LIMITING CONDITIONS FOR OPERATION

3.4 STANDBY LIQUID CONTROL SYSTEM

Applicability

Applies to the operating status of the Standby Liquid Control System.

Objective

To assure the availability of a system with the capability to shut down the reactor and maintain the shutdown condition without the use of control rods.

Specification

A. Normal System Availability

1. Except as specified in 3.4.B.1, the ~~The~~ Standby Liquid Control System shall be operable at all times when there is fuel in the reactor vessel and the reactor is not in a shutdown condition with all operable control rods fully inserted except as specified in 3.4.B.1.

Specification 3.3.A.1 satisfied.

SURVEILLANCE REQUIREMENTS

4.4 STANDBY LIQUID CONTROL SYSTEM

Applicability

Applies to the surveillance requirements of the Standby Liquid Control System.

Objective

To verify the operability of the Standby Liquid Control System.

Specification

A. Normal System Availability

The operability of the Standby Liquid Control System shall be verified by the performance of the following tests:

* Note: This change was submitted to NRC 10/27/87

1. Verify pump OPERABILITY in accordance with Specification 1.0.MM.

2. At least once during each operating cycle:

    a. Check that the setting of the system relief valves is 1,425 ± 75 psig.

    b. Manually initiate the system, except explosive valves. Visually verify flow by pumping boron solution through the recirculation path and back to the Standby Liquid Control Solution Tank. Verify minimum pump flow rate of 39 gpm against a system head of 1275 psig by pumping demineralized water ~~through~~ from the

After pumping boron solution the system shall be flushed with demineralized water.

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3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

B. Operation with Inoperable Components

1. From and after the date that a redundant component is made or found to be inoperable, Specification 3.4.A.1 shall be considered fulfilled and continued operation permitted provided that the component is returned to an operable condition within seven days.

SURVEILLANCE REQUIREMENTS

4.4.A Normal System ~~Applicability~~ Availability

4.4.A.2.b. (Cont'd)

Standby Liquid Control Test Tank. After pumping boron solution, the system shall be flushed with demineralized water.

e

c. Manually initiate one of the Standby Liquid Control System loops and pump demineralized water into the reactor vessel.

This test checks explosion of the charge associated with the tested loop, proper operation of the valves, and pump operability. Replacement charges shall be selected such that the age of charge in service shall not exceed five years from the manufacturer's assembly date.

d. Both systems, including both explosive valves, shall be tested in the course of two operating cycles.

B. Surveillance with Inoperable Components

1. When a component is found to be inoperable, its redundant component shall be demonstrated to be operable immediately and daily thereafter until the inoperable component is repaired.

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LIMITING CONDITIONS FOR OPERATION

3.4.C. Sodium Pentaborate Solution

At all times when the Standby Liquid Control System is required to be operable the following conditions shall be met:

1. The net volume - concentration of the Liquid Control Solution in the liquid control tank shall be maintained as required in Figure 3.4-1.
2. The temperature of the liquid control solution shall be maintained above the curve shown in Figure 3.4-2. This includes the piping between the standby liquid control tank and the suction inlet to the pumps.

E ~~D~~. If Specification 3.4.A through 3.4.~~C~~ D cannot be met, make at least one subsystem operable within 8 hours or the reactor shall be placed in a Shutdown Condition with all operable control rods fully inserted within ~~24~~ the following 12 hours.

1. At least 180 lbs Boron-10 must be stored in the Standby Liquid Control Solution Tank and be available for injection.
2. The sodium penta borate Solution Concentration must be equal to or less than 9.2% by weight

SURVEILLANCE REQUIREMENTS

4.4.C. Sodium Pentaborate Solution

The following tests shall be performed to verify the availability of the Liquid Control Solution:

1. Volume: Check at least once per day.
2. Temperature: Check at least once per day.
3. Concentration: Check at least once per month. Also check concentration any time water or boron is added to the solution or solution temperature is below the temperature required in Figure 3.4-2.

2. Sodium Pentaborate Concentration Check at least once per month. Also, check concentration within 24 hours any time water or boron is added to the Solution
3. Boron-10 Quantity: At least on per month, Calculate and record the quantity of Boron-10 stored in the Standby Liquid Control Solution Tank.
4. Boron-10 Enrichment: At least once per 18 months and following each addition of boron to the Standby Liquid Control Solution Tank:
   a. Calculate the enrichment within 24 hours.
   b. Verify by analysis within 30 days

E. No additional surveillance required

New Page

DBY LIQUID CONTROL SYSTEM

CONDITIONS FOR OPERATION | SURVEILLANCE REQUIREMENTS

D

The Standby Liquid Control System conditions must satisfy the following equation.

$$\frac{(\quad C \quad)(\quad Q \quad)(\quad E \quad)}{(13\ \text{wt.\%})(86\ \text{gpm})(19.8\ \text{atom\%})} \geq 1$$

where,

C = sodium pentaborate solution concentration (weight percent)

Determined by the most recent performance of the surveillance instruction required by Specification 4.4.C.2.

Q = pump flow rate (gpm)

Determined by the most recent performance of the surveillance instruction required by Specification 4.4.A.2.b.

E = Boron-10 enrichment (atom percent Boron-10)

Determined by the most recent performance of the surveillance instruction required by Specification 4.4.C.4.b.

D

4.4.~~E~~. Verify that the equation given in Specification 3.4.~~E~~ D is satisfied at least once per month and any time water or boron is added to the solution.

within 24 hours

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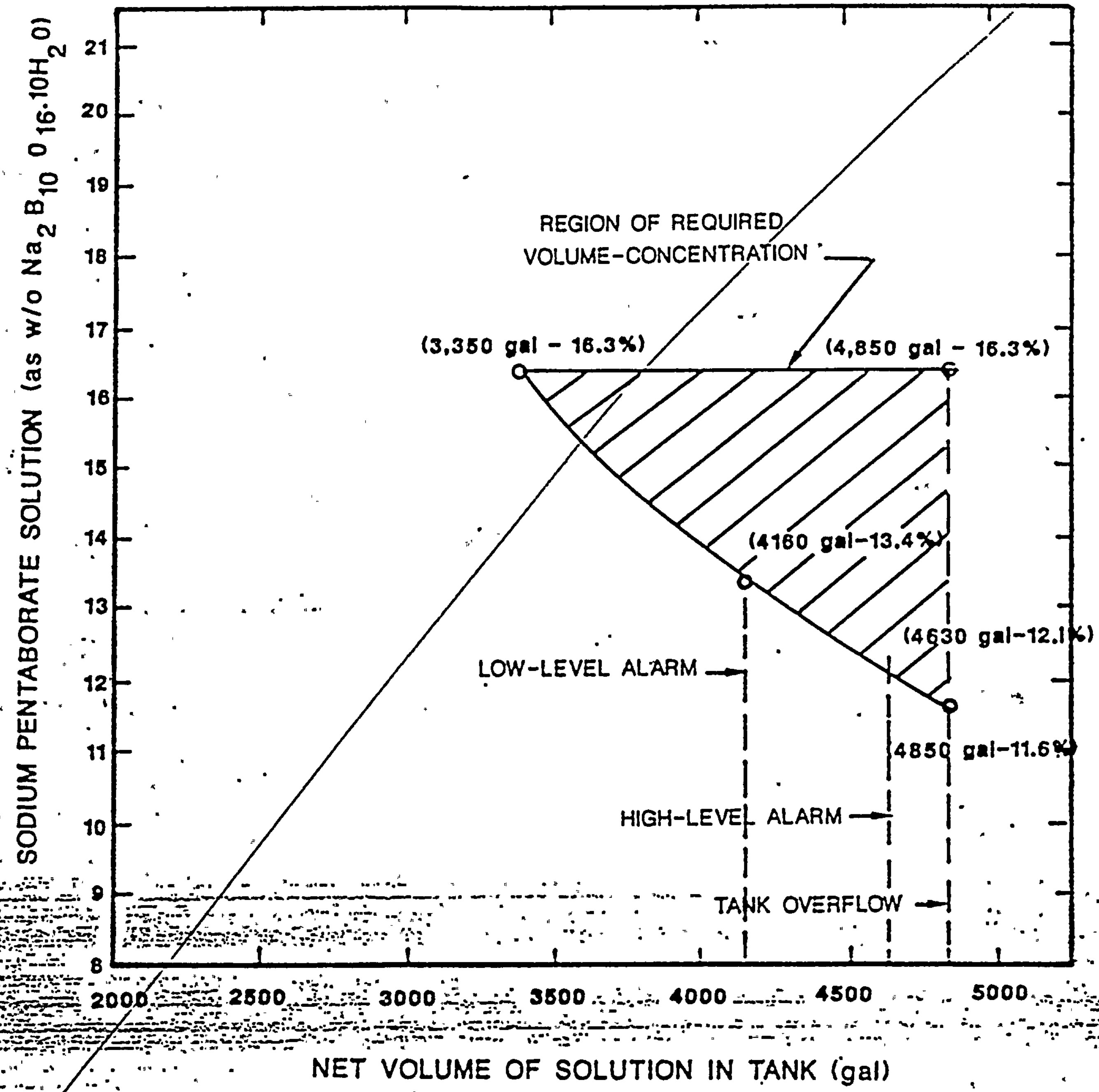

SODIUM PENTABORATE SOLUTION VOLUME-CONCENTRATED REQUIREMENTS

FIGURE 3.4-1

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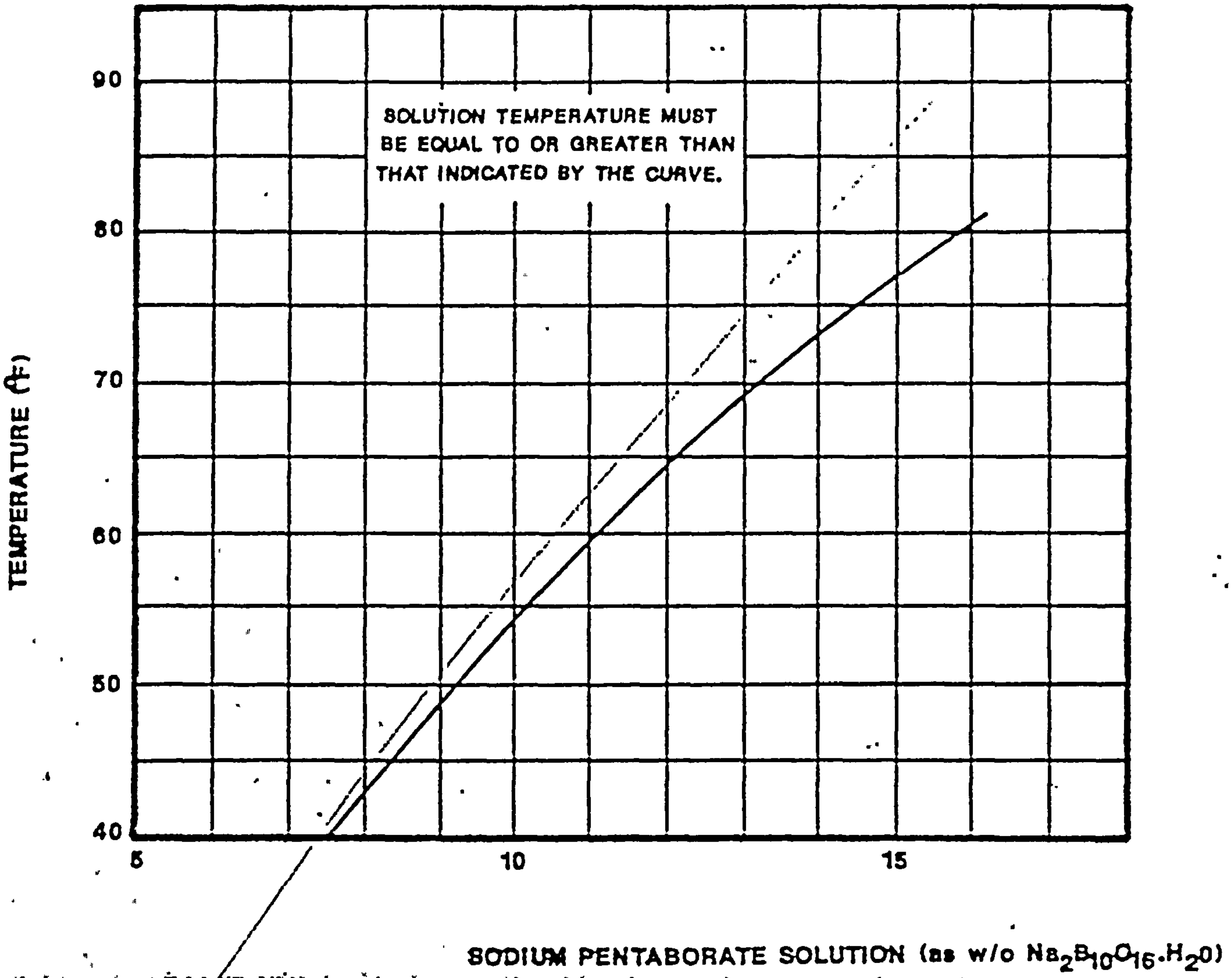

SODIUM PENTABORATE SOLUTION TEMPERATURE REQUIREMENTS

FIGURE 3.4-2

Major portion of [illegible]

3.4 BASES: STANDBY LIQUID CONTROL SYSTEM

A. If no more than one OPERABLE control rod is withdrawn, the basic shutdown reactivity requirement for the core is satisfied and the Standby Liquid Control System is not required. Thus, the basic reactivity requirement for the core is the primary determinant of when the liquid control system is required.

The purpose of the liquid control system is to provide the capability of bringing the reactor from full power to a cold, xenon-free shutdown condition assuming that none of the withdrawn control rods can be inserted. To meet this objective, the liquid control system is designed to inject a quantity of Boron-10 (the boron isotope with the high neutron cross section) that produces a concentration greater than 660 600 ppm of natural boron in the reactor core. This amount of Boron-10 is required to bring the reactor from full power to a subcritical condition, considering the hot to cold reactivity difference, xenon poisoning, etc. The quantity of stored boron includes an additional margin (25 percent) beyond the amount needed to shut down the reactor to allow for possible imperfect mixing of the chemical solution in the reactor water. The minimum limitation on the relief valve setting is intended to prevent the loss of liquid control solution via the lifting of a relief valve at too low a pressure. The upper limit on the relief valve settings provides system protection from overpressure.

B. Only one of the two standby liquid control pumping loops is needed for operating the system. One INOPERABLE pumping circuit does not immediately threaten shutdown capability, and reactor operation can continue while the circuit is being repaired. Assurance that the remaining system will perform its intended function and that the long-term average availability of the system is not reduced is obtained from a one-out-of-two system by an allowable equipment out-of-service time of one-third of the normal surveillance frequency. This method determines an equipment out-of-service time of 10 days. Additional conservatism is introduced by reducing the allowable out-of-service time to seven days, and by increased testing of the OPERABLE redundant component.

C. Level indication and alarm indicate whether the solution volume has changed, which might indicate a possible solution concentration change. The test interval has been established in consideration of these factors. Liquid level alarm for the system is annunciated in the control room.

The sodium pentaborate solution concentration is limited to less than 9.2 weight percent. This ~~restriction~~ concentration limits the saturation temperature to 40°F which yields a 10°F margin below the abnormal minimum ambient temperature. of 50°F

D ~~E~~. To meet 10 CFR 50.62, the Standby Liquid Control system must have a minimum flow capacity and boron content equivalent in control capacity to 86 gpm of 13 weight percent natural sodium pentaborate solution.

3.4 BASES (Cont'd)

This equivalency requirement is met when the equation given in 3.4.~~E~~D is satisfied. Each parameter in the equation is tested consistent with its potential to vary. The enriched sodium pentaborate solution is made by combining stoichiometric quantities of borax and boric acid in demineralized water. Since the chemicals used have known Boron-10 enrichments, the Boron-10 enrichment of the sodium pentaborate formed can be calculated. Following initial solution formation or chemical addition, the result of this calculation will be used to determine compliance with 3.4.~~E~~D pending subsequent verification by analysis.

4.4 BASES: STANDBY LIQUID CONTROL SYSTEM

Experience with pump operability indicates that the pump loop functional test, in combination with the tests during each operating cycle, is sufficient to maintain pump performance. Various components of the system are individually tested periodically, thus making unnecessary more frequent testing of the entire system.

The solution volume, concentration and B-10 enrichment are checked at a frequency to assure a high reliability of operation of the system should it ever be required.

ENCLOSURE 2

DESCRIPTION AND JUSTIFICATION
BROWNS FERRY NUCLEAR PLANT
UNITS 1, 2, AND 3

Description of Change

This change modifies the Standby Liquid Control System (SLCS) to allow enriched sodium pentaborate to be used. Boric acid, enriched to 92 atom percent Boron-10, is combined with borax (natural boron) to form sodium pentaborate. Enriched sodium pentaborate has an increased shutdown capacity due to the increased percentage of boron-10.

The limiting conditions for operation of technical specification section 3.4.C are changed to restore the cold shutdown requirement in terms of Boron-10 and to limit the concentration of the sodium pentaborate solution, thus limiting the saturation temperature. Technical specification section 3.4.D is added to incorporate an equivalency equation to ensure the requirements for reduction of risk from Anticipated Transients Without Scram (ATWS) events of 10 CFR 50.62 are met.

Three new surveillance requirements are also added -- technical specification 4.4.C.3, 4.4.C.4, and 4.4.D. The first requires the quantity of Boron-10 which is stored in the standby liquid control (SLC) solution tank to be calculated and recorded at least once per month. The second specifies that the Boron-10 enrichment be checked any time boron is added to the solution. The third requires verification that the equivalency equation given in specification 3.4.D is satisfied.

Due to the lower required concentration of sodium pentaborate and its associated saturation temperature, the requirement to monitor the solution temperature is deleted. In addition, figures 3.4-1 "Sodium Pentaborate Solution Volume - Concentration Requirements" and 3.4-2 "Sodium Pentaborate Solution Temperature Requirements" are deleted.

The final change, which is not directly related to the ATWS rule, is to revise the SLCS operability requirement technical specification 3.4.A.1. The revision will replace the requirement that all operable control rods be fully inserted with a requirement that the reactivity limitations of technical specification 3.3.A.1 are satisfied.

Reason for Change

Paragraph (c)(4) of 10 CFR 50.62 states in part "Each boiling water reactor must have a SLCS with a minimum flow capacity and boron content equivalent in control capacity to 86 gpm of 13 weight percent sodium pentaborate solution."

Reason for Change (Cont'd)

Three options for meeting this requirement are (1) increased flow rate by two pump operation, (2) increased sodium pentaborate concentration, or (3) Boron-10 enrichment. Two pump operation would require system modification of the SLCS and would eliminate the redundancy of the pumps operated independently. Increased sodium pentaborate solution concentration would require more maintenance due to the higher required solution temperature and might involve system modification. The third option does not involve hardware modification (only setpoint changes). In addition, Boron-10 enrichment will allow BFN to eliminate heat tracing, reduce the volume of solution required, and reduce cleanup time if SLC injection became necessary.

Boron-10 with its large neutron absorption capability is the active component in the solution. The use of a highly enriched solution will provide a faster negative reactivity insertion rate even at lower solution concentrations. The use of lower solution concentrations also eliminates the necessity for heat tracing.

Justification for Change

I. Equivalency with the ATWS Rule (Sufficient Boron to Achieve Hot Shutdown)

The requirement of the ATWS rule in 10 CFR 50.62, paragraph (C)(4) is that the SLCS have a minimum flow capacity and boron content equivalent in control capacity to 86 gallons per minute of 13 weight percent sodium pentaborate solution. This requirement assumes the use of natural boron which contains 19.8 atom percent Boron-10. Boron-10 is the isotope of concern when determining the control capacity of the sodium pentaborate. Equivalency can be satisfied by comparing concentration, flow rate, and Boron-10 enrichment for the actual system with the ATWS rule. (Refer to General Electric's Licensing Topical Report NEDE-31096-PA and NRC's safety evaluation of the report, dated October 21, 1986, page XII, reference 1.) BFN will continue to check the solution concentration at least once a month and any time water or boron is added to the solution. The flow rate used in the equation will be determined once during each operating cycle as required by technical specification section 4.4.A.2.b. A requirement is added to calculate and subsequently verify by analysis the Boron-10 enrichment following each addition of boron to the solution tank.

II. Standby Liquid Control System Requirements for Cold Shutdown

Currently the Browns Ferry Nuclear Plant Final Safety Analysis Report (FSAR) specifies 600 ppm natural boron as the average concentration in the reactor coolant to provide the required shutdown margin.This concentration will not be adequate to meet the SLCS shutdown margin.

requirement for future cycles beginning with cycle 6 of unit 2. General Electric has recommended in Service Information Letter 325 (reference 2) an increase in final boron concentration to 660 ppm. TVA Reactor Fuel and Analysis staff has confirmed that 660 ppm natural boron will satisfy the SLCS shutdown requirement for projected future cycles. This 660 ppm natural boron concentration is increased by 25 percent to 825 ppm natural boron to allow for imperfect mixing, leakage, and piping connected to the reactor.

Using this 825 ppm natural boron and the volume of reactor coolant in cold shutdown, the amount of natural boron required can be determined. Then using 19.8 percent, the atom percent of Boron-10 in natural boron, the amount of Boron-10 required for cold shutdown can be determined. This calculation shows that 179.4 pounds of Boron-10 is required to achieve cold shutdown. Therefore, at least 180 pounds of Boron-10 must be stored in the SLC solution tank at all times when the SLCS is required to be operable. (Refer to BFN calculation, BFN APS7-007.)

III. Maximum Allowed Sodium Pentaborate Concentration Without Heat Tracing

TVA Drawing 47W225-63 gives a minimum normal temperature of 60°F and a minimum abnormal temperature of 50°F for the SLC tank area on elevation 639.0 of the Reactor Building. The saturation temperature of a 9.2 weight percent sodium pentaborate solution is 40°F. Thus, a 10° F margin is maintained at all times.

The temperature monitoring requirements have been deleted from the technical specification since the new upper limit on the solution concentration has been set at 9.2 weight percent sodium pentaborate. At this concentration, the saturation temperature is 10°F below the minimum abnormal temperature for that area of the building. Therefore, technical specification surveillance of the solution temperature is no longer necessary. However, a temperature alarm at a preset low temperature will remain in operation. Its alarm setpoint will be changed to 50°F plus an allowance for drift.

The current technical specification bases state that should evaporation occur the low level alarm will annunciate before the temperature-concentration requirements are exceeded. The revised bases have deleted this statement since (1) the volume and concentration requirements have changed, (2) the system heat tracing will no longer be used for normal operation, thereby reducing any evaporative losses, and (3) significant evaporation has not occurred in the past.

The low level alarm setpoint has been lowered because of the reduced volume of solution required. The high level alarm setpoint has also been lowered which will enhance its primary safety function of warning the operator before the tank can overflow if water is being added accidently.

Justification for Change (Cont'd)

IV. Maximum and Minimum Injection Rates

The BFN FSAR limits the boron injection rate to the range of eight to 20 ppm boron per minute. The basis for the lower eight ppm per minute is the maximum time allowed to shutdown the reactor. The upper 20 ppm per minute injection rate limit assures sufficient reactor vessel mixing such that the boron does not recirculate through the core in uneven concentrations which could result in nuclear power cyclic oscillations. These requirements are both superseded by the more stringent ATWS rule.

V. Solution Surveillance

The tank level will be observed daily. The sodium pentaborate concentration will be analyzed with the same frequency as at present. In addition, the Boron-10 enrichment will be determined by calculation within 24 hours of an addition of boron and once per 18 months. The 24-hour interval is based on engineering judgment considering the capability to perform the surveillance. Calculations will be confirmed by analysis within 30 days. BFN intends to have the capability to perform the enrichment analysis on site within seven days of addition of boron. A 30-day period is necessary should a sample need to be sent off site because of test equipment inoperability. As the boron enrichment is not expected to vary over time except by addition of boron with a different Boron-10 enrichment, this is an adequate surveillance interval. The possibility of a loss of enrichment control will be precluded by procurement from a certified vendor, segregated storage, random sampling prior to use by an offsite laboratory, the removal from the site of all remaining natural boron, and the handling and addition of boron only by chemistry personnel.

VI. Normal System Availability

The bases for specification 3.4.A.1 states "If no more than one operable control rod is withdrawn, the basic shutdown reactivity for the core is satisfied and the SLCS is not required." This comes from technical specification 3.3.A.1, which requires a sufficient number of control rods operable to make the core subcritical in the most reactive condition with the strongest control rod fully withdrawn and all other operable rods fully inserted. Meeting technical specification 3.3.A.1 will assure a sufficient reactivity margin is available to shutdown the reactor with control rods. Thus revising technical specification 3.4.A.1 to require that the SLCS be operable when there is fuel in the reactor vessel and the reactor is not shutdown with technical specification 3.3.A.1 satisfied will provide consistency among the technical specifications. This change is also similar to Standard Technical Specifications (NUREG 1202) which allow the control rods to be withdrawn under limited conditions while not requiring the SLCS to be operable.

Justification for Change

The surveillance requirements are being revised to eliminate ambiguity by reordering the sentences in technical specification 4.4.A.2.b. This change is included for clarification only and does not result from any change in the testing procedure.

VII. Shutdown Requirement

Technical specification 3.4.E is revised and renumbered to allow eight hours to make at least one of the subsystems operable or shutdown the reactor within the following 12 hours. With the SLCS unable to perform its function, continued operation is only justifiable for a short time period. The eight hour timeframe is based on engineering judgment considering the low probability of the requirement to use the SLCS. If at least one subsystem cannot be made operable, the reactor must be placed in hot shutdown within the following 12 hours. The 12 hour timeframe to reach hot shutdown is based on engineering judgment considering the capability to reach the specified condition. Insertion of all control rods places the plant in a condition that does not require the SLCS to be operable. The eight and 12 hour timeframes are consistent with the Standard Technical Specifications (NUREG 1202) and are more conservative than the present 24 hours to achieve shutdown. In addition, an explicit eight hours are allowed from discovery of the total inoperability to attempt to fix the problem before initiating actions to bring the plant to hot shutdown.

VIII. Conclusion

The proposed technical specification changes are warranted in order to comply with the ATWS requirements of 10 CFR 50.62 to meet the SLCS shutdown requirements for future fuel cycles, and to clarify the technical specifications. TVA has concluded based on the safety evaluation performed that the proposed changes increase the margin of nuclear safety.

References:

1. General Electric Company Licensing Topical Report NEDE-91096 PA of February 1987 - Anticipated Transients Without Scram Response to NRC ATWS Rule, 10 CFR 50.62

2. General Electric Service Information Letter 325 - Standby Liquid Control System capability dated June 1980.