INFORMATION ONLY

CHEMISTRY MANUAL 5.2
POST ACCIDENT PROCEDURE USE GUIDELINES

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Post Accident Procedure Use Guidelines

1. Purpose

NOTE:	A 50.59 screening is required to make major changes to this section. Minor changes per NSD 703 can be made without a 50:59.

NOTE:	Seven Control copies and one Information Only copy of this CSM shall be routed to the Emergency Preparedness Team within three (3) working days following any approved changes/modifications.

This section provides guidelines on the administration and use of chemistry post accident procedures and the precautions that should be observed during the use of these procedures. Special attention is given to limits and precautions associated with the execution of a procedure during a projected accident. Personnel requirements and procedure work locations will be given for personnel exposure consideration. Also, a listing of RIAs of interest to Chemistry for planning and assessment activities is included in Enclosures 6.1 and 6.2. This information is intended only as guidelines with the knowledge that an actual accident situation may deviate greatly from a projected scenario.

2. Guidelines

2.1 Limits and Precautions

2.1.1 Valve alignments should NOT be made and samples should NOT be taken without prior authorization from the TSC/OSC.

2.1.2 Do NOT attempt any phase of sampling or analysis without Radiation Protection coverage.

2.1.3 ALL personnel will need prior authorization from the OSC to exceed any exposure limit.

2.1.4 Radiation levels of the sampling and analysis area should be measured continuously during all phases of sampling, sample preparation, and analysis.

2.1.4.1 Air activity should be determined by use of installed air monitors or through the use of portable air sampling equipment.

2.1.4.2 Area dose rates should be established by the use of installed radiation monitors or by portable radiation survey instruments.

2.1.4.3 Portable shielding, remote handling equipment, video equipment, etc., should be used where practical during sample preparation and sample analysis.

2.1.4.4 All personnel working in the lab area and transporting samples shall monitor their personal dosimetry frequently to avoid exceeding maximum dose limits.

2.1.5 The post accident analysis should be done in a fume hood and/or other precautions should be taken to avoid the release of gaseous activity.

2.1.6 Radiation exposure to an individual during all phases of sampling should be limited so as not to exceed an annual accumulative exposure of 2 rem whole body; 50 rem skin of whole body; 50 rem extremities; or 15 rem eye respectively. All personnel will need prior authorization from the TSC/OSC to knowingly exceed any exposure limit. The exposure received may require an occupational exposure penalty and/or a medical decision as to whether an individual can continue in radiation work.

2.2 Waste Disposal

2.2.1 Determine by detailed planning meeting, the exact course of action to be taken. Under no condition should liquid or solid wastes be disposed of without prior specific RP directions.

2.2.2 Designate a sealable carboy as the "Post Accident Lab Waste" container. This container should be shielded and used as an interim liquid waste disposal container for all liquid analytical waste.

2.2.3 Request RP to designate an area where the "RCS Flush" bottle(s), "RCS Sample" bottle(s) and "Post Accident Lab Waste" container may be stored until final disposal.

2.2.4 In the event an area is grossly contaminated and cannot be decontaminated, evaluate the need for shielding or protective covering to prevent the spread of airborne activity.

2.2.5 In the event of a liquid spill and subsequent release to the unprotected area, or a planned release to the Keowee Tailrace, an estimate of the radiation exposure may be determined by use of Enc. 6.5.

2.3 Procedures

2.3.1 CP/1,2,3/A/2002/001 Unit One, Two, or Three Primary Sampling System

Description - Defines the steps necessary to sample tanks, systems, etc., associated with the primary system to determine various chemical concentrations and radioactive isotopes.

Personnel - One (1) Chemistry technician - to sample
One (1) RP technician

Precautions - Personnel should expect high dose rates and possible airborne activity. Use applicable RIA's listed in Enc. 6.1 and 6.2. Some sample points will be at system pressure.

CAUTION: If the hydrogen purge unit is in service on Unit 2 or 3 the ventilation flow path for the Primary and waste sample hoods has been isolated. The hydrogen purge unit will typically not be placed into service for about 7 days after a LOCA and then only if the hydrogen recombiner is out of service. The hydrogen purge unit must be secured prior to sampling.

Use - This procedure should be used to obtain reactor coolant samples when possible. Other primary systems and tanks such as LPI, BWST, SFP, etc. can be sampled using these procedures.

Location - Third floor Aux building - Primary sample hoods; First floor Aux building - Waste sample hoods

2.3.2 CP/1,2,3/A/2002/004 C Operating Procedure for the Post Accident Liquid Sampling (PALSS) System

Description - Outlines method to sample primary coolant using the remotely operated PALSS sampling system. System can sample from RCS "J-Leg", LPI Pump Discharge, and HPI Letdown.

Personnel - One (1) Chemistry technician - panel operation
One (1) person to communicate with control room for LP-65 (if required)
One (1) Radiation Protection technician.

Precautions - Because of location of sample panels, personnel may be in high radiation area with airborne activity. Evaluate shuttle of personnel to and from lower dose areas. Use the readings from applicable RIAs listed in Enc. 6.1 and 6.2 to plan sampling activities.

Use - This procedure should be used to sample primary coolant when significant fuel damage is expected. System is designed to limit personnel exposure during sampling. Sample point for RCS "J-Leg" needs flow through that loop to ensure representative sample. If significant loss of coolant has occurred, need to also sample LPI Pump Discharge.

Location - First floor auxiliary building Near 1 & 2 Waste Disposal Hood - Units 1 & 2; Near 3 Waste Disposal Hood - Unit 3

2.3.3 CP/0/A/2002/004E Reactor Coolant Sampling During an Appendix "R" Accident

Description - This procedure provides instruction on sampling the RCS via an ice cooled sampler installed on the discharge side of valve 1, 2, 3 RC-179 of the affected unit during an Appendix "R" accident situation.

Personnel - Two (2) Chemistry Technicians
One (1) Radiation Protection Technician
Two (2) I&E Technicians

Precautions - Personnel should expect normal dose rates and a high probability of airborne activity due to fission gas release during sample flush to floor drain. Sample temperature and pressure will be very high and if not cooled properly will flash to steam.

Use - This procedure should only be used during an Appendix "R" fire when all power is lost. It should be considered the last alternative for Reactor coolant sampling.
Location - Unit 1, 2, 3 LPI Pump rooms

2.3.4 CP/1&2,3/A/2002/005 Post Accident Caustic Injection Into the Low Pressure Injection System

Description - Outlines the method used to raise the pH of the primary coolant to ~ 7.0 - 8.0 following a LOCA. Caustic additions will improve the iodine liquid partition factor and inhibit hydrogen gas formation. Use Enc. 6.3 to calculate quantity of caustic required for addition.

Personnel - Two (2) Chemistry technicians
One (1) Radiation Protection tech (if required)
Two (2) additional OSC personnel to move Caustic (as needed)

Precautions - High radiation areas and airborne activity may be a concern. Use readings from applicable RIAs listed in Enc. 6.1 and 6.2 to plan addition. Establish Low Dose Waiting Areas as needed. Heat Stress conditions may also be a concern.

Use - This procedure should be used when a significant loss of coolant to the Reactor Building has occurred and there is concern about an Iodine release and/or hydrogen gas formation. The LPI System <u>MUST</u> be in service and taking suction from the emergency sump.

Location - Units 1&2 - 2nd floor of the Aux. Bldg, Chemical Addition Area
Unit 3 - 1st floor of the Aux Bldg, Chemical Addition Area

2.3.5 LM-O-P003C Determination of Boron by Manual Colorimetric Titration

Description - Outlines the use of manual potentiometric titrations to determine boron concentration. The range for this analysis is between 100 and 2500 ppm. Samples with concentrations greater than 1000 ppm must be diluted for dose and time considerations.

Personnel- One (1) Chemistry technician
One (1) Radiation Protection technician

Precautions - Personnel should expect high dose rates and possible airborne activity. Use the readings from applicable RIAs listed in Enc. 6.1 and 6.2 to determine if the Primary Lab is available for use.

Use - This procedure should be used to analyze for boron whenever conditions have resulted in the loss of the normal analytical instrumentation, such as an Appendix "R" Accident.

Location - Rooms 329 and 330.

2.3.6 LM-O-P003A Determination of Boron Using the Mettler DL40GP

Description - This method covers the precise determination of boron concentration in the 1 - 3,000 ppm range in high purity water (RCS) using the Mettler DL40GP Memotitrator System.

Personnel - One (1) Chemistry technician
One (1) Radiation Protection technician

Precautions - Personnel should expect high dose rates and possible airborne activity. Use the readings from applicable RIAs listed in Enc. 6.1 and 6.2 to determine if the Primary Lab is available for use.

Use - This procedure should be used as the primary method for determining boron concentration.

Location - Rooms 329 and 330.

2.3.7 LM-O-P0013 The Analysis of Water Using the Dionex 2020I Ion Chromatograph

Description - Outlines the use of ion chromatograph in determination of chloride concentration in primary coolant when fuel failure is expected.

Personnel - One (1) Chemistry technician
One (1) Radiation Protection technician

Precautions - Personnel should expect high dose rates and possible airborne activity. If too much dilution is required based on dose consideration, then this procedure could not be utilized. Use the readings from applicable RIAs listed in Enc. 6.1 and 6.2 to determine if the Dionex Lab is available for use.

Use - This procedure should be used when dose consideration allows a reasonable expectancy of being able to detect chloride at the dilution required.

Location - Rooms 324.

2.3.8 LM-O-P008 The Determination of Hydrogen in Gas Samples Using the Carle Gas Chromatograph

Description - This procedure covers the use of the Carle Series 100 and 400 Analytical Gas Chromatographs to determine the concentration of hydrogen in gas samples.

Personnel - One (1) Chemistry technician
One (1) Radiation Protection technician

Precautions - Personnel should expect high dose rates and possible airborne activity. Use the readings from applicable RIAs listed in Enc. 6.1 and 6.2 to determine if the Primary Lab is available for use.

Use - This procedure should be used in an accident situation to analyze for hydrogen concentration.

Location - Rooms 329 and 330.

2.3.9 LM-O-G004 Determination of Gamma Isotopic Activity

Description - Outline of method used to prepare sample for gamma isotopic analysis.

Personnel - One (1) Chemistry technician
One (1) Radiation Protection technician

Precautions - Personnel should expect high dose rates and possible airborne activity. Utilize remote handling when possible. Use the readings from applicable RIAs listed in Enc. 6.1 and 6.2 to determine if the Primary Lab and Count Room are available for use.

Use - This procedure should be used when a gamma isotopic analysis is required.

Location - Rooms 329 and 330.

3. Additional Information

3.1 Tank volumes:

Quench Tank	5,834 gallons
BWST	388,000 gallons
CBAST	22,440 gallons
BAMT	2,500 gallons
BHUT	82,000 gallons
LDST	4,488 gallons (31.26 gal/in)
CFT	10,470 gallons
SFP (1&2)	546,000 gallons
SFP (3)	374,000 gallons
LiOH	30 gallons
NaOH	100 gallons
MWT	20,200 gallons
HAWT	2,000 gallons
LAWT	3,000 gallons

3.2 System Volumes:

RCS (cold/hot)	88,000/60,000 gallons
Reactor Building	1,910,000 ft^3 free volume
CST	30,000 gallons
Waste Gas	23,800 ft^3
Hotwell	150,000 gallons
OTSG (2ndry)	28,000 gallons

3.3 Cooler Supplies:

Quench Tank	-	CC
Decay Heat	-	LPSW
Letdown	-	CC
Seal Return	-	RCW
RBCU	-	LPSW
CC	-	LPSW
RCW	-	CCW
Pri Sample	-	RCW
PALSS	--	RCW

4. Suggested Actions

4.1 Normal Operating Conditions:

Observation: Loose part or mechanical failure has caused suspected loss of some fuel integrity.

Actions:

- Do not over react, close coordination with OPS and RP will be necessary to understand where and how to sample coolant.
- First find out exact status of unit (subcritical, pressure, temperature, # of RCP on, letdown flow rate, area monitor readings?)
- If the unit is shutdown, then remember that samples will show normal coolant fission product spiking - must compare to earlier unit trip results.
- Have RP survey letdown piping (if in service) and compare to normal values before deciding which method to use in sampling.
- For truly mechanical damage, gap activity isotope should increase (Xenons, Kryptons, iodines) with much smaller increases in (Strontium, Barium, Cesium, less mobile isotopes).
- With gap activity release, degassing of coolant fission gases will be much more pronounced. Appropriate respiratory protection should be considered while sampling.

4.2 Overheat Condition Without Fuel Melt

Observation: RB pressure and temperature increase. Suspect loss of coolant to Reactor Building.

Actions:

- If ES actuation occurs, then letdown will be automatically secured thus rendering normal sample point useless (Ops may manually override)
- Make immediate plans to move necessary equipment to RW facility or Environmental lab for chemical analysis of boron and pH. Dose rates may render Primary lab useless.
- Before deciding which sample location to use, a careful evaluation of all data should be performed.
  1. Boron concentration can be calculated based on injection volumes and known concentrations.
  2. RIA readings from RIA 57, 58 can closely estimate failed fuel percentage without need for sampling.
  3. If recirculation of water through vessel is not available, the PALS J-leg sample will not be representative.
  4. Core exit thermocouple readings and mapping can aid in estimating area and extent of core damage.
- If electrical system load shed has occurred, then many of the normal power supplies to the Chemistry group may be unavailable without Operations assistance.

4.3 Fuel Melt

Actions:

- All of 4.2 action items are applicable.
- Expect higher levels of Barium, Strontium and Praesyodimium from fuel matrix loss.
- Expect high suspended solids in any sampling attempted.
- Both hydrogen percentage and RIA 57, 58 readings can and should be used in lieu of sampling, at least until dose levels have significantly dropped.
- Boron as a criticality concern should be minimal - weighing the small benefit of a sample versus the extreme risk to an individual(s) should be considered.

5. References

5.1 ONS Post Accident Procedures

5.2 ONS OFD Drawings

5.3 ONS UFSAR

6. Enclosures

6.1 RIAs of Interest to Chemistry

6.2 Location of Sample Points for Multipoint RIAs

6.3 Caustic Addition Calculations

6.4 $\bar{E}$, A and R Values for 1% Failed Fuel and DBA

6.5 Liquid Effluent Release Exposure Estimation

6.6 Technical Basis for Caustic Addition Calculations

6.7 Quarterly Inspection of Post Accident Equipment

Enclosure 6.1
RIAs of Interest to Chemistry
Sheet 1 of 1

RIA #	RANGE	LOCATION	INFORMATION USED FOR
1RIA-4 2RIA-4 3RIA-4	0.1 - 10e7 mR/hr	Reactor Building Entrance/ Personnel Hatch	Indicates a LOCA with moderate to severe fuel damage; 2RIA-4 is located near the Primary Lab and Count Room - Readings used to assess the need to prepare alternate labs
RIA-8	0.1 - 10e7 mR/hr	Primary Chemistry Lab	Used to assess the need to prepare the alternate Primary Lab and/or Count Room
1RIA-10 2RIA-10 3RIA-10	0.1 - 10e7 mR/hr	Unit 1 Primary Sample Hood Unit 2 Primary Sample Hood Unit 3 Primary Sample Hood	Used for planning sampling. Readings will be high once sampling is started if significant fuel damage has occurred
1RIA-12 3RIA-12	0.1 - 10e7 mR/hr	Unit 1&2 Boric Acid Mix Tank Unit 3 Boric Acid Mix Tank	Readings used for planning chemical additions (ie: Caustic Additions)
1RIA-13 3RIA-13	0.1 - 10e7 mR/hr	Unit 1&2 Waste Sample Hood Unit 3 Waste Sample Hood	Used for planning sampling activities from the PALS. Readings may be high if significant fuel damage has occurred
1RIA-15 3RIA-15	0.1 - 10e7 mR/hr	Unit 1&2 HPI Pump Room Unit 3 HPI Pump Room	Provide preliminary indications of significant fuel damage
1RIA-16,17 2RIA-16,17 3RIA-16,17	0.01 - 10e3 mR/hr	Unit 1 'A & B' Main Steam Lines Unit 2 'A & B' Main Steam Lines Unit 3 'A & B' Main Steam Lines	Readings > background from these RIAs are indications of primary/secondary steam generator tube leaks
3RIA-19	0.1 - 10e7 mR/hr	Laundry and Hot Shower Tank Room	Used for planning Unit 3 caustic; readings may be high if significant fuel damage has occurred due to being near LDST
1RIA-31 3RIA-31	10 - 10e6 CPM	Behind air compressors in Turbine Building Basement, west of Unit 2 Powdex North of sewage ejectors at Unit 3, west wall of Turbine Building	Multipoint RIA that monitors LPSW effluents from LPI Cooler, and CC Cooler. Readings > background indicate a primary coolant leak into the LPSW System. See Enc. 6.2 for sample point locations.
1RIA-32 3RIA-32	10 - 10e6 CPM	Monitor on first floor of Aux Building; sample points are located in various room/areas throughout the Aux Building	Multipoint RIA that measures airborne activity levels in various locations (up to 24) through the Aux Building. Used to plan sampling and chemical addition activities. See Enc. 6.2 for sample point locations.
1RIA-35 2RIA-35 3RIA-35	10 - 10e6 CPM	Behind air compressors in Turbine Building Basement, west of Unit 2 Powdex Same location as 3RIA-31	Monitors LPSW discharge from the Building. Readings > background are indicators of primary coolant leak into the LPSW System; RIA-31 readings will increase also.
1RIA-40 2RIA-40 3RIA-40	10 - 10e6 CPM	Unit 1 CSAE Off Gas Discharge Unit 2 CSAE Off Gas Discharge Unit 3 CSAE Off Gas Discharge	Monitors CSAE Off Gas effluent to each unit vent. Indicates steam generator tube leaks.
1,2,3 RIA-57&58	1 - 10e7 R/hr	Unit 1 Reactor Building Unit 2 Reactor Building Unit 3 Reactor Building	Measures activity in the Rx building during a LOCA. Readings from these RIAs can be related to % failed fuel.

Enclosure 6.2
Location of Sample Points for Multipoint RIAs
Sheet 1 of 1

1RIA-31 SAMPLE POINTS

1RIA-31-1	LPI/Decay Heat Cooler 1A Outlet
1RIA-31-2	LPI/Decay Heat Cooler 1B Outlet
1RIA-31-3	RB Component Cooler 1A Outlet
1RIA-31-4	RB Ventilation (Cooling) Unit 1A Outlet
1RIA-31-5	RB Ventilation (Cooling) Unit 1B Outlet
1RIA-31-6	RB Ventilation (Cooling) Unit 1C Outlet
1RIA-31-7	LPI/Decay Heat Cooler 2A Outlet
1RIA-31-8	LPI/Decay Heat Cooler 2B Outlet
1RIA-31-9	RB Component Cooler 2B Outlet
1RIA-31-10	RB Ventilation (Cooling) Unit 2A Outlet
1RIA-31-11	RB Ventilation (Cooling) Unit 2B Outlet
1RIA-31-12	RB Ventilation (Cooling) Unit 2C Outlet

3RIA-31 SAMPLE POINTS

3RIA-31-1	LPI/Decay Heat Cooler 3A Outlet
3RIA-31-2	LPI/Decay Heat Cooler 3B Outlet
3RIA-31-3	RB Component Cooler 3B Outlet
3RIA-31-4	RB Ventilation (Cooling) Unit 3B Outlet
3RIA-31-5	RB Ventilation (Cooling) Unit 3A Outlet
3RIA-31-6	RB Ventilation (Cooling) Unit 3C Outlet

1RIA-32 SAMPLE POINTS

1RIA-32-1	Unit 1 Pipe Rooms; Elevation 758 and 771
1RIA-32-2	Unit 2 Pipe Rooms; Elevation 758 and 771
1RIA-32-3	Spent Resin Storage Tanks, Condensate Test Tanks, Unit 1 Letdown Storage Tank, Boric Acid Mix Tank
1RIA-32-4	RC Bleed Evaporator Room, Unit 1&2 Miscellaneous Waste Holdup Tank, Unit 2 Letdown Storage Tank
1RIA-32-5	Waste Drumming Area
1RIA-32-6	Miscellaneous Waste Evaporator Room
1RIA-32-7	Unit 1 RC Bleed Transfer Pump, Unit 1 RC Bleed Holdup Tanks, Unit 1 Concentrated Boric Acid Storage Tank
1RIA-32-8	Unit 2 RC Bleed Transfer Pump, Unit 2 RC Bleed Holdup Tanks, Unit 2 Concentrated Boric Acid Storage Tank
1RIA-32-10	Waste Gas Compressor, RC Bleed Evaporator Feed Tank
1RIA-32-11	Unit 1 Pipe Rooms; Elevations 783-796
1RIA-32-12	Unit 2 Pipe Rooms; Elevations 783-796

3RIA-32 SAMPLE POINTS

3RIA-32-1	Unit 3 Pipe Rooms; Elevation 758 and 771
3RIA-32-2	Unit 3 Pipe Rooms; Elevations 783-796
3RIA-32-3	RB Component Coolers, Letdown Filters, Hatches, Waste Gas Compressor Room, Waste Gas Decay Tanks
3RIA-32-4	Unit 3 RC Bleed Holdup Tanks, Unit 3 Concentrated Boric Acid Storage Tank, Unit 3 Miscellaneous Waste Holdup Tank Area
3RIA-32-5	High Activity Spent Resin Storage Tank, Boric Acid Mix Tank and Pumps, Spent Resin Storage Tank Area

Enclosure 6.3
Caustic Addition Calculations
Sheet 1 of 3

1. Initial Conditions for Injection

1.1 An emergency is in effect due to a LOCA.

1.2 The Low Pressure Injection (LPI) system is in operation with the LPI pumps taking suction from the BWST.

1.3 The Reactor Building Emergency Spray system may or may not be in operation from the BWST through the spray headers.

1.4 The addition of caustic SHALL begin WITHIN thirty (30) minutes AFTER switchover to the recirculation mode of core cooling. The recirculation mode is in effect whenever the suction for the LPI pumps' is isolated from the BWST and aligned to the Reactor Building Emergency Sump.

1.5 The addition of caustic will be made upon authorization of the TSC/OSC.

2. Bases for Caustic Addition Calculations

2.1 Calculations for the amount of caustic required for neutralization of the borated water are dependent on:

2.1.1 An accurate estimation of the volume of borated water being used as the core flooding coolant;

2.1.2 The boron concentration of the core flooding coolant;

2.1.3 One (1) pound of caustic neutralizing seventeen (17) pounds of H_3BO_3 to a pH of 7.5.

2.2 If the total volumes of the CFTs and BWST are used, then the maximum amount of caustic required for neutralization of the borated water to a pH of 7.5 is 700 gallons. The amount of 700 gallons has been calculated with the following considerations:

2.2.1 Both CFTs and the BWST have a total volume of 403,000 gallons with a boron concentration of 2300 ppm;

2.2.2 The RCS has a volume of 88,000 gallons with a boron concentration of 1000 ppm.

2.3 Boric Acid for the purposes of these calculations behaves as a simple monoprotic acid.

Enclosure 6.3
Caustic Addition Calculations
Sheet 2 of 3

3. Calculations of the Amount of Caustic required for Neutralization to a pH of 7.5 Based on Core Flooding Coolant Boron Content.

NOTE:	Calculate the quantity of caustic as outlined below or use the computer program by opening Oconee Desktop; Oconee Information Library; Chemistry Information Library; CUG-S-19-Caustic.

Date _________ Time _________ Unit _________ By ___________________

CFT 'A' Boron _________ CFT 'B' Boron _________ RCS Boron _________

BWST Boron _________ BWST Vol. dumped to RCS _________

3.1 The 2 CFT's have a total volume of 15,000 gal. Average the most recent boron results for the A&B CFT's and enter the average into the equation below. Calculate the (lbs of) H_3BO_3 in the CFT's:

$$\text{Lbs. CFT } H_3BO_3 = \frac{(\_\_\_\_\text{ppm})\ (15{,}000\text{ gal})\ (8.34\text{ lbs/gal})}{(1 \times 10^6)\ (0.175)} = \_\_\_\_$$

3.2 The RCS has a volume of 88,000 gal. Calculate the lbs. H_3BO_3 in the RCS:

$$\text{Lbs. RCS } H_3BO_3 = \frac{(\_\_\_\_\text{ppm})\ (88{,}000\text{ gal})\ (8.34\text{ lbs/gal})}{(1 \times 10^6)\ (0.175)} = \_\_\_\_$$

3.3 The BWST has a total volume of 388,000 gal. Obtain from Operations an estimate of the volume of borated water that has been dropped from the BWST: __________ gal. Calculate the lbs. H_3BO_3 added to the core from the BWST:

$$\text{Lbs. BWST } H_3BO_3 = \frac{(\_\_\_\_\text{ppm})\ (\_\_\_\_\text{gal})\ (8.34\text{ lbs/gal})}{(1 \times 10^6)\ (0.175)} = \_\_\_\_$$

3.4 Calculate the Gal. NaOH required to adjust the borated water of the CFT's and the RCS to 7.5.

$$\text{Gal. 35\% NaOH required} = \frac{(1\text{ lb NaOH})\ (\text{lbs CFT } H_3BO_3 + \text{lbs RCS } H_3BO_3 + \text{lbs BWST } H_3BO_3)\ (1\text{ Gal. 35\% NaOH})}{(17\text{ lbs } H_3BO_3)\ (4\text{ lbs NaOH})}$$

= ________ Gallons

3.5 For the initial caustic addition, it is recommended that only half of the calculated amount should be added. Note that if using the computer program to calculate the initial addition, the results have already been halved. This is clearly stated by the computer program. Record the actual amount to be added below.

Amount of 35% NaOH to add _______ gallons.

Enclosure 6.3
Caustic Addition Calculations
Sheet 3 of 3

4. Calculation of the amount of 35% caustic required for neutralization of a pH between 7.0 and 8.0 based on core flooding coolant actual pH.

NOTE:	Calculate as outlined below or use the computer program by opening Oconee Desktop; Oconee Information Library; Chemistry Information Library; CUG-S-19-Caustic.

Date ________ Time ________ Unit ________ By ______________

4.1 Core Coolant pH ________________.

4.2 Core Coolant Boron Concentration (approximately) in ppm is _______.

4.3 Core Coolant Volume (RCS, BWST vol. dumped, CFTs) in gallons is ______________.

4.4 Calculate the volume of 35% NaOH required to adjust the core coolant water to a pH between 7.0 and 8.0.

35% NaOH to Add = $((4.7 \times 10^{-6} - 1.6 \times 10^{-13}/10^{-pH})\text{ppm B} - 10^{-pH} + 10^{(pH-14)}) * V * 0.0829$

Where,

Gallons = Volume in gallons of 35% NaOH to add to the Reactor Coolant

B = Reactor Coolant boron concentration in ppm

V = Volume of reactor cooling water (including BWST, CFT, etc.) in gallons

8.29×10^{-2} = Conversion Factor

pH = Actual measured pH of reactor coolant water.

Gals 35% NaOH = ______________________ Gallons

NOTE :	1.	This volume does not account for the associated piping volume between the caustic injection tank and the suction of the low pressure injection pump.
	2.	If reactor coolant pH is between 7.0 and 8.0, this formula "MAY" produce a negative number which means that no caustic addition is necessary.

Enclosure 6.4

$\bar{E}$, A and R Values for 1% Failed Fuel and DBA

Sheet 1 of 1

<u>1% Failed Fuel</u>:

$\bar{E} \sim 0.34$ MeV/dis.

A ~ 0.293 mCi/ml

R = 0.18 mR/hr-mCi at lm for $\bar{E} \sim 0.34$ MeV

<u>100% Failed Fuel or Design Basis Accident (DBA)</u>:

$\bar{E} \sim 1.14$ MeV/dis.

A ~ 1.324×10^5 uCi/ml

R = 0.58 R/hr-Ci at lm for $\bar{E} \sim 1.14$ MeV

A direct proportion should exist between $\bar{E}$ and R for any failed fuel value > 1% and < 100%.

Enclosure 6.5
Liquid Effluent Release Exposure Estimation
Sheet 1 of 1

The following are instructions to access and run the "CODARPT" computer program on TSOPRDB for the purpose of estimating radiation exposure to the public from drinking water and fish pathways.

1. Logon to the TSOPRDA screen.
2. At the READY prompt, enter 'CODARPT' and depress the ENTER key.
3. At the cursor, type 'P' and depress the ENTER key.
4. At the cursor, type 'L'.
5. At the cursor, type 'ONS'.
6. At the cursor, type the year (i.e. 93).
7. At the cursor, type the release start date (Julian), type the release start time.
8. At the cursor, repeat step 7.0 for the release stop.
9. At the cursor, type a title for the release type. (i.e. DMT, WMTA, etc.) and depress the TAB key.
10. Tab down twice and at the cursor, enter the dilution volume for the release (2.3245E+09 liters/day * number of days) of which the release covers (minimum of 1).
11. At the cursor, enter the number of gallons to be released and depress the TAB key.
12. At the cursor, type 'ONOOB2F' to print to the 2nd floor OOB high speed printer. (You may print to any available high speed print location with a proper address code.)
13. At the cursor, enter a nuclide name (i.e., Cs-137), depress the TAB key and enter the nuclide concentration (N.NNE$\pm$NN) μCi/ml, and repeat for each nuclide present.
14. Verify data was entered correctly (you may TAB to an earlier location) and depress the ENTER key.
15. At the cursor, type 'E' and depress ENTER to exit the program (must be done twice).
16. Select the print and save log option.

Enclosure 6.6
Technical Basis for Caustic Addition Calculations
Sheet 1 of 3

Initial Addition Based on Pounds of Boric Acid:

The initial addition is based on the ability of one pound of caustic to neutralize 17 pounds of boric acid. This value was calculated using the methodology described in the Babcock & Wilcox Water Chemistry Manual (BAW-1385), Section 8 (1990 revision) and was confirmed by benchtop titration studies. Please reference Memo to File, dated 1-24-96, "Results of Caustic Titration Study", File #OS-715.00 for further details.

Subsequent Additions Based on Measured pH:

The basic assumption is that boric acid (H_3BO_3) behaves as a simple monoprotic acid versus the complex monoprotic acid that it is. Thus, it was assumed that when boric acid is placed in water only the H_2BO_3 borate ion is produced. Typically, boric acid in water will produce 3 to 4 different borate ions (Ref.: B&W or Westinghouse literature on boric acid). The equation will therefore read as follows:

$$H_3BO_3 \longleftrightarrow H^+ + H_2BO_3^-$$

where the acid dissociation constant (K_a) equation would be

$$K_a = \frac{\{H_2BO_3^-\}\{H^+\}}{\{H_3BO_3\}} \qquad \text{(Eqn. 1)}$$

The pH equations for the hydrogen and hydroxyl ion are as follows:

$$pH = -Log\{H^+\} \qquad \text{(Eqn. 2)}$$

$$10^{-14} = \{H^+\}\{OH^-\} \qquad \text{(Eqn. 3)}$$

For calculation simplification purposes, it is assumed that the only species contributing to the neutralization equation listed below are NaOH, H_3BO_3, and H_2O:

$$\{Na^+\} + \{H^+\} - \{OH^-\} - \{H_2BO_3^-\} = 0 \qquad \text{(Eqn. 4)}$$

By substituting Equations 1, 2, and 3 above into equation 4 and solving for the sodium ion concentration, the amount of caustic added to the reactor coolant water can be determined given the system pH. The equation would be:

$$\{Na^+\} = K_a\{H_3BO_3\}/(10^{-pH}) + 10^{14-pH} - 10^{-pH} \qquad \text{(Eqn. 5)}$$

Enclosure 6.6
Technical Basis for Caustic Addition Calculations
Sheet 2 of 3

Since it is desired to adjust the system pH to a point between 7.0 and 8.0, then the desired amount of sodium necessary to achieve a system pH of 7.5 can be determined by solving equation 5 above for a pH equal to 7.5. Therefore, subtracting the sodium concentration calculated at the actual system pH from the sodium concentration at the desired pH of 7.5 yields the amount of sodium necessary for pH adjustment.

At a pH of 7.0, the terms 10^{-pH} and 10^{14-pH} cancel each other. This leaves the following equation:

$$\{Na^+\} = (K_a'\{H_3BO_3\}/(10^{-pH'})) - (K_a\{H_3BO_3\}/(10^{-pH}) + 10^{pH-14} - 10^{-pH}) \qquad \text{(Eqn. 6)}$$

where " ' " represents the terms for when pH is 7.0.

Substituting A for the term $K_a'/(10^{-pH'})$ and B for K_a the above equation becomes,

$$\{Na^+\} = (A - B/(10^{-pH}))\ \{H_3BO_3\} - 10^{pH-14} + 10^{-pH} \qquad \text{(Eqn. 7)}$$

Next, using conversion factors and solving for sodium in terms of gallons of 35% NaOH to add, the equation becomes,

$$\text{35\% NaOH to Add (Gallons)} = ((A-B/(10^{-pH}))\text{ppm B} - 10^{pH-14} + 10^{-pH}) * V * 0.0829 \qquad \text{(Eqn. 8)}$$

where,

ppm B	=	boron concentration of reactor cooling water
V	=	volume of reactor cooling water to pH adjust, gallons
pH	=	pH of reactor cooling water after making initial caustic add
0.0829	=	conversion factor
A & B	=	coefficients for boric acid dissociation constants at 25° C.

Enclosure 6.6
Technical Basis for Caustic Addition Calculations
Sheet 3 of 3

The 0.0829 conversion factor came from the conversion of Na ion concentration to gallons of 35% NaOH. The number was reached by the following equations:

Gallons 35% NaOH	=	(moles Na / liters soln.) * (gals soln.) * (1 mole NaOH / 1 mole Na) 35% * (3.785 liters soln. / 1 gal soln.) * (40.01 gms NaOH / 1 mole NaOH) * (100 gms soln. / 35 gms NaOH) * (1 cubic centimeter / 1.38 gms) * (1 liter 35% naOH / 1000 cubic centimeters 35% NaOH) * (1 gal 35% NaOH / 3.785 liters 35% NaOH)
Gallons 35% NaOH	=	(moles Na / liters soln.) * (gals soln.) * 0.0829 (liter soln. * gal 35% NaOH) / (gal soln. * moles Na)

The initial guesses for the A and B coefficients were calculated from apparent monoprotic dissociation constants using a pH - specific conductivity computer program. The initial coefficients were $A = 9 \times 10^{-6}$ and $B = 3.09 \times 10^{-13}$. Laboratory data was then utilized to fine tune the coefficients. Titrations of various boron concentrations resulted in coefficients $A = 4.7 \times 10^{-6}$ and $B = 1.6 \times 10^{-13}$. Thus, the formula for calculating the quantity of caustic to add based on pH as shown in Enc. 6.3 is:

$$\text{35\% NaOH to Add} = ((4.7 \times 10^{-6} - 1.6 \times 10^{-13}/10^{-pH})\text{ppm B} - 10^{-pH} + 10^{pH-14}) * V * 0.0829 \qquad \text{(Eqn. 9)}$$

Reference: Memo to File, dated 5/29/89, "pH Adjustment of Reactor Coolant During a LOCA Using Sodium Hydroxide", File #OS-715.00.

Enclosure 6.7
Quarterly Inspection of Post Accident Equipment
Sheet 1 of 1

1. Caustic addition equipment stored in the brown cabinet in Warehouse #3:

Goggles
Corrosive suit
Boots
Tank to valve adapter
Face shield
Gloves
Stainless steel flex hose
Tape measure
Bung Wrench
Flashlight

2. Appendix 'R' sampling apparatus stationed in each units respective LPI room:

	UNITS		
	1 (RM-61)	**2 (RM-63)**	**3 (RM-82)**
Sample cooler	______	______	______
Ice container (30 gal. drum)	______	______	______
Glass thermometer	______	______	______
Plastic liter bottles (3)	______	______	______
Tygon tubing for cooler	______	______	______
Plastic sleeving for drum drain	______	______	______