ENCLOSURE 2
HOLTEC INTERNATIONAL
SEQUOYAH NUCLEAR PLANT (SQN) UNITS 1 AND 2
DOCKET NOS. 50-327 AND 50-328
(HI-992302)

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QA Record

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APR 21 2000

Holtec International
555 Lincoln Drive West
Marlton, New Jersey 08053

Attention: Mr. K. K. Niyogi

Gentlemen:

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2 - SPENT FUEL POOL CRITICALITY ANALYSIS WITH BORON CREDIT - CONTRACT 99NNQ-254781 - LETTER NO. 30M383

DOCUMENT SUBMITTAL - SPENT FUEL POOL BORON DILUTION ANALYSIS - N2N-056

We acknowledge receipt of the document listed below submitted by your letter dated March 17, 2000, and return herewith one copy marked (A), "Approved".

Document No.	Revision	Title
HI-992302	01	Spent Fuel Pool Boron Dilution Analysis Report, Units 1 and 2

We note that the above document has been revised to address the TVA comments on the previous revision of the spent fuel pool boron dilution report which were documented by TVA Letter 30M380.

The spent fuel pool boron dilution summary report will be submitted to NRC for review as part of the technical basis for the formal Sequoyah license amendment request (Sequoyah Technical Specification Change No. TVA-SQN-TS-99-17) which will modify the present spent fuel pool fuel storage requirements to be consistent with the revised spent fuel pool criticality calculations summarized in Holtec Report HI-992349. The revised spent fuel pool criticality calculations take partial credit for dissolved boron in the spent fuel pool water in accordance with 10CFR50.68 requirements.

Your March 17, 2000, letter also submitted a draft version of Document No. HI-992349, Revision 01 for our review and approval. The draft version of the document submitted on March 17 was superseded by the final version of document submitted by your letter dated March 21, 2000. We will acknowledge the March 21 submittal by separate correspondence. Further acknowledgment of the March 17 submittal is not required.

QA Record

B88 000421 800

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BORON DILUTION ANALYSIS

SEQUOYAH NUCLEAR PLANT UNITS 1 & 2

APPROVED
This approval does not relieve the Contractor from any part of his responsibility for the correctness of design, details and dimensions.
Letter No. 30M383
Date: April 20, 2000
TENNESSEE VALLEY AUTHORITY
SQEP (N) BY M. J. Burzynski

FOR

TENNESSEE VALLEY AUTHORITY

PROJECT Sequoyah DISCIPLINE N
CONTRACT 99NNQ-254781 UNIT 1&2
DESC. SFP Boron Dilution Analysis
DWG/DOC NO. HI-992302
SHEET - OF - REV. 01
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Holtec Report No.: HI-992302

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Report Category: A

Report Class: Safety Related

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REVIEW AND CERTIFICATION LOG

DOCUMENT NAME :	BORON DILUTION ANALYSIS - SEQUOYAH NUCLEAR PLANT
HOLTEC DOCUMENT I.D. NUMBER :	992302
HOLTEC PROJECT NUMBER :	90941
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REVISION BLOCK

REVISION NUMBER *	AUTHOR & DATE !!	REVIEWER & DATE !!	QA & DATE !!	APPROVED & DATE !	DIST. x
ORIGINAL	KK NIYOGI 1/10/2000	F.Rosse 01/12/2000	MPHIPPS 1/12/00	KK NIYOGI 1/13/2000	C
REVISION 1	KK NIYOGI 3/15/2000	F.ROSSE 03/15/2000	MPhipps 3/17/00	KK NIYOGI 3/17/2000	C
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Summary of Revisions
Holtec Report No. HI-992302

Revision 1

This revision implements editorial comments made by Tennessee Valley Authority on the earlier revision, to improve primarily the clarity of the text. Also, the report has been designated as "Non-Proprietary". This revision does not change any calculations contained in the earlier revision.

BORON DILUTION ANALYSIS - SEQUOYAH NUCLEAR PLANT

TABLE OF CONTENTS

1.0 INTRODUCTION

The objective of this evaluation is to confirm that design features, instrumentation, administrative procedures, and sufficient time are available to detect and mitigate boron dilution in the spent fuel pit before the boron concentration is reduced below the value assumed in the spent fuel rack criticality analysis which credits boron to remain below the design basis criticality limit (0.95 k_{eff}). This report identifies the potential boron dilution sources and dilution events, the instrumentation available for detection of dilution, and the operating and administrative procedures available for the detection and mitigation of dilution. The report also determines the dilution rates, the time to reach any alarm set points, and the time to reach the minimum boron concentration limit established by a separate criticality analysis [5.1].

2.0 SPENT FUEL STORAGE AND RELATED SYSTEMS

A single Spent Fuel Storage system serves both Unit 1 and Unit 2 of Sequoyah Nuclear Plant. The spent fuel storage pool consists of a 380" x 474.0" (nominal) rectangular pit and a separate 380.5" x 144.0" (nominal) pit next to the fuel pool pit for cask handling operations [5.2]. The pool is connected to the cask handing area and the fuel transfer canal through weir gates on the intermediate wall between the two pits and the west wall. Figure 1 shows the spent fuel pit and related systems. The spent fuel pit provides storage locations for a maximum of 2091 fuel assemblies [5.2] of which 2089 are capable of fuel assembly storage [5.3] and are designed to maintain the stored fuel in a safe, coolable, and sub-critical configuration during normal operation and postulated abnormal and accident conditions.

2.1 Spent Fuel Pit (SFP)

The pool is filled with borated water with boron concentration of at least 2000 ppm [5.3]. The water removes decay heat, provides shielding, and removes a portion of iodine released during a fuel handling accident. A periodic makeup of water is provided to replenish pool water loss by evaporation. Demineralized water is usually used for makeup, although procedures allow other sources [5.13]

The spent fuel pit is a seismically designed, stainless steel lined, reinforced concrete structure. The water-tight liner has dedicated drain lines to collect and detect any liner leakage. The pool is approximately 40 feet deep [5.2]. The bottom of the pit is at 686' - 2 3/4" elevation [5.2], and the fuel storage racks are 14'-1.25" high.

There is a curb (about 2 inches high) around the pit and this prevents any small spills from coming into the pit.

The volume of the pit (excluding the cask handling area and the transfer canal) is 373,800 gallons at the low level alarm elevation of 725' - 11 1/2" [5.2]. The volume of water in the pool is established by subtracting the volume of the fuel assemblies and the volume of the racks. The volume of the fuel assemblies is conservatively (providing additional 2% margin) determined considering 2,132 fuel assembly locations at 104,143 gallons. The volume of the racks is 4,459 gallons. The minimum water volume is established as 265,200 gallons.

The spent fuel pit is initially filled with water that is at the same boron concentration as that in the refueling water storage tank. Borated water may be supplied from the refueling water storage tank via the refueling water purification pump connection, or by running a temporary line from the boric acid blender located in the Chemical and Volume Control system directly into the pit or spent fuel pump suction lines. Demineralized water can also be added for makeup purposes (i.e., to replace evaporative losses) through a 2 inch connection in the recirculation return line.

The spent fuel pit water is separated from the water in the transfer canal by a gate. The gate is installed so that the transfer canal may be drained to allow maintenance of the fuel transfer equipment. The water in the transfer canal is pumped, via a refueling water purification pump, into a holdup tank in the Chemical and Volume Control system. When the maintenance of the fuel transfer equipment is completed, the water is returned to the transfer canal by the holdup tank recirculation pump.

2.2 Spent Fuel Pool Cooling (SFPC) System

The Spent Fuel Pool Cooling system consists of two cooling trains with a backup pump capable of operation in either train, and is designed to remove the heat generated by the stored spent fuel elements.

When the Spent Fuel Pit Cooling system is in operation, water flows from the spent fuel pool pit to both spent fuel pit pump suctions, is pumped through the tube side of the heat exchangers, and is returned to the pit. The heat exchangers are cooled by component cooling water. Each pump's suction line, which is protected by a strainer, is located at an elevation four feet below the normal spent fuel pit water level, while the return line contains an anti-siphon hole near the surface of the water to prevent gravity drainage of the pit [5.3]. System piping is configured so that failure of any piping in the cooling system cannot drain the spent fuel pit below the suction pipe elevation, (elevation 722 ft) which is about 22 ft. above the top of the spent fuel assemblies.

The portion of the spent fuel pit cooling system which, if failed, could result in significant release of pit water, is seismically designed.

2.3 Spent Fuel Pit Cleanup System

The spent fuel pit cleanup system is designed to maintain water clarity and to control borated water chemistry. The cleanup system is connected to the spent fuel pit cooling system. While the heat removal operation is in process, a portion of the spent fuel pit water may be diverted through a demineralizer and a filter to maintain spent fuel pit water clarity and purity. This purification loop is sufficient for removing fission products and other contaminants which may be introduced if a fuel assembly with defective cladding is transferred to the spent fuel pit.

The spent fuel pit demineralizer may be isolated, by manual valves, from the heat removal portion of the Spent Fuel Pit Cooling system. By so doing, the isolated demineralizer may be used in conjunction with a refueling water purification pump and filter to clean and purify the refueling water while spent fuel pit heat removal operations proceed. Connections are provided such that the refueling water may be pumped from either the refueling water storage tank or the refueling cavity of either unit, through the demineralizer and filter, and discharged to the refueling cavity or refueling water storage tank of either unit. Connections are also provided to allow cleanup of the water in the transfer canal. Water can be drawn from either the top or the bottom of the canal and is pumped by a refueling water purification pump through the fuel pit demineralizer and a refueling water purification filter before being returned to the transfer canal.

To further assist in maintaining spent fuel pit water clarity, the water surface is cleaned by a skimmer loop. Water is removed from the surface by the skimmers, pumped through a strainer and filter, and returned to the pit surface at three locations remote from the skimmers. The skimmer pump is a centrifugal pump with 100 gpm capacity at 50 feet total dynamic head (TDH) [5.3].

2.4 Potential Dilution Sources

Normal inventory addition to the spent fuel pit is governed by Sequoyah Operating Procedure 0-SO-78-1 [5.13]. This procedure does not allow inventory additions from non-borated water sources under normal operating conditions which will reduce the pool boron concentration below 2000 ppm. During abnormal and emergency conditions non-borated water may be added to the pit under approved and controlled procedures.

2.4.1 Demineralized Water System

Inventory from the Demineralized Water System and the primary water system may be added to the spent fuel pit under Sequoyah Procedure EA-78-1 [5.20] during emergency conditions (station blackout). The procedure requires a boron concentration sample upon completion of the inventory makeup. Any sample below the TVA administrative limit of 2000 ppm will initiate actions to increase the boron concentration.

This Demineralized Water System contains a 10,000 gallon demineralized water storage tank, plus a 15,000 gallon Cask Wash Down storage tank, each located on the roof of the Auxiliary Building. Demineralized water is pumped into the system through a 4-inch line by the demineralized water pumps [5.6]. If a manual isolation valve is inadvertently left open in a 2-inch pipe aligned to feed the SFPC return header, it would result in a conservatively calculated gravity flow of 250 gpm (Appendix A).

2.4.2 Component Cooling Water System

The spent fuel pit heat exchangers are cooled by the component cooling water system. There is no direct connection between the spent fuel pit cooling system and the component cooling water system. In case of a heat exchanger tube break a leak path would be established. Since the operating pressure in the component cooling water side is higher (100-125 psig) than the spent fuel pit side (50-55 psig) any tube leak would allow non-borated component cooling water to enter the spent fuel pit cooling system [5.7].

Any significant leakage from the component cooling water system to the spent fuel pit would lower the component cooling water surge tank level. A low surge tank level would alert the control room operator. If the alarm were to fail and the leakage were to continue undetected, the component cooling water surge tank would be periodically refilled with demineralized water system. The resulting boron dilution would be bounded by the dilution event which occurs when the manual demineralizer isolation valve is postulated to remain inadvertently open (see Section 2.4.1).

2.4.3 Drain Systems

The equipment or floor drain systems associated with the spent fuel pit pumps, heat exchangers, filters, demineralizers, demineralizer filters, the skimmer pump, and the skimmer filter connect directly to the spent fuel pit cooling and skimmer system. Each of the drain lines has a normally closed isolation valve. Back flow is not possible. Hence, the drain systems are not considered as potential boron dilution source. All floor drains in the areas of the SFP piping are directed to the Floor Drain Collector Tank, which has a capacity of 23,000 gallons [5.14].

2.4.4 Fire Protection System

In case of a loss of spent fuel pit water inventory, the fire protection system can be used as the makeup source. There are two fire hose stations (rated 95 gpm at 100 psig) located in the vicinity of the spent fuel pit. These stations are capable of supplying a total maximum of 300 gpm (Appendix A) of non-borated water.

Non-borated water from the fire protection system may be added to the spent fuel pit in accordance with the procedure [5.19] under the supervision of plant chemistry personnel. A boron concentration sample is required upon completion of the inventory makeup.

There is a potential for non-seismic break of the fire piping spilling non-borated water in the vicinity of the SFP. Pipe breaks are discussed in Section 2.8.

2.4.5 Spent Fuel Pit Demineralizer

The spent fuel pit demineralizer has a maximum capacity of 30 ft^3 [5.8] and is operated at 100 gpm nominal flow rate [5.8]. The amount of resin can only supply a limited amount of anion. The amount of boron that can be removed is insignificant to change the boron concentration of the spent fuel pit.

2.4.6 Chemical and Volume Control System (CVCS)

The CVCS has connections to the Spent Fuel Pit Cooling system at the heat exchanger inlet. One of these connections is to transfer water from the spent fuel pit to the CVCS holdup tanks. The line is normally isolated with a closed manual valve. There is another connection from the holdup tank recirculation pump to the transfer canal piping. This line is also normally closed with a manual valve. The tank recirculation pumps take suction off the CVCS holdup tanks. If these valves fail open or are inadvertently left open, there will be loss of inventory from the spent fuel pit and not a dilution. The water level in the CVCS holdup tank (High Level El. 681'-1 5/15") is lower than the pit water elevation.

2.5 Boration Sources

2.5.1 Refueling Water Storage Tank

The normal source of borated water to the spent fuel pit is from the refueling water storage tank (RWST). The RWST connects to the inlet of the spent fuel pit cooling system purification loop via the refueling water purification pump. This connection is normally used to supply borated water to the spent fuel pit. The RWST is required by Technical Specification [5.9] to be maintained at a boron concentration of 2,500 to 2,700 ppm.

2.5.2 Direct Addition of Boric Acid

If necessary, it is possible to increase the boron concentration by adding boric acid directly to the spent fuel pit water.

2.6 Spent Fuel Pit Instrumentation

Instrumentation is provided to measure the temperature of the water in the spent fuel pit and give local indication as well as annunciation in the control room if the temperature exceeds 127°F [5.10 ref. 4 in list]. Instrumentation is also provided to give local indication of the temperature of the spent fuel pit water as it leaves the heat exchangers.

Instrumentation is provided to give local indication of the flow leaving the spent fuel pit filter and local indication of flow through each Spent Fuel Pit Cooling system pump.

Instrumentation is provided which gives an alarm in the control room when the water level in the spent fuel pit reaches either the high or low level condition.

2.7 Controls

There are several controls to check and control the spent fuel pit boron concentration and water inventory.

1. The plant personnel perform rounds once every 12 hours [5.11] to observe the Spent Fuel Pit Cooling System conditions. Plant will implement additional measures in the operator round sheets to verify water level in the pit.

2. Procedures are available to respond to the high and low pit level alarms [5.12].
3. Procedures for SFP makeup [5.13] specify when borated water sources should be used and when non-borated sources could be used.
4. The plant will implement a technical specification limiting condition for operation (LCO) to assure the boron concentration is maintained at or above 2000 ppm. Verification by sample analysis every seven days will be required.

2.8 Pipe Breaks

There are several piping systems which travel over the spent fuel pit. These include the Raw Service Water system, Cask Wash Down system, Demineralized Water system, Ice Blowing system, Ethylene Glycol system, and Auxiliary Building Roof Drain. Any postulated rupture of these piping systems (except Ice Blowing system piping) could spill water directly into the spent fuel pit. However, these piping systems are designed for Seismic Category 1 requirements. They are supported such that a loss of pressure boundary will not occur under design basis seismic loading.

2.8.1 Fire Protection Piping

There is an 8 inch fire protection system piping header located outside the spent fuel pit area. Any rupture of the header would release non-borated water in the area. The maximum theoretical flowrate with both the electric motor driven and the diesel engine fire pumps in operation would be equal to 5,000 gpm [5.16]. However, since one fire pump is a backup pump and would not start, the maximum flow is 2500 gpm.

Since the fire protection headers are approximately 150 feet from the pit area, flow from a rupture would flood the general area of the floor without spilling directly into the spent fuel pit. The 2-inch curb around spent fuel pit, and other floor drains and stairwell openings would prevent any significant flow into the pit.

There are two fire hose stations located in the vicinity of the spent fuel pit. The supply pipe (2-1/2 inch) is about 20 feet from the pit boundary and is about 6 feet high. A worst case split rupture of this pipe may spray a jet of water into to pit, if the rupture is both toward the direction of the pit and in the upper portion of the pipe. However, there is a 3 feet high plexiglas skirt at the pit boundary. As a result, a fraction of the break flow would be prevented from spilling into the pit. A conservative estimate of the total flow from the rupture under this worst case combination of circumstances would be 2100 gpm (Appendix A). Moreover, this estimate does not consider any reduction due to the presence of the skirt.

The fire protection system is equipped with instrumentation which would trigger an alarm in the control room in case there is any significant pressure drop in the system due to a break. In that case, isolation of the break would be initiated by the operator.

If the size of the break is not large enough for the alarm and the jockey pump maintains the required pressure, the break flow (100 gpm [5.16] capacity of two pumps) might continue undetected, and might dilute the SFP.

2.9 Loss of Offsite Power

The spent fuel pit level instrumentation is not powered from the emergency diesel generator power supply. The loss of offsite power would therefore affect the ability to respond to a dilution event.

The loss of offsite power would also affect the spent fuel pit boration. The refueling water purification pump is not powered from the emergency bus, and would not be available for supplying borated water from the RWST. The low head injection pumps are powered from the emergency bus and can be used to deliver borated water from the RWST to the spent fuel pit.

3.0 SPENT FUEL PIT DILUTION EVALUATION

3.1 Calculation of Boron Dilution Times and Volumes

The purpose of the evaluations in this section is to calculate for each potential dilution event the dilution rate, the time to reach any alarm set points, and the time to reach the minimum pit dilution limit, if the possibility exists.

For the purpose of evaluating the spent fuel pit boron dilution times the total volume available for dilution, as discussed in Section 2.1, is conservatively taken at 265,200 gallons.

Based on criticality analysis [5.1], for the most severe postulated accident (fuel misloading and handling) condition, the minimum soluble boron concentration required to maintain the spent fuel pit $k_{eff} < 0.95$, is 700 ppm with a 95% probability at a 95% confidence level (95/95). For the normal acceptable storage configurations, a minimum of 300 ppm soluble boron concentration is required to maintain the reactivity less than 0.95, including all calculational biases and uncertainties due to manufacturing tolerances.

The time to reach the minimum boron dilution limit depends on the initial water volume in the pit, the initial boron concentration, and the rate of dilution. Based on the conservative assumption of feed and bleed operation, the time (t_f) to reach the final concentration (C_f) can be determined from the following expression [5.15]:

$$t_f = (V/Q) \ln (C_i / C_f)$$

where C_i is the initial concentration, V is the water volume in the pit.

Possible stratification in the pool was considered and determined not to be a pertinent factor. As a starting point, under normal conditions based on the design cooling flow rate, the pool volume is turned over approximately every three hours with one pump running. With this cooling flow plus the convection effect from spent fuel decay heat, it is very unlikely that through mixing would not occur. Furthermore, the evaluation of a boron dilution event is based on a conservative model of the dilution mechanism. The pool is approximately 40 feet deep and the water level in the pool is about 26 feet above the top of the spent fuel assemblies. Any inventory exchange during postulated dilution events will, in actuality, affect predominantly the top of the pool, with only limited mixing with water surrounding the fuel. The boron dilution calculation was based on an assumption of instananteous, complete mixing. The boron credit concentration limit for normal storage is 300 ppm to maintain a design basis k_{eff} of 0.95. Reaching this limit involves a 1700 ppm decrease from the starting pool boron concentration of 2000 ppm. However, if it is hypothetically postulated that mixing is not adequate and that a localized pocket of non-borated water forms somewhere in the pool, keff would still be less than 1.0 on a 95/95 basis based on the criticality analysis for the spent fuel pool completely filled with non-borated water.

3.2 Evaluation of Boron Dilution Events

3.2.1 Small Dilution Scenario

A very slow, long term dilution, where non-borated water enters the pool, and pool outflow is small enough to go essentially unnoticed, could occur if a seal in the piping, pumps, or possibly the pool liner were to break. Normal makeup operations (with demineralized water) would continue on a regular basis, at a slightly higher frequency than that required without leakage. Pool level is maintained within normal range.

The maximum flowrate that could be leaving the SFP systems unnoticed is assumed to be 5 gpm. This is on the same order as possible evaporative losses. The target drain system unaccounted flowrate is currently less than 2 gpm [5.18], and the flowrate increases about 1-2 gpm during periods of heavy rain. Therefore, 5 gpm is a reasonable assumption for the "unnoticed" dilution event.

With a leak rate of 5 gpm, the SFP makeup would be required every 7.8 hours between low and high level alarms. SFP boron concentration could become slowly depleted as illustrated in Figure 2, if an equivalent amount of unborated inleakage would occur. It requires more than 34 days with a non-borated source to achieve a boron dilution to 800 ppm (for fuel movement /accident conditions) and 76 days to reach 300 ppm (for non-movement conditions). This condition would be detected by sampling, which will be conducted once every week while the units are operating and by the sampling surveillance required before fuel movement is initiated into or within the pool.

3.2.2 Large Dilution Scenario

A large dilution scenario occurs when the non-borated SFP supply far exceeds the normal small makeup flows. A typical case can be described as follows:

1. The SFP is initially at the low level alarm setpoint, (elevation 725' 11-1/2") with 2000 ppm boron concentration. The conditions are considered normal.
2. An non-borated source of water begins to enter the SFP, raising the level and directly diluting the boron concentration, as no water outlet exists as yet. This condition may or may not have a coincident indication or alarm condition, depending on the source and magnitude of flowrate into the SFP.
3. The SFP High Level Alarm, (elevation 726' 2-1/2"), is the first indication of abnormal conditions. This occurs after 2,340 gallons of non-borated water has been introduced into the pool. At this point, the boron concentration would be reduced to 1982 ppm.
4. SFP Ventilation Ducts (elevation 727' 0-1/2") begin flooding as pool level increases. At this point, 10,150 gallons (Appendix A) of undiluted water has been introduced into the pool, and boron concentration is reduced to 1926 ppm.
5. Analysis now considers a "feed and bleed (with instantaneous mixing)" methodology, as the continuing inflow of non-borated water now has the simultaneous escape of an equal quantity of borated SFP water.

6. SFP ventilation ducts are completely flooded (elevation 728' 11-1/2"), and water now begins to flood the sheet-metal ducts exterior to the SFP in the Auxiliary Building Gas Treatment (ABGT) room. At this point, 30,240 gallons (Appendix A) of non-borated water have been introduced into the pool, and the boron concentration has been reduced to 1791 ppm.
7. Sheet-metal ducts continue to accumulate water. The ducts will leak through the bolted joints, and at some point, collapse due to excessive loads and spill large quantities of SFP water onto the floor of the Auxiliary Building. The water level would have to rise about 28 inches for a length of about 40 feet of the duct before flowing into the Auxiliary Building Gas Treatment fan housing.
8. If this scenario continues, at the point when the SFP boron concentration reaches 800 ppm, more than 222,000 gallons (1.8 million pounds) of SFP water would have been spilled into the ventilation system sheet-metal ductwork. This would definitely activate the high level alarms in the drain collection system tanks which have only 23,000 gallons capacity.

This scenario is interrupted by either depletion of available dilution water inventory, or plant operator actions to stop the flow of non-borated water into the pool. In a separate analysis [5.17] it has been determined that for a 10-inch line break with a flow rate of 1.2 ft^3/sec into the duct, within 60 minutes (total flow about 32,300 gallons) water would flow under the ABGT room door. Based on the plant configuration and operational practices, this detection time has been accepted as reasonable.

Based on this outlined scenario, the time (t_f) to reach the final dilution (C_f) can be determined using the following expression:

$$t_f = (V/Q) \ln (C_i / C_f) + 10{,}150/Q$$

where C_i is the initial concentration, V is the water volume in the pit at the time commencing "Feed and Bleed", (elevation 727' 0-1 /2",= 275,350 gal), and Q is the dilution flowrate.

The spent fuel pool boron concentration is currently maintained above 2050, with a procedural lower limit of 2000 ppm [5.13]. For present calculations the initial boron concentration is conservatively assumed as 2,000 ppm. To dilute the SFP water from 2,000 ppm to 800 ppm would require an addition of 252,500 gallons of non-borated water, based on the large dilution scenario presented above.

The following sections illustrate certain specific postulated scenarios and their consequences.

3.2.3 Dilution from Demineralized Water System

For conservative estimates an unlimited quantity of demineralized water is assumed available. Assuming gravity flow in a 2 inch line, with 75 feet head, a 250 gpm flow is conservatively calculated (Appendix A).

With 250 gpm dilution flow the high level alarm would be initiated at 9.4 minutes. If the flow is not terminated the 800 ppm boron concentration would be reached in 16.8 hours, and 300 ppm in 36.5 hours. An operator on round would detect this within 12 hours.

Figure 3 shows the boron concentration change with time for an unrestricted 250 gpm dilution event.

3.2.4 Dilution from Fire Protection System

This scenario is postulated as two fire hoses each with 150 gpm flow are left unattended, and a total of 300 gpm of non-borated fire water continuously spills into the spent fuel pit.

With 300 gpm dilution flow the high level alarm would be initiated at 7.8 minutes. If the flow is not isolated the 800 ppm boron concentration would be reached in 14.0 hours, and 300 ppm in 30.4 hours. An operator on round would detect this within 12 hours.

Figure 4 shows the spent fuel pit boron concentration with time.

3.2.5 Dilution from Flooding Resulting from Pipe Breaks

A break in the fire piping header (150 feet from the pit area) is identified as a possible dilution source. A hypothetical maximum flow of 5,000 gpm (same as the capacity of two fire pumps) can be postulated from a double-ended break in this piping, but the flow will spill on the floor, and escape through the floor drains and the stairwell openings. Also there is a 2-inch curb around the pit. However, if it is postulated that, hypothetically, the break flows into the spent fuel pit, a 5,000 gpm flow into the pit would generate a high level alarm within a minute and also a Fire Protection System pressure drop alarm, both in the Control Room. Operators would stop the fire protection pumps and isolate the break. If the flow continued, the spent fuel pit would be diluted from 2000 ppm to 800 ppm within one hour, and to 300 ppm in less than 2 hours. In the mean time, the Auxiliary Building would be flooded with 222,000 gallons (for 800 ppm) or 517,000 gallons (for 300 ppm) of water on the floor. This situation is not considered to be credible.

A split rupture of the fire hose supply line (discussed in Section 2.8.1) results in a flow of 2100 gpm of non-borated water into the pit. Again both the Fire Protection System low pressure and spent fuel pool low level alarms would sound in the Control Room. Figure 5 shows the pit boron concentration with time for this scenario. More than 2 hours would be required to dilute the SFP below 800 ppm (and more than 4 hours to 300 ppm) under these conditions.

As discussed earlier any large breaks would be detected and isolated before the boron concentration reaches the limit of 800 ppm.

3.2.6 Dilution from Spent Fuel Pool Demineralizer

The spent fuel pit demineralizer charged with fresh resin can initially remove boron from water passing through it. The amount of boron that can be removed by the maximum anion content of 30 ft^3 resin is a few ppm. In reality, a much lower amount of boron would be removed since the demineralizer uses a mixed bed of anion and cation.

3.3 Summary of Dilution Results

SOURCE	FLOW RATE (GPM)	TIME			REMARKS
		TO INITIATE ALARM	TO REACH 800 PPM	TO REACH 300 PPM	
Demineralized Water System	250	9.4 minutes	16.8 hours	36.5 hours	
Fire Protection System	300	7.8 minutes	14.0 hours	30.4 hours	
Fire Header Break	2100 2500 5000	1.1 minute 0.9 minute 0.5 minute	2.1 hours 1.7 hours 50 minutes	4.4 hours 3.7 hours 1.8 hours	 Theoretical Case

The addition of unborated water to the SFP from the fire header break results in the shortest boron dilution time. Based on control room alarms which would result from 1) start of the fire protection pumps due to low pressure in the fire protection piping, and 2) high level in the spent fuel pit, the associated operator responses will detect and terminate the dilution transient.

The next shortest dilution time and the worst case scenario for normal operation is due to the continuous drawdown of unborated water from the demineralized water makeup sources in the case of a manual isolation valve left inadvertently open. Although it is fed from a tank with a capacity less than the volume required to dilute the pit from 2000 to 800 ppm, the tank receives automatic makeup from the demineralized water makeup tank with a volume larger than the required volume for dilution.

Irrespective of the source of the dilution water, at the time when the boron concentration in the spent fuel pit reaches 300 ppm, 517,000 gallons of water would spill on the Auxiliary Building floor. Long before this would happen, the floor drain systems would be flooded resulting in high sump level alarms, and operators dispatched to investigate the source of excess water in the building would detect and terminate the source.

4.0 CONCLUSIONS

For the most severe postulated accident (fuel misloading and handling) condition, the minimum soluble boron concentration required to maintain the spent fuel pit $k_{eff} < 0.95$, is 700 ppm. A plant surveillance instruction [5.21] requires boron sampling before fuel movement is initiated. For the normal acceptable storage configurations, a minimum of 300 ppm soluble boron concentration is required to maintain the reactivity less than 0.95. The causes of pool dilution and fuel misplacement are unrelated. It is concluded that a dilution event resulting in a spent fuel pit boron concentration reduction from 2000 ppm to 300 ppm is not credible. The conclusion is based on the following:

- In order to dilute the spent fuel pit to the design k_{eff} of 0.95 with boron credit, a substantial amount of non-borated water (547,000 gallons) would be required. This volume of water is only available through the postulation of leaving manual isolation valves open following a normal dilution or makeup operation.

- Since a large volume of water (517,000 gallons) would spill over during the event, it would be readily detected by plant personnel due to the level alarms, flooding in the Auxiliary Building, and by usual operator rounds in the Auxiliary Building.

- It has been demonstrated as part of the criticality analysis [5.1] that for the most severe postulated fuel handling accident condition, k_{eff} for the spent fuel racks would remain less than or equal to 0.95 for a boron concentration of 700 ppm.

- The plant will implement a technical specification limiting condition for operation (LCO) to assure the boron concentration is maintained at or above 2000 ppm.

In summary, an unplanned or inadvertent event that would dilute the spent fuel pool boron concentration from 2000 ppm to 300 ppm is not credible for Sequoyah. The combination of pool high level and system alarms, the large volume of water required, plant personnel rounds, and the technical specification control on the spent fuel pool concentration and associated 7-day sampling requirement will detect a dilution event. Moreover, the criticality evaluation for the spent fuel storage pool confirms that k_{eff} remains less than 1.0 at a 95/95 probability/confidence level even if the pool were completely filled with unborated water. If the spent fuel pool water were diluted to a boron concentration of zero ppm it would take significantly more water than indicated above.

4.0 CONCLUSIONS

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5.0 REFERENCES

5.1 Holtec Report HI-992249, Criticality Analysis with Boron Credit.

5.2 Holtec Report HI-91668, Thermal-Hydraulic Analysis for Sequoyah Units 1 & 2 Spent Fuel Pool, Rev 4, December 10, 1992.

5.3 UFSAR, Sequoyah Nuclear Plant, TVA.

5.4 Sequoyah Mechanical Flow Diagram, CVCS, 47W809.

5.5 Sequoyah Mechanical Flow Diagram, PWMS, 47W819.

5.6 Sequoyah Mechanical Flow Diagram, Demineralized Water, 47W856-1, Rev. 39.

5.7 Sequoyah Mechanical Flow Diagram, Component Cooling Water, 47W859-1 Rev. 37.

5.8 Sequoah Design Criteria SQN-DC-V-33.0, Table 5.1-1, "Spent Fuel Cooling System Design Parameters."

5.9 Sequoyah Technical Specification, 3.1.2.5, "Reactivity Control."

5.10 Sequoyah Master Equipment List (MEL) Component Specification Template - Component SQN-0-TIS-078-004.

5.11 Sequoyah 0-GO-14, Attachment 2 Operator Round Instructions - AB Round for 10/14/99.

5.12 Sequoyah Alarm Response Procedure 1-AR-M6-D, Rev. 15.

5.13 Sequoyah Operating Instruction, 0-SO-78-1, SFP Coolant System, Rev 5, April 20, 1999.

5.14 Sequoyah Mechanical Flow Diagram, Floor & Equipment Drains, 47W852-3, Rev. 10.

5.15 WCAP-14181, "Evaluation of the Potential for Diluting PWR Spent Fuel Pools," July 1995.

5.16 Sequoyah Design Criteria Document SQN-DC-V-43.0, Rev. 3, High Pressure Fire Protection Water Supply System.

5.17 Sequoyah Calculation SQN-SQS4-56.

5.18 Sequoyah Liquid Radwaste Weekly Report dated October 8, 1999.

5.19 Sequoyah Procedure AOP-M.06, Rev. 01.

5.20 Sequoyah Procedure EA-78-1, Rev. 00.

5.21 Sequoyah Instruction 0-SI-NUC-000-002.0.

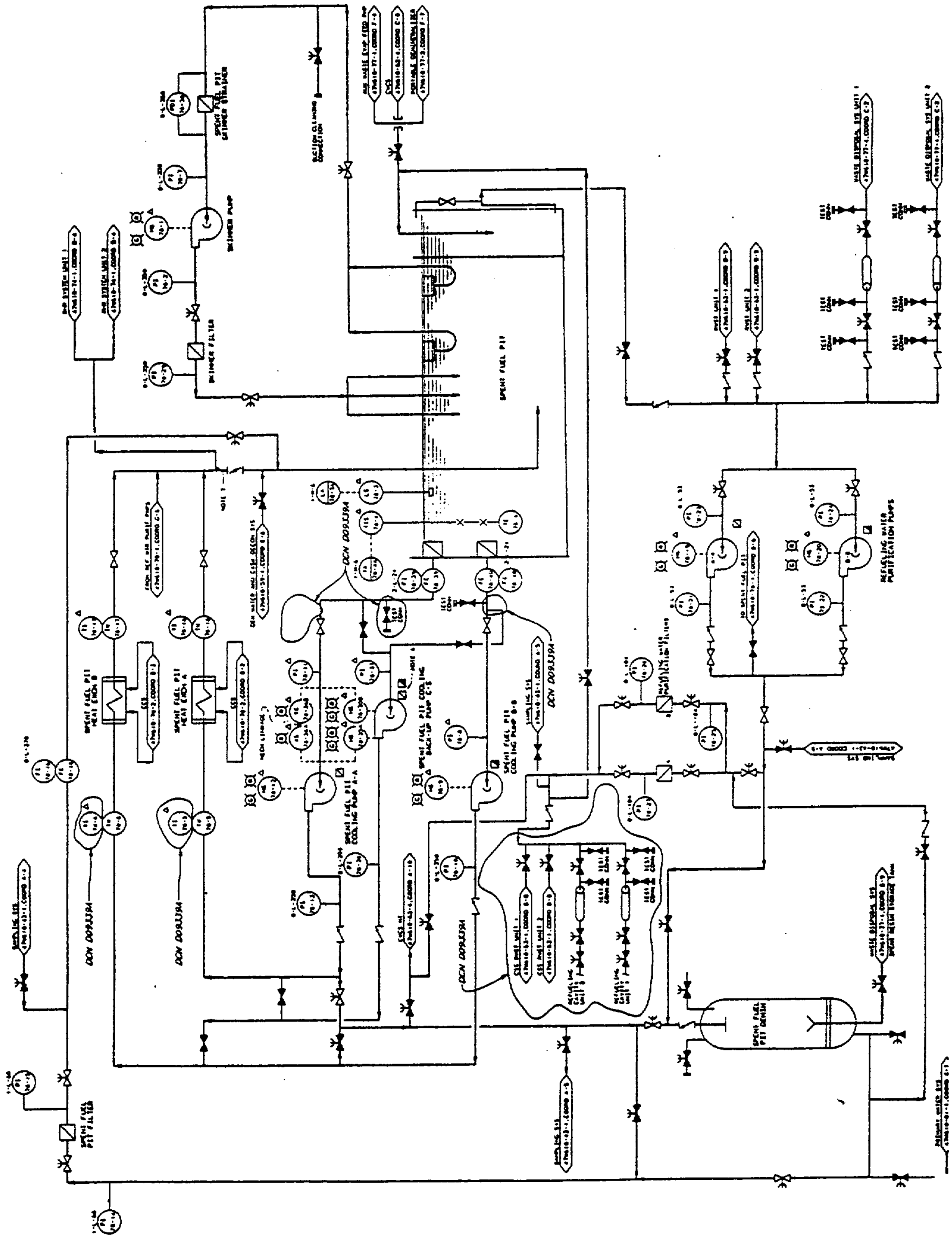


Figure 1: Spent Fuel Pit and Related Systems

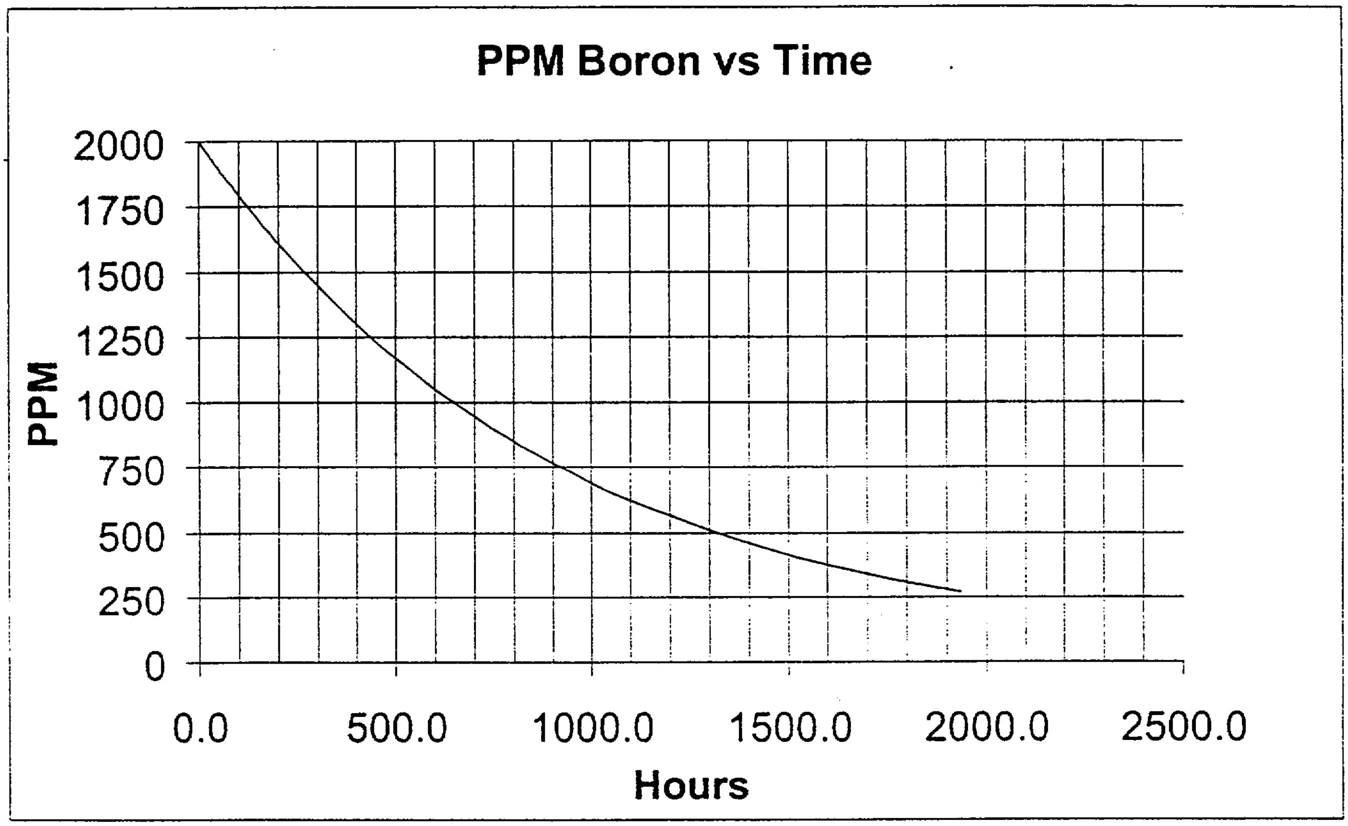


Figure 2: Boron Dilution with 5 gpm Non-Borated Water

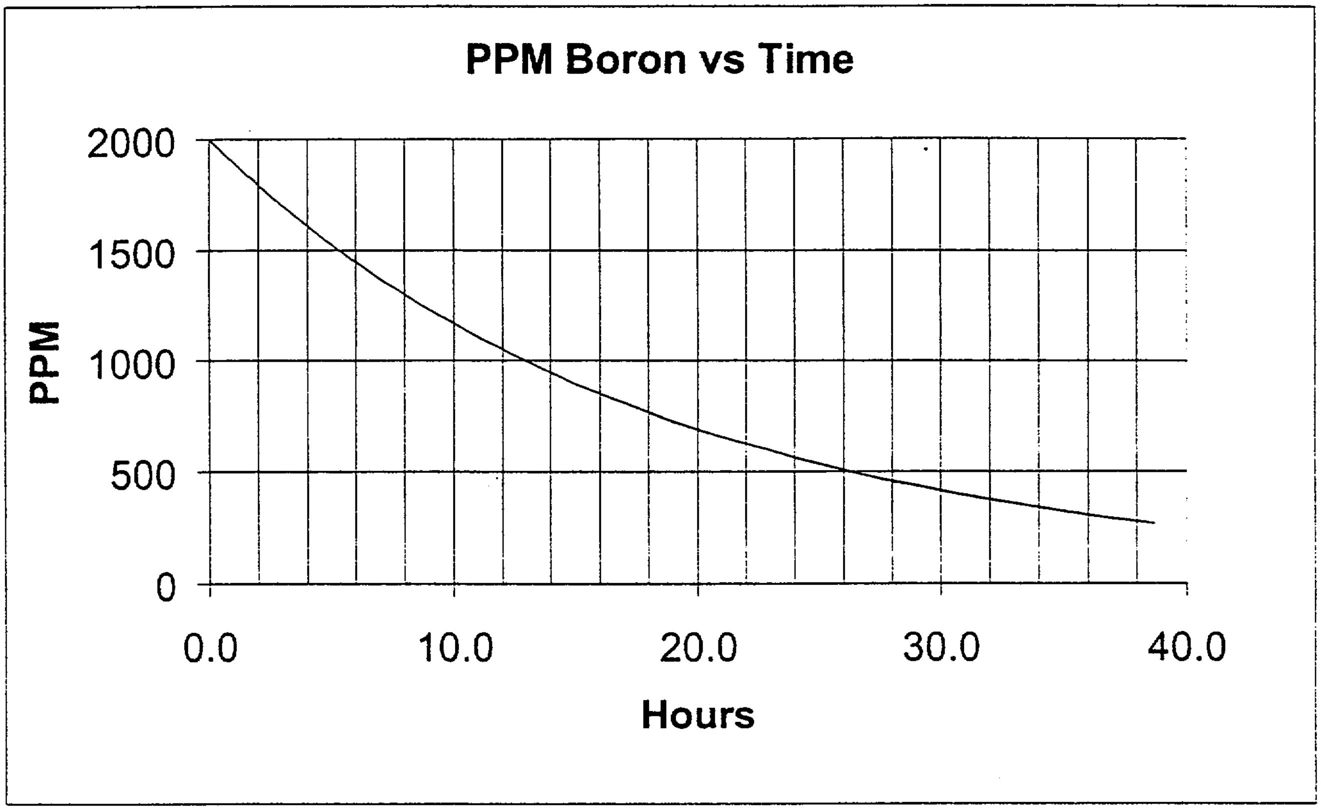


Figure 3: Boron Dilution with 250 gpm Demineralized Water

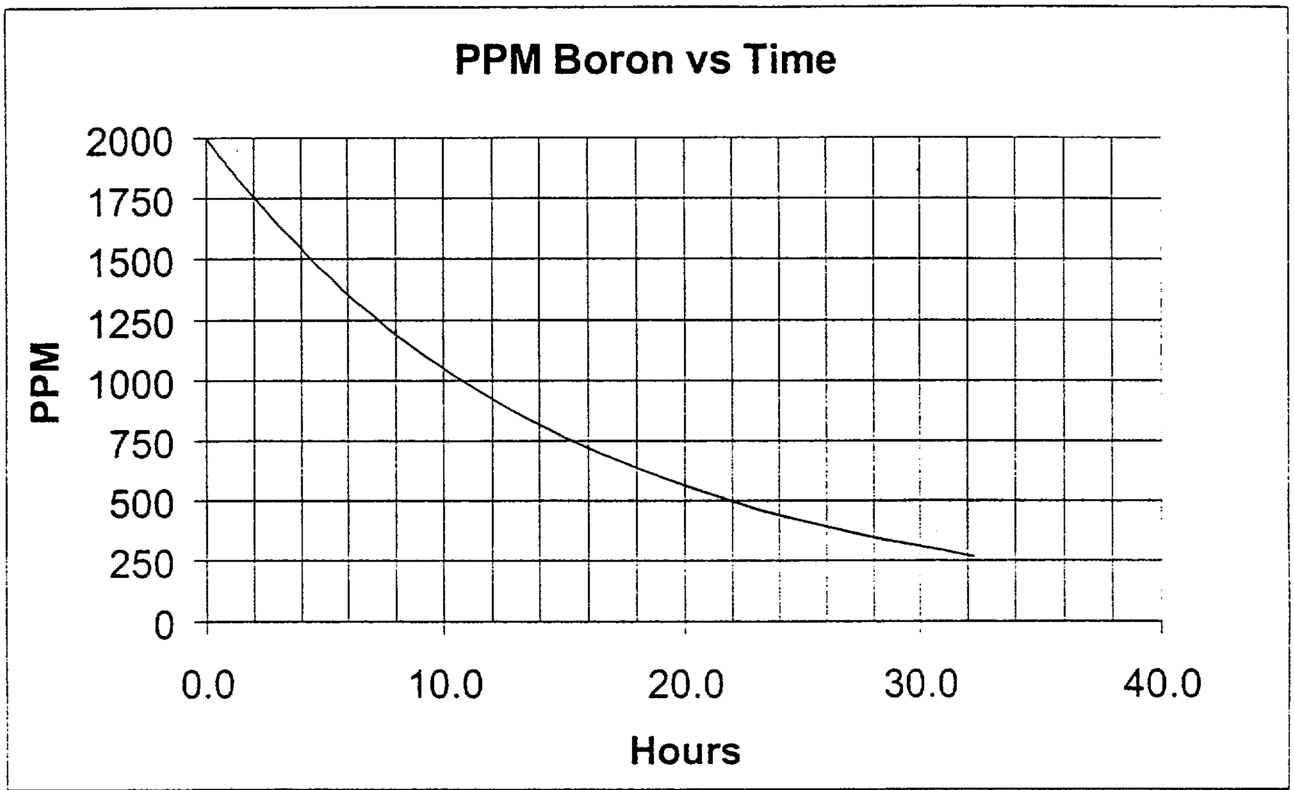


Figure 4: Boron Dilution with 300 gpm Fire Water

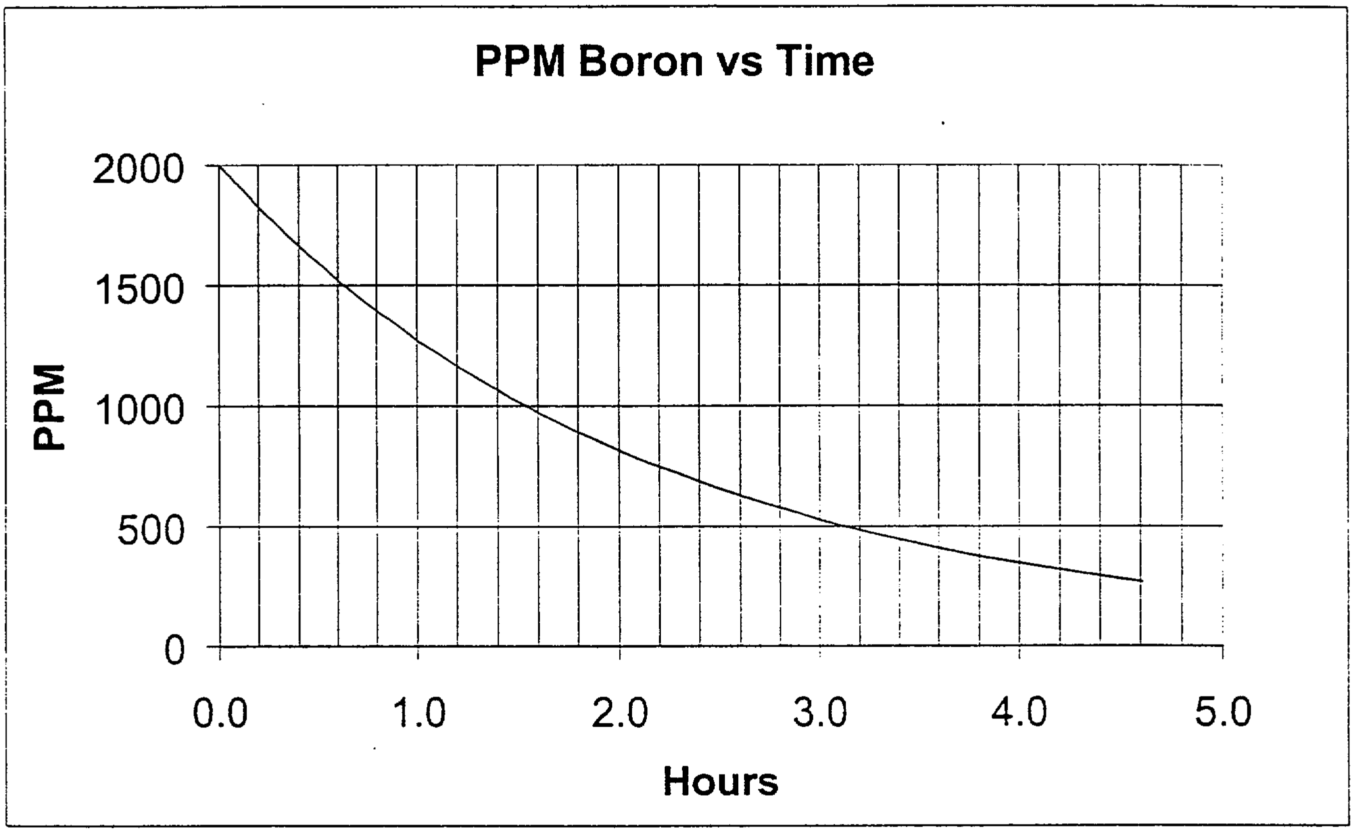


Figure 5: Boron Dilution with 2100 gpm Fire Water

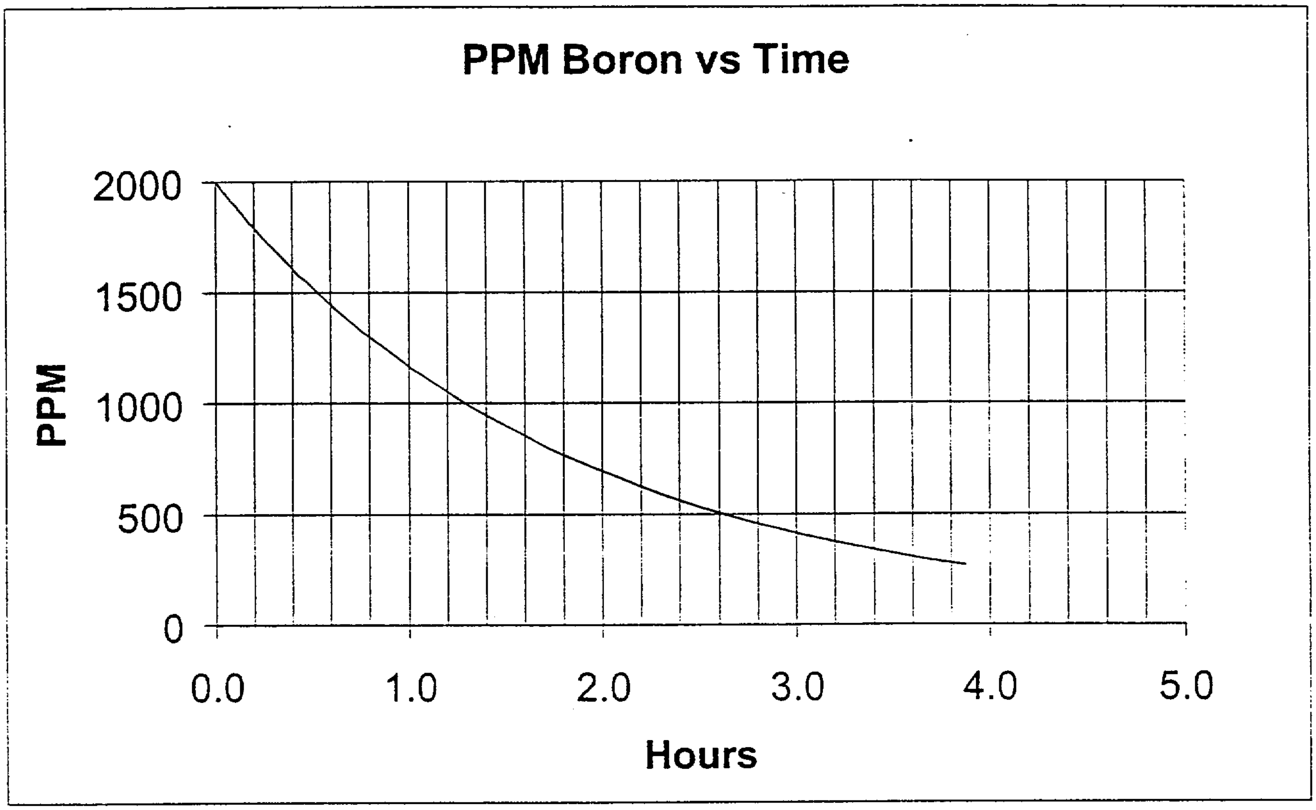


Figure 6: Boron Dilution with 2500 gpm Fire Water

APPENDIX A

CALCULATIONS

CONTENTS

1. Calculation of Gravity Flow from Demineralized Water Tank to SFP

Tank Elevation = 799 ft , Line Size = 2 inch (2.067 inch ID)
[Ref. TVA Flow Diagram, Demineralized Water System, DWG 47W865-1, Rev. 39]

Spent Fuel Pool Level = 725.96 (Low Level)
[TVA Flow Diagram, Fuel Pool Cooling and Cleaning System, DWG 47W855-1]

Pressure Head = 799 - 725.96 = 73.04 ft

Loss Factors:
Assuming
Total Loss Factor for 1 Diaphragm Valves, 2 Elbows and other Fittings = 3.5
[This is considered to be a conservatively low estimate for the loss factor]
Pipe Roughness = 0.001
Pipe Length = 40 (Approximate measurement during walkdown)
Pipe Roughness, ε = 0.001 inch
$\varepsilon / d = 0.001/2.067 = 0.0005$
$f = 0.017$
Exit Loss Factor = 1.0
Pipe Friction Factor = $fl/d = 0.017 \times 40 / (2.067/12) = 3.95$

Velocity = $[73.04 \times 2 \times 32.2 / (3.5 + 3.95 + 1.0)]^{1/2}$ = 23.59 ft/sec

Flow = $(\pi / 4)\ (2.067/12)^2 \times 23.59$ = 0.550 cu ft/sec = 0.566 x 7.48 x 60 gpm = 247 ~ 250 gpm

2. Calculation of Flow from Fire Hose Supply Pipe Break

Pipe Size = 2 - 1/2 inch Schedule 40 (2.469 inch ID)
Nominal Pressure = 130 psig

Area of the break = $(\pi/4)\ (2.469)^2$ = 4.79 sq. inches

Velocity through break = $[2g \times \text{Pressure Head}]^{1/2} = [2 \times 32.2 \times 130 \times 2.31]^{1/2}$ = 139 ft/sec

Flow = 4.79 x 139 / 144 cu. ft/sec = 4.62 x 7.48 x 60 gpm = 2073 gpm ~ 2100 gpm

3. Calculation of Flow from 4 inch Fire Line Break

Pipe Size = 4 inch Schedule 40 (4.026 inch ID)
[TVA Flow Diagram, Fire Protection System, 47W850-7, Rev. 18]

Pump Capacity = 2500 gpm @ 125 psig
[TVA Criteria Document, SQN-DC-V-43.0, Rev. 3]

Nominal Pressure at the Header = 125 psig

Loss Factor from the Header to Break:
Assuming
Total Loss Factor Valves, Fittings, and Elbows = 2.0
[This is considered to be a conservatively low estimate for the loss factor]
Pipe Length = 50
Pipe Roughness, ε = 0.002 inch
ε / d = 0.002/4.026 = 0.0005
f = 0.017
Pipe Friction Factor = fl/d = 0.017 x 50 / (4.026/12) = 2.53
Exit Loss Factor = 1.0

Velocity = $[125 \times 2.31 \times 2 \times 32.2 / (2.0 + 2.53 + 1.0)]^{1/2}$ = 57.99 ft/sec

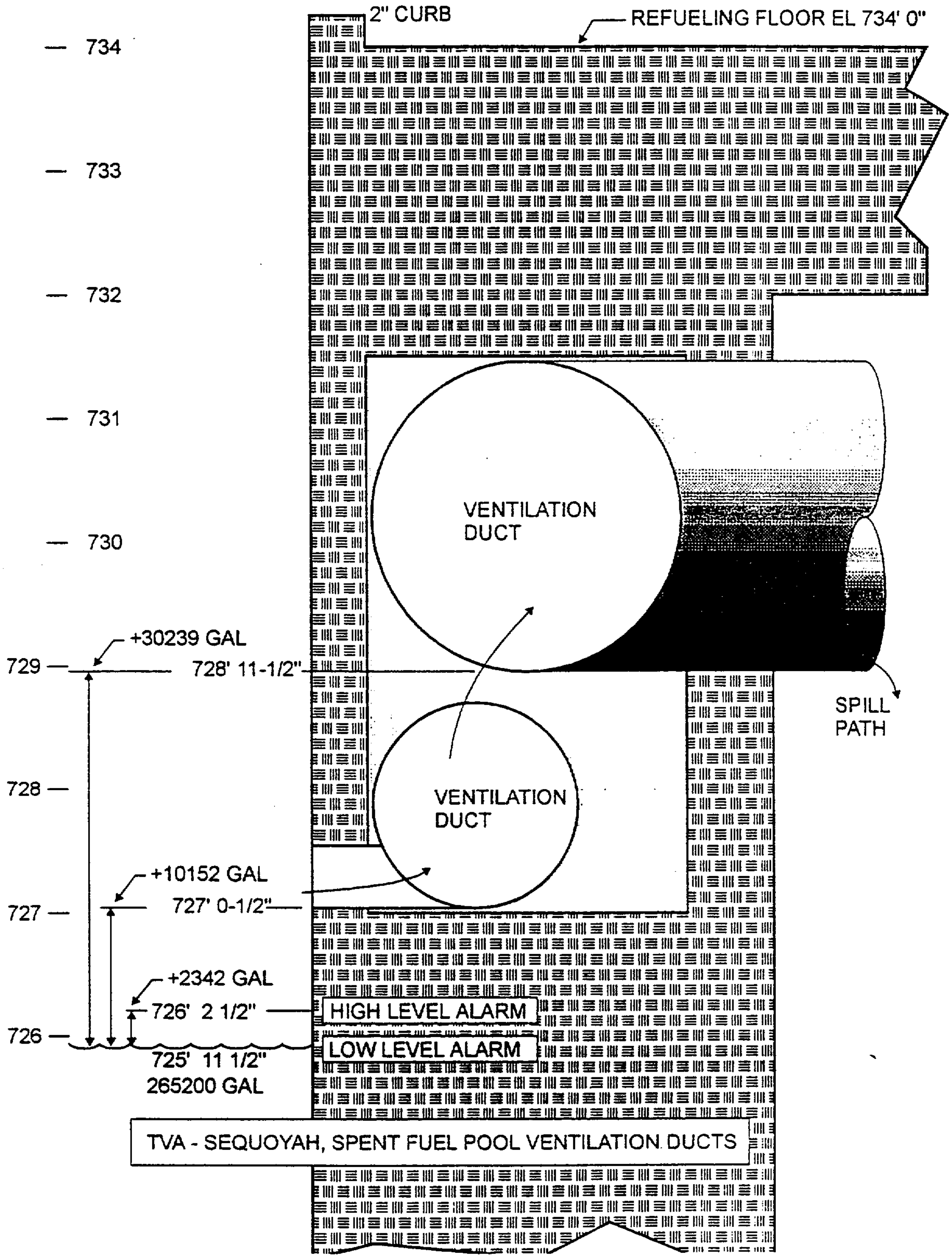
Flow = $(\pi / 4)(4.026/12)^2 \times 57.99$ = 0.605 cu ft/sec = 5.127 x 7.48 x 60 gpm = 2300 gpm

Hence, a conservative estimate of Break Flow = Pump Flow = 2500 gpm

4. Calculation of Fire Hose Nozzle Flow

Flow Capacity of the Nozzle = 95 gpm @ 100 psi pressure [Elkhart Brass Nozzle]
Nominal Pressure = 130 psi
Nozzle Flow at 130 psi = 95 (130/100)1/2 = 108 gpm
The flow is conservatively assumed to be 150 gpm for each Fire Hose with a total of 300 gpm for the two hoses.

	TVA SEQUOYAH, SFP FILLED TO VENTS, OVERFLOW INTO HVAC							
	Problem Statement;							
	How much SFP Volume at low level alarm?							
	How much SFP filling to have spill into exterior ductwork?							
	Inputs;							
	686.23	Pool Floor Elev			ft			Ref 1
	725.958	initial pool low level alarm elevation				ft		Ref 3
	726.208	pool high level alarm elevation				ft		Ref 3
	31.71 x 39.5		Pool Water Surface dimensions, ft					Ref 1
	13921.36	fuel volume, (2132 assy)			ft3			Ref 1
	596.1	rack assy volume, (2091 assy)			ft3			Ref 1
	727.042	HVAC inlets elev						Ref 2
	728.958	endpoint spill level			ft			Ref 2
		Ductwork dimensions & geometry						Ref 2
	Assumptions;							
	Duct inlets from SFP to round encapsulated ducts							
	negected, insignificant volume							
	Conclusions;							
	265,200	GAL SFP WATER @ Low Level Alarm Point						
	9370	GAL/FT	Pool Free Surface Volume/elevation relation					
	2342	GAL LL Alarm to HL Alarm						
	10152	GAL LL Alarm to Entrance into Ductwork (encapsulated)						
	30239	GAL LL Alarm to Entrance into Exterior Sheetmetal Ductwork						
	Ref:							
	1	Holtec International Analysis Report						
		HI-91668 Rev 4, SFP Reracking Evaluation						
	2	TVA HVAC Ductwork DWGs						
		47W920-7						
	3	TVA - FSAR						
		Chapter 9.1, SFP Systems						



TVA - SEQUOYAH, SPENT FUEL POOL VENTILATION DUCTS

		POOL WATER VOLUME CALC					
			31.7	WIDTH			
		X	39.5	LENGTH			
			1252.5	POOL PLAN VIEW AREA			
			726.0	FILL ELEV			
		-	686.2	BOTTOM ELEV			
			39.9	POOL WATER DEPTH			
			39.9				
		X	1252.5				
			49974.0	GROSS VOLUME			
			49974.0				
		-	13922.0	FUEL VOLUME			
		-	596.1	RACKS VOLUME			
			35455.9	NET WATER VOLUME			
			35455.94				
		X	7.480519 us gal / ft3				
			265206	SFP WATER GALLONS @ LL Alarm			
		POOL FILLING TO HL ALARM AND TO VENTS					
			1252.545	POOL PLAN VIEW AREA			
		X	7.480519 us gal / ft3				
			9369	WATER GALLONS PER FT			
			726.208	pool high level alarm elevation			
		-	725.958	initial pool low level alarm elevation			
			0.25	elev change			
		X	9369	WATER GALLONS PER FT			
			2342.25	**WATER GALLONS LL to HL**			
			727.042	HVAC inlets elev			
		-	725.958	initial pool low level alarm elevation			
			1.084	elev change			
		X	9369	WATER GALLONS PER FT			
			10152	**WATER GALLONS LL to Enter Ducts**			
			728.958	endpoint spill level			
			725.958	initial pool low level alarm elevation			
			3	elev change			
		X	9369	WATER GALLONS PER FT			
			28121	Sub Total, in pool, Gallons			
		+	2118	Encapsulated Ducts, Gallons (see pg 2)			
			30239	**WATER GALLONS LL to Spill out Ducts**			

POOL FILLING TO HL ALARM AND TO VENTS (Cont.)

SFP Encapsulated Ducts

dia	length	volume	
inch	feet	FT3	
Ref 2	Ref 2	Calc	
14	12	12.82817	
16	12	16.75516	
20	20	43.63323	
14	15	16.03521	
18	12	21.20575	
20	15	32.72492	
14	12	12.82817	
16	12	16.75516	
20	20	43.63323	
14	12	12.82817	
18	12	21.20575	
20	15	32.72492	
		283.1579	total FT3
	X	7.480519	US GAL / ft3
		2118.168	WATER GALLONS PER FT

TVA SEQUOYAH **BORON DILUTION ANALYSIS**

BORON CREDIT STUDY **UNBORATED WATER FLOW INTO SPENT FUEL POOL**

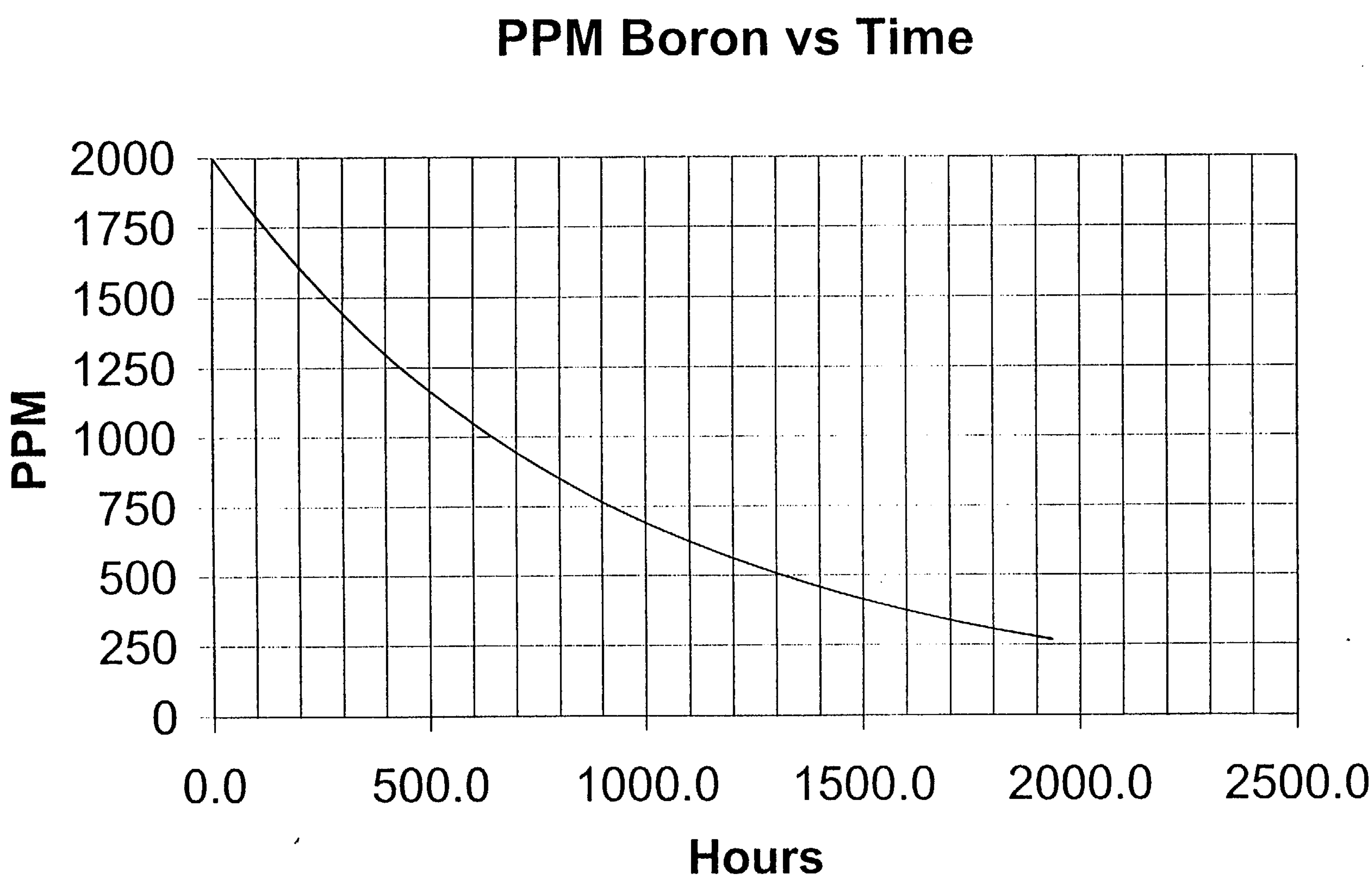
*****THIS CALCULATION IS BASED ON THE FORMULATION AND THE SCENARIOS DESCRIBED IN SECTION 3.2.2 OF THE REPORT*****

Dilution FlowRate		725.96	Lo Level Alarm		727.04	Begin Enter Vents	
5	GPM	726.21	Hi Level Alarm		728.96	Vents Spilling	

	min	gal	ft	Alarm		gpm	gal	GAL	Hours		
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES	HOURS	PPMboron
1	0.00	265200	725.96		2000	5	0	0	Initial Condition, Low Level Alarm Point	0.0	2000
2	52.06	265460	725.99		1998	5	260	0	9370 gal/ft	0.9	1998
3	104.11	265721	726.02		1996	5	521	0		1.7	1996
4	156.17	265981	726.04		1994	5	781	0		2.6	1994
5	208.22	266241	726.07		1992	5	1041	0		3.5	1992
6	260.28	266501	726.10		1990	5	1301	0		4.3	1990
7	312.33	266762	726.13		1988	5	1562	0		5.2	1988
8	364.39	267022	726.15		1986	5	1822	0		6.1	1986
9	416.44	267282	726.18		1984	5	2082	0	2342.5 Gal, Low Level to High Level	6.9	1984
10	468.50	267543	726.21		1982	5	2343	0	High Level Alarm @ 468.50 Minutes	7.8	1982
11	624.69	268323	726.29	A	1977	5	3123	0	Filling Pool Above High Level Alarm	10.4	1977
12	780.88	269104	726.38	A	1971	5	3904	0		13.0	1971
13	937.07	269885	726.46	A	1965	5	4685	0		15.6	1965
14	1093.26	270666	726.54	A	1960	5	5466	0		18.2	1960
15	1249.45	271447	726.63	A	1954	5	6247	0		20.8	1954
16	1405.64	272228	726.71	A	1948	5	7028	0		23.4	1948
17	1561.83	273009	726.79	A	1943	5	7809	0		26.0	1943
18	1718.02	273790	726.88	A	1937	5	8590	0		28.6	1937
19	1874.21	274571	726.96	A	1932	5	9371	0	Water Enters Vents, Begin	31.2	1932
20	2030.40	275352	727.04	A	1926	5	10152	0	Flooding Encapsulated Ductwork	33.8	1926
21	2432.14	275352	727.24	A	1912	5	12161	0	Feed&Bleed Model @ 2432.14 Minutes	40.5	1912
22	2833.88	275352	727.43	A	1898	5	14169	0	10480 gal/ft	47.2	1898
23	3235.62	275352	727.62	A	1885	5	16178	0		53.9	1885
24	3637.36	275352	727.81	A	1871	5	18187	0		60.6	1871
25	4039.10	275352	728.00	A	1858	5	20196	0		67.3	1858
26	4440.84	275352	728.19	A	1844	5	22204	0		74.0	1844
27	4842.58	275352	728.39	A	1831	5	24213	0		80.7	1831

28	5244.32	275352	728.58	A	1817		5	26222	0					87.4	1817
29	5646.06	275352	728.77	A	1804		5	28230	0					94.1	1804
30	6047.80	275352	728.96	A	1791		5	30239	0	Filled All Encapsulated Ducts				100.8	1791
31	6652.58	275352	728.96	A	1772		5	33263	3024	Spilling Into Non-Encapsulated Ducts				110.9	1772
32	7317.84	275352	728.96	A	1751		5	36589	6350	Pool Level Not Increasing				122.0	1751
33	8049.62	275352	728.96	A	1728		5	40248	10009					134.2	1728
34	8854.58	275352	728.96	A	1703		5	44273	14034	117043	LB Spilled into Sheetmetal Ducts			147.6	1703
35	9740.04	275352	728.96	A	1676		5	48700	18461					162.3	1676
36	10714.05	275352	728.96	A	1647		5	53570	23331					178.6	1647
37	11785.45	275352	728.96	A	1615		5	58927	28688					196.4	1615
38	12964.00	275352	728.96	A	1581		5	64820	34581					216.1	1581
39	14260.40	275352	728.96	A	1545		5	71302	41063					237.7	1545
40	15686.44	275352	728.96	A	1506		5	78432	48193	401931	LB Spilled into Sheetmetal Ducts			261.4	1506
41	17255.08	275352	728.96	A	1464		5	86275	56036					287.6	1464
42	18980.59	275352	728.96	A	1420		5	94903	64664					316.3	1420
43	20878.65	275352	728.96	A	1373		5	104393	74154					348.0	1373
44	22966.51	275352	728.96	A	1322		5	114833	84594					382.8	1322
45	25263.16	275352	728.96	A	1269		5	126316	96077					421.1	1269
46	27789.48	275352	728.96	A	1214		5	138947	108708					463.2	1214
47	30568.43	275352	728.96	A	1155		5	152842	122603					509.5	1155
48	33625.27	275352	728.96	A	1095		5	168126	137887					560.4	1095
49	36987.79	275352	728.96	A	1032		5	184939	154700					616.5	1032
50	40686.57	275352	728.96	A	967		5	203433	173194	1444437	LB Spilled into Sheetmetal Ducts			678.1	967
51	44755.23	275352	728.96	A	900		5	223776	193537					745.9	900
52	49230.75	275352	728.96	A	833		5	246154	215915					820.5	833
53	54153.83	275352	728.96	A	764		5	270769	240530					902.6	764
54	59569.21	275352	728.96	A	696		5	297846	267607					992.8	696
55	65526.13	275352	728.96	A	628		5	327631	297392					1092.1	628
56	72078.75	275352	728.96	A	561		5	360394	330155					1201.3	561
57	79286.62	275352	728.96	A	496		5	396433	366194					1321.4	496
58	87215.29	275352	728.96	A	434		5	436076	405837					1453.6	434
59	95936.81	275352	728.96	A	374		5	479684	449445					1598.9	374
60	########	275352	728.96	A	319		5	527652	497413	4148428	LB Spilled into Sheetmetal Ducts			1758.8	319
61	########	275352	728.96	A	268		5	580418	550179					1934.7	268

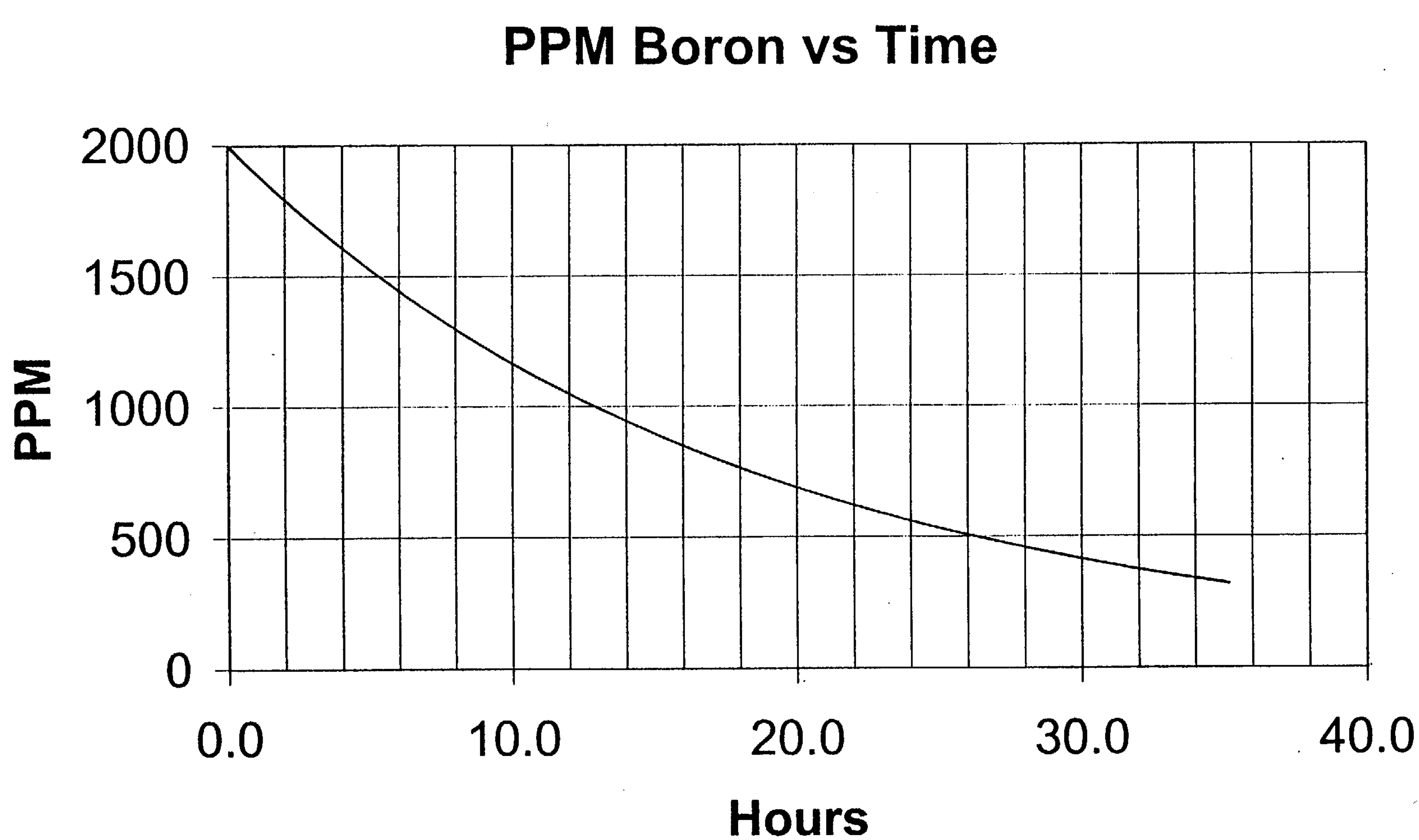
5	GPM UNBORATED DILUTION FLOW	
2000	PPM BORON INITIAL CONCENTRATION	



	TVA SEQUOYAH				**BORON DILUTION ANALYSIS**									
	BORON CREDIT STUDY				**UNBORATED WATER FLOW INTO SPENT FUEL POOL**									
	*****THIS CALCULATION IS BASED ON THE FORMULATION AND THE SCENARIOS DESCRIBED IN SECTION 3.2.2 OF THE REPORT*****													
	Dilution FlowRate		725.96		Lo Level Alarm			727.04	Begin Enter Vents					
	250	GPM	726.21		Hi Level Alarm			728.96	Vents Spilling					
	min	gal	ft	Alarm		gpm	gal	GAL	Hours					
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES				HOURS	PPMboron
1	0.00	265200	725.96		2000	250	0	0	Initial Condition, Low Level Alarm Point				0.0	2000
2	1.04	265460	725.99		1998	250	260	0		9370 gal/ft			0.0	1998
3	2.08	265721	726.02		1996	250	521	0					0.0	1996
4	3.12	265981	726.04		1994	250	781	0					0.1	1994
5	4.16	266241	726.07		1992	250	1041	0					0.1	1992
6	5.21	266501	726.10		1990	250	1301	0					0.1	1990
7	6.25	266762	726.13		1988	250	1562	0					0.1	1988
8	7.29	267022	726.15		1986	250	1822	0					0.1	1986
9	8.33	267282	726.18		1984	250	2082	0	2342.5 Gal, Low Level to High Level				0.1	1984
10	9.37	267543	726.21		1982	250	2343	0	High Level Alarm @		9.37	Minutes	0.2	1982
11	12.49	268323	726.29	A	1977	250	3123	0	Filling Pool Above High Level Alarm				0.2	1977
12	15.62	269104	726.38	A	1971	250	3904	0					0.3	1971
13	18.74	269885	726.46	A	1965	250	4685	0					0.3	1965
14	21.87	270666	726.54	A	1960	250	5466	0					0.4	1960
15	24.99	271447	726.63	A	1954	250	6247	0					0.4	1954
16	28.11	272228	726.71	A	1948	250	7028	0					0.5	1948
17	31.24	273009	726.79	A	1943	250	7809	0					0.5	1943
18	34.36	273790	726.88	A	1937	250	8590	0					0.6	1937
19	37.48	274571	726.96	A	1932	250	9371	0	Water Enters Vents, Begin				0.6	1932
20	40.61	275352	727.04	A	1926	250	10152	0	Flooding Encapsulated Ductwork				0.7	1926
21	48.64	275352	727.24	A	1912	250	12161	0	Feed&Bleed Model @		48.64	Minutes	0.8	1912
22	56.68	275352	727.43	A	1898	250	14169	0		10480 gal/ft			0.9	1898
23	64.71	275352	727.62	A	1885	250	16178	0					1.1	1885
24	72.75	275352	727.81	A	1871	250	18187	0					1.2	1871
25	80.78	275352	728.00	A	1858	250	20196	0					1.3	1858
26	88.82	275352	728.19	A	1844	250	22204	0					1.5	1844
27	96.85	275352	728.39	A	1831	250	24213	0					1.6	1831

28	104.89	275352	728.58	A	1817		250	26222	0					1.7	1817
29	112.92	275352	728.77	A	1804		250	28230	0					1.9	1804
30	120.96	275352	728.96	A	1791		250	30239	0	Filled All Encapsulated Ducts				2.0	1791
31	133.05	275352	728.96	A	1772		250	33263	3024	Spilling Into Non-Encapsulated Ducts				2.2	1772
32	146.36	275352	728.96	A	1751		250	36589	6350	Pool Level Not Increasing				2.4	1751
33	160.99	275352	728.96	A	1728		250	40248	10009					2.7	1728
34	177.09	275352	728.96	A	1703		250	44273	14034	117043	LB Spilled into Sheetmetal Ducts			3.0	1703
35	194.80	275352	728.96	A	1676		250	48700	18461					3.2	1676
36	214.28	275352	728.96	A	1647		250	53570	23331					3.6	1647
37	235.71	275352	728.96	A	1615		250	58927	28688					3.9	1615
38	259.28	275352	728.96	A	1581		250	64820	34581					4.3	1581
39	285.21	275352	728.96	A	1545		250	71302	41063					4.8	1545
40	313.73	275352	728.96	A	1506		250	78432	48193	401931	LB Spilled into Sheetmetal Ducts			5.2	1506
41	345.10	275352	728.96	A	1464		250	86275	56036					5.8	1464
42	379.61	275352	728.96	A	1420		250	94903	64664					6.3	1420
43	417.57	275352	728.96	A	1373		250	104393	74154					7.0	1373
44	459.33	275352	728.96	A	1322		250	114833	84594					7.7	1322
45	505.26	275352	728.96	A	1269		250	126316	96077					8.4	1269
46	555.79	275352	728.96	A	1214		250	138947	108708					9.3	1214
47	611.37	275352	728.96	A	1155		250	152842	122603					10.2	1155
48	672.51	275352	728.96	A	1095		250	168126	137887					11.2	1095
49	739.76	275352	728.96	A	1032		250	184939	154700					12.3	1032
50	813.73	275352	728.96	A	967		250	203433	173194	1444437	LB Spilled into Sheetmetal Ducts			13.6	967
51	895.10	275352	728.96	A	900		250	223776	193537					14.9	900
52	984.62	275352	728.96	A	833		250	246154	215915					16.4	833
53	1083.08	275352	728.96	A	764		250	270769	240530					18.1	764
54	1191.38	275352	728.96	A	696		250	297846	267607					19.9	696
55	1310.52	275352	728.96	A	628		250	327631	297392					21.8	628
56	1441.57	275352	728.96	A	561		250	360394	330155					24.0	561
57	1585.73	275352	728.96	A	496		250	396433	366194					26.4	496
58	1744.31	275352	728.96	A	434		250	436076	405837					29.1	434
59	1918.74	275352	728.96	A	374		250	479684	449445					32.0	374
60	2110.61	275352	728.96	A	319		250	527652	497413	4148428	LB Spilled into Sheetmetal Ducts			35.2	319
61	2321.67	275352	728.96	A	268		250	580418	550179					38.7	

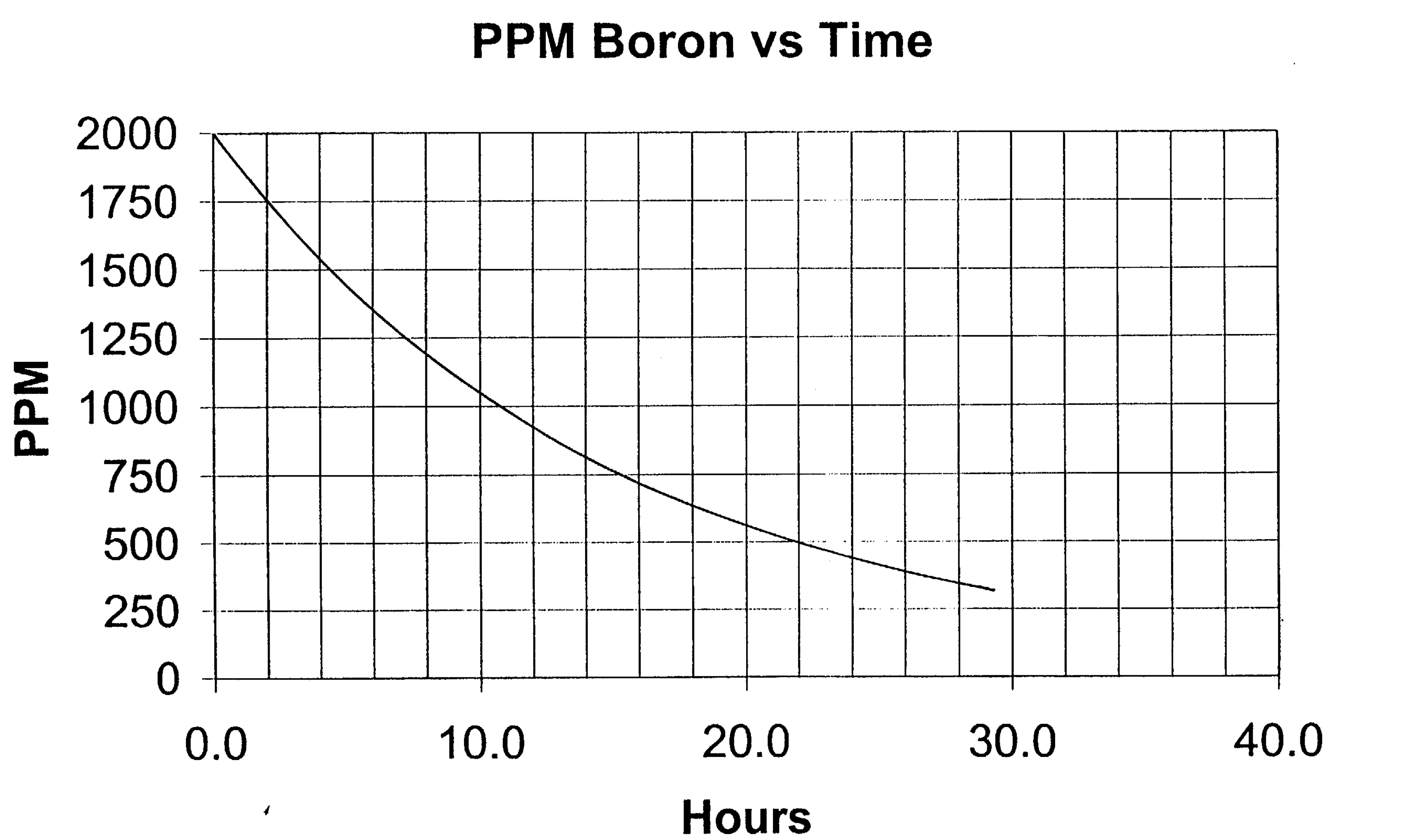
250	GPM UNBORATED DILUTION FLOW	2000	PPM BORON INITIAL CONCENTRATION



	TVA SEQUOYAH				**BORON DILUTION ANALYSIS**									
	BORON CREDIT STUDY				**UNBORATED WATER FLOW INTO SPENT FUEL POOL**									
	*****THIS CALCULATION IS BASED ON THE FORMULATION AND THE SCENARIOS DESCRIBED IN SECTION 3.2.2 OF THE REPORT*****													
	Dilution FlowRate		725.96		Lo Level Alarm			727.04	Begin Enter Vents					
	300	GPM	726.21		Hi Level Alarm			728.96	Vents Spilling					
	min	gal	ft	Alarm		gpm	gal	GAL	Hours					
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES				HOURS	PPMboron
1	0.00	265200	725.96		2000	300	0	0	Initial Condition, Low Level Alarm Point				0.0	2000
2	0.87	265460	725.99		1998	300	260	0		9370 gal/ft			0.0	1998
3	1.74	265721	726.02		1996	300	521	0					0.0	1996
4	2.60	265981	726.04		1994	300	781	0					0.0	1994
5	3.47	266241	726.07		1992	300	1041	0					0.1	1992
6	4.34	266501	726.10		1990	300	1301	0					0.1	1990
7	5.21	266762	726.13		1988	300	1562	0					0.1	1988
8	6.07	267022	726.15		1986	300	1822	0					0.1	1986
9	6.94	267282	726.18		1984	300	2082	0	2342.5 Gal, Low Level to High Level				0.1	1984
10	7.81	267543	726.21		1982	300	2343	0	High Level Alarm @		7.81	Minutes	0.1	1982
11	10.41	268323	726.29	A	1977	300	3123	0	Filling Pool Above High Level Alarm				0.2	1977
12	13.01	269104	726.38	A	1971	300	3904	0					0.2	1971
13	15.62	269885	726.46	A	1965	300	4685	0					0.3	1965
14	18.22	270666	726.54	A	1960	300	5466	0					0.3	1960
15	20.82	271447	726.63	A	1954	300	6247	0					0.3	1954
16	23.43	272228	726.71	A	1948	300	7028	0					0.4	1948
17	26.03	273009	726.79	A	1943	300	7809	0					0.4	1943
18	28.63	273790	726.88	A	1937	300	8590	0					0.5	1937
19	31.24	274571	726.96	A	1932	300	9371	0	Water Enters Vents, Begin				0.5	1932
20	33.84	275352	727.04	A	1926	300	10152	0	Flooding Encapsulated Ductwork				0.6	1926
21	40.54	275352	727.24	A	1912	300	12161	0	Feed&Bleed Model @		40.54	Minutes	0.7	1912
22	47.23	275352	727.43	A	1898	300	14169	0		10480 gal/ft			0.8	1898
23	53.93	275352	727.62	A	1885	300	16178	0					0.9	1885
24	60.62	275352	727.81	A	1871	300	18187	0					1.0	1871
25	67.32	275352	728.00	A	1858	300	20196	0					1.1	1858
26	74.01	275352	728.19	A	1844	300	22204	0					1.2	1844
27	80.71	275352	728.39	A	1831	300	24213	0					1.3	1831

28	87.41	275352	728.58	A	1817		300	26222	0					1.5	1817
29	94.10	275352	728.77	A	1804		300	28230	0					1.6	1804
30	100.80	275352	728.96	A	1791		300	30239	0	Filled All Encapsulated Ducts				1.7	1791
31	110.88	275352	728.96	A	1772		300	33263	3024	Spilling Into Non-Encapsulated Ducts				1.8	1772
32	121.96	275352	728.96	A	1751		300	36589	6350	Pool Level Not Increasing				2.0	1751
33	134.16	275352	728.96	A	1728		300	40248	10009					2.2	1728
34	147.58	275352	728.96	A	1703		300	44273	14034	117043	LB Spilled into Sheetmetal Ducts			2.5	1703
35	162.33	275352	728.96	A	1676		300	48700	18461					2.7	1676
36	178.57	275352	728.96	A	1647		300	53570	23331					3.0	1647
37	196.42	275352	728.96	A	1615		300	58927	28688					3.3	1615
38	216.07	275352	728.96	A	1581		300	64820	34581					3.6	1581
39	237.67	275352	728.96	A	1545		300	71302	41063					4.0	1545
40	261.44	275352	728.96	A	1506		300	78432	48193	401931	LB Spilled into Sheetmetal Ducts			4.4	1506
41	287.58	275352	728.96	A	1464		300	86275	56036					4.8	1464
42	316.34	275352	728.96	A	1420		300	94903	64664					5.3	1420
43	347.98	275352	728.96	A	1373		300	104393	74154					5.8	1373
44	382.78	275352	728.96	A	1322		300	114833	84594					6.4	1322
45	421.05	275352	728.96	A	1269		300	126316	96077					7.0	1269
46	463.16	275352	728.96	A	1214		300	138947	108708					7.7	1214
47	509.47	275352	728.96	A	1155		300	152842	122603					8.5	1155
48	560.42	275352	728.96	A	1095		300	168126	137887					9.3	1095
49	616.46	275352	728.96	A	1032		300	184939	154700					10.3	1032
50	678.11	275352	728.96	A	967		300	203433	173194	1444437	LB Spilled into Sheetmetal Ducts			11.3	967
51	745.92	275352	728.96	A	900		300	223776	193537					12.4	900
52	820.51	275352	728.96	A	833		300	246154	215915					13.7	833
53	902.56	275352	728.96	A	764		300	270769	240530					15.0	764
54	992.82	275352	728.96	A	696		300	297846	267607					16.5	696
55	1092.10	275352	728.96	A	628		300	327631	297392					18.2	628
56	1201.31	275352	728.96	A	561		300	360394	330155					20.0	561
57	1321.44	275352	728.96	A	496		300	396433	366194					22.0	496
58	1453.59	275352	728.96	A	434		300	436076	405837					24.2	434
59	1598.95	275352	728.96	A	374		300	479684	449445					26.6	374
60	1758.84	275352	728.96	A	319		300	527652	497413	4148428	LB Spilled into Sheetmetal Ducts			29.3	319
61	1934.73	275352	728.96	A	268		300	580418	550179					32.2	

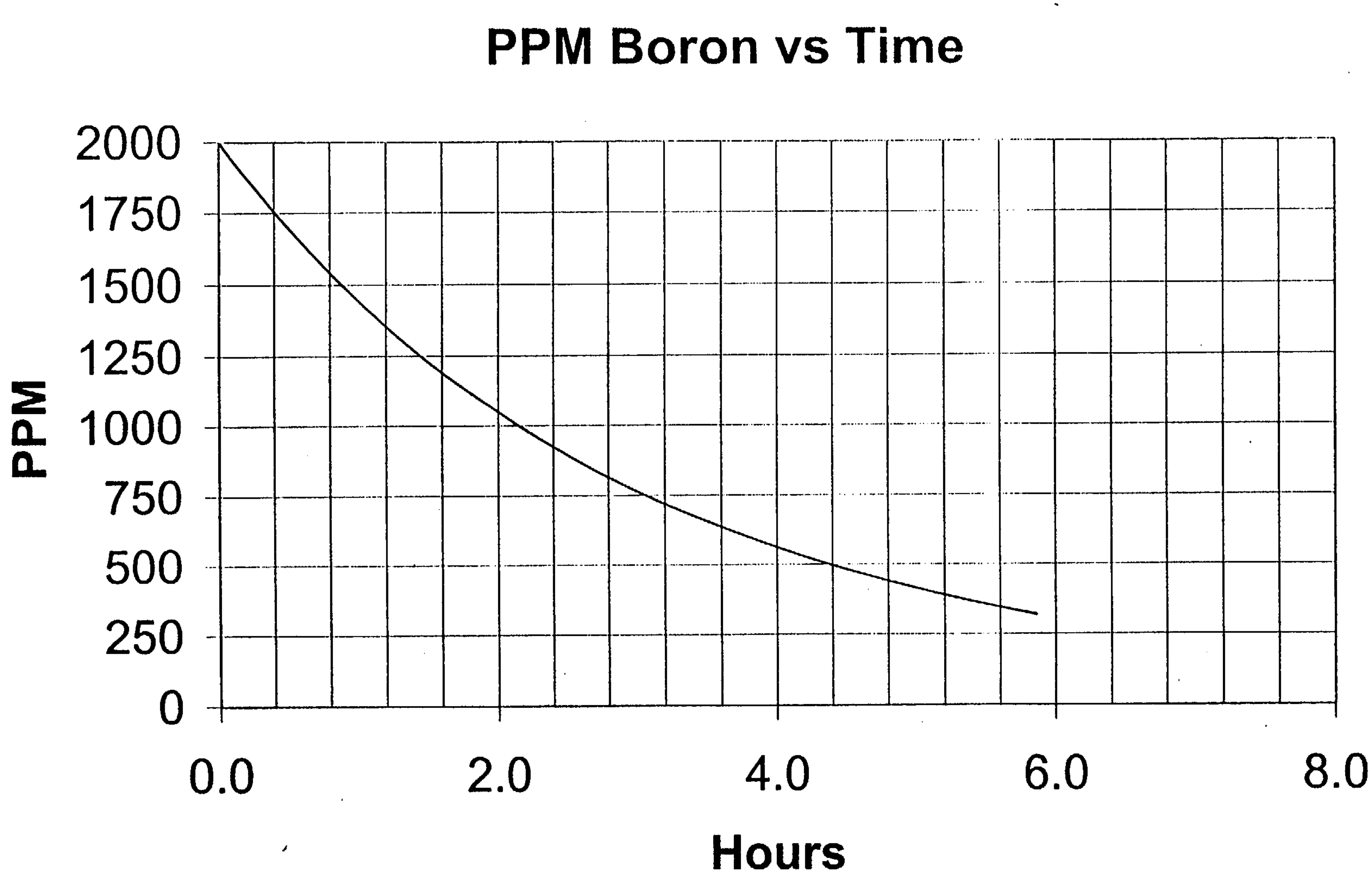
300	GPM UNBORATED DILUTION FLOW	2000	PPM BORON INITIAL CONCENTRATION



	TVA SEQUOYAH				**BORON DILUTION ANALYSIS**									
	BORON CREDIT STUDY				**UNBORATED WATER FLOW INTO SPENT FUEL POOL**									
	Dilution FlowRate		725.96		Lo Level Alarm			727.04	Begin Enter Vents					
	1500	GPM	726.21		Hi Level Alarm			728.96	Vents Spilling					
	min	gal	ft	Alarm		gpm	gal	GAL	Hours					
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES				HOURS	PPMboron
1	0.00	265200	725.96		2000	1500	0	0	Initial Condition, Low Level Alarm Point				0.0	2000
2	0.17	265460	725.99		1998	1500	260	0		9370 gal/ft			0.0	1998
3	0.35	265721	726.02		1996	1500	521	0					0.0	1996
4	0.52	265981	726.04		1994	1500	781	0					0.0	1994
5	0.69	266241	726.07		1992	1500	1041	0					0.0	1992
6	0.87	266501	726.10		1990	1500	1301	0					0.0	1990
7	1.04	266762	726.13		1988	1500	1562	0					0.0	1988
8	1.21	267022	726.15		1986	1500	1822	0					0.0	1986
9	1.39	267282	726.18		1984	1500	2082	0	2342.5 Gal, Low Level to High Level				0.0	1984
10	1.56	267543	726.21		1982	1500	2343	0	High Level Alarm @		1.56	Minutes	0.0	1982
11	2.08	268323	726.29	A	1977	1500	3123	0	Filling Pool Above High Level Alarm				0.0	1977
12	2.60	269104	726.38	A	1971	1500	3904	0					0.0	1971
13	3.12	269885	726.46	A	1965	1500	4685	0					0.1	1965
14	3.64	270666	726.54	A	1960	1500	5466	0					0.1	1960
15	4.16	271447	726.63	A	1954	1500	6247	0					0.1	1954
16	4.69	272228	726.71	A	1948	1500	7028	0					0.1	1948
17	5.21	273009	726.79	A	1943	1500	7809	0					0.1	1943
18	5.73	273790	726.88	A	1937	1500	8590	0					0.1	1937
19	6.25	274571	726.96	A	1932	1500	9371	0	Water Enters Vents, Begin				0.1	1932
20	6.77	275352	727.04	A	1926	1500	10152	0	Flooding Encapsulated Ductwork				0.1	1926
21	8.11	275352	727.24	A	1912	1500	12161	0	Feed&Bleed Model @		8.11	Minutes	0.1	1912
22	9.45	275352	727.43	A	1898	1500	14169	0		10480 gal/ft			0.2	1898
23	10.79	275352	727.62	A	1885	1500	16178	0					0.2	1885
24	12.12	275352	727.81	A	1871	1500	18187	0					0.2	1871
25	13.46	275352	728.00	A	1858	1500	20196	0					0.2	1858
26	14.80	275352	728.19	A	1844	1500	22204	0					0.2	1844
27	16.14	275352	728.39	A	1831	1500	24213	0					0.3	1831

28	17.48	275352	728.58	A	1817		1500	26222	0					0.3	1817
29	18.82	275352	728.77	A	1804		1500	28230	0					0.3	1804
30	20.16	275352	728.96	A	1791		1500	30239	0	Filled All Encapsulated Ducts				0.3	1791
31	22.18	275352	728.96	A	1772		1500	33263	3024	Spilling Into Non-Encapsulated Ducts				0.4	1772
32	24.39	275352	728.96	A	1751		1500	36589	6350	Pool Level Not Increasing				0.4	1751
33	26.83	275352	728.96	A	1728		1500	40248	10009					0.4	1728
34	29.52	275352	728.96	A	1703		1500	44273	14034	117043	LB Spilled into Sheetmetal Ducts			0.5	1703
35	32.47	275352	728.96	A	1676		1500	48700	18461					0.5	1676
36	35.71	275352	728.96	A	1647		1500	53570	23331					0.6	1647
37	39.28	275352	728.96	A	1615		1500	58927	28688					0.7	1615
38	43.21	275352	728.96	A	1581		1500	64820	34581					0.7	1581
39	47.53	275352	728.96	A	1545		1500	71302	41063					0.8	1545
40	52.29	275352	728.96	A	1506		1500	78432	48193	401931	LB Spilled into Sheetmetal Ducts			0.9	1506
41	57.52	275352	728.96	A	1464		1500	86275	56036					1.0	1464
42	63.27	275352	728.96	A	1420		1500	94903	64664					1.1	1420
43	69.60	275352	728.96	A	1373		1500	104393	74154					1.2	1373
44	76.56	275352	728.96	A	1322		1500	114833	84594					1.3	1322
45	84.21	275352	728.96	A	1269		1500	126316	96077					1.4	1269
46	92.63	275352	728.96	A	1214		1500	138947	108708					1.5	1214
47	101.89	275352	728.96	A	1155		1500	152842	122603					1.7	1155
48	112.08	275352	728.96	A	1095		1500	168126	137887					1.9	1095
49	123.29	275352	728.96	A	1032		1500	184939	154700					2.1	1032
50	135.62	275352	728.96	A	967		1500	203433	173194	1444437	LB Spilled into Sheetmetal Ducts			2.3	967
51	149.18	275352	728.96	A	900		1500	223776	193537					2.5	900
52	164.10	275352	728.96	A	833		1500	246154	215915					2.7	833
53	180.51	275352	728.96	A	764		1500	270769	240530					3.0	764
54	198.56	275352	728.96	A	696		1500	297846	267607					3.3	696
55	218.42	275352	728.96	A	628		1500	327631	297392					3.6	628
56	240.26	275352	728.96	A	561		1500	360394	330155					4.0	561
57	264.29	275352	728.96	A	496		1500	396433	366194					4.4	496
58	290.72	275352	728.96	A	434		1500	436076	405837					4.8	434
59	319.79	275352	728.96	A	374		1500	479684	449445					5.3	374
60	351.77	275352	728.96	A	319		1500	527652	497413	4148428	LB Spilled into Sheetmetal Ducts			5.9	319
61	386.95	275352	728.96	A	268		1500	580418	550179					6.4	

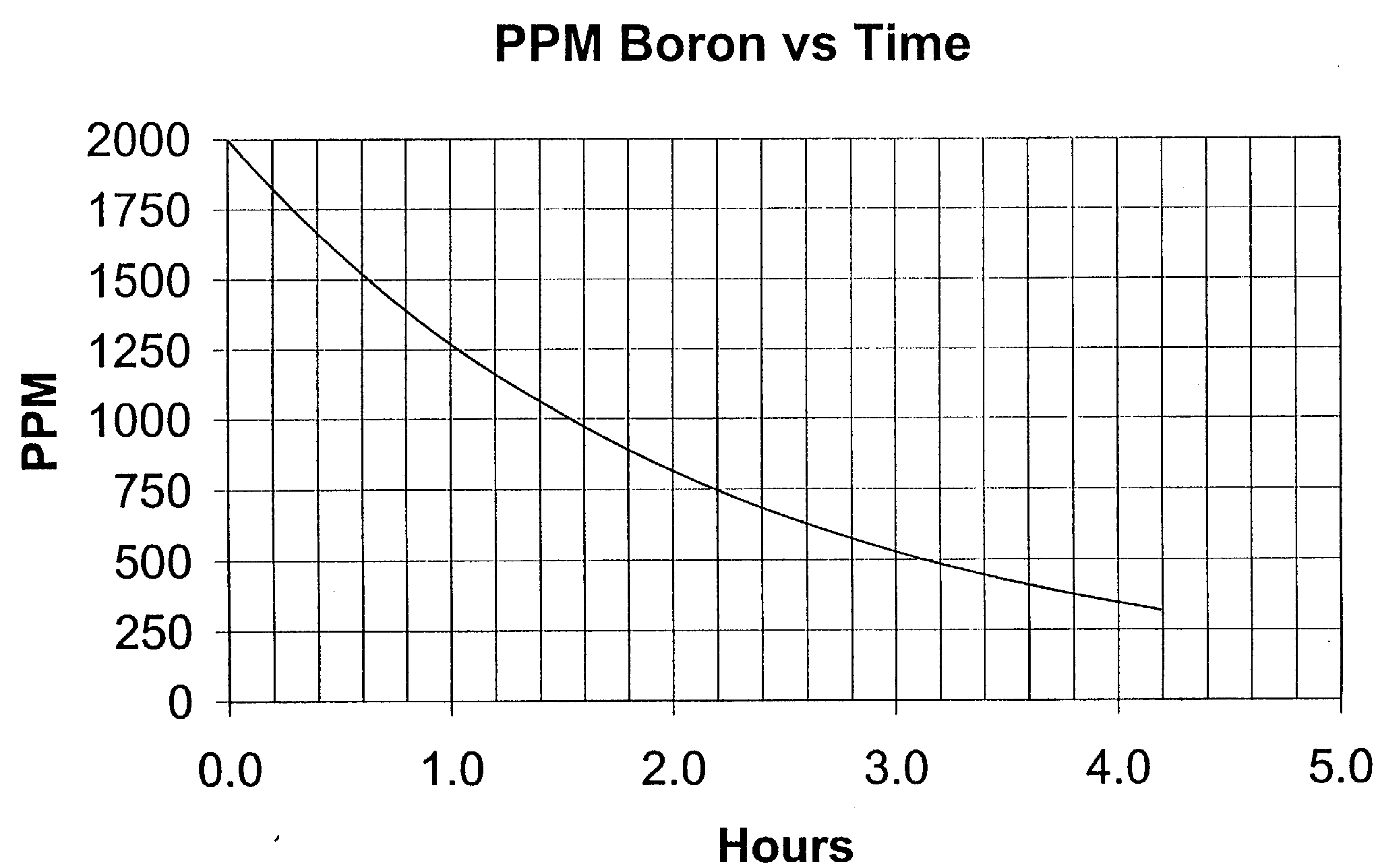
1500	GPM UNBORATED DILUTION FLOW	2000	PPM BORON INITIAL CONCENTRATION



	TVA SEQUOYAH				**BORON DILUTION ANALYSIS**									
	BORON CREDIT STUDY				**UNBORATED WATER FLOW INTO SPENT FUEL POOL**									
	*****THIS CALCULATION IS BASED ON THE FORMULATION AND THE SCENARIOS DESCRIBED IN SECTION 3.2.2 OF THE REPORT*****													
	Dilution FlowRate		725.96		Lo Level Alarm			727.04	Begin Enter Vents					
	2100	GPM	726.21		Hi Level Alarm			728.96	Vents Spilling					
	min	gal	ft	Alarm		gpm	gal	GAL	Hours					
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES				HOURS	PPMboron
1	0.00	265200	725.96		2000	2100	0	0	Initial Condition, Low Level Alarm Point				0.0	2000
2	0.12	265460	725.99		1998	2100	260	0		9370 gal/ft			0.0	1998
3	0.25	265721	726.02		1996	2100	521	0					0.0	1996
4	0.37	265981	726.04		1994	2100	781	0					0.0	1994
5	0.50	266241	726.07		1992	2100	1041	0					0.0	1992
6	0.62	266501	726.10		1990	2100	1301	0					0.0	1990
7	0.74	266762	726.13		1988	2100	1562	0					0.0	1988
8	0.87	267022	726.15		1986	2100	1822	0					0.0	1986
9	0.99	267282	726.18		1984	2100	2082	0	2342.5 Gal, Low Level to High Level				0.0	1984
10	1.12	267543	726.21		1982	2100	2343	0	High Level Alarm @		1.12	Minutes	0.0	1982
11	1.49	268323	726.29	A	1977	2100	3123	0	Filling Pool Above High Level Alarm				0.0	1977
12	1.86	269104	726.38	A	1971	2100	3904	0					0.0	1971
13	2.23	269885	726.46	A	1965	2100	4685	0					0.0	1965
14	2.60	270666	726.54	A	1960	2100	5466	0					0.0	1960
15	2.97	271447	726.63	A	1954	2100	6247	0					0.0	1954
16	3.35	272228	726.71	A	1948	2100	7028	0					0.1	1948
17	3.72	273009	726.79	A	1943	2100	7809	0					0.1	1943
18	4.09	273790	726.88	A	1937	2100	8590	0					0.1	1937
19	4.46	274571	726.96	A	1932	2100	9371	0	Water Enters Vents, Begin				0.1	1932
20	4.83	275352	727.04	A	1926	2100	10152	0	Flooding Encapsulated Ductwork				0.1	1926
21	5.79	275352	727.24	A	1912	2100	12161	0	Feed&Bleed Model @		5.79	Minutes	0.1	1912
22	6.75	275352	727.43	A	1898	2100	14169	0		10480 gal/ft			0.1	1898
23	7.70	275352	727.62	A	1885	2100	16178	0					0.1	1885
24	8.66	275352	727.81	A	1871	2100	18187	0					0.1	1871
25	9.62	275352	728.00	A	1858	2100	20196	0					0.2	1858
26	10.57	275352	728.19	A	1844	2100	22204	0					0.2	1844
27	11.53	275352	728.39	A	1831	2100	24213	0					0.2	1831

28	12.49	275352	728.58	A	1817		2100	26222	0					0.2	1817
29	13.44	275352	728.77	A	1804		2100	28230	0					0.2	1804
30	14.40	275352	728.96	A	1791		2100	30239	0	Filled All Encapsulated Ducts				0.2	1791
31	15.84	275352	728.96	A	1772		2100	33263	3024	Spilling Into Non-Encapsulated Ducts				0.3	1772
32	17.42	275352	728.96	A	1751		2100	36589	6350	Pool Level Not Increasing				0.3	1751
33	19.17	275352	728.96	A	1728		2100	40248	10009					0.3	1728
34	21.08	275352	728.96	A	1703		2100	44273	14034	117043	LB Spilled into Sheetmetal Ducts			0.4	1703
35	23.19	275352	728.96	A	1676		2100	48700	18461					0.4	1676
36	25.51	275352	728.96	A	1647		2100	53570	23331					0.4	1647
37	28.06	275352	728.96	A	1615		2100	58927	28688					0.5	1615
38	30.87	275352	728.96	A	1581		2100	64820	34581					0.5	1581
39	33.95	275352	728.96	A	1545		2100	71302	41063					0.6	1545
40	37.35	275352	728.96	A	1506		2100	78432	48193	401931	LB Spilled into Sheetmetal Ducts			0.6	1506
41	41.08	275352	728.96	A	1464		2100	86275	56036					0.7	1464
42	45.19	275352	728.96	A	1420		2100	94903	64664					0.8	1420
43	49.71	275352	728.96	A	1373		2100	104393	74154					0.8	1373
44	54.68	275352	728.96	A	1322		2100	114833	84594					0.9	1322
45	60.15	275352	728.96	A	1269		2100	126316	96077					1.0	1269
46	66.17	275352	728.96	A	1214		2100	138947	108708					1.1	1214
47	72.78	275352	728.96	A	1155		2100	152842	122603					1.2	1155
48	80.06	275352	728.96	A	1095		2100	168126	137887					1.3	1095
49	88.07	275352	728.96	A	1032		2100	184939	154700					1.5	1032
50	96.87	275352	728.96	A	967		2100	203433	173194	1444437	LB Spilled into Sheetmetal Ducts			1.6	967
51	106.56	275352	728.96	A	900		2100	223776	193537					1.8	900
52	117.22	275352	728.96	A	833		2100	246154	215915					2.0	833
53	128.94	275352	728.96	A	764		2100	270769	240530					2.1	764
54	141.83	275352	728.96	A	696		2100	297846	267607					2.4	696
55	156.01	275352	728.96	A	628		2100	327631	297392					2.6	628
56	171.62	275352	728.96	A	561		2100	360394	330155					2.9	561
57	188.78	275352	728.96	A	496		2100	396433	366194					3.1	496
58	207.66	275352	728.96	A	434		2100	436076	405837					3.5	434
59	228.42	275352	728.96	A	374		2100	479684	449445					3.8	374
60	251.26	275352	728.96	A	319		2100	527652	497413	4148428	LB Spilled into Sheetmetal Ducts			4.2	319
61	276.39	275352	728.96	A	268		2100	580418	550179					4.6	

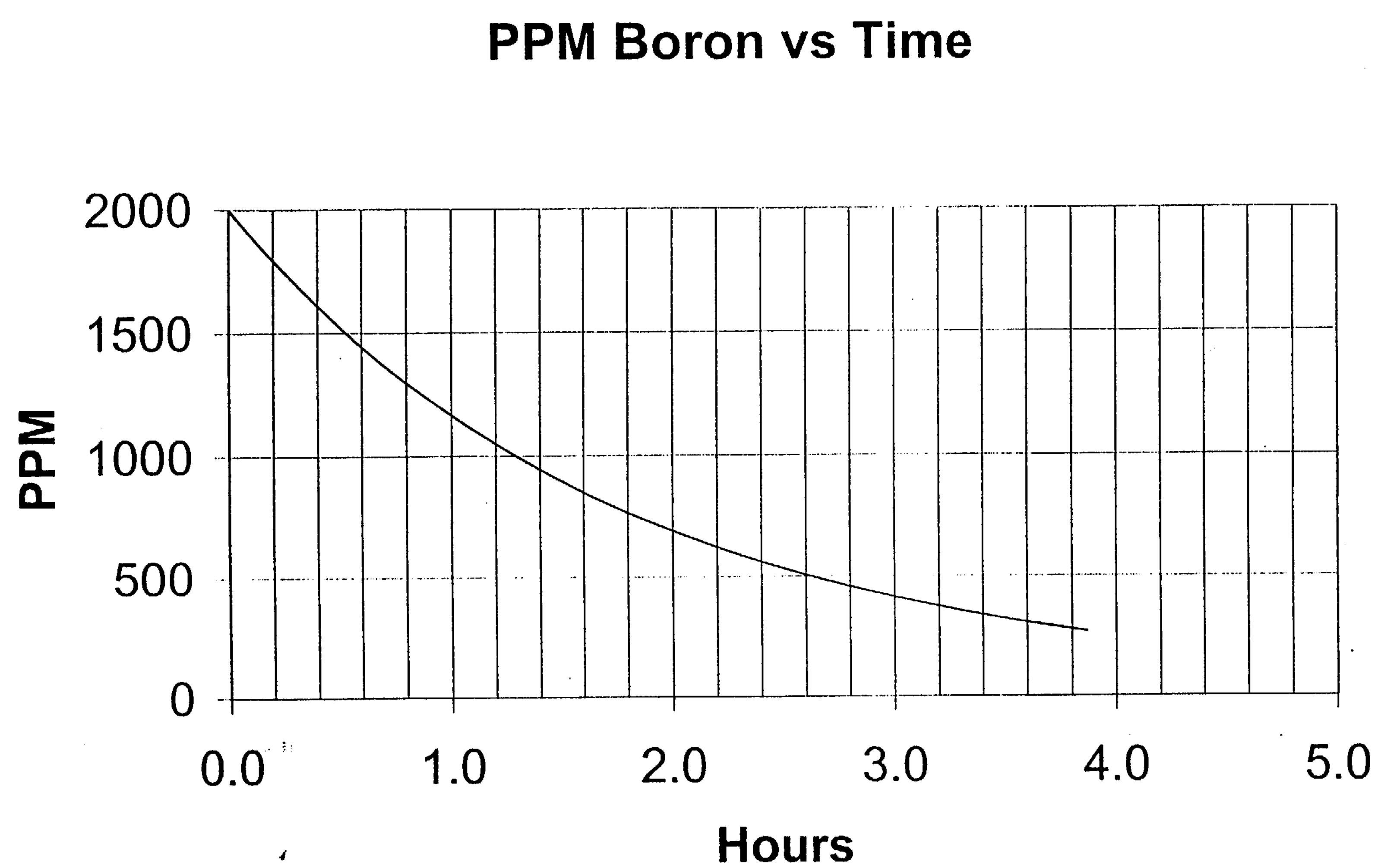
2100	GPM UNBORATED DILUTION FLOW	2000	PPM BORON INITIAL CONCENTRATION



	TVA SEQUOYAH				BORON DILUTION ANALYSIS									
	BORON CREDIT STUDY				UNBORATED WATER FLOW INTO SPENT FUEL POOL									
	*****THIS CALCULATION IS BASED ON THE FORMULATION AND THE SCENARIOS DESCRIBED IN SECTION 3.2.2 OF THE REPORT*****													
	Dilution FlowRate		725.96		Lo Level Alarm			727.04	Begin Enter Vents					
	2500	GPM	726.21		Hi Level Alarm			728.96	Vents Spilling					
	min	gal	ft	Alarm		gpm	gal	GAL	Hours					
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES				HOURS	PPMboron
1	0.00	265200	725.96		2000	2500	0	0	Initial Condition, Low Level Alarm Point				0.0	2000
2	0.10	265460	725.99		1998	2500	260	0		9370 gal/ft			0.0	1998
3	0.21	265721	726.02		1996	2500	521	0					0.0	1996
4	0.31	265981	726.04		1994	2500	781	0					0.0	1994
5	0.42	266241	726.07		1992	2500	1041	0					0.0	1992
6	0.52	266501	726.10		1990	2500	1301	0					0.0	1990
7	0.62	266762	726.13		1988	2500	1562	0					0.0	1988
8	0.73	267022	726.15		1986	2500	1822	0					0.0	1986
9	0.83	267282	726.18		1984	2500	2082	0	2342.5 Gal, Low Level to High Level				0.0	1984
10	0.94	267543	726.21		1982	2500	2343	0	High Level Alarm @		0.94	Minutes	0.0	1982
11	1.25	268323	726.29	A	1977	2500	3123	0	Filling Pool Above High Level Alarm				0.0	1977
12	1.56	269104	726.38	A	1971	2500	3904	0					0.0	1971
13	1.87	269885	726.46	A	1965	2500	4685	0					0.0	1965
14	2.19	270666	726.54	A	1960	2500	5466	0					0.0	1960
15	2.50	271447	726.63	A	1954	2500	6247	0					0.0	1954
16	2.81	272228	726.71	A	1948	2500	7028	0					0.0	1948
17	3.12	273009	726.79	A	1943	2500	7809	0					0.1	1943
18	3.44	273790	726.88	A	1937	2500	8590	0					0.1	1937
19	3.75	274571	726.96	A	1932	2500	9371	0	Water Enters Vents, Begin				0.1	1932
20	4.06	275352	727.04	A	1926	2500	10152	0	Flooding Encapsulated Ductwork				0.1	1926
21	4.86	275352	727.24	A	1912	2500	12161	0	Feed&Bleed Model @		4.86	Minutes	0.1	1912
22	5.67	275352	727.43	A	1898	2500	14169	0		10480 gal/ft			0.1	1898
23	6.47	275352	727.62	A	1885	2500	16178	0					0.1	1885
24	7.27	275352	727.81	A	1871	2500	18187	0					0.1	1871
25	8.08	275352	728.00	A	1858	2500	20196	0					0.1	1858
26	8.88	275352	728.19	A	1844	2500	22204	0					0.1	1844
27	9.69	275352	728.39	A	1831	2500	24213	0					0.2	1831

28	10.49	275352	728.58	A	1817	2500	26222	0			0.2	1817
29	11.29	275352	728.77	A	1804	2500	28230	0			0.2	1804
30	12.10	275352	728.96	A	1791	2500	30239	0	Filled All Encapsulated Ducts		0.2	1791
31	13.31	275352	728.96	A	1772	2500	33263	3024	Spilling Into Non-Encapsulated Ducts		0.2	1772
32	14.64	275352	728.96	A	1751	2500	36589	6350	Pool Level Not Increasing		0.2	1751
33	16.10	275352	728.96	A	1728	2500	40248	10009			0.3	1728
34	17.71	275352	728.96	A	1703	2500	44273	14034	117043	LB Spilled into Sheetmetal Ducts	0.3	1703
35	19.48	275352	728.96	A	1676	2500	48700	18461			0.3	1676
36	21.43	275352	728.96	A	1647	2500	53570	23331			0.4	1647
37	23.57	275352	728.96	A	1615	2500	58927	28688			0.4	1615
38	25.93	275352	728.96	A	1581	2500	64820	34581			0.4	1581
39	28.52	275352	728.96	A	1545	2500	71302	41063			0.5	1545
40	31.37	275352	728.96	A	1506	2500	78432	48193	401931	LB Spilled into Sheetmetal Ducts	0.5	1506
41	34.51	275352	728.96	A	1464	2500	86275	56036			0.6	1464
42	37.96	275352	728.96	A	1420	2500	94903	64664			0.6	1420
43	41.76	275352	728.96	A	1373	2500	104393	74154			0.7	1373
44	45.93	275352	728.96	A	1322	2500	114833	84594			0.8	1322
45	50.53	275352	728.96	A	1269	2500	126316	96077			0.8	1269
46	55.58	275352	728.96	A	1214	2500	138947	108708			0.9	1214
47	61.14	275352	728.96	A	1155	2500	152842	122603			1.0	1155
48	67.25	275352	728.96	A	1095	2500	168126	137887			1.1	1095
49	73.98	275352	728.96	A	1032	2500	184939	154700			1.2	1032
50	81.37	275352	728.96	A	967	2500	203433	173194	1444437	LB Spilled into Sheetmetal Ducts	1.4	967
51	89.51	275352	728.96	A	900	2500	223776	193537			1.5	900
52	98.46	275352	728.96	A	833	2500	246154	215915			1.6	833
53	108.31	275352	728.96	A	764	2500	270769	240530			1.8	764
54	119.14	275352	728.96	A	696	2500	297846	267607			2.0	696
55	131.05	275352	728.96	A	628	2500	327631	297392			2.2	628
56	144.16	275352	728.96	A	561	2500	360394	330155			2.4	561
57	158.57	275352	728.96	A	496	2500	396433	366194			2.6	496
58	174.43	275352	728.96	A	434	2500	436076	405837			2.9	434
59	191.87	275352	728.96	A	374	2500	479684	449445			3.2	374
60	211.06	275352	728.96	A	319	2500	527652	497413	4148428	LB Spilled into Sheetmetal Ducts	3.5	319
61	232.17	275352	728.96	A	268	2500	580418	550179			3.9	268

2500	GPM UNBORATED DILUTION FLOW	2000	PPM BORON INITIAL CONCENTRATION



	TVA SEQUOYAH				**BORON DILUTION ANALYSIS**									
	BORON CREDIT STUDY				**UNBORATED WATER FLOW INTO SPENT FUEL POOL**									
	*****THIS CALCULATION IS BASED ON THE FORMULATION AND THE SCENARIOS DESCRIBED IN SECTION 3.2.2 OF THE REPORT*****													
	Dilution FlowRate		725.96		Lo Level Alarm			727.04	Begin Enter Vents					
	5000	GPM	726.21		Hi Level Alarm			728.96	Vents Spilling					
	min	gal	ft	Alarm		gpm	gal	GAL	Hours					
	TIME	POOL	LEVEL		PPMboron	INFLO	SUM,in	SPILL	NOTES				HOURS	PPMboron
1	0.00	265200	725.96		2000	5000	0	0	Initial Condition, Low Level Alarm Point				0.0	2000
2	0.05	265460	725.99		1998	5000	260	0		9370 gal/ft			0.0	1998
3	0.10	265721	726.02		1996	5000	521	0					0.0	1996
4	0.16	265981	726.04		1994	5000	781	0					0.0	1994
5	0.21	266241	726.07		1992	5000	1041	0					0.0	1992
6	0.26	266501	726.10		1990	5000	1301	0					0.0	1990
7	0.31	266762	726.13		1988	5000	1562	0					0.0	1988
8	0.36	267022	726.15		1986	5000	1822	0					0.0	1986
9	0.42	267282	726.18		1984	5000	2082	0	2342.5 Gal, Low Level to High Level				0.0	1984
10	0.47	267543	726.21		1982	5000	2343	0	High Level Alarm @		0.47	Minutes	0.0	1982
11	0.62	268323	726.29	A	1977	5000	3123	0	Filling Pool Above High Level Alarm				0.0	1977
12	0.78	269104	726.38	A	1971	5000	3904	0					0.0	1971
13	0.94	269885	726.46	A	1965	5000	4685	0					0.0	1965
14	1.09	270666	726.54	A	1960	5000	5466	0					0.0	1960
15	1.25	271447	726.63	A	1954	5000	6247	0					0.0	1954
16	1.41	272228	726.71	A	1948	5000	7028	0					0.0	1948
17	1.56	273009	726.79	A	1943	5000	7809	0					0.0	1943
18	1.72	273790	726.88	A	1937	5000	8590	0					0.0	1937
19	1.87	274571	726.96	A	1932	5000	9371	0	Water Enters Vents, Begin				0.0	1932
20	2.03	275352	727.04	A	1926	5000	10152	0	Flooding Encapsulated Ductwork				0.0	1926
21	2.43	275352	727.24	A	1912	5000	12161	0	Feed&Bleed Model @		2.43	Minutes	0.0	1912
22	2.83	275352	727.43	A	1898	5000	14169	0		10480 gal/ft			0.0	1898
23	3.24	275352	727.62	A	1885	5000	16178	0					0.1	1885
24	3.64	275352	727.81	A	1871	5000	18187	0					0.1	1871
25	4.04	275352	728.00	A	1858	5000	20196	0					0.1	1858
26	4.44	275352	728.19	A	1844	5000	22204	0					0.1	1844
27	4.84	275352	728.39	A	1831	5000	24213	0					0.1	1831

28	5.24	275352	728.58	A	1817		5000	26222	0					0.1	1817
29	5.65	275352	728.77	A	1804		5000	28230	0					0.1	1804
30	6.05	275352	728.96	A	1791		5000	30239	0	Filled All Encapsulated Ducts				0.1	1791
31	6.65	275352	728.96	A	1772		5000	33263	3024	Spilling Into Non-Encapsulated Ducts				0.1	1772
32	7.32	275352	728.96	A	1751		5000	36589	6350	Pool Level Not Increasing				0.1	1751
33	8.05	275352	728.96	A	1728		5000	40248	10009					0.1	1728
34	8.85	275352	728.96	A	1703		5000	44273	14034	117043	LB Spilled into Sheetmetal Ducts			0.1	1703
35	9.74	275352	728.96	A	1676		5000	48700	18461					0.2	1676
36	10.71	275352	728.96	A	1647		5000	53570	23331					0.2	1647
37	11.79	275352	728.96	A	1615		5000	58927	28688					0.2	1615
38	12.96	275352	728.96	A	1581		5000	64820	34581					0.2	1581
39	14.26	275352	728.96	A	1545		5000	71302	41063					0.2	1545
40	15.69	275352	728.96	A	1506		5000	78432	48193	401931	LB Spilled into Sheetmetal Ducts			0.3	1506
41	17.26	275352	728.96	A	1464		5000	86275	56036					0.3	1464
42	18.98	275352	728.96	A	1420		5000	94903	64664					0.3	1420
43	20.88	275352	728.96	A	1373		5000	104393	74154					0.3	1373
44	22.97	275352	728.96	A	1322		5000	114833	84594					0.4	1322
45	25.26	275352	728.96	A	1269		5000	126316	96077					0.4	1269
46	27.79	275352	728.96	A	1214		5000	138947	108708					0.5	1214
47	30.57	275352	728.96	A	1155		5000	152842	122603					0.5	1155
48	33.63	275352	728.96	A	1095		5000	168126	137887					0.6	1095
49	36.99	275352	728.96	A	1032		5000	184939	154700					0.6	1032
50	40.69	275352	728.96	A	967		5000	203433	173194	1444437	LB Spilled into Sheetmetal Ducts			0.7	967
51	44.76	275352	728.96	A	900		5000	223776	193537					0.7	900
52	49.23	275352	728.96	A	833		5000	246154	215915					0.8	833
53	54.15	275352	728.96	A	764		5000	270769	240530					0.9	764
54	59.57	275352	728.96	A	696		5000	297846	267607					1.0	696
55	65.53	275352	728.96	A	628		5000	327631	297392					1.1	628
56	72.08	275352	728.96	A	561		5000	360394	330155					1.2	561
57	79.29	275352	728.96	A	496		5000	396433	366194					1.3	496
58	87.22	275352	728.96	A	434		5000	436076	405837					1.5	434
59	95.94	275352	728.96	A	374		5000	479684	449445					1.6	374
60	105.53	275352	728.96	A	319		5000	527652	497413	4148428	LB Spilled into Sheetmetal Ducts			1.8	319
61	116.08	275352	728.96	A	268		5000	580418	550179					1.9	

5000	GPM UNBORATED DILUTION FLOW		2000	PPM BORON INITIAL CONCENTRATION