ATTACHMENT 4 TO NL-04-162

POLESTAR NON-PROPRIETARY CALCULATION

(42 PAGES)

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT 3
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CALCULATION TITLE PAGE

CALCULATION NUMBER: PSAT 3056CT.QA.04

CALCULATION TITLE: Calculation of Indian Point 3 Engineered Safety Feature Component Leakage Iodine Release with Boundary Layer Effect

	ORIGINATOR	CHECKER	IND REVIEWER
	Print/Sign/Date	Print/Sign/Date	Print/Sign/Date
REVISION: 0	Jun Li	Rudolph Sher	James Metcalf
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REASON FOR REVISION: Nonconformance Rpt

0 – Initial Issue   N/A

1 – Compliance with 10CFR2.2790, Jan, 2003. Proprietary   N/A
designation removed from all pages except first page and
those pages actually containing proprietary information.

Proprietary information on each proprietary page designated
in [[brackets]]

On Page 2 of Attachment 2, errors have been found in the
row of Temperature (K) from the 2nd value to the 7th. They
should be 370.9, the same as the first value in that row,
instead of 397.0. They are corrected. Since the calculation
used only the first value in that row, the errors and the
correction have no impact at all on the results in the report.

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Table of Contents

Purpose

In accordance with the requirements of Section 4.2, Reference [1], the purpose of this calculation is to determine the Indian Point 3 (IP3) engineered safety feature (ESF) component leakage iodine release to the environment with and without consideration of the effect of the gas boundary layer that exists at the interface between the ESF liquid leakage and the bulk gas in the room into which the ESF leakage occurs (i.e., liquid–gas interface).

Methodology

The approach is to apply the Reference [2] Standard Review Plan (SRP) guidance that if the calculated flash fraction is less than 10% or if the water is less than 212 F, then an amount of iodine smaller than 10% of the iodine in the leakage may be used if justified by the actual sump pH history and ventilation rates. In addition, the effect of the gas boundary layer existing at the liquid–gas interface on the bulk gas iodine concentration has been included. The steps in the calculation are as follows:

- Evaluate the elemental iodine concentration in the ESF liquid. This is a function of the core inventory of iodine, the iodine release from the core during the DBA LOCA (this iodine is assumed to go into solution in the RCS and containment sump liquid which is in turn recirculated through certain primary auxiliary building (PAB) rooms as ESF liquid), the total ESF liquid mass, and the ESF liquid pH.

- Assume that ESF liquid leaks onto the floors of certain PAB rooms during the recirculation and cumulates to form a pool. [[

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- Evaluate the gaseous iodine concentration at the pool surface. [[

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- Evaluate the resistance to the mass transport of iodine across the boundary layer, which is referred to as decontamination factor (DF) in this report. [[

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- Using the volumetric flow of gas from the ESF gas space to the environment and gaseous iodine concentration in the ESF gas space (with or without consideration of boundary layer DF), calculate iodine release to the environment.

The ESF liquid is circulated outside containment beginning at 6.5 hours after the initiating event per Reference [3], items 4.2-4.4. Per Assumption 4, it is assumed that leakage can occur in the RHR cells, the Sump Tank Room, the Hallway to the Sump Room, the Hallway Outside (which includes the Sump Room), the Piping Penetration Area, and the High Head Pump Room.

Assumptions

Assumption 1: Flashing need not be considered.

Justification: The peak post-recirculation ESF liquid temperature is about 208 F at 6.5 hours (Reference [3]). This is less than 212 F (saturation temperature at atmospheric pressure). Thus, flashing will not occur.

Assumption 2: Iodine partitioning to the gas phase is assumed to take place instantaneously under equilibrium conditions at the ESF leakage pool surface. The partition coefficient depends only on the temperature of the liquid.

Justification: The assumption of equilibrium conditions is made to simplify the calculation, and in addition is conservative since the gaseous iodine concentration is actually lower before reaching equilibrium condition.

Assumption 3: The liquid is assumed to always be well-mixed and homogeneous.

Justification: This assumption is conservative, since it over-estimates aqueous phase iodine concentration near the pool surface and therefore over-estimates the release to the gas phase.

Assumption 4: The continuous ESF leakage (i.e., 4 gph) will be assumed to be distributed in all rooms in which ESF components are located.

Justification: Distributing the ESF leakage involves a greater gas phase volume and thus effectively increases the partitioning of I_2 to the gas phase, since per Assumption 2, the gaseous iodine concentration at the pool surface is in equilibrium with the aqueous phase iodine, and so the larger the gas volume, the greater the gaseous I_2 content that is necessary to maintain the equilibrium gaseous concentration. In addition to resulting in a larger gaseous I_2 content, distributing the ESF leakage will increase the volumetric exchange rate to the environment. The combination of these effects will therefore lead to a conservative iodine release to the environment.

Assumption 5: The volumetric exchange with the environment will be assumed to be the sum of the exchange rates of all ESF rooms into which leakage can occur with the rooms being well-mixed.

Justification: As mentioned above it is conservative to assume that the flow from all ESF rooms into which leakage can occur is available since maximizing the exchange with the environment will maximize the iodine release. It is also conservative to assume well-mixed rooms since time for mixing would slow the exchange with the environment relative to the well-mixed case.

Assumption 6: Per Assumption 8 below, the ESF liquid leakage is expected to pool on the floor of the area into which the leakage occurs. However, for purposes of quantifying the effect of the gas-liquid boundary layer, the ESF leakage is assumed to be in the form of a liquid film on the floor, walls, and structural surfaces of the ESF area into which the leakage occurs.

Justification: In considering the effect of the boundary layer, it is conservative to maximize the area of the liquid surface which will in turn increase the mass of iodine transported across the boundary layer. Thus, while it is expected that the liquid will be pooled on the floor, this assumption provides significant conservatism.

Assumption 7: Transient effects will be neglected in calculating the iodine concentration in the bulk gas region.

Justification: In the boundary layer calculation, both the steady state and the transient equation for bulk gas region iodine concentration are solved and it is shown that equilibrium is reached quickly compared to the time intervals used to characterize temperature.

Assumption 8:   The ESF leakage is assumed to pool on floor surfaces. [[

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References

Reference 1: PSAT 3056CT.QA.02, "Implementing Procedure for Design Control for Calculation of Indian Point 3 Engineered Safety Feature Component Leakage Iodine Release," Rev. 0.

Reference 2: NUREG-0800, NRC Standard Review Plan, Section 15.6.5, Appendix B, "Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Engineered Safety Features Components Outside Containment".

Reference 3: PSAT 3056CT.QA.03,"Plant-Specific Design Input for Calculation of Indian Point 3 ESF Component Leakage Iodine Release", Rev. 0.

Reference 4: [[

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Reference 5: D. Powers and S. Burson, "A Simplified Model of Aerosol Removal by Containment Sprays," NUREG/CR 5966, June, 1993.

Reference 6: L. Soffer et al., "Accident Source Terms for Light-Water Nuclear Power Plants," NUREG-1465, February, 1995.

Reference 7: R. Sher and J. Jokiniemi, "NAUAHYGROS 1.0: A Code for Calculating the Behavior of Aerosols in Nuclear Plant Containments Following a Severe Accident," EPRI Report TR-102775, July, 1993.

Reference 8: [[ ]]

Reference 9: [[ ]]

Reference 10: "Calculation of Indian Point 2 Engineered Safety Feature Component Leakage Iodine Release with Boundary Layer Effect", PSAT 126.02CT.QA.05, Rev.1, Polestar Applied Technology, Inc.

Calculation

The basic calculational approach is described in detail in Reference [10], and only requires minor numerical changes to account for differences in some of the input data for IP3, e.g. core inventory of iodine, assumed pH, peak average pool temperature, and geometry and flow data. [[

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As previously noted, external recirculation begins at 6.5 hours after the initiating event. There are 7 rooms into which ESF leakage can occur and through which there is bulk gas flow. The geometry and flow characteristics of these rooms, taken from Reference [3], are shown in Table 1. They are the volume (V), the volumetric flow rate to environment ($\dot{V}$), the total surface area (A, taken to be the sum of all wall surfaces, except for the ends since the ends are open, plus additional area equal to twice the floor area to conservatively account for equipment surfaces), the length of the room (L), the cross-section area of the room (A_c), and flow velocity (U, derived from $\dot{V}$ divided by A_c). The volumetric exchange rate with the environment, $\dot{V}/V$, is (4000+4000+200+12000+7500+11700+4000) = 33400 cfm or 2.004E6 cfh divided by the total volume of 1.02857E5 ft3 = 19.48 vol/hr.

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Table 1. Geometry & flow characteristics of rooms into which ESF leakage can occur

Room	V (m^3)	V-dot (m^3/s)	V-dot/V (hr^{-1})	A $(m^{2)}$	L (m)	A_c (m^2)	U (m/s)
RHR Room 31	75	1.89	90.7	118	5.79	13	0.146
RHR Room 32	113	1.89	90.7	155	5.79	19.5	0.097
Sump Tank Room	55.6	0.094	6.1	77.7	3.35	16.6	0.0057
Hallway to Sump Room	34	5.66	599	85.5	6.1	5.57	1.016
Hallway Outside (incl. Sump Room)	617	3.54[a]	20.7	619	13.7[b]	45	0.079
Penetration Area	1389	1.89	4.9	858	13.0[b]	107	0.018
High Head Pump Room	629	5.52	31.6	689	17.9	35	0.157

[a] The supplied flow rate includes the flow in the RHR cells, which has been subtracted to obtain V-dot.

[b] Irregular shape; values chosen for length and width are arbitrary and preserve the floor area.

Table 2. [[

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]] The details of the iodine release calculation are presented in Appendix B and the results are given in Table 3, which is the same as the table in Appendix B.

Table 3. **Fraction of incoming iodine released to the environment during external recirculation beginning at 6.5 hours.**

Time period	pH = 7.9	pH = 7.61	pH = 7.27
0 to 6.5 hours	N/A	N/A	N/A
6.5 to 8 hours	0.0268	0.0881	0.2652
8 to 24 hours	0.0278	0.0921	0.2787
1 day to 4 days	0.0274	0.0907	0.2746
4 to 30 days	0.0265	0.0881	0.2697

The boundary layer DFs are calculated in Attachment 2, following the method used in ref. [10]. The results are shown in Table 4 below and the minimum DF is 10.

Table 4. The boundary layer DF for all PAB rooms in question

Room	V (m³)	V-dot (m³/s)	V-dot/V (hr⁻¹)	A (m²)	L (m)	A_c (m²)	U (m/s)	DF
RHR Room 31	75	1.89	90.7	118	5.79	13	0.146	[[
RHR Room 32	113	1.89	90.7	155	5.79	19.5	0.097	
Sump Tank Room	55.6	0.094	6.1	77.7	3.35	16.6	0.0057	
Hallway to Sump Room	34	5.66	599	85.5	6.1	5.57	1.016	
Hallway Outside	617	3.54[a]	20.7	619	13.7[b]	45	0.079	
Penetration Area	1389	1.89	4.9	858	13.0[b]	107	0.018	
High Head Pump Room	629	5.52	31.6	689	17.9	35	0.157	]]

Results

In Table 5 below, the fractional releases with boundary layer effects are shown. For pH = 7.27 and 7.61, a DF of 10 was applied to the releases shown in Table 3 above. For pH = 7.9, the result for DF = 1 is shown. The results are in units of fraction of the incoming iodine in the ESF leakage into the ESF component room(s) (i.e., fraction of the total dissolved iodine in the 4 gph leakage water). In the first 6.5 hours (23400 seconds) the release is zero since recirculation has not yet started. The fractional releases depend strongly on the pH, and for the same DF, differ by an order of magnitude between pH = 7.9 and pH = 7.27. [[

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For pH = 7.27, the average release rate (with DF = 10) is about 2.7% of the total incoming rate of iodine in the leakage water. For pH = 7.61, the average release rate (with DF = 10) is about 0.9%, while for pH = 7.9, the limiting value with DF = 1 is about 2.7%.

It is noted that the results reported here are quite conservative with respect to several effects in addition to the cooling due to heat transfer, as has been discussed previously: [[

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Table 5. **Fraction of incoming iodine released to the environment during external recirculation beginning at 6.5 hours with boundary layer effects.**

Time period	pH = 7.9 DF = 1	pH = 7.61 DF = 10	pH = 7.27 DF = 10
0 to 6.5 hours	N/A	N/A	N/A
6.5 to 8 hours	0.0268	0.00881	0.02652
8 to 24 hours	0.0278	0.00921	0.02787
1 day to 4 days	0.0274	0.00907	0.02746
4 to 30 days	0.0265	0.00881	0.02697

Conclusions

The conclusions from this calculation are as follows:

- The iodine release from ESF leakage for IP3 is very sensitive to the assumed pH and the boundary layer DF. The fractional release for pH = 7.27 is approximately 2.7%. For pH = 7.61 it is about 0.9%, while for pH = 7.9 it is about 2.7% (DF = 1). [[

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Appendix A. [[

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Appendix B. Calculation of IP3 ESF Component Leakage Iodine Release

Definition of variables

I_{ion} — concentration of Iodine ion in liquid pool

I_{2L} — concentration of elemental iodine in liquid pool

I_{2C} — concentration of elemental iodine in gas volume

M_I — total mole of Iodine in the system in question

$pH := 7.5$ — pH valule

$kgmole := 1000\,mole$ — Kilogram mole definition

$mpl := \dfrac{mole}{liter}$ — mole/litter, the same as kgmole/m3

$H(pH) := 10^{-pH} \cdot mp$ — H+ concentration as a function of pH

$d := 6.05 \cdot 10^{-14} \cdot mp$
$e := 1.47 \cdot 10^{-9}$
— constants used in iodine conversion equation

$mw_I := 130\,kg \cdot kgmole^{-1}$ — Molecular weight of Iodine

$\rho_w(T) := \dfrac{83.12}{0.2621^{\left[1+\left[1-T \cdot (647.29 \cdot K)^{-1}\right]^{0.23072}\right]}} \cdot \dfrac{kg}{m^3}$ — Water density

$f_1(pH) := \left[\dfrac{\left(H(pH) \cdot mpl^{-1}\right)^2}{d + e \cdot H(pH)}\right]$ — Eq. 1a is rewritten as: $\quad I_{2L} = I_{ion}^2 \cdot f_1(pH)$

$PC(T) := 10^{\left(6.29 - 0.0149 \cdot T \cdot K^{-1}\right)}$ — Partition coefficient as a function of temperature (K).

Eq. 2 is rewritten as:

$$I_{2G} = I_{2L} \cdot PC(T)^{-1} = I_{ion}^2 \cdot f_1(pH) \cdot PC(T)^{-1}$$

Other variables and given conditions are

$m_{H2O} := 3.1 \cdot 10^6 \cdot lb$ — total mass of water in containment sump (Item 3.1, Ref. [1])

$I_{tot} := 26.121 \cdot kg$ — total core inventory of iodine

$f := 0.4$ — iodine release fraction from core to containment, Ref. [2]

$$c_0(T) := \frac{I_{tot} \cdot f \cdot \rho_w(T)}{mw_I \cdot m_{H2O}}$$

I ion concentration in cont. sump $c_0(396\,K) = 5.31718 \times 10^{-5}\,mpl$

$$gph := gal \cdot hr^{-1}$$

Volumetric flow rate unit - gallon per hour

$$W := 4 \cdot gph$$

Leak rate of cont. sump water into the pool, Item 4.1, Ref. [1]

$$t_L := 23400\,sec$$

Time to initiate the ESF leakage, Item 4.3, Ref. [1]

$$V_L(t) := \begin{vmatrix} W \cdot (t - t_L) \\ \\ 0 \cdot m^3 & \text{if } t \le t_L \end{vmatrix}$$

liquid pool volume due ESF leakage

$$V_G := 2913\,m^3$$

Total gas volume after 6.5 hours (sum of volumes from Item 5.2 through 5.4, Ref. [1])

$$\lambda := 19.48\,hr^{-1}$$

Exchange rate between gas volume & environment > 6.5 hrs (ratio of the sum of flow rates from Item 5.2 through 5.4, Ref. [1] to the sum of volumes VG)

Derivation of iodine release to environment

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From 23400 to 28800 sec

$\tau_i := 23400\,\mathrm{sec}$ $\tau_f := 28800\,\mathrm{sec}$ $x := 0 \cdot \mathrm{mpl}$

$\mathrm{Frac} := \mathrm{RF}\!\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\mathrm{Frac}^T = \left(2.88 \times 10^4 \quad 5.553035 \times 10^{-5} \quad 7.9 \quad 315.2 \quad 0.026789\right)$ RFC_{H_0} Frac_4

From 28800 to 30000 sec

$\tau_i := 28800 \, sec$ $\tau_f := 30000 \, sec$ $x := Frac_1 \cdot mp$ $T := 315.7 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$ $\varepsilon := 0.005$

$Frac^T = (3 \times 10^4 \quad 5.552959 \times 10^{-5} \quad 7.9 \quad 315.7 \quad 0.027501)$ $RFC_{H_1} := Frac_4$

From 30000 to 40000 sec

$\tau_i := 30000 \, sec$ $\tau_f := 40000 \, sec$ $x := Frac_1 \cdot mp$ $T := 315.9 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (4 \times 10^4 \quad 5.551489 \times 10^{-5} \quad 7.9 \quad 315.9 \quad 0.027683)$ $RFC_{H_2} := Frac_4$

From 40000 to 50000 sec

$\tau_i := 40000 \, sec$ $\tau_f := 50000 \, sec$ $x := Frac_1 \cdot mp$ $T := 316 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (5 \times 10^4 \quad 5.550767 \times 10^{-5} \quad 7.9 \quad 316 \quad 0.027772)$ $RFC_{H_3} := Frac_4$

From 50000 to 60000 sec

$\tau_i := 50000 \, sec$ $\tau_f := 60000 \, sec$ $x := Frac_1 \cdot mp$ $T := 316 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (6 \times 10^4 \quad 5.550446 \times 10^{-5} \quad 7.9 \quad 316 \quad 0.027768)$ $RFC_{H_4} := Frac_4$

From 60000 to 70000 sec

$\tau_i := 60000 \, sec$ $\tau_f := 70000 \, sec$ $x := Frac_1 \cdot mp$ $T := 316.2 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (7 \times 10^4 \quad 5.549839 \times 10^{-5} \quad 7.9 \quad 316.2 \quad 0.027959)$ $RFC_{H_5} := Frac_4$

From 70000 to 80000 sec

$\tau_i := 70000 \, sec$ $\tau_f := 80000 \, sec$ $x := Frac_1 \cdot mp$ $T := 316 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (8 \times 10^4 \quad 5.549803 \times 10^{-5} \quad 7.9 \quad 316 \quad 0.02776)$ $RFC_{H_6} := Frac_4$

From 80000 to 86400 sec

$\tau_i := 80000\,sec$ $\qquad$ $\tau_f := 86400\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 316\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(8.64 \times 10^4 \quad 5.549809 \times 10^{-5} \quad 7.9 \quad 316 \quad 0.027761\right)$ $\qquad$ $RFC_{H_7} := Frac_4$

From 86400 to 90000 sec

$\tau_i := 86400\,sec$ $\qquad$ $\tau_f := 90000\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 315.9\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(9 \times 10^4 \quad 5.549832 \times 10^{-5} \quad 7.9 \quad 315.9 \quad 0.027661\right)$ $\qquad$ $RFC_{H_8} := Frac_4$

From 90000 to 100000 sec

$\tau_i := 90000\,sec$ $\qquad$ $\tau_f := 100000\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 315.9\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(1 \times 10^5 \quad 5.549936 \times 10^{-5} \quad 7.9 \quad 315.9 \quad 0.027664\right)$ $\qquad$ $RFC_{H_9} := Frac_4$

From 100000 to 172800 sec $\qquad\qquad\qquad\qquad$ $\varepsilon := 0.05$

$\tau_i := 100000\,sec$ $\qquad$ $\tau_f := 172800\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 316.3\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(1.728 \times 10^5 \quad 5.548301 \times 10^{-5} \quad 7.9 \quad 316.3 \quad 0.028044\right)$ $\qquad$ $RFC_{H_{10}} := Frac_4$

From 172800 to 200000 sec

$\tau_i := 172800\,sec$ $\qquad$ $\tau_f := 200000\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 315.9\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(2 \times 10^5 \quad 5.548714 \times 10^{-5} \quad 7.9 \quad 315.9 \quad 0.027651\right)$ $\qquad$ $RFC_{H_{11}} := Frac_4$

From 200000 to 300000 sec

$\tau_i := 200000\,sec$ $\qquad$ $\tau_f := 300000\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 315.2\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(3 \times 10^5 \quad 5.551902 \times 10^{-5} \quad 7.9 \quad 315.2 \quad 0.026998\right)$ $\qquad$ $RFC_{H_{12}} := Frac_4$

From 300000 to 345600 sec

$\tau_i := 300000\,sec$ $\qquad$ $\tau_f := 345600\,sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 315\,K$

$Frac := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$Frac^T = \left(3.456 \times 10^5 \quad 5.552916 \times 10^{-5} \quad 7.9 \quad 315 \quad 0.026827\right)$ $\qquad$ $RFC_{H_{13}} := Frac_4$

<u>From 345600 to 400000 sec</u>

$\tau_i := 345600\,sec$ $\tau_f := 400000\,sec$ $x := Frac_1 \cdot mp$ $T := 314.8\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (4 \times 10^5 \quad 5.554165 \times 10^{-5} \quad 7.9 \quad 314.8 \quad 0.026652)$ $RFC_{H_{14}} := Frac_4$

<u>From 400000 to 500000 sec</u>

$\tau_i := 400000\,sec$ $\tau_f := 500000\,sec$ $x := Frac_1 \cdot mp$ $T := 314.7\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (5 \times 10^5 \quad 5.555847 \times 10^{-5} \quad 7.9 \quad 314.7 \quad 0.026572)$ $RFC_{H_{15}} := Frac_4$

<u>From 500000 to 2590000 sec</u> $\varepsilon := 0.5$

$\tau_i := 500000\,sec$ $\tau_f := 2590000\,sec$ $x := Frac_1 \cdot mp$ $T := 314.5\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (2.59 \times 10^6 \quad 5.562135 \times 10^{-5} \quad 7.9 \quad 314.5 \quad 0.026437)$ $RFC_{H_{16}} := Frac_4$

Assuming that pH is 7.61, the release fraction of iodine atoms are:

$\varepsilon := 2 \cdot 10^{-3}$ $\lambda := 19.48\,hr^{-1}$ $pH := 7.61$ $T := 315.2\,K$

<u>From 23400 to 28800 sec</u>

$\tau_i := 23400\,sec$ $\tau_f := 28800\,sec$ $x := 0 \cdot mp1$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (2.88 \times 10^4 \quad 5.190837 \times 10^{-5} \quad 7.61 \quad 315.2 \quad 0.08806)$ $RFC_{M_0} := Frac_4$

<u>From 28800 to 30000 sec</u>

$\tau_i := 28800\,sec$ $\tau_f := 30000\,sec$ $x := Frac_1 \cdot mp$ $T := 315.7\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (3 \times 10^4 \quad 5.190364 \times 10^{-5} \quad 7.61 \quad 315.7 \quad 0.091329)$ $RFC_{M_1} := Frac_4$

<u>From 30000 to 40000 sec</u> $\varepsilon := 0.005$

$\tau_i := 30000\,sec$ $\tau_f := 40000\,sec$ $x := Frac_1 \cdot mp$ $T := 315.9\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (4 \times 10^4 \quad 5.186616 \times 10^{-5} \quad 7.61 \quad 315.9 \quad 0.09187)$ $RFC_{M_2} := Frac_4$

From 40000 to 50000 sec

$\tau_i := 40000\,sec$ $\qquad \tau_f := 50000\,sec$ $\qquad x := Frac_1 \cdot mp$ $\qquad T := 316\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = \begin{pmatrix} 5 \times 10^4 & 5.184997 \times 10^{-5} & 7.61 & 316 & 0.092117 \end{pmatrix}$ $\qquad RFC_{M_3} := Frac_4$

From 50000 to 60000 sec

$\tau_i := 50000\,sec$ $\qquad \tau_f := 60000\,sec$ $\qquad x := Frac_1 \cdot mp$ $\qquad T := 316\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = \begin{pmatrix} 6 \times 10^4 & 5.184319 \times 10^{-5} & 7.61 & 316 & 0.092081 \end{pmatrix}$ $\qquad RFC_{M_4} := Frac_4$

From 60000 to 70000 sec

$\tau_i := 60000\,sec$ $\qquad \tau_f := 70000\,sec$ $\qquad x := Frac_1 \cdot mp$ $\qquad T := 316.2\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = \begin{pmatrix} 7 \times 10^4 & 5.183004 \times 10^{-5} & 7.61 & 316.2 & 0.092694 \end{pmatrix}$ $\qquad RFC_{M_5} := Frac_4$

From 70000 to 80000 sec

$\tau_i := 70000\,sec$ $\qquad \tau_f := 80000\,sec$ $\qquad x := Frac_1 \cdot mp$ $\qquad T := 316\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = \begin{pmatrix} 8 \times 10^4 & 5.182975 \times 10^{-5} & 7.61 & 316 & 0.092023 \end{pmatrix}$ $\qquad RFC_{M_6} := Frac_4$

From 80000 to 86400 sec

$\tau_i := 80000\,sec$ $\qquad \tau_f := 86400\,sec$ $\qquad x := Frac_1 \cdot mp$ $\qquad T := 316\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = \begin{pmatrix} 8.64 \times 10^4 & 5.182982 \times 10^{-5} & 7.61 & 316 & 0.092027 \end{pmatrix}$ $\qquad RFC_{M_7} := Frac_4$

From 86400 to 90000 sec

$\tau_i := 86400\,sec$ $\qquad \tau_f := 90000\,sec$ $\qquad x := Frac_1 \cdot mp$ $\qquad T := 315.9\,K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = \begin{pmatrix} 9 \times 10^4 & 5.183075 \times 10^{-5} & 7.61 & 315.9 & 0.091697 \end{pmatrix}$ $\qquad RFC_{M_8} := Frac_4$

From 90000 to 100000 sec

$\tau_i := 90000\,\text{sec}$ $\tau_f := 100000\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 315.9\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(1 \times 10^5 \quad 5.183332 \times 10^{-5} \quad 7.61 \quad 315.9 \quad 0.091709\right)$ $\text{RFC}_{M_9} := \text{Frac}_4$

From 100000 to 172800 sec $\varepsilon := 0.05$

$\tau_i := 100000\,\text{sec}$ $\tau_f := 172800\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 316.3\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(1.728 \times 10^5 \quad 5.179914 \times 10^{-5} \quad 7.61 \quad 316.3 \quad 0.092931\right)$ $\text{RFC}_{M_{10}} := \text{Frac}_4$

From 172800 to 200000 sec

$\tau_i := 172800\,\text{sec}$ $\tau_f := 200000\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 315.9\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(2 \times 10^5 \quad 5.180831 \times 10^{-5} \quad 7.61 \quad 315.9 \quad 0.091613\right)$ $\text{RFC}_{M_{11}} := \text{Frac}_4$

From 200000 to 300000 sec

$\tau_i := 200000\,\text{sec}$ $\tau_f := 300000\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 315.2\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(3 \times 10^5 \quad 5.18788 \times 10^{-5} \quad 7.61 \quad 315.2 \quad 0.08954\right)$ $\text{RFC}_{M_{12}} := \text{Frac}_4$

From 300000 to 345600 sec

$\tau_i := 300000\,\text{sec}$ $\tau_f := 345600\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 315\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(3.456 \times 10^5 \quad 5.190106 \times 10^{-5} \quad 7.61 \quad 315 \quad 0.089053\right)$ $\text{RFC}_{M_{13}} := \text{Frac}_4$

From 345600 to 400000 sec

$\tau_i := 345600\,\text{sec}$ $\tau_f := 400000\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 314.8\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(4 \times 10^5 \quad 5.192704 \times 10^{-5} \quad 7.61 \quad 314.8 \quad 0.08852\right)$ $\text{RFC}_{M_{14}} := \text{Frac}_4$

From 400000 to 500000 sec

$\tau_i := 400000\,\text{sec}$ $\tau_f := 500000\,\text{sec}$ $x := \text{Frac}_1 \cdot \text{mp}$ $T := 314.7\,\text{K}$

$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$

$\text{Frac}^T = \left(5 \times 10^5 \quad 5.196211 \times 10^{-5} \quad 7.61 \quad 314.7 \quad 0.088313\right)$ $\text{RFC}_{M_{15}} := \text{Frac}_4$

From 500000 to 2590000 sec $\qquad$ $\varepsilon := 0.5$

$\tau_i := 500000 \sec$ $\qquad$ $\tau_f := 2590000 \sec$ $\qquad$ $x := Frac_1 \cdot mp!$ $\qquad$ $T := 314.5 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (2.59 \times 10^6 \quad 5.208562 \times 10^{-5} \quad 7.61 \quad 314.5 \quad 0.088067)$ $\qquad$ $RFC_{M_{16}} := Frac_4$

Assuming that pH is 7.27, the release fraction of iodine atoms are:

$\varepsilon := 2 \cdot 10^{-3}$ $\qquad$ $\lambda := 19.48 hr^{-1}$ $\qquad$ $pH := 7.27$

From 23400 to 28800 sec

$\tau_i := 23400 \sec$ $\qquad$ $\tau_f := 28800 \sec$ $\qquad$ $x := 0 \cdot mp!$ $\qquad$ $T := 315.2 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (2.88 \times 10^4 \quad 4.143422 \times 10^{-5} \quad 7.27 \quad 315.2 \quad 0.265162)$ $\qquad$ $RFC_{L_0} := Frac_4$

From 28800 to 30000 sec

$\tau_i := 28800 \sec$ $\qquad$ $\tau_f := 30000 \sec$ $\qquad$ $x := Frac_1 \cdot mp!$ $\qquad$ $T := 315.7 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (3 \times 10^4 \quad 4.139628 \times 10^{-5} \quad 7.27 \quad 315.7 \quad 0.278069)$ $\qquad$ $RFC_{L_1} := Frac_4$

From 30000 to 40000 sec $\qquad$ $\varepsilon := 0.005$

$\tau_i := 30000 \sec$ $\qquad$ $\tau_f := 40000 \sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 315.9 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (4 \times 10^4 \quad 4.12693 \times 10^{-5} \quad 7.27 \quad 315.9 \quad 0.278577)$ $\qquad$ $RFC_{L_2} := Frac_4$

From 40000 to 50000 sec

$\tau_i := 40000 \sec$ $\qquad$ $\tau_f := 50000 \sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 316 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$Frac^T = (5 \times 10^4 \quad 4.123248 \times 10^{-5} \quad 7.27 \quad 316 \quad 0.278745)$ $\qquad$ $RFC_{L_3} := Frac_4$

From 50000 to 60000 sec

$\tau_i := 50000 \sec$ $\qquad$ $\tau_f := 60000 \sec$ $\qquad$ $x := Frac_1 \cdot mp$ $\qquad$ $T := 316 K$

$Frac := RF(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x)$

$$\text{Frac}^T = \left(6 \times 10^4 \quad 4.122018 \times 10^{-5} \quad 7.27 \quad 316 \quad 0.278457\right)$$

$RFC_{L_4} := \text{Frac}_4$

From 60000 to 70000 sec

$\tau_i := 60000\,\text{sec}$ $\qquad \tau_f := 70000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot \text{mp}$ $\qquad T := 316.2\,\text{K}$

$$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$$

$$\text{Frac}^T = \left(7 \times 10^4 \quad 4.11913 \times 10^{-5} \quad 7.27 \quad 316.2 \quad 0.280131\right)$$

$RFC_{L_5} := \text{Frac}_4$

From 70000 to 80000 sec

$\tau_i := 70000\,\text{sec}$ $\qquad \tau_f := 80000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot \text{mp}$ $\qquad T := 316\,\text{K}$

$$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$$

$$\text{Frac}^T = \left(8 \times 10^4 \quad 4.119493 \times 10^{-5} \quad 7.27 \quad 316 \quad 0.278025\right)$$

$RFC_{L_6} := \text{Frac}_4$

From 80000 to 86400 sec

$\tau_i := 80000\,\text{sec}$ $\qquad \tau_f := 86400\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot \text{mp}$ $\qquad T := 316\,\text{K}$

$$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$$

$$\text{Frac}^T = \left(8.64 \times 10^4 \quad 4.119662 \times 10^{-5} \quad 7.27 \quad 316 \quad 0.278071\right)$$

$RFC_{L_7} := \text{Frac}_4$

From 86400 to 90000 sec

$\tau_i := 86400\,\text{sec}$ $\qquad \tau_f := 90000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot \text{mp}$ $\qquad T := 315.9\,\text{K}$

$$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$$

$$\text{Frac}^T = \left(9 \times 10^4 \quad 4.120024 \times 10^{-5} \quad 7.27 \quad 315.9 \quad 0.277104\right)$$

$RFC_{L_8} := \text{Frac}_4$

From 90000 to 100000 sec

$\tau_i := 90000\,\text{sec}$ $\qquad \tau_f := 100000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot \text{mp}$ $\qquad T := 315.9\,\text{K}$

$$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$$

$$\text{Frac}^T = \left(1 \times 10^5 \quad 4.120831 \times 10^{-5} \quad 7.27 \quad 315.9 \quad 0.277203\right)$$

$RFC_{L_9} := \text{Frac}_4$

From 100000 to 172800 sec $\qquad\qquad \varepsilon := 0.05$

$\tau_i := 100000\,\text{sec}$ $\qquad \tau_f := 172800\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot \text{mp}$ $\qquad T := 316.3\,\text{K}$

$$\text{Frac} := \text{RF}\left(\tau_i, \tau_f, \varepsilon, \lambda, T, \text{pH}, V_G, x\right)$$

$$\text{Frac}^T = \left(1.728 \times 10^5 \quad 4.11355 \times 10^{-5} \quad 7.27 \quad 316.3 \quad 0.280518\right)$$

$RFC_{L_{10}} := \text{Frac}_4$

From 172800 to 200000 sec

$\tau_i := 172800\,\text{sec}$ $\qquad \tau_f := 200000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot mp$ $\qquad T := 315.9\,\text{K}$

$\text{Frac} := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\text{Frac}^T = \left(2 \times 10^5 \quad 4.116181 \times 10^{-5} \quad 7.27 \quad 315.9 \quad 0.276476\right)$ $\qquad RFC_{L_{11}} := \text{Frac}_4$

From 200000 to 300000 sec

$\tau_i := 200000\,\text{sec}$ $\qquad \tau_f := 300000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot mp$ $\qquad T := 315.2\,\text{K}$

$\text{Frac} := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\text{Frac}^T = \left(3 \times 10^5 \quad 4.132961 \times 10^{-5} \quad 7.27 \quad 315.2 \quad 0.271233\right)$ $\qquad RFC_{L_{12}} := \text{Frac}_4$

From 300000 to 345600 sec

$\tau_i := 300000\,\text{sec}$ $\qquad \tau_f := 345600\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot mp$ $\qquad T := 315\,\text{K}$

$\text{Frac} := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\text{Frac}^T = \left(3.456 \times 10^5 \quad 4.137765 \times 10^{-5} \quad 7.27 \quad 315 \quad 0.270537\right)$ $\qquad RFC_{L_{13}} := \text{Frac}_4$

From 345600 to 400000 sec

$\tau_i := 345600\,\text{sec}$ $\qquad \tau_f := 400000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot mp$ $\qquad T := 314.8\,\text{K}$

$\text{Frac} := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\text{Frac}^T = \left(4 \times 10^5 \quad 4.143152 \times 10^{-5} \quad 7.27 \quad 314.8 \quad 0.269334\right)$ $\qquad RFC_{L_{14}} := \text{Frac}_4$

From 400000 to 500000 sec

$\tau_i := 400000\,\text{sec}$ $\qquad \tau_f := 500000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot mp$ $\qquad T := 314.7\,\text{K}$

$\text{Frac} := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\text{Frac}^T = \left(5 \times 10^5 \quad 4.150024 \times 10^{-5} \quad 7.27 \quad 314.7 \quad 0.269196\right)$ $\qquad RFC_{L_{15}} := \text{Frac}_4$

From 500000 to 2590000 sec
$\qquad\qquad\qquad\qquad\qquad \varepsilon := 0.5$

$\tau_i := 500000\,\text{sec}$ $\qquad \tau_f := 2590000\,\text{sec}$ $\qquad x := \text{Frac}_1 \cdot mp$ $\qquad T := 314.5\,\text{K}$

$\text{Frac} := RF\left(\tau_i, \tau_f, \varepsilon, \lambda, T, pH, V_G, x\right)$

$\text{Frac}^T = \left(2.59 \times 10^6 \quad 4.169013 \times 10^{-5} \quad 7.27 \quad 314.5 \quad 0.269715\right)$ $\qquad RFC_{L_{16}} := \text{Frac}_4$

Iodine release fractions during X/Q time intervals:

$i := 2..9$ $\qquad t_{i-2} := i \cdot 10000$ $\qquad t_0 := 28800$ $\qquad t_7 := 86400$

$i := 9..11$ $\qquad t_{i-1} := i \cdot 10000$ $\qquad t_{10} := 172800$ $\qquad i := 12..14$ $\qquad t_{i-1} := (i - 10) \cdot 100000$

$$t_{i+2} := (i - 8) \cdot 100000 \qquad t_{13} := 345600 \qquad t_{16} := 2.59 \cdot 10^6$$

$$\text{Ave}\left(i_0, i_1, \text{RFC}, t\right) := \begin{vmatrix} \text{dummy} \leftarrow 0 \\ \text{for } j \in i_0 .. i_1 \\ \quad \text{dummy} \leftarrow \text{dummy} + \text{RFC}_j \cdot \left(t_j - t_{j-1}\right) \\ \dfrac{\text{dummy}}{t_{i_1} - t_{i_0 - 1}} \end{vmatrix}$$

<u>From 6.5 to 8 hour:</u>

$$\text{RFC}_{H_0} = 0.0268 \qquad\qquad \text{RFC}_{M_0} = 0.0881 \qquad\qquad \text{RFC}_{L_0} = 0.26516$$

<u>From 8 to 24 hour:</u>

$$\text{Ave}\left(1, 7, \text{RFC}_H, t\right) = 0.02778 \qquad \text{Ave}\left(1, 7, \text{RFC}_M, t\right) = 0.09213 \qquad \text{Ave}\left(1, 7, \text{RFC}_L, t\right) = 0.27869$$

<u>From 1 to 4 days:</u>

$$\text{Ave}\left(8, 13, \text{RFC}_H, t\right) = 0.02737 \qquad \text{Ave}\left(8, 13, \text{RFC}_M, t\right) = 0.09074 \qquad \text{Ave}\left(8, 13, \text{RFC}_L, t\right) = 0.27458$$

<u>From 4 to 30 days:</u>

$$\text{Ave}\left(14, 16, \text{RFC}_H, t\right) = 0.02645 \qquad \text{Ave}\left(14, 16, \text{RFC}_M, t\right) = 0.08809 \qquad \text{Ave}\left(14, 16, \text{RFC}_L, t\right) = 0.26968$$

Summary of the results for iodine release fractions

Time Interval (sec)			pH = 7.9	pH = 7.61	pH = 7.27
23400	to	28800	0.0268	0.0881	0.2652
28800	to	86400	0.0278	0.0921	0.2787
86400	to	345600	0.0274	0.0907	0.2746
345600	to	2590000	0.0265	0.0881	0.2697

References:

1.   PSAT 3056CT.QA.03, "Plant Specific Design Input for Calculation of Indian Point 3 ESF Component Leakage Iodine Release" Rev. 0.

2.   L. Soffer et al., "Accident Source Terms for Light-Water Nuclear Power Plants, " NUREG-1465, February, 1995.

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Attachment 2 XL Spreadsheet Calculation of Iodine Concentration in Bulk Gas with BL Effect, Hallway Outside

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Attachment 2 XL Spreadsheet Calculation of Iodine Concentration In Bulk Gas w/ BL Effects	Hallway Outside	Penetration Area		Pump Room 31	Pump Room 32	Sump Tank Room	Hallway to Sump Room	High Head Pump Room
Exchange flow (cfm)	7500	4000		4000	4000	200	12000	11700
Case-Specific Parameter Inputs	Volume 1							
Exchg rate betw. vol 1 and 2 (m3/s)	0	0	0		0	0	0	0
Total room volume, V (m3)	617.4	1389.0		75.1	113.0	55.6	34.0	628.8
Exchg rate with env. (vol/hr)	20.6	4.9		90.5	60.2	6.1	600.0	31.6
Vol. flow to env., V-dot (m3/s)	3.5	1.9		1.9	1.9	0.1	5.7	5.5
Cross sectional area, Ac (m2)	45.0	107.2		13.0	19.5	16.6	5.6	35.1
Temperature, T (K)	370.9	370.9		370.9	370.9	370.9	370.9	370.9
Pressure (atm)	1.0	1.0		1.0	1.0	1.0	1.0	1.0
Length scale, L (m)	13.7	13.0		5.8	5.8	3.4	6.1	17.9
Area, A (m2)	618.7	857.6		118.3	155.3	77.7	85.5	688.6

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Attachment 2 XL Spreadsheet Calculation of Iodine Concentration in Bulk Gas with BL Effect

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Attachment 2 XL Spreadsheet Calculation of Iodine Concentration In Bulk Gas with BL Effect

Calculation of elemental iodine concentration at liquid edge of gas bounday layer

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ATTACHMENT 5 TO NL-04-162

COMMITMENTS

ENTERGY NUCLEAR OPERATIONS, INC
INDIAN POINT NUCLEAR GENERATING UNIT 3
DOCKET 50-286

COMMITMENTS

No.	Commitment	Date
1	Relocate the FSB and Containment Purge Testing requirements to the FSAR and indicate they must be maintained to comply with 10 CFR 50, Appendix I.	April15, 2005
2	The Technical Analysis in Attachment 1 said "A penalty has been applied to the Containment Spray System (CSS) flow rate to provide margin for future results from CSS pump testing." The analysis will be amended and submitted to the NRC staff for review and approval if it is determined that the test results of the containment spray system flow rate did not provide adequate margin.	Post Test