VOID

CHEMISTRY CONTROL OF THE REACTOR COOLANT SYSTEM

VOID

1.0 PURPOSE

This procedure provides instructions for controlling the chemistry environment of the Reactor Coolant System (RCS).

2.0 DEFINITIONS

2.1 DOSE EQUIVALENT IODINE-131 (DEQ I-131)

Shall be that concentration of I-131 (microcurie/gram) which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134 and I-135 actually present. The thyroid dose conversion factors used for this calculation shall be those listed in Table E-7 of NRC Regulatory Guide 1.109 Revision 1, October 1977.

2.2 E-BAR ($\bar{E}$)

Average disintegration energy shall be the average (weighted in proportion to the concentration of each radionuclide in the sample) of the sum of the average beta and gamma energies per disintegration (MEV/D) for the radionuclides other than radioiodines, with half-lives greater than 14 minutes making up at least 95% of the total non-radioiodine activity in the sample.

2.3 ZEOLITES

Compounds of calcium, magnesium, aluminum and silica that, when incorporated into crud, can cause (1) a significant barrier to the heat transfer, and (2) densification of crud, with the potential for increased concentration of lithium hydroxide at the clad surface.

2.4 MODE

Operational modes refers to plant reactivity, thermal power and average coolant temperature conditions as stated in Table 1.2 of section 1 of the Technical Specifications.

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3.0 PRECAUTIONS AND LIMITATIONS

3.1 The following list of chemistry related Technical Specifications and Limiting Condition for Operation (LCO) apply to the Reactor Coolant System:

3.1.1 3/4.4.7 Chemistry

LCO 3.4.7 - The RCS chemistry shall be maintained within the limits specified below at all times.

Reactor Coolant System Chemistry Limits

Parameter	Steady State Limit	Transient Limit
Dissolved Oxygen*	≤ 0.10 ppm	≤ 1.00 ppm
Chloride	≤ 0.15 ppm	≤ 1.50 ppm
Fluoride	≤ 0.15 ppm	≤ 1.50 ppm

*Limit not applicable with Tavg less than or equal to 250°F.

Action:

1) Modes 1, 2, 3, and 4:

   a. With any one or more chemistry parameters in excess of its steady-state limit but within its transient limit, restore the parameter to within its steady-state limit within 24 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

   b. With any one or more chemistry parameters in excess of its transient limit, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

2) At All Other Times:

With the concentration of either chloride or fluoride in the RCS in excess of its steady-state limit for more than 24 hours or in excess of its transient limit reduce the pressurizer pressure to less than or equal to 500 psig, if applicable, and perform an engineering evaluation to determine the effects of the out-of-limit condition on the structural integrity of the RCS; determine that the RCS remains acceptable for continued operation prior to increasing the pressurizer pressure above 500 psig or prior to proceeding to Mode 4.

The sample and analysis frequency is at least once per 72 hours except dissolved oxygen when Tavg is ≤ 250°F.

3.1.2 3/4.4.8 Specific Activity

LCO 3.4.8 - The specific activity of the reactor coolant shall be limited to:

a. Less than or equal to 1 microcurie per gram DEQ I-131, and

b. Less than or equal to 100/$\bar{E}$ microcuries per gram of gross activity.

Applicability: Modes 1, 2, 3, 4 and 5

Action:

1) Modes 1, 2 and 3*:

a. With the specific activity of the reactor coolant greater than 1 microcurie per gram DEQ I-131 for more than 48 hours during one continuous time interval or exceeding the limit line shown on Figure 1, be in at least HOT STANDBY with Tavg less than 500°F within 6 hours and

*With Tavg greater than or equal to 500°F.

b. With the specific activity of the reactor coolant greater than 100/$\bar{E}$ microcuries per gram of gross radioactivity, be in at least HOT STANDBY with Tavg less than 500°F within 6 hours.

2) Modes 1, 3, 3, 4 and 5:

With the specific activity of the reactor coolant greater than 1 microcurie per gram DEO I-131 or greater than 100/$\bar{E}$ microcuries per gram of gross radioactivity, perform the sampling and analysis requirements stated below until the specific activity of the reactor coolant is restored to within its limits.

NOTE

Special reports to the commission may be required as a result of exceeding RCS specific activity limits, refer to procedure 30020-C "Chemistry Reports" and Tech Spec 6.8.1.2.h.

Reactor Coolant Specific Activity Sample and Analysis Program

Type of Measurement And Analysis	Sample and Analysis Frequency	Modes in Which Sample And Analysis Required
1. Gross Radioactivity Determination*	At least once per 72 hours	1, 2, 3, 4
2. Isotopic Analysis for DEQ I-131 concentration	Once per 14 days	1
3. Radiochemical for E Determination**	Once per 6 months***	1
4. Isotopic Analysis for Iodine including I-131, I-133, and I-135	a. Once per 4 hours whenever the specific activity exceeds 1 uCi/gram of DEQ I-131 or 100/E uCi/gram radioactivity and,	1#, 2#, 3#, 4#, 5#
	b. One sample between 2 and 6 hours following a thermal power change exceeding 15% of the rated thermal power within a 1 hour period	1, 2, 3

* A gross radioactivity analysis shall consist of the quantitative measurement of the total specific activity of the reactor coolant except for radionuclides with half-lives less than 14 minutes and all radioiodines. The total specific activity shall be the sum of the degassed beta-gamma activity and the total of all identified gaseous activities in the sample within 2 hours after the sample is taken and extrapolated back to when the sample was taken. Determination of the contributors to the gross specific activity shall be based upon those energy peaks identified with a 95% confidence level. The latest available data may be used for pure beta-emitting radionuclides.

** A Radiochemical analysis for Ē shall consist of the quantitative measurement of the specific activity for each radionuclide <u>except</u> for radionuclides with half-lives less than 14 minutes and all radioiodines, which are identified in the reactor coolant. The specific activities for these individual radionuclides shall be used in the determination of Ē for the reactor coolant sample. Determination of the contributors to Ē shall be based upon those energy peaks identifiable with a 95% confidence level.

*** Sample to be taken after a minimum of 2 EFPD and 20 days of POWER OPERATION have elapsed since reactor was last subcritical for 48 hours or longer

Until the specific activity of the RCS is restored within its limits.

3.1.3 3/4.9 <u>Refueling Operations</u>

3/4.9.1 <u>Boron Concentration</u>

LCO 3.9.1 - The boron concentration of all filled portions of the reactor coolant system and the refueling canal shall be maintained uniform and sufficient to ensure that the more restrictive of the following reactivity conditions is met; either:

a. A Keff of 0.95 or less, or

b. A boron concentration of greater than or equal to 2000 ppm.

<u>Applicability</u>: Mode 6

<u>Action</u>:

With the requirements of the above specification not satisfied, immediately suspend all operations involving CORE ALTERATIONS or positive reactivity changes and initiate and continue boration at greater than or equal to 30 gpm of a solution containing greater than or equal to 7000 ppm boron or its equivalent until Keff is reduced to less than or equal to 0.95 or the boron concentration is restored to greater than or equal to 2000 ppm, whichever is more restrictive.

<u>Surveillance Requirement</u>:

The boron concentration of the reactor coolant system and refueling canal shall be determined by chemical analysis at least once per 72 hours.

3.2 All liquid and gas associated with the RCS and its directly connected support systems is potentially radioactive and should be treated as such at all times. Ensure good health physics practices are exercised when handling liquid or gas associated with the primary systems.

3.3 The concept of time-distance-shielding should be followed to maintain dose as low as reasonably achievable (ALARA).

3.4 All reactor coolant contains some amount of dissolved radioactive gas. Handling of reactor coolant liquids should be done in a well ventilated area.

3.5 Sample vessels containing radioactive or potentially radioactive liquid should be tightly sealed and properly labeled at all times unless actually performing analyses.

3.6 When all analyses for a given sample are complete, any remaining sample, liquid or gas, should be properly disposed of as soon as possible. Do not leave unmarked or partially filled containers of liquid or gas in the lab hoods or sinks or on counter tops.

3.7 Evaporation or distillation of any radioactive liquid must be performed only in a laboratory fume hood.

3.8 Radioisotopic analysis, for radioactive liquid and gas samples, should normally be performed as soon as possible after sample collection to prevent the loss of short half-life isotopes due to decay.

NOTE

Certain samples may be held longer for decay of short lived isotopes in order to enhance detection of the longer lived isotopes.

3.9 If a significant discrepancy develops in chemistry parameters between the reactor coolant liquid and the pressurizer liquid samples,(eg., greater than 40 ppm boron difference) request that operations increase the pressurizer spray to equalize the parameters.

3.10 The pressurizer gas space is normally vented to the VCT through the steam space sample line. This relieves the "hard bubble" that causes RCS pressure control problems. Refer to Procedure 35515-C, "Operation Of The Nuclear Sampling System - Liquid" for additional instructions.

4.0 PROCEDURE

4.1 CHEMISTRY OBJECTIVES

4.1.1 Monitor the integrity of the fuel cladding.

4.1.2 Minimize crud production and activation thereby reducing the radiation exposure to personnel.

4.1.3 Maintain adequate controls through monitoring, analysis, and chemical conditioning to allow continued operation within the limits established by technical specifications and this procedure.

4.1.4 Monitoring of the chemical shim to assist operations in the reactivity control.

4.2 GENERAL SYSTEM DESCRIPTION

The reactor coolant system (RCS) consists of four similar heat transfer loops connected in parallel to the reactor pressure vessel. Each loop contains a reactor coolant pump, steam generator, and associated piping and valves. In addition, the system includes a pressurizer, pressurizer relief and safety valves, interconnecting piping, and instrumentation necessary for operational control. All of the above components are located in the containment building.

During operation, the RCS transfers the heat generated in the core to the steam generators, where steam is produced to drive the turbine-generator. Borated demineralized water is circulated in the RCS at a flowrate and temperature consistent with achieving the reactor core thermal-hydraulic performance. The water also acts as a neutron moderator and reflector and as a solvent for the neutron absorber used in chemical shim control.

The RCS pressure is controlled by the use of the pressurizer where water and steam are maintained at saturation conditions by electrical heaters and water sprays. Steam can be formed (by the heaters) or condensed (by the pressurizer spray) to minimize pressure variations due to contraction and expansion of the reactor coolant. Spring-loaded safety valves and power-operated relief valves connected to the pressurizer provide for steam discharge from the RCS. Discharged steam is piped to the pressurizer relief tank (pressurizer relief discharge system), where the steam is condensed and cooled by mixing with water.

Material of construction for the major components of the RCS are stainless steel and Inconel.

4.3 ACTION LEVELS

Three action levels have been defined in accordance with EPRI Primary Water Chemistry Guidelines for taking remedial action when monitored parameters are observed and confirmed to be outside normal operating values. Normal operating values are consistent with long term system reliability. Action Level 1 is implemented whenever an out of normal operating value is detected and confirmed. Action Level 2 is implemented when abnormal conditions indicate significant damage could be done to the system in the short term, thereby warranting a prompt correction of these conditions. Action Level 3 is implemented when conditions indicate that it is inadvisable to continue operation of the plant.

4.3.1 Action Level 1

If a parameter exceeds the Action Level 1 value return the parameter to within the Action Level 1 value within 7 days or go to Action Level 2 if the parameter has an Action Level 2 value.

4.3.2 Action Level 2

If a parameter exceeds the Action Level 2 value, return the parameter to within the Action Level 2 value within 24 hours. If the parameter has not been restored to within the Action Level 2 value within 24 hours, an orderly unit shutdown should be initiated and the plant should be brought to a cold shutdown condition as quickly as permitted by other plant constraints. If chemistry is improved to within the requirements of Action Level 2 prior to plant shutdown, full power operation may be resumed.

4.3.3 Action Level 3

If a parameter exceeds the Action level 3 value, an orderly unit shutdown should be initiated immediately, with reduction of coolant temperature to less than 250°F as rapidly as other plant constraints permit.

4.4 SAMPLE LOCATIONS

Samples of the RCS are obtained via the Primary Sample Panel grab sample points. Refer to Procedure 35515-C, "Operation Of The Nuclear Sampling System".

4.5 SAMPLE FREQUENCY

4.5.1 Routine samples are obtained at the frequencies specified in Procedure 30025-C, "Periodic Analysis Scheduling Program".

4.5.2 Non-routine samples are obtained at frequencies contained in guidelines in this procedure.

4.5.3 Technical Specification 3/4.4.8 requires sampling for DEQ-I 131 between 2 and 6 hours following a thermal power change exceeding 15% of rated thermal power within a 1 hour period. When notified of this power change by Operations Department, log the notifications, perform RCS DEQ-I 131 analysis and log appropriate DEQ-I 131 analysis information of Data Sheet . attached. Route to foremar for review.

4.5.4 Technical Specification 3/4.11.2 requires sampling of the RCS for DEQ-I 131 and monitoring of the noble gas plant vent monitor, (and under conditions of primary to secondary leakage, the condenser air ejector noble gas monitor,) for effluent activity following each startup, shutdown and greater than 15% thermal power change within a one hour period. When notified by Operations Department, log the notifications, perform required RCS DEQ-I 131 and log appropriate DEQ-I 131, plant vent noble gas monitor readings and condenser air ejector noble gas monitor readings (if applicable) on Data Sheet 5 attached.

NOTE

Use the ten minute average reading of one hour preceding the event as the pre-event value. Use the ten minute average reading taken when sampling the RCS for DEQ-I131 for the post-event value. Other ten minute averages may be used upon Lab Supervision approval.

4.5.5 To determine if the change in activity monitored by the gaseous monitors indicate a positive change above the statical deviation of the background (such as when PERMS monitor hourly average is reading at or near zero rather than a significant positive number). Perform the following calculation on Data Sheet 5.

$(\sqrt{Bcpm} \times 0.62)$ (Yuci/cc/cpm) = Z uci/cc

B = Current background subtract reading in cpm
Y = Current gain factor setting in uci/cc/cpm
Z = Level of activity which current reading must be above in uci/cc

4.5.5.1 If the pre-reading is less than the statistical deviation calculated in 4.5.5 above (Z), multiply the statistical deviation (Z) by 3 and compare to the post reading taken to determine if it is a factor of 3 greater.

4.5.5.2 If the pre-reading is above the statistical deviation calculated in 4.5.5 above, this actual reading is multiplied by a factor of 3 then compared to the post reading value taken to determine if the post reading is a factor of 3 greater.

4.6 SAMPLE DATA RECORDING

4.6.1 Log all analysis results on the appropriate attached Data Sheet in accordance with procedure 31045-C, "Chemistry Logkeeping, Filing And Records Storage".

4.6.2 If the lithium concentration falls outside of the control bands of Figure 7, take actions, as indicated on the figure, to ensure that the lithium concentration is returned to the appropriate concentration.

4.6.3 Immediately notify the Laboratory Foreman of any out of specification conditions. Immediately notify the Operations Shift Supervisor of confirmed technical specification violations.

4.7 CHEMISTRY CRITERIA

System chemistry parameters, specifications, and corrective actions are set forth in Table 1 through Table 10.

4.8 SYSTEM MONITORS

In-line radiation monitor, CVCS Letdown Monitor - RE-48000, is located downstream of the letdown heat exchanger providing indication of abnormal activity levels in the reactor coolant system.

4.9 DATA CORRELATIONS

4.9.1 Relation of pH And Conductivity

Based on physical chemistry fundamentals, a relation exists between the pH and conductivity of a pure solution of an acid or base. In particular, for a given pH, the conductivity must always be equal to or greater than the value indicated in Figure 2. In situations where the reported data (pH/conductivity) place a point within the "impossible region", the data evaluator can confidently state that one or both results are incorrect.

4.9.2 Relation of pH To Lithium And Boron Concentration

In the absence of significant concentrations of impurities in the primary coolant, a well-defined relation exists between the pH and conductivity and the lithium and boron concentrations. The dependence of pH on lithium and boron concentration at 25°C is shown in Figure 3 and Figure 4. Similar information for the conductivity and the lithium and boron relation is given in Figure 5 and Figure 6. Such information can be used to verify the consistency of the data. If pH or conductivity deviates from the indicated values in Figures 3, 4, 5 and 6, one of two conclusions can be reached.

a. One of the measured parameters is in error. Review of trend graphs for each parameter can sometimes give a rapid indication of which parameter is in error.

b. Presuming the analytical results are correct, an unidentified species is present in the primary coolant. For example, a neutral salt (NaCl) will increase solution conductivity, but the pH will remain in agreement with the expected value. A strong base (NaOH) or a weak base (NH_4OH) will increase the pH and conductivity compared to expected values. A strong acid (H_2SO_4) will increase conductivity and decrease the pH compared to expected values.

4.10 USEFUL INFORMATION AND FORMULAS

4.10.1 RCS Volume (Including Pressurizer)

Hot 61,346 gallons
Cold 93,222 gallons

NOTE

The above volumes are equivalent gallons of water at STP.

4.10.2 Purification Flow

Normal (gal/min) 75
Maximum (gal/min) 120

4.10.3 Formulas

a. Purification Half-Life (T1/2)

$$T_{1/2} = \frac{0.693}{Q} V$$

Where: Q = Letdown Rate
V = System Volume

b. Decontamination Factor (DF)

$$DF = \frac{\text{Initial Activity}}{\text{Final Activity}}$$

c. Infinite Dilution - assumes pure water for feed

$$CF = Ci \times e^{-}\left(\frac{QT}{V}\right)$$

Where: CF = Final concentration
Ci = Initial concentration
Q = Bleed & feed rate
T = Time elapsed
V = System volume

d. Volume of Bleed and Feed to Change Concentration

$$VF = VS \ln \frac{CF - Ci}{CF - Cf}$$

Where: VF = Volume of feed
VS = Volume of system
CF = Concentration of feed
Ci = Initial concentration
Cf = Final concentration

NOTE

If concentration of the feed is zero, this formula will not work, use Infinite Dilution formula above.

e. Theoretical RCS Hydrogen Concentration

Assumes VCT temperature between 100°F and 150°F. Formula incorporates conversion from mole fraction to cc/kg and includes Henry's Law Coefficient.

RCS H_2(cc/kg) = (1.13) (P_I)

Where:

P_I = Partial pressure of H_2 in the VCT in psia. For example if VCT is operating at 30 psig and 80% H_2.

P_I = (30 psig + 14.7 atmospheric) x (0.8)

P_I = 35.76 psia H_2

f. Lithium Removal, Calculations of Time to have CVCS Cation Bed in service

t = [V/Q ln Co/Ci] / 60

V = RCS volume (gallons).

Q = Letdown flowrate (gallons/minute)

C_o = Initial Li conc. (PPM).

Ci = Desired Li conc. (PPM).

t = time to place cation bed in service (hours).

g. Grams of Li-OH to Add.

$Li_{ADDITION}$ = 0.023 (ΔLi x V_{RCS})

Li = desired increase in Li (PPM)

V_{RCS} = RCS volume (gallons)

$Li_{ADDITION}$ = grams of Li-OH to Add.

4.11 CHEMICAL ADDITION

4.11.1 Chemical additions to the RCS are made using the Chemical Mixing Tank 1(2)-1208-T6-005 located on level A Elevation 195 of the Auxiliary Building.

4.11.2 Refer to Procedure 30006-C, "Laboratory Safety Manual", when handling chemicals for addition.

4.11.3 Notify Operations when chemical additions are to be made.

4.11.4 Request that operations isolate the Chemical Mixing Tank 1(2)-1208-T6-005.

4.11.5 When the Mixing Tank has been isolated open drain valve 1(2)-1208-U4-180 and vent valve 1(2)-1208-U4-179. Drain all water from the Chemical Mixing Tank.

4.11.6 Close drain valve 1(2)-1208-U4-180 and open fill valve 1(2)-1208-U4-178.

4.11.7 Slowly add chemicals through fill valve, 1(2)-1208-U4-178.

NOTE

The volume of the Chemical Mixing Tank is 5 gallons. Do not overfill.

4.11.8 Close fill valve 1(2)-1208-U4-178 and request that Operations vent the Chemical Mixing Tank.

4.11.9 Close the vent valve, 1(2)-1208-U4-179, and request that Operations open the isolation valves to the Chemical Mixing Tank 1(2)-1208-T6-005 to add the Chemicals to the RCS.

4.12 HIGH ACTIVITY IN THE REACTOR COOLANT SYSTEM

4.12.1 RCS activity limits are listed in Table 1 and Table 5.

4.12.2 Symptoms of high activity include:

4.12.2.1 Alarm on the CVCS Letdown Monitor (RE-48000)

4.12.2.2 Abnormal radiation levels at sampling stations.

4.12.2.3 Abnormal increase in any routine radiochemical analysis (i.e., greater than 25% increase in isotopic activity between equilibrium conditions).

4.12.3 Actions

4.12.3.1 Keep Operations informed of all activities and results so that required Technical Specification actions can be taken.

4.12.3.2 If the CVCS Letdown Monitor alarms, perform an isotopic analysis on the RCS to determine the validity of the alarm and to assist in core damage assessment. Draw sufficient samples to prevent unnecessary additional sampling.

4.12.3.3 If sample results are normal, check monitor operation, including local radiation levels.

4.12.3.4 If the first indication of high activity is discovered during routine analysis, determine the cause and inform Operations.

NOTE

Confirmation of the cause for high RCS activity is made by laboratory analysis.

4.12.3.5 If a fuel defect is suspected, perform:

a. Dose Equivalent Iodine

b. I-131/I-133 Ratio

NOTE

If the Iodine Ratio is approximately ten (10) times the normal ratio of 0.05-0.07, fuel defects are indicated.

4.12.3.6 If the Dose Equivalent Iodine is greater than 1.0 uCi/gm, perform surveillances in accordance with Technical Specifications 3/4.4.8. Refer to Step 3.1.2. of this procedure.

4.12.3.7 If high activity is determined to be from crud, check the following to determine the magnitude and source or cause of the problem.

a. VCT cover gas (type of gas and overpressure both correct?)

b. RCS chemistry (i.e., dissolved oxygen, chemical contaminants, lithium concentration, hydrogen concentration).

c. CVCS demineralizer exhaustion.

d. Recent chemical addition.

e. Review operating conditions, RCS pump starts, trips, thermal transients.

4.12.3.8 Corrective Actions

a. Plant action should be in accordance with the Technical Specifications.

b. Cleanup can be accomplished by increasing purification flow, changing the CVCS demineralizers, purging the VCT, and/or bleeding and feeding the RCS.

5.0 REFERENCES

5.1 Chemistry Criteria and Specifications - Westinghouse Electric Corporation

5.2 FSAR

5.2.1 Chapter 5.0

5.2.2 Chapter 9.0, Section 9.3.4

5.3 PWR Primary Water Chemistry Guidelines - EPRI NP-4762-SR, Sept. 1986.

5.4 P&ID's

5.4.1 1X4DB111 Reactor Coolant System

5.4.2 1X4DB112 Reactor Coolant System

5.4.3 1X4DB114 Chemical and Volume Control System

5.4.4 1X4D114-118 Chemical and Volume Control System

5.5 PROCEDURES

5.5.1 30025-C, "Periodic Analysis Scheduling Program"

5.5.2 31045-C, "Chemistry Logkeeping, Filing, Records Storage And Control And Implementation Of The Standing Order Book, Shift Turnover Log, Required Reading Book, And Laboratory Log Books"

5.5.3 34200-C, "Operation And Calibration Of Liquid Process Monitors"

5.5.4 35515-C, "Operation Of The Nuclear Sampling System"

END OF PROCEDURE TEXT

TABLE 1

SPECIFICATIONS FOR RCS SHUTDOWN/RHR
(MODES 3, 4, 5 and 6)

PARAMETER	SPECIFICATIONS	TRANSIENT LIMIT	CORRECTIVE ACTION
Chloride	≤ 0.150 ppm Action Level 1 - > 0.15 ppm	≤ 1.50 ppm	Increase letdown purification flow, verify makeup water quality, check CVCS mixed bed outlet quality, (see Step 3.1.1 for Tech Spec required action)
Fluoride	≤ 0.150 ppm Action Level 1 - > 0.15 ppm	≤ 1.50 ppm	Increase letdown purification flow, verify makeup water quality, check CVCS mixed bed outlet quality, (see Step 3.1.1 for Tech Spec required action)
Dissolved[1] Oxygen	≤ 0.100 ppm Tech Spec limits when Tavg is 250°F Limits do not apply if Tavg is 250°F	≤ 1.00 ppm	If Tavg ≤ 250°F add hydrazine to attain a concentration of 2 times the dissolved oxygen concentration. If Tavg > 250°F see Step 3.1.1 for Tech Spec required action.

NOTE [1] Control of dissolved oxygen must be achieved before the reactor coolant system temperature exceeds 180°F. Before exceeding 180°F dissolved oxygen must be less than 2 ppm with excess hydrazine present in the coolant. This condition is to be achieved with coolant in the RHR/RCS, all pressurizer spray lines open, and a nitrogen overpressure established in the Volume Control Tank. If dissolved oxygen is greater than 0.1 ppm a hydrazine residual of at least twice the dissolved oxygen concentration must be present in the coolant before heatup beyond 180°F. The CVCS ion exchange system should be valved out of service while hydrazine is being used for oxygen scavenging. If no dissolved oxygen is present in the RCS, no Hydrazine addition is necessary.

TABLE 1 (CONT'D.)

PARAMETER	SPECIFICATIONS	TRANSIENT LIMIT	CORRECTIVE ACTION
Boron [3]	Varies with plant condition and fuel burnup (Nominal 2000 ppm when system in refueling		
Lithium as Li^7	During heatup prior to exceeding 180°F, establish a lithium concentration (using Li^7 OH) that is coordinated with the amount of Boron present. (See Figure 7)		Low; add lithium-7 hydroxide. High; use appropriate CVCS demin bed
Gross Activity (Req'd in Modes 3,4)	$\leq 100/\bar{E}$ uci/gm		
Isotopic Iodine [2]	≤ 1 uci/gm and See Figure 1		

NOTE [2] Isotopic iodine required 2-6 hours following a thermal power change of 15% in 1 hr. period, (ie... A trip to Mode 3), and if gross activity is out of specification. Isotopic Iodines are required once per 4 hours in modes 3, 4 and 5 until gross activity returns to within limits.

NOTE [3] If Boron $\leq$ 300 ppm notify engineering to perform Tech Spec Surv. 4.1.1.3B per procedure 54009-C.

TABLE 2

GUIDELINES FOR RCS SHUTDOWN RHR (MODES 3,4,5 AND 6)

PARAMETER	SPECIFICATION	CORRECTIVE ACTION
pH at [illegible]	Variable, see Figure 3 or 4	Check Li, NH_3, and Dissolved Oxygen to determine cause. Add chemicals and/or use CVCS purification as necessary.
Conductivity at 25°C μmhos/cm	Variable, consistent with additives present, see Figure 5 or 6.	Check Li, NH_3, and Dissolved Oxygen to determine cause. Add chemicals and/or use CVCS purification as necessary.
Silica	≤ 0.100 ppm	Check CVCS mixed bed performance, check [illegible] water, check boric acid storage tanks, use new CVCS mixed [illegible] feed and bleed.
Suspended Solids	≤ 0.050 ppm	Check VCT cover gas for oxygen, Check RCS dissolved oxygen, Increase Letdown
Aluminum	≤ 0.080 ppm	Check makeup water quality increase purification letdown flow, feed and bleed as required.
Calcium + Magnesium	≤ 0.080 ppm	Check makeup water quality increase purification letdown flow, feed and bleed as required.
Magnesium	≤ 0.040 ppm	Check makeup water quality increase purification letdown flow, feed and bleed as required.
Sulfate	≤ 0.100 ppm	Check makeup water quality increase purification letdown flow, feed and bleed as required.

TABLE 3

SPECIFICATIONS FOR THE RCS DURING
NORMAL POWER OPERATION

PARAMETER	SPECIFICATIONS	TRANSIENT LIMIT	CORRECTIVE ACTION
Chloride	≤ 0.150 ppm Action level 2 - > 0.150 ppm Action Level 3 - > 1.50 ppm	≤ 1.50 ppm	Increase letdown purification flow, Verify makeup water quality, Check CVCS mixed bed outlet quality (see Step 3.1.1 for Tech Spec required action)
Fluoride	≤ 0.150 ppm Action level 2 - > 0 150 ppm Action Level 3 - > 1.50 ppm	≤ 1.50 ppm	Increase letdown purification flow, Verify makeup water quality, Check CVCS mixed bed outlet quality (see Step 3.1.1 for Tech Spec required action)
Dissolved Oxygen	≤ 0.100 ppm Action Level 2 - > 0.100 ppm Action Level 3 - > 1.0 ppm	≤ 1.00 ppm	Check VCT gas space for hydrogen concentration and overpressure. (See Step 3.1.1 for Tech Spec required action)
Boron [1]	Varies with plant conditions determined by reactor power, fuel burnup; Normal range 0-2000 ppm, at power < 1200 ppm		Controlled by Operations Department
Lithium as Li[7]	Coordinated with Boron, See Figure 7		With lithium concentration at or above the control value for Li/B coordinated curve, use CVCS demin bed to reduce Li concentration to lower control value. Lithium concentration below control value for Li/B coordinated curve add Lithium-7 hydroxide to upper control value.

NOTE [1] If Boron ≤ 300 ppm notify engineering to perform Tech Spec Surv. 4.1.1.3B per procedure 54009-C.

TABLE 3 (CONT'D.)

PARAMETER	SPECIFICATIONS	TRANSIENT LIMIT	CORRECTIVE ACTION
Dissolved Hydrogen	25-35 cc(STP)/ KgH_2O Action Level 1 - < 25 > 50 cc(STP)/ KgH_2O Action Level 2 - ≤ 15 cc(STP)/ KgH_2O Action Level 3 - ≤ 5 cc(STP)/ KgH_2O		Check that VCT overpressure > 15 psig. Check hydrogen concentration, increase or decrease overpressure as required; Low H_2 increase, High H_2 decrease; Purge if concentration of H_2 is low.
Dissolved Hydrogen	≤ 5 cc(STP)/ KgH_2O prior to opening the RCS		Increase letdown, purge VCT with nitrogen, purge pressurizer Steam Space to VCT thru NSSG.

TABLE 4

GUIDELINES FOR THE RCS DURING NORMAL POWER OPERATION

PARAMETER	SPECIFICATION	CORRECTIVE ACTION
pH at 25°C	See Figure 3 or 4	Check Li concentration; Check Dissolved Oxygen concentration; Add chemicals and/or use CVCS letdown purification as necessary.
Conductivity at 25°C umhos/cm	See Figure 5 or 6	
Silica	≤ 0.100 ppm	Check CVCS mixed bed performance; check boric acid storage tanks. Use new CVCS mixed bed or feed and bleed.
Suspended Solids	≤ 0.200 ppm	Check VCT cover gas for oxygen, Check RCS dissolved oxygen, Increase Letdown
Aluminum	≤ 0.050 ppm	Check makeup water quality, increase purification letdown flow, feed and bleed as required.
Calcium + Magnesium	≤ 0.050 ppm	Check makeup water quality, increase purification letdown flow, feed and bleed as required.
Magnesium	≤ 0.025 ppm	Check makeup water quality, increase purification letdown flow, feed and bleed as required.
Sulfate	≤ 0.100 ppm	Check makeup water quality, increase purification letdown flow, feed and bleed as required.

TABLE 5

RCS OPERATING RADIOCHEMISTRY SPECIFICATIONS

PARAMETER	TECH SPEC LIMIT	CORRECTIVE ACTION
Dose equivalent Iodine-131 (DEQ I-131) 1	≤ 1.0 microcurie per gram See Figure 1	See Step 3.1.2 for required action
Specific Activity (Performed as part of Gross Radioactivity Below) 1	See Below	See Step 3.1.2 for required action
Gross Radioactivity 1	≤ $100/\bar{E}$ microcuries/gram of gross radioactivity	See Step 3.1.2 for required action

1 Specific activity analysis (gamma spectroscopy sample count) normally encompasses both dose equivalent iodine -131 and gross activity analyses through the use of additional reports generated upon request of the gamma spectroscopy computer software.

TABLE 6

RCS OPERATING RADIOCHEMISTRY GUIDELINES

PARAMETER	VALUE
Iodine Ratio I-131/I-133	0.05-0.07 Nominal without fuel defects 0.5 - 0.7 Nominal fuel defects
RCS Crud Activity	[illegible]
Tritium	[illegible]
Hafnium - 181	Mo[illegible]

Note 1: Hafnium - 181 monitored as an indication of RCCA thinning or cracking per NRC IE Information Notice No. 87-19.

TABLE 7

PRESSURIZER LIQUID CHEMISTRY

PARAMETER	SPECIFICATION	CORRECTIVE ACTION
Chloride Fluoride Boron	Same as for the RCS	If a significant difference between the Pressurizer and RCS (eg. greater than 40 ppm boron) increase pressurizer spray to equalize the RCS and Pressurizer, then follow the corrective actions required per Table 3 and 4.

TABLE 8

PRESSURIZER VAPOR SPACE CHEMISTRY GUIDELINES

PARAMETER	NORMAL OPERATING SPECIFICATION	PRIOR TO OPENING SYSTEM	CORRECTIVE ACTION
Hydrogen	≥ 98%	≤ 4%	Purge to VCT 1
Oxygen	≤ 0.1%	≤ 0.1%	Purge to VCT 1
Nitrogen	≤ 2%	≥ 95%	Purge to VCT 1

1 Verify RCS dissolved hydrogen and dissolved oxygen are in specification. Verify with operators that correct type and pressure of cover gas is being supplied to the VCT.

TABLE 9

VCT VAPOR SPACE CHEMISTRY GUIDELINES

PARAMETER	SPECIFICATIONS	CORRECTIVE ACTION
Hydrogen Oxygen Nitrogen	Same as for Pressurizer Vapor Space	Increase/Decrease Hydrogen/ Nitrogen pressure as appropriate and purge to Gaseous Waste Management System

TABLE 10

CVCS DEMINERALIZER GUIDELINES

PARAMETER	SPECIFICATIONS	CORRECTIVE ACTION
Chloride DF	Monitor	If detectable on effluent immediately notify Laboratory Supervsion
Gross Activity DF	Monitor	If Low (DF < 2), verify no chemical contaminants in effluent, have Laboratory Supervision evaluate for possible replacement.

Log DF results as well as date resin loaded, date placed into service and date resin discharged in the remarks section of the RCS Logsheet, update information on the Laboratory Resin Bed Status Board.

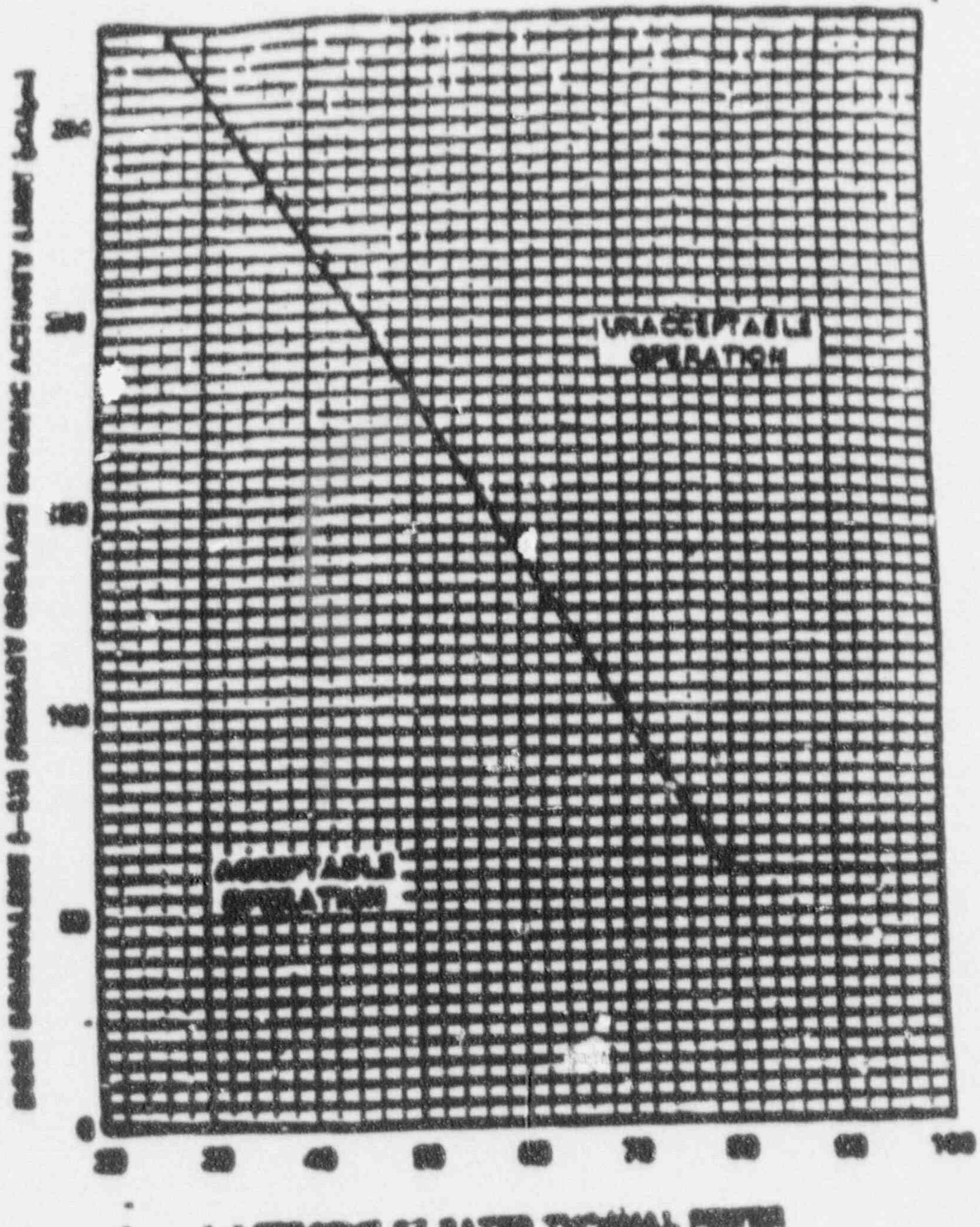


Figure 1
Dose Equivalent I-131 Reactor Coolant Specific Activity Limit Versus Percent of Rated Thermal Power with the Reactor Coolant Specific Activity 1.0 uCi/gram Dose Equivalent I-131

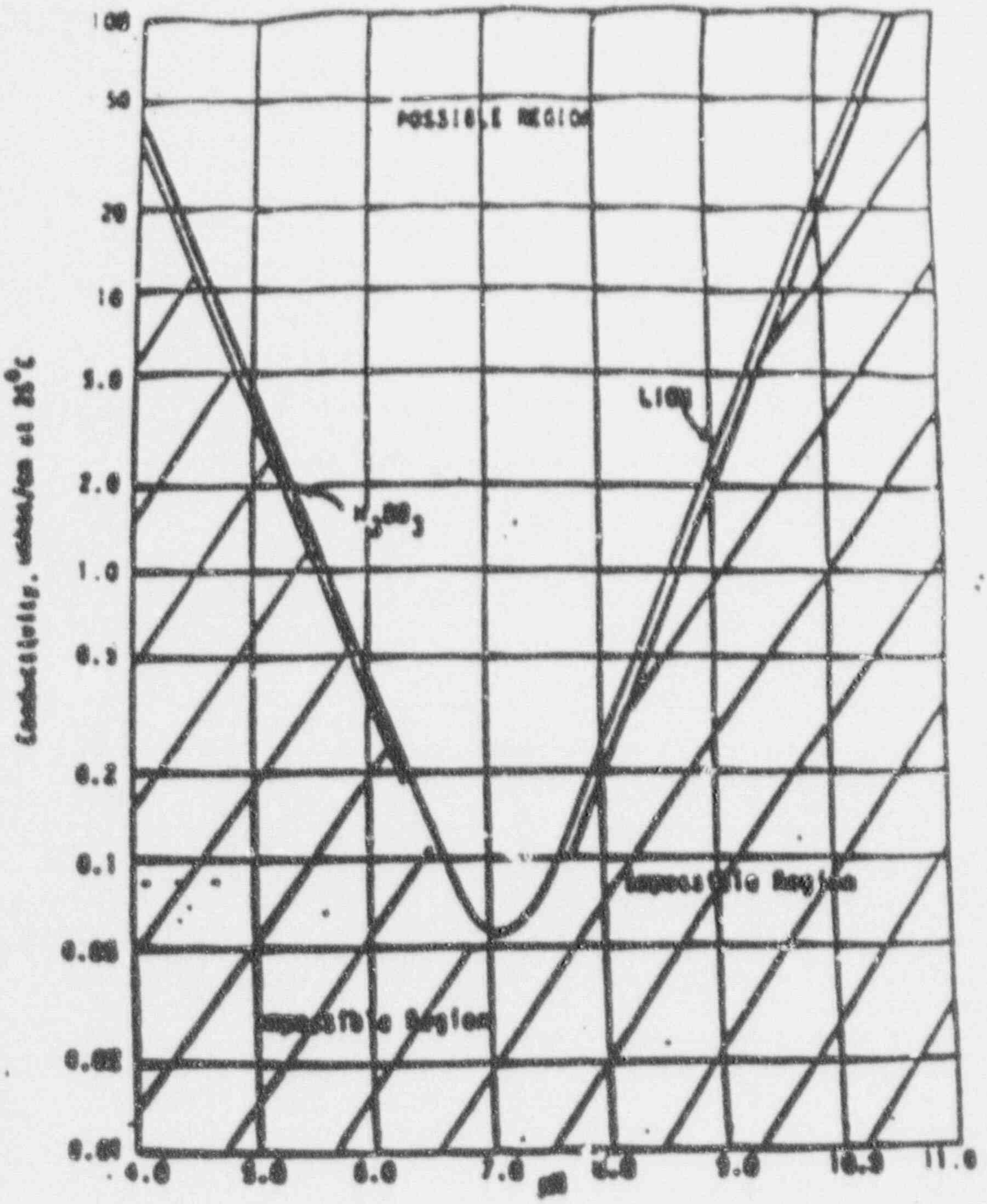


Figure 2
Restrictions Imposed by the Conductivity/pH Relation

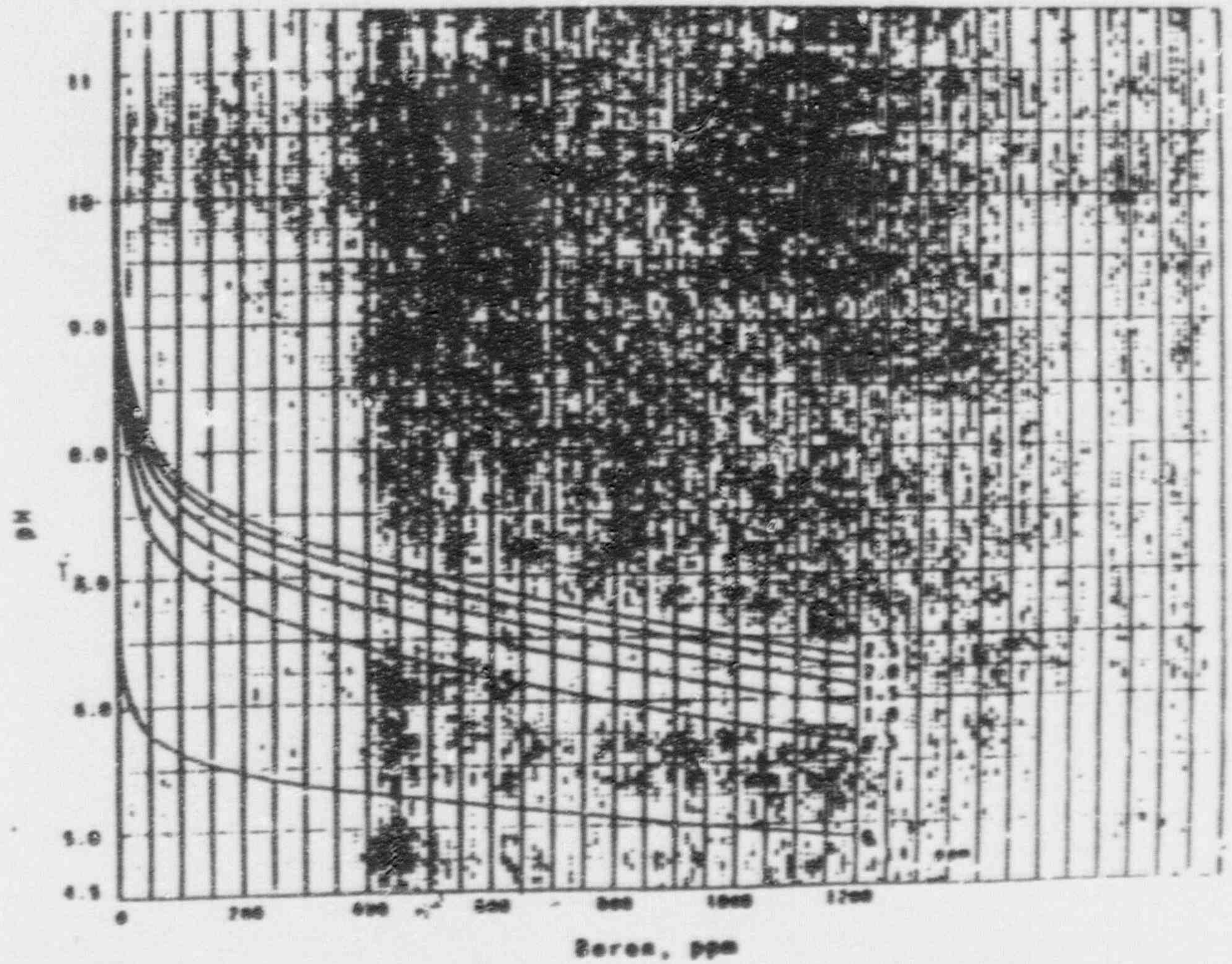


Figure 3 - pH of Lithium Hydroxide/Boric Acid Solutions at 25°C

LITHIUM CONCENTRATION, ppm

Boron	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0	7.00	9.54	9.84	10.01	10.14	10.23	10.31	10.38	10.43	10.48	10.53
50	5.78	7.12	7.42	7.60	7.72	7.82	7.91	7.97	8.04	8.09	8.14
100	5.63	6.88	7.11	7.29	7.41	7.51	7.59	7.66	7.72	7.77	7.81
150	5.54	6.63	6.93	7.10	7.23	7.32	7.40	7.47	7.53	7.58	7.63
200	5.47	6.50	6.79	6.97	7.09	7.19	7.27	7.34	7.39	7.44	7.49
300	5.37	6.30	6.60	6.77	6.39	6.99	7.07	7.13	7.19	7.24	7.29
400	5.29	6.15	6.44	6.62	6.74	6.84	6.91	6.98	7.64	7.09	7.13
500	5.23	6.02	6.31	6.48	6.61	6.70	6.78	6.85	6.91	6.96	7.00
600	5.17	5.91	6.20	6.37	6.49	6.59	6.67	6.73	6.29	6.84	6.89
700	5.12	5.80	6.09	6.26	6.38	6.48	6.56	6.62	6.68	6.73	6.78
800	5.07	5.71	5.99	6.16	6.28	6.38	6.46	6.52	6.58	6.63	6.68
900	5.02	5.62	5.90	6.07	6.19	6.29	6.36	6.43	6.49	6.54	6.58
1000	4.97	5.54	5.81	5.98	6.10	6.20	6.28	6.34	6.40	6.45	6.50
1100	4.93	5.46	5.73	5.90	6.02	6.11	6.19	6.26	6.32	6.37	6.41
1200	4.89	5.38	5.65	5.82	5.94	6.03	6.11	6.18	6.23	6.29	6.33
1300	4.85	5.32	5.58	5.74	5.86	5.96	6.04	6.10	6.16	6.21	6.25
1400	4.82	5.25	5.50	5.67	5.79	5.88	5.96	6.03	6.09	6.14	6.18
1500	4.78	5.19	5.44	5.60	5.72	5.82	5.89	5.96	6.02	6.07	6.11
1600	4.75	5.13	5.37	5.54	5.65	5.75	5.83	5.89	5.95	6.00	6.04
1700	4.72	5.08	5.31	5.47	5.59	5.68	5.76	5.83	5.88	5.93	5.98
1800	4.68	5.02	5.26	5.41	5.53	5.62	5.70	5.77	5.82	5.87	5.92
1900	4.65	4.98	5.20	5.36	5.47	5.57	5.64	5.71	5.76	5.81	5.8[illegible]
2000	4.63	4.93	5.15	5.30	5.42	5.51	5.59	5.65	5.72	5.76	5.80

Figure 4 - pH of Lithium Hydroxide/Boric Acid Solutions at 25°C

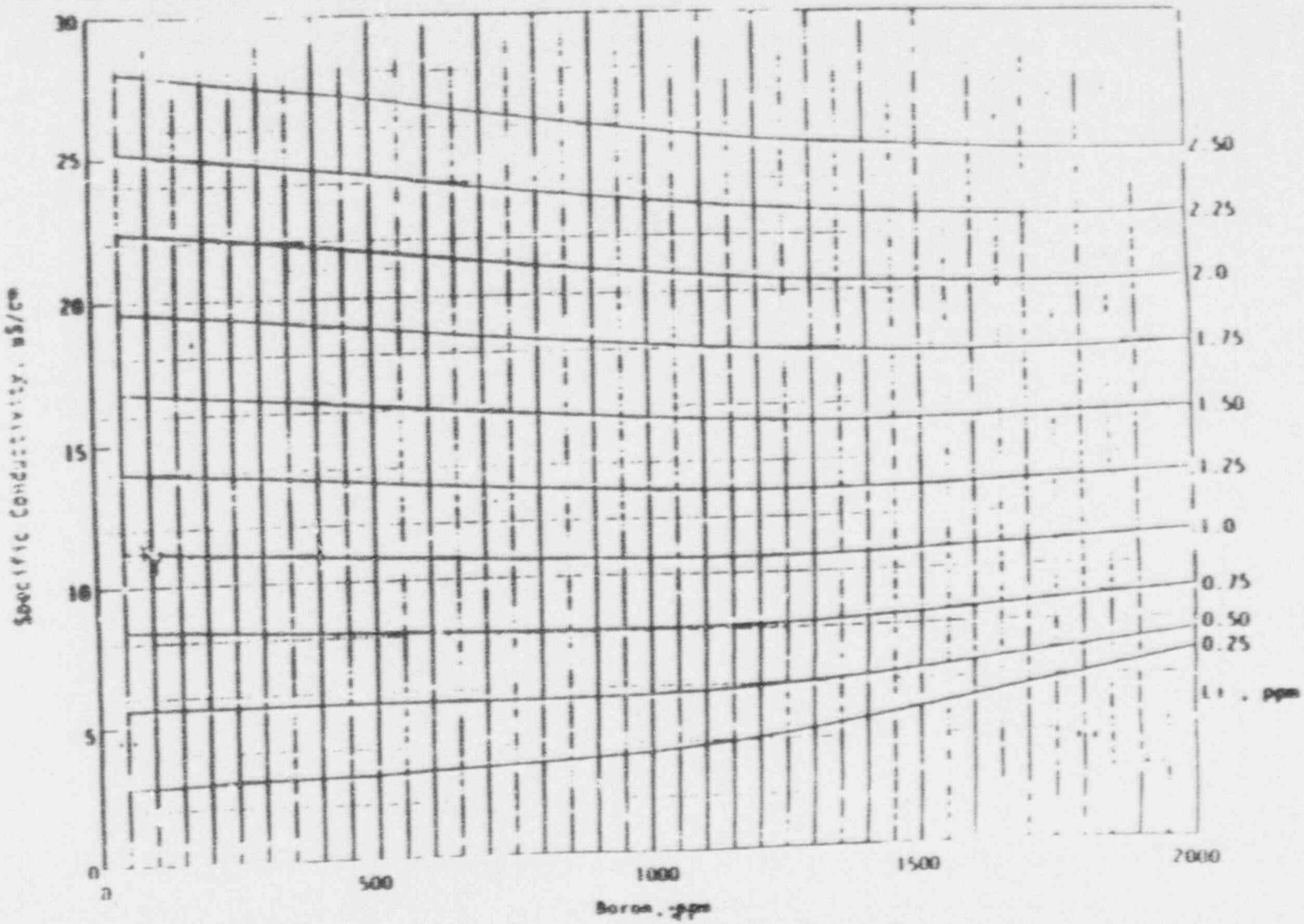


Figure 5
Specific Conductivity of Coordinated Li/B Solutions
as a Function of Boron Concentration at 25°C

LITHIUM CONCENTRATION, ppm

B, ppm	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0	.08	8.2	16.5	24.7	32.9	41.2	49.4	57.6	65.8	74.0	82.2
50	.64	2.8	5.6	8.4	11.2	14.0	16.8	19.6	22.4	25.2	28.0
100	.91	2.8	5.6	8.4	11.2	13.9	16.7	19.5	22.3	25.1	27.9
150	1.13	2.9	5.6	8.4	11.1	13.9	16.7	19.5	22.2	25.0	27.8
200	1.37	2.9	5.6	8.3	11.1	13.9	16.6	19.4	22.2	24.9	27.7
300	1.63	2.9	5.6	8.3	11.0	13.8	16.5	19.3	22.0	24.7	27.5
400	1.97	3.0	5.6	8.3	11.0	13.7	16.4	19.1	21.8	24.5	27.2
500	2.29	3.1	5.6	8.2	10.9	13.5	16.2	18.9	21.6	24.3	27.0
600	2.61	3.1	5.6	8.2	10.8	13.4	16.1	18.7	21.4	24.1	26.7
700	2.93	3.2	5.6	8.1	10.7	13.3	15.9	18.6	21.2	23.8	26.5
800	3.31	3.4	5.6	8.1	10.7	13.2	15.8	18.4	21.0	23.6	26.2
900	3.68	3.5	5.7	8.1	10.6	13.2	15.7	18.3	20.9	23.4	26.0
1000	4.07	3.7	5.7	8.1	10.6	13.1	15.6	18.2	20.7	23.3	25.8
1100	4.40	3.9	5.8	8.1	10.6	13.0	15.5	18.1	20.6	23.1	25.6
1200	4.91	4.1	5.9	8.2	10.6	13.0	15.5	18.0	20.5	23.0	25.5
1300	5.35	4.4	6.1	8.2	10.6	13.0	15.4	17.9	20.4	22.9	25.4
1400	5.82	4.7	6.2	8.3	10.6	13.0	15.4	17.9	20.3	22.8	25.3
1500	6.30	5.0	6.4	8.4	10.7	13.0	15.4	17.8	20.3	22.7	25.2
1600	6.81	5.3	6.6	8.5	10.8	13.1	15.4	17.8	20.3	22.7	25.1
1700	7.32	5.7	6.8	8.7	10.8	13.1	15.5	17.8	20.2	22.7	25.1
1800	7.86	6.1	7.0	8.9	11.0	13.2	15.5	17.9	20.2	22.6	25.0
1900	8.41	6.5	7.3	9.0	11.1	13.3	15.6	17.9	20.3	22.6	25.0
2000	8.98	6.9	7.6	9.2	11.2	13.4	15.6	18.0	20.3	22.7	25.0

Figure 6 - Specific Conductivity of Coordinated Li/B Solutions as a Function of Boron Concentration at 25°C

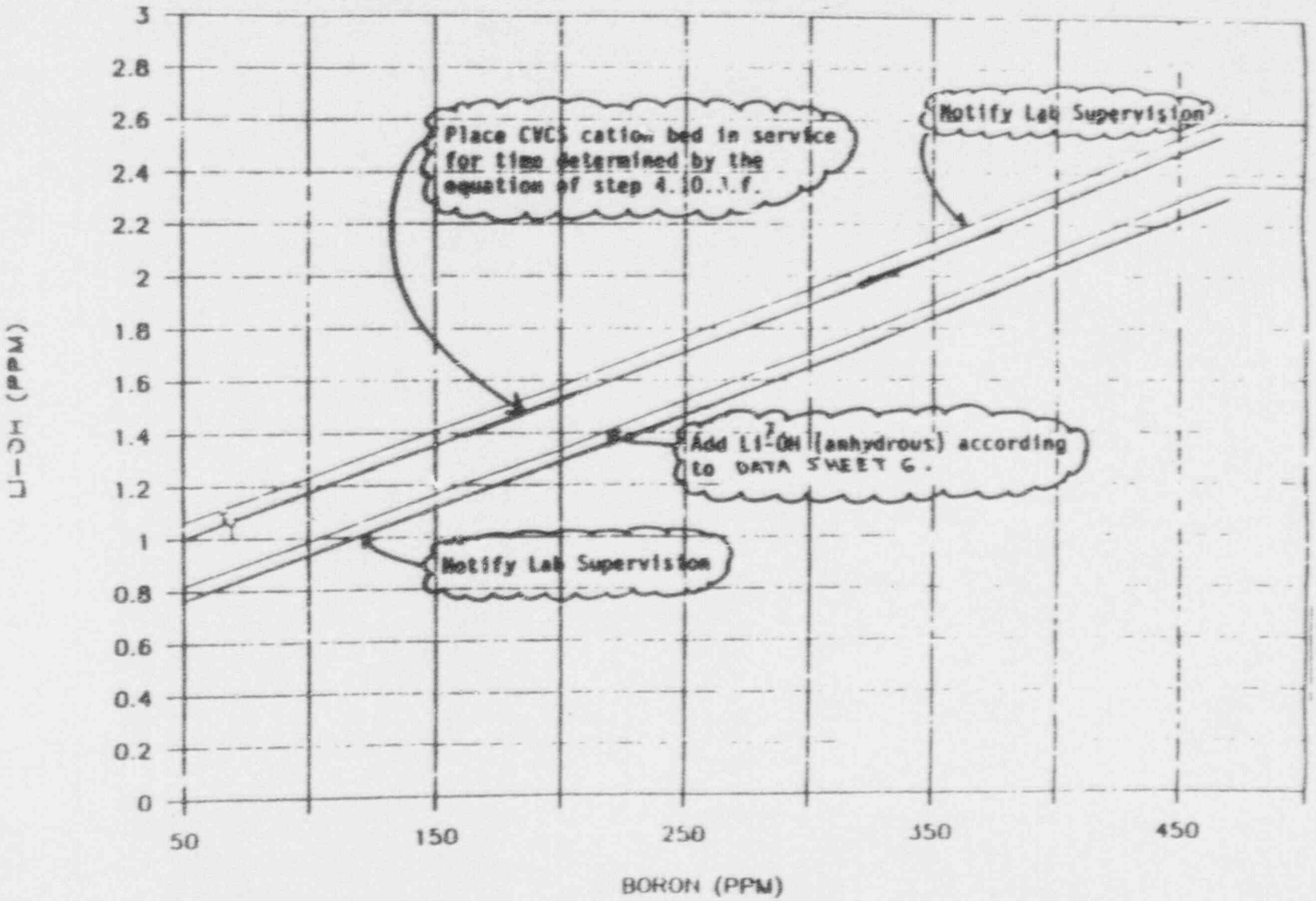


Figure 7
Lithium/Boron Coordination (0-500 BORON)

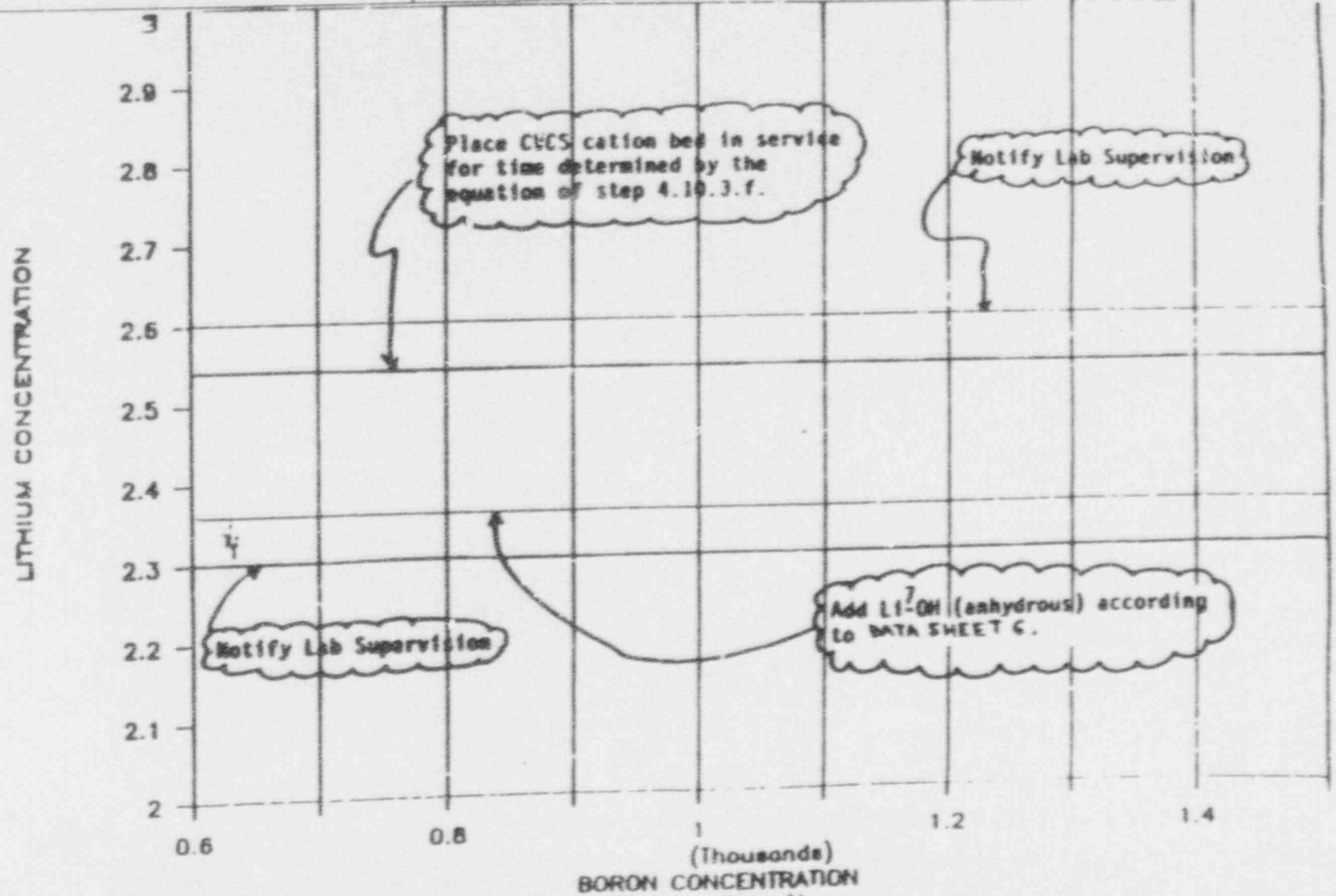
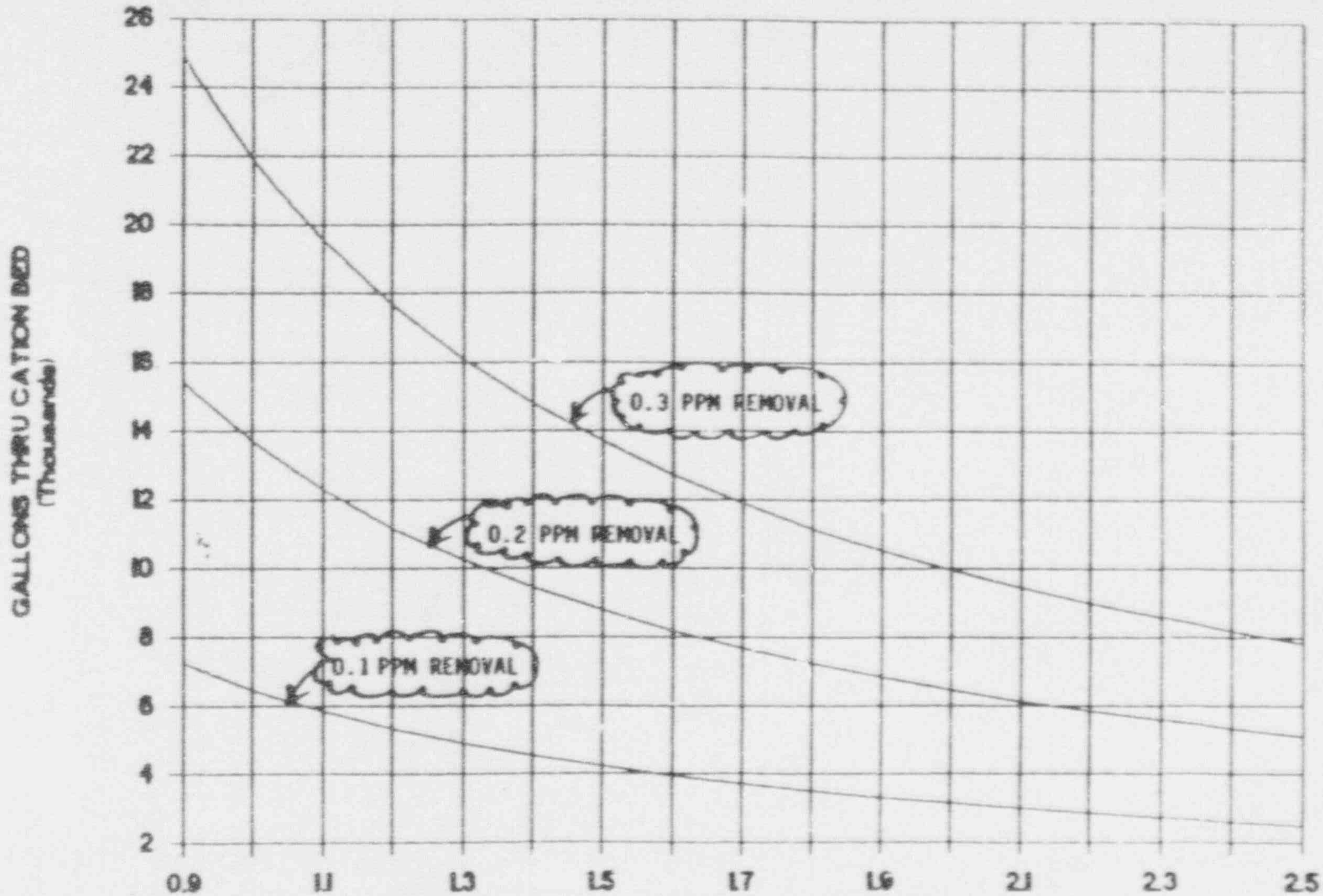


Figure 7 (continued)
Lithium/Boron Coordination (500-1(·0 ppm Boron)



LITHIUM CONCENTRATION (PPM)

FIGURE 8

DATA SHEET 1

PAGE 1 OF 1

MONTH ______

YEAR ______

— TOR COOLANT SYSTEM OPERATING

UNIT ______

LIMITS		%	VAR.	VAR.	T.S. ≤150 ppb	T.S. ≤150 ppb	T.S. ≤100 ppb	Fig. 7	VAR.	25-35 cc/kg	≤1000 ppb	≤50 ppb	≤50 ppb	≤25 ppb	≤0.200 ppm	≤100 ppb		
DATE	TIME	POWER LEVEL	p^H	COND	Cl^-	F^-	(1) O_2	Li	(3) BORON	H_2	SiO_2	Al	Ca + Mg	Mg	SUSP. SOLIDS	SULFATE	TECH. INIT.	FORMN. INIT.

LIMITS		T.S. ≤ 1.0 uCi/gm	T.S. ≤ 100/Ē uCi/gm	MONITOR	MONITOR	T.S. MONITOR	MONITOR			
DATE	TIME	DEQ I-131	(2) SPECIFIC ACTIVITY	I-131 / I-133	RCS CRUD ACTIVITY	GROSS ACTIVITY	TRITIUM	REMARKS	TECH. INIT.	FORMN. INIT.

(1) LIMIT DOES NOT APPLY IF RCS T AVG. IS LESS THAN OR EQUAL TO 250° F.
(2) SPECIFIC ACTIVITY DONE AS PART OF GROSS ACTIVITY ANALYSIS.
(3) IF BORON ≤ 300 PPM NOTIFY ENGINEERING TO PERFORM TECH SPEC SURV. 4.1.1.3.B per procedure 54009-C.

REVIEWED BY ______________ / ______
DATE

704610

DATA SHEET 2

PAGE 1 OF 1

MONTH ________

YEAR ________

RCS SHUTDOWN/RHR
(MODES 3, 4, 5 AND 6)

UNIT ________

DATE	TIME	p^H	COND	Cl^-	F^-	O_2 (1)	Li	BORON (4)	SiO_2	Al	Ca + Mg	Mg	SUSP. SOLIDS	GROSS Activity	DEQ I-131	SO_4	TOC	TECH. INIT.	FORMN. INIT.
LIMITS		VAR.	VAR.	T.S. ≤150 ppb	T.S. ≤150 ppb	T.S. ≤100 ppb	VAR.	VAR.	≤1000 ppb	≤80 ppb	≤80 ppb	≤40 ppb	≤0.35 ppm	T.S. (2)	T.S. (2)	≤100 ppb	≤20 ppb (3)		

(1) LIMIT DOES NOT APPLY IF RCS T AVG. IS LESS THAN OR EQUAL TO 250° F.

(2) Gross Activity req'd in modes 3&4, DEQ I-131 Req'd in mode 3, 2 to 6 hrs following a trip; once per 4 hrs In modes 3, 4 & 5 when DEQ I-131 1 uci/gm or Gross Activity exceeds 100/E.

(3) A total organic carbon analysis should be performed anytime the fuel transfer canal has been flooded with the reactor vessel head off. The analysis is to be performed prior to heat up above 180°F. Laboratory supervision is to be notified if result is above limits.

(4) If Boron ≤ 300 ppm, notify engineering to perform Tech Spec. Surv. 4.1.1.3.B per procedure 54009-C.

REVIEWED BY ________________ / ________
DATE

DATA SHEET 3

PAGE 1 OF 1

PRESSURIZER LIQUID CHEMISTRY

MONTH __________

YEAR __________

UNIT __________

LIMITS		T.S. ≤150 ppb	T.S. ≤150 ppb	VAR.	REMARKS		
DATE	TIME	Cl^-	F^-	BORON[1]		TECH. INIT.	FORMN. INIT.

REMARKS: ____________________

____

____

____

REVIEWED BY ____________________ / ______ DATE

1 If > 40 ppm difference between pressurizer and RCS Boron, notify Operations Departm_nt.

DATA SHEET 4

VCT VAPOR SPACE

PAGE 1 OF 1

MONTH ________

YEAR ________

UNIT ________

LIMITS		$\geq 98\%$	$\leq 0.1\%$	$\leq 2\%$	REMARKS		
DATE	TIME	H_2	O_2	N_2		TECH. INIT.	FORMN. INIT.

REMARKS: ________________________________

____

____

____

REVIEWED BY ________________ / ________
DATE

DATA SHEET 5

POWER CHANGE EVENT NOTIFICATION RESPONSE

A) TYPE OF EVENT
Startup ______ Shutdown ______ 15% Power Change/Hr _____

Time/Date Notified (Central) ________ ______
Time/Date Of Event (Central) ________ ______
Notified By (Print Name) ____________ ____________

B) DOSE EQUIVALENT IODINE (RCS)

Pre-event Value _________uci/cc Date/Time (Central)________

Post-event Value _________uci/cc Date/Time (Central)________

Pre-event/Post-event Ratio ≤ 3 ________ > 3__________
(check one)

C) PLANT VENT (Gaseous Monitor Reading)

Pre-event Value [1] [2] ___ ____uci/cc Date/Time (Central)_______

($\sqrt{\_\_}$ cpm X 0.62) (gain factor in uci/cc/cpm) = _____uci/cc

Post-event Value [1] [2] _________uci/cc Date/Time (Central)________

($\sqrt{\_\_}$ cpm X 0.62) (gain factor in uci/cc/cpm) = _____uci/cc

Pre-event/Post-event Ratio [1] [2] ≤ 3 _______ > 3__________
(check one)

D) CONDENSER AIR EJECTOR EXHAUST (Gaseous Monitor Reading)
(Required when secondary water is contaminated by primary water).

Pre-event Value [2] _______ __uci/cc Date/Time (Central)________

2 ($\sqrt{\_\_}$ cpm X 0.62) (gain factor in uci/cc/cpm) = _____uci/cc

Post-event Value _________uci/cc Date/Time (Central)________

2 ($\sqrt{\_\_}$ cpm X 0.62) (gain factor in uci/cc/cpm) = _____uci/cc

Pre-event/Post-event Ratio ≤ 3 ________ > 3_________
(check one)

1 12444-C values may be used if 12442-C is out-of-service, same monitor must be used for both readings.

2 Use ten minute averages (ensure background not being run during period used)

PERFORMED BY: ______________________________
DATE/TIME (Central)

REVIEWED BY: ______________________________
DATE/TIME (Central)

703445

DATA SHEET 6

CALCULATION FOR LITHIUM ADDITION

UNIT _____

A) DESIRED INCREASE IN LITHIUM CONCENTRATION (PPM)

1. Present lithium concentration, L_p = ________ ppm
2. Desired lithium concentration, L_d = ________ ppm

$\Delta L = L_p - L_d$ = (______) - (________) = ____________

B) RCS VOLUME (GALLONS)

V_{RCS} = 61,346 gallons : VOLUME HOT

or

V_{RCS} = 93,222 gallons : VOLUME COLD

C) GRAMS OF Li-OH TO ADD

$Li_{ADDITION}$ = 0.023 (ΔL * V_{RCS})

$Li_{ADDITION}$ = 0.023 (*) = ______________

$Li_{ADDITION}$ = Grams of Li-OH to add

L = Desired increase in lithium concentration (ppm) as calculated in Section A

V_{RCS} = Volume of RCS as determined in Section B

Technician : ____________ / ________ / ________
Date Time

Independent Verification: ____________ / ________ / ________
Date Time

Foreman: ____________ / ________ / ________
Date Time