.18E+07	1.20E+07	1.20E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07
	5.94E+04	6.20E+04	1.38E+05	2.96E+05	8.47E+05	1.32E+06	1.78E+06	3.62E+06	5.43E+06	7.19E+06	8.92E+06	1.10E+07	1.44E+07	1.70E+07	2.08E+07	2.43E+07	2.66E+07	3.09E+07	3.68E+07	4.12E+07	4.20E+07
	5.68E+04	5.93E+04	1.31E+05	2.74E+05	7.32E+05	1.07E+06	1.38E+06	2.27E+06	2.80E+06	3.13E+06	3.32E+06	3.46E+06	3.57E+06	3.60E+06	3.61E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06
	4.76E+04	4.97E+04	1.11E+05	2.38E+05	6.81E+05	1.06E+06	1.44E+06	2.96E+06	4.47E+06	5.98E+06	7.49E+06	9.36E+06	1.25E+07	1.50E+07	1.87E+07	2.23E+07	2.48E+07	2.96E+07	3.68E+07	4.28E+07	4.40E+07
	7.01E+05	7.32E+05	1.62E+06	3.44E+06	9.44E+06	1.42E+07	1.86E+07	3.34E+07	4.43E+07	5.25E+07	5.86E+07	6.41E+07	6.98E+07	7.24E+07	7.45E+07	7.55E+07	7.59E+07	7.62E+07	7.64E+07	7.64E+07	7.64E+07
	2.38E+02	2.48E+02	5.54E+02	1.19E+03	3.41E+03	5.31E+03	7.21E+03	1.48E+04	2.24E+04	3.00E+04	3.76E+04	4.71E+04	6.30E+04	7.56E+04	9.46E+04	1.14E+05	1.26E+05	1.52E+05	1.90E+05	2.21E+05	2.28E+05
	1.45E+02	1.46E+02	1.66E+02	2.09E+02	3.57E+02	4.84E+02	6.11E+02	1.12E+03	1.63E+03	2.13E+03	2.64E+03	3.28E+03	4.34E+03	5.18E+03	6.45E+03	7.72E+03	8.57E+03	1.03E+04	1.28E+04	1.49E+04	1.53E+04
	1.15E+01	1.23E+01	3.42E+01	7.96E+01	2.39E+02	3.75E+02	5.11E+02	1.06E+03	1.60E+03	2.15E+03	2.69E+03	3.37E+03	4.51E+03	5.42E+03	6.78E+03	8.14E+03	9.05E+03	1.09E+04	1.36E+04	1.59E+04	1.63E+04
	8.18E+03	8.55E+03	1.91E+04	4.09E+04	1.17E+05	1.83E+05	2.48E+05	5.10E+05	7.71E+05	1.03E+06	1.29E+06	1.62E+06	2.17E+06	2.60E+06	3.26E+06	3.91E+06	4.34E+06	5.21E+06	6.52E+06	7.61E+06	7.82E+06
	1.70E+03	1.78E+03	3.95E+03	8.37E+03	2.31E+04	3.49E+04	4.59E+04	8.35E+04	1.13E+05	1.35E+05	1.52E+05	1.68E+05	1.86E+05	1.94E+05	2.02E+05	2.06E+05	2.07E+05	2.09E+05	2.10E+05	2.10E+05	2.10E+05
	1.82E+04	1.91E+04	4.25E+04	9.11E+04	2.61E+05	4.06E+05	5.50E+05	1.12E+06	1.69E+06	2.25E+06	2.80E+06	3.49E+06	4.60E+06	5.48E+06	6.75E+06	7.99E+06	8.80E+06	1.04E+07	1.26E+07	1.44E+07	1.47E+07
	1.59E+04	1.66E+04	3.34E+04	5.95E+04	1.00E+05	1.10E+05	1.13E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05
	2.16E+04	2.26E+04	4.85E+04	9.71E+04	2.23E+05	2.92E+05	3.38E+05	4.10E+05	4.24E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05
	2.37E+04	2.48E+04	5.54E+04	1.19E+05	3.40E+05	5.28E+05	7.17E+05	1.46E+06	2.20E+06	2.94E+06	3.66E+06	4.55E+06	6.02E+06	7.17E+06	8.85E+06	1.05E+07	1.16E+07	1.36E+07	1.66E+07	1.90E+07	1.94E+07
	2.32E+04	2.42E+04	5.28E+04	1.09E+05	2.72E+05	3.78E+05	4.62E+05	6.49E+05	7.19E+05	7.46E+05	7.55E+05	7.60E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05
	2.38E+04	2.49E+04	5.56E+04	1.19E+05	3.40E+05	5.29E+05	7.17E+05	1.46E+06	2.19E+06	2.90E+06	3.60E+06	4.45E+06	5.83E+06	6.90E+06	8.43E+06	9.88E+06	1.08E+07	1.26E+07	1.50E+07	1.69E+07	1.73E+07
	2.59E+04	2.70E+04	5.98E+04	1.26E+05	3.40E+05	5.04E+05	6.52E+05	1.11E+06	1.42E+06	1.62E+06	1.75E+06	1.86E+06	1.95E+06	1.98E+06	2.00E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06
	1.89E+04	1.97E+04	4.00E+04	7.25E+04	1.27E+05	1.42E+05	1.47E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05
	1.24E+04	1.28E+04	2.29E+04	3.38E+04	4.10E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04
	2.26E+04	2.37E+04	5.28E+04	1.13E+05	3.21E+05	4.97E+05	6.71E+05	1.34E+06	1.98E+06	2.59E+06	3.17E+06	3.85E+06	4.90E+06	5.65E+06	6.68E+06	7.58E+06	8.12E+06	9.07E+06	1.02E+07	1.10E+07	1.11E+07
	9.69E+03	1.01E+04	2.26E+04	4.82E+04	1.37E+05	2.12E+05	2.85E+05	5.69E+05	8.34E+05	1.08E+06	1.32E+06	1.59E+06	2.00E+06	2.29E+06	2.67E+06	3.00E+06	3.19E+06	3.52E+06	3.90E+06	4.13E+06	4.17E+06
	5.05E+00	5.28E+00	1.18E+01	2.52E+01	7.23E+01	1.13E+02	1.53E+02	3.14E+02	4.76E+02	6.37E+02	7.98E+02	1.00E+03	1.34E+03	1.61E+03	2.01E+03	2.41E+03	2.68E+03	3.22E+03	4.03E+03	4.70E+03	4.83E+03
	1.26E+03	1.32E+03	2.95E+03	6.31E+03	1.81E+04	2.82E+04	3.82E+04	7.84E+04	1.18E+05	1.58E+05	1.98E+05	2.47E+05	3.29E+05	3.94E+05	4.90E+05	5.85E+05	6.48E+05	7.73E+05	9.57E+05	1.11E+06	1.14E+06
	1.38E+02	1.44E+02	3.21E+02	6.89E+02	1.97E+03	3.08E+03	4.18E+03	8.58E+03	1.30E+04	1.74E+04	2.18E+04	2.73E+04	3.65E+04	4.38E+04	5.48E+04	6.58E+04	7.32E+04	8.78E+04	1.10E+05	1.28E+05	1.32E+05

Gamma *(Photon)* Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	3.00E+17	3.14E+17	7.14E+17	1.54E+18	4.44E+18	6.92E+18	9.40E+18	1.93E+19	2.92E+19	3.92E+19	4.91E+19	6.15E+19	8.21E+19	9.87E+19	1.23E+20	1.48E+20	1.65E+20	1.98E+20	2.47E+20	2.88E+20	2.97E+20
	3.56E+20	3.71E+20	7.75E+20	1.44E+21	2.66E+21	3.03E+21	3.18E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21	3.28E+21
	2.01E+21	2.08E+21	3.59E+21	5.04E+21	5.75E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21	5.77E+21
	1.07E+22	1.12E+22	2.23E+22	3.84E+22	5.93E+22	6.29E+22	6.37E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22	6.39E+22
	8.40E+20	8.79E+20	1.99E+21	4.28E+21	1.21E+22	1.85E+22	2.48E+22	4.78E+22	6.80E+22	8.56E+22	1.01E+23	1.18E+23	1.40E+23	1.54E+23	1.70E+23	1.82E+23	1.87E+23	1.96E+23	2.03E+23	2.06E+23	2.07E+23
	1.68E+21	1.76E+21	3.83E+21	7.66E+21	1.73E+22	2.23E+22	2.55E+22	3.00E+22	3.08E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22	3.09E+22
	9.58E+20	1.01E+21	2.39E+21	5.23E+21	1.50E+22	2.32E+22	3.13E+22	6.17E+22	8.97E+22	1.15E+23	1.39E+23	1.66E+23	2.04E+23	2.30E+23	2.63E+23	2.90E+23	3.04E+23	3.28E+23	3.53E+23	3.67E+23	3.70E+23
	5.49E+21	5.72E+21	1.14E+22	1.90E+22	2.71E+22	2.81E+22	2.82E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22
	3.02E+21	3.17E+21	7.39E+21	1.57E+22	4.08E+22	5.82E+22	7.23E+22	1.08E+23	1.23E+23	1.31E+23	1.34E+23	1.35E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23
	5.27E+21	5.43E+21	8.52E+21	1.07E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22
	6.63E+21	6.94E+21	1.55E+22	3.07E+22	6.45E+22	7.91E+22	8.69E+22	9.51E+22	9.57E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22
	4.69E+17	4.94E+17	1.19E+18	2.63E+18	7.63E+18	1.19E+19	1.61E+19	3.25E+19	4.83E+19	6.36E+19	7.83E+19	9.59E+19	1.24E+20	1.44E+20	1.73E+20	1.99E+20	2.15E+20	2.44E+20	2.82E+20	3.08E+20	3.13E+20
	8.65E+20	9.09E+20	2.19E+21	4.85E+21	1.42E+22	2.21E+22	3.01E+22	6.20E+22	9.38E+22	1.26E+23	1.57E+23	1.97E+23	2.63E+23	3.16E+23	3.95E+23	4.74E+23	5.26E+23	6.31E+23	7.87E+23	9.17E+23	9.43E+23
	3.34E+20	3.52E+20	8.48E+20	1.87E+21	5.42E+21	8.41E+21	1.14E+22	2.28E+22	3.37E+22	4.40E+22	5.37E+22	6.52E+22	8.28E+22	9.55E+22	1.13E+23	1.28E+23	1.37E+23	1.52E+23	1.71E+23	1.83E+23	1.86E+23
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.34E+19	3.49E+19	7.76E+19	1.65E+20	4.61E+20	7.02E+20	9.33E+20	1.76E+21	2.45E+21	3.03E+21	3.51E+21	4.00E+21	4.61E+21	4.96E+21	5.32E+21	5.55E+21	5.65E+21	5.78E+21	5.88E+21	5.92E+21	5.92E+21
	1.71E+20	1.78E+20	3.66E+20	6.73E+20	1.22E+21	1.38E+21	1.45E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21
	2.19E+17	2.29E+17	4.91E+17	9.77E+17	2.21E+18	2.86E+18	3.27E+18	3.89E+18	4.00E+18	4.01E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18
	7.62E+16	7.96E+16	1.78E+17	3.81E+17	1.09E+18	1.70E+18	2.31E+18	4.72E+18	7.12E+18	9.51E+18	1.19E+19	1.48E+19	1.97E+19	2.35E+19	2.92E+19	3.48E+19	3.85E+19	4.57E+19	5.63E+19	6.48E+19	6.65E+19
	3.61E+18	3.72E+18	6.23E+18	8.47E+18	9.43E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18
	8.79E+17	9.19E+17	2.05E+18	4.39E+18	1.25E+19	1.95E+19	2.64E+19	5.37E+19	8.05E+19	1.07E+20	1.32E+20	1.64E+20	2.14E+20	2.53E+20	3.09E+20	3.62E+20	3.96E+20	4.60E+20	5.49E+20	6.16E+20	6.29E+20
	9.39E+19	9.81E+19	2.16E+20	4.53E+20	1.20E+21	1.75E+21	2.23E+21	3.60E+21	4.39E+21	4.84E+21	5.10E+21	5.28E+21	5.40E+21	5.43E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21
	1.53E+20	1.60E+20	3.56E+20	7.56E+20	2.10E+21	3.19E+21	4.22E+21	7.84E+21	1.08E+22	1.31E+22	1.50E+22	1.69E+22	1.91E+22	2.03E+22	2.15E+22	2.21E+22	2.24E+22	2.28E+22	2.30E+22	2.31E+22	2.31E+22
	2.69E+16	2.81E+16	6.27E+16	1.34E+17	3.84E+17	5.97E+17	8.10E+17	1.65E+18	2.49E+18	3.31E+18	4.11E+18	5.11E+18	6.73E+18	8.00E+18	9.84E+18	1.16E+19	1.28E+19	1.50E+19	1.82E+19	2.06E+19	2.11E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.65E+20	1.72E+20	3.69E+20	7.36E+20	1.67E+21	2.17E+21	2.49E+21	2.97E+21	3.05E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21
	2.59E+20	2.70E+20	5.27E+20	8.94E+20	1.35E+21	1.42E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21
	6.04E+18	6.24E+18	1.09E+19	1.56E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	6.57E+19	6.86E+19	1.53E+20	3.27E+20	9.31E+20	1.44E+21	1.94E+21	3.89E+21	5.73E+21	7.47E+21	9.12E+21	1.11E+22	1.40E+22	1.62E+22	1.90E+22	2.15E+22	2.30E+22	2.56E+22	2.87E+22	3.07E+22	3.11E+22
	1.31E+18	1.37E+18	3.06E+18	6.56E+18	1.88E+19	2.92E+19	3.97E+19	8.11E+19	1.22E+20	1.63E+20	2.03E+20	2.53E+20	3.34E+20	3.99E+20	4.93E+20	5.85E+20	6.45E+20	7.62E+20	9.31E+20	1.07E+21	1.09E+21
	3.98E+18	4.16E+18	9.29E+18	1.99E+19	5.71E+19	8.89E+19	1.21E+20	2.48E+20	3.75E+20	5.03E+20	6.30E+20	7.89E+20	1.05E+21	1.26E+21	1.58E+21	1.90E+21	2.11E+21	2.53E+21	3.16E+21	3.69E+21	3.79E+21
	6.83E+18	7.13E+18	1.58E+19	3.36E+19	9.28E+19	1.40E+20	1.85E+20	3.37E+20	4.56E+20	5.48E+20	6.19E+20	6.87E+20	7.61E+20	7.98E+20	8.31E+20	8.49E+20	8.56E+20	8.63E+20	8.67E+20	8.68E+20	8.68E+20
	4.18E+18	4.35E+18	9.14E+18	1.75E+19	3.54E+19	4.26E+19	4.62E+19	4.96E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19
	1.79E+19	1.87E+19	4.17E+19	8.94E+19	2.56E+20	3.97E+20	5.38E+20	1.10E+21	1.65E+21	2.18E+21	2.71E+21	3.36E+21	4.41E+21	5.23E+21	6.40E+21	7.53E+21	8.25E+21	9.63E+21	1.16E+22	1.30E+22	1.33E+22
	1.59E+19	1.66E+19	3.41E+19	6.29E+19	1.15E+20	1.31E+20	1.37E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.83E+18	1.91E+18	4.22E+18	8.86E+18	2.37E+19	3.50E+19	4.50E+19	7.50E+19	9.38E+19	1.05E+20	1.13E+20	1.18E+20	1.22E+20	1.24E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20
	6.08E+17	6.35E+17	1.42E+18	3.03E+18	8.67E+18	1.35E+19	1.82E+19	3.71E+19	5.56E+19	7.36E+19	9.13E+19	1.13E+20	1.48E+20	1.74E+20	2.13E+20	2.49E+20	2.72E+20	3.16E+20	3.76E+20	4.22E+20	4.30E+20
	2.07E+18	2.16E+18	4.76E+18	9.99E+18	2.67E+19	3.91E+19	5.01E+19	8.25E+19	1.02E+20	1.14E+20	1.21E+20	1.26E+20	1.30E+20	1.31E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20
	1.22E+17	1.28E+17	2.85E+17	6.11E+17	1.75E+18	2.73E+18	3.70E+18	7.59E+18	1.15E+19	1.54E+19	1.92E+19	2.40E+19	3.20E+19	3.84E+19	4.79E+19	5.74E+19	6.36E+19	7.61E+19	9.46E+19	1.10E+20	1.13E+20
	1.61E+19	1.68E+19	3.72E+19	7.88E+19	2.16E+20	3.25E+20	4.27E+20	7.65E+20	1.02E+21	1.20E+21	1.34E+21	1.47E+21	1.60E+21	1.66E+21	1.71E+21	1.73E+21	1.74E+21	1.75E+21	1.75E+21	1.75E+21	1.75E+21
	5.06E+13	5.29E+13	1.18E+14	2.53E+14	7.26E+14	1.13E+15	1.54E+15	3.16E+15	4.78E+15	6.40E+15	8.02E+15	1.00E+16	1.34E+16	1.61E+16	2.02E+16	2.42E+16	2.69E+16	3.23E+16	4.04E+16	4.72E+16	4.85E+16
	1.26E+13	1.27E+13	1.45E+13	1.82E+13	3.11E+13	4.22E+13	5.32E+13	9.75E+13	1.42E+14	1.86E+14	2.30E+14	2.86E+14	3.78E+14	4.52E+14	5.62E+14	6.73E+14	7.47E+14	8.94E+14	1.12E+15	1.30E+15	1.34E+15
	2.34E+12	2.49E+12	6.95E+12	1.62E+13	4.85E+13	7.62E+13	1.04E+14	2.15E+14	3.26E+14	4.36E+14	5.47E+14	6.86E+14	9.17E+14	1.10E+15	1.38E+15	1.66E+15	1.84E+15	2.21E+15	2.76E+15	3.23E+15	3.32E+15
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.78E+15	9.17E+15	2.05E+16	4.39E+16	1.26E+17	1.95E+17	2.65E+17	5.41E+17	8.14E+17	1.08E+18	1.35E+18	1.68E+18	2.22E+18	2.64E+18	3.25E+18	3.85E+18	4.24E+18	4.99E+18	6.07E+18	6.92E+18	7.08E+18
	5.34E+17	5.56E+17	1.12E+18	2.00E+18	3.36E+18	3.68E+18	3.78E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18
	2.57E+17	2.68E+17	5.76E+17	1.15E+18	2.65E+18	3.47E+18	4.01E+18	4.87E+18	5.03E+18	5.06E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18
	2.32E+18	2.43E+18	5.42E+18	1.16E+19	3.32E+19	5.17E+19	7.01E+19	1.43E+20	2.16E+20	2.87E+20	3.58E+20	4.46E+20	5.89E+20	7.01E+20	8.66E+20	1.03E+21	1.13E+21	1.33E+21	1.63E+21	1.86E+21	1.90E+21
	5.57E+17	5.82E+17	1.27E+18	2.61E+18	6.53E+18	9.10E+18	1.11E+19	1.56E+19	1.73E+19	1.79E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	2.43E+18	2.54E+18	5.66E+18	1.21E+19	3.47E+19	5.39E+19	7.30E+19	1.49E+20	2.23E+20	2.95E+20	3.66E+20	4.53E+20	5.94E+20	7.02E+20	8.58E+20	1.01E+21	1.10E+21	1.28E+21	1.53E+21	1.72E+21	1.76E+21
	7.99E+18	8.34E+18	1.85E+19	3.88E+19	1.05E+20	1.56E+20	2.01E+20	3.43E+20	4.37E+20	5.00E+20	5.41E+20	5.73E+20	6.01E+20	6.11E+20	6.18E+20	6.20E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20
	1.07E+17	1.12E+17	2.27E+17	4.12E+17	7.22E+17	8.05E+17	8.34E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17
	4.48E+18	4.64E+18	8.28E+18	1.22E+19	1.48E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.82E+17	1.90E+17	4.23E+17	9.04E+17	2.57E+18	3.97E+18	5.35E+18	1.07E+19	1.56E+19	2.03E+19	2.47E+19	2.98E+19	3.75E+19	4.30E+19	5.01E+19	5.63E+19	5.98E+19	6.60E+19	7.30E+19	7.74E+19	7.82E+19
	1.89E+13	1.98E+13	4.41E+13	9.44E+13	2.71E+14	4.22E+14	5.73E+14	1.18E+15	1.78E+15	2.38E+15	2.99E+15	3.74E+15	5.00E+15	6.01E+15	7.52E+15	9.03E+15	1.00E+16	1.20E+16	1.51E+16	1.76E+16	1.81E+16
	2.82E+14	2.94E+14	6.57E+14	1.41E+15	4.03E+15	6.28E+15	8.53E+15	1.75E+16	2.64E+16	3.53E+16	4.41E+16	5.51E+16	7.33E+16	8.78E+16	1.09E+17	1.31E+17	1.45E+17	1.72E+17	2.13E+17	2.47E+17	2.53E+17
	2.73E+13	2.86E+13	6.38E+13	1.37E+14	3.92E+14	6.10E+14	8.29E+14	1.70E+15	2.58E+15	3.45E+15	4.33E+15	5.42E+15	7.24E+15	8.70E+15	1.09E+16	1.31E+16	1.45E+16	1.74E+16	2.18E+16	2.54E+16	2.62E+16
	3.92E+22	4.09E+22	8.30E+22	1.49E+23	2.85E+23	3.57E+23	4.11E+23	5.66E+23	6.82E+23	7.81E+23	8.71E+23	9.73E+23	1.13E+24	1.24E+24	1.39E+24	1.53E+24	1.61E+24	1.77E+24	1.98E+24	2.15E+24	2.18E+24

Total Integrated Gamma Energy in Containment at Given Timesteps (MeV/cm³)

3.96E+12	4.12E+12	8.37E+12	1.51E+13	2.88E+13	3.59E+13	4.15E+13	5.71E+13	6.88E+13	7.88E+13	8.78E+13	9.81E+13	1.14E+14	1.25E+14	1.40E+14	1.54E+14	1.62E+14	1.78E+14	2.00E+14	2.17E+14	2.20E+14

Beta Particle Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	3.37E+19	3.52E+19	8.01E+19	1.73E+20	4.98E+20	7.77E+20	1.06E+21	2.17E+21	3.28E+21	4.40E+21	5.51E+21	6.90E+21	9.22E+21	1.11E+22	1.39E+22	1.66E+22	1.85E+22	2.22E+22	2.78E+22	3.24E+22	3.33E+22
	5.17E+20	5.39E+20	1.12E+21	2.09E+21	3.86E+21	4.40E+21	4.62E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21	4.76E+21
	3.36E+21	3.47E+21	5.99E+21	8.40E+21	9.59E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21	9.62E+21
	1.98E+21	2.06E+21	4.10E+21	7.06E+21	1.09E+22	1.16E+22	1.17E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22	1.18E+22
	1.86E+21	1.95E+21	4.42E+21	9.49E+21	2.68E+22	4.11E+22	5.50E+22	1.06E+23	1.51E+23	1.90E+23	2.24E+23	2.61E+23	3.11E+23	3.42E+23	3.77E+23	4.02E+23	4.15E+23	4.34E+23	4.50E+23	4.57E+23	4.58E+23
	2.05E+21	2.15E+21	4.68E+21	9.36E+21	2.11E+22	2.72E+22	3.11E+22	3.67E+22	3.76E+22	3.77E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22	3.78E+22
	4.56E+20	4.79E+20	1.14E+21	2.49E+21	7.16E+21	1.11E+22	1.49E+22	2.94E+22	4.27E+22	5.49E+22	6.61E+22	7.88E+22	9.71E+22	1.10E+23	1.25E+23	1.38E+23	1.45E+23	1.56E+23	1.68E+23	1.75E+23	1.76E+23
	1.16E+21	1.21E+21	2.42E+21	4.04E+21	5.76E+21	5.95E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21
	2.03E+21	2.13E+21	4.96E+21	1.05E+22	2.74E+22	3.90E+22	4.85E+22	7.22E+22	8.28E+22	8.76E+22	8.97E+22	9.09E+22	9.14E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22
	1.21E+21	1.25E+21	1.96E+21	2.45E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21
	1.55E+21	1.62E+21	3.62E+21	7.17E+21	1.51E+22	1.85E+22	2.03E+22	2.22E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22
	3.31E+18	3.49E+18	8.41E+18	1.86E+19	5.39E+19	8.38E+19	1.14E+20	2.30E+20	3.41E+20	4.49E+20	5.53E+20	6.77E+20	8.72E+20	1.02E+21	1.22E+21	1.40E+21	1.52E+21	1.72E+21	1.99E+21	2.18E+21	2.21E+21
	8.72E+19	9.17E+19	2.21E+20	4.90E+20	1.43E+21	2.23E+21	3.04E+21	6.25E+21	9.46E+21	1.27E+22	1.59E+22	1.99E+22	2.65E+22	3.19E+22	3.98E+22	4.78E+22	5.31E+22	6.36E+22	7.94E+22	9.25E+22	9.51E+22
	1.54E+19	1.62E+19	3.91E+19	8.64E+19	2.50E+20	3.88E+20	5.25E+20	1.05E+21	1.55E+21	2.03E+21	2.48E+21	3.01E+21	3.82E+21	4.41E+21	5.20E+21	5.89E+21	6.30E+21	7.02E+21	7.90E+21	8.46E+21	8.56E+21
	5.92E+19	6.22E+19	1.50E+20	3.32E+20	9.69E+20	1.52E+21	2.06E+21	4.25E+21	6.43E+21	8.62E+21	1.08E+22	1.35E+22	1.81E+22	2.17E+22	2.72E+22	3.26E+22	3.63E+22	4.35E+22	5.45E+22	6.35E+22	6.54E+22
	1.57E+19	1.64E+19	3.65E+19	7.75E+19	2.17E+20	3.30E+20	4.39E+20	8.27E+20	1.15E+21	1.42E+21	1.65E+21	1.88E+21	2.17E+21	2.33E+21	2.50E+21	2.61E+21	2.65E+21	2.72E+21	2.76E+21	2.78E+21	2.78E+21
	4.29E+19	4.46E+19	9.15E+19	1.68E+20	3.05E+20	3.46E+20	3.61E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20
	1.01E+19	1.05E+19	2.26E+19	4.50E+19	1.02E+20	1.32E+20	1.51E+20	1.79E+20	1.84E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20
	3.13E+16	3.27E+16	7.30E+16	1.56E+17	4.48E+17	6.97E+17	9.46E+17	1.94E+18	2.92E+18	3.90E+18	4.87E+18	6.08E+18	8.07E+18	9.65E+18	1.20E+19	1.43E+19	1.58E+19	1.87E+19	2.31E+19	2.66E+19	2.73E+19
	3.28E+19	3.39E+19	5.67E+19	7.71E+19	8.58E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19
	4.72E+18	4.94E+18	1.10E+19	2.36E+19	6.74E+19	1.05E+20	1.42E+20	2.89E+20	4.33E+20	5.73E+20	7.11E+20	8.80E+20	1.15E+21	1.36E+21	1.66E+21	1.95E+21	2.13E+21	2.47E+21	2.95E+21	3.31E+21	3.38E+21
	9.52E+18	9.94E+18	2.19E+19	4.59E+19	1.22E+20	1.77E+20	2.26E+20	3.65E+20	4.45E+20	4.91E+20	5.17E+20	5.35E+20	5.47E+20	5.50E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20
	3.95E+19	4.12E+19	9.16E+19	1.95E+20	5.41E+20	8.21E+20	1.09E+21	2.02E+21	2.77E+21	3.38E+21	3.87E+21	4.36E+21	4.93E+21	5.23E+21	5.53E+21	5.70E+21	5.78E+21	5.86E+21	5.92E+21	5.94E+21	5.94E+21
	1.15E+20	1.20E+20	2.68E+20	5.74E+20	1.64E+21	2.55E+21	3.46E+21	7.07E+21	1.06E+22	1.41E+22	1.76E+22	2.18E+22	2.88E+22	3.42E+22	4.21E+22	4.97E+22	5.46E+22	6.42E+22	7.77E+22	8.82E+22	9.03E+22
	4.39E+18	4.58E+18	1.02E+19	2.19E+19	6.29E+19	9.80E+19	1.33E+20	2.73E+20	4.14E+20	5.54E+20	6.94E+20	8.70E+20	1.16E+21	1.40E+21	1.75E+21	2.10E+21	2.33E+21	2.80E+21	3.50E+21	4.08E+21	4.20E+21
	1.57E+20	1.64E+20	3.51E+20	7.00E+20	1.59E+21	2.06E+21	2.37E+21	2.82E+21	2.90E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21
	3.87E+19	4.03E+19	7.87E+19	1.34E+20	2.02E+20	2.13E+20	2.15E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20
	1.54E+20	1.59E+20	2.77E+20	3.96E+20	4.63E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20
	9.33E+19	9.75E+19	2.17E+20	4.65E+20	1.32E+21	2.05E+21	2.76E+21	5.52E+21	8.14E+21	1.06E+22	1.30E+22	1.57E+22	1.99E+22	2.29E+22	2.70E+22	3.06E+22	3.27E+22	3.64E+22	4.08E+22	4.36E+22	4.41E+22
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.52E+17	1.59E+17	3.55E+17	7.61E+17	2.18E+18	3.40E+18	4.62E+18	9.48E+18	1.43E+19	1.92E+19	2.41E+19	3.01E+19	4.03E+19	4.84E+19	6.05E+19	7.26E+19	8.07E+19	9.68E+19	1.21E+20	1.41E+20	1.45E+20
	1.73E+19	1.81E+19	4.02E+19	8.52E+19	2.35E+20	3.56E+20	4.69E+20	8.56E+20	1.16E+21	1.39E+21	1.57E+21	1.74E+21	1.93E+21	2.03E+21	2.11E+21	2.15E+21	2.17E+21	2.19E+21	2.20E+21	2.20E+21	2.20E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.50E+18	2.61E+18	5.83E+18	1.25E+19	3.57E+19	5.55E+19	7.52E+19	1.53E+20	2.30E+20	3.05E+20	3.79E+20	4.69E+20	6.16E+20	7.29E+20	8.93E+20	1.05E+21	1.15E+21	1.34E+21	1.61E+21	1.82E+21	1.86E+21
	8.17E+18	8.51E+18	1.75E+19	3.23E+19	5.91E+19	6.73E+19	7.06E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19
	1.53E+17	1.60E+17	3.57E+17	7.64E+17	2.19E+18	3.41E+18	4.63E+18	9.51E+18	1.44E+19	1.92E+19	2.41E+19	3.01E+19	4.02E+19	4.82E+19	6.02E+19	7.21E+19	8.00E+19	9.58E+19	1.19E+20	1.39E+20	1.42E+20
	3.58E+18	3.74E+18	8.27E+18	1.74E+19	4.65E+19	6.86E+19	8.81E+19	1.47E+20	1.84E+20	2.07E+20	2.21E+20	2.32E+20	2.40E+20	2.43E+20	2.44E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20
	1.14E+18	1.20E+18	2.67E+18	5.71E+18	1.63E+19	2.54E+19	3.44E+19	6.99E+19	1.05E+20	1.39E+20	1.72E+20	2.13E+20	2.78E+20	3.28E+20	4.00E+20	4.69E+20	5.12E+20	5.95E+20	7.08E+20	7.94E+20	8.10E+20
	3.10E+18	3.23E+18	7.14E+18	1.50E+19	4.00E+19	5.86E+19	7.51E+19	1.24E+20	1.53E+20	1.71E+20	1.81E+20	1.89E+20	1.95E+20	1.96E+20	1.97E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20
	5.28E+17	5.51E+17	1.23E+18	2.64E+18	7.56E+18	1.18E+19	1.60E+19	3.28E+19	4.96E+19	6.63E+19	8.30E+19	1.04E+20	1.38E+20	1.66E+20	2.07E+20	2.48E+20	2.75E+20	3.29E+20	4.09E+20	4.75E+20	4.88E+20
	1.07E+19	1.12E+19	2.49E+19	5.27E+19	1.45E+20	2.18E+20	2.85E+20	5.12E+20	6.80E+20	8.06E+20	8.99E+20	9.83E+20	1.07E+21	1.11E+21	1.14E+21	1.16E+21	1.16E+21	1.17E+21	1.17E+21	1.17E+21	1.17E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.70E+15	5.95E+15	1.33E+16	2.85E+16	8.17E+16	1.27E+17	1.73E+17	3.55E+17	5.37E+17	7.20E+17	9.02E+17	1.13E+18	1.51E+18	1.81E+18	2.27E+18	2.72E+18	3.03E+18	3.63E+18	4.54E+18	5.30E+18	5.45E+18
	2.12E+17	2.22E+17	4.92E+17	1.04E+18	2.88E+18	4.34E+18	5.72E+18	1.04E+19	1.40E+19	1.68E+19	1.89E+19	2.10E+19	2.31E+19	2.42E+19	2.52E+19	2.56E+19	2.58E+19	2.60E+19	2.61E+19	2.62E+19	2.62E+19
	1.46E+18	1.53E+18	3.41E+18	7.31E+18	2.09E+19	3.25E+19	4.41E+19	9.02E+19	1.36E+20	1.81E+20	2.25E+20	2.80E+20	3.69E+20	4.39E+20	5.42E+20	6.41E+20	7.06E+20	8.32E+20	1.01E+21	1.15E+21	1.18E+21
	3.07E+18	3.19E+18	6.42E+18	1.15E+19	1.93E+19	2.11E+19	2.17E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19
	3.38E+18	3.52E+18	7.58E+18	1.52E+19	3.49E+19	4.56E+19	5.28E+19	6.41E+19	6.62E+19	6.67E+19	6.67E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19
	3.67E+17	3.84E+17	8.57E+17	1.83E+18	5.25E+18	8.17E+18	1.11E+19	2.27E+19	3.41E+19	4.54E+19	5.66E+19	7.05E+19	9.31E+19	1.11E+20	1.37E+20	1.62E+20	1.79E+20	2.11E+20	2.57E+20	2.93E+20	3.01E+20
	2.15E+18	2.25E+18	4.91E+18	1.01E+19	2.52E+19	3.51E+19	4.29E+19	6.03E+19	6.68E+19	6.93E+19	7.02E+19	7.06E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19
	1.38E+17	1.44E+17	3.22E+17	6.89E+17	1.97E+18	3.06E+18	4.15E+18	8.44E+18	1.26E+19	1.68E+19	2.08E+19	2.58E+19	3.37E+19	3.99E+19	4.87E+19	5.72E+19	6.26E+19	7.28E+19	8.70E+19	9.78E+19	9.99E+19
	1.82E+18	1.90E+18	4.20E+18	8.85E+18	2.39E+19	3.54E+19	4.58E+19	7.82E+19	9.96E+19	1.14E+20	1.23E+20	1.31E+20	1.37E+20	1.39E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	2.39E+18	2.48E+18	5.05E+18	9.16E+18	1.60E+19	1.79E+19	1.85E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19
	1.39E+18	1.44E+18	2.57E+18	3.81E+18	4.62E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18
	9.52E+17	9.95E+17	2.22E+18	4.74E+18	1.35E+19	2.09E+19	2.82E+19	5.65E+19	8.34E+19	1.09E+20	1.33E+20	1.62E+20	2.06E+20	2.38E+20	2.81E+20	3.19E+20	3.41E+20	3.81E+20	4.30E+20	4.62E+20	4.67E+20
	3.01E+17	3.15E+17	7.02E+17	1.50E+18	4.26E+18	6.59E+18	8.88E+18	1.77E+19	2.59E+19	3.37E+19	4.10E+19	4.95E+19	6.22E+19	7.13E+19	8.32E+19	9.33E+19	9.93E+19	1.09E+20	1.21E+20	1.28E+20	1.30E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.72E+22	1.79E+22	3.66E+22	6.74E+22	1.41E+23	1.87E+23	2.24E+23	3.38E+23	4.23E+23	4.95E+23	5.57E+23	6.25E+23	7.21E+23	7.86E+23	8.68E+23	9.36E+23	9.75E+23	1.04E+24	1.12E+24	1.18E+24	1.19E+24

Total Integrated Beta Energy in Containment at Given Timesteps (MeV/cm³)

	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	1.73E+12	1.80E+12	3.69E+12	6.80E+12	1.42E+13	1.88E+13	2.26E+13	3.41E+13	4.27E+13	4.99E+13	5.61E+13	6.30E+13	7.27E+13	7.93E+13	8.75E+13	9.44E+13	9.83E+13	1.05E+14	1.13E+14	1.19E+14	1.20E+14

Class	Isotopic Nuclide	24 Hours	96 Hours	720 Hours	24 Hours	96 Hours	720 Hours	
9	Am-241	1.31E-02	5.47E-02	4.15E-01	1.10E+02	4.56E+02	3.46E+03	
6	Ba-139	4.41E+02	4.41E+02	4.41E+02	3.68E+06	3.68E+06	3.68E+06	
6	Ba-140	9.05E+03	3.48E+04	1.45E+05	7.55E+07	2.90E+08	1.21E+09	
8	Ce-141	2.11E+02	8.52E+02	4.98E+03	1.76E+06	7.11E+06	4.16E+07	
8	Ce-143	1.53E+02	3.48E+02	4.03E+02	1.28E+06	2.90E+06	3.36E+06	
8	Ce-144	1.81E+02	7.49E+02	5.51E+03	1.51E+06	6.25E+06	4.60E+07	
9	Cm-242	5.96E+00	2.47E+01	1.77E+02	4.97E+04	2.06E+05	1.48E+06	
9	Cm-244	1.15E+00	4.79E+00	3.63E+01	9.59E+03	3.99E+04	3.03E+05	8.343E+03
7	Co-58	3.63E+00	1.49E+01	9.98E+01	3.03E+04	1.24E+05	8.33E+05	
7	Co-60	4.36E+00	1.82E+01	1.37E+02	3.64E+04	1.52E+05	1.14E+06	
3	Cs-134	1.14E+04	4.75E+04	3.56E+05	9.49E+07	3.96E+08	2.97E+09	
3	Cs-136	3.38E+03	1.31E+04	5.51E+04	2.82E+07	1.09E+08	4.60E+08	
3	Cs-137	1.01E+04	4.24E+04	3.21E+05	8.46E+07	3.53E+08	2.68E+09	
2	I-131	7.24E+04	2.67E+05	8.56E+05	6.04E+08	2.23E+09	7.14E+09	
2	I-132	1.11E+04	1.11E+04	1.11E+04	9.22E+07	9.23E+07	9.23E+07	
2	I-133	1.05E+05	1.90E+05	1.99E+05	8.79E+08	1.59E+09	1.66E+09	
2	I-134	3.76E+03	3.76E+03	3.76E+03	3.13E+07	3.13E+07	3.13E+07	
2	I-135	4.96E+04	5.47E+04	5.47E+04	4.14E+08	4.56E+08	4.56E+08	
1	Kr-85	3.56E+03	1.48E+04	1.12E+05	2.97E+07	1.24E+08	9.37E+08	
1	Kr-85m	1.45E+04	1.49E+04	1.49E+04	1.21E+08	1.25E+08	1.25E+08	
1	Kr-87	5.34E+03	5.34E+03	5.34E+03	4.45E+07	4.45E+07	4.45E+07	
1	Kr-88	2.35E+04	2.36E+04	2.36E+04	1.96E+08	1.97E+08	1.97E+08	
9	La-140	7.85E+01	1.95E+02	2.42E+02	6.55E+05	1.63E+06	2.02E+06	
9	La-141	1.66E+01	1.69E+01	1.69E+01	1.39E+05	1.41E+05	1.41E+05	
9	La-142	4.68E+00	4.68E+00	4.68E+00	3.91E+04	3.91E+04	3.91E+04	
7	Mo-99	1.04E+03	3.10E+03	4.91E+03	8.71E+06	2.58E+07	4.10E+07	
9	Nb-95	8.70E+01	3.52E+02	2.10E+03	7.26E+05	2.94E+06	1.75E+07	
9	Nd-147	3.32E+01	1.26E+02	4.86E+02	2.77E+05	1.05E+06	4.05E+06	
8	Np-239	2.72E+03	7.68E+03	1.12E+04	2.27E+07	6.40E+07	9.32E+07	
9	Pr-143	7.51E+01	2.90E+02	1.24E+03	6.26E+05	2.42E+06	1.04E+07	
8	Pu-238	1.22E+00	5.09E+00	3.86E+01	1.02E+04	4.25E+04	3.22E+05	
8	Pu-239	5.86E-02	2.05E-01	1.47E+00	4.89E+02	1.71E+03	1.23E+04	
8	Pu-240	1.26E-01	5.28E-01	4.01E+00	1.05E+03	4.40E+03	3.35E+04	
8	Pu-241	2.45E+01	1.02E+02	7.71E+02	2.04E+05	8.49E+05	6.43E+06	
3	Rb-86	1.11E+02	4.39E+02	2.16E+03	9.26E+05	3.66E+06	1.80E+07	
7	Rh-105	4.93E+02	1.16E+03	1.37E+03	4.11E+06	9.64E+06	1.14E+07	
7	Ru-103	9.89E+02	4.01E+03	2.45E+04	8.25E+06	3.35E+07	2.04E+08	
7	Ru-105	1.52E+02	1.57E+02	1.57E+02	1.27E+06	1.31E+06	1.31E+06	
7	Ru-106	3.71E+02	1.54E+03	1.14E+04	3.10E+06	1.29E+07	9.52E+07	
4	Sb-127	9.90E+02	3.21E+03	6.28E+03	8.26E+06	2.68E+07	5.24E+07	
4	Sb-129	8.88E+02	9.12E+02	9.12E+02	7.41E+06	7.61E+06	7.61E+06	
5	Sr-89	4.94E+03	2.02E+04	1.29E+05	4.12E+07	1.68E+08	1.08E+09	
5	Sr-90	6.29E+02	2.62E+03	1.98E+04	5.25E+06	2.18E+07	1.66E+08	
5	Sr-91	2.77E+03	3.42E+03	3.43E+03	2.31E+07	2.86E+07	2.86E+07	
5	Sr-92	8.28E+02	8.30E+02	8.30E+02	6.90E+06	6.92E+06	6.92E+06	
7	Tc-99m	3.24E+02	3.50E+02	3.50E+02	2.70E+06	2.92E+06	2.92E+06	
4	Te-127	4.72E+02	5.78E+02	5.79E+02	3.94E+06	4.83E+06	4.83E+06	
4	Te-127m	1.81E+02	7.45E+02	5.21E+03	1.51E+06	6.22E+06	4.35E+07	
4	Te-129	1.39E+02	1.39E+02	1.39E+02	1.16E+06	1.16E+06	1.16E+06	
4	Te-129m	7.73E+02	3.12E+03	1.84E+04	6.45E+06	2.61E+07	1.54E+08	
4	Te-131m	1.89E+03	4.11E+03	4.63E+03	1.58E+07	3.43E+07	3.86E+07	
4	Te-132	1.63E+04	5.08E+04	8.93E+04	1.36E+08	4.24E+08	7.45E+08	
1	Xe-133	4.81E+05	1.66E+06	4.01E+06	4.02E+09	1.39E+10	3.35E+10	
1	Xe-135	5.97E+04	7.24E+04	7.25E+04	4.98E+08	6.04E+08	6.05E+08	
9	Y-90	5.68E+00	1.67E+01	2.60E+01	4.74E+04	1.39E+05	2.17E+05	
9	Y-91	6.42E+01	2.63E+02	1.72E+03	5.36E+05	2.19E+06	1.43E+07	
9	Y-92	1.16E+01	1.18E+01	1.18E+01	9.71E+04	9.82E+04	9.82E+04	
9	Y-93	2.36E+01	2.98E+01	2.98E+01	1.97E+05	2.48E+05	2.49E+05	
9	Zr-95	8.68E+01	3.56E+02	2.35E+03	7.24E+05	2.97E+06	1.96E+07	
9	Zr-97	5.10E+01	8.23E+01	8.40E+01	4.25E+05	6.86E+05	7.01E+05	

Class	Isotopic Nuclide	24 Hours	96 Hours	720 Hours	24 Hours	96 Hours	720 Hours	
9	Am-241	3.19E-02	1.33E-01	1.01E+00	1.10E+02	4.56E+02	3.46E+03	
6	Ba-139	1.07E+03	1.07E+03	1.07E+03	3.68E+06	3.68E+06	3.68E+06	
6	Ba-140	2.20E+04	8.46E+04	3.52E+05	7.55E+07	2.90E+08	1.21E+09	
8	Ce-141	5.14E+02	2.07E+03	1.21E+04	1.76E+06	7.11E+06	4.16E+07	
8	Ce-143	3.72E+02	8.46E+02	9.80E+02	1.28E+06	2.90E+06	3.36E+06	3.43E+03
8	Ce-144	4.39E+02	1.82E+03	1.34E+04	1.51E+06	6.25E+06	4.60E+07	
9	Cm-242	1.45E+01	6.00E+01	4.31E+02	4.97E+04	2.06E+05	1.48E+06	
9	Cm-244	2.80E+00	1.16E+01	8.82E+01	9.59E+03	3.99E+04	3.03E+05	
7	Co-58	8.83E+00	3.62E+01	2.43E+02	3.03E+04	1.24E+05	8.33E+05	
7	Co-60	1.06E+01	4.42E+01	3.34E+02	3.64E+04	1.52E+05	1.14E+06	
3	Cs-134	2.77E+04	1.16E+05	8.67E+05	9.49E+07	3.96E+08	2.97E+09	
3	Cs-136	8.22E+03	3.18E+04	1.34E+05	2.82E+07	1.09E+08	4.60E+08	
3	Cs-137	2.47E+04	1.03E+05	7.82E+05	8.46E+07	3.53E+08	2.68E+09	
2	I-131	1.76E+05	6.50E+05	2.08E+06	6.04E+08	2.23E+09	7.14E+09	
2	I-132	2.69E+04	2.69E+04	2.69E+04	9.22E+07	9.23E+07	9.23E+07	
2	I-133	2.56E+05	4.63E+05	4.83E+05	8.79E+08	1.59E+09	1.66E+09	
2	I-134	9.14E+03	9.14E+03	9.14E+03	3.13E+07	3.13E+07	3.13E+07	
2	I-135	1.21E+05	1.33E+05	1.33E+05	4.14E+08	4.56E+08	4.56E+08	
9	La-140	1.91E+02	4.74E+02	5.89E+02	6.55E+05	1.63E+06	2.02E+06	
9	La-141	4.04E+01	4.12E+01	4.12E+01	1.39E+05	1.41E+05	1.41E+05	
9	La-142	1.14E+01	1.14E+01	1.14E+01	3.91E+04	3.91E+04	3.91E+04	
7	Mo-99	2.54E+03	7.54E+03	1.20E+04	8.71E+06	2.58E+07	4.10E+07	
9	Nb-95	2.12E+02	8.57E+02	5.10E+03	7.26E+05	2.94E+06	1.75E+07	
9	Nd-147	8.09E+01	3.07E+02	1.18E+03	2.77E+05	1.05E+06	4.05E+06	
8	Np-239	6.62E+03	1.87E+04	2.72E+04	2.27E+07	6.40E+07	9.32E+07	
9	Pr-143	1.83E+02	7.06E+02	3.03E+03	6.26E+05	2.42E+06	1.04E+07	
8	Pu-238	2.97E+00	1.24E+01	9.39E+01	1.02E+04	4.25E+04	3.22E+05	
8	Pu-239	1.42E-01	4.98E-01	3.58E+00	4.89E+02	1.71E+03	1.23E+04	
8	Pu-240	3.06E-01	1.28E+00	9.76E+00	1.05E+03	4.40E+03	3.35E+04	
8	Pu-241	5.95E+01	2.48E+02	1.88E+03	2.04E+05	8.49E+05	6.43E+06	
3	Rb-86	2.70E+02	1.07E+03	5.26E+03	9.26E+05	3.66E+06	1.80E+07	
7	Rh-105	1.20E+03	2.81E+03	3.33E+03	4.11E+06	9.64E+06	1.14E+07	
7	Ru-103	2.41E+03	9.76E+03	5.95E+04	8.25E+06	3.35E+07	2.04E+08	
7	Ru-105	3.70E+02	3.81E+02	3.81E+02	1.27E+06	1.31E+06	1.31E+06	
7	Ru-106	9.03E+02	3.75E+03	2.78E+04	3.10E+06	1.29E+07	9.52E+07	
4	Sb-127	2.41E+03	7.81E+03	1.53E+04	8.26E+06	2.68E+07	5.24E+07	
4	Sb-129	2.16E+03	2.22E+03	2.22E+03	7.41E+06	7.61E+06	7.61E+06	
5	Sr-89	1.20E+04	4.91E+04	3.14E+05	4.12E+07	1.68E+08	1.08E+09	
5	Sr-90	1.53E+03	6.37E+03	4.83E+04	5.25E+06	2.18E+07	1.66E+08	
5	Sr-91	6.75E+03	8.33E+03	8.34E+03	2.31E+07	2.86E+07	2.86E+07	
5	Sr-92	2.01E+03	2.02E+03	2.02E+03	6.90E+06	6.92E+06	6.92E+06	
7	Tc-99m	7.89E+02	8.51E+02	8.51E+02	2.70E+06	2.92E+06	2.92E+06	
4	Te-127	1.15E+03	1.41E+03	1.41E+03	3.94E+06	4.83E+06	4.83E+06	
4	Te-127m	4.40E+02	1.81E+03	1.27E+04	1.51E+06	6.22E+06	4.35E+07	
4	Te-129	3.38E+02	3.38E+02	3.38E+02	1.16E+06	1.16E+06	1.16E+06	
4	Te-129m	1.88E+03	7.60E+03	4.48E+04	6.45E+06	2.61E+07	1.54E+08	
4	Te-131m	4.60E+03	1.00E+04	1.13E+04	1.58E+07	3.43E+07	3.86E+07	
4	Te-132	3.97E+04	1.24E+05	2.17E+05	1.36E+08	4.24E+08	7.45E+08	
9	Y-90	1.38E+01	4.06E+01	6.33E+01	4.74E+04	1.39E+05	2.17E+05	
9	Y-91	1.56E+02	6.40E+02	4.18E+03	5.36E+05	2.19E+06	1.43E+07	
9	Y-92	2.83E+01	2.86E+01	2.86E+01	9.71E+04	9.82E+04	9.82E+04	
9	Y-93	5.73E+01	7.24E+01	7.25E+01	1.97E+05	2.48E+05	2.49E+05	
9	Zr-95	2.11E+02	8.66E+02	5.73E+03	7.24E+05	2.97E+06	1.96E+07	
9	Zr-97	1.24E+02	2.00E+02	2.04E+02	4.25E+05	6.86E+05	7.01E+05	

ADDITIONAL ATTACHMENTS TO
10-10-05 Letter: Supplement to Request for LAR Application of AST
Attachment 004 AST – LM-0642 Rev 1 pH Att B (Pages 10-13)

Class	Isotopic Nuclide	Decay Constant (hours)^-1	Release Fractions 0-0.5 hours	Release Fractions 0.5-2 hours	Initial Core Activity (Ci)	Gap Release Activity in Containment at 0.5 hours (Ci)	Gap Release Time Integrated Activity in Containment through 0.5 hours (Ci-hours)	Early In-vessel Release Activity in Containment at 2.0 hours (Ci)	Early In-vessel Release Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Time Integrated Activity in Containment through 2.0 hours (Ci-hours)	TOTAL Activity in Containment at 2.0 hours (Ci)	Gamma *(Photon)* Emission Energy (MeV/decay)	Gamma *(Photon)* Emission Energy per Unit of Activity (MeV/Ci-hour)	Beta Particle Emission Energy (MeV/decay)	Beta Particle Emission Energy per Unit of Activity (MeV/Ci-hour)
2	I-131	3.592E-03	0.05	0.25	9.479E+07	4.73E+06	1.18E+06	2.35E+07	1.77E+07	1.89E+07	2.82E+07	3.81E-01	5.08E+13	1.81E-01	2.42E+13
2	I-132	3.014E-01	0.05	0.25	1.369E+08	5.89E+06	1.55E+06	1.87E+07	1.64E+07	1.80E+07	2.25E+07	2.29E+00	3.05E+14	4.86E-01	6.47E+13
2	I-133	3.332E-02	0.05	0.25	1.960E+08	9.64E+06	2.42E+06	4.58E+07	3.50E+07	3.74E+07	5.50E+07	6.07E-01	8.08E+13	4.07E-01	5.42E+13
2	I-134	7.907E-01	0.05	0.25	2.175E+08	7.32E+06	2.10E+06	1.12E+07	1.30E+07	1.51E+07	1.34E+07	2.63E+00	3.50E+14	6.03E-01	8.03E+13
2	I-135	1.049E-01	0.05	0.25	1.832E+08	8.69E+06	2.21E+06	3.71E+07	2.94E+07	3.16E+07	4.46E+07	1.58E+00	2.10E+14	3.68E-01	4.91E+13
3	Rb-86	1.548E-03	0.05	0.20	2.300E+05	1.15E+04	2.87E+03	4.58E+04	3.44E+04	3.73E+04	5.73E+04	9.45E-02	1.26E+13	6.67E-01	8.89E+13
3	Cs-134	3.835E-05	0.05	0.20	2.569E+07	1.28E+06	3.21E+05	5.14E+06	3.85E+06	4.17E+06	6.42E+06	1.56E+00	2.07E+14	1.57E-01	2.09E+13
3	Cs-136	2.205E-03	0.05	0.20	7.150E+06	3.57E+05	8.93E+04	1.42E+06	1.07E+06	1.16E+06	1.78E+06	2.17E+00	2.89E+14	1.00E-01	1.33E+13
3	Cs-137	2.636E-06	0.05	0.20	1.601E+07	8.00E+05	2.00E+05	3.20E+06	2.40E+06	2.60E+06	4.00E+06	0.00E+00	0.00E+00	1.71E-01	2.27E+13
4	Sb-127	7.502E-03	0.00	0.05	1.022E+07	0.00E+00	0.00E+00	5.03E+05	3.79E+05	3.79E+05	5.03E+05	6.62E-01	8.82E+13	3.11E-01	4.14E+13
4	Sb-129	1.605E-01	0.00	0.05	3.047E+07	0.00E+00	0.00E+00	1.11E+06	9.00E+05	9.00E+05	1.11E+06	1.43E+00	1.90E+14	3.58E-01	4.76E+13
4	Te-127	7.413E-02	0.00	0.05	1.014E+07	0.00E+00	0.00E+00	4.37E+05	3.40E+05	3.40E+05	4.37E+05	4.84E-03	6.44E+11	2.23E-01	2.97E+13
4	Te-127m	2.650E-04	0.00	0.05	1.360E+06	0.00E+00	0.00E+00	6.80E+04	5.10E+04	5.10E+04	6.80E+04	1.12E-02	1.50E+12	4.61E-03	6.13E+11
4	Te-129	5.975E-01	0.00	0.05	2.999E+07	0.00E+00	0.00E+00	4.54E+05	4.70E+05	4.70E+05	4.54E+05	5.77E-02	7.68E+12	5.25E-01	6.99E+13
4	Te-129m	8.596E-04	0.00	0.05	4.470E+06	0.00E+00	0.00E+00	2.23E+05	1.67E+05	1.67E+05	2.23E+05	3.94E-02	5.25E+12	2.12E-01	2.82E+13
4	Te-131m	2.310E-02	0.00	0.05	1.365E+07	0.00E+00	0.00E+00	6.52E+05	4.94E+05	4.94E+05	6.52E+05	1.43E+00	1.90E+14	1.45E-01	1.92E+13
4	Te-132	8.864E-03	0.00	0.05	1.348E+08	0.00E+00	0.00E+00	6.62E+06	4.99E+06	4.99E+06	6.62E+06	2.31E-01	3.07E+13	5.94E-02	7.91E+12
5	Sr-89	5.719E-04	0.00	0.02	9.873E+07	0.00E+00	0.00E+00	1.97E+06	1.48E+06	1.48E+06	1.97E+06	1.36E-04	1.82E+10	5.83E-01	7.76E+13
5	Sr-90	2.715E-06	0.00	0.02	1.121E+07	0.00E+00	0.00E+00	2.24E+05	1.68E+05	1.68E+05	2.24E+05	0.00E+00	0.00E+00	1.96E-01	2.61E+13
5	Sr-91	7.296E-02	0.00	0.02	1.341E+08	0.00E+00	0.00E+00	2.32E+06	1.80E+06	1.80E+06	2.32E+06	6.87E-01	9.15E+13	6.53E-01	8.70E+13
5	Sr-92	2.558E-01	0.00	0.02	1.417E+08	0.00E+00	0.00E+00	1.70E+06	1.45E+06	1.45E+06	1.70E+06	1.34E+00	1.78E+14	2.00E-01	2.66E+13
6	Ba-139	5.029E-01	0.00	0.02	1.794E+08	0.00E+00	0.00E+00	1.31E+06	1.29E+06	1.29E+06	1.31E+06	3.53E-02	4.70E+12	8.97E-01	1.19E+14
6	Ba-140	2.267E-03	0.00	0.02	1.727E+08	0.00E+00	0.00E+00	3.44E+06	2.58E+06	2.58E+06	3.44E+06	1.91E-01	2.54E+13	2.71E-01	3.61E+13
7	Co-58	4.079E-04	0.00	0.0025	5.394E+06	0.00E+00	0.00E+00	1.35E+04	1.01E+04	1.01E+04	1.35E+04	9.76E-01	1.30E+14	0.00E+00	0.00E+00
7	Co-60	1.500E-05	0.00	0.0025	6.361E+06	0.00E+00	0.00E+00	1.59E+04	1.19E+04	1.19E+04	1.59E+04	2.51E+00	3.34E+14	9.58E-02	1.28E+13
7	Mo-99	1.050E-02	0.00	0.0025	1.792E+08	0.00E+00	0.00E+00	4.39E+05	3.31E+05	3.31E+05	4.39E+05	1.55E-01	2.06E+13	3.93E-01	5.24E+13
7	Tc-99m	1.151E-01	0.00	0.0025	1.569E+08	0.00E+00	0.00E+00	3.12E+05	2.48E+05	2.48E+05	3.12E+05	1.27E-01	1.69E+13	0.00E+00	0.00E+00
7	Ru-103	7.353E-04	0.00	0.0025	1.483E+08	0.00E+00	0.00E+00	3.70E+05	2.78E+05	2.78E+05	3.70E+05	4.84E-01	6.44E+13	6.75E-02	9.00E+12
7	Ru-105	1.561E-01	0.00	0.0025	1.026E+08	0.00E+00	0.00E+00	1.88E+05	1.52E+05	1.52E+05	1.88E+05	7.84E-01	1.04E+14	4.03E-01	5.36E+13
7	Ru-106	7.844E-05	0.00	0.0025	6.104E+07	0.00E+00	0.00E+00	1.53E+05	1.14E+05	1.14E+05	1.53E+05	0.00E+00	0.00E+00	1.00E-02	1.34E+12
7	Rh-105	1.960E-02	0.00	0.0025	9.709E+07	0.00E+00	0.00E+00	2.33E+05	1.77E+05	1.77E+05	2.33E+05	7.76E-02	1.03E+13	1.52E-01	2.03E+13
8	Ce-141	8.886E-04	0.00	0.0005	1.585E+08	0.00E+00	0.00E+00	7.91E+04	5.94E+04	5.94E+04	7.91E+04	7.69E-02	1.02E+13	1.45E-01	1.93E+13
8	Ce-143	2.100E-02	0.00	0.0005	1.562E+08	0.00E+00	0.00E+00	7.49E+04	5.68E+04	5.68E+04	7.49E+04	2.73E-01	3.64E+13	4.10E-01	5.46E+13
8	Ce-144	1.016E-04	0.00	0.0005	1.269E+08	0.00E+00	0.00E+00	6.34E+04	4.76E+04	4.76E+04	6.34E+04	1.93E-02	2.57E+12	8.33E-02	1.11E+13
8	Np-239	1.226E-02	0.00	0.0005	1.904E+09	0.00E+00	0.00E+00	9.29E+05	7.01E+05	7.01E+05	9.29E+05	1.72E-01	2.29E+13	1.15E-01	1.53E+13
8	Pu-238	9.012E-07	0.00	0.0005	6.336E+05	0.00E+00	0.00E+00	3.17E+02	2.38E+02	2.38E+02	3.17E+02	1.60E-03	2.13E+11	0.00E+00	0.00E+00
8	Pu-239	3.286E-09	0.00	0.0005	4.234E+04	0.00E+00	0.00E+00	2.12E+01	1.45E+02	1.45E+02	2.12E+01	6.54E-04	8.71E+10	0.00E+00	0.00E+00
8	Pu-240	1.210E-08	0.00	0.0005	4.543E+04	0.00E+00	0.00E+00	2.27E+01	1.15E+01	1.15E+01	2.27E+01	1.53E-03	2.03E+11	0.00E+00	0.00E+00
8	Pu-241	5.491E-06	0.00	0.0005	2.181E+07	0.00E+00	0.00E+00	1.09E+04	8.18E+03	8.18E+03	1.09E+04	0.00E+00	0.00E+00	5.23E-03	6.97E+11
9	Y-90	1.083E-02	0.00	0.0002	1.154E+07	0.00E+00	0.00E+00	2.26E+03	1.70E+03	1.70E+03	2.26E+03	0.00E+00	0.00E+00	9.35E-01	1.25E+14
9	Y-91	4.936E-04	0.00	0.0002	1.217E+08	0.00E+00	0.00E+00	2.43E+04	1.82E+04	1.82E+04	2.43E+04	3.61E-03	4.81E+11	6.02E-01	8.02E+13
9	Y-92	1.958E-01	0.00	0.0002	1.421E+08	0.00E+00	0.00E+00	1.92E+04	1.59E+04	1.59E+04	1.92E+04	2.52E-01	3.35E+13	1.44E+00	1.92E+14
9	Y-93	6.863E-02	0.00	0.0002	1.597E+08	0.00E+00	0.00E+00	2.78E+04	2.16E+04	2.16E+04	2.78E+04	8.91E-02	1.19E+13	1.17E+00	1.56E+14
9	Zr-95	4.514E-04	0.00	0.0002	1.584E+08	0.00E+00	0.00E+00	3.16E+04	2.37E+04	2.37E+04	3.16E+04	7.35E-01	9.79E+13	1.16E-01	1.55E+13
9	Zr-97	4.101E-02	0.00	0.0002	1.643E+08	0.00E+00	0.00E+00	3.03E+04	2.32E+04	2.32E+04	3.03E+04	1.81E-01	2.41E+13	6.97E-01	9.29E+13
9	Nb-95	8.217E-04	0.00	0.0002	1.592E+08	0.00E+00	0.00E+00	3.18E+04	2.38E+04	2.38E+04	3.18E+04	7.64E-01	1.02E+14	4.34E-02	5.79E+12
9	La-140	1.721E-02	0.00	0.0002	1.771E+08	0.00E+00	0.00E+00	3.42E+04	2.59E+04	2.59E+04	3.42E+04	2.32E+00	3.09E+14	5.27E-01	7.03E+13
9	La-141	1.764E-01	0.00	0.0002	1.637E+08	0.00E+00	0.00E+00	2.30E+04	1.89E+04	1.89E+04	2.30E+04	4.27E-02	5.69E+12	9.48E-01	1.26E+14
9	La-142	4.496E-01	0.00	0.0002	1.599E+08	0.00E+00	0.00E+00	1.30E+04	1.24E+04	1.24E+04	1.30E+04	2.72E+00	3.62E+14	8.46E-01	1.13E+14
9	Pr-143	2.130E-03	0.00	0.0002	1.515E+08	0.00E+00	0.00E+00	3.02E+04	2.26E+04	2.26E+04	3.02E+04	0.00E+00	0.00E+00	3.16E-01	4.20E+13
9	Nd-147	2.630E-03	0.00	0.0002	6.483E+07	0.00E+00	0.00E+00	1.29E+04	9.69E+03	9.69E+03	1.29E+04	1.41E-01	1.87E+13	2.33E-01	3.11E+13
9	Am-241	1.830E-07	0.00	0.0002	3.361E+04	0.00E+00	0.00E+00	6.72E+00	5.05E+00	5.05E+00	6.72E+00	2.81E-02	3.74E+12	0.00E+00	0.00E+00
9	Cm-242	1.774E-04	0.00	0.0002	8.424E+06	0.00E+00	0.00E+00	1.68E+03	1.26E+03	1.26E+03	1.68E+03	1.67E-03	2.23E+11	0.00E+00	0.00E+00
9	Cm-244	4.366E-06	0.00	0.0002	9.181E+05	0.00E+00	0.00E+00	1.84E+02	1.38E+02	1.38E+02	1.84E+02	1.49E-03	1.98E+11	0.00E+00	0.00E+00

Disintegrations per Curie-hour=	1.3320E+14
Suppression Pool Water Volume cm^3=	4.9554E+09
MeV/cm^3 to Mrad Conversion Factor=	1.6021E-14

Activity in Containment at Given Timesteps (Ci-hours)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	1.89E+07	1.98E+07	4.70E+07	1.03E+08	2.96E+08	4.58E+08	6.16E+08	1.22E+09	1.77E+09	2.27E+09	2.73E+09	3.26E+09	4.02E+09	4.54E+09	5.18E+09	5.71E+09	6.00E+09	6.47E+09	6.96E+09	7.24E+09	7.28E+09
	1.80E+07	1.87E+07	3.74E+07	6.24E+07	8.89E+07	9.20E+07	9.25E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07	9.26E+07
	3.74E+07	3.92E+07	9.15E+07	1.94E+08	5.05E+08	7.20E+08	8.95E+08	1.33E+09	1.53E+09	1.62E+09	1.66E+09	1.68E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09	1.69E+09
	1.51E+07	1.55E+07	2.44E+07	3.05E+07	3.20E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07	3.21E+07
	3.16E+07	3.31E+07	7.39E+07	1.46E+08	3.08E+08	3.77E+08	4.14E+08	4.53E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08	4.56E+08
	3.73E+04	3.92E+04	9.46E+04	2.09E+05	6.06E+05	9.43E+05	1.28E+06	2.58E+06	3.84E+06	5.05E+06	6.22E+06	7.62E+06	9.81E+06	1.14E+07	1.37E+07	1.58E+07	1.71E+07	1.94E+07	2.24E+07	2.45E+07	2.49E+07
	4.17E+06	4.39E+06	1.06E+07	2.34E+07	6.84E+07	1.07E+08	1.45E+08	2.99E+08	4.53E+08	6.07E+08	7.60E+08	9.52E+08	1.27E+09	1.53E+09	1.91E+09	2.29E+09	2.54E+09	3.05E+09	3.80E+09	4.43E+09	4.55E+09
	1.16E+06	1.22E+06	2.94E+06	6.48E+06	1.88E+07	2.91E+07	3.94E+07	7.90E+07	1.17E+08	1.52E+08	1.86E+08	2.26E+08	2.87E+08	3.31E+08	3.90E+08	4.42E+08	4.73E+08	5.27E+08	5.92E+08	6.35E+08	6.43E+08
	2.60E+06	2.74E+06	6.60E+06	1.46E+07	4.26E+07	6.66E+07	9.07E+07	1.87E+08	2.83E+08	3.79E+08	4.75E+08	5.95E+08	7.95E+08	9.55E+08	1.19E+09	1.43E+09	1.59E+09	1.91E+09	2.39E+09	2.79E+09	2.87E+09
	3.79E+05	3.96E+05	8.80E+05	1.87E+06	5.23E+06	7.97E+06	1.06E+07	2.00E+07	2.78E+07	3.43E+07	3.98E+07	4.54E+07	5.23E+07	5.62E+07	6.03E+07	6.29E+07	6.41E+07	6.56E+07	6.67E+07	6.71E+07	6.72E+07
	9.00E+05	9.37E+05	1.92E+06	3.53E+06	6.40E+06	7.26E+06	7.59E+06	7.78E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06	7.79E+06
	3.40E+05	3.55E+05	7.61E+05	1.52E+06	3.43E+06	4.44E+06	5.08E+06	6.04E+06	6.20E+06	6.23E+06	6.23E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06	6.24E+06
	5.10E+04	5.33E+04	1.19E+05	2.55E+05	7.30E+05	1.14E+06	1.54E+06	3.16E+06	4.76E+06	6.36E+06	7.95E+06	9.92E+06	1.32E+07	1.57E+07	1.95E+07	2.33E+07	2.57E+07	3.06E+07	3.76E+07	4.34E+07	4.45E+07
	4.70E+05	4.85E+05	8.11E+05	1.10E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06	1.23E+06
	1.67E+05	1.75E+05	3.90E+05	8.36E+05	2.39E+06	3.71E+06	5.03E+06	1.02E+07	1.53E+07	2.03E+07	2.52E+07	3.12E+07	4.08E+07	4.82E+07	5.88E+07	6.89E+07	7.54E+07	8.76E+07	1.04E+08	1.17E+08	1.20E+08
	4.94E+05	5.16E+05	1.14E+06	2.38E+06	6.31E+06	9.21E+06	1.17E+07	1.90E+07	2.31E+07	2.55E+07	2.69E+07	2.78E+07	2.84E+07	2.86E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07	2.87E+07
	4.99E+06	5.21E+06	1.16E+07	2.46E+07	6.84E+07	1.04E+08	1.37E+08	2.55E+08	3.50E+08	4.27E+08	4.90E+08	5.51E+08	6.23E+08	6.61E+08	6.99E+08	7.21E+08	7.30E+08	7.41E+08	7.48E+08	7.50E+08	7.51E+08
	1.48E+06	1.55E+06	3.45E+06	7.39E+06	2.11E+07	3.29E+07	4.46E+07	9.10E+07	1.37E+08	1.82E+08	2.27E+08	2.81E+08	3.71E+08	4.40E+08	5.42E+08	6.40E+08	7.04E+08	8.26E+08	1.00E+09	1.14E+09	1.16E+09
	1.68E+05	1.76E+05	3.92E+05	8.41E+05	2.41E+06	3.76E+06	5.10E+06	1.05E+07	1.59E+07	2.12E+07	2.66E+07	3.33E+07	4.46E+07	5.35E+07	6.70E+07	8.04E+07	8.94E+07	1.07E+08	1.34E+08	1.57E+08	1.61E+08
	1.80E+06	1.88E+06	4.04E+06	8.05E+06	1.83E+07	2.37E+07	2.72E+07	3.25E+07	3.34E+07	3.35E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07	3.36E+07
	1.45E+06	1.51E+06	2.95E+06	5.01E+06	7.58E+06	7.99E+06	8.08E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06	8.10E+06
	1.29E+06	1.33E+06	2.32E+06	3.32E+06	3.88E+06	3.89E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06	3.90E+06
	2.58E+06	2.70E+06	6.02E+06	1.29E+07	3.66E+07	5.66E+07	7.64E+07	1.53E+08	2.25E+08	2.94E+08	3.59E+08	4.35E+08	5.51E+08	6.35E+08	7.48E+08	8.46E+08	9.04E+08	1.01E+09	1.13E+09	1.21E+09	1.22E+09
	1.01E+04	1.06E+04	2.36E+04	5.05E+04	1.45E+05	2.25E+05	3.05E+05	6.24E+05	9.40E+05	1.25E+06	1.56E+06	1.95E+06	2.57E+06	3.07E+06	3.79E+06	4.50E+06	4.96E+06	5.86E+06	7.16E+06	8.20E+06	8.40E+06
	1.19E+04	1.25E+04	2.78E+04	5.96E+04	1.71E+05	2.66E+05	3.62E+05	7.43E+05	1.12E+06	1.51E+06	1.89E+06	2.36E+06	3.16E+06	3.79E+06	4.74E+06	5.69E+06	6.32E+06	7.59E+06	9.48E+06	1.11E+07	1.14E+07
	3.31E+05	3.45E+05	7.67E+05	1.63E+06	4.49E+06	6.79E+06	8.95E+06	1.63E+07	2.21E+07	2.65E+07	3.00E+07	3.33E+07	3.69E+07	3.87E+07	4.03E+07	4.11E+07	4.15E+07	4.18E+07	4.20E+07	4.21E+07	4.21E+07
	2.48E+05	2.58E+05	5.42E+05	1.04E+06	2.10E+06	2.52E+06	2.74E+06	2.94E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06	2.95E+06
	2.78E+05	2.90E+05	6.48E+05	1.39E+06	3.96E+06	6.16E+06	8.35E+06	1.70E+07	2.55E+07	3.39E+07	4.21E+07	5.22E+07	6.85E+07	8.11E+07	9.93E+07	1.17E+08	1.28E+08	1.49E+08	1.79E+08	2.02E+08	2.07E+08
	1.52E+05	1.59E+05	3.26E+05	6.02E+05	1.10E+06	1.26E+06	1.32E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06	1.35E+06
	1.14E+05	1.20E+05	2.67E+05	5.72E+05	1.64E+06	2.55E+06	3.47E+06	7.12E+06	1.08E+07	1.44E+07	1.80E+07	2.26E+07	3.01E+07	3.61E+07	4.51E+07	5.40E+07	5.99E+07	7.17E+07	8.92E+07	1.04E+08	1.07E+08
	1.77E+05	1.85E+05	4.08E+05	8.57E+05	2.30E+06	3.38E+06	4.35E+06	7.25E+06	9.06E+06	1.02E+07	1.09E+07	1.14E+07	1.18E+07	1.20E+07	1.20E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07	1.21E+07
	5.94E+04	6.20E+04	1.38E+05	2.96E+05	8.47E+05	1.32E+06	1.78E+06	3.62E+06	5.43E+06	7.19E+06	8.92E+06	1.10E+07	1.44E+07	1.70E+07	2.08E+07	2.43E+07	2.66E+07	3.09E+07	3.68E+07	4.12E+07	4.20E+07
	5.68E+04	5.93E+04	1.31E+05	2.74E+05	7.32E+05	1.07E+06	1.38E+06	2.27E+06	2.80E+06	3.13E+06	3.32E+06	3.46E+06	3.57E+06	3.60E+06	3.61E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06	3.62E+06
	4.76E+04	4.97E+04	1.11E+05	2.38E+05	6.81E+05	1.06E+06	1.44E+06	2.96E+06	4.47E+06	5.98E+06	7.49E+06	9.36E+06	1.25E+07	1.50E+07	1.87E+07	2.23E+07	2.48E+07	2.96E+07	3.68E+07	4.28E+07	4.40E+07
	7.01E+05	7.32E+05	1.62E+06	3.44E+06	9.44E+06	1.42E+07	1.86E+07	3.34E+07	4.43E+07	5.25E+07	5.86E+07	6.41E+07	6.98E+07	7.24E+07	7.45E+07	7.55E+07	7.59E+07	7.62E+07	7.64E+07	7.64E+07	7.64E+07
	2.38E+02	2.48E+02	5.54E+02	1.19E+03	3.41E+03	5.31E+03	7.21E+03	1.48E+04	2.24E+04	3.00E+04	3.76E+04	4.71E+04	6.30E+04	7.56E+04	9.46E+04	1.14E+05	1.26E+05	1.52E+05	1.90E+05	2.21E+05	2.28E+05
	1.45E+02	1.46E+02	1.66E+02	2.09E+02	3.57E+02	4.84E+02	6.11E+02	1.12E+03	1.63E+03	2.13E+03	2.64E+03	3.28E+03	4.34E+03	5.18E+03	6.45E+03	7.72E+03	8.57E+03	1.03E+04	1.28E+04	1.49E+04	1.53E+04
	1.15E+01	1.23E+01	3.42E+01	7.96E+01	2.39E+02	3.75E+02	5.11E+02	1.06E+03	1.60E+03	2.15E+03	2.69E+03	3.37E+03	4.51E+03	5.42E+03	6.78E+03	8.14E+03	9.05E+03	1.09E+04	1.36E+04	1.59E+04	1.63E+04
	8.18E+03	8.55E+03	1.91E+04	4.09E+04	1.17E+05	1.83E+05	2.48E+05	5.10E+05	7.71E+05	1.03E+06	1.29E+06	1.62E+06	2.17E+06	2.60E+06	3.26E+06	3.91E+06	4.34E+06	5.21E+06	6.52E+06	7.61E+06	7.82E+06
	1.70E+03	1.78E+03	3.95E+03	8.37E+03	2.31E+04	3.49E+04	4.59E+04	8.35E+04	1.13E+05	1.35E+05	1.52E+05	1.68E+05	1.86E+05	1.94E+05	2.02E+05	2.06E+05	2.07E+05	2.09E+05	2.10E+05	2.10E+05	2.10E+05
	1.82E+04	1.91E+04	4.25E+04	9.11E+04	2.61E+05	4.06E+05	5.50E+05	1.12E+06	1.69E+06	2.25E+06	2.80E+06	3.49E+06	4.60E+06	5.48E+06	6.75E+06	7.99E+06	8.80E+06	1.04E+07	1.26E+07	1.44E+07	1.47E+07
	1.59E+04	1.66E+04	3.34E+04	5.95E+04	1.00E+05	1.10E+05	1.13E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05	1.14E+05
	2.16E+04	2.26E+04	4.85E+04	9.71E+04	2.23E+05	2.92E+05	3.38E+05	4.10E+05	4.24E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05	4.27E+05
	2.37E+04	2.48E+04	5.54E+04	1.19E+05	3.40E+05	5.28E+05	7.17E+05	1.46E+06	2.20E+06	2.94E+06	3.66E+06	4.55E+06	6.02E+06	7.17E+06	8.85E+06	1.05E+07	1.16E+07	1.36E+07	1.66E+07	1.90E+07	1.94E+07
	2.32E+04	2.42E+04	5.28E+04	1.09E+05	2.72E+05	3.78E+05	4.62E+05	6.49E+05	7.19E+05	7.46E+05	7.55E+05	7.60E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05	7.61E+05
	2.38E+04	2.49E+04	5.56E+04	1.19E+05	3.40E+05	5.29E+05	7.17E+05	1.46E+06	2.19E+06	2.90E+06	3.60E+06	4.45E+06	5.83E+06	6.90E+06	8.43E+06	9.88E+06	1.08E+07	1.26E+07	1.50E+07	1.69E+07	1.73E+07
	2.59E+04	2.70E+04	5.98E+04	1.26E+05	3.40E+05	5.04E+05	6.52E+05	1.11E+06	1.42E+06	1.62E+06	1.75E+06	1.86E+06	1.95E+06	1.98E+06	2.00E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06	2.01E+06
	1.89E+04	1.97E+04	4.00E+04	7.25E+04	1.27E+05	1.42E+05	1.47E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05	1.49E+05
	1.24E+04	1.28E+04	2.29E+04	3.38E+04	4.10E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04	4.13E+04
	2.26E+04	2.37E+04	5.28E+04	1.13E+05	3.21E+05	4.97E+05	6.71E+05	1.34E+06	1.98E+06	2.59E+06	3.17E+06	3.85E+06	4.90E+06	5.65E+06	6.68E+06	7.58E+06	8.12E+06	9.07E+06	1.02E+07	1.10E+07	1.11E+07
	9.69E+03	1.01E+04	2.26E+04	4.82E+04	1.37E+05	2.12E+05	2.85E+05	5.69E+05	8.34E+05	1.08E+06	1.32E+06	1.59E+06	2.00E+06	2.29E+06	2.67E+06	3.00E+06	3.19E+06	3.52E+06	3.90E+06	4.13E+06	4.17E+06
	5.05E+00	5.28E+00	1.18E+01	2.52E+01	7.23E+01	1.13E+02	1.53E+02	3.14E+02	4.76E+02	6.37E+02	7.98E+02	1.00E+03	1.34E+03	1.61E+03	2.01E+03	2.41E+03	2.68E+03	3.22E+03	4.03E+03	4.70E+03	4.83E+03
	1.26E+03	1.32E+03	2.95E+03	6.31E+03	1.81E+04	2.82E+04	3.82E+04	7.84E+04	1.18E+05	1.58E+05	1.98E+05	2.47E+05	3.29E+05	3.94E+05	4.90E+05	5.85E+05	6.48E+05	7.73E+05	9.57E+05	1.11E+06	1.14E+06
	1.38E+02	1.44E+02	3.21E+02	6.89E+02	1.97E+03	3.08E+03	4.18E+03	8.58E+03	1.30E+04	1.74E+04	2.18E+04	2.73E+04	3.65E+04	4.38E+04	5.48E+04	6.58E+04	7.32E+04	8.78E+04	1.10E+05	1.28E+05	1.32E+05

Gamma *(Photon)* Radiation Energy in Containment at Given Timesteps (MeV)

1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
	9.58E+20	1.01E+21	2.39E+21	5.23E+21	1.50E+22	2.32E+22	3.13E+22	6.17E+22	8.97E+22	1.15E+23	1.39E+23	1.66E+23	2.04E+23	2.30E+23	2.63E+23	2.90E+23	3.04E+23	3.28E+23	3.53E+23	3.67E+23	3.70E+23
	5.49E+21	5.72E+21	1.14E+22	1.90E+22	2.71E+22	2.81E+22	2.82E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22	2.83E+22
	3.02E+21	3.17E+21	7.39E+21	1.57E+22	4.08E+22	5.82E+22	7.23E+22	1.08E+23	1.23E+23	1.31E+23	1.34E+23	1.35E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23	1.36E+23
	5.27E+21	5.43E+21	8.52E+21	1.07E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22	1.12E+22
	6.63E+21	6.94E+21	1.55E+22	3.07E+22	6.45E+22	7.91E+22	8.69E+22	9.51E+22	9.57E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22	9.58E+22
	4.69E+17	4.94E+17	1.19E+18	2.63E+18	7.63E+18	1.19E+19	1.61E+19	3.25E+19	4.83E+19	6.36E+19	7.83E+19	9.59E+19	1.24E+20	1.44E+20	1.73E+20	1.99E+20	2.15E+20	2.44E+20	2.82E+20	3.08E+20	3.13E+20
	8.65E+20	9.09E+20	2.19E+21	4.85E+21	1.42E+22	2.21E+22	3.01E+22	6.20E+22	9.38E+22	1.26E+23	1.57E+23	1.97E+23	2.63E+23	3.16E+23	3.95E+23	4.74E+23	5.26E+23	6.31E+23	7.87E+23	9.17E+23	9.43E+23
	3.34E+20	3.52E+20	8.48E+20	1.87E+21	5.42E+21	8.41E+21	1.14E+22	2.28E+22	3.37E+22	4.40E+22	5.37E+22	6.52E+22	8.28E+22	9.55E+22	1.13E+23	1.28E+23	1.37E+23	1.52E+23	1.71E+23	1.83E+23	1.86E+23
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	3.34E+19	3.49E+19	7.76E+19	1.65E+20	4.61E+20	7.02E+20	9.33E+20	1.76E+21	2.45E+21	3.03E+21	3.51E+21	4.00E+21	4.61E+21	4.96E+21	5.32E+21	5.55E+21	5.65E+21	5.78E+21	5.88E+21	5.92E+21	5.92E+21
	1.71E+20	1.78E+20	3.66E+20	6.73E+20	1.22E+21	1.38E+21	1.45E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21	1.48E+21
	2.19E+17	2.29E+17	4.91E+17	9.77E+17	2.21E+18	2.86E+18	3.27E+18	3.89E+18	4.00E+18	4.01E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18	4.02E+18
	7.62E+16	7.96E+16	1.78E+17	3.81E+17	1.09E+18	1.70E+18	2.31E+18	4.72E+18	7.12E+18	9.51E+18	1.19E+19	1.48E+19	1.97E+19	2.35E+19	2.92E+19	3.48E+19	3.85E+19	4.57E+19	5.63E+19	6.48E+19	6.65E+19
	3.61E+18	3.72E+18	6.23E+18	8.47E+18	9.43E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18	9.44E+18
	8.79E+17	9.19E+17	2.05E+18	4.39E+18	1.25E+19	1.95E+19	2.64E+19	5.37E+19	8.05E+19	1.07E+20	1.32E+20	1.64E+20	2.14E+20	2.53E+20	3.09E+20	3.62E+20	3.96E+20	4.60E+20	5.49E+20	6.16E+20	6.29E+20
	9.39E+19	9.81E+19	2.16E+20	4.53E+20	1.20E+21	1.75E+21	2.23E+21	3.60E+21	4.39E+21	4.84E+21	5.10E+21	5.28E+21	5.40E+21	5.43E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21	5.45E+21
	1.53E+20	1.60E+20	3.56E+20	7.56E+20	2.10E+21	3.19E+21	4.22E+21	7.84E+21	1.08E+22	1.31E+22	1.50E+22	1.69E+22	1.91E+22	2.03E+22	2.15E+22	2.21E+22	2.24E+22	2.28E+22	2.30E+22	2.31E+22	2.31E+22
	2.69E+16	2.81E+16	6.27E+16	1.34E+17	3.84E+17	5.97E+17	8.10E+17	1.65E+18	2.49E+18	3.31E+18	4.11E+18	5.11E+18	6.73E+18	8.00E+18	9.84E+18	1.16E+19	1.28E+19	1.50E+19	1.82E+19	2.06E+19	2.11E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.65E+20	1.72E+20	3.69E+20	7.36E+20	1.67E+21	2.17E+21	2.49E+21	2.97E+21	3.05E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21	3.07E+21
	2.59E+20	2.70E+20	5.27E+20	8.94E+20	1.35E+21	1.42E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21	1.44E+21
	6.04E+18	6.24E+18	1.09E+19	1.56E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	6.57E+19	6.86E+19	1.53E+20	3.27E+20	9.31E+20	1.44E+21	1.94E+21	3.89E+21	5.73E+21	7.47E+21	9.12E+21	1.11E+22	1.40E+22	1.62E+22	1.90E+22	2.15E+22	2.30E+22	2.56E+22	2.87E+22	3.07E+22	3.11E+22
	1.31E+18	1.37E+18	3.06E+18	6.56E+18	1.88E+19	2.92E+19	3.97E+19	8.11E+19	1.22E+20	1.63E+20	2.03E+20	2.53E+20	3.34E+20	3.99E+20	4.93E+20	5.85E+20	6.45E+20	7.62E+20	9.31E+20	1.07E+21	1.09E+21
	3.98E+18	4.16E+18	9.29E+18	1.99E+19	5.71E+19	8.89E+19	1.21E+20	2.48E+20	3.75E+20	5.03E+20	6.30E+20	7.89E+20	1.05E+21	1.26E+21	1.58E+21	1.90E+21	2.11E+21	2.53E+21	3.16E+21	3.69E+21	3.79E+21
	6.83E+18	7.13E+18	1.58E+19	3.36E+19	9.28E+19	1.40E+20	1.85E+20	3.37E+20	4.56E+20	5.48E+20	6.19E+20	6.87E+20	7.61E+20	7.98E+20	8.31E+20	8.49E+20	8.56E+20	8.63E+20	8.67E+20	8.68E+20	8.68E+20
	4.18E+18	4.35E+18	9.14E+18	1.75E+19	3.54E+19	4.26E+19	4.62E+19	4.96E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19	4.98E+19
	1.79E+19	1.87E+19	4.17E+19	8.94E+19	2.56E+20	3.97E+20	5.38E+20	1.10E+21	1.65E+21	2.18E+21	2.71E+21	3.36E+21	4.41E+21	5.23E+21	6.40E+21	7.53E+21	8.25E+21	9.63E+21	1.16E+22	1.30E+22	1.33E+22
	1.59E+19	1.66E+19	3.41E+19	6.29E+19	1.15E+20	1.31E+20	1.37E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.83E+18	1.91E+18	4.22E+18	8.86E+18	2.37E+19	3.50E+19	4.50E+19	7.50E+19	9.38E+19	1.05E+20	1.13E+20	1.18E+20	1.22E+20	1.24E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20	1.25E+20
	6.08E+17	6.35E+17	1.42E+18	3.03E+18	8.67E+18	1.35E+19	1.82E+19	3.71E+19	5.56E+19	7.36E+19	9.13E+19	1.13E+20	1.48E+20	1.74E+20	2.13E+20	2.49E+20	2.72E+20	3.16E+20	3.76E+20	4.22E+20	4.30E+20
	2.07E+18	2.16E+18	4.76E+18	9.99E+18	2.67E+19	3.91E+19	5.01E+19	8.25E+19	1.02E+20	1.14E+20	1.21E+20	1.26E+20	1.30E+20	1.31E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20	1.32E+20
	1.22E+17	1.28E+17	2.85E+17	6.11E+17	1.75E+18	2.73E+18	3.70E+18	7.59E+18	1.15E+19	1.54E+19	1.92E+19	2.40E+19	3.20E+19	3.84E+19	4.79E+19	5.74E+19	6.36E+19	7.61E+19	9.46E+19	1.10E+20	1.13E+20
	1.61E+19	1.68E+19	3.72E+19	7.88E+19	2.16E+20	3.25E+20	4.27E+20	7.65E+20	1.02E+21	1.20E+21	1.34E+21	1.47E+21	1.60E+21	1.66E+21	1.71E+21	1.73E+21	1.74E+21	1.75E+21	1.75E+21	1.75E+21	1.75E+21
	5.06E+13	5.29E+13	1.18E+14	2.53E+14	7.26E+14	1.13E+15	1.54E+15	3.16E+15	4.78E+15	6.40E+15	8.02E+15	1.00E+16	1.34E+16	1.61E+16	2.02E+16	2.42E+16	2.69E+16	3.23E+16	4.04E+16	4.72E+16	4.85E+16
	1.26E+13	1.27E+13	1.45E+13	1.82E+13	3.11E+13	4.22E+13	5.32E+13	9.75E+13	1.42E+14	1.86E+14	2.30E+14	2.86E+14	3.78E+14	4.52E+14	5.62E+14	6.73E+14	7.47E+14	8.94E+14	1.12E+15	1.30E+15	1.34E+15
	2.34E+12	2.49E+12	6.95E+12	1.62E+13	4.85E+13	7.62E+13	1.04E+14	2.15E+14	3.26E+14	4.36E+14	5.47E+14	6.86E+14	9.17E+14	1.10E+15	1.38E+15	1.66E+15	1.84E+15	2.21E+15	2.76E+15	3.23E+15	3.32E+15
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	8.78E+15	9.17E+15	2.05E+16	4.39E+16	1.26E+17	1.95E+17	2.65E+17	5.41E+17	8.14E+17	1.08E+18	1.35E+18	1.68E+18	2.22E+18	2.64E+18	3.25E+18	3.85E+18	4.24E+18	4.99E+18	6.07E+18	6.92E+18	7.08E+18
	5.34E+17	5.56E+17	1.12E+18	2.00E+18	3.36E+18	3.68E+18	3.78E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18	3.82E+18
	2.57E+17	2.68E+17	5.76E+17	1.15E+18	2.65E+18	3.47E+18	4.01E+18	4.87E+18	5.03E+18	5.06E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18	5.07E+18
	2.32E+18	2.43E+18	5.42E+18	1.16E+19	3.32E+19	5.17E+19	7.01E+19	1.43E+20	2.16E+20	2.87E+20	3.58E+20	4.46E+20	5.89E+20	7.01E+20	8.66E+20	1.03E+21	1.13E+21	1.33E+21	1.63E+21	1.86E+21	1.90E+21
	5.57E+17	5.82E+17	1.27E+18	2.61E+18	6.53E+18	9.10E+18	1.11E+19	1.56E+19	1.73E+19	1.79E+19	1.82E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19	1.83E+19
	2.43E+18	2.54E+18	5.66E+18	1.21E+19	3.47E+19	5.39E+19	7.30E+19	1.49E+20	2.23E+20	2.95E+20	3.66E+20	4.53E+20	5.94E+20	7.02E+20	8.58E+20	1.01E+21	1.10E+21	1.28E+21	1.53E+21	1.72E+21	1.76E+21
	7.99E+18	8.34E+18	1.85E+19	3.88E+19	1.05E+20	1.56E+20	2.01E+20	3.43E+20	4.37E+20	5.00E+20	5.41E+20	5.73E+20	6.01E+20	6.11E+20	6.18E+20	6.20E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20	6.21E+20
	1.07E+17	1.12E+17	2.27E+17	4.12E+17	7.22E+17	8.05E+17	8.34E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17	8.49E+17
	4.48E+18	4.64E+18	8.28E+18	1.22E+19	1.48E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19	1.50E+19
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.82E+17	1.90E+17	4.23E+17	9.04E+17	2.57E+18	3.97E+18	5.35E+18	1.07E+19	1.56E+19	2.03E+19	2.47E+19	2.98E+19	3.75E+19	4.30E+19	5.01E+19	5.63E+19	5.98E+19	6.60E+19	7.30E+19	7.74E+19	7.82E+19
	1.89E+13	1.98E+13	4.41E+13	9.44E+13	2.71E+14	4.22E+14	5.73E+14	1.18E+15	1.78E+15	2.38E+15	2.99E+15	3.74E+15	5.00E+15	6.01E+15	7.52E+15	9.03E+15	1.00E+16	1.20E+16	1.51E+16	1.76E+16	1.81E+16
	2.82E+14	2.94E+14	6.57E+14	1.41E+15	4.03E+15	6.28E+15	8.53E+15	1.75E+16	2.64E+16	3.53E+16	4.41E+16	5.51E+16	7.33E+16	8.78E+16	1.09E+17	1.31E+17	1.45E+17	1.72E+17	2.13E+17	2.47E+17	2.53E+17
	2.73E+13	2.86E+13	6.38E+13	1.37E+14	3.92E+14	6.10E+14	8.29E+14	1.70E+15	2.58E+15	3.45E+15	4.33E+15	5.42E+15	7.24E+15	8.70E+15	1.09E+16	1.31E+16	1.45E+16	1.74E+16	2.18E+16	2.54E+16	2.62E+16
	2.36E+22	2.46E+22	5.05E+22	9.25E+22	1.88E+23	2.44E+23	2.88E+23	4.15E+23	5.10E+23	5.92E+23	6.65E+23	7.51E+23	8.82E+23	9.79E+23	1.11E+24	1.24E+24	1.32E+24	1.47E+24	1.68E+24	1.84E+24	1.87E+24

TOTAL Integrated Gamma Energy in Suppresion Pool Water at Given Timesteps (MeV/cm³)

4.76E+12	4.97E+12	1.02E+13	1.87E+13	3.80E+13	4.92E+13	5.82E+13	8.38E+13	1.03E+14	1.19E+14	1.34E+14	1.52E+14	1.78E+14	1.98E+14	2.25E+14	2.50E+14	2.66E+14	2.96E+14	3.38E+14	3.71E+14	3.77E+14

TOTAL Integrated Gamma Dose in Pool at Given Timesteps (Mrad)

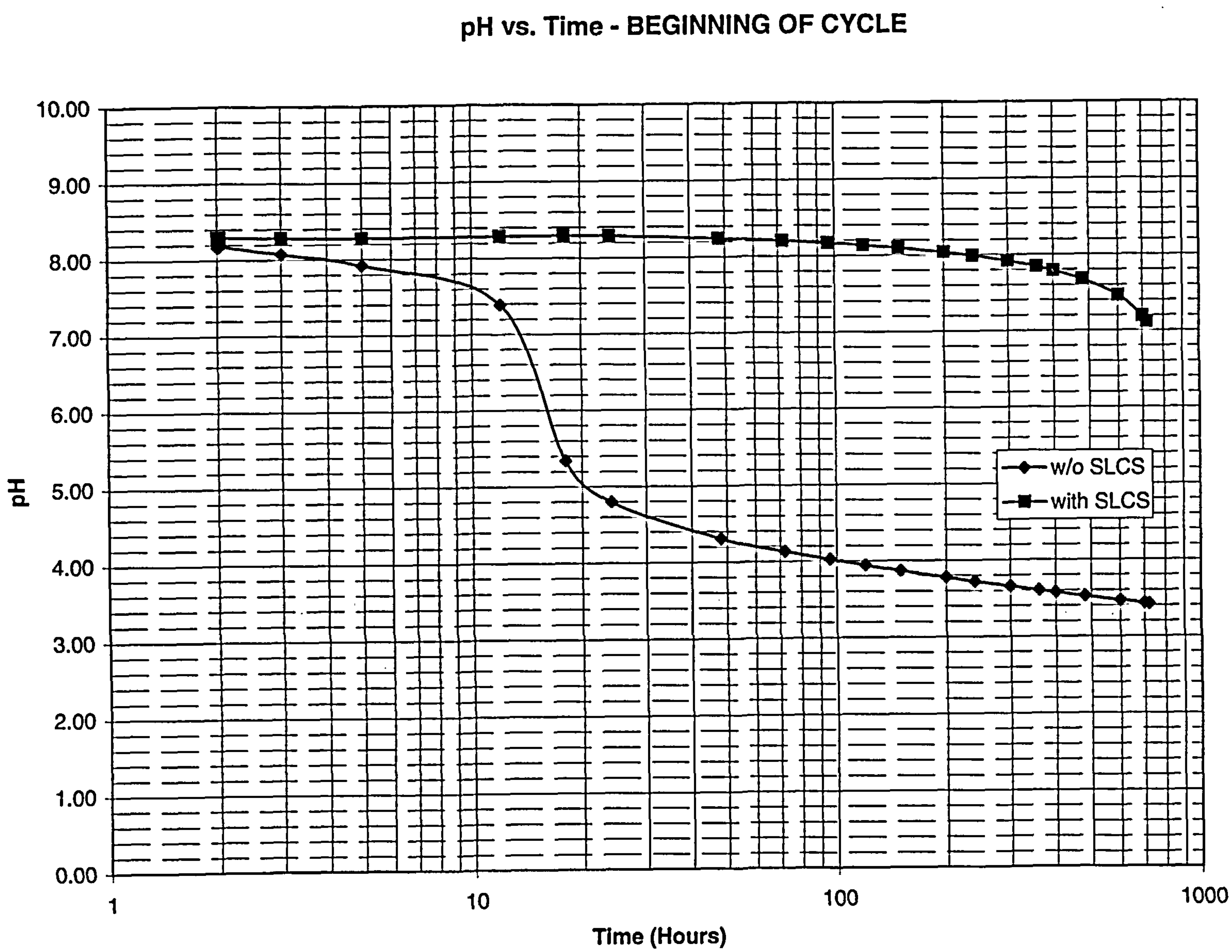
7.63E-02	7.96E-02	1.63E-01	2.99E-01	6.09E-01	7.89E-01	9.32E-01	1.34E+00	1.65E+00	1.91E+00	2.15E+00	2.43E+00	2.85E+00	3.16E+00	3.60E+00	4.01E+00	4.27E+00	4.75E+00	5.42E+00	5.94E+00	6.04E+00

TOTAL Gamma + Beta Pool Dose (Mrad)

1.00E-01	1.04E-01	2.16E-01	3.99E-01	8.29E-01	1.09E+00	1.29E+00	1.88E+00	2.31E+00	2.68E+00	3.00E+00	3.37E+00	3.94E+00	4.36E+00	4.94E+00	5.47E+00	5.81E+00	6.44E+00	7.30E+00	7.97E+00	8.09E+00

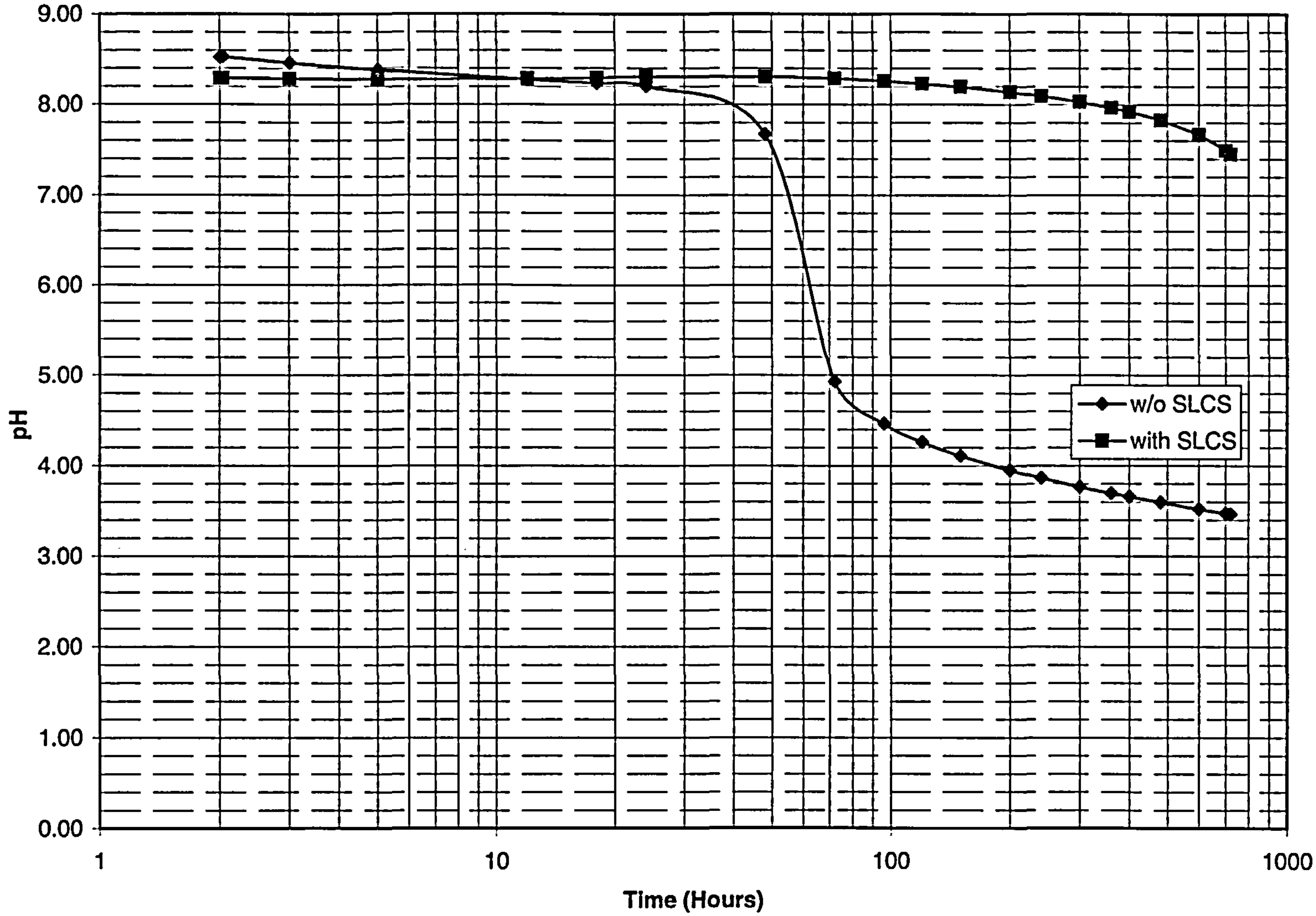
1	2	2.0336	3	5	12	18	24	48	72	96	120	150	200	240	300	360	400	480	600	700	720
Beta Particle Radiation Energy in Containment at Given Timesteps (MeV)																					
	4.56E+20	4.79E+20	1.14E+21	2.49E+21	7.16E+21	1.11E+22	1.49E+22	2.94E+22	4.27E+22	5.49E+22	6.61E+22	7.88E+22	9.71E+22	1.10E+23	1.25E+23	1.38E+23	1.45E+23	1.56E+23	1.68E+23	1.75E+23	1.76E+23
	1.16E+21	1.21E+21	2.42E+21	4.04E+21	5.76E+21	5.95E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21	5.99E+21
	2.03E+21	2.13E+21	4.96E+21	1.05E+22	2.74E+22	3.90E+22	4.85E+22	7.22E+22	8.28E+22	8.76E+22	8.97E+22	9.09E+22	9.14E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22	9.15E+22
	1.21E+21	1.25E+21	1.96E+21	2.45E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21	2.57E+21
	1.55E+21	1.62E+21	3.62E+21	7.17E+21	1.51E+22	1.85E+22	2.03E+22	2.22E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22	2.24E+22
	3.31E+18	3.49E+18	8.41E+18	1.86E+19	5.39E+19	8.38E+19	1.14E+20	2.30E+20	3.41E+20	4.49E+20	5.53E+20	6.77E+20	8.72E+20	1.02E+21	1.22E+21	1.40E+21	1.52E+21	1.72E+21	1.99E+21	2.18E+21	2.21E+21
	8.72E+19	9.17E+19	2.21E+20	4.90E+20	1.43E+21	2.23E+21	3.04E+21	6.25E+21	9.46E+21	1.27E+22	1.59E+22	1.99E+22	2.65E+22	3.19E+22	3.98E+22	4.78E+22	5.31E+22	6.36E+22	7.94E+22	9.25E+22	9.51E+22
	1.54E+19	1.62E+19	3.91E+19	8.64E+19	2.50E+20	3.88E+20	5.25E+20	1.05E+21	1.55E+21	2.03E+21	2.48E+21	3.01E+21	3.82E+21	4.41E+21	5.20E+21	5.89E+21	6.30E+21	7.02E+21	7.90E+21	8.46E+21	8.56E+21
	5.92E+19	6.22E+19	1.50E+20	3.32E+20	9.69E+20	1.52E+21	2.06E+21	4.25E+21	6.43E+21	8.62E+21	1.08E+22	1.35E+22	1.81E+22	2.17E+22	2.72E+22	3.26E+22	3.63E+22	4.35E+22	5.45E+22	6.35E+22	6.54E+22
	1.57E+19	1.64E+19	3.65E+19	7.75E+19	2.17E+20	3.30E+20	4.39E+20	8.27E+20	1.15E+21	1.42E+21	1.65E+21	1.88E+21	2.17E+21	2.33E+21	2.50E+21	2.61E+21	2.65E+21	2.72E+21	2.76E+21	2.78E+21	2.78E+21
	4.29E+19	4.46E+19	9.15E+19	1.68E+20	3.05E+20	3.46E+20	3.61E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20	3.71E+20
	1.01E+19	1.05E+19	2.26E+19	4.50E+19	1.02E+20	1.32E+20	1.51E+20	1.79E+20	1.84E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20	1.85E+20
	3.13E+16	3.27E+16	7.30E+16	1.56E+17	4.48E+17	6.97E+17	9.46E+17	1.94E+18	2.92E+18	3.90E+18	4.87E+18	6.08E+18	8.07E+18	9.65E+18	1.20E+19	1.43E+19	1.58E+19	1.87E+19	2.31E+19	2.66E+19	2.73E+19
	3.28E+19	3.39E+19	5.67E+19	7.71E+19	8.58E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19	8.59E+19
	4.72E+18	4.94E+18	1.10E+19	2.36E+19	6.74E+19	1.05E+20	1.42E+20	2.89E+20	4.33E+20	5.73E+20	7.11E+20	8.80E+20	1.15E+21	1.36E+21	1.66E+21	1.95E+21	2.13E+21	2.47E+21	2.95E+21	3.31E+21	3.38E+21
	9.52E+18	9.94E+18	2.19E+19	4.59E+19	1.22E+20	1.77E+20	2.26E+20	3.65E+20	4.45E+20	4.91E+20	5.17E+20	5.35E+20	5.47E+20	5.50E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20	5.52E+20
	3.95E+19	4.12E+19	9.16E+19	1.95E+20	5.41E+20	8.21E+20	1.09E+21	2.02E+21	2.77E+21	3.38E+21	3.87E+21	4.36E+21	4.93E+21	5.23E+21	5.53E+21	5.70E+21	5.78E+21	5.86E+21	5.92E+21	5.94E+21	5.94E+21
	1.15E+20	1.20E+20	2.68E+20	5.74E+20	1.64E+21	2.55E+21	3.46E+21	7.07E+21	1.06E+22	1.41E+22	1.76E+22	2.18E+22	2.88E+22	3.42E+22	4.21E+22	4.97E+22	5.46E+22	6.42E+22	7.77E+22	8.82E+22	9.03E+22
	4.39E+18	4.58E+18	1.02E+19	2.19E+19	6.29E+19	9.80E+19	1.33E+20	2.73E+20	4.14E+20	5.54E+20	6.94E+20	8.70E+20	1.16E+21	1.40E+21	1.75E+21	2.10E+21	2.33E+21	2.80E+21	3.50E+21	4.08E+21	4.20E+21
	1.57E+20	1.64E+20	3.51E+20	7.00E+20	1.59E+21	2.06E+21	2.37E+21	2.82E+21	2.90E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21	2.92E+21
	3.87E+19	4.03E+19	7.87E+19	1.34E+20	2.02E+20	2.13E+20	2.15E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20	2.16E+20
	1.54E+20	1.59E+20	2.77E+20	3.96E+20	4.63E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20	4.65E+20
	9.33E+19	9.75E+19	2.17E+20	4.65E+20	1.32E+21	2.05E+21	2.76E+21	5.52E+21	8.14E+21	1.06E+22	1.30E+22	1.57E+22	1.99E+22	2.29E+22	2.70E+22	3.06E+22	3.27E+22	3.64E+22	4.08E+22	4.36E+22	4.41E+22
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	1.52E+17	1.59E+17	3.55E+17	7.61E+17	2.18E+18	3.40E+18	4.62E+18	9.48E+18	1.43E+19	1.92E+19	2.41E+19	3.01E+19	4.03E+19	4.84E+19	6.05E+19	7.26E+19	8.07E+19	9.68E+19	1.21E+20	1.41E+20	1.45E+20
	1.73E+19	1.81E+19	4.02E+19	8.52E+19	2.35E+20	3.56E+20	4.69E+20	8.56E+20	1.16E+21	1.39E+21	1.57E+21	1.74E+21	1.93E+21	2.03E+21	2.11E+21	2.15E+21	2.17E+21	2.19E+21	2.20E+21	2.20E+21	2.20E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	2.50E+18	2.61E+18	5.83E+18	1.25E+19	3.57E+19	5.55E+19	7.52E+19	1.53E+20	2.30E+20	3.05E+20	3.79E+20	4.69E+20	6.16E+20	7.29E+20	8.93E+20	1.05E+21	1.15E+21	1.34E+21	1.61E+21	1.82E+21	1.86E+21
	8.17E+18	8.51E+18	1.75E+19	3.23E+19	5.91E+19	6.73E+19	7.06E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19	7.26E+19
	1.53E+17	1.60E+17	3.57E+17	7.64E+17	2.19E+18	3.41E+18	4.63E+18	9.51E+18	1.44E+19	1.92E+19	2.41E+19	3.01E+19	4.02E+19	4.82E+19	6.02E+19	7.21E+19	8.00E+19	9.58E+19	1.19E+20	1.39E+20	1.42E+20
	3.58E+18	3.74E+18	8.27E+18	1.74E+19	4.65E+19	6.86E+19	8.81E+19	1.47E+20	1.84E+20	2.07E+20	2.21E+20	2.32E+20	2.40E+20	2.43E+20	2.44E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20	2.45E+20
	1.14E+18	1.20E+18	2.67E+18	5.71E+18	1.63E+19	2.54E+19	3.44E+19	6.99E+19	1.05E+20	1.39E+20	1.72E+20	2.13E+20	2.78E+20	3.28E+20	4.00E+20	4.69E+20	5.12E+20	5.95E+20	7.08E+20	7.94E+20	8.10E+20
	3.10E+18	3.23E+18	7.14E+18	1.50E+19	4.00E+19	5.86E+19	7.51E+19	1.24E+20	1.53E+20	1.71E+20	1.81E+20	1.89E+20	1.95E+20	1.96E+20	1.97E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20	1.98E+20
	5.28E+17	5.51E+17	1.23E+18	2.64E+18	7.56E+18	1.18E+19	1.60E+19	3.28E+19	4.96E+19	6.63E+19	8.30E+19	1.04E+20	1.38E+20	1.66E+20	2.07E+20	2.48E+20	2.75E+20	3.29E+20	4.09E+20	4.75E+20	4.88E+20
	1.07E+19	1.12E+19	2.49E+19	5.27E+19	1.45E+20	2.18E+20	2.85E+20	5.12E+20	6.80E+20	8.06E+20	8.99E+20	9.83E+20	1.07E+21	1.11E+21	1.14E+21	1.16E+21	1.16E+21	1.17E+21	1.17E+21	1.17E+21	1.17E+21
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	5.70E+15	5.95E+15	1.33E+16	2.85E+16	8.17E+16	1.27E+17	1.73E+17	3.55E+17	5.37E+17	7.20E+17	9.02E+17	1.13E+18	1.51E+18	1.81E+18	2.27E+18	2.72E+18	3.03E+18	3.63E+18	4.54E+18	5.30E+18	5.45E+18
	2.12E+17	2.22E+17	4.92E+17	1.04E+18	2.88E+18	4.34E+18	5.72E+18	1.04E+19	1.40E+19	1.68E+19	1.89E+19	2.10E+19	2.31E+19	2.42E+19	2.52E+19	2.56E+19	2.58E+19	2.60E+19	2.61E+19	2.62E+19	2.62E+19
	1.46E+18	1.53E+18	3.41E+18	7.31E+18	2.09E+19	3.25E+19	4.41E+19	9.02E+19	1.36E+20	1.81E+20	2.25E+20	2.80E+20	3.69E+20	4.39E+20	5.42E+20	6.41E+20	7.06E+20	8.32E+20	1.01E+21	1.15E+21	1.18E+21
	3.07E+18	3.19E+18	6.42E+18	1.15E+19	1.93E+19	2.11E+19	2.17E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19	2.20E+19
	3.38E+18	3.52E+18	7.58E+18	1.52E+19	3.49E+19	4.56E+19	5.28E+19	6.41E+19	6.62E+19	6.67E+19	6.67E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19	6.68E+19
	3.67E+17	3.84E+17	8.57E+17	1.83E+18	5.25E+18	8.17E+18	1.11E+19	2.27E+19	3.41E+19	4.54E+19	5.66E+19	7.05E+19	9.31E+19	1.11E+20	1.37E+20	1.62E+20	1.79E+20	2.11E+20	2.57E+20	2.93E+20	3.01E+20
	2.15E+18	2.25E+18	4.91E+18	1.01E+19	2.52E+19	3.51E+19	4.29E+19	6.03E+19	6.68E+19	6.93E+19	7.02E+19	7.06E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19	7.07E+19
	1.38E+17	1.44E+17	3.22E+17	6.89E+17	1.97E+18	3.06E+18	4.15E+18	8.44E+18	1.26E+19	1.68E+19	2.08E+19	2.58E+19	3.37E+19	3.99E+19	4.87E+19	5.72E+19	6.26E+19	7.28E+19	8.70E+19	9.78E+19	9.99E+19
	1.82E+18	1.90E+18	4.20E+18	8.85E+18	2.39E+19	3.54E+19	4.58E+19	7.82E+19	9.96E+19	1.14E+20	1.23E+20	1.31E+20	1.37E+20	1.39E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20	1.41E+20
	2.39E+18	2.48E+18	5.05E+18	9.16E+18	1.60E+19	1.79E+19	1.85E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19	1.89E+19
	1.39E+18	1.44E+18	2.57E+18	3.81E+18	4.62E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18	4.65E+18
	9.52E+17	9.95E+17	2.22E+18	4.74E+18	1.35E+19	2.09E+19	2.82E+19	5.65E+19	8.34E+19	1.09E+20	1.33E+20	1.62E+20	2.06E+20	2.38E+20	2.81E+20	3.19E+20	3.41E+20	3.81E+20	4.30E+20	4.62E+20	4.67E+20
	3.01E+17	3.15E+17	7.02E+17	1.50E+18	4.26E+18	6.59E+18	8.88E+18	1.77E+19	2.59E+19	3.37E+19	4.10E+19	4.95E+19	6.22E+19	7.13E+19	8.32E+19	9.33E+19	9.93E+19	1.09E+20	1.21E+20	1.28E+20	1.30E+20
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	7.35E+21	7.67E+21	1.62E+22	3.08E+22	6.81E+22	9.19E+22	1.11E+23	1.67E+23	2.06E+23	2.37E+23	2.63E+23	2.93E+23	3.37E+23	3.70E+23	4.13E+23	4.53E+23	4.77E+23	5.22E+23	5.82E+23	6.27E+23	6.35E+23
Total Integrated Beta Energy in Suppression Pool Water at Given Timesteps (MeV/cm^3)																					
	1.48E+12	1.55E+12	3.27E+12	6.22E+12	1.38E+13	1.85E+13	2.25E+13	3.37E+13	4.15E+13	4.77E+13	5.31E+13	5.91E+13	6.81E+13	7.46E+13	8.34E+13	9.14E+13	9.63E+13	1.05E+14	1.17E+14	1.26E+14	1.28E+14
TOTAL Integrated Beta Dose in Pool at Given Timesteps (Mrad)																					
	2.38E-02	2.48E-02	5.24E-02	9.97E-02	2.20E-01	2.97E-01	3.60E-01	5.40E-01	6.65E-01	7.65E-01	8.51E-01	9.47E-01	1.09E+00	1.19E+00	1.34E+00	1.46E+00	1.54E+00	1.69E+00	1.88E+00	2.03E+00	2.05E+00

ADDITIONAL ATTACHMENTS TO
10-10-05 Letter: Supplement to Request for LAR Application of AST
Attachment 005 AST – LM-0642 Rev 1 pH Att C,D,&E.



LGS pH CALC.xls BOC Graph

pH vs. Time - END OF CYCLE



LGS pH CALC.xls EOC Graph

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	LIMERICK pH CALCULATION					pH TRANSIENT	BEGINNING OF CYCLE				Cable Data [22]				
2							Linear Absorption Coefficients [4]			$S_{A\,tray}$ [cm²]	2,668,443	Cable Surface [trays]- Drywell + 10% contingency			
3	V_{POOL}	4.955E+06	Liters [175,000 ft³] [13]				$U_{beta\ air}$	1.980E-02	1/cm	$S_{A\,fa}$ [cm²]	133,422	Cable Surface [free air]- Drywell + 10% contingency			
4	m_I	1.700E+02	Iodine inventory [g-atoms] BOC[19]				$U_{beta\ hypalon}$	52.08	1/cm	$S_{B\,tray}$ [cm²]	0	Cable Surface [trays] - Supp. Pool + 10% contingency			
5	m_{Cs}	1.600E+03	Cesium inventory [g-atoms] BOC[19]				$U_{gamma\ air}$	3.75E-05	1/cm	$S_{B\,fa}$ [cm²]	0	Cable Surface [free air] - Supp. Pool + 10% contingency			
6	t_{gap}	3.361E-02	Onset of Gap release [hrs] [20]				$U_{gamma\ hypalon}$	0.099	1/cm						
7							$r_{[gamma\ free\ path-DRYWELL]}$ [16]	1310.42	cm	th [cm]	0.62992	Hypalon Jacket Thickness [22]			
8							$r_{[gamma\ free\ path-SUPP\ POOL\ AIR]}$ [16]	1310.42	cm						
9				INTEGRATED DOSES											
10			Beta+Gamma[18]	Gamma[18]	Beta[18]	Gamma[18]	Beta[18]			From Beta	From Gamma	From Beta	From Gamma		
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp. Pool AIR	Supp. Pool AIR	[HI] [1]	$[HNO_3]$ [2]	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]	[HCL] -CONTAIN [5]	[HCL] -CONTAIN [6]	Total [H+] [7]	[CsOH] [3]
12	Hours	Deg F [17]	Mrad	MeV/cm³	MeV/cm³	MeV/cm³	MeV/cm³	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-ions/liter	g-mols/liter
13	0	95						0.00E+00						5.012E-06	0.000E+00
14	1	187.2						2.191E-07						5.231E-06	3.206E-05
15	2	195.8	1.001E-01	3.956E+12	1.730E+12	3.956E+12	1.730E+12	5.050E-07	7.306E-07	8 675E-07	5.784E-06	0.000E+00	0.000E+00	1.290E-05	6.968E-05
16	2.0336	195.8	1.044E-01	4.121E+12	1.802E+12	4.121E+12	1.802E+12	5.146E-07	7.619E-07	9.037E-07	6.025E-06	0.000E+00	0.000E+00	1.322E-05	7.094E-05
17	3	199.9	2.158E-01	8.368E+12	3.689E+12	8.368E+12	3.689E+12	5.146E-07	1.575E-06	1.850E-06	1.223E-05	0.000E+00	0.000E+00	2.118E-05	7.094E-05
18	5	203.1	3.988E-01	1.505E+13	6.797E+12	1.505E+13	6.797E+12	5.146E-07	2.911E-06	3.408E-06	2.201E-05	0.000E+00	0.000E+00	3.385E-05	7.094E-05
19	12	199.5	8.293E-01	2.878E+13	1.421E+13	2.878E+13	1.421E+13	5.146E-07	6.054E-06	7.124E-06	4.208E-05	0.000E+00	0.000E+00	6.078E-05	7.094E-05
20	18	193.1	1.086E+00	3.595E+13	1.881E+13	3.595E+13	1.881E+13	5.146E-07	7.927E-06	9.432E-06	5.256E-05	0.000E+00	0.000E+00	7.544E-05	7.094E-05
21	24	186.6	1.292E+00	4.145E+13	2.263E+13	4.145E+13	2.263E+13	5.146E-07	9.429E-06	1.135E-05	6.060E-05	0.000E+00	0.000E+00	8.690E-05	7.094E-05
22	48	186.6	1.883E+00	5.709E+13	3.409E+13	5.709E+13	3.409E+13	5.146E-07	1.375E-05	1.709E-05	8.348E-05	0.000E+00	0.000E+00	1.198E-04	7.094E-05
23	72	186.6	2.315E+00	6.878E+13	4.269E+13	6.878E+13	4.269E+13	5.146E-07	1.690E-05	2.141E-05	1.006E-04	0.000E+00	0.000E+00	1.444E-04	7.094E-05
24	96	186.6	2.678E+00	7.877E+13	4.988E+13	7.877E+13	4.988E+13	5.146E-07	1.955E-05	2.501E-05	1.152E-04	0.000E+00	0.000E+00	1.653E-04	7.094E-05
25	120	186.6	3.002E+00	8.778E+13	5.615E+13	8.778E+13	5.615E+13	5.146E-07	2.192E-05	2.815E-05	1.283E-04	0.000E+00	0.000E+00	1.839E-04	7.094E-05
26	150	186.6	3.375E+00	9.807E+13	6.303E+13	9.807E+13	6.303E+13	5.146E-07	2.464E-05	3.160E-05	1.434E-04	0.000E+00	0.000E+00	2.051E-04	7.094E-05
27	200	186.6	3.942E+00	1.135E+14	7.274E+13	1.135E+14	7.274E+13	5.146E-07	2.877E-05	3.647E-05	1.660E-04	0.000E+00	0.000E+00	2.368E-04	7.094E-05
28	240	186.6	4.359E+00	1.247E+14	7.928E+13	1.247E+14	7.928E+13	5.146E-07	3.182E-05	3.975E-05	1.823E-04	0.000E+00	0.000E+00	2.594E-04	7.094E-05
29	300	186.6	4.939E+00	1.400E+14	8.754E+13	1.400E+14	8.754E+13	5.146E-07	3.605E-05	4.389E-05	2.047E-04	0.000E+00	0.000E+00	2.902E-04	7.094E-05
30	360	186.6	5.473E+00	1.538E+14	9.436E+13	1.538E+14	9.436E+13	5.146E-07	3.995E-05	4.732E-05	2.249E-04	0.000E+00	0.000E+00	3.177E-04	7.094E-05
31	400	186.6	5.809E+00	1.624E+14	9.830E+13	1.624E+14	9.830E+13	5.146E-07	4.240E-05	4.929E-05	2.375E-04	0.000E+00	0.000E+00	3.347E-04	7.094E-05
32	480	186.6	6.438E+00	1.784E+14	1.051E+14	1.784E+14	1.051E+14	5.146E-07	4.700E-05	5.269E-05	2.608E-04	0.000E+00	0.000E+00	3.660E-04	7.094E-05
33	600	186.6	7.301E+00	2.000E+14	1.133E+14	2.000E+14	1.133E+14	5.146E-07	5.330E-05	5.681E-05	2.924E-04	0.000E+00	0.000E+00	4.080E-04	7.094E-05
34	700	186.6	7.966E+00	2.166E+14	1.190E+14	2.166E+14	1.190E+14	5.146E-07	5.815E-05	5.967E-05	3.166E-04	0.000E+00	0.000E+00	4.400E-04	7.094E-05
35	720	186.6	8.094E+00	2.198E+14	1.201E+14	2.198E+14	1.201E+14	5.146E-07	5.909E-05	6.020E-05	3.213E-04	0.000E+00	0.000E+00	4.461E-04	7.094E-05
36															
37	NOTES:						14	Acid dissociation constant from: Entergy Eng. Report GGNS-98-0039 Rev.3, Sect 6.1,p.21							
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]					15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7							
39	2	Ibid, Equation 3-2b					16	See attachment B for gamma free paths							
40	3	Ibid, Equation 3-4d [30+90 min release duration]					17	ECR 01-01233 for SIL-636, extrpolated to times beyond 24 hours using the constant value at 24 hours							
41	4	Ibid, Table A-1					18	Attachment B							
42	5	Ibid, Equation 3-3a					19	Attachment B							
43	6	Ibid, Equation 3-3b					20	USNRC Reg. Guide 1.183							
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7					21	See page C-6 of this attachment.							
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					22	Cable Data from Attachment A.							
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7; initial 5.3 pH value (before Cesium addition) from LGS UFSAR Sec. 6.1.1.2													
50	13	Max. Suppression Pool volume from Calc. body section 4.4, including													
51		UFSAR Table 6.2-4A HWL Suppression Pool volume of 134,600 cu ft, Reactor Coolant System Liquid Volume of 13,108 cu ft													
52		and low-pressure Emergency Core Cooling System sources, roundd up to 175,000 cu. Ft.													
53		(For Attachment B page B-6 minimization of Drywell + Suppression Pool Airspace volume, the LLRT Program													
54		403,120 cu ft value - 175,000 + 122,120 Tech Spec 3/4.5.3 nominal minimum Suppression Pool Volume is used)													

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1				pH TRANSIENT		BEGINNING OF CYCLE							
2	Cable Data [22]												
3	2,425,858	Cable Surface [Trays] - DRYWELL [cm2]											
4	121,293	Cable Surface [Free air] - DRYWELL [cm2]					1008.67	g. mols $Na_2B_{10}O_{16}*10H_2O$ Added[21]					
5	0	Cable Surface [Free air] - Supp. Pool [cm2]					10086.71	g.atoms total boron[21]					
6	0	Cable Surface [Trays] - Supp. Pool [cm2]											
7													
8						pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTION							
9													
10							Strong Acid						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}*10H_2O$	Borate	Boric Acid	pK_a	pH	
12	g-ions/liter			g-ions/liter	Before SLC	[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	[15]	
13	1.995E-09	1.369E+01	-2.101E-09	5.014E-06	5.30	6.867E-10	2.485E+01	1008.7	1992	8094	9.16	8.55	
14	3.206E-05	1.249E+01	5.219E-06	1.194E-08	7.92	1.226E-09	5.915E-02	1008.7	2017	8069	8.91	8.31	
15	6.968E-05	1.241E+01	1.289E-05	6.818E-09	8.17	1.276E-09	3.379E-02	1008.7	2017	8069	8.89	8.29	
16	7.094E-05	1.241E+01	1.321E-05	6.707E-09	8.17	1.276E-09	3.323E-02	1008.7	2017	8069	8.89	8.29	
17	7.094E-05	1.237E+01	2.118E-05	8.481E-09	8.07	1.300E-09	4.203E-02	1008.7	2017	8069	8.89	8.28	
18	7.094E-05	1.235E+01	3.384E-05	1.215E-08	7.92	1.319E-09	6.019E-02	1008.7	2017	8069	8.88	8.28	
19	7.094E-05	1.238E+01	6.074E-05	4.103E-08	7.39	1.298E-09	2.033E-01	1008.7	2017	8070	8.89	8.28	
20	7.094E-05	1.244E+01	7.086E-05	4.578E-06	5.34	1.261E-09	2.268E+01	1008.7	1995	8092	8.90	8.29	
21	7.094E-05	1.250E+01	7.092E-05	1.598E-05	4.80	1.223E-09	7.918E+01	1008.7	1938	8149	8.91	8.29	
22	7.094E-05	1.250E+01	7.094E-05	4.891E-05	4.31	1.223E-09	2.423E+02	1008.7	1775	8312	8.91	8.24	
23	7.094E-05	1.250E+01	7.094E-05	7.345E-05	4.13	1.223E-09	3.640E+02	1008.7	1653	8433	8.91	8.21	
24	7.094E-05	1.250E+01	7.094E-05	9.432E-05	4.03	1.223E-09	4.674E+02	1008.7	1550	8537	8.91	8.17	
25	7.094E-05	1.250E+01	7.094E-05	1.130E-04	3.95	1.223E-09	5.599E+02	1008.7	1457	8629	8.91	8.14	
26	7.094E-05	1.250E+01	7.094E-05	1.342E-04	3.87	1.223E-09	6.651E+02	1008.7	1352	8734	8.91	8.10	
27	7.094E-05	1.250E+01	7.094E-05	1.658E-04	3.78	1.223E-09	8.217E+02	1008.7	1196	8891	8.91	8.04	
28	7.094E-05	1.250E+01	7.094E-05	1.885E-04	3.72	1.223E-09	9.341E+02	1008.7	1083	9003	8.91	7.99	
29	7.094E-05	1.250E+01	7.094E-05	2.192E-04	3.66	1.223E-09	1.086E+03	1008.7	931	9156	8.91	7.92	
30	7.094E-05	1.250E+01	7.094E-05	2.468E-04	3.61	1.223E-09	1.223E+03	1008.7	795	9292	8.91	7.84	
31	7.094E-05	1.250E+01	7.094E-05	2.637E-04	3.58	1.223E-09	1.307E+03	1008.7	710	9376	8.91	7.79	
32	7.094E-05	1.250E+01	7.094E-05	2.950E-04	3.53	1.223E-09	1.462E+03	1008.7	555	9531	8.91	7.68	
33	7.094E-05	1.250E+01	7.094E-05	3.371E-04	3.47	1.223E-09	1.670E+03	1008.7	347	9740	8.91	7.46	
34	7.094E-05	1.250E+01	7.094E-05	3.690E-04	3.43	1.223E-09	1.829E+03	1008.7	189	9898	8.91	7.19	
35	7.094E-05	1.250E+01	7.094E-05	3.752E-04	3.43	1.223E-09	1.859E+03	1008.7	158	9928	8.91	7.12	
36													
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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	LIMERICK pH CALCULATION					pH TRANSIENT	END OF CYCLE				Cable Data [22]				
2							Linear Absorption Coefficients [4]			$S_{A\,tray}$ [cm²]	2,668,443	Cable Surface [trays]- Drywell + 10% contingency			
3	V_{POOL}	4.955E+06	Liters [175,000 ft³] [13]				$u_{beta\,air}$	1.980E-02	1/cm	$S_{A\,fa}$ [cm²]	133,422	Cable Surface [free air]- Drywell + 10% contingency			
4	m_I	2.900E+02	Iodine inventory [g-atoms] EOC [19]				$u_{beta\,hypalon}$	52.08	1/cm	$S_{B\,tray}$ [cm²]	0	Cable Surface [trays] - Supp. Pool + 10% contingency			
5	m_{Cs}	3.200E+03	Cesium inventory [g-atoms] EOC [19]				$u_{gamma\,air}$	3.75E-05	1/cm	$S_{B\,fa}$ [cm²]	0	Cable Surface [free air] - Supp. Pool + 10% contingency			
6	t_{gap}	3.361E-02	Onset of Gap release [hrs] [20]				$u_{gamma\,hypalon}$	0.099	1/cm						
7							$r_{[gamma\,free\,path-DRYWELL]}$ [16]	1310.42	cm	th [cm]	0.70514	Hypalon Jacket Thickness [22]			
8							$r_{[gamma\,free\,path-SUPP\,POOL\,AIR]}$ [16]	1310.42	cm						
9				INTEGRATED DOSES											
10			Beta+Gamma [18]	Gamma [18]	Beta [18]	Gamma [18]	Beta [18]			From Beta	From Gamma	From Beta	From Gamma		
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp. Pool AIR	Supp. Pool AIR	[HI] [1]	[HNO_3] [2]	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]	[HCL] -CONTAIN [5]	[HCL] -CONTAIN [6]	Total [H+] [7]	[CsOH] [3]
12	Hours	Deg F [17]	Mrad	MeV/cm³	MeV/cm³	MeV/cm³	MeV/cm³	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-ions/liter	g-mols/liter
13	0	95						0.00E+00						5.012E-06	0.000E+00
14	1	187.2						3.738E-07						5.386E-06	6.534E-05
15	2	195.8	1.001E-01	3.956E+12	1.730E+12	3.956E+12	1.730E+12	8.614E-07	7.306E-07	8.675E-07	6.451E-06	0.000E+00	0.000E+00	1.392E-05	1.422E-04
16	2.0336	195.8	1.044E-01	4.121E+12	1.802E+12	4.121E+12	1.802E+12	8.778E-07	7.619E-07	9.037E-07	6.719E-06	0.000E+00	0.000E+00	1.427E-05	1.448E-04
17	3	199.9	2.158E-01	8.368E+12	3.689E+12	8.368E+12	3.689E+12	8.778E-07	1.575E-06	1.850E-06	1.364E-05	0.000E+00	0.000E+00	2.296E-05	1.448E-04
18	5	203.1	3.988E-01	1.505E+13	6.797E+12	1.505E+13	6.797E+12	8.778E-07	2.911E-06	3.408E-06	2.454E-05	0.000E+00	0.000E+00	3.675E-05	1.448E-04
19	12	199.5	8.293E-01	2.878E+13	1.421E+13	2.878E+13	1.421E+13	8.778E-07	6.054E-06	7.124E-06	4.693E-05	0.000E+00	0.000E+00	6.600E-05	1.448E-04
20	18	193.1	1.086E+00	3.595E+13	1.881E+13	3.595E+13	1.881E+13	8.778E-07	7.927E-06	9.432E-06	5.862E-05	0.000E+00	0.000E+00	8.186E-05	1.448E-04
21	24	186.6	1.292E+00	4.145E+13	2.263E+13	4.145E+13	2.263E+13	8.778E-07	9.429E-06	1.135E-05	6.759E-05	0.000E+00	0.000E+00	9.425E-05	1.448E-04
22	48	186.6	1.883E+00	5.709E+13	3.409E+13	5.709E+13	3.409E+13	8.778E-07	1.375E-05	1.709E-05	9.310E-05	0.000E+00	0.000E+00	1.298E-04	1.448E-04
23	72	186.6	2.315E+00	6.878E+13	4.269E+13	6.878E+13	4.269E+13	8.778E-07	1.690E-05	2.141E-05	1.121E-04	0.000E+00	0.000E+00	1.563E-04	1.448E-04
24	96	186.6	2.678E+00	7.877E+13	4.988E+13	7.877E+13	4.988E+13	8.778E-07	1.955E-05	2.501E-05	1.285E-04	0.000E+00	0.000E+00	1.789E-04	1.448E-04
25	120	186.6	3.002E+00	8.778E+13	5.615E+13	8.778E+13	5.615E+13	8.778E-07	2.192E-05	2.815E-05	1.431E-04	0.000E+00	0.000E+00	1.991E-04	1.448E-04
26	150	186.6	3.375E+00	9.807E+13	6.303E+13	9.807E+13	6.303E+13	8.778E-07	2.464E-05	3.160E-05	1.599E-04	0.000E+00	0.000E+00	2.220E-04	1.448E-04
27	200	186.6	3.942E+00	1.135E+14	7.274E+13	1.135E+14	7.274E+13	8.778E-07	2.877E-05	3.647E-05	1.851E-04	0.000E+00	0.000E+00	2.563E-04	1.448E-04
28	240	186.6	4.359E+00	1.247E+14	7.928E+13	1.247E+14	7.928E+13	8.778E-07	3.182E-05	3.975E-05	2.034E-04	0.000E+00	0.000E+00	2.808E-04	1.448E-04
29	300	186.6	4.939E+00	1.400E+14	8.754E+13	1.400E+14	8.754E+13	8.778E-07	3.605E-05	4.389E-05	2.283E-04	0.000E+00	0.000E+00	3.141E-04	1.448E-04
30	360	186.6	5.473E+00	1.538E+14	9.436E+13	1.538E+14	9.436E+13	8.778E-07	3.995E-05	4.732E-05	2.508E-04	0.000E+00	0.000E+00	3.440E-04	1.448E-04
31	400	186.6	5.809E+00	1.624E+14	9.830E+13	1.624E+14	9.830E+13	8.778E-07	4.240E-05	4.929E-05	2.648E-04	0.000E+00	0.000E+00	3.624E-04	1.448E-04
32	480	186.6	6.438E+00	1.784E+14	1.051E+14	1.784E+14	1.051E+14	8.778E-07	4.700E-05	5.269E-05	2.908E-04	0.000E+00	0.000E+00	3.964E-04	1.448E-04
33	600	186.6	7.301E+00	2.000E+14	1.133E+14	2.000E+14	1.133E+14	8.778E-07	5.330E-05	5.681E-05	3.261E-04	0.000E+00	0.000E+00	4.421E-04	1.448E-04
34	700	186.6	7.966E+00	2.166E+14	1.190E+14	2.166E+14	1.190E+14	8.778E-07	5.815E-05	5.967E-05	3.531E-04	0.000E+00	0.000E+00	4.768E-04	1.448E-04
35	720	186.6	8.094E+00	2.198E+14	1.201E+14	2.198E+14	1.201E+14	8.778E-07	5.909E-05	6.020E-05	3.583E-04	0.000E+00	0.000E+00	4.835E-04	1.448E-04
36															
37	NOTES:						14	Acid dissociation constant from: Entergy Eng. Report GGNS-98-0039 Rev.3, Sect.6.1,p.21							
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]					15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7							
39	2	Ibid, Equation 3-2b					16	See attachment B for gamma free paths							
40	3	Ibid, Equation 3-4d [30+90 min release duration]					17	ECR 01-01233 for SIL-636, extrpolated to times beyond 24 hours using the constant value at 24 hours							
41	4	Ibid, Table A-1					18	Attachment B							
42	5	Ibid, Equation 3-3a					19	Attachment B							
43	6	Ibid, Equation 3-3b					20	USNRC Reg. Guide 1.183							
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7					21	Page C-6 of this attachment							
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					22	Cable Data from Attachment A.							
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7													
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7; initial 5.3 pH value (before Cesium addition) from LGS UFSAR Sec. 6.1.1.2													
50	13	Max. Suppression Pool volume from Calc. body section 4.4, including													
51		UFSAR Table 6.2-4A HWL Suppression Pool volume of 134,600 cu ft, Reactor Coolant System Liquid Volume of 13,108 cu ft													
52		and low-pressure Emergency Core Cooling System sources, roundd up to 175,000 cu. Ft.													
53		(For Attachment B page B-6 minimization of Drywell + Suppression Pool Airspace volume, the LLRT Program													
54		403,120 cu ft value - 175,000 + 122,120 Tech Spec 3/4.5.3 nominal minimum Suppression Pool Volume is used)													

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1				pH TRANSIENT		END OF CYCLE							
2	**Cable Data** [22]												
3	2,425,858	Cable Surface [Trays] - DRYWELL [cm2]											
4	121,293	Cable Surface [Free air] - DRYWELL [cm2]					1008.67	g. mols $Na_2B_{10}O_{16}$*$10H_2O$ Added[21]					
5	0	Cable Surface [Free air] - Supp. Pool [cm2]					10086.71	g.atoms total boron					
6	0	Cable Surface [Trays] - Supp. Pool [cm2]											
7													
8						pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTION							
9													
10							Strong Acid						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}$*$10H_2O$	Borate	Boric Acid	pK_a	pH	
12	g-ions/liter			g-ions/liter	Before SLC	[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	[15]	
13	1.995E-09	1.369E+01	-2.101E-09	5.014E-06	5.30	6.867E-10	2.485E+01	1008.7	1992	8094	9.16	8.55	
14	6.534E-05	1.249E+01	5.380E-06	5.343E-09	8.27	1.226E-09	2.648E-02	1008.7	2017	8069	8.91	8.31	
15	1.422E-04	1.241E+01	1.392E-05	3.019E-09	8.52	1.276E-09	1.496E-02	1008.7	2017	8069	8.89	8.29	
16	1.448E-04	1.241E+01	1.427E-05	2.967E-09	8.53	1.276E-09	1.470E-02	1008.7	2017	8069	8.89	8.29	
17	1.448E-04	1.237E+01	2.296E-05	3.465E-09	8.46	1.300E-09	1.717E-02	1008.7	2017	8069	8.89	8.28	
18	1.448E-04	1.235E+01	3.675E-05	4.172E-09	8.38	1.319E-09	2.068E-02	1008.7	2017	8069	8.88	8.28	
19	1.448E-04	1.238E+01	6.599E-05	5.314E-09	8.27	1.298E-09	2.633E-02	1008.7	2017	8069	8.89	8.28	
20	1.448E-04	1.244E+01	8.186E-05	5.807E-09	8.24	1.261E-09	2.878E-02	1008.7	2017	8069	8.90	8.30	
21	1.448E-04	1.250E+01	9.425E-05	6.257E-09	8.20	1.223E-09	3.101E-02	1008.7	2017	8069	8.91	8.31	
22	1.448E-04	1.250E+01	1.298E-04	2.114E-08	7.67	1.223E-09	1.047E-01	1008.7	2017	8069	8.91	8.31	
23	1.448E-04	1.250E+01	1.447E-04	1.161E-05	4.94	1.223E-09	5.753E+01	1008.7	1960	8127	8.91	8.30	
24	1.448E-04	1.250E+01	1.448E-04	3.415E-05	4.47	1.223E-09	1.692E+02	1008.7	1848	8239	8.91	8.26	
25	1.448E-04	1.250E+01	1.448E-04	5.433E-05	4.26	1.223E-09	2.692E+02	1008.7	1748	8339	8.91	8.23	
26	1.448E-04	1.250E+01	1.448E-04	7.729E-05	4.11	1.223E-09	3.830E+02	1008.7	1634	8452	8.91	8.20	
27	1.448E-04	1.250E+01	1.448E-04	1.115E-04	3.95	1.223E-09	5.525E+02	1008.7	1465	8622	8.91	8.14	
28	1.448E-04	1.250E+01	1.448E-04	1.361E-04	3.87	1.223E-09	6.743E+02	1008.7	1343	8744	8.91	8.10	
29	1.448E-04	1.250E+01	1.448E-04	1.694E-04	3.77	1.223E-09	8.392E+02	1008.7	1178	8909	8.91	8.03	
30	1.448E-04	1.250E+01	1.448E-04	1.992E-04	3.70	1.223E-09	9.873E+02	1008.7	1030	9057	8.91	7.97	
31	1.448E-04	1.250E+01	1.448E-04	2.177E-04	3.66	1.223E-09	1.079E+03	1008.7	939	9148	8.91	7.92	
32	1.448E-04	1.250E+01	1.448E-04	2.516E-04	3.60	1.223E-09	1.247E+03	1008.7	770	9316	8.91	7.83	
33	1.448E-04	1.250E+01	1.448E-04	2.973E-04	3.53	1.223E-09	1.473E+03	1008.7	544	9543	8.91	7.67	
34	1.448E-04	1.250E+01	1.448E-04	3.321E-04	3.48	1.223E-09	1.646E+03	1008.7	372	9715	8.91	7.50	
35	1.448E-04	1.250E+01	1.448E-04	3.388E-04	3.47	1.223E-09	1.679E+03	1008.7	339	9748	8.91	7.45	
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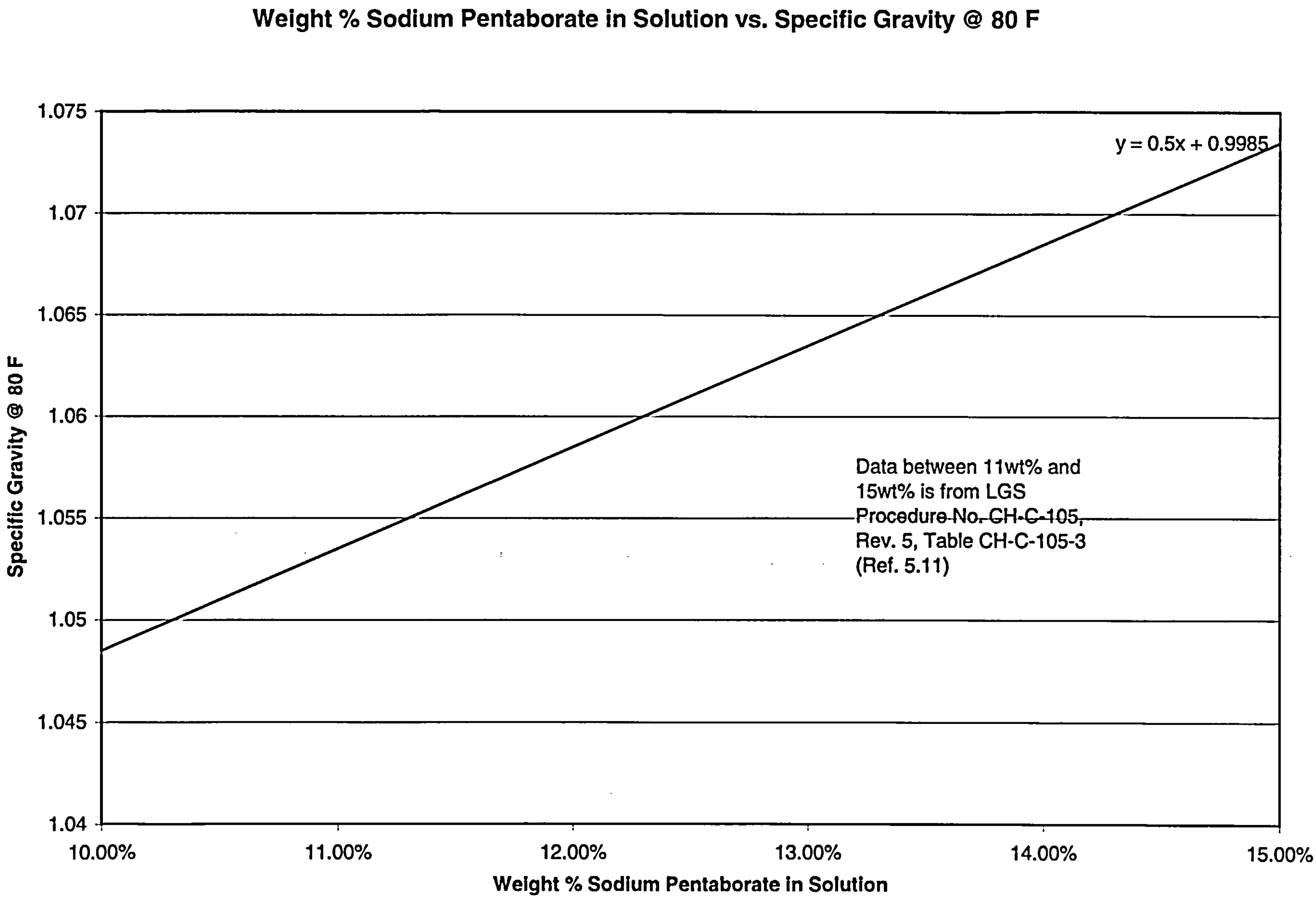

Weight % Sodium Pentaborate in Solution vs. Specific Gravity @ 80 F
Specific Gravity @ 80 F
1.075
1.07
1.065
1.06
1.055
1.05
1.045
1.04
10.00%
11.00%
12.00%
13.00%
14.00%
15.00%
Weight % Sodium Pentaborate in Solution
y = 0.5x + 0.9985
Data between 11wt% and 15wt% is from LGS Procedure No. CH-C-105, Rev. 5, Table CH-C-105-3 (Ref. 5.11)

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D	E
1	Available Boron Calculation				
2					
3					
4	Quantity	Value	Basis		
5					
6	Volume of Solution (gal)=	1.5000E+03	Assumed Minimum (LGS Tech Spec Sect. 4.1.5		
7			indicates 3160 gallons)		
8	wt% of $Na_2B_{10}O_{16}$*$10H_2O$=	10%	LGS Technical Specification figure 3.1.5-1		
9	Specific Gravity (gm/cm^3)=	1.0485	Table CH-C-105-3		
10	Conversion Factor (cm^3/gal)=	3785.41			
11	Conversion Factor (lbs/gm)=	0.0022			
12					
13	Total Mass of Solution (lbs)=	1.3125E+04			
14	Total $Na_2B_{10}O_{16}$*$10H_2O$ (lbs)=	1.3125E+03			
15	Total $Na_2B_{10}O_{16}$*$10H_2O$ (gm)=	5.9535E+05			
16	Total $Na_2B_{10}O_{16}$*$10H_2O$				
17	(gm-moles)=	1.0087E+03			
18	Total Boron (gm-atoms)=	1.0087E+04			
19					
20					
21	*Total Available Boron (lbs)=*	*2.4041E+02*			
22	*l Available Boron (gm-atoms)=*	*1.0087E+04*			
23					
24	B-10 Enrichment=	19.90%			
25					
26		Molar Mass		Total Molar Mass of	
27		(gm/mole)		$Na_2B_{10}O_{16}$ * $10H_2O$	
28	Sodium	22.99		590.2330	
29	*Boron*	*10.8110*			
30	Oxygen	16.00			
31	Hydrogen	1.01			
32	Boron-10	10.0129			
33	Boron-11	11.0093			
34					
35	Percentage of Total Boron=	18.3165%			

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D	E	F	G	H	I
1	LIMERICK					pH TRANSIENT	EGINNING OF CYCL		
2							Linear Absorption		
3	V_{POOL}	=175000*28.3168	Liters [175,000 ft3] 13				$U_{beta\ air}$	0.0198	1/cm
4	m_I	=170	Iodine inventory [g-atom				$U_{beta\ hypalon}$	52.08	1/cm
5	m_{Cs}	=1600	Cesium inventory [g-ato				$U_{gamma\ air}$	0.0000375	1/cm
6	t_{gap}	=121/3600	Onset of Gap release [h				$U_{gamma\ hypalon}$	0.099	1/cm
7							r [gamma free path-DRYWELL]	894.08	cm
8							r [gamma free path-SUPP POO	894.08	cm
9				INTEGRATED					
10			Beta+Gamma 18	Gamma 18	Beta 18	Gamma 18	Beta 18		
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp Pool AIR	Supp Pool AIR	[HI] 1	[HNO3] 2
12	Hours	Deg F 17	Mrad	MeV/cm3	MeV/cm3	MeV/cm3	MeV/cm3	g-mols/liter	g-mols/liter
13	0	95						0	
14	1	187.2						=$B$4/(120*$B$3)*($A14-(0.5+$B$6))+$B$4/(400*$B$3)	
15	2	195.8	0.100087111151012	3956052849546.56	1730013153896.35	3956052849546.56	1730013153896.35	=$B$4/(120*$B$3)*($A15-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C15
16	=0.5+1.5+B6	195.8	0.104365847573824	4120748284326.69	1802214752482.87	4120748284326.69	1802214752482.87	=$B$4/(120*$B$3)*($A16-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C16
17	3	199.9	0.215756878516613	8367522752309.87	3688722168022.81	8367522752309.87	3688722168022.81	=H$16	=0.0000073*$C17
18	5	203.1	0.398753951242835	15051283188018	6796717122483.9	15051283188018	6796717122483.9	=H$16	=0.0000073*$C18
19	12	199.5	0.829274158572949	28781202708989.2	14207462998066.7	28781202708989.2	14207462998066.7	=H$16	=0.0000073*$C19
20	18	193.1	1.08584565286588	35947219280802.3	18809856471831.5	35947219280802.3	18809856471831.5	=H$16	=0.0000073*$C20
21	24	186.6	1.29165941930598	41450203689486.6	22625236709381.3	41450203689486.6	22625236709381.3	=H$16	=0.0000073*$C21
22	48	186.6	1.88316646363286	57094527006647.7	34089477741320.3	57094527006647.7	34089477741320.3	=H$16	=0.0000073*$C22
23	72	186.6	2.31488045241861	68775684974726	42694278802823	68775684974726	42694278802823	=H$16	=0.0000073*$C23
24	96	186.6	2.67760819687578	78774903495935.1	49880534617235	78774903495935.1	49880534617235	=H$16	=0.0000073*$C24
25	120	186.6	3.0022610140995	87776415615034.7	56145093552860.5	87776415615034.7	56145093552860.5	=H$16	=0.0000073*$C25
26	150	186.6	3.37480313336637	98069389403685.5	63027129381434.4	98069389403685.5	63027129381434.4	=H$16	=0.0000073*$C26
27	200	186.6	3.94157016913884	113525022634318	72737793079027.3	113525022634318	72737793079027.3	=H$16	=0.0000073*$C27
28	240	186.6	4.35914715584886	124718856946027	79280404587774.5	124718856946027	79280404587774.5	=H$16	=0.0000073*$C28
29	300	186.6	4.93895422570735	139994683781518	87536763527759.8	139994683781518	87536763527759.8	=H$16	=0.0000073*$C29
30	360	186.6	5.47325714195057	153829094639737	94361689798228.1	153829094639737	94361689798228.1	=H$16	=0.0000073*$C30
31	400	186.6	5.80851378579049	162409963290567	98299968870279.8	162409963290567	98299968870279.8	=H$16	=0.0000073*$C31
32	480	186.6	6.43777056431354	178352381268313	105070419526278	178352381268313	105070419526278	=H$16	=0.0000073*$C32
33	600	186.6	7.30114927597588	199990905047147	113291889646017	199990905047147	113291889646017	=H$16	=0.0000073*$C33
34	700	186.6	7.96603186890977	216560042435043	119000318577454	216560042435043	119000318577454	=H$16	=0.0000073*$C34
35	720	186.6	8.09431558980373	219753186435482	120054170939062	219753186435482	120054170939062	=H$16	=0.0000073*$C35
36									
37	NOTES:						14	Acid dissociation constant from: Entergy Eng. Report GGNS-98	
38	1	Entergy Eng. Report					15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7	
39	2	Ibid, Equation 3-2b					16	See attachment B for gamma free paths	
40	3	Ibid, Equation 3-4d [3					17	LGS UFSAR Rev. 11	
41	4	Ibid, Table A-1					18	Attachment B	
42	5	Ibid, Equation 3-3a					19	Attachment B	
43	6	Ibid, Equation 3-3b					20	USNRC Reg. Guide 1.183	
44	7	Ibid, Equation 3-5a; E					21	See page C-6 of this attachment.	
45	8	Ibid, Equation 3-5b; E					22	Cable Data from Attachment A.	
46	9	Ibid, Equation 3-0a; E							
47	10	Ibid, Equation 3-5d; E							
48	11	Ibid, Equation 3-5d; E							
49	12	Ibid, Equation 3-5e; E							
50	13	Max. Suppression Po							
51		UFSAR Table 6.2-4A							
52		and low-pressure Em							
53		(For Attachment B pa							
54		403,120 cu ft value -							

	J	K	L
1		**Cable Data** [22]	
2	$S_{A\,tray}$ [cm^2]	=$P$3*1.1	Cable Surface [trays]- Drywell + 10% contingency
3	$S_{A\,fa}$ [cm^2]	=$P$4*1.1	Cable Surface [free air]- Drywell + 10% contingency
4	$S_{B\,tray}$ [cm^2]	=$P$6*0.95*1.1	Cable Surface [trays] - Supp. Pool + 10% contingency
5	$S_{B\,fa}$ [cm^2]	=P6*1.1*0.05	Cable Surface [free air] - Supp. Pool + 10% contingency
6			
7	th [cm]	0.62992	Hypalon Jacket Thickness [22]
8			
9			
10	From Beta	From Gamma	From Beta
11	[HCL] -DRYWELL[5]	[HCL] -DRYWELL[6]	[HCL] -CONTAIN[5]
12	g-mols/liter	g-mols/liter	g-mols/liter
13			
14			
15	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E15	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E15
16	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E16	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E16
17	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E17	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E17
18	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E18	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E18
19	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E19	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E19
20	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E20	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E20
21	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E21	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E21
22	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E22	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E22
23	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E23	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E23
24	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E24	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E24
25	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E25	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E25
26	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E26	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E26
27	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E27	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E27
28	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E28	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E28
29	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E29	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E29
30	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E30	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E30
31	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E31	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E31
32	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E32	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E32
33	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E33	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E33
34	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E34	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E34
35	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E35	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E35
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	M	N	O
1			
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9			
10	From Gamma		
11	[HCL] -CONTAIN[6]	Total [H+] [7]	[CsOH] [3]
12	g-mols/liter	g-ions/liter	g-mols/liter
13		=POWER(10,-$T$13)+$H13+$I13+$J13+$K13+$L13+$M13	0
14		=POWER(10,-$T$13)+$H14+$I14+$J14+$K14+$L14+$M14	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A14-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
15	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=POWER(10,-$T$13)+$H15+$I15+$J15+$K15+$L15+$M15	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A15-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
16	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=POWER(10,-$T$13)+$H16+$I16+$J16+$K16+$L16+$M16	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A16-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
17	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=POWER(10,-$T$13)+$H17+$I17+$J17+$K17+$L17+$M17	=$O$16
18	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=POWER(10,-$T$13)+$H18+$I18+$J18+$K18+$L18+$M18	=$O$16
19	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=POWER(10,-$T$13)+$H19+$I19+$J19+$K19+$L19+$M19	=$O$16
20	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=POWER(10,-$T$13)+$H20+$I20+$J20+$K20+$L20+$M20	=$O$16
21	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=POWER(10,-$T$13)+$H21+$I21+$J21+$K21+$L21+$M21	=$O$16
22	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=POWER(10,-$T$13)+$H22+$I22+$J22+$K22+$L22+$M22	=$O$16
23	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=POWER(10,-$T$13)+$H23+$I23+$J23+$K23+$L23+$M23	=$O$16
24	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=POWER(10,-$T$13)+$H24+$I24+$J24+$K24+$L24+$M24	=$O$16
25	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=POWER(10,-$T$13)+$H25+$I25+$J25+$K25+$L25+$M25	=$O$16
26	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=POWER(10,-$T$13)+$H26+$I26+$J26+$K26+$L26+$M26	=$O$16
27	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=POWER(10,-$T$13)+$H27+$I27+$J27+$K27+$L27+$M27	=$O$16
28	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=POWER(10,-$T$13)+$H28+$I28+$J28+$K28+$L28+$M28	=$O$16
29	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=POWER(10,-$T$13)+$H29+$I29+$J29+$K29+$L29+$M29	=$O$16
30	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=POWER(10,-$T$13)+$H30+$I30+$J30+$K30+$L30+$M30	=$O$16
31	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=POWER(10,-$T$13)+$H31+$I31+$J31+$K31+$L31+$M31	=$O$16
32	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=POWER(10,-$T$13)+$H32+$I32+$J32+$K32+$L32+$M32	=$O$16
33	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=POWER(10,-$T$13)+$H33+$I33+$J33+$K33+$L33+$M33	=$O$16
34	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=POWER(10,-$T$13)+$H34+$I34+$J34+$K34+$L34+$M34	=$O$16
35	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=POWER(10,-$T$13)+$H35+$I35+$J35+$K35+$L35+$M35	=$O$16
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	P	Q	R	S	T	U
1				pH TRANSIEN		BEGINNING OF CYCLE
2	**Cable Data** [22]					
3	2425857.59715346	Cable Surface [Trays] - DRYWELL [cm2]				
4	=$P$3*0.05	Cable Surface [Free air] - DRYWELL [cm2]				
5	=P6*0.05	Cable Surface [Free air] - Supp. Pool [cm2]				
6	0	Cable Surface [Trays] - Supp. Pool [cm2]				
7						
8						pH EFFECT
9						
10						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a
12	g-ions/liter			g-ions/liter	Before SLC	[14]
13	=POWER(10,-14)/POWER(10,-$T$13)+$O13	=15.5129-0.0224*$B13+0.00003352*POWER(B13,2)	=(N13+P13-SQRT(POWER(($N13+$P13),2)-(4*(N13*P13-POWER(10,-$Q13)))))/2	=$N13-$R13	5.3	=(0.0585*B13+1.309)/10000000000
14	=POWER(10,-14)/POWER(10,-$T$13)+$O14	=15.5129-0.0224*$B14+0.00003352*POWER(B14,2)	=(N14+P14-SQRT(POWER(($N14+$P14),2)-(4*(N14*P14-POWER(10,-$Q14)))))/2	=$N14-$R14	=-LOG10($S14)	=(0.0585*B14+1.309)/10000000000
15	=POWER(10,-14)/POWER(10,-$T$13)+$O15	=15.5129-0.0224*$B15+0.00003352*POWER(B15,2)	=(N15+P15-SQRT(POWER(($N15+$P15),2)-(4*(N15*P15-POWER(10,-$Q15)))))/2	=$N15-$R15	=-LOG10($S15)	=(0.0585*B15+1.309)/10000000000
16	=POWER(10,-14)/POWER(10,-$T$13)+$O16	=15.5129-0.0224*$B16+0.00003352*POWER(B16,2)	=(N16+P16-SQRT(POWER(($N16+$P16),2)-(4*(N16*P16-POWER(10,-$Q16)))))/2	=$N16-$R16	=-LOG10($S16)	=(0.0585*B16+1.309)/10000000000
17	=POWER(10,-14)/POWER(10,-$T$13)+$O17	=15.5129-0.0224*$B17+0.00003352*POWER(B17,2)	=(N17+P17-SQRT(POWER(($N17+$P17),2)-(4*(N17*P17-POWER(10,-$Q17)))))/2	=$N17-$R17	=-LOG10($S17)	=(0.0585*B17+1.309)/10000000000
18	=POWER(10,-14)/POWER(10,-$T$13)+$O18	=15.5129-0.0224*$B18+0.00003352*POWER(B18,2)	=(N18+P18-SQRT(POWER(($N18+$P18),2)-(4*(N18*P18-POWER(10,-$Q18)))))/2	=$N18-$R18	=-LOG10($S18)	=(0.0585*B18+1.309)/10000000000
19	=POWER(10,-14)/POWER(10,-$T$13)+$O19	=15.5129-0.0224*$B19+0.00003352*POWER(B19,2)	=(N19+P19-SQRT(POWER(($N19+$P19),2)-(4*(N19*P19-POWER(10,-$Q19)))))/2	=$N19-$R19	=-LOG10($S19)	=(0.0585*B19+1.309)/10000000000
20	=POWER(10,-14)/POWER(10,-$T$13)+$O20	=15.5129-0.0224*$B20+0.00003352*POWER(B20,2)	=(N20+P20-SQRT(POWER(($N20+$P20),2)-(4*(N20*P20-POWER(10,-$Q20)))))/2	=$N20-$R20	=-LOG10($S20)	=(0.0585*B20+1.309)/10000000000
21	=POWER(10,-14)/POWER(10,-$T$13)+$O21	=15.5129-0.0224*$B21+0.00003352*POWER(B21,2)	=(N21+P21-SQRT(POWER(($N21+$P21),2)-(4*(N21*P21-POWER(10,-$Q21)))))/2	=$N21-$R21	=-LOG10($S21)	=(0.0585*B21+1.309)/10000000000
22	=POWER(10,-14)/POWER(10,-$T$13)+$O22	=15.5129-0.0224*$B22+0.00003352*POWER(B22,2)	=(N22+P22-SQRT(POWER(($N22+$P22),2)-(4*(N22*P22-POWER(10,-$Q22)))))/2	=$N22-$R22	=-LOG10($S22)	=(0.0585*B22+1.309)/10000000000
23	=POWER(10,-14)/POWER(10,-$T$13)+$O23	=15.5129-0.0224*$B23+0.00003352*POWER(B23,2)	=(N23+P23-SQRT(POWER(($N23+$P23),2)-(4*(N23*P23-POWER(10,-$Q23)))))/2	=$N23-$R23	=-LOG10($S23)	=(0.0585*B23+1.309)/10000000000
24	=POWER(10,-14)/POWER(10,-$T$13)+$O24	=15.5129-0.0224*$B24+0.00003352*POWER(B24,2)	=(N24+P24-SQRT(POWER(($N24+$P24),2)-(4*(N24*P24-POWER(10,-$Q24)))))/2	=$N24-$R24	=-LOG10($S24)	=(0.0585*B24+1.309)/10000000000
25	=POWER(10,-14)/POWER(10,-$T$13)+$O25	=15.5129-0.0224*$B25+0.00003352*POWER(B25,2)	=(N25+P25-SQRT(POWER(($N25+$P25),2)-(4*(N25*P25-POWER(10,-$Q25)))))/2	=$N25-$R25	=-LOG10($S25)	=(0.0585*B25+1.309)/10000000000
26	=POWER(10,-14)/POWER(10,-$T$13)+$O26	=15.5129-0.0224*$B26+0.00003352*POWER(B26,2)	=(N26+P26-SQRT(POWER(($N26+$P26),2)-(4*(N26*P26-POWER(10,-$Q26)))))/2	=$N26-$R26	=-LOG10($S26)	=(0.0585*B26+1.309)/10000000000
27	=POWER(10,-14)/POWER(10,-$T$13)+$O27	=15.5129-0.0224*$B27+0.00003352*POWER(B27,2)	=(N27+P27-SQRT(POWER(($N27+$P27),2)-(4*(N27*P27-POWER(10,-$Q27)))))/2	=$N27-$R27	=-LOG10($S27)	=(0.0585*B27+1.309)/10000000000
28	=POWER(10,-14)/POWER(10,-$T$13)+$O28	=15.5129-0.0224*$B28+0.00003352*POWER(B28,2)	=(N28+P28-SQRT(POWER(($N28+$P28),2)-(4*(N28*P28-POWER(10,-$Q28)))))/2	=$N28-$R28	=-LOG10($S28)	=(0.0585*B28+1.309)/10000000000
29	=POWER(10,-14)/POWER(10,-$T$13)+$O29	=15.5129-0.0224*$B29+0.00003352*POWER(B29,2)	=(N29+P29-SQRT(POWER(($N29+$P29),2)-(4*(N29*P29-POWER(10,-$Q29)))))/2	=$N29-$R29	=-LOG10($S29)	=(0.0585*B29+1.309)/10000000000
30	=POWER(10,-14)/POWER(10,-$T$13)+$O30	=15.5129-0.0224*$B30+0.00003352*POWER(B30,2)	=(N30+P30-SQRT(POWER(($N30+$P30),2)-(4*(N30*P30-POWER(10,-$Q30)))))/2	=$N30-$R30	=-LOG10($S30)	=(0.0585*B30+1.309)/10000000000
31	=POWER(10,-14)/POWER(10,-$T$13)+$O31	=15.5129-0.0224*$B31+0.00003352*POWER(B31,2)	=(N31+P31-SQRT(POWER(($N31+$P31),2)-(4*(N31*P31-POWER(10,-$Q31)))))/2	=$N31-$R31	=-LOG10($S31)	=(0.0585*B31+1.309)/10000000000
32	=POWER(10,-14)/POWER(10,-$T$13)+$O32	=15.5129-0.0224*$B32+0.00003352*POWER(B32,2)	=(N32+P32-SQRT(POWER(($N32+$P32),2)-(4*(N32*P32-POWER(10,-$Q32)))))/2	=$N32-$R32	=-LOG10($S32)	=(0.0585*B32+1.309)/10000000000
33	=POWER(10,-14)/POWER(10,-$T$13)+$O33	=15.5129-0.0224*$B33+0.00003352*POWER(B33,2)	=(N33+P33-SQRT(POWER(($N33+$P33),2)-(4*(N33*P33-POWER(10,-$Q33)))))/2	=$N33-$R33	=-LOG10($S33)	=(0.0585*B33+1.309)/10000000000
34	=POWER(10,-14)/POWER(10,-$T$13)+$O34	=15.5129-0.0224*$B34+0.00003352*POWER(B34,2)	=(N34+P34-SQRT(POWER(($N34+$P34),2)-(4*(N34*P34-POWER(10,-$Q34)))))/2	=$N34-$R34	=-LOG10($S34)	=(0.0585*B34+1.309)/10000000000
35	=POWER(10,-14)/POWER(10,-$T$13)+$O35	=15.5129-0.0224*$B35+0.00003352*POWER(B35,2)	=(N35+P35-SQRT(POWER(($N35+$P35),2)-(4*(N35*P35-POWER(10,-$Q35)))))/2	=$N35-$R35	=-LOG10($S35)	=(0.0585*B35+1.309)/10000000000
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	V	W	X	Y	Z	AA
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4	='Available E	g. mols				
5	='Available E	g.atoms				
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8	OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTIOI					
9						
10	Strong Acid					
11	g-equiv.	$_{10}O_{16}$*1(	Borate	Boric Acid	pK_a	pH
12	et [H+] * V_{PO}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	15
13	=S13*$B$3	=$V$4	=W13*2-V13	=W13*8+V13	=-LOG10(U13)	=Z13+LOG10((X13/$B$3)/(Y13/$B$3))
14	=S14*$B$3	=$V$4	=W14*2-V14	=W14*8+V14	=-LOG10(U14)	=Z14+LOG10((X14/$B$3)/(Y14/$B$3))
15	=S15*$B$3	=$V$4	=W15*2-V15	=W15*8+V15	=-LOG10(U15)	=Z15+LOG10((X15/$B$3)/(Y15/$B$3))
16	=S16*$B$3	=$V$4	=W16*2-V16	=W16*8+V16	=-LOG10(U16)	=Z16+LOG10((X16/$B$3)/(Y16/$B$3))
17	=S17*$B$3	=$V$4	=W17*2-V17	=W17*8+V17	=-LOG10(U17)	=Z17+LOG10((X17/$B$3)/(Y17/$B$3))
18	=S18*$B$3	=$V$4	=W18*2-V18	=W18*8+V18	=-LOG10(U18)	=Z18+LOG10((X18/$B$3)/(Y18/$B$3))
19	=S19*$B$3	=$V$4	=W19*2-V19	=W19*8+V19	=-LOG10(U19)	=Z19+LOG10((X19/$B$3)/(Y19/$B$3))
20	=S20*$B$3	=$V$4	=W20*2-V20	=W20*8+V20	=-LOG10(U20)	=Z20+LOG10((X20/$B$3)/(Y20/$B$3))
21	=S21*$B$3	=$V$4	=W21*2-V21	=W21*8+V21	=-LOG10(U21)	=Z21+LOG10((X21/$B$3)/(Y21/$B$3))
22	=S22*$B$3	=$V$4	=W22*2-V22	=W22*8+V22	=-LOG10(U22)	=Z22+LOG10((X22/$B$3)/(Y22/$B$3))
23	=S23*$B$3	=$V$4	=W23*2-V23	=W23*8+V23	=-LOG10(U23)	=Z23+LOG10((X23/$B$3)/(Y23/$B$3))
24	=S24*$B$3	=$V$4	=W24*2-V24	=W24*8+V24	=-LOG10(U24)	=Z24+LOG10((X24/$B$3)/(Y24/$B$3))
25	=S25*$B$3	=$V$4	=W25*2-V25	=W25*8+V25	=-LOG10(U25)	=Z25+LOG10((X25/$B$3)/(Y25/$B$3))
26	=S26*$B$3	=$V$4	=W26*2-V26	=W26*8+V26	=-LOG10(U26)	=Z26+LOG10((X26/$B$3)/(Y26/$B$3))
27	=S27*$B$3	=$V$4	=W27*2-V27	=W27*8+V27	=-LOG10(U27)	=Z27+LOG10((X27/$B$3)/(Y27/$B$3))
28	=S28*$B$3	=$V$4	=W28*2-V28	=W28*8+V28	=-LOG10(U28)	=Z28+LOG10((X28/$B$3)/(Y28/$B$3))
29	=S29*$B$3	=$V$4	=W29*2-V29	=W29*8+V29	=-LOG10(U29)	=Z29+LOG10((X29/$B$3)/(Y29/$B$3))
30	=S30*$B$3	=$V$4	=W30*2-V30	=W30*8+V30	=-LOG10(U30)	=Z30+LOG10((X30/$B$3)/(Y30/$B$3))
31	=S31*$B$3	=$V$4	=W31*2-V31	=W31*8+V31	=-LOG10(U31)	=Z31+LOG10((X31/$B$3)/(Y31/$B$3))
32	=S32*$B$3	=$V$4	=W32*2-V32	=W32*8+V32	=-LOG10(U32)	=Z32+LOG10((X32/$B$3)/(Y32/$B$3))
33	=S33*$B$3	=$V$4	=W33*2-V33	=W33*8+V33	=-LOG10(U33)	=Z33+LOG10((X33/$B$3)/(Y33/$B$3))
34	=S34*$B$3	=$V$4	=W34*2-V34	=W34*8+V34	=-LOG10(U34)	=Z34+LOG10((X34/$B$3)/(Y34/$B$3))
35	=S35*$B$3	=$V$4	=W35*2-V35	=W35*8+V35	=-LOG10(U35)	=Z35+LOG10((X35/$B$3)/(Y35/$B$3))
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	A	B	C	D	E	F	G
1	**LIMERICK pH CALCULATION**					pH TRANSIENT	END OF CYCLE
2							Linear Absorption Coefficients [4]
3	V_{POOL}	=175000*28.3168	Liters [175,000 ft^3] [13]				$U_{beta\ air}$
4	m_I	=290	Iodine inventory [g-atoms] EOC [19]				$U_{beta\ hypalon}$
5	m_{Cs}	=3200	Cesium inventory [g-atoms] EOC [19]				$U_{gamma\ air}$
6	t_{gap}	=121/3600	Onset of Gap release [hrs] [20]				$U_{gamma\ hypalon}$
7							$r_{[gamma\ free\ path-DRYWELL]}$ [16]
8							$r_{[gamma\ free\ path-SUPP\ POOL\ AIR]}$ [16]
9				INTEGRATED DOSES			
10			Beta+Gamma [18]	Gamma [18]	Beta [18]	Gamma [18]	Beta [18]
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	Supp Pool AIR	Supp Pool AIR
12	Hours	Deg F [17]	Mrad	MeV/cm^3	MeV/cm^3	MeV/cm^3	MeV/cm^3
13	0	95					
14	1	187.2					
15	2	195.8	0.100087111151012	3956052849546.56	1730013153896.35	3956052849546.56	1730013153896.35
16	=0.5+1.5+B6	195.8	0.104365847573824	4120748284326.69	1802214752482.87	4120748284326.69	1802214752482.87
17	3	199.9	0.215756878516613	8367522752309.87	3688722168022.81	8367522752309.87	3688722168022.81
18	5	203.1	0.398753951242835	15051283188018	6796717122483.9	15051283188018	6796717122483.9
19	12	199.5	0.829274158572949	28781202708989.2	14207462998066.7	28781202708989.2	14207462998066.7
20	18	193.1	1.08584565286588	35947219280802.3	18809856471831.5	35947219280802.3	18809856471831.5
21	24	186.6	1.29165941930598	41450203689486.6	22625236709381.3	41450203689486.6	22625236709381.3
22	48	186.6	1.88316646363286	57094527006647.7	34089477741320.3	57094527006647.7	34089477741320.3
23	72	186.6	2.31488045241861	68775684974726	42694278802823	68775684974726	42694278802823
24	96	186.6	2.67760819687578	78774903495935.1	49880534617235	78774903495935.1	49880534617235
25	120	186.6	3.0022610140995	87776415615034.7	56145093552860.5	87776415615034.7	56145093552860.5
26	150	186.6	3.37480313336637	98069389403685.5	63027129381434.4	98069389403685.5	63027129381434.4
27	200	186.6	3.94157016913884	113525022634318	72737793079027.3	113525022634318	72737793079027.3
28	240	186.6	4.35914715584886	124718856946027	79280404587774.5	124718856946027	79280404587774.5
29	300	186.6	4.93895422570735	139994683781518	87536763527759.8	139994683781518	87536763527759.8
30	360	186.6	5.47325714195057	153829094639737	94361689798228.1	153829094639737	94361689798228.1
31	400	186.6	5.80851378579049	162409963290567	98299968870279.8	162409963290567	98299968870279.8
32	480	186.6	6.43777056431354	178352381268313	105070419526278	178352381268313	105070419526278
33	600	186.6	7.30114927597588	199990905047147	113291889646017	199990905047147	113291889646017
34	700	186.6	7.96603186890977	216560042435043	119000318577454	216560042435043	119000318577454
35	720	186.6	8.09431558980373	219753186435482	120054170939062	219753186435482	120054170939062
36							
37	NOTES:						14
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]					15
39	2	Ibid, Equation 3-2b					16
40	3	Ibid, Equation 3-4d [30+90 min release duration]					17
41	4	Ibid, Table A-1					18
42	5	Ibid, Equation 3-3a					19
43	6	Ibid, Equation 3-3b					20
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7					21
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					22
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7					
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5-7; initial 5.3 pH value (					
50	13	Max. Suppression Pool volume from Calc. body section 4.4, including					
51		UFSAR Table 6.2-4A HWL Suppression Pool volume of 134,600 cu ft, Reactor Coolant Syste					
52		and low-pressure Emergency Core Cooling System sources, roundd up to 175,000 cu. Ft.					
53		(For Attachment B page B-6 minimization of Drywell + Suppression Pool Airspace volume, the					
54		403,120 cu ft value - 175,000 + 122,120 Tech Spec 3/4.5.3 nominal minimum Suppression Po					

LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	H	I	J	K
1				Cable Data [22]
2			$S_{A\,tray}$ [cm^2]	=$P$3*1.1
3	0.0198	1/cm	$S_{A\,fa}$ [cm^2]	=$P$4*1.1
4	52.08	1/cm	$S_{B\,tray}$ [cm^2]	=$P$6*0.95*1.1
5	0.0000375	1/cm	$S_{B\,fa}$ [cm^2]	=P6*1.1*0.05
6	0.099	1/cm		
7	894.08	cm	th [cm]	0.70514
8	894.08	cm		
9				
10			From Beta	From Gamma
11	[HI] [1]	$[HNO_3]$ [2]	[HCL] -DRYWELL [5]	[HCL] -DRYWELL [6]
12	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter
13	0			
14	=$B$4/(120*$B$3)*($A14-(0.5+$B$6))+$B$4/(400*$B$3)			
15	=$B$4/(120*$B$3)*($A15-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C15	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E15	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D15
16	=$B$4/(120*$B$3)*($A16-(0.5+$B$6))+$B$4/(400*$B$3)	=0.0000073*$C16	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E16	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D16
17	=H$16	=0.0000073*$C17	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E17	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D17
18	=H$16	=0.0000073*$C18	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E18	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D18
19	=H$16	=0.0000073*$C19	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E19	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D19
20	=H$16	=0.0000073*$C20	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E20	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D20
21	=H$16	=0.0000073*$C21	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E21	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D21
22	=H$16	=0.0000073*$C22	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E22	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D22
23	=H$16	=0.0000073*$C23	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E23	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D23
24	=H$16	=0.0000073*$C24	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E24	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D24
25	=H$16	=0.0000073*$C25	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E25	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D25
26	=H$16	=0.0000073*$C26	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E26	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D26
27	=H$16	=0.0000073*$C27	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E27	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D27
28	=H$16	=0.0000073*$C28	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E28	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D28
29	=H$16	=0.0000073*$C29	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E29	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D29
30	=H$16	=0.0000073*$C30	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E30	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D30
31	=H$16	=0.0000073*$C31	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E31	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D31
32	=H$16	=0.0000073*$C32	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E32	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D32
33	=H$16	=0.0000073*$C33	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E33	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D33
34	=H$16	=0.0000073*$C34	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E34	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D34
35	=H$16	=0.0000073*$C35	=3.512E-20/$B$3*($K$2*0.95/2+$K$3)/$H$3*$E35	=3.512E-20/$B$3*($K$2*0.95+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D35
36				
37	Acid dissociation constant from: Entergy Eng. Report GGNS-98-0039 Rev.3, Sect.6.1,p.21			
38	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7			
39	See attachment B for gamma free paths			
40	LGS UFSAR Rev. 11)			
41	Attachment B			
42	Attachment B			
43	USNRC Reg. Guide 1.183			
44	Page C-6 of this attachment			
45	Cable Data from Attachment A.			
46				
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	L	M	N
1			
2	Cable Surface [trays]- Drywell + 10% contingency		
3	Cable Surface [free air]- Drywell + 10% contingency		
4	Cable Surface [trays] - Supp. Pool + 10% contingency		
5	Cable Surface [free air] - Supp. Pool + 10% contingency		
6			
7	Hypalon Jacket Thickness [22]		
8			
9			
10	From Beta	From Gamma	
11	[HCL] -CONTAIN[5]	[HCL] -CONTAIN[6]	Total [H+] [7]
12	g-mols/liter	g-mols/liter	g-ions/liter
13			=POWER(10,-$T$13)+$H13+$I13+$J13+$K13+$L13+$M13
14			=POWER(10,-$T$13)+$H14+$I14+$J14+$K14+$L14+$M14
15	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E15	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=POWER(10,-$T$13)+$H15+$I15+$J15+$K15+$L15+$M15
16	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E16	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=POWER(10,-$T$13)+$H16+$I16+$J16+$K16+$L16+$M16
17	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E17	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=POWER(10,-$T$13)+$H17+$I17+$J17+$K17+$L17+$M17
18	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E18	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=POWER(10,-$T$13)+$H18+$I18+$J18+$K18+$L18+$M18
19	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E19	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=POWER(10,-$T$13)+$H19+$I19+$J19+$K19+$L19+$M19
20	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E20	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=POWER(10,-$T$13)+$H20+$I20+$J20+$K20+$L20+$M20
21	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E21	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=POWER(10,-$T$13)+$H21+$I21+$J21+$K21+$L21+$M21
22	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E22	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=POWER(10,-$T$13)+$H22+$I22+$J22+$K22+$L22+$M22
23	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E23	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=POWER(10,-$T$13)+$H23+$I23+$J23+$K23+$L23+$M23
24	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E24	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=POWER(10,-$T$13)+$H24+$I24+$J24+$K24+$L24+$M24
25	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E25	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=POWER(10,-$T$13)+$H25+$I25+$J25+$K25+$L25+$M25
26	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E26	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=POWER(10,-$T$13)+$H26+$I26+$J26+$K26+$L26+$M26
27	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E27	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=POWER(10,-$T$13)+$H27+$I27+$J27+$K27+$L27+$M27
28	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E28	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=POWER(10,-$T$13)+$H28+$I28+$J28+$K28+$L28+$M28
29	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E29	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=POWER(10,-$T$13)+$H29+$I29+$J29+$K29+$L29+$M29
30	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E30	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=POWER(10,-$T$13)+$H30+$I30+$J30+$K30+$L30+$M30
31	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E31	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=POWER(10,-$T$13)+$H31+$I31+$J31+$K31+$L31+$M31
32	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E32	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=POWER(10,-$T$13)+$H32+$I32+$J32+$K32+$L32+$M32
33	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E33	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=POWER(10,-$T$13)+$H33+$I33+$J33+$K33+$L33+$M33
34	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E34	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=POWER(10,-$T$13)+$H34+$I34+$J34+$K34+$L34+$M34
35	=3.512E-20/$B$3*($K$4*0.95/2+$K$5)/$H$3*$E35	=3.512E-20/$B$3*($K$4*0.95+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=POWER(10,-$T$13)+$H35+$I35+$J35+$K35+$L35+$M35
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	O	P	Q
1			
2		**Cable Data** [22]	
3		2425857.59715346	Cable Surface [Trays] - DRYWELL [cm2]
4		=$P$3*0.05	Cable Surface [Free air] - DRYWELL [cm2]
5		=P6*0.05	Cable Surface [Free air] - TORUS [cm2]
6		0	Cable Surface [Trays] - TORUS [cm2]
7			
8			
9			
10			
11	[CsOH] [3]	Total [OH+] [8]	-LOG(Kw) [9]
12	g-mols/liter	g-ions/liter	
13	0	=POWER(10,-14)/POWER(10,-$T$13)+$O13	=15.5129-0.0224*$B13+0.00003352*POWER(B13,2)
14	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A14-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3	=POWER(10,-14)/POWER(10,-$T$13)+$O14	=15.5129-0.0224*$B14+0.00003352*POWER(B14,2)
15	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A15-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3	=POWER(10,-14)/POWER(10,-$T$13)+$O15	=15.5129-0.0224*$B15+0.00003352*POWER(B15,2)
16	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A16-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3	=POWER(10,-14)/POWER(10,-$T$13)+$O16	=15.5129-0.0224*$B16+0.00003352*POWER(B16,2)
17	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O17	=15.5129-0.0224*$B17+0.00003352*POWER(B17,2)
18	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O18	=15.5129-0.0224*$B18+0.00003352*POWER(B18,2)
19	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O19	=15.5129-0.0224*$B19+0.00003352*POWER(B19,2)
20	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O20	=15.5129-0.0224*$B20+0.00003352*POWER(B20,2)
21	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O21	=15.5129-0.0224*$B21+0.00003352*POWER(B21,2)
22	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O22	=15.5129-0.0224*$B22+0.00003352*POWER(B22,2)
23	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O23	=15.5129-0.0224*$B23+0.00003352*POWER(B23,2)
24	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O24	=15.5129-0.0224*$B24+0.00003352*POWER(B24,2)
25	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O25	=15.5129-0.0224*$B25+0.00003352*POWER(B25,2)
26	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O26	=15.5129-0.0224*$B26+0.00003352*POWER(B26,2)
27	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O27	=15.5129-0.0224*$B27+0.00003352*POWER(B27,2)
28	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O28	=15.5129-0.0224*$B28+0.00003352*POWER(B28,2)
29	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O29	=15.5129-0.0224*$B29+0.00003352*POWER(B29,2)
30	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O30	=15.5129-0.0224*$B30+0.00003352*POWER(B30,2)
31	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O31	=15.5129-0.0224*$B31+0.00003352*POWER(B31,2)
32	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O32	=15.5129-0.0224*$B32+0.00003352*POWER(B32,2)
33	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O33	=15.5129-0.0224*$B33+0.00003352*POWER(B33,2)
34	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O34	=15.5129-0.0224*$B34+0.00003352*POWER(B34,2)
35	=$O$16	=POWER(10,-14)/POWER(10,-$T$13)+$O35	=15.5129-0.0224*$B35+0.00003352*POWER(B35,2)
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	R	S	T	U	V	W	X	Y
1		pH TRANSIENT		END OF CYCLE				
2								
3								
4					='Available Boron'!B17	g. mols $Na_2B_{10}O_{16}$*$10H_2O$ Added		
5					='Available Boron'!B22	g.atoms total boron		
6								
7								
8				pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CO				
9								
10					Strong Acid			
11	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}$*$10H_2O$	Borate	Boric Acid
12		g-ions/liter	Before SLC	[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.
13	=(N13+P13-SQRT(POWER(($N13+$P13),2)-(4*(N13*P13-POWER(10,-$Q13)))))/2	=$N13-$R13	5.3	=(0.0585*B13+1.309)/10000000000	=S13*$B$3	=$V$4	=W13*2-V13	=W13*8+V13
14	=(N14+P14-SQRT(POWER(($N14+$P14),2)-(4*(N14*P14-POWER(10,-$Q14)))))/2	=$N14-$R14	=-LOG10($S14)	=(0.0585*B14+1.309)/10000000000	=S14*$B$3	=$V$4	=W14*2-V14	=W14*8+V14
15	=(N15+P15-SQRT(POWER(($N15+$P15),2)-(4*(N15*P15-POWER(10,-$Q15)))))/2	=$N15-$R15	=-LOG10($S15)	=(0.0585*B15+1.309)/10000000000	=S15*$B$3	=$V$4	=W15*2-V15	=W15*8+V15
16	=(N16+P16-SQRT(POWER(($N16+$P16),2)-(4*(N16*P16-POWER(10,-$Q16)))))/2	=$N16-$R16	=-LOG10($S16)	=(0.0585*B16+1.309)/10000000000	=S16*$B$3	=$V$4	=W16*2-V16	=W16*8+V16
17	=(N17+P17-SQRT(POWER(($N17+$P17),2)-(4*(N17*P17-POWER(10,-$Q17)))))/2	=$N17-$R17	=-LOG10($S17)	=(0.0585*B17+1.309)/10000000000	=S17*$B$3	=$V$4	=W17*2-V17	=W17*8+V17
18	=(N18+P18-SQRT(POWER(($N18+$P18),2)-(4*(N18*P18-POWER(10,-$Q18)))))/2	=$N18-$R18	=-LOG10($S18)	=(0.0585*B18+1.309)/10000000000	=S18*$B$3	=$V$4	=W18*2-V18	=W18*8+V18
19	=(N19+P19-SQRT(POWER(($N19+$P19),2)-(4*(N19*P19-POWER(10,-$Q19)))))/2	=$N19-$R19	=-LOG10($S19)	=(0.0585*B19+1.309)/10000000000	=S19*$B$3	=$V$4	=W19*2-V19	=W19*8+V19
20	=(N20+P20-SQRT(POWER(($N20+$P20),2)-(4*(N20*P20-POWER(10,-$Q20)))))/2	=$N20-$R20	=-LOG10($S20)	=(0.0585*B20+1.309)/10000000000	=S20*$B$3	=$V$4	=W20*2-V20	=W20*8+V20
21	=(N21+P21-SQRT(POWER(($N21+$P21),2)-(4*(N21*P21-POWER(10,-$Q21)))))/2	=$N21-$R21	=-LOG10($S21)	=(0.0585*B21+1.309)/10000000000	=S21*$B$3	=$V$4	=W21*2-V21	=W21*8+V21
22	=(N22+P22-SQRT(POWER(($N22+$P22),2)-(4*(N22*P22-POWER(10,-$Q22)))))/2	=$N22-$R22	=-LOG10($S22)	=(0.0585*B22+1.309)/10000000000	=S22*$B$3	=$V$4	=W22*2-V22	=W22*8+V22
23	=(N23+P23-SQRT(POWER(($N23+$P23),2)-(4*(N23*P23-POWER(10,-$Q23)))))/2	=$N23-$R23	=-LOG10($S23)	=(0.0585*B23+1.309)/10000000000	=S23*$B$3	=$V$4	=W23*2-V23	=W23*8+V23
24	=(N24+P24-SQRT(POWER(($N24+$P24),2)-(4*(N24*P24-POWER(10,-$Q24)))))/2	=$N24-$R24	=-LOG10($S24)	=(0.0585*B24+1.309)/10000000000	=S24*$B$3	=$V$4	=W24*2-V24	=W24*8+V24
25	=(N25+P25-SQRT(POWER(($N25+$P25),2)-(4*(N25*P25-POWER(10,-$Q25)))))/2	=$N25-$R25	=-LOG10($S25)	=(0.0585*B25+1.309)/10000000000	=S25*$B$3	=$V$4	=W25*2-V25	=W25*8+V25
26	=(N26+P26-SQRT(POWER(($N26+$P26),2)-(4*(N26*P26-POWER(10,-$Q26)))))/2	=$N26-$R26	=-LOG10($S26)	=(0.0585*B26+1.309)/10000000000	=S26*$B$3	=$V$4	=W26*2-V26	=W26*8+V26
27	=(N27+P27-SQRT(POWER(($N27+$P27),2)-(4*(N27*P27-POWER(10,-$Q27)))))/2	=$N27-$R27	=-LOG10($S27)	=(0.0585*B27+1.309)/10000000000	=S27*$B$3	=$V$4	=W27*2-V27	=W27*8+V27
28	=(N28+P28-SQRT(POWER(($N28+$P28),2)-(4*(N28*P28-POWER(10,-$Q28)))))/2	=$N28-$R28	=-LOG10($S28)	=(0.0585*B28+1.309)/10000000000	=S28*$B$3	=$V$4	=W28*2-V28	=W28*8+V28
29	=(N29+P29-SQRT(POWER(($N29+$P29),2)-(4*(N29*P29-POWER(10,-$Q29)))))/2	=$N29-$R29	=-LOG10($S29)	=(0.0585*B29+1.309)/10000000000	=S29*$B$3	=$V$4	=W29*2-V29	=W29*8+V29
30	=(N30+P30-SQRT(POWER(($N30+$P30),2)-(4*(N30*P30-POWER(10,-$Q30)))))/2	=$N30-$R30	=-LOG10($S30)	=(0.0585*B30+1.309)/10000000000	=S30*$B$3	=$V$4	=W30*2-V30	=W30*8+V30
31	=(N31+P31-SQRT(POWER(($N31+$P31),2)-(4*(N31*P31-POWER(10,-$Q31)))))/2	=$N31-$R31	=-LOG10($S31)	=(0.0585*B31+1.309)/10000000000	=S31*$B$3	=$V$4	=W31*2-V31	=W31*8+V31
32	=(N32+P32-SQRT(POWER(($N32+$P32),2)-(4*(N32*P32-POWER(10,-$Q32)))))/2	=$N32-$R32	=-LOG10($S32)	=(0.0585*B32+1.309)/10000000000	=S32*$B$3	=$V$4	=W32*2-V32	=W32*8+V32
33	=(N33+P33-SQRT(POWER(($N33+$P33),2)-(4*(N33*P33-POWER(10,-$Q33)))))/2	=$N33-$R33	=-LOG10($S33)	=(0.0585*B33+1.309)/10000000000	=S33*$B$3	=$V$4	=W33*2-V33	=W33*8+V33
34	=(N34+P34-SQRT(POWER(($N34+$P34),2)-(4*(N34*P34-POWER(10,-$Q34)))))/2	=$N34-$R34	=-LOG10($S34)	=(0.0585*B34+1.309)/10000000000	=S34*$B$3	=$V$4	=W34*2-V34	=W34*8+V34
35	=(N35+P35-SQRT(POWER(($N35+$P35),2)-(4*(N35*P35-POWER(10,-$Q35)))))/2	=$N35-$R35	=-LOG10($S35)	=(0.0585*B35+1.309)/10000000000	=S35*$B$3	=$V$4	=W35*2-V35	=W35*8+V35
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	Z	AA	AB
1			
2			
3			
4			
5			
6			
7			
8	NTROL [SLC] SOLUTION		
9			
10			
11	pK_a	pH	
12	$-\log_{10}K_a$	15	
13	=-LOG10(U13)	=Z13+LOG10((X13/$B$3)/(Y13/$B$3))	
14	=-LOG10(U14)	=Z14+LOG10((X14/$B$3)/(Y14/$B$3))	
15	=-LOG10(U15)	=Z15+LOG10((X15/$B$3)/(Y15/$B$3))	
16	=-LOG10(U16)	=Z16+LOG10((X16/$B$3)/(Y16/$B$3))	
17	=-LOG10(U17)	=Z17+LOG10((X17/$B$3)/(Y17/$B$3))	
18	=-LOG10(U18)	=Z18+LOG10((X18/$B$3)/(Y18/$B$3))	
19	=-LOG10(U19)	=Z19+LOG10((X19/$B$3)/(Y19/$B$3))	
20	=-LOG10(U20)	=Z20+LOG10((X20/$B$3)/(Y20/$B$3))	
21	=-LOG10(U21)	=Z21+LOG10((X21/$B$3)/(Y21/$B$3))	
22	=-LOG10(U22)	=Z22+LOG10((X22/$B$3)/(Y22/$B$3))	
23	=-LOG10(U23)	=Z23+LOG10((X23/$B$3)/(Y23/$B$3))	
24	=-LOG10(U24)	=Z24+LOG10((X24/$B$3)/(Y24/$B$3))	
25	=-LOG10(U25)	=Z25+LOG10((X25/$B$3)/(Y25/$B$3))	
26	=-LOG10(U26)	=Z26+LOG10((X26/$B$3)/(Y26/$B$3))	
27	=-LOG10(U27)	=Z27+LOG10((X27/$B$3)/(Y27/$B$3))	
28	=-LOG10(U28)	=Z28+LOG10((X28/$B$3)/(Y28/$B$3))	
29	=-LOG10(U29)	=Z29+LOG10((X29/$B$3)/(Y29/$B$3))	
30	=-LOG10(U30)	=Z30+LOG10((X30/$B$3)/(Y30/$B$3))	
31	=-LOG10(U31)	=Z31+LOG10((X31/$B$3)/(Y31/$B$3))	
32	=-LOG10(U32)	=Z32+LOG10((X32/$B$3)/(Y32/$B$3))	
33	=-LOG10(U33)	=Z33+LOG10((X33/$B$3)/(Y33/$B$3))	
34	=-LOG10(U34)	=Z34+LOG10((X34/$B$3)/(Y34/$B$3))	
35	=-LOG10(U35)	=Z35+LOG10((X35/$B$3)/(Y35/$B$3))	
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LIMERICK GENERATING STATION
TRANSIENT POOL pH CALCULATION

	A	B	C	D
1				
2	**Available Boron Calculation**			
3				
4	**Quantity**	**Value**	**Basis**	
5				
6	**Volume of Solution (gal)=**	1500	Assumed Minimum (LGS Tech Spec Sect. 4	
7			indicates 3160 gallons)	
8	**wt% of Na2B10O16*10H2O=**	0.1	LGS Technical Specification figure 3.1.5-1	
9	**Specific Gravity (gm/cm3)=**	=0.5*($B$8)+0.9985	Table CH-C-105-3	
10	**Conversion Factor (cm3/gal)=**	3785.412		
11	**Conversion Factor (lbs/gm)=**	=(1/453.59)		
12				
13	**Total Mass of Solution (lbs)=**	=B6*B9*B10*B11		
14	**Total $Na_2B_{10}O_{16}$*$10H_2O$ (lbs)=**	=B13*B8		
15	**Total $Na_2B_{10}O_{16}$*$10H_2O$ (gm)=**	=B14/B11		
16	**Total $Na_2B_{10}O_{16}$*$10H_2O$**			
17	**(gm-moles)=**	=B15/D28		
18	**Total Boron (gm-atoms)=**	=10*B17		
19				
20				
21	***Total Available Boron (lbs)=***	=B14*B35		
22	***Total Available Boron (gm-atoms)=***	=(B21/B11)/B29		
23				
24	**B-10 Enrichment=**	0.199		
25				
26		Molar Mass		Total Molar Mass of
27		(gm/mole)		Na2B10O16 * 10H2O
28	**Sodium**	22.98977		=2*(B28)+10*(B29)+16*(B30)+10*((2*B31)+(1*(B30)))
29	**Boron**	=B32*(B24)+B33*(1-B24)		
30	**Oxygen**	15.9994		
31	**Hydrogen**	1.00794		
32	**Boron-10**	10.0129369		
33	**Boron-11**	11.0093054		
34				
35	**Percentage of Total Boron=**	=10*(B29)/D28		

GRAND GULF REFERENCE CALCULATION

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	CASE 1	GRAND GULF REFERENCE DATA			pH TRANSIENT											
2							Linear Absorption Coefficients [4]			$L_{A\ tray}$ [lb]	873.65	Cable Length [trays]- Zone A				SLC [lbs]
3	V_{POOL}	4.841E+06	Liters [Min.Tech Spec Basis B 3.6.2.2]				$u_{beta\ air}$	1.980E-02	1/cm	$L_{A\ fa}$ [lb]	873.65	Cable Length [free air]- Zone A				
4	m_I	325	Iodine inventory [g-atoms]				$u_{beta\ hypalon}$	52.08	1/cm	$L_{B\ tray}$ [lb]	14049.27	Cable Length [trays] - Zone B				
5	m_{Cs}	2400	Cesium inventory [g-atoms]				$u_{gamma\ air}$	3.75E-05	1/cm	$L_{B\ fa}$ [lb]	1561.03	Cable Length [free air] - Zone B				
6	t_{gap}	0.0336	Onset of Gap release [hrs]				$u_{gamma\ hypalon}$	0.099	1/cm	R_0 [cm^2]/lb	800	Cable Area				
7							$r_{[gamma\ free\ path-A]}$	1112.5	cm	th [cm]	0.7112	Hypalon Jacket Thickness [13]				
8							$r_{[gamma\ free\ path-B]}$	1384	cm							
9				INTEGRATED DOSES						CONCENTRATIONS						
10			Beta+Gamma	Gamma	Beta	Gamma	Beta			From Beta	From Gamma	From Beta	From Gamma			
11	TIME	POOL Temp	POOL	DRYWELL	DRYWELL	CONTAINMENT	CONTAINMENT	[HI] [1]	[HNO_3] [2]	[HCL] -A [5]	[HCL] -A [6]	[HCL] -B [5]	[HCL] -B [6]	Total [H+] [7]	[CsOH] [3]	Total [OH+] [8]
12	Hours	Deg F	Mrad	MeV/cm^3	MeV/cm^3	MeV/cm^3	MeV/cm^3	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter	g-ions/liter	g-mols/liter	g-ions/liter
13	0	77						0.00E+00						5.012E-06	0.0000E+00	2.00E-09
14	1	160						4.288E-07						5.441E-06	4.7472E-05	4.75E-05
15	2	160	1.3645E-01	1.4200E+12	2.8733E+12	0.0000E+00	1.1220E+12	9.8825E-07	9.961E-07	1.104E-06	1.067E-06	2.824E-06	0.000E+00	1.199E-05	1.0295E-04	1.03E-04
16	2.0336	160	1.4229E-01	1.4506E+12	2.8784E+12	0.0000E+00	1.2148E+12	1.0071E-06	1.039E-06	1.106E-06	1.090E-06	3.057E-06	0.000E+00	1.231E-05	1.0481E-04	1.05E-04
17	3	159.1	2.9415E-01	2.1630E+12	3.0235E+12	6.6925E+10	1.2908E+12	1.0071E-06	2.147E-06	1.161E-06	1.625E-06	3.249E-06	5.560E-07	1.476E-05	1.0481E-04	1.05E-04
18	5	155.5	5.4364E-01	3.0991E+12	3.3208E+12	6.4671E+11	1.4468E+12	1.0071E-06	3.969E-06	1.276E-06	2.328E-06	3.641E-06	5.373E-06	2.261E-05	1.0481E-04	1.05E-04
19	12	149.2	1.1306E+00	4.7032E+12	4.3312E+12	1.6404E+12	1.9789E+12	1.0071E-06	8.253E-06	1.664E-06	3.533E-06	4.980E-06	1.363E-05	3.808E-05	1.0481E-04	1.05E-04
20	18	146.4	1.4804E+00	5.4462E+12	5.1609E+12	2.1006E+12	2.4183E+12	1.0071E-06	1.081E-05	1.982E-06	4.091E-06	6.086E-06	1.745E-05	4.644E-05	1.0481E-04	1.05E-04
21	24	144.3	1.7610E+00	5.9733E+12	5.9584E+12	2.4271E+12	2.8430E+12	1.0071E-06	1.286E-05	2.289E-06	4.487E-06	7.155E-06	2.016E-05	5.297E-05	1.0481E-04	1.05E-04
22	48	139.4	2.5674E+00	7.2434E+12	8.8503E+12	3.2138E+12	4.4038E+12	1.0071E-06	1.874E-05	3.400E-06	5.442E-06	1.108E-05	2.670E-05	7.138E-05	1.0481E-04	1.05E-04
23	72	136.5	3.1560E+00	7.9863E+12	1.1319E+13	3.6740E+12	5.7649E+12	1.0071E-06	2.304E-05	4.348E-06	6.000E-06	1.451E-05	3.052E-05	8.444E-05	1.0481E-04	1.05E-04
24	96	134.4	3.6505E+00	8.5135E+12	1.3425E+13	4.0005E+12	6.9521E+12	1.0071E-06	2.665E-05	5.157E-06	6.396E-06	1.750E-05	3.323E-05	9.495E-05	1.0481E-04	1.05E-04
25	120	132.8	4.0931E+00	8.9224E+12	1.5224E+13	4.2538E+12	7.9874E+12	1.0071E-06	2.988E-05	5.848E-06	6.703E-06	2.010E-05	3.534E-05	1.039E-04	1.0481E-04	1.05E-04
26	150	131.3	4.6010E+00	9.3312E+12	1.7105E+13	4.5071E+12	9.0975E+12	1.0071E-06	3.359E-05	6.571E-06	7.010E-06	2.290E-05	3.744E-05	1.135E-04	1.0481E-04	1.05E-04
27	200	129.2	5.3738E+00	9.8584E+12	1.9521E+13	4.8336E+12	1.0574E+13	1.0071E-06	3.923E-05	7.499E-06	7.406E-06	2.661E-05	4.016E-05	1.269E-04	1.0481E-04	1.05E-04
28	240	127.9	5.9431E+00	1.0192E+13	2.0955E+13	5.0405E+12	1.1486E+13	1.0071E-06	4.338E-05	8.050E-06	7.657E-06	2.891E-05	4.187E-05	1.359E-04	1.0481E-04	1.05E-04
29	300	126.3	6.7335E+00	1.0601E+13	2.2506E+13	5.2938E+12	1.2519E+13	1.0071E-06	4.915E-05	8.645E-06	7.964E-06	3.151E-05	4.398E-05	1.473E-04	1.0481E-04	1.05E-04
30	360	125	7.4620E+00	1.0935E+13	2.3551E+13	5.5007E+12	1.3252E+13	1.0071E-06	5.447E-05	9.047E-06	8.215E-06	3.335E-05	4.570E-05	1.568E-04	1.0481E-04	1.05E-04
31	400	124.3	7.9191E+00	1.1128E+13	2.4049E+13	5.6203E+12	1.3618E+13	1.0071E-06	5.781E-05	9.238E-06	8.360E-06	3.427E-05	4.669E-05	1.624E-04	1.0481E-04	1.05E-04
32	480	123	8.7770E+00	1.1463E+13	2.4727E+13	5.8272E+12	1.4143E+13	1.0071E-06	6.407E-05	9.499E-06	8.612E-06	3.559E-05	4.841E-05	1.722E-04	1.0481E-04	1.05E-04
33	600	121.4	9.9540E+00	1.1871E+13	2.5259E+13	6.0805E+12	1.4592E+13	1.0071E-06	7.266E-05	9.703E-06	8.918E-06	3.672E-05	5.051E-05	1.845E-04	1.0481E-04	1.05E-04
34	700	120.3	1.0861E+01	1.2154E+13	2.5472E+13	6.2555E+12	1.4791E+13	1.0071E-06	7.928E-05	9.785E-06	9.131E-06	3.722E-05	5.197E-05	1.934E-04	1.0481E-04	1.05E-04
35	720	120.1	1.1035E+01	1.2205E+13	2.5500E+13	6.2875E+12	1.4819E+13	1.0071E-06	8.056E-05	9.795E-06	9.169E-06	3.729E-05	5.223E-05	1.951E-04	1.0481E-04	1.05E-04
36																
37	NOTES															
38	1	Entergy Eng. Report GGNS-98-0039 Rev.3 , Equation 3-1d [30+90 min release duration]						14	Acid dissociation constant from: Entergy Eng. Rep. GGNS-98-0039 Rev.3, Sect.6.1,p.21							
39	2	Ibid, Equation 3-2b						15	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7							
40	3	Ibid, Equation 3-4d [30+90 min release duration]														
41	4	Ibid, Table A-1														
42	5	Ibid, Equation 3-3a; Entergy Calc. XC-Q11111-98013 Rev.2, Equation 5-1														
43	6	Ibid, Equation 3-3b; Entergy Calc. XC-Q11111-98013 Rev.2, Equation 5-2														
44	7	Ibid, Equation 3-5a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
45	8	Ibid, Equation 3-5b; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
46	9	Ibid, Equation 3-0a; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
47	10	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
48	11	Ibid, Equation 3-5d; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
49	12	Ibid, Equation 3-5e; Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.7														
50	13	Entergy Calc. XC-Q11111-98013 Rev.2, Section 5.2.2														

GRAND GULF REFERENCE CALCULATION

	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1													
2	5800	$Na_2B_{10}O_{16}$ Added [MW=410]											
3													
4													
5													
6													
7													
8					pH EFFECT OF ADDITION OF SODIUM PENTABORATE STANDBY LIQUID CONTROL [SLC] SOLUTION								
9													
10						Strong Acid							
11	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a	g-equiv.	$Na_2B_{10}O_{16}$	Borate	Boric Acid	pK_a	pH		
12			g-ions/liter		[14]	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$			
13	1.399E+01	-6.1360E-11	5.0119E-06	5.300	5.8135E-10	2.4262E+01	6416.8	12809	51359	9.24	8.63		
14	1.279E+01	5.4368E-06	3.8846E-09	8.411	1.0669E-09	1.8805E-02	6416.8	12834	51334	8.97	8.37		
15	1.279E+01	1.1989E-05	1.7953E-09	8.746	1.0669E-09	8.6909E-03	6416.8	12834	51334	8.97	8.37		
16	1.279E+01	1.2309E-05	1.7653E-09	8.753	1.0669E-09	8.5458E-03	6416.8	12834	51334	8.97	8.37		
17	1.280E+01	1.4755E-05	1.7698E-09	8.752	1.0616E-09	8.5676E-03	6416.8	12834	51334	8.97	8.37		
18	1.284E+01	2.2603E-05	1.7573E-09	8.755	1.0406E-09	8.5071E-03	6416.8	12834	51334	8.98	8.38		
19	1.292E+01	3.8076E-05	1.8140E-09	8.741	1.0037E-09	8.7813E-03	6416.8	12834	51334	9.00	8.40		
20	1.295E+01	4.6435E-05	1.9133E-09	8.718	9.8734E-10	9.2620E-03	6416.8	12834	51334	9.01	8.40		
21	1.298E+01	5.2967E-05	2.0264E-09	8.693	9.7506E-10	9.8098E-03	6416.8	12834	51334	9.01	8.41		
22	1.304E+01	7.1382E-05	2.7173E-09	8.566	9.4639E-10	1.3154E-02	6416.8	12834	51334	9.02	8.42		
23	1.308E+01	8.4432E-05	4.0825E-09	8.389	9.2943E-10	1.9763E-02	6416.8	12834	51334	9.03	8.43		
24	1.311E+01	9.4943E-05	7.9048E-09	8.102	9.1714E-10	3.8266E-02	6416.8	12834	51334	9.04	8.44		
25	1.313E+01	1.0382E-04	7.4496E-08	7.128	9.0778E-10	3.6063E-01	6416.8	12833	51335	9.04	8.44		
26	1.315E+01	1.0480E-04	8.7215E-06	5.059	8.9901E-10	4.2220E+01	6416.8	12791	51376	9.05	8.44		
27	1.318E+01	1.0481E-04	2.2110E-05	4.655	8.8672E-10	1.0703E+02	6416.8	12727	51441	9.05	8.45		
28	1.320E+01	1.0481E-04	3.1080E-05	4.508	8.7912E-10	1.5045E+02	6416.8	12683	51485	9.06	8.45		
29	1.322E+01	1.0481E-04	4.2457E-05	4.372	8.6976E-10	2.0553E+02	6416.8	12628	51540	9.06	8.45		
30	1.324E+01	1.0481E-04	5.1990E-05	4.284	8.6215E-10	2.5168E+02	6416.8	12582	51586	9.06	8.45		
31	1.325E+01	1.0481E-04	5.7578E-05	4.240	8.5806E-10	2.7873E+02	6416.8	12555	51613	9.07	8.45		
32	1.326E+01	1.0481E-04	6.7392E-05	4.171	8.5045E-10	3.2624E+02	6416.8	12507	51660	9.07	8.45		
33	1.329E+01	1.0481E-04	7.9730E-05	4.098	8.4109E-10	3.8596E+02	6416.8	12448	51720	9.08	8.46		
34	1.330E+01	1.0481E-04	8.8596E-05	4.053	8.3466E-10	4.2888E+02	6416.8	12405	51763	9.08	8.46		
35	1.331E+01	1.0481E-04	9.0259E-05	4.045	8.3349E-10	4.3693E+02	6416.8	12397	51771	9.08	8.46		
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GRAND GULF REFERENCE CALCULATION

	A	B	C	D	E	F	G	H
1	CASE 1	GRAND GULF REFERE			pH TRANSIENT			
2							Linear Absorption Coeffici	
3	V_{POOL}	=170954*28.3168	Liters [Min.Tech Spec Basis E				$u_{beta\ air}$	0.0198
4	m_I	=325	Iodine inventory [g-atoms]				$u_{beta\ hypalon}$	52.08
5	m_{Cs}	=2400	Cesium inventory [g-atoms]				$u_{gamma\ air}$	0.0000375
6	t_{gap}	=121/3600	Onset of Gap release [hrs]				$u_{gamma\ hypalon}$	0.099
7							$r_{[gamma\ free\ path-A]}$	1112.5
8							$r_{[gamma\ free\ path-B]}$	1384
9				INTEGRATED DOSES				
10			Beta+Gamma	Gamma	Beta	Gamma	Beta	
11	TIME	POOL Temp	POOL	DRYWELL-A	DRYWELL-A	DRYWELL-B	DRYWELL-B	[HI] [1]
12	Hours	Deg F	Mrad	MeV/cm³	MeV/cm³	MeV/cm³	MeV/cm³	g-mols/liter
13	0	77						0
14	1	160						=$B$4/(120*$B$3)*($A14-(0.5+$B$6))+$B$4/(400*$B$3)
15	2	160	1.3783	1420000000000	2873300000000	0	1122000000000	=$B$4/(120*$B$3)*($A15-(0.5+$B$6))+$B$4/(400*$B$3)
16	=0.5+1.5+B6	160	1.3792	1450600000000	2878400000000	0	1214800000000	=$B$4/(120*$B$3)*($A16-(0.5+$B$6))+$B$4/(400*$B$3)
17	3	159.1	1.4049	2163000000000	3023500000000	66925000000	1290800000000	=H$16
18	5	155.5	1.4581	3099100000000	3320800000000	646710000000	1446800000000	=H$16
19	12	149.2	1.6425	4703200000000	4331200000000	1640400000000	1978900000000	=H$16
20	18	146.4	1.7985	5446200000000	5160900000000	2100600000000	2418300000000	=H$16
21	24	144.3	1.9526	5973300000000	5958400000000	2427100000000	2843000000000	=H$16
22	48	139.4	2.5509	7243400000000	8850300000000	3213800000000	4403800000000	=H$16
23	72	136.5	3.1213	7986300000000	11319000000000	3674000000000	5764900000000	=H$16
24	96	134.4	3.6648	8513500000000	13425000000000	4000500000000	6952100000000	=H$16
25	120	132.8	4.183	8922400000000	15224000000000	4253800000000	7987400000000	=H$16
26	150	131.3	4.7966	9331200000000	17105000000000	4507100000000	9097500000000	=H$16
27	200	129.2	5.7409	9858400000000	19521000000000	4833600000000	10574000000000	=H$16
28	240	127.9	6.4313	10192000000000	20955000000000	5040500000000	11486000000000	=H$16
29	300	126.3	7.3686	10601000000000	22506000000000	5293800000000	12519000000000	=H$16
30	360	125	8.1999	10935000000000	23551000000000	5500700000000	13252000000000	=H$16
31	400	124.3	8.7011	11128000000000	24049000000000	5620300000000	13618000000000	=H$16
32	480	123	9.5911	11463000000000	24727000000000	5827200000000	14143000000000	=H$16
33	600	121.4	10.685	11871000000000	25259000000000	6080500000000	14592000000000	=H$16
34	700	120.3	11.417	12154000000000	25472000000000	6255500000000	14791000000000	=H$16
35	720	120.1	11.546	12205000000000	25500000000000	6287500000000	14819000000000	=H$16
36								
37	NOTES							
38	1	Entergy Eng. Report GG						14
39	2	Ibid, Equation 3-2b						15
40	3	Ibid, Equation 3-4d [30+9						
41	4	Ibid, Table A-1						
42	5	Ibid, Equation 3-3a; Ente						
43	6	Ibid, Equation 3-3b; Ente						
44	7	Ibid, Equation 3-5a; Ente						
45	8	Ibid, Equation 3-5b; Ente						
46	9	Ibid, Equation 3-0a; Ente						
47	10	Ibid, Equation 3-5d; Ente						
48	11	Ibid, Equation 3-5d; Ente						
49	12	Ibid, Equation 3-5e; Ente						
50	13	Entergy Calc. XC-Q111						

GRAND GULF REFERENCE CALCULATION

	I	J	K	L
1				
2		$L_{A\,tray}$ [lb]	873.65	Cable Length [trays]- Zone A
3	1/cm	$L_{A\,fa}$ [lb]	873.65	Cable Length [free air]- Zone A
4	1/cm	$L_{B\,tray}$ [lb]	14049.27	Cable Length [trays] - Zone B
5	1/cm	$L_{B\,fa}$ [lb]	1561.03	Cable Length [free air] - Zone B
6	1/cm	R_0 [cm^2]/lb	800	Cable Area
7	cm	th [cm]	=0.28*2.54	Hypalon Jacket Thickness [13]
8	cm			
9		CONCENTRATIONS		
10		From Beta	From Gamma	From Beta
11	$[HNO_3]$ [2]	[HCL] -A [5]	[HCL] -A [6]	[HCL] -B [5]
12	g-mols/liter	g-mols/liter	g-mols/liter	g-mols/liter
13				
14				
15	=0.0000073*$C15	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E15	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D15	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G15
16	=0.0000073*$C16	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E16	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D16	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G16
17	=0.0000073*$C17	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E17	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D17	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G17
18	=0.0000073*$C18	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E18	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D18	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G18
19	=0.0000073*$C19	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E19	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D19	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G19
20	=0.0000073*$C20	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E20	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D20	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G20
21	=0.0000073*$C21	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E21	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D21	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G21
22	=0.0000073*$C22	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E22	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D22	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G22
23	=0.0000073*$C23	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E23	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D23	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G23
24	=0.0000073*$C24	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E24	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D24	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G24
25	=0.0000073*$C25	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E25	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D25	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G25
26	=0.0000073*$C26	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E26	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D26	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G26
27	=0.0000073*$C27	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E27	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D27	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G27
28	=0.0000073*$C28	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E28	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D28	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G28
29	=0.0000073*$C29	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E29	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D29	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G29
30	=0.0000073*$C30	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E30	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D30	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G30
31	=0.0000073*$C31	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E31	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D31	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G31
32	=0.0000073*$C32	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E32	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D32	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G32
33	=0.0000073*$C33	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E33	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D33	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G33
34	=0.0000073*$C34	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E34	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D34	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G34
35	=0.0000073*$C35	=3.512E-20/$B$3*$K$6*($K$2/2+$K$3)/$H$3*$E35	=3.512E-20/$B$3*$K$6*($K$2+$K$3)*(1-EXP(-$H$5*$H$7))/$H$5*(1-EXP(-$H$6*$K$7))*$D35	=3.512E-20/$B$3*$K$6*($K$4/2+$K$5)/$H$3*$G35
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37				
38	Acid dissociation consta			
39	Entergy Calc. XC-Q111			
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GRAND GULF REFERENCE CALCULATION

	M	N	O
1			
2			
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9			
10	From Gamma		
11	[HCL] -B [6]	Total [H+] [7]	[CsOH] [3]
12	g-mols/liter	g-ions/liter	g-mols/liter
13		=POWER(10,-$T$13)+$H13+$I13+$J13+$K13+$L13+$M13	0
14		=POWER(10,-$T$13)+$H14+$I14+$J14+$K14+$L14+$M14	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A14-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
15	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F15	=POWER(10,-$T$13)+$H15+$I15+$J15+$K15+$L15+$M15	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A15-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
16	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F16	=POWER(10,-$T$13)+$H16+$I16+$J16+$K16+$L16+$M16	=(0.4*$B$5-0.475*$B$4)/(3*$B$3)*($A16-(0.5+$B$6))+(0.05*$B$5-0.0475*$B$4)/$B$3
17	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F17	=POWER(10,-$T$13)+$H17+$I17+$J17+$K17+$L17+$M17	=$O$16
18	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F18	=POWER(10,-$T$13)+$H18+$I18+$J18+$K18+$L18+$M18	=$O$16
19	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F19	=POWER(10,-$T$13)+$H19+$I19+$J19+$K19+$L19+$M19	=$O$16
20	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F20	=POWER(10,-$T$13)+$H20+$I20+$J20+$K20+$L20+$M20	=$O$16
21	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F21	=POWER(10,-$T$13)+$H21+$I21+$J21+$K21+$L21+$M21	=$O$16
22	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F22	=POWER(10,-$T$13)+$H22+$I22+$J22+$K22+$L22+$M22	=$O$16
23	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F23	=POWER(10,-$T$13)+$H23+$I23+$J23+$K23+$L23+$M23	=$O$16
24	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F24	=POWER(10,-$T$13)+$H24+$I24+$J24+$K24+$L24+$M24	=$O$16
25	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F25	=POWER(10,-$T$13)+$H25+$I25+$J25+$K25+$L25+$M25	=$O$16
26	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F26	=POWER(10,-$T$13)+$H26+$I26+$J26+$K26+$L26+$M26	=$O$16
27	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F27	=POWER(10,-$T$13)+$H27+$I27+$J27+$K27+$L27+$M27	=$O$16
28	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F28	=POWER(10,-$T$13)+$H28+$I28+$J28+$K28+$L28+$M28	=$O$16
29	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F29	=POWER(10,-$T$13)+$H29+$I29+$J29+$K29+$L29+$M29	=$O$16
30	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F30	=POWER(10,-$T$13)+$H30+$I30+$J30+$K30+$L30+$M30	=$O$16
31	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F31	=POWER(10,-$T$13)+$H31+$I31+$J31+$K31+$L31+$M31	=$O$16
32	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F32	=POWER(10,-$T$13)+$H32+$I32+$J32+$K32+$L32+$M32	=$O$16
33	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F33	=POWER(10,-$T$13)+$H33+$I33+$J33+$K33+$L33+$M33	=$O$16
34	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F34	=POWER(10,-$T$13)+$H34+$I34+$J34+$K34+$L34+$M34	=$O$16
35	=3.512E-20/$B$3*$K$6*($K$4+$K$5)*(1-EXP(-$H$5*$H$8))/$H$5*(1-EXP(-$H$6*$K$7))*$F35	=POWER(10,-$T$13)+$H35+$I35+$J35+$K35+$L35+$M35	=$O$16
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GRAND GULF REFERENCE CALCULATION

	P	Q	R	S	T	U
1						
2	SLC [lbs]	5800	$Na_2B_4O_7 10H_2O$ Added [MW=410]			
3						
4						
5						
6						
7						
8						pH EFFECT OF ADDITION OF SODIU
9						
10						
11	Total [OH+] [8]	-LOG(Kw) [9]	Root x [10]	Net [H+] [11]	pH [12]	K_a
12	g-Ions/liter			g-Ions/liter		[14]
13	=POWER(10,-14)/POWER(10,-$T$13)+$O13	=15.5129-0.0224*$B13+0.00003352*POWER(B13,2)	=(N13+P13-SQRT(POWER(($N13+$P13),2)-(4*(N13*P13-POWER(10,-$Q13)))))/2	=$N13-$R13	5.3	=(0.0585*B13+1.309)/10000000000
14	=POWER(10,-14)/POWER(10,-$T$13)+$O14	=15.5129-0.0224*$B14+0.00003352*POWER(B14,2)	=(N14+P14-SQRT(POWER(($N14+$P14),2)-(4*(N14*P14-POWER(10,-$Q14)))))/2	=$N14-$R14	=-LOG10($S14)	=(0.0585*B14+1.309)/10000000000
15	=POWER(10,-14)/POWER(10,-$T$13)+$O15	=15.5129-0.0224*$B15+0.00003352*POWER(B15,2)	=(N15+P15-SQRT(POWER(($N15+$P15),2)-(4*(N15*P15-POWER(10,-$Q15)))))/2	=$N15-$R15	=-LOG10($S15)	=(0.0585*B15+1.309)/10000000000
16	=POWER(10,-14)/POWER(10,-$T$13)+$O16	=15.5129-0.0224*$B16+0.00003352*POWER(B16,2)	=(N16+P16-SQRT(POWER(($N16+$P16),2)-(4*(N16*P16-POWER(10,-$Q16)))))/2	=$N16-$R16	=-LOG10($S16)	=(0.0585*B16+1.309)/10000000000
17	=POWER(10,-14)/POWER(10,-$T$13)+$O17	=15.5129-0.0224*$B17+0.00003352*POWER(B17,2)	=(N17+P17-SQRT(POWER(($N17+$P17),2)-(4*(N17*P17-POWER(10,-$Q17)))))/2	=$N17-$R17	=-LOG10($S17)	=(0.0585*B17+1.309)/10000000000
18	=POWER(10,-14)/POWER(10,-$T$13)+$O18	=15.5129-0.0224*$B18+0.00003352*POWER(B18,2)	=(N18+P18-SQRT(POWER(($N18+$P18),2)-(4*(N18*P18-POWER(10,-$Q18)))))/2	=$N18-$R18	=-LOG10($S18)	=(0.0585*B18+1.309)/10000000000
19	=POWER(10,-14)/POWER(10,-$T$13)+$O19	=15.5129-0.0224*$B19+0.00003352*POWER(B19,2)	=(N19+P19-SQRT(POWER(($N19+$P19),2)-(4*(N19*P19-POWER(10,-$Q19)))))/2	=$N19-$R19	=-LOG10($S19)	=(0.0585*B19+1.309)/10000000000
20	=POWER(10,-14)/POWER(10,-$T$13)+$O20	=15.5129-0.0224*$B20+0.00003352*POWER(B20,2)	=(N20+P20-SQRT(POWER(($N20+$P20),2)-(4*(N20*P20-POWER(10,-$Q20)))))/2	=$N20-$R20	=-LOG10($S20)	=(0.0585*B20+1.309)/10000000000
21	=POWER(10,-14)/POWER(10,-$T$13)+$O21	=15.5129-0.0224*$B21+0.00003352*POWER(B21,2)	=(N21+P21-SQRT(POWER(($N21+$P21),2)-(4*(N21*P21-POWER(10,-$Q21)))))/2	=$N21-$R21	=-LOG10($S21)	=(0.0585*B21+1.309)/10000000000
22	=POWER(10,-14)/POWER(10,-$T$13)+$O22	=15.5129-0.0224*$B22+0.00003352*POWER(B22,2)	=(N22+P22-SQRT(POWER(($N22+$P22),2)-(4*(N22*P22-POWER(10,-$Q22)))))/2	=$N22-$R22	=-LOG10($S22)	=(0.0585*B22+1.309)/10000000000
23	=POWER(10,-14)/POWER(10,-$T$13)+$O23	=15.5129-0.0224*$B23+0.00003352*POWER(B23,2)	=(N23+P23-SQRT(POWER(($N23+$P23),2)-(4*(N23*P23-POWER(10,-$Q23)))))/2	=$N23-$R23	=-LOG10($S23)	=(0.0585*B23+1.309)/10000000000
24	=POWER(10,-14)/POWER(10,-$T$13)+$O24	=15.5129-0.0224*$B24+0.00003352*POWER(B24,2)	=(N24+P24-SQRT(POWER(($N24+$P24),2)-(4*(N24*P24-POWER(10,-$Q24)))))/2	=$N24-$R24	=-LOG10($S24)	=(0.0585*B24+1.309)/10000000000
25	=POWER(10,-14)/POWER(10,-$T$13)+$O25	=15.5129-0.0224*$B25+0.00003352*POWER(B25,2)	=(N25+P25-SQRT(POWER(($N25+$P25),2)-(4*(N25*P25-POWER(10,-$Q25)))))/2	=$N25-$R25	=-LOG10($S25)	=(0.0585*B25+1.309)/10000000000
26	=POWER(10,-14)/POWER(10,-$T$13)+$O26	=15.5129-0.0224*$B26+0.00003352*POWER(B26,2)	=(N26+P26-SQRT(POWER(($N26+$P26),2)-(4*(N26*P26-POWER(10,-$Q26)))))/2	=$N26-$R26	=-LOG10($S26)	=(0.0585*B26+1.309)/10000000000
27	=POWER(10,-14)/POWER(10,-$T$13)+$O27	=15.5129-0.0224*$B27+0.00003352*POWER(B27,2)	=(N27+P27-SQRT(POWER(($N27+$P27),2)-(4*(N27*P27-POWER(10,-$Q27)))))/2	=$N27-$R27	=-LOG10($S27)	=(0.0585*B27+1.309)/10000000000
28	=POWER(10,-14)/POWER(10,-$T$13)+$O28	=15.5129-0.0224*$B28+0.00003352*POWER(B28,2)	=(N28+P28-SQRT(POWER(($N28+$P28),2)-(4*(N28*P28-POWER(10,-$Q28)))))/2	=$N28-$R28	=-LOG10($S28)	=(0.0585*B28+1.309)/10000000000
29	=POWER(10,-14)/POWER(10,-$T$13)+$O29	=15.5129-0.0224*$B29+0.00003352*POWER(B29,2)	=(N29+P29-SQRT(POWER(($N29+$P29),2)-(4*(N29*P29-POWER(10,-$Q29)))))/2	=$N29-$R29	=-LOG10($S29)	=(0.0585*B29+1.309)/10000000000
30	=POWER(10,-14)/POWER(10,-$T$13)+$O30	=15.5129-0.0224*$B30+0.00003352*POWER(B30,2)	=(N30+P30-SQRT(POWER(($N30+$P30),2)-(4*(N30*P30-POWER(10,-$Q30)))))/2	=$N30-$R30	=-LOG10($S30)	=(0.0585*B30+1.309)/10000000000
31	=POWER(10,-14)/POWER(10,-$T$13)+$O31	=15.5129-0.0224*$B31+0.00003352*POWER(B31,2)	=(N31+P31-SQRT(POWER(($N31+$P31),2)-(4*(N31*P31-POWER(10,-$Q31)))))/2	=$N31-$R31	=-LOG10($S31)	=(0.0585*B31+1.309)/10000000000
32	=POWER(10,-14)/POWER(10,-$T$13)+$O32	=15.5129-0.0224*$B32+0.00003352*POWER(B32,2)	=(N32+P32-SQRT(POWER(($N32+$P32),2)-(4*(N32*P32-POWER(10,-$Q32)))))/2	=$N32-$R32	=-LOG10($S32)	=(0.0585*B32+1.309)/10000000000
33	=POWER(10,-14)/POWER(10,-$T$13)+$O33	=15.5129-0.0224*$B33+0.00003352*POWER(B33,2)	=(N33+P33-SQRT(POWER(($N33+$P33),2)-(4*(N33*P33-POWER(10,-$Q33)))))/2	=$N33-$R33	=-LOG10($S33)	=(0.0585*B33+1.309)/10000000000
34	=POWER(10,-14)/POWER(10,-$T$13)+$O34	=15.5129-0.0224*$B34+0.00003352*POWER(B34,2)	=(N34+P34-SQRT(POWER(($N34+$P34),2)-(4*(N34*P34-POWER(10,-$Q34)))))/2	=$N34-$R34	=-LOG10($S34)	=(0.0585*B34+1.309)/10000000000
35	=POWER(10,-14)/POWER(10,-$T$13)+$O35	=15.5129-0.0224*$B35+0.00003352*POWER(B35,2)	=(N35+P35-SQRT(POWER(($N35+$P35),2)-(4*(N35*P35-POWER(10,-$Q35)))))/2	=$N35-$R35	=-LOG10($S35)	=(0.0585*B35+1.309)/10000000000
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GRAND GULF REFERENCE CALCULATION

	V	W	X	Y	Z	AA
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2						
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10	Strong Acid					
11	g-equiv.	$Na_2B_4O_710H_2O$	Borate	Boric Acid	pK_a	pH
12	Net [H+] * V_{POOL}	g-mols	g-equiv.	g-equiv.	$-log_{10}K_a$	[15]
13	=S13*$B$3	=$Q$2*453.6/410	=W13*2-V13	=W13*8+V13	=-LOG10(U13)	=Z13+LOG10((X13/$B$3)/(Y13/$B$3))
14	=S14*$B$3	=$Q$2*453.6/410	=W14*2-V14	=W14*8+V14	=-LOG10(U14)	=Z14+LOG10((X14/$B$3)/(Y14/$B$3))
15	=S15*$B$3	=$Q$2*453.6/410	=W15*2-V15	=W15*8+V15	=-LOG10(U15)	=Z15+LOG10((X15/$B$3)/(Y15/$B$3))
16	=S16*$B$3	=$Q$2*453.6/410	=W16*2-V16	=W16*8+V16	=-LOG10(U16)	=Z16+LOG10((X16/$B$3)/(Y16/$B$3))
17	=S17*$B$3	=$Q$2*453.6/410	=W17*2-V17	=W17*8+V17	=-LOG10(U17)	=Z17+LOG10((X17/$B$3)/(Y17/$B$3))
18	=S18*$B$3	=$Q$2*453.6/410	=W18*2-V18	=W18*8+V18	=-LOG10(U18)	=Z18+LOG10((X18/$B$3)/(Y18/$B$3))
19	=S19*$B$3	=$Q$2*453.6/410	=W19*2-V19	=W19*8+V19	=-LOG10(U19)	=Z19+LOG10((X19/$B$3)/(Y19/$B$3))
20	=S20*$B$3	=$Q$2*453.6/410	=W20*2-V20	=W20*8+V20	=-LOG10(U20)	=Z20+LOG10((X20/$B$3)/(Y20/$B$3))
21	=S21*$B$3	=$Q$2*453.6/410	=W21*2-V21	=W21*8+V21	=-LOG10(U21)	=Z21+LOG10((X21/$B$3)/(Y21/$B$3))
22	=S22*$B$3	=$Q$2*453.6/410	=W22*2-V22	=W22*8+V22	=-LOG10(U22)	=Z22+LOG10((X22/$B$3)/(Y22/$B$3))
23	=S23*$B$3	=$Q$2*453.6/410	=W23*2-V23	=W23*8+V23	=-LOG10(U23)	=Z23+LOG10((X23/$B$3)/(Y23/$B$3))
24	=S24*$B$3	=$Q$2*453.6/410	=W24*2-V24	=W24*8+V24	=-LOG10(U24)	=Z24+LOG10((X24/$B$3)/(Y24/$B$3))
25	=S25*$B$3	=$Q$2*453.6/410	=W25*2-V25	=W25*8+V25	=-LOG10(U25)	=Z25+LOG10((X25/$B$3)/(Y25/$B$3))
26	=S26*$B$3	=$Q$2*453.6/410	=W26*2-V26	=W26*8+V26	=-LOG10(U26)	=Z26+LOG10((X26/$B$3)/(Y26/$B$3))
27	=S27*$B$3	=$Q$2*453.6/410	=W27*2-V27	=W27*8+V27	=-LOG10(U27)	=Z27+LOG10((X27/$B$3)/(Y27/$B$3))
28	=S28*$B$3	=$Q$2*453.6/410	=W28*2-V28	=W28*8+V28	=-LOG10(U28)	=Z28+LOG10((X28/$B$3)/(Y28/$B$3))
29	=S29*$B$3	=$Q$2*453.6/410	=W29*2-V29	=W29*8+V29	=-LOG10(U29)	=Z29+LOG10((X29/$B$3)/(Y29/$B$3))
30	=S30*$B$3	=$Q$2*453.6/410	=W30*2-V30	=W30*8+V30	=-LOG10(U30)	=Z30+LOG10((X30/$B$3)/(Y30/$B$3))
31	=S31*$B$3	=$Q$2*453.6/410	=W31*2-V31	=W31*8+V31	=-LOG10(U31)	=Z31+LOG10((X31/$B$3)/(Y31/$B$3))
32	=S32*$B$3	=$Q$2*453.6/410	=W32*2-V32	=W32*8+V32	=-LOG10(U32)	=Z32+LOG10((X32/$B$3)/(Y32/$B$3))
33	=S33*$B$3	=$Q$2*453.6/410	=W33*2-V33	=W33*8+V33	=-LOG10(U33)	=Z33+LOG10((X33/$B$3)/(Y33/$B$3))
34	=S34*$B$3	=$Q$2*453.6/410	=W34*2-V34	=W34*8+V34	=-LOG10(U34)	=Z34+LOG10((X34/$B$3)/(Y34/$B$3))
35	=S35*$B$3	=$Q$2*453.6/410	=W35*2-V35	=W35*8+V35	=-LOG10(U35)	=Z35+LOG10((X35/$B$3)/(Y35/$B$3))
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