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3/4.9.1 BORON CONCENTRATION

The limit on the boron concentration of the Reactor Coolant System (RCS), the refueling cavity, the fuel storage pool and the refueling canal 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 Core Operating Limits Report (COLR). Plant procedures ensure the specified boron concentration in order to maintain an overall core reactivity of $K_{eff} \leq 0.95$ during fuel handling, with control rods and fuel assemblies assumed to be in the most adverse configuration (least negative reactivity) allowed by plant procedures.

General Design Criterion 26 of 10CFR 50, Appendix A requires that two independent reactivity control systems of different design principles be provided. One of these systems must be capable of holding the reactor core subcritical under cold conditions. The Chemical and Volume Control System (CVCS) is the system capable of maintaining the reactor subcritical in cold conditions by maintaining the 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 are then flooded with borated water from the refueling water storage tank through the open reactor vessel by gravity feeding or by the use of the Residual Heat Removal (RHR) System pumps. The fuel storage pool is also adjusted to the refueling boron concentration specified in the COLR.

The pumping action of the RHR System in the RCS and the natural circulation due to thermal driving heads in the reactor vessel and refueling cavity mix the added concentrated boric acid with the water in the refueling canal. The RHR System is in operation during refueling (see TS 3/4.9.8, "Residual Heat Removal (RHR) and Coolant Circulation - All Water levels, " and "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.

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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 Keff of the core will remain ≤ 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 RCS boron concentration satisfies Criterion 2 10CFR50.36(c)(2)(ii).

The LCO requires that a minimum boron concentration be maintained in the RCS, the refueling canal, the fuel storage pool and the refueling cavity while in MODE 6. The boron concentration limit specified in the COLR ensures that a core Keff ≤ 0.95 is maintained during fuel handling operations. Violation of the LCO could lead to an inadvertent criticality during MODE 6.

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 Keff ≤ 0.95 . A note to this LCO modifies the Applicability. The note states that the limits on boron concentration are only applicable to the refueling canal, the fuel storage pool and the refueling cavity when those volumes are connected to the Reactor Coolant System. When the refueling canal, the fuel storage pool and the refueling cavity are isolated from the RCS, no potential path for boron dilution exists. Above MODE 6, LCOs 3.1.1.1 and 3.1.1.2 ensure that an adequate amount of negative reactivity is available to shut down the reactor and maintain it subcritical.

Continuation of CORE ALTERATIONS or 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, the fuel storage pool or the refueling cavity is less than its limit, all operations involving CORE ALTERATIONS or positive reactivity additions must be suspended immediately. Suspension of CORE ALTERATIONS and 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.

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In addition to immediately suspending CORE ALTERATIONS and 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 actions have been initiated, they 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.

The Surveillance Requirement (SR) ensures that the coolant boron concentration in the RCS, and connected portions of the refueling canal, the fuel storage pool 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 reconnecting portions of the refueling canal, the fuel storage pool or the refueling cavity to the RCS, this SR must be met per SR 4.0.4. 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 Surveillance Frequency is based on operating experience, equipment reliability, and plant risk and is controlled under the Surveillance Frequency Control Program.

3/4.9.2.1 UNBORATED WATER SOURCE ISOLATION VALVES

During MODE 6 operations, all isolation valves for the reactor makeup water sources containing unborated water that are connected to the Reactor Coolant System (RCS) must be closed to prevent unplanned boron dilution of the reactor coolant. The isolation valves must be secured in the closed position.

Securing the required valves in the closed position during refueling operations ensures that the valves cannot be inadvertently opened, and prevents the flow of unborated water to the filled portion of the RCS. This action precludes the possibility of an inadvertent boron dilution event occurring during MODE 6 refueling operations. By isolating unborated water sources, a safety analysis for an uncontrolled boron dilution event in accordance with the Standard Review Plan (NUREG-0800, Section 15.4.6) is not required for MODE 6.

If any required valve is found not secured in the closed position, there is a potential of having a diluted boron concentration in the RCS. Immediately suspend CORE ALTERATIONS, and initiate actions to secure the valve in the closed position. Surveillance Requirement 4.9.1 must be performed to demonstrate that the required boron concentration exists. The 4 hour completion time is sufficient to obtain and analyze a reactor coolant sample for boron concentration.

Surveillance Requirement 4.9.2.1 demonstrates through a system walkdown that the required valves are closed. The surveillance frequency is controlled under the Surveillance Frequency Control Program.

3/4.9.2.2 INSTRUMENTATION

The source range neutron flux monitors are used during refueling operations to determine the core reactivity condition. Two OPERABLE source range neutron flux monitors are required to

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alert the operator to unexpected changes in core reactivity, such as a boron dilution event. This ensures that redundant monitoring capability is available to detect changes in core reactivity. Based on isolating all boron dilution paths per LCO 3.9.2.1, only the source range neutron flux monitor visual indication in the control room is required for OPERABILITY.

Any combination of NIS source range neutron flux monitors and/or Gamma-Metrics post-accident neutron flux monitors may be used to satisfy the LCO. Two of the four total source range neutron flux monitors are required to be OPERABLE.

With only one required source range neutron flux monitor OPERABLE, redundancy has been lost. Suspending positive reactivity additions that could result in failure to meet the minimum boron concentration limit is required to assure continued safe operation.

With no required source range neutron flux monitor OPERABLE, action to restore a monitor to OPERABLE status shall be initiated immediately. With no source range neutron flux monitor OPERABLE, there is 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 confirmed by performing Surveillance Requirement 4.9.1 to ensure that the required boron concentration exists and adequate shutdown margin is maintained.

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3/4.9.4 CONTAINMENT BUILDING PENETRATIONS

During movement of irradiated fuel assemblies within containment the requirements for containment building penetration closure capability and OPERABILITY ensure that a release of fission product radioactivity within containment will not exceed the guidelines and dose calculations described in Reg Guide 1.183, Alternative Radiological Source Term for Evaluating Design Basis Accidents at Nuclear Power Plants. In MODE 6, the potential for containment pressurization as a result of an accident is not likely. Therefore, the requirements to isolate the containment from the outside atmosphere can be less stringent. The LCO requirements during movement of irradiated fuel assemblies within containment are referred to as "containment closure" rather than containment OPERABILITY. For the containment to be OPERABLE, CONTAINMENT INTEGRITY must be maintained. Containment closure means that all potential release paths are closed or capable of being closed. Closure restrictions include the administrative controls to allow the opening of both airlock doors and the equipment hatch during fuel movement provided that: 1) the equipment inside door or an equivalent closure device installed is capable of being closed with four bolts within 1 hour by a designated personnel; 2) the airlock doors are capable of being closed within 1 hour by designated personnel, 3) either the Containment Purge System or the Auxiliary Building Ventilation System taking suction from the containment atmosphere are operating and 4) the plant is in Mode 6 with at least 23 feet of water above the reactor pressure vessel flange.

Administrative requirements are established for the responsibilities and appropriate actions of the designated personnel in the event of a Fuel Handling Accident inside containment. These requirements include the responsibility to be able to communicate with the control room, to ensure that the equipment hatch is capable of being closed, and to close the equipment hatch and personnel airlocks within 1 hour in the event of a fuel handling accident inside containment. These administrative controls ensure containment closure will be established in accordance with and not to exceed the dose calculations performed using guidelines of Regulatory Guide 1.183.

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The containment serves to limit the fission product radioactivity that may be released from the reactor core following an accident, such that offsite radiation exposures are maintained well within the requirements of 10CFR100 and Reg Guide 1.183, Alternative Source Term, as applicable. Additionally, the containment provides radiation shielding from the fission products that may be present in the containment atmosphere following accident conditions.

The Containment Equipment Hatch, which is part of the containment pressure boundary, provides a means for moving large equipment and components into or out of containment. During movement of irradiated fuel assemblies within containment can be open provided that: 1) it is capable of being closed with four bolts within 1 hour by designated personnel, 2) either the Containment Purge System or the Auxiliary Building Ventilation System taking suction from the containment atmosphere are operating and 3) the plant is in Mode 6 with at least 23 feet of water above the reactor pressure vessel flange. Good engineering practice dictates that the bolts required by the LCO are approximately equally spaced.

An equivalent closure device may be installed as an alternative to installing the Containment Equipment Hatch inside door with a minimum of four bolts. Such a closure device may provide penetrations for temporary services used to support maintenance activities inside containment at times when containment closure is required; and may be installed in place of the Containment Equipment Hatch inside door or outside door. Penetrations incorporated into the design of an equivalent closure device will be considered a part of the containment boundary and as such will be subject to the requirements of Technical Specification 3/4.9.4. Any equivalent closure device used to satisfy the requirements of Technical Specification 3/4.9.4.a will be designed, fabricated, installed, tested, and utilized in accordance with established procedures to ensure that the design requirements for the mitigation of a fuel handling accident during refueling operations are met. In case that this equivalent closure device is installed in lieu of the equipment hatch inside door, the same restrictions and administrative controls apply to ensure closure will take place within 1 hour following a Fuel Handling Accident inside containment.

The containment air locks, which are also part of the containment pressure boundary, provide a means for personnel access during operation in MODES 1, 2, 3, and 4 as specified in LCO 3.6.1.3, "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 and frequent containment entry is necessary, the air lock interlock mechanism may be disabled. This allows both doors of an airlock to remain open for extended periods. During movement of irradiated fuel assemblies within containment, containment closure may be required; therefore, the door interlock mechanism may remain disabled, and both doors of each containment airlock may be open if: 1) At least one door of each airlock is capable of being closed within 1 hour by dedicated personnel,) 2) either the Containment Purge System or the Auxiliary Building Ventilation System taking suction from the containment atmosphere are operating and 3) The plant is in Mode 6 with at least 23 feet of water above the reactor pressure vessel flange.

In the postulated FHA, the revised dose calculations performed using RG 1.183 criteria, do not assume automatic containment purge isolation thus allowing for continuous monitoring of containment activity until the release pathways are isolated. If required, manual isolation of containment purge can be initiated from the control room.

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 may include the use of a material that can provide a temporary atmospheric pressure, ventilation barrier. Any equivalent method used to satisfy the requirements of Technical Specification 3/4.9.4.c.1 will be designed, fabricated, installed, tested, and utilized in accordance with established procedures to ensure that the design requirements for the mitigation of a fuel handling accident during refueling operations are met.

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The surveillance requirement 4.9.4.2 demonstrates that the necessary hardware, tools, and equipment are available to close the equipment hatch. The surveillance is performed once per refueling prior to the start of movement of irradiated fuel assemblies within the containment. This surveillance is only required to be met when the equipment hatch is open.

3/4.9.5 COMMUNICATIONS

Deleted.

3/4.9.6 MANIPULATOR CRANE

Deleted.

3/4.9.7 CRANE TRAVEL - SPENT FUEL STORAGE BUILDING

Deleted.

3/4.9.8 RESIDUAL HEAT REMOVAL AND COOLANT CIRCULATION

The requirements that at least one residual heat removal loop be in operation ensures that (1) sufficient cooling capacity is available to remove decay heat and maintain the water in the reactor pressure vessel below 140°F as required during the REFUELING MODE, and (2) sufficient coolant circulation is maintained through the reactor core to minimize the effects of a boron dilution incident and prevent boron stratification. A minimum flow rate of 1000 gpm is required. Additional flow limitations are specified in plant procedures, with the design basis documented in the Salem UFSAR. These flow limitations address the concerns related to vortexing and air entrapment in the Residual Heat Removal system, and provide operational flexibility by adjusting the flow limitations based on time after shutdown. The requirement to have two RHR loops OPERABLE when there is less than 23 feet of water above the reactor vessel flange ensures that a single failure of the operating RHR loop will not result in a complete loss of residual heat removal capability.

For support systems: Service Water (SW) and Component Cooling (CC), component redundancy is necessary to ensure no single active component failure will cause the loss of Decay Heat Removal. One piping path of SW and CC is adequate when it supports both RHR loops. The support systems needed before entering into the desired configuration (e.g., one service water loop out for maintenance in Modes 5 and 6) are controlled by procedures, and include the following:

- A requirement that the two RHR, two CC and two SW pumps, powered from two different vital buses be kept operable
- A listing of the active (air/motor operated) valves in the affected flow path to be locked open or disable.

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Note that four filled reactor coolant loops, with at least two steam generators with at least their secondary side water level greater than or equal to 5% (narrow range), may be substituted for one residual heat removal loop. This ensures that single failure does not cause a loss of decay heat removal.

With the reactor vessel head removed and 23 feet of water above the reactor pressure vessel flange, a large heat sink is available for core cooling. Thus, in the event of a failure of the operating RHR loop, adequate time is provided to initiate emergency procedures to cool the core.

3/4.9.9 (Not Used)

3/4.9.10 and 3/4/9/11 WATER LEVEL - REACTOR VESSEL AND STORAGE POOL

The restrictions on minimum water level ensure that sufficient water depth is available to remove 99% of the assumed 10% iodine gap activity released from the rupture of an irradiated fuel assembly. The minimum water depth is consistent with the assumptions of the accident analysis.

3/4.9.12 DELETED