

## B 3.9 REFUELING OPERATIONS

### B 3.9.1 Boron Concentration

#### BASES

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##### BACKGROUND

The limit on the boron concentrations of the Reactor Coolant System (RCS), the refueling canal, and the refueling cavity during refueling ensures that the reactor remains subcritical during MODE 6. Refueling boron concentration is the soluble boron concentration in the coolant in each of these volumes having direct access to the reactor core during refueling.

The soluble boron concentration offsets the core reactivity and is measured by chemical analysis of a representative sample of the coolant in each of the volumes. The refueling boron concentration limit is specified in the COLR. Plant procedures ensure the specified boron concentration in order to maintain an overall core reactivity of  $k_{\text{eff}} \leq 0.95$  during fuel handling, with control rods and fuel assemblies assumed to be in the most adverse configuration (least negative reactivity) allowed by plant procedures.

GDC 26 of 10 CFR 50, Appendix A, requires that two independent reactivity control systems of different design principles be provided (Ref. 1). One of these systems must be capable of holding the reactor core subcritical under cold conditions. The Low Head Safety Injection (LHSI) System and the Medium Head Safety Injection (MHSI) System are capable of maintaining the reactor subcritical in cold conditions by supplying borated water from the In-Containment Refueling Water Storage Tank (IRWST) to maintain boron concentration.

The reactor is brought to shutdown conditions before beginning operations to open the reactor vessel for refueling. After the RCS is cooled and depressurized and the vessel head is unbolted, the head is slowly removed to form the refueling cavity. The refueling canal and the refueling cavity can then be flooded with borated water from the IRWST through the open reactor vessel by the use of the LHSI pumps.

The mixing action of the LHSI pump in RHR mode and the natural circulation currents due to thermal driving heads in the upper reactor vessel and refueling cavity further mix the added concentrated boric acid with the water in the refueling canal. The LHSI pump in RHR mode is in operation during refueling (see LCO 3.9.4, "Residual Heat Removal (RHR) Loops - High Water Level," and LCO 3.9.5, "Residual Heat Removal (RHR) Loops - Low Water Level") to provide forced circulation in the RCS and assist in maintaining the boron concentrations in the RCS, the refueling canal, and the refueling cavity above the COLR limit.

## BASES

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### APPLICABLE SAFETY ANALYSES

During refueling operations, the reactivity condition of the core is consistent with the initial conditions assumed for the boron dilution accident in the accident analysis and is conservative for MODE 6. The boron concentration limit specified in the COLR is based on the core reactivity at the beginning of each fuel cycle (the end of refueling) and includes an uncertainty allowance.

The required boron concentration and the plant refueling procedures that verify the correct fuel loading plan (including full core mapping) ensure that the  $k_{\text{eff}}$  of the core will remain  $\leq 0.95$  during the refueling operation. Hence, at least a 5%  $\Delta k/k$  margin of safety is established during refueling.

During refueling, the water volume in the spent fuel pool, the transfer canal, the refueling canal, the refueling cavity, and the reactor vessel form a single mass. As a result, the soluble boron concentration is relatively the same in each of these volumes.

The limiting boron dilution accident analyzed occurs in MODE 5 (Ref. 2). A detailed discussion of this event is provided in Bases B 3.1.1, "SHUTDOWN MARGIN (SDM)."

The RCS boron concentration satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

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### LCO

The LCO requires that a minimum boron concentration be maintained in the RCS, the refueling canal, and the refueling cavity while in MODE 6. The boron concentration limit specified in the COLR ensures that a core  $k_{\text{eff}}$  of  $\leq 0.95$  is maintained during fuel handling operations. Violation of the LCO could lead to an inadvertent criticality during MODE 6.

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### APPLICABILITY

This LCO is applicable in MODE 6 to ensure that the fuel in the reactor vessel will remain subcritical. The required boron concentration ensures a  $k_{\text{eff}} \leq 0.95$ . Above MODE 6, LCO 3.1.1, "SHUTDOWN MARGIN (SDM)," ensures that an adequate amount of negative reactivity is available to shut down the reactor and maintain it subcritical.

The Applicability is modified by a Note. The Note states that the limits on boron concentration are only applicable to the refueling canal and the refueling cavity when those volumes are connected to the RCS. When the refueling canal and the refueling cavity are isolated from the RCS, no potential path for boron dilution exists.

## BASES

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### ACTIONS

#### A.1

Continuation of positive reactivity additions (including actions to reduce boron concentration) is contingent upon maintaining the unit in compliance with the LCO. If the boron concentration of any coolant volume in the RCS, the refueling canal, or the refueling cavity is less than its limit, all operations involving positive reactivity additions must be suspended immediately.

Suspension of positive reactivity additions shall not preclude moving a component to a safe position. Operations that individually add limited positive reactivity (e.g., temperature fluctuations from inventory addition or temperature control fluctuations), but when combined with all other operations affecting core reactivity (e.g., intentional boration) result in overall net negative reactivity addition, are not precluded by this action.

#### A.2

In addition to immediately suspending positive reactivity additions, boration to restore the concentration must be initiated immediately.

In determining the required combination of boration flow rate and concentration, no unique Design Basis Event must be satisfied. The only requirement is to restore the boron concentration to its required value as soon as possible. In order to raise the boron concentration as soon as possible, the operator should begin boration with the best source available for unit conditions.

Once action has been initiated, it must be continued until the boron concentration is restored. The restoration time depends on the amount of boron that must be injected to reach the required concentration.

## BASES

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### SURVEILLANCE REQUIREMENTS

#### SR 3.9.1.1

This SR ensures that the coolant boron concentration in the RCS, and connected portions of the refueling canal and the refueling cavity, is within the COLR limits. The boron concentration of the coolant in each required volume is determined periodically by chemical analysis. Prior to re-connecting portions of the refueling canal or the refueling cavity to the RCS, this SR must be met per SR 3.0.4. If any dilution activity has occurred while the cavity or canal was disconnected from the RCS, this SR ensures the correct boron concentration prior to communication with the RCS.

The Frequency of once every 72 hours is a reasonable amount of time to verify the boron concentration of representative samples. The Frequency is based on operating experience, which has shown 72 hours to be adequate.

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### REFERENCES

1. 10 CFR 50, Appendix A, GDC 26.
  2. FSAR Section 15.4.
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## B 3.9 REFUELING OPERATIONS

### B 3.9.2 Nuclear Instrumentation

#### BASES

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BACKGROUND	<p>Three source range neutron flux monitors are used during refueling operations and prior to criticality to monitor the core reactivity condition. The installed source range neutron flux monitors are part of the nuclear instrumentation system. These detectors are located external to the reactor vessel and detect neutrons leaking from the core.</p> <p>The installed source range neutron flux monitors are boron-lined detectors operating in the proportional region of the gas filled detector characteristic curve. The detectors monitor the neutron flux in counts per second. The instrument range covers the lower six decades of neutron flux (1E+6 cps). The detectors also provide visual indication in the control room and can provide an audible count rate to alert operators to a possible dilution accident. The nuclear instrumentation is designed in accordance with the criteria presented in Reference 1.</p>
APPLICABLE SAFETY ANALYSES	<p>The source range neutron flux monitors have no safety function and are not assumed to function during any design basis accident or transient analysis. However, the source range neutron flux monitors provide the only on scale monitoring of neutron flux levels during startup and refueling. Therefore, they are being retained in the Technical Specifications. The source range neutron flux monitors satisfy Criterion 3 of 10CFR 50.36 (c)(2)(ii).</p>
LCO	<p>This LCO requires that two source range neutron flux monitors be OPERABLE to ensure that redundant monitoring capability is available to detect changes in core reactivity. To be OPERABLE, each monitor must provide visual indication in the control room.</p>
APPLICABILITY	<p>In MODE 6, the source range neutron flux monitors must be OPERABLE to determine changes in core reactivity. There are no other direct means available to check core reactivity levels.</p>

## BASES

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### ACTIONS

#### A.1 and A.2

With one required source range neutron flux monitor inoperable redundancy has been lost. Since these instruments are the only direct means of monitoring core reactivity conditions, positive reactivity additions including introduction of coolant into the RCS with boron concentration less than required to meet the minimum boron concentration specified in the COLR must be suspended immediately. Suspending positive reactivity additions that could result in failure to meet the minimum boron concentration limit is required to assure continued safe operation. Introduction of coolant inventory must be from sources that have a boron concentration greater than what would be required in the RCS for minimum refueling boron concentration. This may result in an overall reduction in RCS boron concentration, but provides acceptable margin to maintaining subcritical operation. Performance of Required Action A.1 shall not preclude completion of movement of a component to a safe position.

#### B.1

With no source range neutron flux monitor OPERABLE, action to restore a monitor to OPERABLE status shall be initiated immediately. Once initiated, action shall be continued until a source range neutron flux monitor is restored to OPERABLE status.

#### B.2

With no source range neutron flux monitor OPERABLE, there are no direct means of detecting changes in core reactivity. However, since positive reactivity additions are not to be made, the core reactivity condition is stabilized until the source range neutron flux monitors are OPERABLE. This stabilized condition is determined by performing SR 3.9.1.1 to ensure that the required boron concentration exists.

The Completion Time of once per 12 hours is sufficient to obtain and analyze a reactor coolant sample for boron concentration and ensures that unplanned changes in boron concentration would be identified. The 12 hour Frequency is reasonable, considering the low probability of a change in core reactivity during this time period.

## BASES

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### SURVEILLANCE REQUIREMENTS

#### SR 3.9.2.1

SR 3.9.2.1 is a CHANNEL CHECK, which is a comparison of the parameter indicated on one channel to a similar parameter on other channels. It is based on the assumption that the two indication channels should be consistent with core conditions. Changes in fuel loading and core geometry can result in significant differences between source range channels, but each channel should be consistent with its local conditions.

The Frequency of 12 hours is based on operating experience that demonstrates channel failure is rare.

#### SR 3.9.2.2

SR 3.9.2.2 is the performance of a CALIBRATION every 24 months. This SR is modified by a Note stating that neutron detectors are excluded from the CALIBRATION. The CALIBRATION for the source range neutron flux monitors consists of obtaining the detector plateau or preamp discriminator curves, evaluating those curves, and comparing the curves to the manufacturer's data. The CALIBRATION also includes verification of the audible count rate and alarm function. The 24 month Frequency is based on the need to perform this Surveillance under the conditions that apply during a plant outage.

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### REFERENCES

1. 10 CFR 50, Appendix A, GDC 13, GDC 26, GDC 28, and GDC 29.
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## B 3.9 REFUELING OPERATIONS

### B 3.9.3 Decay Time

#### BASES

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BACKGROUND	<p>The movement of irradiated fuel assemblies within containment or in the fuel handling area inside the Fuel Building requires allowing at least 34 hours for radioactive decay time before fuel assembly handling can be initiated. During fuel handling, the decay time ensures that sufficient radioactive decay has occurred in the event of a fuel handling accident (Refs. 1 and 2). Sufficient radioactive decay of short-lived fission products would have occurred to limit offsite doses from the accident to within the values reported in FSAR Chapter 15 (Ref. 2). Additional limitations on movement of irradiated fuel assemblies to the spent fuel pool are discussed in FSAR Section 9.1 (Ref. 3).</p>
APPLICABLE SAFETY ANALYSES	<p>During movement of irradiated fuel assemblies, the radioactivity decay time is an initial condition design parameter in the analysis of a fuel handling accident inside containment or in the Fuel Building, as postulated by Regulatory Guide 1.183 (Ref. 1).</p> <p>The fuel handling accident analysis inside containment or in the Fuel Building is described in Reference 2. This analysis assumes a minimum radioactive decay time of 34 hours.</p> <p>Radioactive decay time satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).</p>
LCO	<p>A minimum radioactive decay time of 34 hours is required to ensure that the radiological consequences of a postulated fuel handling accident inside containment or in the Fuel Building are within the values calculated in Reference 2.</p>
APPLICABILITY	<p>Radioactive decay time is applicable when moving irradiated fuel assemblies in containment or in the Fuel Building. The LCO minimizes the possibility of radioactive release due to a fuel handling accident that is beyond the assumptions of the safety analysis. If irradiated fuel assemblies are not being moved, there can be no significant radioactivity release as a result of a postulated fuel handling accident. Requirements for fuel handling accidents in the spent fuel pool are also covered by LCO 3.7.14, "Spent Fuel Storage Pool Water Level" and LCO 3.9.6, "Refueling Cavity Water Level".</p>



## BASES

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### ACTIONS

#### A.1

With a decay time of less than 34 hours, all operations involving movement of irradiated fuel assemblies within containment or in the fuel handling area inside the Fuel Building shall be suspended immediately to ensure that a fuel handling accident cannot occur.

The suspension of fuel movement shall not preclude completion of movement to a safe position.

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### SURVEILLANCE REQUIREMENTS

#### SR 3.9.3.1

Verification that the reactor has been subcritical for at least 34 hours prior to movement of irradiated fuel assemblies in the reactor pressure vessel to the refueling cavity in containment or to the Fuel Building ensures that the design basis for the analysis of the postulated fuel handling accident during refueling operations is met. Specifying radioactive decay time limits the consequences of damaged fuel rods that are postulated to result from a fuel handling accident (Ref. 2).

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### REFERENCES

1. Regulatory Guide 1.183, July 2000.
  2. FSAR Chapter 15.
  3. FSAR Section 9.1.
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## B 3.9 REFUELING OPERATIONS

### B 3.9.4 Residual Heat Removal (RHR) Loops - High Water Level

#### BASES

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BACKGROUND	The purpose of the RHR System in MODE 6 is to remove decay heat and sensible heat from the RCS, as required by GDC 34 (Ref. 1). Heat is removed from the RCS by circulating reactor coolant through the LHSI heat exchanger(s), where the heat is transferred to the Component Cooling Water System. The coolant is then returned to the RCS via the RCS cold leg(s). Operation of the RHR System for normal cooldown or decay heat removal is accomplished from the control room. The heat removal rate is adjusted by controlling the flow of reactor coolant through the LHSI heat exchanger(s) and the bypass.
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APPLICABLE SAFETY ANALYSES	If the reactor coolant temperature is not maintained below 200°F, boiling of the reactor coolant could result. This could lead to a loss of coolant in the reactor vessel. Additionally, boiling of the reactor coolant could lead to a reduction in boron concentration in the coolant due to boron plating out on components near the areas of the boiling activity. The loss of reactor coolant and the reduction of boron concentration in the reactor coolant would eventually challenge the integrity of the fuel cladding, which is a fission product barrier. One train of the RHR System is required to be in operation in MODE 6, with the water level $\geq 23$ ft above the top of the reactor vessel flange, to prevent this challenge. The LCO does permit the LHSI pump to be removed from operation for short durations, under the condition that the boron concentration is not diluted. This conditional stopping of the LHSI pump does not result in a challenge to the fission product barrier.
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The RHR System satisfies Criterion 4 of 10 CFR 50.36(c)(2)(ii).

## BASES

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### LCO

Only one RHR loop is required for decay heat removal in MODE 6, with the water level  $\geq 23$  ft above the top of the reactor vessel flange. Only one RHR loop is required to be OPERABLE because the volume of water above the reactor vessel flange provides backup decay heat removal capability. At least one RHR loop must be OPERABLE and in operation to provide:

- a. Removal of decay heat; and
- b. Indication of reactor coolant temperature.

An OPERABLE RHR loop includes an LHSI pump, an LHSI heat exchanger, valves, piping, instruments, and controls to ensure an OPERABLE flow path and to determine the low end temperature. The flow path starts in one of the RCS hot legs and is returned to the RCS cold legs.

The LCO is modified by a Note that allows the required operating RHR loop to be removed from operation for up to 1 hour per 8 hour period, provided no operations are permitted that would dilute the RCS boron concentration by introduction of coolant into the RCS with boron concentration less than required to meet the minimum boron concentration of LCO 3.9.1, "Boron Concentration." Boron concentration reduction with coolant at boron concentrations less than required to assure the RCS boron concentration is maintained is prohibited because uniform concentration distribution cannot be ensured without forced circulation. This permits operations such as core mapping or alterations in the vicinity of the reactor vessel hot leg nozzles. During this 1 hour period, decay heat is removed by natural convection to the large mass of water in the refueling cavity.

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### APPLICABILITY

One RHR loop must be OPERABLE and in operation in MODE 6, with the water level  $\geq 23$  ft above the top of the reactor vessel flange, to provide decay heat removal. The 23 ft water level was selected because it corresponds to the 23 ft requirement established for fuel movement in LCO 3.9.6, "Refueling Cavity Water Level." Requirements for the RHR System in other MODES are covered by LCOs in Section 3.4, RCS. RHR loop requirements in MODE 6 with the water level  $< 23$  ft are located in LCO 3.9.5, "Residual Heat Removal (RHR) Loops - Low Water Level."

## BASES

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### ACTIONS

#### A.1

If RHR loop requirements are not met, actions shall be taken immediately to suspend loading of irradiated fuel assemblies in the core. With no forced circulation cooling, decay heat removal from the core occurs by natural convection to the heat sink provided by the water above the core. A minimum refueling water level of 23 ft above the reactor vessel flange provides an adequate available heat sink. Suspending any operation that would increase decay heat load, such as loading a fuel assembly, is a prudent action under this condition.

#### A.2

If RHR loop requirements are not met, actions shall be initiated and continued in order to satisfy RHR loop requirements. With the unit in MODE 6 and the refueling water level  $\geq$  23 ft above the top of the reactor vessel flange, corrective actions shall be initiated immediately.

#### A.3, A.4, and A.5

If no RHR loop is in operation, the following actions must be taken:

- a. The equipment hatch must be closed and secured;
- b. One door in each air lock must be closed; and
- c. Each penetration providing direct access from the containment atmosphere to the outside atmosphere must be either closed by a manual or automatic isolation valve, blind flange, or equivalent, or verified to be capable of being closed by an OPERABLE Containment Ventilation System.

With the RHR loop requirements not met, the potential exists for the coolant to boil and release radioactive gas to the containment atmosphere. Performing the actions described above ensures that all containment penetrations are either closed or can be closed so that the dose limits are not exceeded.

The Completion Time of 4 hours allows fixing of most RHR problems and is reasonable, based on the low probability of the coolant boiling in that time.

## BASES

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### SURVEILLANCE REQUIREMENTS

#### SR 3.9.4.1

This Surveillance demonstrates that the RHR loop is in operation and circulating reactor coolant. The minimum flow rate specified is to prevent thermal and boron stratification in the core. The Frequency of 12 hours is sufficient, considering the flow, temperature, pump control, and alarm indications available to the operator in the control room for monitoring the RHR System.

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### REFERENCES

1. FSAR Section 5.4.7.
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## B 3.9 REFUELING OPERATIONS

### B 3.9.5 Residual Heat Removal (RHR) Loops - Low Water Level

#### BASES

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BACKGROUND	The purpose of the RHR System in MODE 6 is to remove decay heat and sensible heat from the RCS, as required by GDC 34 (Ref. 1). Heat is removed from the RCS by circulating reactor coolant through the LHSI heat exchangers where the heat is transferred to the Component Cooling Water System. The coolant is then returned to the RCS via the RCS cold leg(s). Operation of the RHR System for normal cooldown decay heat removal is manually accomplished from the control room. The heat removal rate is adjusted by controlling the flow of reactor coolant through the LHSI heat exchanger(s) and the bypass lines.
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APPLICABLE SAFETY ANALYSES	If the reactor coolant temperature is not maintained below 200°F, boiling of the reactor coolant could result. This could lead to a loss of coolant in the reactor vessel. Additionally, boiling of the reactor coolant could lead to a reduction in boron concentration in the coolant due to the boron plating out on components near the areas of the boiling activity. The loss of reactor coolant and the reduction of boron concentration in the reactor coolant will eventually challenge the integrity of the fuel cladding, which is a fission product barrier. Two trains of the RHR System are required to be OPERABLE, and one train in operation, in order to prevent this challenge.
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The RHR System satisfies Criterion 4 of 10 CFR 50.36(c)(2)(ii).

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LCO	<p>In MODE 6, with the water level &lt; 23 ft above the top of the reactor vessel flange, two RHR loops must be OPERABLE. Additionally, one loop of RHR must be in operation in order to provide:</p> <ul style="list-style-type: none"><li>a. Removal of decay heat; and</li><li>b. Indication of reactor coolant temperature.</li></ul>
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## BASES

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### LCO (continued)

An OPERABLE RHR loop consists of an LHSI pump, an LHSI heat exchanger, valves, piping, instruments and controls to ensure an OPERABLE flow path and to determine the low end temperature. The flow path starts in one of the RCS hot legs and is returned to the RCS cold legs.

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### APPLICABILITY

Two RHR loops are required to be OPERABLE, and one RHR loop must be in operation in MODE 6, with the water level < 23 ft above the top of the reactor vessel flange, to provide decay heat removal. Requirements for the RHR System in other MODES are covered by LCOs in Section 3.4, RCS. RHR loop requirements in MODE 6 with the water level  $\geq$  23 ft are located in LCO 3.9.4, "Residual Heat Removal (RHR) Loops - High Water Level."

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### ACTIONS

#### A.1 and A.2

If less than the required number of RHR loops are OPERABLE, action shall be immediately initiated and continued until the RHR loop is restored to OPERABLE status and to operation or until  $\geq$  23 ft of water level is established above the reactor vessel flange. When the water level is  $\geq$  23 ft above the reactor vessel flange, the Applicability changes to that of LCO 3.9.4, "Residual Heat Removal (RHR) Loops – High Water Level," and only one RHR loop is required to be OPERABLE and in operation. An immediate Completion Time is necessary for an operator to initiate corrective actions.

#### B.1

If no RHR loop is in operation, actions shall be initiated immediately, and continued, to restore one RHR loop to operation. Since the unit is in Conditions A and B concurrently, the restoration of two OPERABLE RHR loops and one operating RHR loop should be accomplished expeditiously.

#### B.2, B.3, and B.4

If no RHR loop is in operation, the following actions must be taken:

- a. Verify that the equipment hatch is closed and secured;
  - b. Verify that one door in each air lock is closed; and
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## BASES

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### ACTIONS (continued)

- c. Each penetration providing direct access from the containment atmosphere to the outside atmosphere must be either closed by a manual or automatic isolation valve, blind flange, or equivalent, or verified to be capable of being closed by an OPERABLE Containment Ventilation System.

With the RHR loop requirements not met, the potential exists for the coolant to boil and release radioactive gas to the containment atmosphere. Performing the actions stated above ensures that all containment penetrations are either closed or can be closed so that the dose limits are not exceeded.

The Completion Time of 4 hours allows fixing of most RHR problems and is reasonable, based on the low probability of the coolant boiling in that time and the features available to maintain RHR operation and vessel level (Ref. 1).

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### SURVEILLANCE REQUIREMENTS

#### SR 3.9.5.1

This Surveillance demonstrates that one RHR loop is in operation and circulating reactor coolant. The minimum flow rate specified is to prevent thermal and boron stratification in the core. The Frequency of 12 hours is sufficient, considering the flow, temperature, pump control, and alarm indications available to the operator for monitoring the RHR System in the control room.

#### SR 3.9.5.2

Verification that the required pump is OPERABLE ensures that an additional LHSI pump can be placed in operation, if needed, to maintain decay heat removal and reactor coolant circulation. Verification is performed by verifying proper breaker alignment and power available to the required pump. The Frequency of 7 days is considered reasonable in view of other administrative controls available and has been shown to be acceptable by operating experience. This SR is modified by a Note that states the SR is not required to be performed until 24 hours after a required pump is not in operation.

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### REFERENCES

- 1. FSAR Section 5.4.7.
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## B 3.9 REFUELING OPERATIONS

### B 3.9.6 Refueling Cavity Water Level

#### BASES

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**BACKGROUND**      The movement of irradiated fuel assemblies within containment requires a minimum water level of 23 ft above the top of the reactor vessel flange. During refueling, this maintains sufficient water level in the containment, refueling canal, fuel transfer canal, refueling cavity, and spent fuel pool. Sufficient water is necessary to retain iodine fission product activity in the water in the event of a fuel handling accident (Refs. 1 and 2). Sufficient iodine activity would be retained to limit offsite doses from the accident to well within regulatory limits, as provided by the guidance of Table 6 of Regulatory Guide 1.183 (Ref. 3).

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**APPLICABLE SAFETY ANALYSES**      During movement of irradiated fuel assemblies, the water level in the refueling canal and the refueling cavity is an initial condition design parameter in the analysis of a fuel handling accident in containment, as postulated by Regulatory Guide 1.25 (Ref. 1). A minimum water level of 23 ft (Regulatory Position C.1.c of Ref. 1) allows a decontamination factor of 100 (Regulatory Position C.1.g of Ref. 1) to be used in the accident analysis for iodine. This relates to the assumption that 99% of the total iodine released from the pellet to cladding gap of all the dropped fuel assembly rods is retained by the refueling cavity water. The fuel pellet to cladding gap is assumed to contain 10% of the total fuel rod iodine inventory (Ref. 1).

The fuel handling accident analysis inside containment is described in Reference 2. With a minimum water level of 23 ft and a minimum decay time of 34 hours prior to fuel handling, the analysis and test programs demonstrate that the iodine release due to a postulated fuel handling accident is adequately captured by the water and offsite doses are maintained within allowable limits (Ref. 3).

Refueling cavity water level satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

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**LCO**      A minimum refueling cavity water level of 23 ft above the reactor vessel flange is required to ensure that the radiological consequences of a postulated fuel handling accident inside containment are within acceptable limits, as provided by the guidance of Reference 3.

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## BASES

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**APPLICABILITY** LCO 3.9.6 is applicable when moving irradiated fuel assemblies within containment. The LCO minimizes the possibility of a fuel handling accident in containment that is beyond the assumptions of the safety analysis. If irradiated fuel assemblies are not present in containment, there can be no significant radioactivity release as a result of a postulated fuel handling accident. Requirements for fuel handling accidents in the spent fuel pool are covered by LCO 3.7.14, "Spent Fuel Storage Pool Water Level."

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**ACTIONS** A.1

With a water level of < 23 ft above the top of the reactor vessel flange, all operations involving movement of irradiated fuel assemblies within the containment shall be suspended immediately to ensure that a fuel handling accident cannot occur.

The suspension of fuel movement shall not preclude completion of movement of a component to a safe position.

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**SURVEILLANCE REQUIREMENTS** SR 3.9.6.1

Verification of a minimum water level of 23 ft above the top of the reactor vessel flange ensures that the design basis for the analysis of the postulated fuel handling accident during refueling operations is met. Water at the required level above the top of the reactor vessel flange limits the consequences of damaged fuel rods that are postulated to result from a fuel handling accident inside containment (Ref. 2).

The Frequency of 24 hours is based on engineering judgment and is considered adequate in view of the large volume of water and the normal procedural controls of valve positions, which make significant unplanned level changes unlikely.

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**REFERENCES**

1. Regulatory Guide 1.25, March 1972.
2. FSAR Chapter 15.
3. Regulatory Guide 1.183, July 2000.

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## B 3.9 REFUELING OPERATIONS

### B 3.9.7 Containment Penetrations

#### BASES

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BACKGROUND	<p>Containment closure capability provides an added level of defense during reduced inventory conditions with fuel in the reactor vessel in the unlikely event of loss of core cooling. In MODES 5 and 6, the potential for containment pressurization as a result of an accident is not likely; therefore, requirements to isolate the containment from the outside atmosphere can be less stringent. The LCO requirements are referred to as "containment closure" rather than "containment OPERABILITY." Containment closure means that all potential escape paths are closed or capable of being closed. Since there is no requirement for containment leak tightness, the 10 CFR 50 Appendix J leakage criteria and tests are not required.</p> <p>In MODES 5 and 6, the water inventory in the reactor vessel is controlled at varying levels. For installation and removal of steam generator nozzle dams, the RCS is vented and the reactor vessel level is reduced to approximately mid-loop of the hot legs. For reactor vessel head removal or installation, the reactor vessel level would be just below the reactor vessel flange. Prior to commencement of fuel handling operations, the level in the refueling cavity is maintained in accordance with LCO 3.9.6, "Refueling Cavity Water Level."</p> <p>As discussed in NRC Generic Letter 88-17 (Reference 1) and in FSAR Section 19.1.6 (Reference 2), a loss of residual heat removal cooling can potentially lead to steam and radioactive material release from the RCS. As discussed in FSAR Section 5.4.7.2.1 (Reference 3), design features that support improved safety during shutdown and mid-loop operation include:</p> <ul style="list-style-type: none"><li>– During mid-loop operation, the RCS loop level is controlled by the CVCS low pressure reducing valve to ensure there is sufficient RCS water inventory for operation of the Low Head Safety Injection System (LHSI) pumps in residual heat removal (RHR) mode.</li><li>– Redundant hot leg level sensors that initiate RCS make-up when the RCS hot leg loop level has reached low level.</li><li>– Safety injection via Medium Head Safety Injection System (MHSI) with reduced discharge head during low loop level ensures availability of the LHSI pumps for RHR function.</li></ul>
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## BASES

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### BACKGROUND (continued)

- Automatic stop of the LHSI pumps in RHR mode in the event of a low loop level, or low  $\Delta P_{\text{sat}}$  (difference between the RCS hot leg temperature and the RCS hot leg saturation temperature).
- The reactor vessel water level is continually monitored during a refueling outage with a level sensor.
- Temperature sensors, located at the RCS hot legs, allow temperature measurement of each hot leg when in a reduced inventory condition.

Even with these added safety features, the PRA analysis for loss of RHR event recognized that containment closure was a necessary measure in the mitigation of this event. Since the time needed to plan and accomplish containment closure was expected to exceed the time available prior to the onset of boiling in the reactor vessel for a range of operating conditions, containment closure is necessary prior to venting the RCS and placing the unit in a reduced inventory configuration.

The containment equipment hatch, which is part of the containment pressure boundary, provides a means for moving large equipment and components into and out of containment. During reduced inventory conditions with fuel in the reactor vessel, the equipment hatch must be closed.

The containment air locks, which are also part of the containment pressure boundary, provide a means for personnel access during MODES 1, 2, 3, and 4 in accordance with LCO 3.6.2, "Containment Air Locks." Each air lock has a door at both ends. The doors are normally interlocked to prevent simultaneous opening when containment OPERABILITY is required. During periods of unit shutdown when containment closure is not required, the door interlock mechanism may be disabled, allowing both doors of an air lock to remain open for extended periods when frequent containment entry is necessary. During reduced inventory conditions with fuel in the reactor vessel, containment closure is required; therefore, the door interlock mechanism may remain disabled, but one air lock door must always remain closed.

The requirements for containment closure ensure that a release of fission product radioactivity within containment will be restricted to within regulatory limits.

## BASES

### BACKGROUND (continued)

The Containment Building Ventilation System (CBVS) includes two subsystems, the full flow purge subsystem and the low flow purge subsystem. During MODES 1, 2, 3, and 4, the valves in the full flow purge subsystem penetrations are secured in the closed position. The valves in the low flow purge subsystem can be opened intermittently, but are closed automatically by the Distributed Control System (DCS). Neither of the subsystems is subject to an LCO in MODE 5.

In MODE 6, large air exchanges are necessary to conduct refueling operations. The full flow purge subsystem is used for this purpose and the valves are closed by manual initiation or a high radiation signal.

The low flow purge subsystem remains operational in MODE 6, and all four valves are also closed by manual initiation or a high radiation signal.

The other containment penetrations that provide direct access from containment atmosphere to outside atmosphere must be isolated on at least one side. Isolation may be achieved by an OPERABLE automatic isolation valve, or by a manual isolation valve, blind flange, or equivalent. Equivalent isolation methods must be approved and may include use of a material that can provide a temporary, atmospheric pressure, ventilation barrier for the other containment penetrations during reduced inventory conditions with fuel in the reactor vessel.

### APPLICABLE SAFETY ANALYSES

For postulated events in MODES 5 and 6, decay heat removal is provided by the LHSI in RHR mode. RCS inventory makeup is provided by the MHSI and the In-containment Refueling Water Storage Tank. Containment closure is required prior to venting the RCS and entering a reduced inventory configuration in order to limit the release of steam and radioactive material from containment in the event of a loss of RHR event.

Containment penetrations satisfy Criterion 4 of 10 CFR 50.36(c)(2)(ii).

### LCO

This LCO limits the consequences of postulated loss of residual heat removal event during reduced inventory conditions with fuel in the reactor vessel by limiting the potential escape paths for steam and radioactive material released within containment. The LCO requires any penetration providing direct access from the containment atmosphere to the outside atmosphere to be closed except for penetrations capable of being closed by an OPERABLE CBVS. The OPERABILITY requirements for this LCO ensure that these penetrations are isolable by the CBVS. The OPERABILITY requirements for this LCO ensure that the automatic CBVS valve closure times specified in the FSAR can be achieved and, therefore, meet the assumptions used in the PRA analysis.

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BASES

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**APPLICABILITY**      The containment penetration requirements are applicable in MODES 5 and 6 during reduced inventory conditions. In MODES 1, 2, 3, and 4, containment penetration requirements are addressed by LCO 3.6.1, "Containment."

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**ACTIONS**              A.1, A.2, and A.3

If the containment equipment hatch, air locks, or any containment penetration that provides direct access from the containment atmosphere to the outside atmosphere is not in the required status, action must be initiated to place the containment penetrations in their required status, place the unit in MODE 5 with the RCS pressure boundary intact and  $\geq 25\%$  pressurizer level, or to increase the RCS water inventory by raising the reactor cavity water level to  $\geq 23$  feet above the top of the reactor vessel flange.

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**SURVEILLANCE REQUIREMENTS**      SR 3.9.7.1

This Surveillance demonstrates that each of the containment penetrations required to be in its closed position is in that position. The Surveillance on the open valves will demonstrate that the valves are not blocked from closing. Also, the Surveillance will demonstrate that each valve operator has motive power, which will ensure that each valve is capable of being closed from the Main Control Room.

The Surveillance is performed every 7 days with the unit in reduced inventory conditions. The Surveillance interval is selected to ensure that the required penetration status is maintained during reduced inventory conditions.

SR 3.9.7.2

This Surveillance demonstrates that each CBVS valve actuates to its isolation position on manual initiation. The 24 month Frequency maintains consistency with other similar DCS instrumentation and valve testing requirements.

The SR is modified by a Note stating that this Surveillance is not required to be met for valves in closed penetrations. The LCO provides the option to close penetrations in lieu of requiring remote actuation capability.

BASES

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|------------|----|---|
| REFERENCES | 1. | NRC Generic Letter 88-17, Loss of Decay Heat Removal, October 17, 1988. |
|            | 2. | FSAR Section 19.1.6.  |
|            | 3. | FSAR Section 5.4.7.2.1.   |
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