



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-259

BROWNS FERRY NUCLEAR PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 154
License No. DPR-33

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Tennessee Valley Authority (the licensee) dated April 20, 1988, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

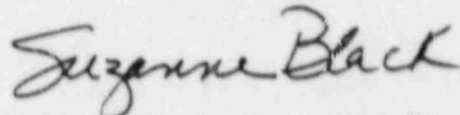
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Facility Operating License No. DPR-33 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 154, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Suzanne Black, Assistant Director
for Projects
TVA Projects Division
Office of Special Projects

Attachment:
Changes to the Technical
Specifications

Date of Issuance: September 2, 1988

ATTACHMENT TO LICENSE AMENDMENT NO. 154

FACILITY OPERATING LICENSE NO. DPR-33

DOCKET NO. 50-259

Revise the Appendix A Technical Specifications by removing the pages identified below and inserting the enclosed pages. The revised pages are identified by the captioned amendment number and contain marginal lines indicating the area of change.

REMOVE

3.4/4.4-1
3.4/4.4-2
3.4/4.4-3
3.4/4.4-4
3.4/4.4-5
3.4/4.4-6
3.4/4.4-7

INSERT

3.4/4.4-1
3.4/4.4-2
3.4/4.4-3
3.4/4.4-4
3.4/4.4-5
3.4/4.4-6
-

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

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 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 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:

1. At least once per month each pump loop shall be functionally tested.
2. At least once during each operating cycle:
 - a. Check that the setting of the system relief valves is $1,425 \pm 75$ 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. After pumping boron solution, the system shall be flushed with demineralized water. Verify minimum

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

4.4.A Normal System Availability
(Cont'd)

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

pump flow rate of
39 gpm against a system
head of 1275 psig by
pumping demineralized
water from the
Standby Liquid Control
Test Tank.

- 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.

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

3.4.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.

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. At least 150 pounds Boron-10 must be stored in the Standby Liquid Control Solution tank and be available for injection.
2. The sodium pentaborate solution concentration must be equal to or less than 9.2% by weight.

SURVEILLANCE REQUIREMENTS

4.4.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.

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. Sodium Pentaborate Concentration check at least once per month. Also check concentration within 24 hours anytime water or boron is added to the solution.
3. Boron-10 Quantity:

At least once 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:

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

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

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

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.

3.4.E If Specification 3.4.A through 3.4.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 the following 12 hours.

a. Calculate the enrichment within 24 hours.

b. Verify by analysis within 30 days.

4.4.D Verify that the equation given in Specification 3.4.D is satisfied at least once per month and within 24 hours anytime water or boron is added to the solution.

4.4.E No additional surveillance required.

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 standby 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 that produces a concentration greater than 660 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. Temperature and liquid level alarms for the system are annunciated in the control room.

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

- D. 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 ppm 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.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 borox 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.D pending subsequent verification by analysis.

4.4 BASES: STANDBY LIQUID CONTROL SYSTEM

Experience with pump operability indicates that the month'y 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.



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-260

BROWNS FERRY NUCLEAR PLANT, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No.150
License No. DPR-52

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Tennessee Valley Authority (the licensee) dated April 20, 1988, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

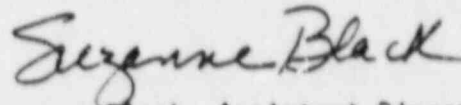
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Facility Operating License No. DPR-52 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 150, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Suzanne Black, Assistant Director
for Projects
TVA Projects Division
Office of Special Projects

Attachment:
Changes to the Technical
Specifications

Date of Issuance: September 2, 1988

ATTACHMENT TO LICENSE AMENDMENT NO. 150

FACILITY OPERATING LICENSE NO. DPR-52

DOCKET NO. 50-260

Revise the Appendix A Technical Specifications by removing the pages identified below and inserting the enclosed pages. The revised pages are identified by the captioned amendment number and contain marginal lines indicating the area of change.

REMOVE

3.4/4.4-1
3.4/4.4-2
3.4/4.4-3
3.4/4.4-4
3.4/4.4-5
3.4/4.4-6
3.4/4.4-7

INSERT

3.4/4.4-1
3.4/4.4-2
3.4/4.4-3
3.4/4.4-4
3.4/4.4-5
3.4/4.4-6
-

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

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 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 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:

1. At least once per month each pump loop shall be functionally tested.
2. At least once during each operating cycle:
 - a. Check that the setting of the system relief valves is $1,425 \pm 75$ 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. After pumping boron solution, the system shall be flushed with demineralized water. Verify minimum

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

4.4.A Normal System Availability
(Cont'd)

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

pump flow rate of
39 gpm against a system
head of 1275 psig by
pumping demineralized
water from the
Standby Liquid Control
Test Tank.

- 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.

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

3.4.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.

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. At least 180 pounds Boron-10 must be stored in the Standby Liquid Control Solution tank and be available for injection.
2. The sodium pentaborate solution concentration must be equal to or less than 9.2% by weight.

4.4.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.

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. Sodium Pentaborate Concentration check at least once per month. Also check concentration within 24 hours anytime water or boron is added to the solution.
3. Boron-10 Quantity:

At least once 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:

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

3.4.D

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

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

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.

3.4.E

If Specification 3.4.A through 3.4.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 the following 12 hours.

a. Calculate the enrichment within 24 hours.

b. Verify by analysis within 30 days.

4.4.D

Verify that the equation given in Specification 3.4.D is satisfied at least once per month and within 24 hours anytime water or boron is added to the solution.

4.4.E

No additional surveillance required.

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 standby 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 that produces a concentration greater than 660 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. Temperature and liquid level alarms for the system are annunciated in the control room.

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

- D. 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 ppm 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.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 borox 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.D pending subsequent verification by analysis.

4.4 BASES: STANDBY LIQUID CONTROL SYSTEM

Experience with pump operability indicates that the monthly 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.



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-296

BROWNS FERRY NUCLEAR PLANT, UNIT 3

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 125
License No. DPR-68

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Tennessee Valley Authority (the licensee) dated April 20, 1988, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

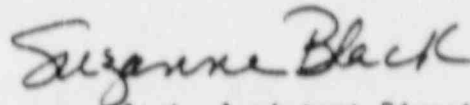
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment and paragraph 2.C.(2) of Facility Operating License No. DPR-68 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendices A and B, as revised through Amendment No. 125, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 60 days from the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Suzanne Black, Assistant Director
for Projects
TVA Projects Division
Office of Special Projects

Attachment:
Changes to the Technical
Specifications

Date of Issuance: September 2, 1988

ATTACHMENT TO LICENSE AMENDMENT NO. 125

FACILITY OPERATING LICENSE NO. DPR-68

DOCKET NO. 50-296

Revise the Appendix A Technical Specifications by removing the pages identified below and inserting the enclosed pages. The revised pages are identified by the captioned amendment number and contain marginal lines indicating the area of change.

REMOVE

3.4/4.4-1
3.4/4.4-2
3.4/4.4-3
3.4/4.4-3
3.4/4.4-4
3.4/4.4-5
3.4/4.4-6
3.4/4.4-7

INSERT

3.4/4.4-1
3.4/4.4-2
3.4/4.4-3
3.4/4.4-3
3.4/4.4-4
3.4/4.4-5
3.4/4.4-6
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3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

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 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 Specification 3.3.A.1 satisfied.

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:

1. At least once per month each pump loop shall be functionally tested.
2. At least once during each operating cycle:
 - a. Check that the setting of the system relief valves is $1,425 \pm 75$ 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. After pumping boron solution, the system shall be flushed with demineralized water. Verify minimum

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

4.4.A Normal System Availability
(Cont'd)

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

pump flow rate of
39 gpm against a system
head of 1275 psig by
pumping demineralized
water from the
Standby Liquid Control
Test Tank.

- 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.

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

3.4.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.

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. At least 180 pounds Boron-10 must be stored in the Standby Liquid Control Solution tank and be available for injection.
2. The sodium pentaborate solution concentration must be equal to or less than 9.2% by weight.

4.4.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.

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. Sodium Pentaborate Concentration check at least once per month. Also check concentration within 24 hours anytime water or boron is added to the solution.
3. Boron-10 Quantity:

At least once 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:

3.4/4.4 STANDBY LIQUID CONTROL SYSTEM

LIMITING CONDITIONS FOR OPERATION

SURVEILLANCE REQUIREMENTS

3.4.D

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

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

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.

3.4.E

If Specification 3.4.A through 3.4.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 the following 12 hours.

a. Calculate the enrichment within 24 hours.

b. Verify by analysis within 30 days.

4.4.D

Verify that the equation given in Specification 3.4.D is satisfied at least once per month and within 24 hours anytime water or boron is added to the solution.

4.4.E

No additional surveillance required.

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 standby 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 that produces a concentration greater than 660 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. Temperature and liquid level alarms for the system are annunciated in the control room.

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

- D. 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 ppm 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.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 borox 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.D pending subsequent verification by analysis.

4.4 BASES: STANDBY LIQUID CONTROL SYSTEM

Experience with pump operability indicates that the monthly 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.