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CRYSTAL RIVER UNIT 3

PLANT OPERATING MANUAL

EMERGENCY PLAN IMPLEMENTING PROCEDURE

EM-225B

POST-ACCIDENT BORON CONCENTRATION MANAGEMENT

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to provide methodology for determining when post LOCA boron precipitation mitigation is required.

2.0 REFERENCES

2.1 Developmental References

FPC Calculation M97-0120 – Sump Suction Valve Open Area

FPC Calculation M97-0122 – DH Dropline Backflow for Boron Dilution

FPC Calculation M97-0097 – Auxiliary Pressurizer Spray Flow Rate

FTI Letter IRS-97-4045 dated 10/10/97 Subject: Required APS Flow

FTI Letter IRS-97-4220 dated 10/29/97 Subject: DH Drop Line Backflow RELAP Sensitivity Evaluation

NOE 97-1628, Instrument Uncertainty Analysis for Boronometer (CA-56-CI)

NOE 97-2696, Engineering Evaluation: Incore Temperature Uncertainty

FPC Calculation M97-0138, "Temperature/Time Response for the Auxiliary Spray Line During Boron Precipitation Mitigation"

FPC Calculation M97-0139, "Temperature/Time Response for the DH Dropline with Gravity Flow Initiated for Born Precipitation"

FPC Calculation M97-0098, Boron Dilution by Hot-Leg Injection

FPC Calculation M97-0119, Post-LOCA Boron Concentration Management

FPC Calculation S96-0134, Fluid Velocity Analysis for RB Sump Screens

FPC Calculation M97-0146, Post-LOCA Boron Concentration Management for CR-3

3.0 PERSONNEL INDOCTRINATION

3.1 Definitions

- **Auxiliary Pressurizer Spray (APS)** - A boron precipitation mitigation method that diverts a portion of LPI flow to the pressurizer spray nozzle. Providing flow to the pressurizer builds a height of water in the core region. When an adequate height of water is developed, reverse flow through the core is initiated. This method is only effective if spray flow exceeds core boil-off and is started early enough to allow a liquid level to be established prior to reaching actual core solubility limits.

- **Delta Boron** - The difference between Expected RB Sump Concentration and actual measured RB sump boron concentration (boronometer, grab sample) after ECCS suction transfer.

- **Dump To Sump (DTS)**- A boron precipitation mitigation method that aligns the DH drop-line to the RB sump through an idle LPI train. This alignment redirects the ECCS injection being lost though a break in the RCS cold leg through the core region. This redirection occurs because the DH drop-line connects to the hot leg at an elevation lower than the RCS cold leg piping.

- **Expected RB Sump Concentration ($Sump_{EXP}$)** - A calculated value of RB sump boron concentration assuming even mixing of the RCS, CFTs, and BWST located in the RB sump.

3.2 Responsibilities

The TSC Accident Assessment Team is responsible for monitoring plant conditions and determining when boron precipitation mitigation is required.

3.3 Limits And Precautions

- APS is the preferred method of boron precipitation mitigation, and should be used if acceptable plant conditions exist. This preference is due to the significant adverse impact on ECCS performance if DTS is improperly implemented, and the need to stop a train of ECCS to perform the DTS alignment.

- If required for A Train APS effectiveness DHV-5 may be closed provided HPI has been established.

- Grab samples should be taken from the recirculating fluid to assure correct boronometer performance, if dose limitations allow.

- Sump sampling should continue to be used after initiation of an active method to assure the boron concentration control mechanism is working effectively.

- The following must be used for T_{incore} measurements:

  - "T_{incore} Average Temp" on SPDS alpha page with input from at least (2) incore thermocouples.

  - The average of at least 2 incore thermocouples displayed on a chesel recorder (If all inputs are operable the average point may be used).

- The "Delta Boron Limit" as shown on Enclosure 5, includes a 25% factor of safety, and shall be used when the core has been in a saturated condition for greater than five (5) hours.

- Boron precipitation can not occur if adequate SCM exists.

- Stopping an RB Spray Pump could cause RB pressure to increase.

4.0 INSTRUCTIONS

4.1 Emergency Repair Team Maintenance

4.1.1 IF ES MCC 3AB can NOT be energized,
THEN coordinate performance of Enclosure 7 in this procedure.

4.2 Boron Precipitation Mitigation Determination

4.2.1 IF adequate SCM exists,
THEN Exit this procedure.

4.2.2 WHEN ECCS suction transfer has been completed,
THEN calculate Expected RB Sump Concentration ($Sump_{EXP}$) using Enclosure 1 in this procedure.

4.2.3 Request the OSC Chemistry Coordinator to have RB sump boron concentration determined on a 2 hour interval.

4.2.4 IF at any time RB sump sample results are received,
THEN calculate Delta Boron ($Sump_{EXP}$ - Measured Sump Boron Concentration).

4.2.5 IF the RB sump can be sampled,
THEN perform Enclosure 2 of this procedure.

4.2.6 IF RB sump can NOT be sampled,
THEN perform Enclosure 3 of this procedure.

4.3 Boron Precipitation Mitigation Prerequisites

4.3.1 IF LPI crosstie is in progress,
THEN prior to directing performance of EOP-14, Enclosure 20, establish HPI piggyback using EM-225E, Guidelines for Long Term Cooling.

4.3.2 IF an HPI pump will be started using EOP-14, Enclosure 20,
THEN ensure HPI flow is controlled within the limits of EM-225E.

4.4 Boron Precipitation Mitigation Initiation

4.4.1 IF APS will be directed,
THEN consider the following regarding use and effectiveness:

- APS should cause Delta Boron to decrease in ≤ 12 hours after initiation.
- Indications of APS flow:
  - Monitor APS line thermocouple indicated on AH-1003-TIR (DH-61-TE) for early indications of flow. The APS line thermocouple should be ≈ DHHE outlet temperature in ≤ 1 minute.
  - Continued RB sump sampling, in the longer term, will provide positive verification of successful mitigation.

4.4.2 IF DTS will be directed,
THEN consider the following regarding use and effectiveness:

- DTS should cause Delta Boron to decrease in ≤ 10 hours after initiation.
- Indications of DH drop-line flow:
  - Monitor DH drop-line thermocouple indicated on AH-1003-TIR (DH-60-TE) for early indications drop-line flow.
  - Continued RB sump sampling, in the longer term, will provide positive verification of successful mitigation.
- Adequate flow in the drop line can be inferred if any of the following exist:
  - IF the difference between initial T_{incore} and average RB temperature is ≤ 40° F,
    THEN T_{incore} should be 90% of average RB temperature within 13 minutes.
  - IF the difference between initial T_{incore} and average RB temperature is > 40° F,
    THEN T_{incore} should be 90% of average RB temperature within 26 minutes.

4.4.3 WHEN boron precipitation mitigation is required,
THEN direct the Control Room to perform the appropriate alignment using EOP-14, Enclosure 20

4.4.4 IF all the following exist:

___ APS has been directed as the boron precipitation mitigation method

___ A Train LPI is providing APS flow

___ APS was aligned using EOP-14, Enclosure 20

___ T_{incore} plots on Enclosure 4 indicate DHV-5 must be closed for APS effectiveness

THEN direct the Control Room to close DHV-5

5.0 FOLLOW-UP ACTIONS

- Continue RB sump monitoring and plotting of Delta Boron.

CALCULATION OF EXPECTED RB SUMP CONCENTRATION

1. Obtain the following data:

   Pre-LOCA BWST Boron Concentration (C_{BWST}) _____ ppmb

   Pre-LOCA RCS Boron Concentration (C_{RCS}) _____ ppmb

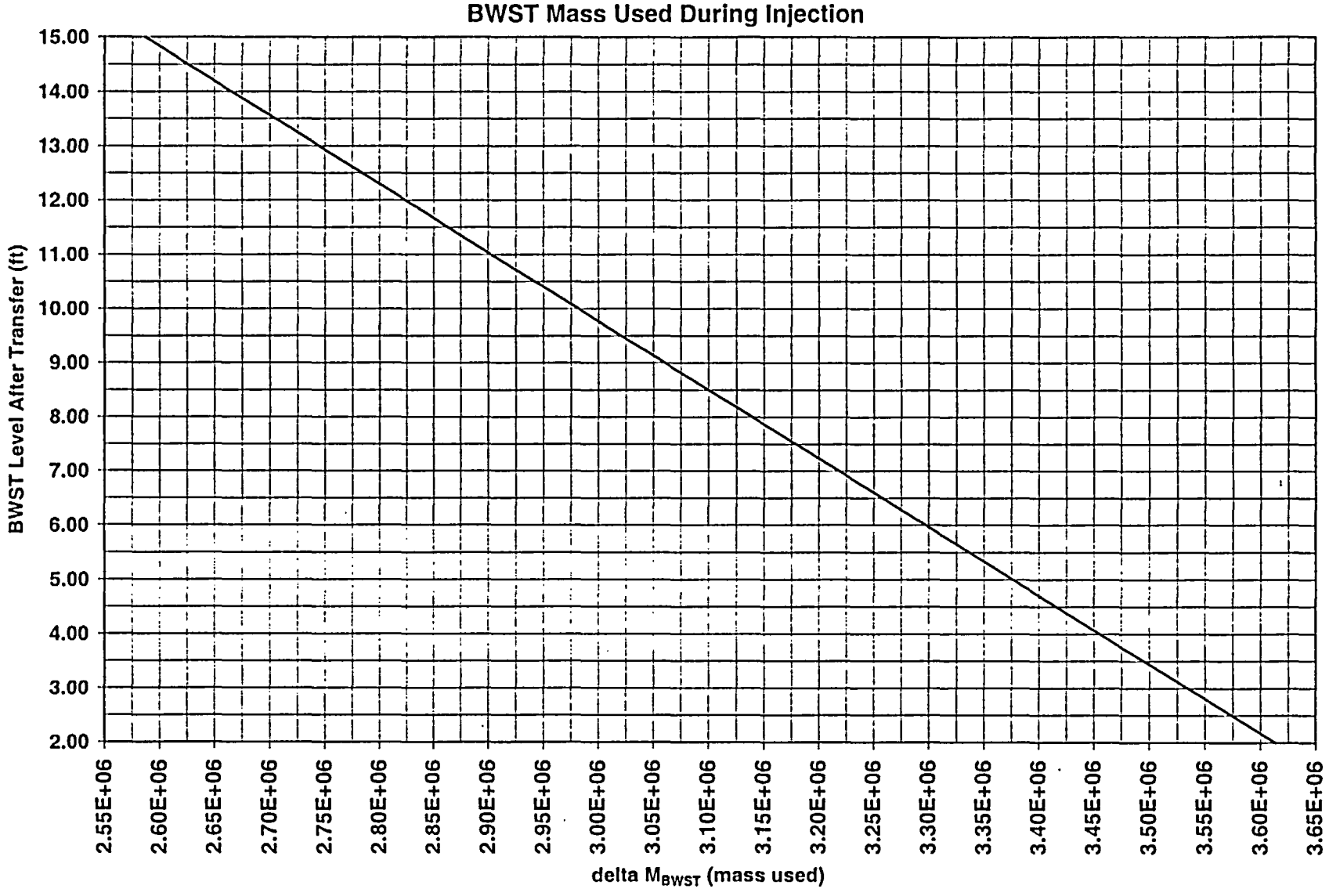
2. Determine ΔM_{BWST} using Page 2 of this Enclosure _____

3. Calculate Expected RB Sump Concentration ($Sump_{EXP}$):

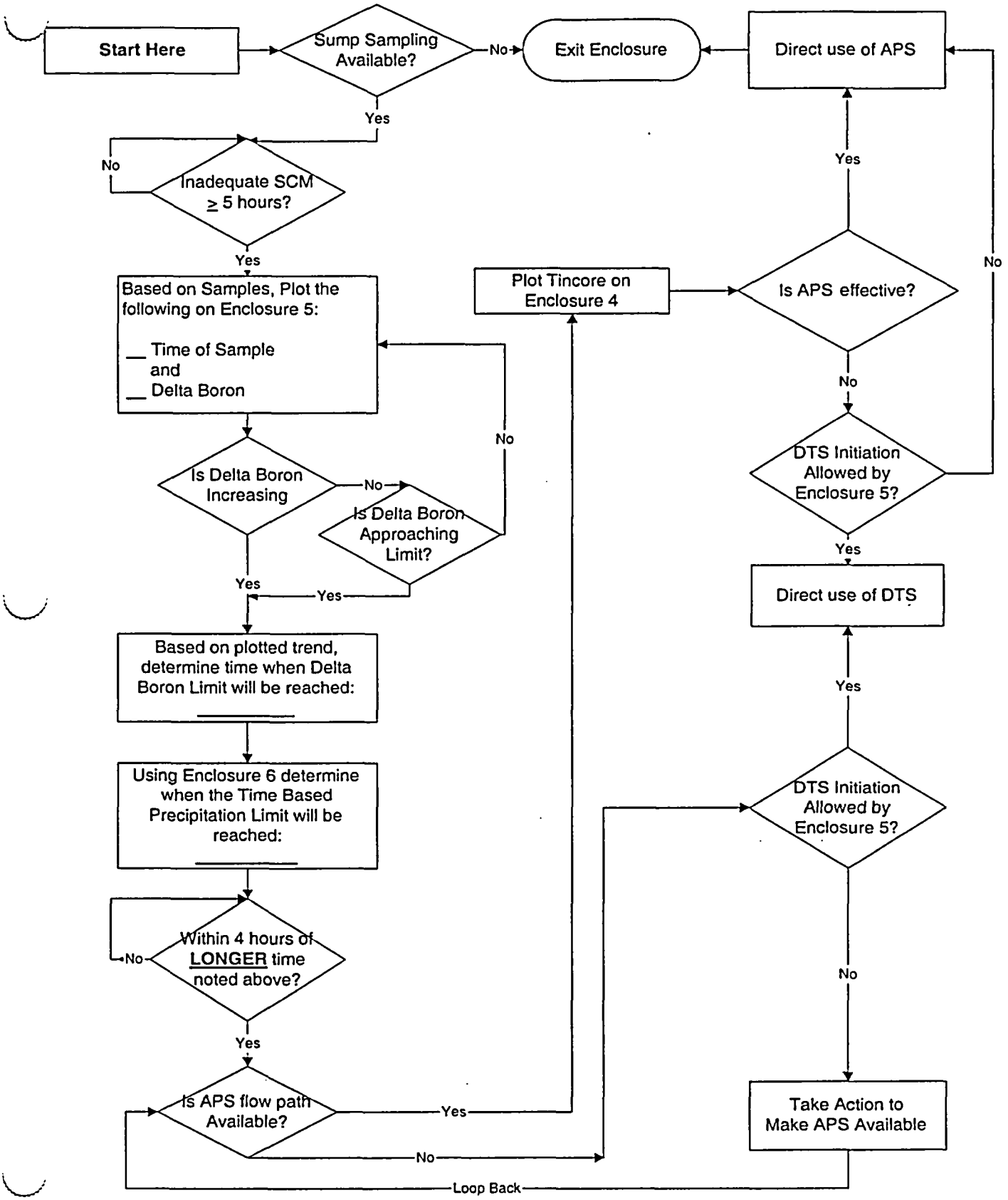
$$Sump_{EXP} = \frac{(\Delta M_{BWST} * C_{BWST}) + (M_{CFTS} * C_{CFTS}) + (M_{RCS} * C_{RCS})}{\Delta M_{BWST} + M_{CFTS} + M_{RCS}}$$

$$\_\_\_\_\_ = \frac{(\quad * \quad) + (4.7\ E^8) + (5.1\ E^5 * \quad)}{(\quad) + (1.3\ E^5) + (5.1\ E^5)}$$

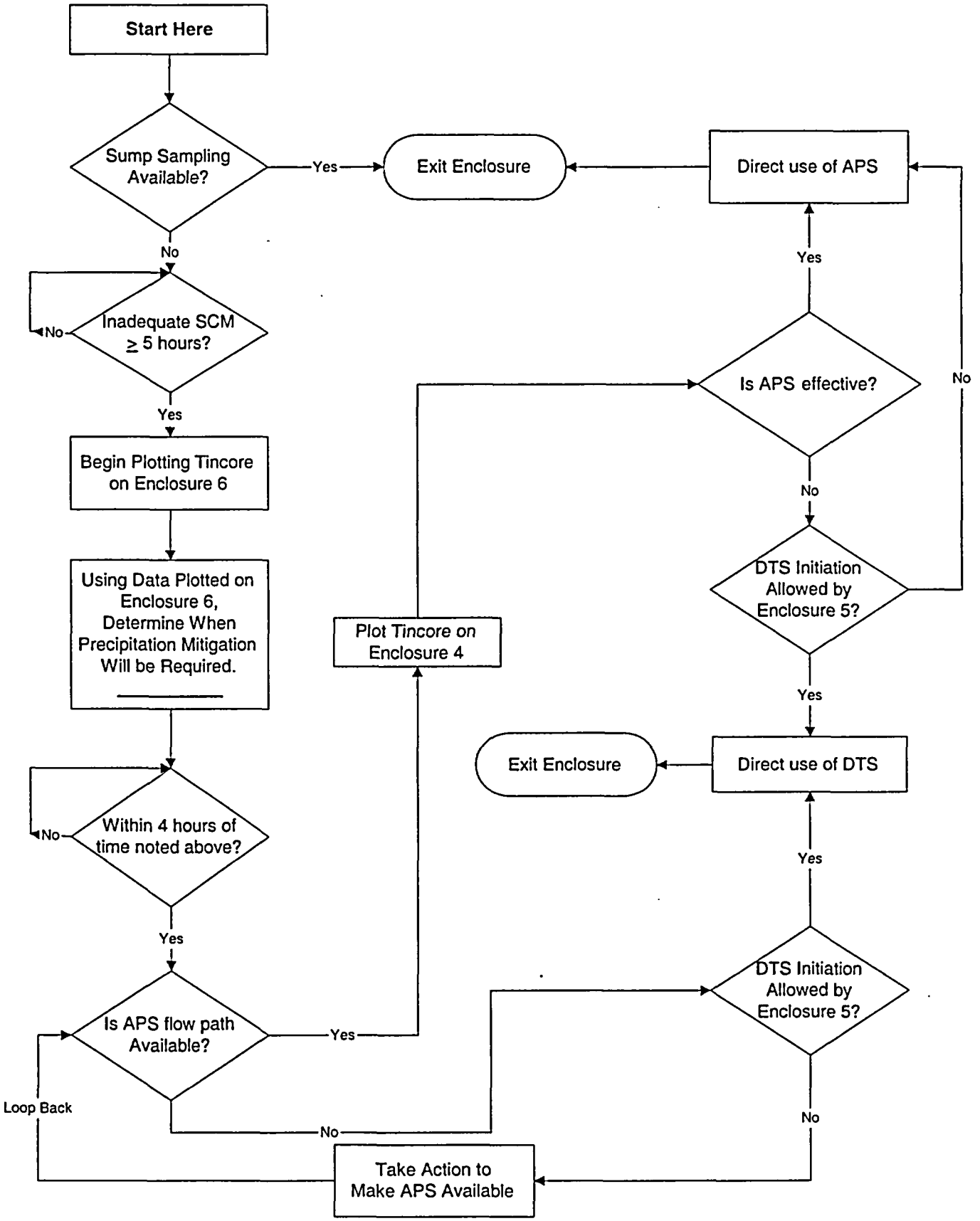
CALCULATION OF EXPECTED RB SUMP CONCENTRATION (Cont'd)

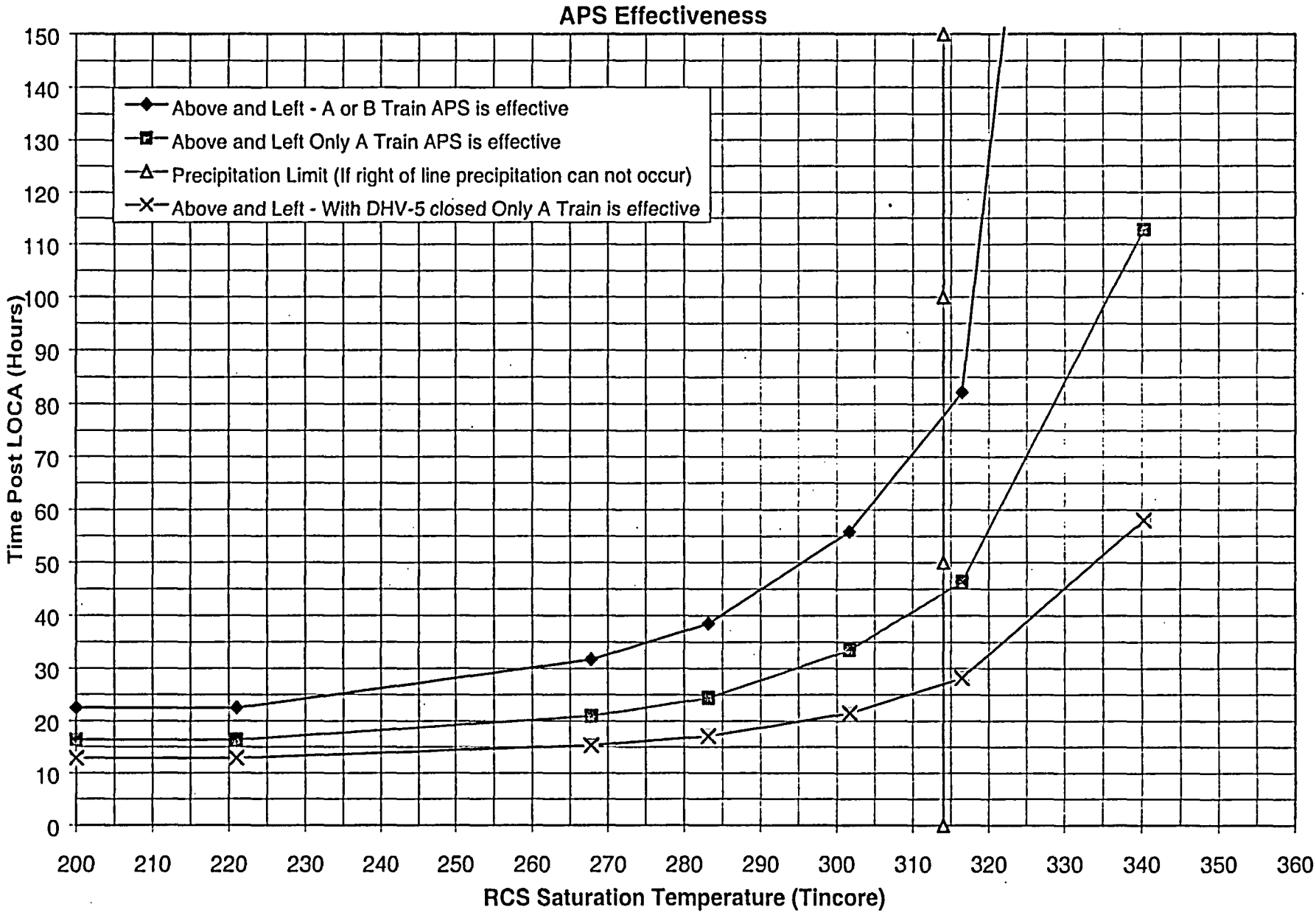


MITIGATION MATRIX WITH RB SUMP SAMPLING

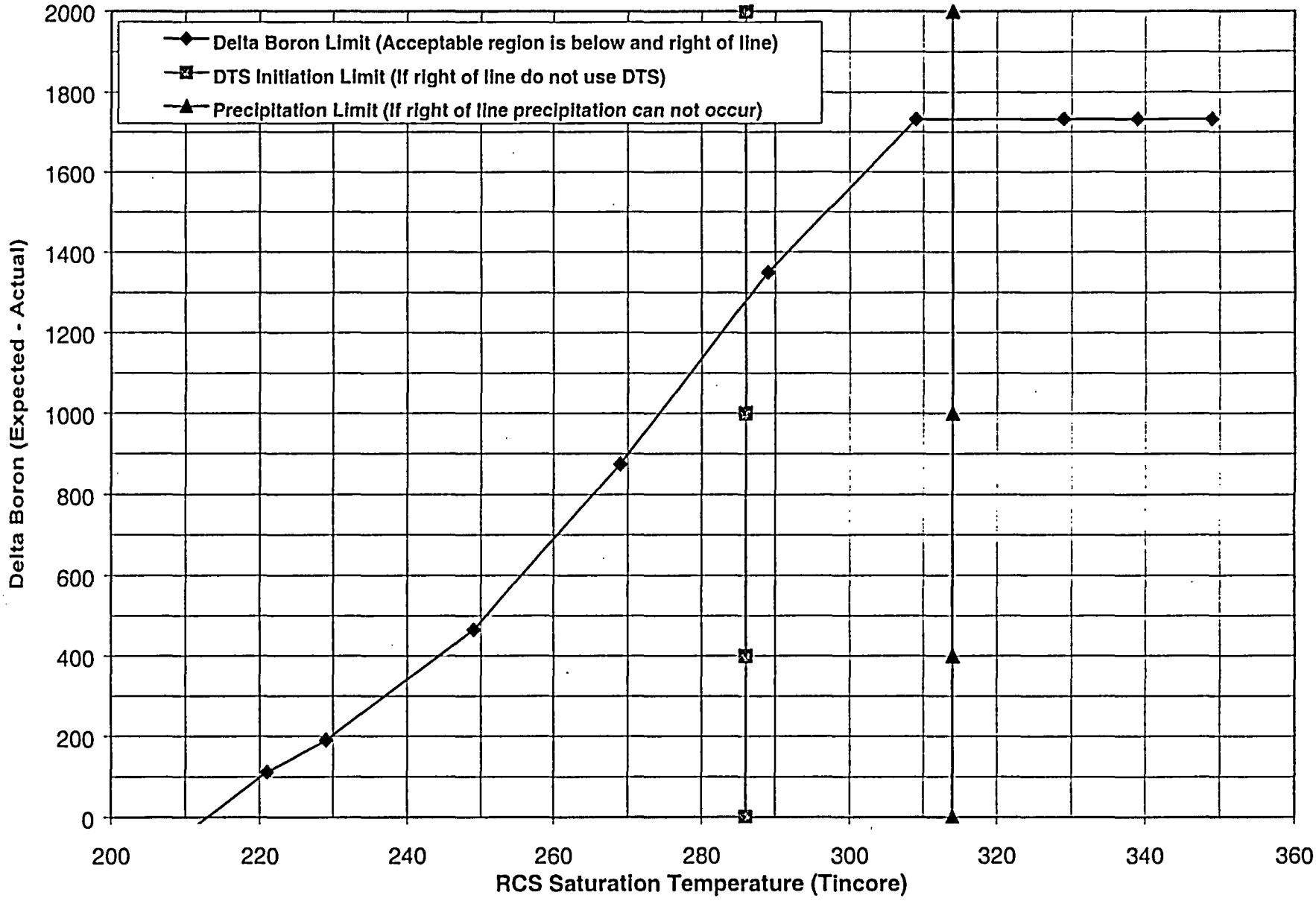


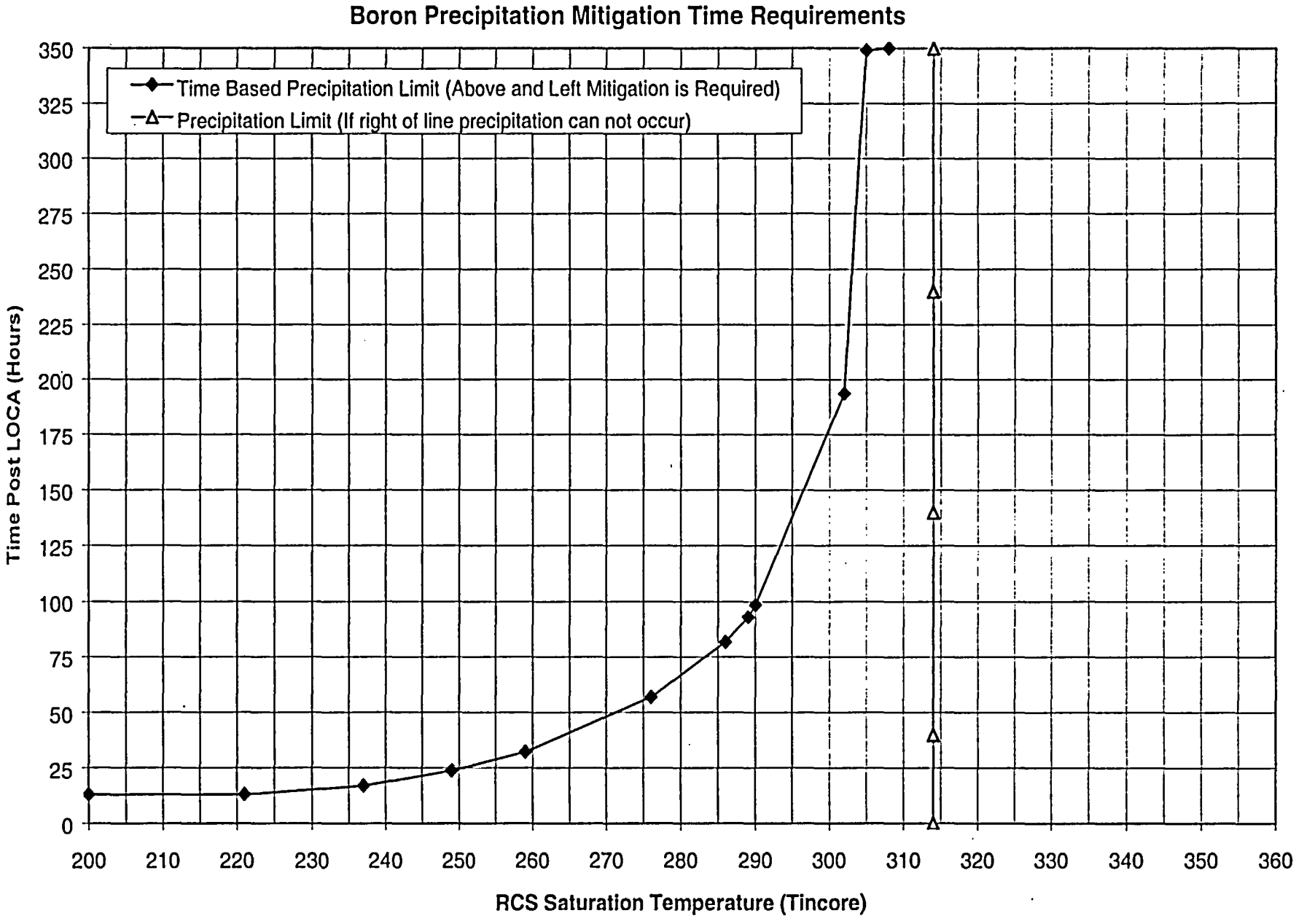
MITIGATION MATRIX WITHOUT RB SUMP SAMPLING




APS Effectiveness
Above and Left - A or B Train APS is effective
Above and Left Only A Train APS is effective
Precipitation Limit (If right of line precipitation can not occur)
Above and Left - With DHV-5 closed Only A Train is effective
Time Post LOCA (Hours)
RCS Saturation Temperature (Tincore)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360

Core Boron Control Limit




Boron Precipitation Mitigation Time Requirements
Time Based Precipitation Limit (Above and Left Mitigation is Required)
Precipitation Limit (If right of line precipitation can not occur)
Time Post LOCA (Hours)
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
RCS Saturation Temperature (Tincore)

CONTINGENCY ACTIONS FOR ESTABLISHING AUXILIARY PRESSURIZER SPRAY

1.0 PURPOSE

The purpose of this enclosure is to manually initiate APS. The instructions provide a method for manually opening DHV-91 and establishing temporary power for RCV-53 in the event of a power failure to ES MCC 3AB. The re-powering instructions are set up in two sections, dependent upon the condition and failure mode of ES MCC 3AB. The condition of ES MCC 3AB and the associated area dose rates must be considered before performing these instructions.

Section "A": Instructions provide temporary power to ES MCC 3AB-5B in the event of loss of power to ES MCC 3AB, however the control circuitry and indication for RCV-53 will still be utilized at ES MCC 3AB-5B.

Section "B": Instructions provide temporary power and control circuitry for RCV-53, utilizing ES MCC 3B1-8C (Ref. dwg. 206-056). Local control and indication will be at this MCC. ES MCC 3AB is assumed to be inoperable, and no longer intact.

2.0 REFERENCES

2.1 Implementing References

2.1.1 MP-405A, Handling, Pulling and Terminations for Safety and Non Safety Related Cables.

2.2 Developmental References

2.2.1 Print EC-206-058, One Line - Motor Control Center ES-3AB- AUX. BLDG.- 119'0'

2.2.2 Print EC-206-056, One Line - Motor Control Center ES-3B1- AUX. BLDG.- 119'0'

2.2.3 Print B-208-047 RC-16 Elementary Diagram, RCV-53

2.2.4 Print B-208-082 RS-10 Elementary Diagram, Remote Shutdown Panel RCV-53

2.2.5 Print 209-047 RC-04 Interconnection Diagram, RCV-53

2.2.6 Print 209-101 Sh. 28 Interconnection Diagram, Penetration 308

2.2.7 Vendor Drawing Y-90543 Sh. 3, ES MCC 3B1-8C fuses

3.0 PERSONNEL INDOCTRINATION

3.1 Material Parts List

Materials for this procedure are located in EOB-13, located at 145' Aux Bldg. near the RB purge exhaust valve room.

3.2 Limits And Precautions

3.2.1 The panel must be de-energized and checked to ensure the absence of any 480 VAC voltage prior to performing work in the panel. Consideration should be given for processing an equipment clearance based on the dose rates and time allowed for this activity.

3.2.2 Cables should exit the panel via the bottom.

3.2.3 This activity must be fully reviewed with the Radiological Assessment Team in the TSC to determine the best route to take in performing this activity. If dose rates are prohibitive in the areas required by this activity, then this activity should not be performed and other measures should be evaluated by the Accident Assessment Team.

3.3 Prerequisites

3.3.1 Personnel assigned shall be knowledgeable, experienced, and qualified to perform the specified tasks as determined by the appropriate supervisor or Maintenance representative in the TSC/OSC.

3.3.2 Tools and equipment required for this task are pre-staged in the tool box (EOB-13) located at 145' Aux Bldg. near the RB purge exhaust valve room. All cables are pre-lugged and marked for proper installation. Electrical gloves, meter, and safety clothing are obtained from the Electric shop prior to entrance into the Aux Bldg.

3.3.3 To remove equipment to be worked from service, evaluate the need to obtain an equipment clearance. Due to the plant conditions, which could be present when performing this activity, tags may not be necessary. Coordinate this activity through the TSC.

3.3.4 The person in charge of this activity must ensure the following:

- Work Group has reviewed and understands previous sections of this enclosure.
- Initial conditions have been met.
- Safety briefing has been conducted.
- Emergency Coordinator has been notified.

Completed by: _____ Date: _____

3.4 Responsibilities

The TSC Emergency Repair Team is responsible for ensuring qualified individuals are assigned to perform the temporary power configurations and that proper work practices and boundaries are considered during this evolution, including the use of Concurrent Verification.

4.0 INSTRUCTIONS

4.1 Verify DHV-91 is open.

4.1.1 IF DHV-91 cannot be opened from the Main Control Room, THEN establish a Re-entry Team to manually open DHV-91 "DH TO PZR SPRAY ISO" 119 ft AB penetration area.

4.2 **Section "A"**: This section of instructions provide temporary power to ES MCC 3AB-5B in the event of loss of power to ES MCC 3AB. However, the control circuitry and indication for RCV-53 will still be utilized at ES MCC 3AB-5B. These instructions anticipate that ES MCC 3AB is still intact and the normal breaker cubicle for RCV-53 can be used.

4.2.1 If required, obtain proper clearances from Operations to work in ES MCC 3B1-8C and ES MCC 3AB-5B.

4.2.2 Obtain approximately 100 ft. of 1-3/C-10 cable. This cable is tagged as "power" and is located in the "Section A" materials bag, in EOB-13 located on 145' Aux Bldg. near the RB purge exhaust valve room.

4.2.3 Route the "power" cable (1-3/C-10) from ES MCC 3B1-8C to ES MCC 3AB-5B.

4.2.4 Ensure the breaker at 480V ES MCC 3AB-5B is open.

4.2.5 Determinate the three conductors on the line side of the breaker in ES MCC 3AB-5B and tape the bare ends of the conductors and secure.

Performed	Concurrent Verification
_____	_____

4.2.6 Remove the bottom plate of ES MCC 3AB below breaker 5C, and open the door to breaker 5C to allow the cable to be routed through the bottom of the motor control center.

4.2.7 Terminate one end of the "power" cable (1-3/C-10) to the line side of breaker located in ES MCC 3AB-5B as follows: L1, L2, L3, left to right respectively.

Performed	Concurrent Verification
_____	_____

4.2.8 Ensure the breaker located in ES MCC 3B1-8C is open.

4.2.9 Determinate the three conductors on the load side of the breaker in ES MCC 3B1-8C and tape the bare ends of the conductors and secure.

Performed	Concurrent Verification
_____	_____

4.2.10 Remove the bottom plate of ES MCC 3B1 below breaker 8D, and open the door to breaker 8D to allow the cable to be routed through the bottom of the motor control center.

4.2.11 Terminate the other end of the "power" cable (1-3/C-10) to the load side of the breaker in ES MCC 3B1-8C as follows: L1, L2, L3, left to right respectively.

Performed	Concurrent Verification
_____	_____

4.2.12 If dose rates allow, then ensure cable is protected where personnel or equipment may need to cross over.

4.2.13 Inspect "power" cable installation and ensure ready for energizing.

4.2.14 Obtain permission from Operations to energize the temporary power installation.

4.2.15 Close the breaker located in ES MCC 3B1-8C.

4.2.16 Verify voltage at the load side of breaker in ES MCC 3B1-8C.

4.2.17 Close the breaker located in ES MCC 3AB-5B.

4.2.18 Verify voltage at the load side of breaker in ES MCC 3AB-5B.

4.2.19 Notify the supervisor in charge of this activity that temporary power installation for RCV-53 is ready to test.

4.2.20 Test temporary power installation for RCV-53 as described in Section 4.4

4.3 **Section "B"**: This section of instructions provide temporary power and control circuitry for RCV-53, utilizing ES MCC 3B1-8C (Ref. dwg. 206-056). Local control and indication will be at ES MCC 3B1-8C. The normal feed for RCV-53,
ES MCC 3AB-5B is assumed to be inoperable, and no longer intact. Remote Shutdown and Control Room indication and control will be removed as a result of this activity.

4.3.1 Coordinate with Operations and obtain clearances as required for ES MCC 3B1-8C and ES MCC 3AB-5B (Ref. dwg. 206-056).

4.3.2 Locate cable RCC281 as indicated on ref. dwg. 209-101 sheet 28, at penetration 308, located outside the RB, in SE quadrant under RB purge exhaust valves and cut cable RCC281 to allow for butt splicing temporary power to the power cables outside the cable tray.

Performed _____ Concurrent Verification _____

4.3.3 Determinate the following conductors (Ref. drawing 209-047 RC-04) at Term Box RC 11, located on the east wall opposite penetration 308:

Circuit	Wire Mark/Color	Term.	Performed	Concurrent Verification
RCC283	1/1	TB-A-1	_____	_____
	11/4	TB-A-5	_____	_____
	12/2	TB-A-6	_____	_____
	13/3	TB-A-7	_____	_____
	14/7	TB-A-8	_____	_____
	15/9	TB-A-9	_____	_____
	21/5	TB-A-13	_____	_____
	33/6	TB-A-14	_____	_____
	32/8	TB-A-16	_____	_____
RCC284	17/4	TB-A-10	_____	_____
	18/3	TB-A-11	_____	_____
	19/7	TB-A-12	_____	_____
	34/1	TB-A-15	_____	_____
RCC312	1/1	TB-A-1	_____	_____
	5/5	TB-A-3	_____	_____
	9/3	TB-A-4	_____	_____
	12/2	TB-A-6	_____	_____
	21/4	TB-A-13	_____	_____

4.3.4 Obtain materials located in the "Section B" materials bag, in EOB-13, located on the 145' Aux Bldg. near the RB purge exhaust valve room.

4.3.5 Route the "control" cable (1-9/C -14) from Term Box RC 11 and the "power" cable (1-3/C-10) from penetration 308 to ES MCC 3B1.

4.3.6 If time allows ensure the cable on the 119' elevation near ES MCC 3B1 is not a tripping hazard. Tie wrap cables as necessary to secure.

NOTE

Butt splices are to be made outside the cable tray.

4.3.7 Splice the "power" cable (1-3/C-10) to cable RCC281 from penetration 308.

Performed	Concurrent Verification
_____	_____

4.3.8 Terminate the "control" cable (1-9/C-14) (Ref. dwg. 209-047 RC-04) at Term Box RC 11 as follows:

Wire Color/Mark	Term.	Performed	Concurrent Verification
1/1	TB-A-1	_____	_____
2/5	TB-A-3	_____	_____
3/9	TB-A-4	_____	_____
4/11	TB-A-5	_____	_____
5/13	TB-A-7	_____	_____
6/14	TB-A-8	_____	_____

4.3.9 Terminate the #14 AWG Jumper (Ref. dwg. 209-047 RC-04) at Term Box RC 11 as follows:

From	To	Performed	Concurrent Verification
TB-A-14	TB-A-1	_____	_____

4.3.10 Ensure the breaker located in ES MCC 3B1-8C is open.

4.3.11 Remove the bottom plate of ES MCC 3B1 below breaker 8D, and open the door to breaker 8D to allow the cable to be routed through the bottom of the motor control center.

4.3.12 Terminate "control" cable (1-9/C-14) at ES MCC 3B1-8C as follows:

Wire Color/Mark	Termination	Performed	Concurrent Verification
1/1	8C-1	_____	_____
2/5	8C-2	_____	_____
3/9	8C-5	_____	_____
4/11	8C-8	_____	_____
5/12	8C-9	_____	_____
6/14	8C-10	_____	_____

4.3.13 Terminate "power" cable (1-3/C-10) at ES MCC 3B1-8C as follows:

Wire Color/Mark	Termination	Performed	Concurrent Verification
1/L1	8C-T1	_____	_____
1/L2	8C-T2	_____	_____
1/L3	8C-T3	_____	_____

4.3.14 Obtain permission from Operations to energize the temporary power installation.

4.3.15 Close the breaker located in ES MCC 3B1-8C.

4.3.16 Verify voltage at the load side of breaker in ES MCC 3B1-8C.

4.3.17 Notify the supervisor in charge of this activity that temporary power installation for RCV-53 is ready to test.

4.3.18 Test the temporary power installation for RCV-53 per Section 4.4

4.4 STEPS FOR CHECKING PROPER MOTOR ROTATION FOR RCV-53

NOTE

Section 4.3 installation instructions remove Remote Shutdown and Control Room indication and control.

CAUTION

If the motor leads are reversed, the open limit switch and/or closed torque switch controls will not automatically stop the valve.

4.4.1 IF the **amber** light is lit on ES MCC 3B1-8C cubicle door,
THEN perform the following:

A. While observing the red (open) and green (close) indicating lights depress and hold the close push button until an indicating light is lit.

B. IF the green light is lit,
THEN the motor rotation is correct.

C. IF the red light is lit,
THEN reverse two of the motor leads in the ES MCC 3B1-8C cubicle to correct the rotation.

D. Notify the supervisor that the system is ready for operation.

CAUTION

If the motor leads are reversed, the open limit switch and/or closed torque switch controls will not automatically stop the valve.

4.4.2 IF the **green** light is lit on ES MCC 3B1-8C cubicle door,
THEN perform the following:

A. Depress and hold the open push button for maximum of three (3) seconds and observe indication lights.

B. IF the green light is lit,
THEN reverse two of the motor leads in the ES MCC 3B1-8C cubicle to correct the rotation.

C. IF the amber light is lit,
THEN the motor rotation is correct.

D. Notify the supervisor that the temporary power for RCV-53 is ready.

CAUTION

If the motor leads are reversed, the open limit switch and/or closed torque switch controls will not automatically stop the valve.

4.4.3 IF the **red** light is lit on ES MCC 3B1-8C cubicle door,
THEN perform the following:

A. Depress and hold the close push button for maximum of three (3) seconds and observe indication lights.

B. IF the red light is lit,
THEN reverse two of the motor leads in the ES MCC 3B1-8C cubicle to correct the rotation.

C. IF the amber light is lit,
THEN motor rotation is correct.

D. Notify the supervisor that the temporary power for RCV-53 is ready.

Summary of Changes
PRR 107944

SECTION	CHANGE
L&P 3.3	Added a new L& P to identify that stopping a RB Spray Pump could cause RB pressure to increase (Ref NTM 54038-32 and IOC OP02-0054)
Throughout	Reformatted procedure and changed Progress Energy icon on front page