3/4.1.2 BORATION SYSTEMS

FLOW PATHS - SHUTDOWN

LIMITING CONDITION FOR OPERATION

3.1.2.1 As a minimum, one of the following boron injection flow paths shall be OPERABLE:

a. A flow path with a piping temperature of greater than 55°F from the boric acid storage tank via either a boric acid pump or a gravity feed connection and a charging pump to the Reactor Coolant System if only the boric acid storage tank in Specification 3.1.2.7a is OPERABLE, or

b. The flow path from the refueling water storage tank via either a charging pump or a high pressure safety injection pump to the Reactor Coolant System if only the refueling water storage tank in Specification 3.1.2.7b is OPERABLE.

APPLICABILTIY: MODES 5 and 6.

ACTION:

With none of the above flow paths OPERABLE, suspend all operations involving CORE ALTERATIONS or positive reactivity changes until at least one injection path is restored to OPERABLE status.

SURVEILLANCE REQUIREMENT

4.1.2.1 At least one of the above required flow paths shall be demonstrated OPERABLE:

a. At least once per 7 days by exercising all testable power operated valves in the flow path required for boron injection through at least one complete cycle,

b. At least once per 31 days by verifying the correct position of all manually operated valves in the boron injection flow path not locked, sealed or otherwise secured in position.

c. At least once per 24 hours by verifying that the boric acid piping temperature is greater than 55°F. This may be accomplished by verifying that the ambient temperature in the vicinity of the boric acid piping on elevations (-)5′-0" and (-)25′-6" is greater than 55°F.

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FLOW PATHS - OPERATING

LIMITING CONDITION FOR OPERATION

3.1.2.2 The following boron injection flowpaths to the RCS via the charging pump(s) shall be OPERABLE:

a. At least one of the following combinations:

1) One boric acid storage tank, with the tank contents in accordance with Figure 3.1-1 and a piping temperature greater than 55°F, its associated gravity feed valve, and boric acid pump.

2) Two boric acid storage tanks, with the weighted average of the combined contents of the tanks in accordance with Figure 3.1-1 and a piping temperature greater than 55°F, their associated gravity feed valves, and boric acid pumps.

3) Two boric acid storage tanks, each with contents in accordance with Figure 3.1-1 and a piping temperature greater than 55°F, at least one gravity feed valve, and at least one boric acid pump.

b. The flow path from an OPERABLE Refueling Water Storage Tank, as per Specification 3.1.2.8.b.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTION:

With fewer than the above required boron injection flow paths to the Reactor Coolant System OPERABLE, restore the required boron injection flow paths to the Reactor Coolant System to OPERABLE status within 48 hours or make the reactor subcritical within the next 2 hours and borate to a SHUTDOWN MARGIN equivalent to at least 1% Δ k/k at 200°F; restore the required flow paths to OPERABLE status within the next 7 days or be in COLD SHUTDOWN within the next 36 hours.

SURVEILLANCE REQUIREMENT

4.1.2.2 The above required flow paths shall be demonstrated OPERABLE:

a. At least once per 7 days by exercising all testable power operated valves in each flow path through at least one complete cycle,

b. At least once per 31 days by verifying the correct position of all manually operated valves in the boron injection flow path not locked, sealed or otherwise secured in position, and

c. At least once per 18 months, during shutdown, by exercising all power operated valves in each flow path through at least one complete cycle.

d. At least once per 24 hours by verifying that the boric acid piping temperature is greater than 55°F. This may be accomplished by verifying that the ambient temperature in the vicinity of the boric acid piping on elevations (-)5'-0" and (-)25-6" is greater than 55°F.

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BORATED WATER SOURCES - SHUTDOWN

LIMITING CONDITION FOR OPERATION

3.1.2.7 As a minimum, one of the following borated water sources shall be OPERABLE:

a. One boric acid storage tank with:

1. A concentration between 2.5 and 3.5 weight percent boron.

2. A minimum volume of 3750 gallons, and

3. A minimum boric acid storage tank temperature of 55°F.

or b. The refueling water storage tank with:

1. A minimum contained volume of 57,300 gallons,

2. A minimum boron concentration of 1720 ppm when in Mode 5,

3. A minimum boron concentration as defined in Specification 3.9.1 when in Mode 6.

4. A minimum solution temperature of 35°F.

APPLICABILITY: MODES 5 and 6.

ACTION:

With no borated water sources OPERABLE, suspend all operations involving CORE ALTERATIONS or positive reactivity changes until at least one borated water source is restored to OPERABLE status.

SURVEILLANCE REQUIREMENT

4.1.2.7 The above required borated water source shall be demonstrated OPERABLE:

a. At least once per 7 days by:

1. Verifying the boron concentration of the water, and

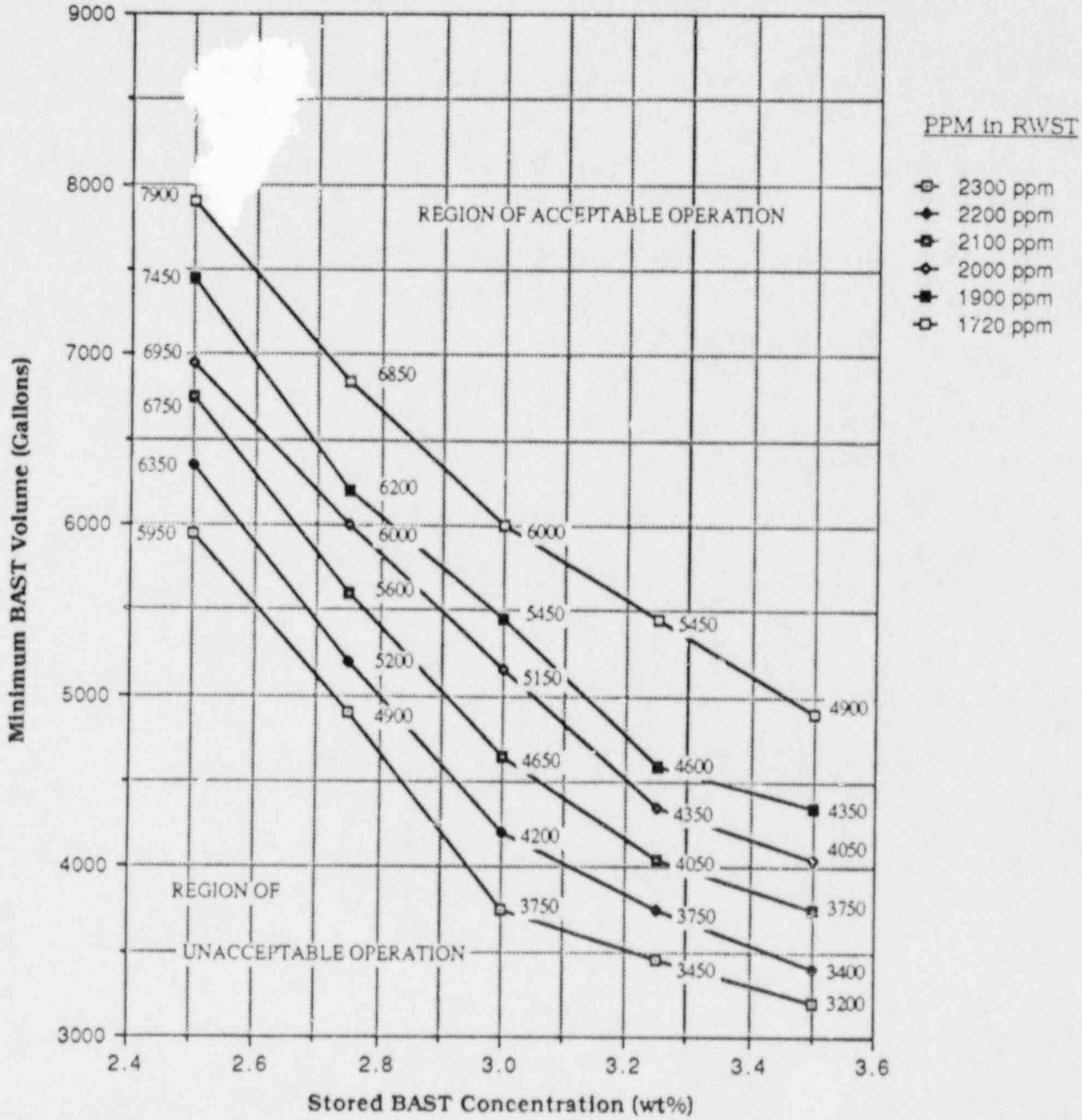
2. Verifying the water level of the tank

b. At least once per 24 hours by verifying the RWST temperature when it is the source of borated water and the RWST ambient air temperature is <35°F.

c. At least once per 24 hours by verifying that the Boric Acid Storage Tank temperature is greater than 55°F when it is the source of borated water. This may be accomplished by verifying that the ambient air temperature in the vicinity of the BAST is greater than 55°F.

FIGURE 3.1-1

MINIMUM BAST VOLUME VS STORED BAST CONCENTRATION (wt%)



BORATED WATER SOURCES - OPERATING

LIMITING CONDITION FOR OPERATION

3.1.2.8 Both of the following borated water sources shall be OPERABLE:

a. At least one of the following Boric Acid Storage Tank(s) combinations:

1) One boric acid storage tank, with the tank contents in accordance with Figure 3.1-1 and a minimum temperature of 55°F, its associated gravity feed valve, and boric acid pump, or

2) Two boric acid storage tanks, with the weighted average of the combined contents of the tanks in accordance with Figure 3.1-1 and a minimum temperature of 55°F, their associated gravity feed valves, and boric acid pumps, or

3) Two boric acid storage tanks, each with contents in accordance with Figure 3.1-1 and a minimum temperature of 55°F, at least one gravity feed valve, and at least one boric acid pump.

and b. The refueling water storage tank with:

1. A minimum contained volume of 370,000 gallons of water,

2. A minimum boron concentration of 1720 ppm,

3. A minimum solution temperature of 50°F when in MODES 1 and 2, and

4. A minimum solution temperature of 35°F when in MODES 3 and 4.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With only one borated water source OPERABLE, restore at least two borated water sources to OPERABLE status within 48 hours or make the reactor subcritical within the next 2 hours and borate to a SHUTDOWN MARGIN equivalent to at least 1% Δ k/k at 200°F; restore at least two borated water sources to OPERABLE status within the next 7 days or be in COLD SHUTDOWN within the next 36 hours.

4.1.2.8 Each borated water source shall be demonstrated OPERABLE:

a. At least once per 7 days by:

1. Verifying the boron concentration in each water source, and

2. Verifying the water level in each water source.

b. When in MODES 3 and 4, at least once per 24 hours by verifying the RWST temperature is $\geq$35°F when the RWST ambient air temperature is <35°F.

c. When in Modes 1 and 2, at least once per 24 hours by verifying the RWST temperature is $\geq$50°F when the RWST ambient air temperature is <50°F.

d. At least once per 24 hours by verifying that the boric acid storage tank temperatures are greater than 55°F. This may be accomplished...

3/4.1.1.5 MINIMUM TEMPERATURE FOR CRITICALITY

The MTC is expected to be slightly negative at operating conditions. However, at the beginning of the fuel cycle, the MTC may be slightly positive at operating conditions and since it will become more positive at lower temperatures, this specification is provided to restrict reactor operation when T_{avg} is significantly below the normal operating temperature.

3/4.1.2 BORATION SYSTEMS

The boron injection system ensures that negative reactivity control is available during each mode of facility operation. The components required to perform this function include 1) borated water sources, 2) charging pumps, 3) separate flow paths, 4) boric acid pumps, and 5) an emergency power supply from OPERABLE diesel generators.

With the RCS average temperature above 200°F, a minimum of two separate and redundant boron injection flowpaths are provided to ensure single functional capability in the event an assumed failure of a pump or valve renders one of the flowpaths inoperable. Redundant flow paths from the Boric Acid Storage Tanks are achieved through Boric Acid Pumps, gravity feed lines and Charging Pumps. Redundant flow paths from the Refueling Water Storage Tank are achieved through Charging Pump flow path guaranteed by Technical Specification 3.1.2.2 and the HPSI flow path guaranteed by Technical Specification 3.5.2 and 3.5.3. Allowable out-of-service periods ensure that minor component repair or corrective action may be completed without undue risk to overall facility safety from injection system failures during the repair period.

The minimum boration capability is sufficient to provide a SHUTDOWN MARGIN of 2.9% Δ k/k at all temperatures above 200°F. The maximum boration capability requirement occurs at EOL from full power equilibrium xenon conditions and requires an equivalent of 4900 gallons of 3.5% boric acid solution from the boric acid tanks plus 15,000 of 1720 ppm borated water from the refueling water storage tank. The refueling water storage tank can also be used alone by feed-and-bleed using well under the 370,000 gallons of 1720 ppm borated water required.

The requirements for a minimum contained volume of 370,000 gallons of borated water in the refueling water storage tank ensures the capability for borating the RCS to the desired level. The specified quantity of borated water is consistent with the ECCS requirements of Specification 3.5.4. Therefore, the larger volume of borated water is specified here too.

3/4.1.2 BORATION SYSTEMS (Continued)

With the RCS temperature below 200°F, one injection system is acceptable without single failure consideration on the basis of the stable reactivity condition of the reactor and the additional restrictions prohibiting CORE ALTERATIONS and positive reactivity change in the event the single injection system becomes inoperable.

The boron capability required below 200°F is based upon providing a 2% Δ k/k SHUTDOWN MARGIN at 140°F after xenon decay. This condition requires either 3750 gallons of 2.5% boric acid solution from the boric acid tanks or 57,300 gallons (including 51,950 gallons assumed to be unusable) of 1720 ppm borated water from the refueling water storage tank.

The maximum boron concentration requirement (3.5%) and the minimum temperature requirement (55°F) for the Boric Acid Storage Tank ensures that boron does not precipitate in the Boric Acid System. The daily surveillance requirement provides sufficient assurance that the temperature of the tank will be maintained higher that 55°F at all times.

A minimum boron concentration of 1720 ppm is required in the RWST at all times in order to satisfy safety analysis assumptions for boron dilution incidents and other transients using the RWST as a borated water source as well as the analysis assumption to determine the boration requirement to ensure adequate shutdown margin.

3/4.1.3 MOVEABLE CONTROL ASSEMBLIES

The specifications of this section ensure that (1) acceptable power distribution limits are maintained, (2) the minimum SHUTDOWN MARGIN is maintained, and (3) the potential effects of a CEA ejection accident are limited to acceptable levels.

The ACTION statements which permit limited variations from the basic requirements are accompanied by additional restrictions which ensure that the original criteria are met.

The ACTION statements applicable to an immovable or untrippable CEA and to a large misalignment (≥20 steps) of two or more CEAs, require a prompt shutdown of the reactor since either

3/4.1.3 MOVEABLE CONTROL ASSEMBLIES (Continued)

of these conditions may be indicative of a possible loss of mechanical functional capability of the CEAs and in the event of a immovable or untrippable CEA, the loss of SHUTDOWN MARGIN.

For small misalignments (<20 steps) of the CEAs, there is 1) a small degradation in the peaking factors relative to those assumed in generating LCOs and LSSS setpoints for DNBR and linear heat rate, 2) a small effect on the time dependent long term power distributions relative to those used in generating LCOs and LSSS setpoints for DNBR and linear heat rate, 3) a small effect on the available SHUTDOWN MARGIN, and 4) a small effect on the ejected CEA worth used in the safety analysis. Therefore, the ACTION statement associated with the small misalignment of a CEA permits a one hour time interval during which attempts may be made to restore the CEA to within its alignment requirements prior to initiating a reduction in THERMAL POWER. The one hour time limit is sufficient to (1) identify causes of a misaligned CEA, (2) take appropriate corrective action to realign the CEAs and (3) minimize the effects of xenon redistribution.

Overpower margin is provided to protect the core in the event of a large misalignment (≥20 steps) of a CEA. However, this misalignment would cause distortion of the core power distribution. The reactor protective system would not detect the degradation in radial peaking factors and since variations in other system parameters (e.g., pressure and coolant temperature) may not be sufficient to cause trips, it is possible that the reactor could be operating with process variables less conservative than those assumed in generating LCO and LSSS setpoints. Therefore, the ACTION statement associated with the large misalignment of a CEA requires a prompt and significant reduction in THERMAL POWER prior to attempting realignment of the misaligned CEA.

The ACTION statements applicable to misaligned or inoperable CEAs include requirements to align the OPERABLE CEAs in a given group with the inoperable CEA. Conformance with these alignment requirements bring the core, within a short period of time, to a configuration consistent with that assumed in generating LCO and LSSS setpoints. However, extended operation with CEAs significantly inserted in the core may lead to perturbations in 1) local burnup, 2) peaking factors and 3) available shutdown margin which are more adverse than the conditions assumed to exist in the

3/4 1.3 MOVEABLE CONTROL ASSEMBLIES (Continued)

safety analyses and LCO and LSSS setpoints determination. Therefore, time limits have been imposed on operation with inoperable CEAs to preclude such adverse conditions from developing.

Operability of the CEA position indicators (Specification 3.1.3.3) is required to determine CEA positions and thereby ensure compliance with the CEA alignment and insertion limits and ensures proper operation of the rod block circuit. The CEA "Full In" and "Full Out" limits provide an additional independent means for determining the CEA positions when the CEAs are at either their fully inserted or fully withdrawn positions. Therefore, the ACTION statements applicable to inoperable CEA position indicators permit continued operations when the positions of CEAs with inoperable position indicators can be verified by the "Full In" or "Full Out" limits.

CEA positions and OPERABILITY of the CEA position indicators are required to be verified on a nominal basis of once per 12 hours with more frequent verifications required if an automatic monitoring channel is inoperable. These verification frequencies are adequate for assuring that the applicable LCO's are satisfied.

The maximum CEA drop time permitted by Specification 3.1.3.4 is the assumed CEA drop time used in the accident analyses. Measurement with T_{avg} 515°F and with all reactor coolant pumps operating ensures that the measured drop times will be representative of insertion times experienced during a reactor trip at operating conditions.

Docket No. 50-336
B12733

Millstone Unit No. 2

Attachment 2

Technical Basis for
Proposed Boric Acid Concentration Reduction

April 1988

TECHNICAL BASIS FOR BAST CONCENTRATION REDUCTION

I. INTRODUCTION

The BAST level and concentration specified in the current Technical Specifications for Modes 1, 2, 3, and 4 were based upon the ability to borate the RCS to the boric acid concentration required to provide a shutdown margin of 2.9% delta k/k at 200°F prior to commencing plant cooldown. In the limiting situation where letdown was not available, this boration was accomplished by charging to the RCS while simultaneously filling the pressurizer. Since boron concentration had to be substantially increased prior to commencing cooldown, highly concentrated boric acid solutions were required due to the limited space that was available in the pressurizer.

The proposed Technical Specification change uses new methodologies for setting BAST concentration and levels. The methodology for setting concentration and level for Modes 1, 2, 3, and 4 differs from previous methodologies in that boration of the reactor coolant system is performed concurrently with plant cooldown, i.e., concentrated boric acid is added concurrently with cooldown as part of normal inventory makeup due to coolant contraction. By knowing the exact boron concentration required to maintain proper shutdown margin at each temperature during a plant cooldown, BAST concentration can be decoupled from pressurizer volume. As a result, the concentration of boric acid required to be maintained in the boric acid storage tanks in order to perform a cooldown to cold shutdown conditions can be lowered to the point where heat tracing of the boric acid storage system is no longer required, i.e., the ambient temperatures that normally exist in the plant's auxiliary building are sufficient to prevent boric acid precipitation.

Similarly, this new methodology was developed for setting the minimum concentration and level of the boration source required to operational in Modes 5 and 6. The new methodology is similar to t new Mode 1 through Mode 4 methodology in that boron is added concurrently with cooldown as part of normal system makeup. By insuring that the boron concentration is maintained greater than that required for proper shutdown margin at each temperature, the boric acid storage tank concentration for Modes 5 and 6 can be substantially lowered.

This analysis was performed by Combustion Engineering using CE methodology. This same methodology has been previously submitted to and approved by the NRC for San Onofre Units 2 and 3 and Arkansas Nuclear One, Unit 2.

II. METHOD OF ANALYSIS

As stated in Section I above, this proposed Technical Specification change requires boration concurrent with cooldown. Therefore, the exact boron concentration required to be present in the reactor coolant system must be known at any temperature during the cooldown process. In addition, in order to insure applicability for an entire cycle, a cooldown scenario was developed which is conservative in that it places the greatest burden on an operator's ability to control reactivity.

II.1 Scenario for Modes 1 through 4

The assumptions used in this cooldown scenario for Modes 1 through 4 are as follows:

1. Conservative core physics parameters were used to determine the required boron concentration and the required Boric Acid Storage Tank volumes to be added during plant cooldown. End-of-cycle initial boron concentration is assumed to be zero. End-of-cycle moderator cooldown effects are used to maximize the reactivity change during the plant cooldown. Beginning-of-cycle (BOC) boron reactivity worths (which are smallest at the beginning of cycle) are used to maximize the amount of boron that must be added to provide the required reactivity change. These assumptions assure that the required boron concentration and the Boric Acid Storage Tank minimum volume requirements conservatively bound all plant cooldowns during core life.

2. The most reactive rod is stuck in the full out position.

3. Prior to time zero, the plant is operating at 100% power with 100% equilibrium xenon. Zero RCS leakage is assumed.

4. At time zero, the plant is shut down and held at hot zero power conditions for 25.5 hours. (This corresponds to the time after shutdown when core reactivity due to xenon decays back to the 100% power equilibrium xenon level). This assures that no credit is taken for the negative reactivity effects of the xenon concentration peak following the reactor shutdown.

5. At 25.5 hours, offsite power is lost and the plant goes into natural circulation. Letdown is isolated. All non-safety grade plant equipment and components are lost. During the natural circulation the RCS average temperature rises 25°F due to decay heat in the core. The initial temperature at the start of the cooldown is 557°F.

6. Approximately 30 minutes later, at 26 hours, the operators commence a cooldown to cold shutdown.

7. An overall cooldown rate of 12.5°F/hr is assumed. This value was selected to conservatively bound (i.e., be slower than) the cooldown rates which can be achieved by natural circulation. Slower cooldown rates are conservative because they allow more time for positive reactivity insertion due to xenon decay.

The scenario outlined above was used to generate the boration requirements for Modes 1, 2, 3, and 4 (Specification 3.1.2.8). It produces a situation where positive reactivity will be added to the reactor coolant system simultaneously from two sources at the time that a plant cooldown from hot shutdown is commenced. These two reactivity sources result from a temperature effect due to an overall negative isothermal temperature coefficient of reactivity, and a poison effect as the xenon-135 level in the core starts to decay below its equilibrium value at 100% power. This scenario, therefore, represents the limiting credible challenge to an operator's ability to borate the reactor coolant system and maintain the required Technial Specification shutdown margin while cooling the plant from hot standby to cold shutdown conditions.

II.2 Scenario for Modes 5 and 6

The following scenario was developed to identify the most limiting cooldown transient for Modes 5 and 6.

1. End-of-cycle (EOC) conditions with the initial RCS boron concentration necessary to provide a 2.0% delta k/k shutdown margin at 200°F and xenon free core. EOC moderator cooldown effects are used to maximize the reactivity change during the plant cooldown. BOC boron worths are used since they are the smallest over core life, therefore, requiring the greatest overall increase in boron concentration in order to maintain proper shutdown margin.

2. Most reactive rod is stuck in the full out position.

3. Zero RCS leakage is assumed.

4. RCS feed-and-bleed can be used to increase boron concentration.

5. RCS makeup is supplied either from the RWST alone or a combination of makeup from the BAST and RWST.

The scenario outlined above was used to determine the boration requirements for Modes 5 and 6 (Specification 3.1.2.7). It produces a situation where positive reactivity will be added to the reactor coolant system due to the overall negative isothermal temperature coefficient of reactivity. Since the core is already assumed to be xenon free there is no contribution to core reactivity due to xenon decay.

III. ANALYSIS

III.1 Analysis for Modes 1 through 4

There are two ways to assure that the minimum required boron concentrations are maintained. These are:

1) Makeup from the BAST and the RWST
2) Feed-and-Bleed from the RWST

III.1.1 Makeup from the BAST and RWST

A complete list of assumption and initial conditions used in calculating the minimum boric acid storage tank inventory requirements for Modes 1, 2, 3, and 4 are contained in Table 1. Note that complete and instantaneous mixing between the reactor coolant system and the pressurizer was assumed for all fluid added to the reactor coolant system via the loop charging nozzles.

The reactor coolant system boron concentration versus temperature for a plant cooldown and depressurization from 557°F and 2250 psia to 200°F and 265 psia with a boric acid storage tank concentration of 3.50 weight percent and a refueling water storage tank concentration of 1720 ppm boron is contained in Figure 1. Note that at each temperature during the cooldown process, RCS boron concentration is greater than that required for a 2.9% delta k/k shutdown margin. Also note in Figure 1 that the shutdown margin drops from 2.9% delta k/k to 2.0% delta k/k at an average coolant temperature of 200°F. The exact temperature at which charging pump suction was switched from the BASTs to the refueling water storage tank (480°F in Figure 1) was determined via an iterative process. In this process, the smallest boric acid storage tank volume necessary to maintain the required shutdown margin was calculated for the given set of tank concentrations.

A detailed parametric analysis was performed for the Modes 1, 2, 3, and 4 Technical Specification (Specification 3.1.2.8). In this study, BAST concentration was varied from 3.5 weight percent boric acid to 2.5 weight percent boric acid and RWST concentration was varied from 1720 ppm boron to 2300 ppm boron. The required BAST volumes are contained in Figure 2. This Figure 2 is the same as proposed Technical specification Figure 3.1-1. The RWST volume required is 15,000 gallons, which is far less than the 370,000 gallon required to be available for this mode. In all cases, the actual system boron concentration is greater than that necessary for the required shutdown margin.

III.1.2 Feed-and-Bleed from the RWST

The proper boron concentration can be maintained by using the RWST as makeup water to compensate for volume contraction due to cooldown and by feeding-and-bleeding. The volume of boric acid solution required to do this is much less than the 370,000 gpm required for these operational modes.

III.2 Analysis for Modes 5 and 6

A complete list of assumptions and initial conditions used in calculating the minimum boric acid storage tank inventory requirements is contained in Table 2. The RCS boron concentrations necessary to maintain the 2% delta k/k shutdown margin for temperatures from 200°F to 130°F are given in Table 3.

There are two ways to assure these concentrations are maintained. These are:

1) Making up from the BAST
2) Feed-and-bleed from the RWST

Each of these methods are analyzed separately.

II.2.1 Makeup from the BAST

The steps in this process are given below:

a) The system is initially at 200°F and 265 psia. Initial concentration in the reactor coolant system, pressurizer, and in the shutdown cooling system is 632.8 ppm boron. The 632.8 ppm initial boron concentration corresponds to a 2% delta k/k shutdown margin at 200°F.

b) Perform a plant cooldown from an average temperature of 200°F to an average temperature of 130°F using makeup water from the BAST (2.5 weight % boric acid solution at 70°F). Charge only as necessary to makeup for coolant contraction.

The boration results from the system cooldown from 200°F to 130°F are plotted as the actual concentration curve in Figure 3. As can be seen from this figure, a shutdown margin of greater than the required 2.0% delta k/k was maintained throughout the evaluation. A concentration of 2.50 weight % boron is therefore acceptable for use as the minimum in Technical Specification requirements. The minimum volume that should be specified in this Technical Specification is 3750 gallons. This volume includes 500 gallons of boric acid included for conservatism.

III.2.2 Feed-and-Bleed from the RWST

The RWST will not provide enough boric acid to compensate for the reactivity inserted during the cooldown if charging is restricted to makeup for cooling contraction only. A feed-and-bleed must be performed to raise the RCS concentration before the cooldown is commenced. Following this feed-and-bleed, the RWST water will be added to make up for system contraction. The initial boron concentration of 632.8 ppm corresponds to a 2% delta k/k shutdown margin at 200°F. The RWST boron concentration is assumed to be at the 1720 ppm minimum Technical Specification requirement.

The results of this process are shown in Figure 4. The feed-and-bleed portion is indicated by the vertical line. The water injected during this portion is 1600 gallons. The total amount of water injected during both the feed-and-bleed and the cooldown portions of the process is 5350 gallons. This value includes 500 gallons included for conservatism. Since 51,950 gallons of the RWST is unusable, the actual required volume is 57,300 gallons. This is minimum value that should be specified in the Technical Specifications.

IV CONCLUSIONS

IV.1 Conclusions for Modes 1 through 4

As stated in the proposed plant Technical Specification Bases 3/4.1.2, the boration capacity must be sufficient to provide a shutdown margin from all operating conditions of 2.9% delta k/k after xenon decay and cooldown to 200 degrees F. This analysis shows that this shutdown margin is available at all reactor coolant system average temperatures above 200°F. The boric acid storage inventories necessary to accomplish this are shown in Figure 2. The RWST volume used is well below the 370,000 gallon minimum requirement.

IV.2 Conclusions for Modes 5 and 6

As stated in the plant's proposed Technical Specification Bases 3/4.1.2, the boration capacity required below a reactor coolant system average temperature of 200°F is based on providing a 2% delta k/k shutdown following xenon decay during a cooldown to 140°F. This can be accomplished by either:

a) making up from the BAST
b) feed-and-bleed from the RWST

The boric acid inventory required to meet this requirement is 3750 gallons from the BAST or 57,300 gallons (including 51,900 gallons of unusable volume) from the RWST.

V. IMPACT ON TECHNICAL SPECIFICATIONS

The Technical Specifications concerning reactivity control system can be significantly changed as a result of this analysis. Specifically, the requirements for the BASTs, the RWST and the flowpaths from these boric acid solution sources can be changed. The proposed changes are summarized below.

The reduction in the required BAST concentration results in an increase in the volume of boric acid required. This increase is accomplished by both a change in the BAST inventory requirements and by requiring the use of RWST water. The current requirements for the BASTs require all the necessary water to be in one tank. The proposed requirements allow the water to be split between the two tanks, as long as:

o The combined volume and the weighted average concentration is consistent with the minimum requirements, and o Both flow paths from both BASTs are operable.

The flow path from the RWST to the RCS via the charging pumps is also required in the proposed Specification for Modes 1 through 4. This is because this analysis credits water from the RWST for maintaining shutdown margin. This flow path is not required in the current Specification since the BASTs alone contain enough boric acid to assure adequate shutdown margin.

The current Specifications require two flow paths (one via the boric acid pumps and the other via the gravity feed valves) from an operable BAST for Modes 1 through 4. The proposed Specifications also require two flow paths from a given BAST if that tank alone is required to meet the shutdown margin requirements. If the combined inventory of both tanks is necessary to meet the requirements, then both flow paths from both tanks must be operable.

The requirements for heat tracing of the boric acid system are deleted. This is because for the maximum 3.5 weight percent solution in the proposed specification, the minimum solution temperature is 50°F. This is well below the temperature for which heat tracing is necessary. The heat tracing requirements have been replaced by requirements on either solution temperature for the BASTs or air temperature in the area around piping. The minimum temperature of 55°F provides adequate margin to the minimum solution temperature, thereby assuring that there is no boron precipitation in the system.

Table 1

Initial Conditions and Assumptions Used in the Modes 1, 2, 3, and 4 Calculation

a. Reactor coolant system volume = 9,260 $ft.^3$

b. Initial reactor coolant system pressure = 2250 psia.

c. Pressurizer level = 600 ft^3 (40% level).

d. Pressurizer is saturated.

e. Zero reactor coolant system Technical Specification leakage.

f. Initial reactor coolant system concentration = 0 ppm.

g. Initial pressurizer concentration = 0 ppm boron

h. Complete and instantaneous mixing between the pressurizer and the reactor coolant system.

i. Constant pressurizer level maintained during the plant cooldown, i.e., charge only as necessary to makeup for coolant contraction.

j. Boron concentration in the Shutdown Cooling System is equal to the boron concentration in the reactor coolant system at the time of shutdown cooling initiation.

k. Letdown is not available.

l. RWST temperature = 50 degrees.

m. BAST temperature = 70 degrees.

Table 2

Initial Conditions and Assumptions Used
in the Modes 5 and 6 Calculation

a. Reactor coolant system volume = 9,260 ft.^{3}

b. Reactor coolant system pressure = 265 psia.

c. Pressurizer level = 460 ft.^{3}

d. Pressurizer is saturated.

e. Zero reactor coolant system leakage is assumed.

f. Boration source concentration = 2.50 weight % boron.

g. Boration source temperature = 70 degrees.

h. Initial reactor coolant system concentration = 632.8 ppm boron.

i. Initial pressurizer concentration = 632.8 ppm boron.

j. Complete and instantaneous mixing between the pressurizer and the reactor coolant system.

k. Constant pressurizer level maintained during the plant cooldown, i.e., charge only as necessary to makeup for coolant contraction.

l. Total system volume (RCS + SDCS + PZR) = 18,980 ft.^{3}

Table 3

Required Boron Concentration for a Cooldown from 200 Degrees to 130 Degrees

Temperature (Degrees F)	Concentration(@) (ppm boron)
200	632.8
190	637.4
180	642.1
170	646.7
160	651.3
150	655.9
140	660.6
130	665.2

(@) Based upon a 2.0% delta k/k shutdown margin after xenon decay.

FIGURE 1, RCS BORON CONCENTRATION

vs TEMPERATURE for 12.5 F/hr COOLDOWN

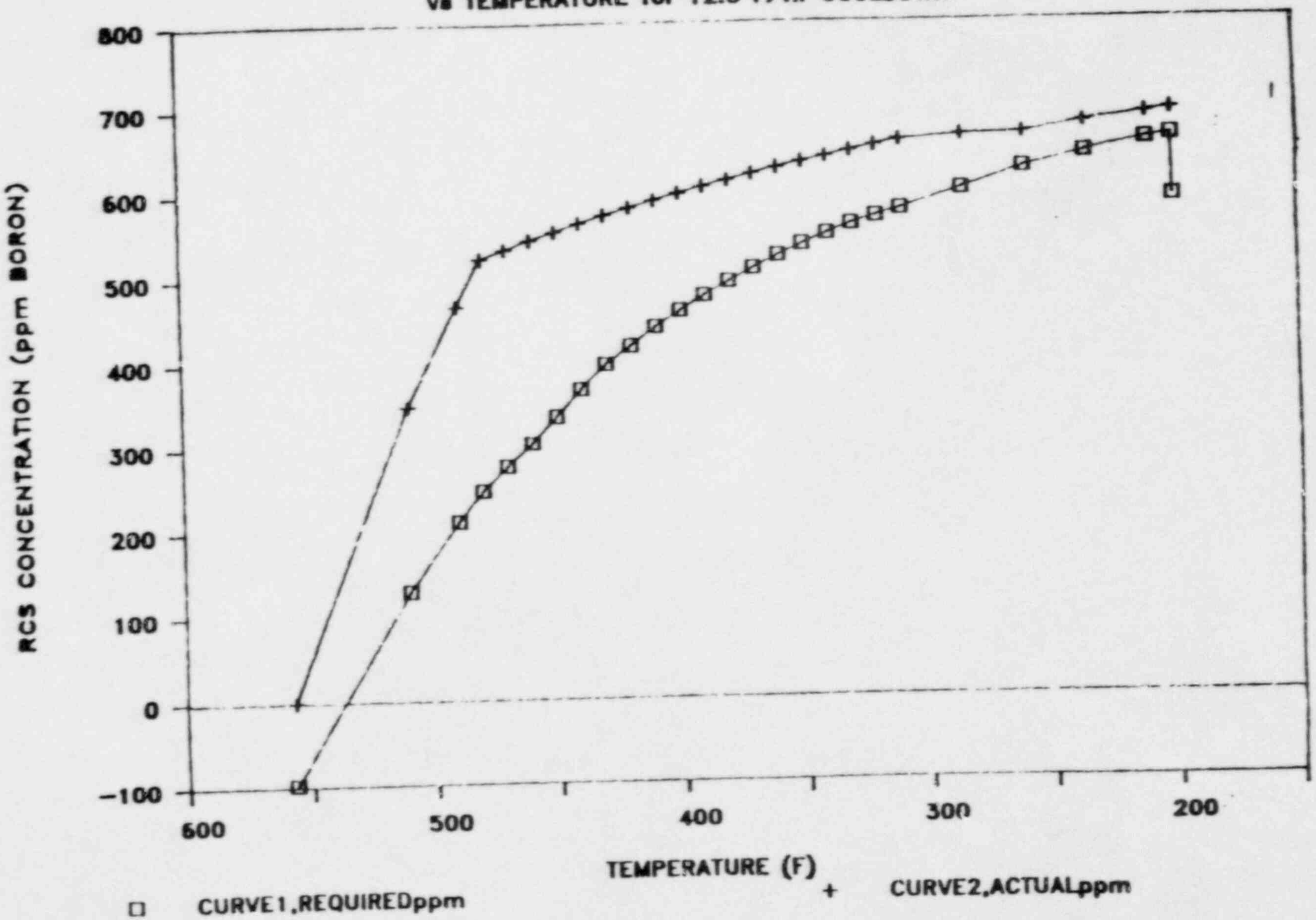


FIGURE 2 MINIMUM BAST VOLUME vs

STORED BAST CONCENTRATION (wt %)

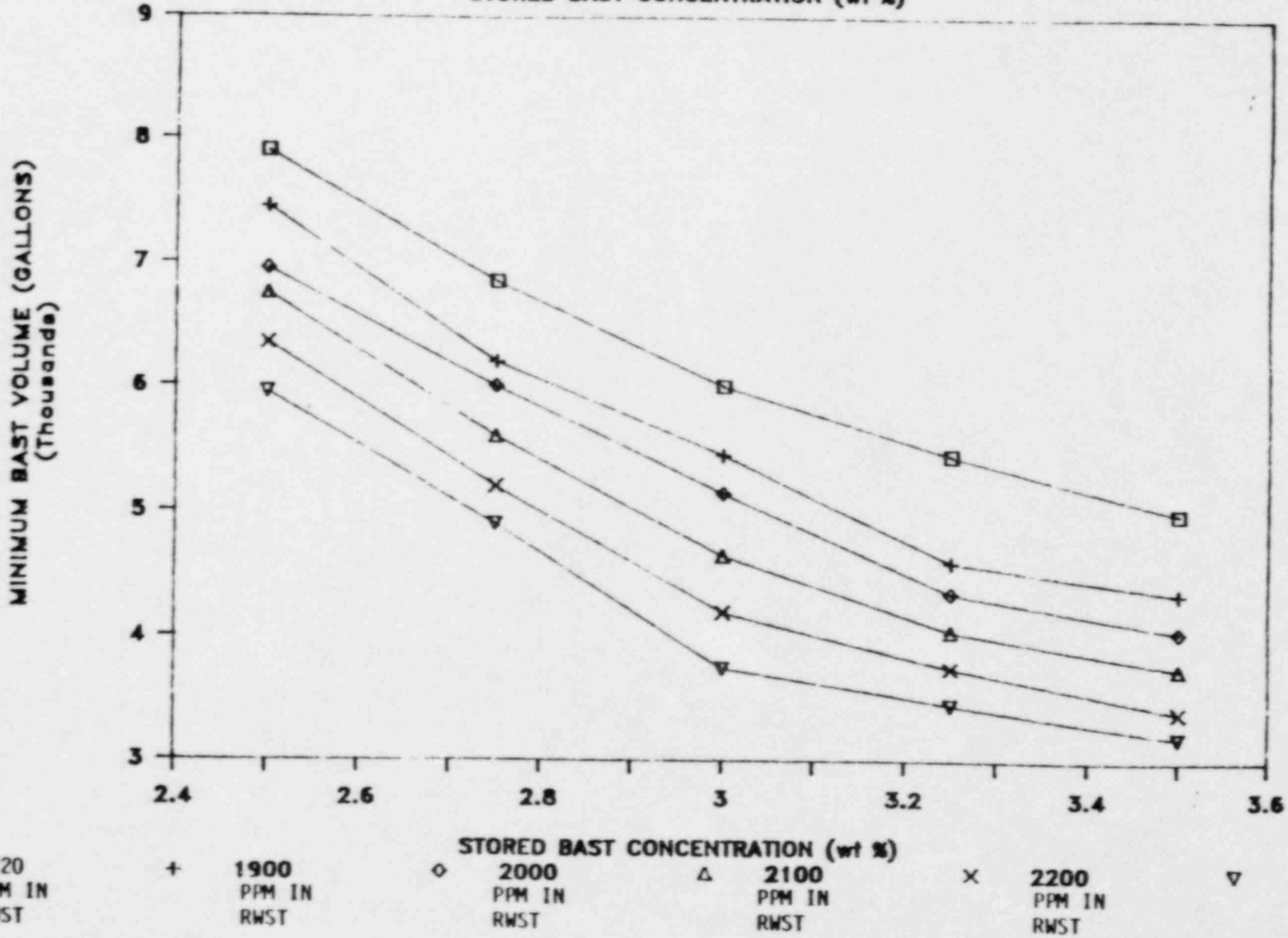


FIGURE 3 RCS BORON CONCENTRATION

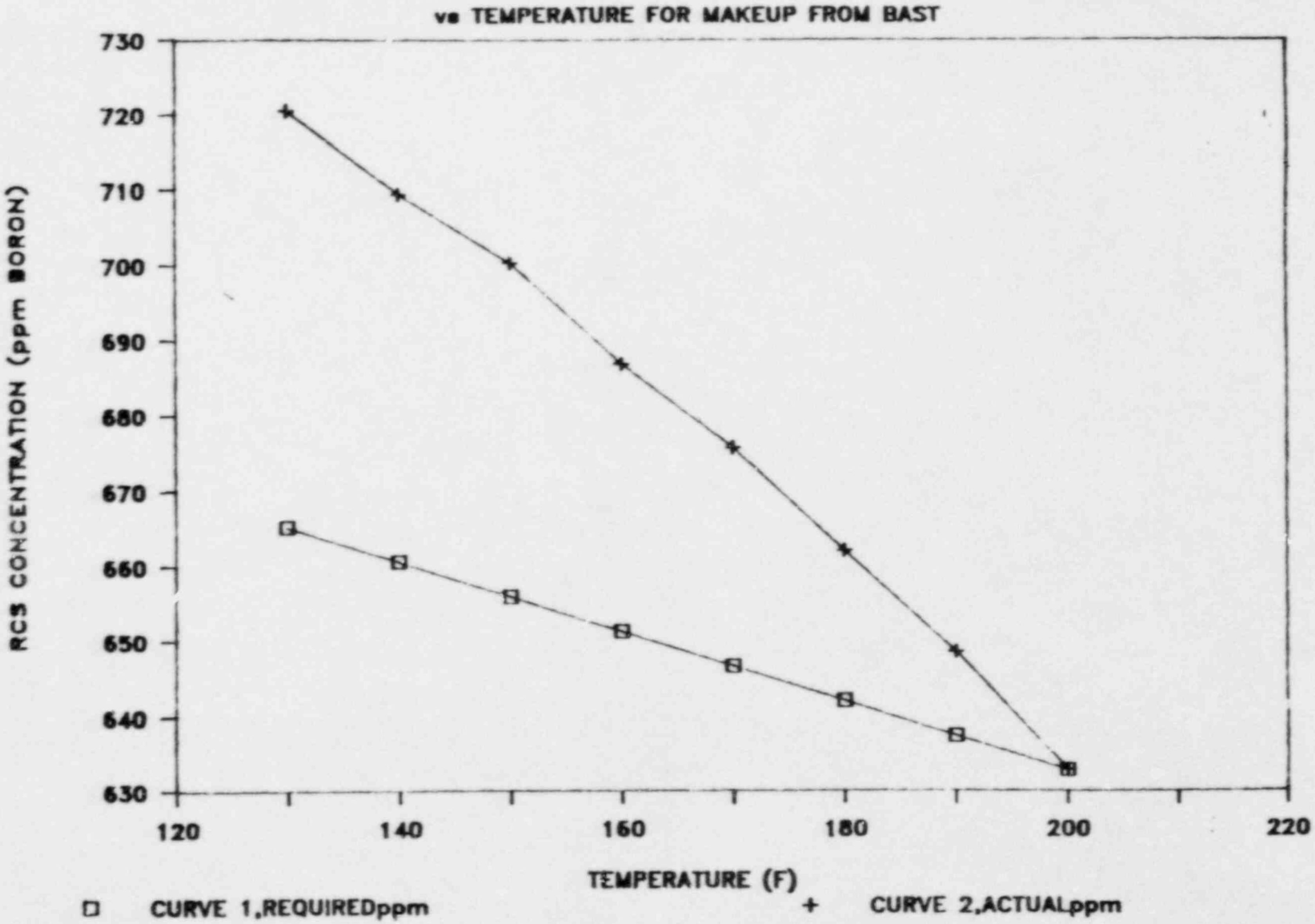


FIGURE 4 RCS BORON CONCENTRATION

vs TEMPERATURE FOR MAKEUP FROM RWST