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Subject: McGuire Nuclear Station
Docket Nos. 50-369, 370
Response To Request For Additional Information
Proposed Technical Specification (TS) Amendment
TS 3.7.15 - Spent Fuel Assembly Storage
TS 4.3 - Fuel Storage

By letter dated April 9, 1999, Duke Energy Corporation (DEC) submitted proposed amendments to TS 3.7.15 - Spent Fuel Assembly Storage and TS 4.3 - Fuel Storage. During a telephone conference call on September 21, 1999 and subsequent conference calls between DEC personnel and the NRC, the NRC staff requested additional information related to the subject TS amendment for McGuire Units 1 and 2. This letter provides the requested information.

Enclosure 1 of this letter documents the questions posed by the NRC Staff and DEC's responses to those questions. As indicated in DEC's responses, some of the information contained in the TS submittal requires revision. Enclosure 2 provides these revised TS submittal pages. The corresponding pages in the submittal currently being reviewed by the NRC Staff should be replaced with these revised pages. Enclosure 3 of this letter contains clarifying information related to the TS submittal and the responses provided in this letter.

There are no regulatory commitments contained in this letter.

Any questions related to this matter should be directed to Julius Bryant, McGuire Regulatory Compliance, at (704) 875-4162.

HB Barron

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Enclosures

A001

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ENCLOSURE 1

QUESTIONS AND RESPONSES

Response to NRC Questions Related To Proposed Amendment to McGuire Nuclear Station Technical Specifications 3.7.15 and 4.3

QUESTION 1:

Did the new fuel storage vault calculations assume 4.75 w/o in the maximum keff case? What moderator density corresponds to this case? What is the maximum keff for a fully flooded vault at 4.75 w/o? Does the fully flooded case meet the 0.95 keff requirements?

Response:

The following provides additional information regarding the new fuel vault criticality analysis.

The new fuel vault calculations were performed assuming an enrichment of 4.75 w/o U-235. An uncertainty was included in the calculation to account for tolerances in the as built enrichment of + 0.05 w/o.

The new fuel storage vault maximum k_{eff}s for fully flooded and optimum moderation conditions are as follows:

Condition	Moderator Density	Maximum k_{eff}
Fully Flooded	1.0	0.9433
Optimum Moderation	0.09	0.9759

From the results above, the new fuel storage vault meets the appropriate limits on k_{eff} for both conditions; namely $k_{eff} < 0.95$ for fully flooded conditions and $k_{eff} < 0.98$ for optimum moderation.

QUESTION 2:

Attachment 6 of the Technical Specification (TS) submittal, page 20 and the revised BASES B3.7.15 in the TS submittal state that 1170 ppm is required to mitigate postulated criticality accidents and maintain $k_{eff} < 0.95$. However, Attachment 6, Table 11 indicates the maximum boron required without accidents is 440 ppm and the maximum boron required for accident conditions is 760 ppm. Adding the 440 ppm (without accidents) to 760 ppm (with accidents) yields 1200 ppm. Explain the difference between the 1170 ppm total boron required and the 1200 ppm from adding the requirements with and without accidents.

Response:

The boron requirements, with and without accidents, are determined for each of the four regions individually. The boron required without accidents is the sum of the boron required for keff < 0.95 and the boron required for reactivity equivalencing as specified in the boron credit methodology. The total boron required with accidents is the boron required without accidents plus the additional boron required from the single accident with the greatest boron requirement. This is because only a single accident need be considered at one time. Finally, the total boron requirement for the entire pool is the maximum total boron requirement of the four regions.

There is an error in Attachment 6, Table 11 of the TS submittal. The boron required for the burnup uncertainty for Region 2A should be 120 ppm, not 90. This yields a total of 440 ppm total boron required without accidents and 1170 ppm total boron required with accidents for this region. A corrected Table 11 of Attachment 6 is attached to this letter.

Thus, the total boron credit required with accidents is 1170 ppm. This comes from the Region 2A boron requirements of 440 ppm without accidents plus 730 ppm boron required for the postulated misload accident. While the boron required for the misload accident in Region 2B is greater (760 vs. 730), the boron requirement without accidents is only 380 ppm for a total of only 1140 ppm. An initial condition to a postulated accident would require at least 440 ppm to maintain $k_{eff} < 0.95$ under normal conditions. If a postulated misload accident were to occur, Region 2B would still only require 1140 ppm to maintain keff < 0.95 since it only requires 380 ppm to maintain keff < 0.95 under non-accident conditions. That is, the additional boron required for the accident is added on top of the boron required to maintain that region < 0.95, not the initial condition boron.

QUESTION 3:

The discussion on page 8 of Attachment 6 to the TS submittal indicates no reactivity penalty for Boraflex gaps. What are the maximum gaps in the models and how does this compare to the measurements?

Response:

The models do not contain any gaps in the Boraflex. An analysis was performed to determine the maximum size gaps before an increase in reactivity would occur. The analysis determined small gaps in the Boraflex panels do not increase the reactivity. The results of this analysis, compared to the results of the gap measurements indicate that the gaps found do not result in an increase in reactivity, and therefore, no reactivity penalty is necessary.

It should be pointed out that a reactivity penalty is included for the end pull back of the Boraflex panels caused by shrinkage in the width and axial directions. These uncertainties are listed in Tables 4 and 5 of Attachment 6 of the TS submittal.

QUESTION 4:

Provide clarification of Table 2 in Attachment 7 of the TS submittal specifically addressing the time steps and the stages of dilution.

Response:

A revised version Table 2, Attachment 7 is provided which has been relabeled to clarify the lower section of the table. This section is intended to provide the boron concentration at different times regardless of dilution stage, and not strictly for Stage 3. In addition, Table A of this letter gives a detailed tabulation of pool boron concentration over time for the limiting 700 gpm case. Table A of this letter also identifies the stages of dilutions and the equations used to calculate the boron concentration.

QUESTION 5:

Provide an analysis of the limiting case dilution accidents with the transfer canal isolated from the main pool region.

Response:

The following sensitivity analysis is provided to show the effect on boron dilution accidents of isolating the Fuel Transfer Canal from the main spent fuel pool area. The purpose of isolating and draining the transfer canal is to drain the canal to gain access to the fuel handling equipment used to transport fuel assemblies between the Spent Fuel Pool and the Refueling Canal. For additional information, refer to Section 5.4 of Attachment 7 of the TS submittal. Isolation of the transfer canal removes approximately 9,712.2 cubic feet of water (or 72,652 gallons) from the initial volume of borated water in the pool. For this special case, a new set of parameters is derived that exclude the water volume in the transfer canal.

Three stages of boron dilution flow are examined. The first stage involves filling up the pool to the top of the Transfer Canal wall at elevation 773' + 6". The second stage involves filling the pool from the top of the Transfer Canal wall up to the top of the pool operational deck at elevation 778' + 10". Because the Transfer Canal wall is lower than the top of the pool wall, the pool will initially overflow into the empty Transfer Canal until it is full (Stage 2a) and then proceed to raise level up to the top of the pool wall (Stage 2b). The third stage involves the flow of unborated water into the pool with an equal amount of the diluted mixture flowing out of the pool into the lower areas of the Spent Fuel Pool Building.

The initial pool volume is 249,798 gallons. The volume of water required to fill the pool up to the top of the Transfer Canal wall is denoted as V_c and is calculated for each compartment and added together.

Calculation of Volume V_c (Stage 1)

Compartment:	Calculation (H x L x W)	Volume (cu. ft.)
Cask Pit	(2.104) x (9.0) x (21.5)	407.12
Main Pool - Long Side	(2.104) x (67.0) x (12.75)	1797.34
Main Pool - Short Side	(2.104) x (26.667) x (8.75)	490.94
	Total Volume =	2695.4

Volume (gallons) =	20,163

The volume of water required to fill the Transfer Canal up to the top of the Transfer Canal wall is denoted as V_{Ta} and calculated below.

Calculation of Volume V_{Ta} (Stage 2a)

Compartment:	Calculation (H x L x W)	Volume (cu. ft.)
Transfer Canal	(42) x (51.25) x (4.75)	10224.38
	Volume (gallons) =	76,483

The volume of water required to fill the pool from the top of the Transfer Canal wall up to the top of the pool is denoted as V_{Tb} and is calculated for each compartment and added together.

Calculation of Volume V_{Tb} (Stage 2b)

Compartment:	Calculation (H x L x W)	Volume (cu. ft.)
Cask Pit	(5.333) x (9.0) x (21.5)	1031.94
Main Pool - Long Side	(5.333) x (67.0) x (21.5)	7682.19
Transfer Canal Extension	(5.333) x (15.0) x (4.75)	379.98
	Total Volume =	9094.11
	Volume (gallons) =	68,029

Using these new parameters, the dilution calculations for the worse case bounding events (the 700 gpm RF line break and the RHT/RMWST misalignment event) are performed. The pool boron concentration at the end of stage 1 (C_1) is found using the following equation:

$$C_1 = \frac{C_o * V_o}{V_o + V_c}$$

where C_o = Initial Pool Boron Concentration (2475 ppm)
V_o = Initial Pool Water Volume (249,798 gallons)
V_c = Volume of water to fill to top of Transfer Canal Wall (20,163 gallons)

This yields a value for C_1 of 2290 ppm.

After Stage 1, the pool begins to overflow the Transfer Canal Wall and refill the Transfer Canal (Stage 2a). The boron concentration in the main pool area when the Transfer Canal has been filled to the top of the canal wall is calculated using the following formula:

$$C_{2a} = C_1 e^{\left(-V_{Ta}/V_{M1}\right)}$$

where,

C_1 = Pool Boron Concentration at the end of Stage 1 (2290 ppm)
V_{Ta} = Water Volume to fill Transfer Canal (76,483 gallons)
V_{M1} = Pool Mixing Volume During Stage 2a (V_o+V_c = 269,961 gallons)

This results in a boron concentration in the main pool area of 1725 ppm.

Proceeding into Stage 2b, it is conservatively assumed that the borated water that is spilled into the Transfer Canal will not mix with rest of pool water volume since the isolation gate is installed. The pool boron concentration at the end of stage 2b (C_{2b}) is found using the following formula:

$$C_{2b} = \frac{C_{2a} * \left(V_o + V_c\right)}{V_o + V_c + V_{Tb}}$$

where C_{2a} = Pool Boron Concentration at end of Stage 2a (1725 ppm)
V_o = Initial Pool Water Volume (249,798 gallons)
V_c = Volume of water to fill to top of Transfer Canal Wall (20,163 gallons)
V_{Tb} = Volume to fill from Canal Wall to Top of Pool (68,029 gallons)

This yields a value for C_{2b} of 1378 ppm. The total volume of water required to reach this concentration is 164,675 gallons. At a flow rate of 700 gpm, it would require 3.92 hours to reach the end of Stage 2b to enter Stage 3 (pool overflow).

After the pool reaches stage 3 where the pool is overflowing, the boron concentration is found using the following equation:

$$C = C_{2b} e^{\left(-Q/V_{M2}\right)(60)(t-t_T)}$$

where C_{2b} = equals the pool concentration at the end of Stage 2b (1378 ppm)
Q = Flow rate into Pool (gpm)
V_{M2} = Total Mixing Volume for Stage 3 (337,991 gallons)

t_T = Length of time to fill to top of pool (hours)

t = Length of time after initiation of dilution flow (hours)

60 = Conversion factor for converting hours to minutes

Using the equation above, the pool boron concentration was estimated for the worse case bounding pipe break event (700 gpm RF line break). Table B of this letter provides a tabulation of boron concentration as a function time after the break initiation.

For the worse case system misalignment(RHT/RMWST misalignment event), the equation above is modified slightly to utilize a fixed dilution volume.

$$C = C_{2b} \cdot e^{-\left(\frac{V - V_C - V_{Ta} - V_{Tb}}{V_{M2}}\right)}$$

where V = Volume of water in the RHT and RMWST tanks (336,000 gallons)

Note: The term ($V-V_C - V_{Ta}-V_{Tb}$) yields the volume of water that overflows the SFP.

Thus,

$$C = (1378) \cdot e^{-\left(\frac{336000-164675}{337991}\right)} = 1378 \cdot e^{-(0.507)} = 830_{\text{ppm}}$$

The results of these sensitivity calculations show that the isolation of Fuel Transfer Canal would result in a lower boron concentration than the other infrequent configuration, isolation of the Cask Loading Pit. However, this difference is not significant relative to the minimum boron credit of 440 ppm used in the non-accident criticality analysis. As discussed in the submittal, isolation of the Fuel Transfer Canal was not considered to be a part of a credible boron dilution accident scenario because of the very low frequency of the configuration, the enormous volume of water required to significantly dilute the pool, and the effective means of early detection and termination of an event. At the most limiting dilution flow rate (700 gpm), it would require 13.11 hours (550,530 gallons total) to dilute a pool down to the 440 ppm limit. This provides ample time for operators to detect and terminate potential boron dilution events. Thus, it is concluded that the Fuel Transfer Canal Isolation configuration does not significantly impact the conclusions of the boron dilution analysis.

QUESTION 6:

Provide additional discussion supporting the conclusions presented in Attachment 7 of the TS submittal. Specifically address the RF line break event that involves water pumped directly from Lake Norman.

Response:

The analysis in Attachment 7 of the TS submittal concluded that an unplanned or inadvertent event which would result in the dilution of the spent fuel pool boron concentration from 2475 ppm to less than 937 ppm is not a credible event. The analysis results showed that the dilution process requires many hours to significantly reduce pool boron concentration even under the most limiting conditions and provides sufficient time for operator actions to terminate the accident.

This conclusion is supported by the following:

- A substantial amount of water is required to significantly dilute the spent fuel pool. In the worse case configuration with the cask loading pit isolated, 336,000 gallons are required to dilute the pool from 2475 ppm to 937 ppm. At the maximum postulated flowrate of 700 gpm, it takes 8 hours to pump a volume of 336,000 gallons. No single tank or combination of two tanks in the plant contains this volume of water and would, therefore, require multiple errors to align the three largest storage tanks to the Spent Fuel Pool. Conservative assumptions were also made that the three largest tanks were all full, which is considered a very infrequent condition.

- Since such a large volume of water is required, a spent fuel pool dilution event would be readily detected by level alarms, flooding in the auxiliary building, or by normal operator rounds through the spent fuel pool area. In the case of the RF line break accident, control room alarms would provide indication that one or more RF pumps had started. In addition, flow alarms on the RF headers would also indicate to operators that the flow was going into the Auxiliary Building. These indications would initiate an immediate investigation into the location of the pipe break and the cause of the RF pump start.

- Sensitivity analysis indicates that even if substantially higher flow rates of unborated water into the SFP are assumed, there is still sufficient time available to detect and respond to such an event (See Table 2 of the TS submittal for the 1000 gpm and 1500 gpm cases).
- The analysis conservatively assumes that the initial Spent Fuel Pool water volume is 322,450 gallons which does not account for a significant volume of water contained within the fuel pin area. The volume of water contained in the KF system piping is also not included, but would be mixed with the pool volume in all scenarios except for the Loss of Off-Site Power scenarios.

QUESTION 7:

Attachment 7 of the TS submittal, Section 5.2 (1st paragraph) refers to additional information contained in "Attachment 2". This information does not appear to be included in the submittal. Please provide this additional information.

Response:

As stated on the cover sheet for Attachment 7 of the TS submittal, the info in Attachment 7 is a summary of applicable portions of the McGuire Nuclear Station Spent Fuel Pool Soluble Boron Credit Boron Dilution Analysis. The Attachment 2 referred to in the TS submittal is contained in the body of that detailed Boron Dilution Analysis. However, Attachment 2 of the detailed Boron Dilution Analysis does not provide applicable information useful for evaluating the TS submittal. The text "Attachment 2" was included in the Attachment 7 summary of the detailed Boron Dilution Analysis only because it was contained within text of that analysis that was applicable to the TS submittal. Based upon the above, a copy of Attachment 2 of the detailed Boron Dilution Analysis was not included as part of the TS submittal. Note that an electronic information copy of Attachment 2 was sent to the NRC staff reviewing the subject TS submittal.

QUESTION 8:

Larry Kopp (NRC) requested that, as part of this letter, McGuire Provide a general summary of administrative controls used to ascertain that fuel assemblies have achieved the appropriate burnup for storage in the burn-up dependent storage racks.

Response:

McGuire utilizes administrative controls to determine, based upon available data for the fuel assemblies, the correct geometric fuel assembly storage configurations that ensure compliance with the requirements of plant Technical Specifications related to spent fuel storage.

Each fuel assembly received at the site is accompanied by documentation verifying the initial U-235 enrichment. This information is entered into a Special Nuclear Material (SNM) tracking database. Prior to discharge of fuel assemblies into the Spent Fuel Pools, their final burnups are determined and entered into the same database. Thus, at the time of discharge, the SNM database contains initial enrichment, total burnup, and discharge date for each fuel assembly being discharged. Based upon this data, plant fuel transfer procedures are then used to specify storage configurations for the fuel assemblies that comply with the Technical Specification requirements. Independent verifications are made prior to transfer of the fuel assemblies to the Spent Fuel Pools to ensure the correct assembly is chosen and to verify the assembly is being moved to a location representing an acceptable storage configuration.

QUESTION 9:

Regarding Table 3, Attachment 7 of the TS submittal, provide information in the table related to the time to reach minimum boron credit concentrations in the pools for the case of an RF line break while the Cask Loading Pit is isolated.

Response:

A revised Table 3, Attachment 7 showing the requested information is provided in this letter. In addition, a revised Page 22 of 35, Attachment 7, is included showing that, for the 700 gpm RF line break and the alternate configuration described, it would take 14.4 hours to lower Spent Fuel Pool boron concentrations below the non-accident conditions minimum boron credit of 440 ppm.

ENCLOSURE 2

REVISED SUBMITTAL PAGES

Table 11
Summary of Boron Credit Requirements

	Unrestricted				Restricted w/ Filler			
	1A	1B	2A	2B	1A	1B	2A	2B
k-eff ≤ 0.95								
Boron required for k-eff ≤ 0.95	310	160	230	160	330	160	240	160
Reactivity Equivalencing								
Boron required for bu unc	20	50	120	120	100	60	120	100
Boron required for measured burnup	20	40	90	100	10	20	40	60
Boron required for IFBA man unc	20	0	0	0	0	0	0	0
Boron required for IFBA calc unc	70	0	0	0	0	0	0	0
Accident conditions								
Boron required for misload	300	370	730	760	300	370	730	760
Boron required for abnormal heat load	0	20	0	0	0	20	0	0
Boron required for emergency makeup	10	0	20	0	10	0	20	0
Boron required for single assy in water	170	170	170	170	170	170	170	170
Total Boron Credit Required w/o Accidents	440	250	440	380	440	240	400	320
Total Boron Credit Required with Accidents	740	620	1170	1140	740	610	1130	1080

Table 2 - Spent Fuel Pool Deboration Accident Analysis
SFP Boron Concentration (ppm)

Initial Pool Boron Conc. = C_o 2475 ppm
Initial Pool Level = L_o 771.396 feet
Initial Spent Fuel Pool Volume = V_o 322,450 gallons
Volume to fill SFP to Top of Transfer Canal = V_c 23,995 gallons
Volume to fill SFP from Canal Wall to Overflow = V_T 68,029 gallons

			Flow Rate Into SFP (gpm)							
			50	*100*	*200*	*300*	*500*	*700*	*1000*	*1500*
Fill To Top of Canal Wall	T_c (hrs)		*8.0*	*4.0*	*2.0*	*1.3*	*0.8*	*0.6*	*0.4*	*0.3*
(Stage 1)	Concentration		*2304*	*2304*	*2304*	*2304*	*2304*	*2304*	*2304*	*2304*
Fill To Pool Overflow Level	t_T (hrs)		*30.7*	*15.3*	*7.7*	*5.1*	*3.1*	*2.2*	*1.5*	*1.0*
(Stage 2)	Concentration		1925	1925	1925	1925	1925	1925	1925	1925
High Level Alarm (Elev. 772'+7")	Detection Time (hrs)		4.51	2.26	1.13	0.75	0.45	0.32	0.23	0.15
	Flowrate -->		*50*	*100*	*200*	*300*	*500*	*700*	*1000*	*1500*
Pool Concentration (ppm) Versus Time and Flowrate	Time (hours)	1	2452	2430	2386	2344	2264	2190	2087	1935
		2	2430	2386	2304	2226	2087	1963	1800	1557
		4	2386	2304	2154	2023	1800	1603	1347	1009
		6	2344	2226	2023	1853	1557	1309	1009	653
		8	2304	2154	1907	1699	1347	1069	755	423
		10	2264	2087	1800	1557	1166	873	565	274
		11	2245	2054	1748	1491	1084	789	489	221
		12	2226	2023	1699	1428	1009	713	423	178
		16	2154	1907	1513	1200	755	475	237	74
		24	2023	1699	1200	848	423	211	74	13
		36	1853	1428	848	503	178	63	13	1
		48	1699	1200	599	299	74	19	2	0
		56	1603	1069	475	211	42	8	1	0
		64	1513	952	377	149	23	4	0	0
		72	1428	848	299	105	13	2	0	0

Table 3 - RF Line Break With Cask Loading Pit Isolated

Time (hrs)	Base Case Concentration (ppm)	Alternate Configuration Case Conc.	Difference
1	2190	2148	-42
2	1963	1897	-66
4	1603	1500	-103
6	1309	1186	-123
8	1069	937	-132
10	873	741	-132
11	789	659	-130
12	713	586	-127
14.44	557	440	-117
16	475	366	-109
24	211	143	-68
36	63	35	-28
48	19	9	-10
56	8	3	5
64	4	1	-3
72	2	1	-1

ensure very prompt detection prior to a significant amount of unborated water being added to the SFP. In fact, the pool would actually spill over into the fuel transfer canal and stop any work taking place there. Piping breaks in the pool area would also be obvious to crews working there. Also, the borated water drained from the transfer canal would be stored in the Recycle Holdup Tanks, effectively eliminating one of the more significant dilution sources. Because of the very low frequency of this configuration, the enormous volume of water required to significantly dilute the pool, and the effective means of early detection of an event, this configuration is not considered to be a part of a credible boron dilution accident scenario and is not considered further in this analysis.

The purpose of isolating and draining the cask loading pit is to prepare for the loading of fuel into a cask or for the actual movement of a cask into or out of the pit. While this activity has been very rare in recent past experience, some cask loading activities are planned for the future. Isolation of the cask loading pit removes approximately 46,423 gallons from the total volume of borated water available in the pool. For this special case, a new set of parameters is derived that exclude water volume in the cask loading area.

Using these new parameters, the previous dilution calculations for the worst case bounding events (the 700 gpm RF line break and the RHT/RMWST misalignment event) were performed again. For the 700 gpm RF line break, the results for this alternate configuration are provided in Table 3 which shows that it would take 14.4 hours for this dilution event to lower pool boron concentrations below the non-accident conditions minimum boron credit of 440 ppm (Attachment 6). For the RHT/RMWST misalignment event, the final pool boron concentration is 937

ENCLOSURE 3

CLARIFYING INFORMATION

(DO NOT REPRESENT REVISED SUBMITTAL PAGES)

Table A - Pool Boron Concentration As A Function of Time
(Flowrate = 700 gpm)

Dilution Stages	Time (hrs)	Total Gallons Added	Concentration (ppm)	Dilution Sequence of Events	Equation
Stage 1	0	0	2475	Dilution Begins (700 gpm)	$C = \frac{C_o * V_o}{V_o + (Q * 60 * t)}$
	0.322	13,524	2375	High Level Alarm (Elev. 772'+7")	
ends —>	0.571	23,982	2304	Level Reaches Top of Canal Wall (Elev. 773.5')	
Stage 2	1	42,000	2190		$C = \frac{C_o * V_o}{V_o + V_c + (Q * 60 * (t - t_c))}$
	2	84,000	1963		
ends —>	2.19	92,024	1925	<— Level Reaches Overflow (Elev. 778.833')	
Stage 3	4	168,000	1603		$C = C_2 e^{(-(Q*60)/V_M)(t - t_T)}$ where, C_2 = Concentration at end of Stage 2 = 1925 ppm V_M = Total Mixing Volume = $V_o+V_c+V_T$ = 414,474 gallons t_T = time required to reach SFP overflow = 2.19 hours Q = Dilution Flowrate = 700 gpm
	6	252,000	1309		
	8	336,000	1069		
	10	420,000	873		
	11	462,000	789		
	12	504,000	713		
	16	672,000	475		
	16.76	703,749	440	<— Boron Limit Reached	
	24	1,008,000	211		
	36	1,512,000	63		
	48	2,016,000	19		
	56	2,352,000	8		
	64	2,688,000	4		
	72	3,024,000	2		

*Note: The equation shown for Stage 3 is slightly different than given in the original submittal. The factor of "60" is now shown which makes the units of time consistent.

Table B - Pool Boron Concentration As A Function of Time With Transfer Canal Isolated
(Flowrate = 700 gpm)

Dilution Stages	Time (hrs)	Total Gallons Added	Concentration (ppm)	Dilution Sequence of Events
Stage 1	0	0	2475	Dilution Begins (700 gpm)
	0.271	11,379	2367	High Level Alarm (Elev. 772'+7")
ends —>	0.48	20,163	2290	Level Reaches Top of Canal Wall (Elev. 773.5')
Stage 2a	1	42,000	2112	Main Pool Spilling Over Into Transfer Canal
	2	84,000	1808	
ends —>	2.3	96,646	1725	<— Transfer Canal Full (Elev. 773.5')
Stage 2b	3	126,000	1556	
ends —>	3.92	164,675	1378	<— Level Reaches Overflow (Elev. 778.833')
Stage 3	4	168,000	1365	
	6	252,000	1064	
	8	336,000	830	
	10	420,000	647	
	11	462,000	572	
	12	504,000	505	
	13.11	550,530	440	<-- Boron Limit Reached
	16	672,000	307	
	24	1,008,000	114	
	36	1,512,000	26	
	48	2,016,000	6	
	56	2,352,000	2	
	64	2,688,000	1	
	72	3,024,000	0.3	