DRAFT SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TOPICAL REPORT WCAP-16294-NP, REVISION 0, "RISK-INFORMED EVALUATION OF CHANGES TO TECHNICAL SPECIFICATION REQUIRED ENDSTATES FOR WESTINGHOUSE NSSS [NUCLEAR STEAM SUPPLY SYSTEM] PWRs [PRESSURIZED WATER REACTORS]," NUCLEAR ENERGY INSTITUTE

PROJECT NO. 689

1.0 INTRODUCTION AND BACKGROUND

By letter dated September 9, 2005 (Reference 1), the Nuclear Energy Institute (NEI) submitted topical report (TR) WCAP-16294, Rev. 0, "Risk-Informed Evaluation of Changes to Technical Specification Required Action Endstates for Westinghouse NSSS PWRs" (Reference 2), for U.S. Nuclear Regulatory Commission (NRC) staff review and approval. The NRC staff issued requests for additional information (RAI) to NEI, by letters dated June 13, 2007, (Reference 3) and October 23, 2008 (Reference 4). Subsequently, by letters dated December 12, 2007 (Reference 5), November 26, 2008 (Reference 6), and November 20, 2009 (Reference 21) the NEI submitted its response, accompanied by proposed markups to TR WCAP-16294-NP. The November 20, 2009, letter contains revisions to the TS and Bases, and additional markups of TR WCAP-16294-NP.

The proposed risk-informed TS changes are intended to maintain or improve safety while reducing unnecessary burden and to make TS requirements consistent with the Commission's other risk-informed regulatory requirements. TR WCAP-16294-NP identifies and evaluates new TS Required Action end states for a number of TS Limiting Conditions for Operation (LCOs), using a risk-informed approach, consistent with Regulatory Guides 1.174 and 1.177 (References 7 and 8). The end states are currently defined based on placing the unit into a Mode or condition in which the TS LCO is not applicable. Mode 5 is the current endstate for LCOs that are applicable in Modes 1 through 4. The risk of the transition from Mode 1 to Modes 4 or 5 depends on the availability of alternating current (AC) sources. During the realignment from Mode 4 to Mode 5, there is an increased potential for loss of shutdown (SD) cooling and loss of inventory events. Decay heat removal following a loss of offsite power event in Mode 5 is dependent on AC power for SD cooling whereas, in Mode 4, the turbine-driven auxiliary feedwater pump will be available. Therefore, transitioning to Mode 5 is not always the appropriate endstate from a risk perspective. Thus, for certain conditions, this TR justifies Mode 4 as an acceptable alternate endstate to Mode 5. The proposed change to the TSs would allow time to perform short-duration repairs which would otherwise necessitate exiting the original Mode of operation. Short duration repairs are on the order of 2-to-3 days, but not more than a week. The Mode 4 TS end state is applied, if risk is assessed and managed. Modified end states are limited to conditions where: (1) entry into the shutdown mode is for a short interval, (2) entry is initiated by inoperability of a single train of equipment or a restriction on a plant operational parameter, unless otherwise stated in the applicable TS, and (3) the primary purpose is to correct the initiating condition and return to power operation as soon as is practical.

1.1 Proposed Action

As summarized in the following table, the requested TS changes would permit an end-state of hot shutdown (Mode 4) rather than an endstate of cold shutdown (Mode 5) for the following TS action requirements that are contained in STS.

Proposed Changes To End States	
TS Condition	**Title**
3.3.2-B 3.3.2-C 3.3.2-K	Engineered Safety Feature Actuation System Instrumentation
3.3.7-C	Control Room Emergency Filtration System Actuation Instrumentation
3.3.8-D	Fuel Building Air Cleanup System Actuation Instrumentation
3.4.13-B	RCS Operational Leakage
3.4.14-B	RCS Pressure Isolation Valve Leakage
3.4.15-E	RCS Leakage Detection Instrumentation
3.5.3-C	Emergency Core Cooling System (ECCS) – Shutdown
3.5.4-C	Refueling Water Storage Tank
3.6.4A-B	Containment Pressure (Atmospheric, Dual, and Ice Condenser) *
3.6.4B-B	Containment Pressure (Subatmospheric) *
3.6.5A-B	Containment Air Temperature (Atmospheric and Dual) *
3.6.5B-B	Containment Air Temperature (Ice Condenser) *
3.6.5C-B	Containment Air Temperature (Subatmospheric) *
3.6.6A-B 3.6.6A-E	Containment Spray (Atmospheric and Dual)
3.6.6B-F	Containment Spray (Atmospheric and Dual)
3.6.6C-B	Containment Spray (Ice Condenser)
3.6.6D-B	Quench Spray System (Subatmospheric)
3.6.6E-F	Recirculation Spray System (Subatmospheric)
3.6.7-B	Spray Additive System (Atmospheric, Subatmospheric, Ice Condenser, and Dual)
3.6.8-B	Shield Building (Dual and Ice Condenser) *
3.6.11-B	Iodine Cleanup System (Atmospheric and Subatmospheric)
3.6.12-B	Vacuum Relief Valves (Atmospheric and Ice Condenser)
3.6.13-B	Shield Building Air Cleanup System (Dual and Ice Condenser)
3.6.14-B	Air Return System (Ice Condenser)
3.6.15-B	Ice Bed (Ice Condenser) *
3.6.16-D	Ice Condenser Doors (Ice Condenser) *
3.6.17-C	Divided Barrier Integrity (Ice Condenser) *

Proposed Changes To End States	
TS Condition	**Title**
3.6.18-C	Containment Recirculation Drains (Ice Condenser)
3.7.7-B	Component Cooling Water System
3.7.8-B	Service Water System
3.7.9-C	Ultimate Heat Sink
3.7.10-C	Control Room Emergency Filtration System
3.7.11-B	Control Room Emergency Air Temperature Control System
3.7.12-C	ECCS Pump Room Exhaust Air Cleanup System
3.7.13-C	Fuel Building Air Cleanup System
3.7.14-C	Penetration Room Exhaust Air Cleanup System
3.8.1-G	Alternating Current (AC) Sources – Operating
3.8.4-D	Direct Current (DC) Sources – Operating
3.8.7-B	Inverters – Operating
3.8.9-D	Distribution Systems – Operating

** As noted in the November 26, 2008, letter from the NEI, the proposed endstate changes to these TS were withdrawn and the TR WCAP-16294-NP will be revised to delete the discussions associated with these proposed changes.*

In addition to the items noted in the above table, the NRC staff also reviewed 6.4.22a, “Recirculation Fluid pH Control System.”

The request is limited to inoperability of a single train of equipment or a restriction on a plant operational parameter, unless otherwise stated in the applicable technical specification, and the primary purpose is to correct the inoperable component(s) and return to power operation as soon as is practical.

1.2 Related NRC Actions

Similar Topical Reports (TR) have been reviewed and approved by the NRC staff for three other plant types. Specifically, TR CE-NPSD-1186 for the Combustion Engineering Owners’ Group (CEOG) was approved on July 17, 2001 (Reference 10), TR NEDC-32988 for the Boiling Water Reactor Owners’ Group (BWROG) was approved on September 27, 2002 (Reference 11), and TR BAW-2441 for the Babcock and Wilcox Owners’ Group (BWOG) was approved on August 25, 2006 (Reference 12).

2.0 REGULATORY EVALUATION

The regulatory requirements and guidance which the NRC staff considered in its review of TR WCAP-16294-NP, Revision 0 are as follows:

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 establishes the fundamental regulatory requirements with respect to the domestic licensing of nuclear production and utilization facilities.

Section 182a of the Atomic Energy Act requires applicants for nuclear power plant operating licenses to include TS as part of the license. The TS ensure the operational capability of structures, systems and components that are required to protect the health and safety of the public. The Commission's regulatory requirements related to the content of the TS are contained in 10 CFR Section 50.36, Technical specifications. That regulation requires that the TSs include items in the following specific categories: (1) safety limits, limiting safety systems settings, and limiting control settings; (2) limiting conditions for operation; (3) surveillance requirements; (4) design features; and (5) administrative controls. 10 CFR 50.36(c)(2) Limiting conditions for operation specifies the required end state for non-compliance with TS as: "When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow the remedial action permitted by the technical specification until the condition can be met." However, the rule does not specify the particular requirements to be included in plant TSs. The NRC staff's guidance as to the content of TS for Westinghouse plants is established in NUREG-1431, Revision 3.0, "Standard Technical Specifications Westinghouse Plants" (STS) (Reference 9).

10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors," requires that the reactor must be provided with an emergency core cooling system (ECCS) that must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in 10 CFR 50.46(b).

10 CFR 50.65(a)(4), "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants", requires that "Before performing maintenance activities ... the licensee shall assess and manage the increase in risk that may result from the proposed maintenance activities. The scope of the assessment may be limited to structures, systems, and components that a risk-informed evaluation process has shown to be significant to public health and safety." Regulatory Guide (RG) 1.182 (Reference 13) provides guidance on implementing the provisions of 10 CFR 50.65(a)(4) by endorsing a revised Section 11 to NUMARC 93-01 (Reference 14). Section 11 states, "The assessment is required for maintenance activities performed during power operations or during shutdown." Planning and scheduling of maintenance activities during shutdown should consider their impact on performance of key shutdown safety functions.

Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 provides, in part, the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety.

Criterion 16, "Containment Design", requires that reactor containment and associated systems shall be provided to establish an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and to assure that the containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.

Criterion 35, "Emergency Core Cooling", requires a system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

Criterion 38, "Containment Heat Removal" requires the establishment of a containment heat removal system that will rapidly reduce containment pressure and temperature following any loss-of-coolant accident. The containment heat removal system supports the containment function by minimizing the duration and intensity of the pressure and temperature increase following a loss-of-coolant accident thus lessening the challenge to containment integrity. Meeting GDC 38 will help ensure that the containment can fulfill its role as the final barrier against the release of radioactivity to the environment.

Criterion 41, "Containment Atmosphere Cleanup", requires systems to control fission products, hydrogen, oxygen, and other substances which may be released into the reactor containment shall be provided as necessary to reduce, consistent with the functioning of other associated systems, the concentration and quality of fission products released to the environment following postulated accidents, and to control the concentration of hydrogen or oxygen and other substances in the containment atmosphere following postulated accidents to assure that containment integrity is maintained.

Criterion 60, "Control of Releases of Radioactive Materials to the Environment", requires the means to control the release of radioactive materials in gaseous and liquid effluents.

RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," (Reference 7), describes a risk-informed approach, acceptable to the NRC, for assessing the nature and impact of proposed permanent licensing-basis changes by considering engineering issues and applying risk insights. This RG also provides risk acceptance guidelines for evaluating the results of such evaluations.

RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," (Reference 8), describes an acceptable risk-informed approach specifically for assessing proposed permanent TS changes in AOT. This RG also provides risk acceptance guidelines for evaluating the results of such assessments. RG 1.177 identifies a three-tiered approach for the licensee's evaluation of the risk associated with a proposed Completion Time (CT) TS change, as summarized below. Per RG 1.777, the improved STS use the terminology "completion times" and "surveillance frequency" in place of allowed outage time" and "surveillance test interval."

- Tier 1 assesses the risk impact of the proposed change in accordance with acceptance guidelines consistent with the Commission's Safety Goal Policy Statement, as documented in RG 1.174 and RG 1.177.

- Tier 2 identifies and evaluates any potential risk-significant plant equipment outage configurations that could result if equipment, in addition to that associated with the proposed license amendment, is taken out-of-service simultaneously, or if other risk-significant operational factors, such as concurrent system or equipment testing, are also involved. The objective of Tier 2 evaluation is to ensure that appropriate restrictions on risk-significant configurations associated with the changes are in place.

- Tier 3 addresses the licensee's overall configuration risk management program (CRMP) to ensure that adequate programs and procedures are in place for identifying risk-significant plant configurations resulting from maintenance or other operational activities and appropriate compensatory measures are taken to avoid risk significant configurations that may not have been considered when the Tier 2 evaluation was performed. The risk impact of out-of-service equipment must be evaluated prior to performing any maintenance activity by the licensee.

General guidance for evaluating the technical basis for proposed risk-informed changes is provided in Section 19.2, "Review of Risk Information Used to Support Permanent Plant-Specific Changes to the Licensing Basis: General Guidance," of the NRC Standard Review Plan (SRP), NUREG-0800 (Reference 15). Guidance on evaluating probabilistic risk assessment (PRA) technical adequacy is provided in Section 19.1, "Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities" (Reference 16). More specific guidance related to risk-informed TS changes is provided in SRP Section 16.1, "Risk-Informed Decision Making: Technical Specifications," (Reference 17), which includes CT changes as part of risk-informed decision making.

In its ongoing program of improving TS, the NRC continues to consider methods to make use of risk and reliability information for defining and improving generic TS requirements. The NRC policy regarding the use of PRA technology is that the PRA methods and data should complement the NRC's deterministic approach and supports its traditional defense-in-depth philosophy. The PRA and associated analyses should be used to reduce unnecessary conservatism associated with current regulatory requirements, regulatory guidance, license commitments, and staff practices.

In implementing risk-informed decision making, Section 19.2 of the SRP states that a risk-informed application should be evaluated to ensure that the proposed changes meet the following key principles:

- The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change.
- The proposed change is consistent with the defense-in-depth philosophy.
- The proposed change maintains sufficient safety margins.
- When a proposed change results in an increase in core damage frequency (CDF) or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement, and
- The impact of the proposed change should be monitored using performance measurement strategies.

Defense-in-depth and safety margins are fundamental safety principles on which the plant design is based and cannot be compromised. Design basis accidents, safety margins and defense-in-depth constitute a combination of postulated challenges and failure events that are used in the plant design to demonstrate a safe plant response. Proposed changes must be evaluated to determine their impact on defense-in-depth and safety margin.

In this TR, the proposed changes need to meet the defense-in-depth philosophy that consists of the following elements:

- A reasonable balance among prevention of core damage, prevention of containment failure, and consequence mitigation is preserved.
- Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided.
- System redundancy, independence, and diversity are maintained commensurate with the expected frequency and consequences of challenges to the system.
- Defenses against potential common cause failures are maintained and the potential for introduction of new common cause failure mechanisms is assessed.
- Independence of physical barriers is not degraded.
- Defenses against human errors are maintained, and
- The intent of the General Design Criteria in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," is maintained.

3.0 TECHNICAL EVALUATION

The STS for Westinghouse plants defines the following six operational modes. Of specific relevance to TR WCAP-16294-NP, Revision 0, are Modes 4 and 5:

- Mode 1 - Power operation. Reactivity condition is such that k_{eff} [1] $\geq$ 0.99 and thermal power is greater than 5 percent of the rated power.
- Mode 2- Startup - Reactivity condition is such that $k_{eff} \geq 0.99$ and thermal power is $\leq$ 5 percent of the rated power. The reactor vessel head closure bolts are fully tensioned.
- Mode 3 - Hot standby - Reactor reactivity condition is such that $k_{eff} < 0.99$ and the average reactor coolant system (RCS) temperature is $\geq 350^oF$. The reactor vessel head closure bolts are fully tensioned.
- Mode 4 - Hot shutdown - The average RCS temperature is greater than 200^oF and less than 350^oF. The reactivity condition is such that $k_{eff} < 0.99$. The reactor vessel head closure bolts are fully tensioned. The RCS pressure would typically be low enough to permit operation of the shutdown cooling (SDC) system, although low pressure is not a requirement of the mode and heat removal may be via the steam generators (SGs).
- Mode 5 - Cold shutdown - The average RCS temperature is less than or equal to 200^oF. The reactor vessel head closure bolts are fully tensioned. The RCS pressure permits

[1] The ratio of the number of thermal neutrons obtained at the end of the neutron cycle to the number of those initiating the cycle is called the effective multiplication factor and is denoted by k_{eff}. It is a significant parameter of the nuclear chain reaction because its value determines the rate of neutron level multiplication.
If $k_{eff} > 1$, the reactor is supercritical; the neutron population, the fission rate, and energy production are increasing exponentially.
If $k_{eff} = 1$, the reactor is critical; the neutron population is constant, as is the fission rate and the energy production. The nuclear chain reaction is sustained and controlled.
If $k_{eff} <1$, the reactor is subcritical; the neutron population, the fission rate, and the energy production are decreasing exponentially.

operation of the SDC system, since heat removal via the SGs cannot maintain RCS temperature below 200°F.

- Mode 6 – Refueling - The reactor mode is shutdown and one or more reactor vessel head closure bolts are less than fully tensioned.

End states for unit conditions are prescribed in TS when Required Actions are not met or cannot be met. The current TS actions require placing a plant in cold shutdown (Mode 5) based on the expectation that this condition would result in the safest condition, since most design basis accidents and transients either cannot physically occur during shutdown, or would have significantly reduced plant impact and occur much less frequently due to the reduced temperatures and pressures in the plant. Accidents and transients unique to shutdown conditions were anticipated to be of less significance compared to the design bases events applicable to power operations. However, in the late 1980s and early 1990s, the NRC and licensees recognized the potential significance of events occurring during shutdown conditions, and actions were implemented to improve shutdown operation.

The requested change to the TSs is to allow a Mode 4 endstate rather than a Mode 5 endstate for selected TS LCO actions. TR WCAP-16294-NP, Revision 0, provides a comparative qualitative assessment of the availability of plant equipment for decay heat removal and accident mitigation in Modes 4 and 5, and considers the likelihood and consequences of initiating events which may occur in these modes. A quantitative risk assessment of operation in these modes, including the risk associated with the transition from Mode 4 to Mode 5 and then back to Mode 4 to support the return to service, is also provided using a shutdown and transition PRA model developed to support the review of TR WCAP-16294-NP, Revision 0.

TR WCAP-16294-NP, Revision 0, concludes that the availability of SG heat removal capability in Mode 4, and the avoidance of transitioning the plant to and from SDC, makes Mode 4 the preferred endstate over Mode 5 for each of the proposed TS conditions being changed. This conclusion is further supported by quantitative risk analyses which demonstrate a reduction in plant risk by remaining in Mode 4 compared to the alternative of transitioning to and from Mode 5 in accordance with the existing TS requirements.

Both the qualitative and quantitative analyses of TR WCAP-16294-NP, Revision 0, support a Mode 4 endstate. This conclusion is primarily due to the availability of SG cooling in Mode 4 via the turbine-driven Auxiliary Feedwater (AFW) pump which is not reliant upon AC power, compared to the use of SDC in Mode 5 which requires the availability of AC power. Further, the transition risks associated with establishing SDC alignments and the resulting potential for loss of inventory or loss of cooling events due to human error during such alignments are avoided by remaining in Mode 4.

This general assessment is applied as the basis for changing the required endstate from Mode 5 to Mode 4 for those TSs which govern plant equipment that is not included in the PRA models, supported by qualitative assessments of the plant impact of the unavailability of the TS equipment. For those TS covering plant equipment that is included in the PRA models, a quantitative risk assessment is also provided which assesses the comparative risk of completing repairs in Mode 4 or proceeding to Mode 5 for repairs and then returning to Mode 4 for plant startup.

Changing the required endstate to Mode 4 will also result in increased unit availability by decreasing the time of shutdown. The additional time required to transition to Mode 5 from Mode 4 when shutting down and also to Mode 4 from Mode 5 when restarting can be eliminated with the endstate change. A typical time for the transition from Mode 4 to Mode 5 during shutdown and from Mode 5 to 4 during startup is 24 hours. Therefore, this change will allow an availability increase of 24 hours.

Changing the end states allows continued operation with the LCO not met by removing the TS requirement to exit the LCO Applicability. In this case the requirements of LCO 3.0.4.a would apply unless otherwise stated. LCO 3.0.4.a allows entry into a MODE or other specified condition in the Applicability with the LCO not met when the associated ACTIONS to be entered permit continued operation in the MODE or other specified condition in the Applicability for an unlimited period of time. Compliance with Required Actions that permit continued operation of the unit for an unlimited period of time in a MODE or other specified condition provides an acceptable level of safety for continued operation. This is without regard to the status of the unit before or after the MODE change. Therefore, in such cases, entry into a MODE or other specified condition in the Applicability may be made in accordance with the provisions of the Required Actions.

Thus, implementing modified end states requires adding a Note to the affected Required Actions to prevent using the allowances of LCO 3.0.4.a when entering Mode 4 from Mode 5. This is done to avoid unit operation in a condition that should be prohibited by TS (i.e., unanalyzed) since LCO 3.0.4.a allows entry into a mode or other specified condition in the Applicability when the associated Actions to be entered permit continued operation in the Mode or other specified condition in the Applicability for an unlimited period of time. Applying the allowances of LCO 3.0.4.a to modified end states was not analyzed in TR WCAP-16294; therefore, appropriate operational limits are applied with the addition of Notes to affected TS Required Actions (Reference 21).

3.1 Technical Analysis

This section provides the NRC staff evaluation of the impact of each proposed endstate change on defense-in-depth, and safety margins as applied to corresponding safety systems. The NRC staff's evaluation approves only the proposed changes to the standard technical specifications as described below. The NRC staff finds that the TR used realistic assumptions regarding the plant conditions and the availability of various mitigating systems in analyzing the risks and considering the defense-in-depth and safety margins. Thus the NRC staff concludes that the TR uses realistic assumptions to justify the change in the endstate. However, during the proposed Mode 4 end state, due to the SI signal blockage and and nonavailability of accumulators, operator actions will be required to mitigate several events.

During the proposed end state (MODE 4), the event mitigating systems, structures and their components such as pumps, and valves must be assessed at predetermined, periodic interval to ensure safety. The NRC staff's review was based, in part, on the assumption that while remaining at Mode 4, that plants would be at the lower end of RCS pressure range so that it will reduce the potential for LOCA and will limit coolant inventory loss in the event of a LOCA, as described further in Sections 3.1.4 and 3.1.5 of this SE.

3.1.1 TS 3.3.2 – Engineered Safety Features Actuation System (ESFAS) Instrumentation

The ESFAS instrumentation initiates necessary safety systems, based on the allowable value of selected unit parameters to protect against violating core design limits and the RCS pressure boundary, and to mitigate accidents. The ESFAS instrumentation functions are listed in Table 3.3.2-1 of Reference 2.

Function 1.a. Safety Injection - Manual Initiation and 1.b. Safety Injection – Automatic Logic and Actuation Relays.

Description: The safety injection (SI) system provides two primary functions: (1) Primary side water addition to ensure maintenance or recovery of reactor vessel water level (coverage of the active fuel for heat removal, clad integrity, and for limiting the peak clad temperature to < 2200°F), and (2) Boration to ensure recovery and maintenance of shutdown margin ($k_{eff} < 1.0$). These functions mitigate the effects of high energy line breaks both inside and outside of containment.

Manual initiation causes actuation of all components in the same manner as any of the automatic actuation signals. The automatic actuation logic and actuation relays must be operable in Mode 4 to support system level manual initiation. The LCO for both Manual Initiation and Automatic Actuation Logic and Actuation Relays requires that two trains shall be operable.

Proposed Required Actions: For the Manual initiation, the end state for Required Action B.2.2 is revised to be in Mode 4 in 60 hours instead of in Mode 5 in 84 hours and a Note is added stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

For automatic logic and actuation relays, the end state for Required Action C.2.2 is revised to be in Mode 4 in 36 hours if the inoperable train is not restored to operable status in 24 hours. A Note is added to Required Action C.2.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one train is inoperable, the other train is available to initiate SI. A cool down to Mode 4 leaves the unit in a state in which transients progress slower than at power, backup core cooling is available via residual heat removal (RHR), there is increased time for operator actions and mitigation strategies, and there is a lower overall risk than proceeding to Mode 5.

If one channel is inoperable, the other channel is available for the operator to initiate SI. Placing the unit in Mode 5 does not increase the instrumentation available for event mitigation. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4.

NRC staff accepts the proposed amendment to delete Required Actions B.2.2 and C.2.2 so that the plant would be allowed to remain in Mode 4, subject to LCO 3.0.4.a being not applicable for entry into Mode 4 from Mode 5 and to the limitations and conditions in Section 4.0.

Function 2.a. Containment Spray – Manual Initiation, and 2.b. Containment Spray - Automatic Actuation Logic and Actuation Relays

Description: The containment spray (CS) system provides three primary functions: (1) Lowers containment pressure and temperature after a high-energy line break (HELB) in containment, (2) Reduces the amount of radioactive iodine in the containment atmosphere, and (3) Adjusts the pH of the water in the containment recirculation sump after a Loss of Coolant Accident (LOCA). These functions are necessary to ensure the containment structure pressure boundary, limit the radioactive iodine release to the environment in the event of failure of containment structure, and minimize corrosion of the internal containment systems following a LOCA.

The operator can initiate CS by simultaneously actuating two CS actuation switches in the same train to prevent inadvertent actuation of CS. Simultaneously actuating the two switches in either set will start both trains of CS.

There are two trains for automatic actuation. In Mode 4, adequate time is available to manually actuate required components in the event of a design basis accident. However, because of the large number of components actuated, actuation is simplified by the use of the manual actuation push buttons. Automatic actuation logic and actuation relays must be operable in Mode 4 to support system level manual initiation.

The LCO for manual Initiation requires that two channels per train and two trains shall be operable. The LCO for Automatic Actuation Logic and Actuation Relays requires that two trains shall be operable.

Proposed Required Actions: For the Manual initiation, the end state for Required Action B.2.2 is revised to be in Mode 4 in 60 hours instead of in Mode 5 in 84 hours and a Note is added to Required Action B.2.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

For automatic logic and actuation relays, the end state for Required Action C.2.2 is revised to be in Mode 4 in 36 hours if the inoperable train is not restored to operable status in 24 hours. A Note is added to Required Action C.2.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one channel or train is inoperable, the other train is available for the operator to initiate CS. A cool down to Mode 4 places the unit in a state in which transients progress slower than at power, backup core cooling is available via RHR, there is increased time for operator actions, and there is a lower overall risk than proceeding to Mode 5. In addition, the containment, containment isolation valves, CS system, and containment cooling system are available.

Placing the unit in Mode 5 does not increase the instrumentation available for event mitigation. In addition, the containment, containment isolation valves, CS System, and containment cooling system are required to be operational. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4.

The staff accepts the proposed amendment to revise Required Actions B.2.2 and C.2.2 so that the plant would be allowed to remain in Mode 4, subject to LCO 3.0.4.a being not applicable for entry into Mode 4 from Mode 5 and to the limitations and conditions in Section 4.0.

Function 3.a (1) Containment Isolation, Phase A Isolation, Manual Isolation
Function 3.a (2) Containment Isolation, Phase A Isolation, Automatic Actuation Logic and Actuation Relays
Function 3. b (1) Containment Isolation, Phase B Isolation, Manual Initiation
Function 3. b (2) Containment Isolation, Phase B Isolation, Automatic Actuation Logic and Actuation Relays

Description: Containment Isolation (CI) provides isolation of the containment atmosphere, and all process systems that penetrate containment, from the environment. This function is necessary to prevent or limit the release of radioactivity to the environment in the event of a large break LOCA.

There are two separate CI signals, Phase A and Phase B. The Phase A signal isolates all automatically isolatable process lines, except component cooling water (CCW), at a relatively low containment pressure. The Phase A CI is actuated automatically by SI, or manually via the automatic actuation logic. All process lines penetrating containment, with the exception of CCW, are isolated.

Phase B signal isolates CCW. Manual Phase B CI is accomplished by the same switches that actuate CS. When the two switches in either set are actuated simultaneously, Phase B CI and CS will be actuated in both trains.

The LCO for 3.a (1) requires that two channels be operable. The LCO for 3.a (2) requires that two trains be operable. The LCO for 3.b (1) requires that two channels per train and two trains be operable. And, the LCO for 3.b (2) requires that two trains shall be operable.

Proposed Required Actions: For Functions 3.a (1), 3.b (1), the end state for Required Action B.2.2 is revised to be in Mode 4 in 60 hours instead of in Mode 5 in 84 hours. For Functions 3.a (2) and 3.b (2), the end state for Required Action C.2.2 is revised to be in Mode 4 in 36 hours if the inoperable train is not restored to operable status in 24 hours. A Note is added to Required Actions B.2.2 and C.2.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one channel is inoperable, the other channel is available to the operator to initiate CI. Two trains of automatic actuation logic are also available to actuate the CI equipment. Placing the unit in Mode 5 does not increase the instrumentation available for event mitigation. In addition, CI valves, CS system, and CCW systems are available. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Actions B.2.2 and C.2.2 so that the plant would be allowed to remain in Mode 4.

Function 7.a. Automatic Switchover to Containment Sump, Automatic Actuation Logic and Actuation Relays.

Description: At the end of the injection phase of a LOCA, since the Refueling Water Storage Tank (RWST) is nearly empty, and continued cooling must be provided by the ECCS to remove decay heat, the source of water for the ECCS pumps is automatically switched to the containment recirculation sump. This switchover must occur before the RWST empties to prevent damage to RHR pumps and a loss of cooling capability. Switchover must not occur before there is sufficient water in the containment sump to support Engineered Safety Feature (ESF) pump suction. Also, early switchover must not occur to ensure that sufficient borated water is injected from the RWST.

There are two trains for automatic actuation and the logic and actuation relays consist of the same features and operate in the same manner as described in Function 1.b. The LCO for this function requires that two trains be operable.

Proposed Required Actions: For Function 7.a, the end state for Required Action C.2.2 is revised to be in Mode 4 in 36 hours instead of in Mode 5 in 60 hours, if the inoperable train is not restored to operable status within 24 hours. A Note is added to Required Action C.2.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one train is inoperable, the other train is available to initiate switchover to the containment sump. In addition, the operator can perform the switchover manually. Placing the unit in Mode 5 does not increase the instrumentation available for event mitigation.

Placing the unit in Mode 5 does not increase the instrumentation available for event mitigation. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action C.2.2 so that the plant would be allowed to remain in Mode 4.

Function 7.b and 7.c Automatic Switchover to Containment Sump - Refueling Water Storage Tank (RWST) Level - Low Low Coincident With Safety Injection, and RWST Level - Low Low Coincident With Containment Sump Level – High

Description: During the injection phase of a LOCA, automatic switchover from RWST to the containment sump occurs only if the RWST low low level signal is coincident with the SI. This prevents accidental switchover during normal operation.

In some units, additional protection from spurious switchover is provided by requiring a Containment Sump Level - High signal as well as RWST Level - Low Low and SI. This ensures sufficient water is available in containment to support the recirculation phase of the accident. A Containment Sump Level - High signal must be present, in addition to the SI signal and the RWST Level - Low Low signal, to transfer the suction of the RIHR pumps to the containment sump.

The RWST has four level transmitters. Units with containment sump level circuitry also have four channels for the sump level instrumentation. The logic requires two out of four channels to initiate the switchover from the RWST to the containment sump. The LCO for this function requires that four channels be operable.

Proposed Required Actions: The end state for Required Action K.2.2 is revised to be in Mode 4 in 18 hours instead of Mode 5 in 42 hours if the inoperable channel is not restored to operable status within 6 hours. A Note is added to Required Action K.2.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one channel is inoperable, the other three channels are available to initiate switchover to the containment sump. The fact that this protection feature is not fully operational would make the operator to be prepared to address a unit transient requiring SI and recirculation knowing that manual initiation of the switchover from RWST to the containment sump may be required. Placement of the unit in Mode 5 does not increase the instrumentation available for event mitigation.

The redundancy is such that a single channel failure and one channel being inoperable will not defeat the initiation of switchover from the RWST to the containment sump. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action K.2.2 so that the plant would be allowed to remain in Mode 4, subject to the conditions and limitations in Section 4.0.

3.1.2 TS 3.3.7 - Control Room Emergency Filtration System (CREFS) Actuation Instrumentation

Description: The CREFS provides an enclosed control room environment from which the unit can be operated following an uncontrolled release of radioactivity. During normal operation, the Auxiliary Building Ventilation System provides control room ventilation. Upon receipt of an actuation signal, the CREFS initiates filtered ventilation and pressurization of the control room.

The actuation instrumentation consists of redundant radiation monitors in the air intakes and control room area. A high radiation signal from any of these detectors will initiate both trains of the CREFS. The control room operator can also initiate the CREFS trains by manual switches in the control room. The CREFS is also actuated by a safety injection (SI) signal. The LCO for this system requires that two channels be operable.

Proposed Required Actions: The end state for Required Action C.2 is to be in Mode 4 in 12 hours instead of in Mode 5 in 36 hours if the Required Action and associated CT for Condition A or B are not met in Mode 1, 2, 3, or 4. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The system design provides redundancy and defense in depth from the multiple channels, trains, and functions available to actuate the CREFS. If one or two channels or trains in one or more functions are inoperable, the Required Actions require one or both CREFS trains to be placed in the emergency radiation protection mode of operation. This places the unit in a conservative mode of operation. In the unlikely event that this is not accomplished and Condition C is entered, the likelihood of an initiating event is not increased and placing the unit in Mode 5 does not increase the instrumentation available for event mitigation. The system design maintains sufficient defense-in-depth when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action C.2. so that the plant would be allowed to remain in Mode 4.

3.1.3 TS 3.3.8 – Fuel Building Air Cleanup System (FBACS) Actuation Instrumentation

Description: The FBACS ensures that radioactive materials in the fuel building atmosphere following a fuel handling accident [involving handling recently irradiated fuel] or a LOCA are filtered and adsorbed prior to exhausting to the environment. The system initiates filtered ventilation of the fuel building automatically following receipt of a high radiation signal (gaseous or particulate) or following an SI signal. Initiation may also be performed manually as needed from the main control room.

Each FBACS train is initiated by high radiation detected by a dedicated channel. Each of the two available channels contains a gaseous and a particulate monitor. High radiation detected by any monitor or an SI signal from the ESFAS initiates fuel building isolation and starts the FBACS. The LCO requirements ensure that instrumentation necessary to initiate the FBACS is operable. The LCO requires that the two trains and [two] channels shall be operable.

Proposed Required Actions: The end state for Required Action D.2 is to be in Mode 4 in 12 hours instead of in Mode 5 in 36 hours if the Required Action and associated CT for Condition A or B are not met in Mode 1, 2, 3, or 4. A Note is added to Required Action D.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one or two channels or trains in one or more functions are inoperable, one or both FBACS trains are to be placed in the emergency radiation protection mode of operation. This accomplishes the actuation instrumentation function and places the unit in a conservative mode of operation. In the unlikely event that this is not accomplished and Condition C is entered, the likelihood of an initiating event is not increased and placing the unit in Mode 5 does not increase the instrumentation available for event mitigation. The system design maintains sufficient defense-in-depth when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action D.2. so that the plant would be allowed to remain in Mode 4.

3.1.4 TS 3.4.13 – Reactor Coolant System (RCS) Operational Leakage

Description: The safety significance of RCS Leakage varies widely depending on its source, rate, and duration. Therefore, detecting and monitoring reactor coolant leakage into the containment area is necessary. A limited amount of leakage inside containment is expected from auxiliary systems that cannot be made 100% leaktight. Leakage from these systems should be detected, located, and isolated from the containment atmosphere, if possible, to not interfere with RCS leakage detection.

This LCO deals with protection of the reactor coolant pressure boundary (RCPB) from degradation and the core from inadequate cooling, in addition to preventing the accident analyses radiation release assumptions from being exceeded.

RCS operational leakage shall be limited to:

a. No pressure boundary leakage,

b. 1 gpm unidentified leakage,

c. 10 gpm identified leakage, and

d. 1 gpm total primary to secondary leakage through all SGs, and

e. [500] gpd primary to secondary leakage through any one SG.

Proposed Required Actions: The end state for Required Action B.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT of Condition A are not met, or pressure boundary leakage exists. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: A RCS leakage that is considered to be not large enough to be a small break LOCA should be treated as an event leading to a controlled shutdown which is not modeled in the quantitative risk analysis. Though lower RCS pressure in Mode 5 compared to Mode 4 enables the unit to reduce RCS leakage to lower amounts, RCS pressure in Mode 4 must be maintained at the lower end of the pressure range at Mode 4.

In Mode 4, the RCS pressure is significantly reduced and this reduces the leakage. All LOCA mitigating systems with the exception of the accumulators are available and the RHR serves as the backup to auxiliary feedwater for decay heat removal. If any pressure boundary leakage leakage exists, or if unidentified leakage, identified leakage, or primary to secondary leakage cannot be reduced to within limits within 4 hours, the reactor must be brought to lower pressure conditions to reduce the severity of the leakage and its potential consequences.

The staff accepts the proposed amendment to revise Required Action B.2 so that the plant would be allowed to remain in Mode 4, subject to LCO 3.0.4.a being not applicable for entry into Mode 4 from Mode 5 and to the conditions and limitations in Section 4.0.

3.1.5 TS 3.4.14 – RCS Pressure Isolation Valve (PIV) Leakage

Description: 10 CFR 50.2, "Definitions," and 10 CFR 50.55a(c), "Codes and Standards" define RCS PIVs as any two normally closed valves in series within the reactor coolant pressure boundary (RCPB), which separate the high pressure RCS from an attached low pressure system. The RCS PIV Leakage LCO allows RCS high pressure operation when leakage through these valves exists in amounts that do not compromise safety. This is true during operation only when the loss of RCS mass through two series valves is determined by a water inventory balance. A known component of the identified leakage before operation begins is the least of the two individual leak rates determined for leaking series PIVs during the required surveillance testing; leakage measured through one PIV in a line is not RCS operational leakage if the other is leaktight.

The main purpose of this specification is to prevent overpressure failure of the low pressure portions of the connecting systems. The leakage limit is an indication that the PIVs between the RCS and the connecting systems are degraded or degrading. PIV leakage could lead to overpressure of the low pressure piping or components. The failure consequences could be a LOCA outside of containment, an unanalyzed accident that could degrade the ability for low pressure injection.

Proposed Required Actions: The end state for Required Action B.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT of Condition A are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: This TS limits RCS leakage because of the concern of over-pressurization of a lower pressure system that can lead to an interfacing system LOCA. Though PIV leakage can be reduced to a lower level in Mode 5 compared to Mode 4 because of lower pressure, the unit should be brought to lower part of Mode 4 where the RCS pressure can be maintained significantly lower than at power which will reduce the effects of the PIV leakage.

In Mode 4, the RCS pressure is significantly reduced which reduces the PIV leakage. All LOCA mitigating systems with the exception of the accumulators are available and RHR serves as the backup to auxiliary feedwater for decay heat removal. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action B.2. so that the plant would be allowed to remain in Mode 4, subject to the conditions and limitations in Section 4.0.

3.1.6 TS 3.4.15 – RCS Leakage Detection Instrumentation

Description: GDC 30 of Appendix A to 10 CFR 50, "Quality of reactor coolant pressure boundary," requires means for detecting and, to the extent practical, identifying the location of the source of RCS leakage. Leakage detection systems must have the capability to detect significant RCPB degradation as soon after occurrence as practical to minimize the potential for propagation to a gross failure. Thus, an early indication or warning signal is necessary to permit proper evaluation of all unidentified RCS leakage.

The LCO requires that the following RCS leakage detection instrumentation be operable:

a. One containment sump (level or discharge flow) monitor,

b. One containment atmosphere radioactivity monitor (gaseous or particulate), and

c. One containment air cooler condensate flow rate monitor.

Proposed Required Actions: The end state for Required Action E.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action E.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one function is inoperable, the other functions are available to provide indication of RCS leakage. In the unlikely event that Condition E occurs, the likelihood of an initiating event is not increased, and placing the unit in Mode 5 does not increase the instrumentation available for detecting RCS leakage. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action E.2 so that the plant would be allowed to remain in Mode 4, subject to the conditions and limitations in Section 4.0.

3.1.7 TS 3.5.3 - ECCS - Shutdown

Description: This TS is only applicable in Mode 4. In MODE 4, the required ECCS train consists of two separate subsystems: centrifugal charging (high head) and RHR (low head). The ECCS flow paths consist of piping, valves, heat exchangers, and pumps such that water from the RWST can be injected into the RCS following an accident. The LCO requires that one ECCS train be operable.

Proposed Required Actions: Condition A is revised from “Required ECCS residual heat removal (RHR) subsystem inoperable” to “Required ECCS train inoperable.” Required action A1 is revised from “Initiate action to restore required ECCS RHR subsystem to OPERABLE status” to “Initiate action to restore required ECCS RHR train to operable status.” This change allows the unit to remain in Mode 4, rather than transitioning to Mode 5 with an inoperable ECCS high head system.

Assessment: The subsystems addressed by this TS are the ECCS RHR and ECCS High Head subsystems which are both included in the quantitative risk evaluation (Reference 2). The requested change in Action A1 will enable the unit to remain in a Mode where steam generator cooling is also available for decay heat removal.

Table 3.2.1 of this SE, shows that POS 4 CDP is approximately seven times greater than the POS 3 CDP. Proceeding to Mode 5 does not significantly increase the protection available and additional risk is introduced by switching from AFW cooling to RHR cooling. This supports remaining in Mode 4 for this configuration rather than cooling down to Mode 5.

The proposed change to the Required Action C.1 end state does not change the operability requirement for the ECCS. One train still must be operable in Mode 4. If one train of RHR is inoperable, then remaining in Mode 4 provides core cooling from the AFW pumps with the operable RHR pump as a backup. If both trains of RHR are inoperable, then the unit will remain on AFW cooling while one train is restored. The probability of transients occurring that require the ECCS are less likely in Mode 4 than at-power and the risk associated with transferring to RHR cooling from AFW cooling is eliminated by remaining in Mode 4. Sufficient defense-in-depth is maintained when the unit remains in Mode 4 rather than transitioning to Mode 5.

The staff accepts the proposed amendment to revise TS 3.5.3 so that the plant would be allowed to remain in Mode 4, subject to the conditions and limitations in Section 4.0.

3.1.8 TS 3.5.4 – Refueling Water Storage Tank (RWST)

Description: The RWST supplies borated water to the Chemical and Volume Control System (CVCS) during abnormal operating conditions, to the refueling pool during refueling, and to the ECCS and the Containment Spray System during accident conditions. The RWST supplies both trains of the ECCS and the Containment Spray System through separate, redundant supply headers during the injection phase of a LOCA recovery.

During normal operation in MODES 1, 2, and 3, the SI and RHR pumps are aligned to take suction from the RWST. This LCO requires that the RWST be operable.

Proposed Required Actions: The end state for Required Action C.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action E.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:. Since SI and recirculation are not available due to inoperable RWST, any loss of inventory events that cannot be isolated can lead to core damage. From Table 3.2.1 of this SE, remaining in Mode 4 (POS 3) instead of cooldown to Mode 5 (POS 4, upper portion of Mode 5) reduces the CDP by more than a factor of 3. The primary accidents such as LOCAs and SLBs are less likely to occur in Mode 4. Since control rods are inserted in Mode 4, the SLB analysis assumption of the highest worth rod stuck is an unlikely scenario. In lower part of Mode 4 transients progress slower than at power, backup cooling is available via RHS and there is increased time for operator action and mitigation strategies. Proceeding to Mode 5 may add additional risk by switching from AFW cooling to RHR cooling. Based on Table 3.2.1 of this SE, if RWST is inoperable for reasons other than boron concentration or temperature, a shutdown to Mode 4 is appropriate.

In Mode 4, the transient conditions are less severe than at power so that variations in the RWST parameters or other reasons of inoperability are less significant. In addition, if the boron concentration is low, the emergency boration equipment is likely to be available to increase the RCS boron concentration. By changing the end state for Required Action C.2 to Mode 4, the possibility of a loss of inventory event due to switching to RHR cooling is eliminated, reducing the possibility that the RWST inventory would be required. Therefore, sufficient defense-in-depth is maintained when the unit remains in Mode 4 rather than transitioning to Mode 5 with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise TS 3.5.4 so that the plant would be allowed to remain in Mode 4, subject to the conditions and limitations in Section 4.0.

3.1.9 TS 3.6.6A, Containment Spray and Cooling Systems (Atmospheric and Dual) (Credit taken for iodine removal by the Containment Spray System)

Description: The CS and containment cooling systems provide containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. Reduction of containment pressure and the iodine removal capability of the spray reduce the release of fission product radioactivity from containment to the environment, in the event of a design basis accident, to within limits.The containment spray system consists of two separate trains of equal capacity, each capable of meeting the design bases. Each train includes a containment spray pump, spray headers, nozzles, valves, and piping. Each train is powered from a separate ESF bus. The RWST supplies borated water to the CS system during the injection phase of operation. In the recirculation mode of operation, CS pump suction is transferred from the RWST to the containment sump(s).

Two trains of containment cooling, each of sufficient capacity to supply 100% of the design cooling requirement, are provided. Each train of two fan units is supplied with cooling water from a separate train of service water (SW). Air is drawn into the coolers through the fan and discharged to the steam generator compartments, pressurizer compartment, instrument tunnel, and outside the secondary shield in the lower areas of containment. Containment Cooling systems are not credited with iodine removal. The LCO requires that two containment spray trains and [two] containment cooling trains shall be operable.

Proposed Required Actions: To revise the end state for Required Action B.2 to be in Mode 4 in 60 hours, and revise the end state for Required Action E.2 to be in Mode 4 in 12 hours. A Note is added to Required Actions B.2 and E.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The CS and containment cooling systems are designed for accident conditions initiated at full power. One train of each system satisfies the assumptions in the safety analyses. One train of CS is required to satisfy assumptions regarding iodine removal. If one train of either CS or containment cooling is inoperable the other train is available to mitigate the accident along with both trains of the other system. If both trains of containment cooling are inoperable, CS can serve as the cooling system and it also serves to remove iodine. Action F requires that if two CS trains are inoperable or any combination of three or more trains is inoperable the plant must immediately enter LCO 3.0.3. The proposed changes to the TS bases were also reviewed as input to the technical specification changes. The requirements of GDC 38 will still be met. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC Staff finds the applicants proposed change to be acceptable.

3.1.10 Technical Specification 3.6.6B - Containment Spray and Cooling Systems (Atmospheric and Dual) (Credit not taken for iodine removal by the Containment Spray System)

Description: The CS and containment cooling systems provide containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. One train of the CS will cause a reduction of containment pressure, in the event of a design basis accident, to within limits.

The CS system consists of two separate trains of equal capacity, each capable of meeting the design bases. Each train includes a CS pump, spray headers, nozzles, valves, and piping. Each train is powered from a separate ESF bus. The RWST supplies borated water to the CS system during the injection phase of operation. In the recirculation mode of operation, CS pump suction is transferred from the RWST to the containment sump(s).

Two trains of containment cooling, each of sufficient capacity to supply 100% of the design cooling requirement, are provided. Each train of two fan units is supplied with cooling water from a separate train of SW. Air is drawn into the coolers through the fan and discharged to the steam generator compartments, pressurizer compartment, instrument tunnel, and outside the secondary shield in the lower areas of containment. The LCO requires that two CS trains and [two] containment cooling trains shall be operable.

Proposed Required Actions: Revise the end state for Required Action F.2 to be in Mode 4 in 12 hours if the Required Action and associated CT of Condition A, B, C, D, or E not met. A Note is added to Required Action F.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The CS and containment cooling systems are designed for accident conditions initiated at full power. One train of each system satisfies the assumptions for containment cooling in the safety analyses. If one train of either CS or containment cooling is inoperable the other train is available to mitigate the accident along with both trains of the other system. If both trains of containment cooling are inoperable, CS can serve as the cooling system and it also serves to remove iodine. Action G requires that if two CS trains are inoperable or any combination of three or more trains inoperable the plant must immediately enter LCO 3.0.3. The proposed changes to the TS bases were also reviewed as input to the TS change. The requirements of GDC 38 will still be met. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change to be acceptable.

3.1.11 TS 3.6.6C, Containment Spray, (Ice Condenser)

Description: The CS system provides containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. Reduction of containment pressure and the iodine removal capability of the spray reduce the release of fission product radioactivity from containment to the environment, in the event of a design basis accident.

Each train includes a CS pump, one CS heat exchanger, spray headers, nozzles, valves, and piping. Each train is powered from a separate engineered safety feature (ESF) bus. The RWST supplies borated water to the CS system during the injection phase of operation. In the recirculation mode of operation, CS pump suction is transferred from the RWST to the containment recirculation sump(s).

The diversion of a portion of the recirculation flow from each train of RHR to additional redundant spray headers completes the CS system heat removal capability. Each RHR train is capable of supplying spray coverage, if required, to supplement the CS system. The RHR spray operation is initiated manually, when required by the emergency operating procedures, after the ECCS is operating in the recirculation mode. The LCO requires that two CS trains shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 60 hours if the Required Action and associated CT not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The CS system is designed for accident conditions initiated at full power. One train satisfies the assumptions in the safety analyses. One train of CS is required to satisfy assumptions regarding iodine removal. If one train of CS is inoperable the other train is available to mitigate the accident. The Ice Condenser is required to be operable and it is designed to handle a heat load in excess of the initial blowdown of a design basis LOCA, or any feedwater or steam line break event inside containment. An event in Mode 4 that releases energy into containment will release far less energy than an event in Mode 1. The proposed changes to the TS bases were also reviewed as input to the change. The requirements of GDC 38 will still be met. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change to be acceptable.

3.1.12 TS 3.6.6D, Quench Spray (QS) System (Subatmospheric)

Description: The QS system is designed to provide containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. The QS system, operating in conjunction with the recirculation spray (RS) system, is designed to cool and depressurize the containment structure to subatmospheric pressure in less than 60 minutes following a design basis accident. Reduction of containment pressure and the iodine removal capability of the spray limit the release of fission product radioactivity from containment to the environment in the event of a design basis accident.

The QS system consists of two separate trains of equal capacity, each capable of meeting the design bases. Each train includes a spray pump, spray headers, nozzles, valves, and piping. Each train is powered from a separate ESF bus. The RWST supplies borated water to the QS system. The QS system is actuated either automatically by a containment High-High pressure signal or manually. Each train of the QS system provides adequate spray coverage to meet the system design requirements for containment heat and iodine fission product removal. The LCO requires that two Quench Spray trains shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 12 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The QS system is designed for accident conditions initiated at power. One train satisfies the assumptions in the safety analyses. In addition, the containment temperature and pressure limits are set to account for the effects of an energy release during an event in full power operation. Events, such as a LOCA or a secondary side break, are less likely in Mode 4 due to less severe thermal-hydraulic conditions. An event in Mode 4 that releases energy into containment will release far less energy than an event in Mode 1. The proposed changes to the TS bases were also reviewed as input to the TS revision. The requirements of GDC 38 will still be met. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change to be acceptable.

3.1.13 TS 3.6.6E, Recirculation Spray (RS) System (Subatmospheric)

Description: The RS system, operating in conjunction with the QS system, is designed to limit the post accident pressure and temperature in the containment to less than the design values and to depressurize the containment structure to a subatmospheric pressure in less than 60 minutes following a design basis accident. The reduction of containment pressure and the removal of iodine from the containment atmosphere by the spray limit the release of fission product radioactivity from containment to the environment in the event of a design basis accident.

The RS system consists of two separate trains of equal capacity, each capable of meeting the design and accident analysis bases. Each train includes one RS subsystem outside containment and one RS subsystem inside containment. Each subsystem consists of one 50% capacity spray pump, one spray cooler, one 180° coverage spray header, nozzles, valves, piping, instrumentation, and controls. Each outside RS subsystem also includes a casing cooling pump with its own valves, piping, instrumentation, and controls. The two outside RS subsystems' spray pumps are located outside containment and the two inside RS subsystems' spray pumps are located inside containment. Each RS train (one inside and one outside RS subsystem) is powered from a separate ESF bus. Each train of the RS system provides adequate spray coverage to meet the system design requirements for containment heat and iodine fission product removal. The LCO requires that four RS subsystems [and a casing cooling tank] shall be operable.

Proposed Required Actions: Revise the end state for Required Action F.2 to be in Mode 4 in 60 hours if the Required Action and associated CT not met. A Note is added to Required Action F.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The RS system is designed for accident conditions initiated at power. One train (two subsystems) satisfies the assumptions in the safety analyses. In addition, the containment temperature and pressure limits are set to account for the effects of an energy release during an event in full power operation. One train of RS is required to satisfy assumptions regarding iodine removal. An event in Mode 4 that releases energy into containment will release far less energy than an event in Mode 1. The proposed changes to the TS bases were also reviewed as input to the TS change. The requirements of GDC 38 will still be met. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change to be acceptable.

3.1.14 TS 3.6.7, Spray Additive System (Atmospheric, Subatmospheric, Ice Condenser, and Dual)

Description: The spray additive system is a subsystem of the CS system that assists in reducing the iodine fission product inventory in the containment atmosphere resulting from a design basis accident.

Radioiodine in its various forms is the fission product of primary concern in the evaluation of a design basis accident. It is absorbed by the spray from the containment atmosphere. To enhance the iodine absorption capacity of the spray, the spray solution is adjusted to an alkaline pH that promotes iodine hydrolysis, in which iodine is converted to nonvolatile forms.

For an eductor feed system, the spray additive system consists of one spray additive tank that is shared by the two trains of spray additive equipment. Each train of equipment provides a flow path from the spray additive tank to a CS pump and consists of an eductor for each CS pump, valves, instrumentation, and connecting piping. Each eductor draws the NaOH spray solution from the common tank using a portion of the borated water discharged by the containment spray pump as the motive flow. The eductor mixes the NaOH solution and the borated water and discharges the mixture into the spray pump suction line.

For a gravity feed system, the spray additive system consists of one spray additive tank, two parallel redundant motor operated valves in the line between the additive tank and the RWST, instrumentation, and recirculation pumps. The NaOH solution is added to the spray water by a balanced gravity feed from the additive tank through the connecting piping into a weir within the RWST. There, it mixes with the borated water flowing to the spray pump suction.

In MODES 1, 2, 3, and 4, a design basis accident (DBA) could cause a release of radioactive material to containment requiring the operation of the Spray Additive System. The Spray Additive System assists in reducing the iodine fission product inventory prior to release to the environment. The LCO requires that the spray additive system shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 60 hours if the Required Action and associated CT not met. A Note is added to Required Action F.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The TR applicant justifies the proposed change by indicating "[e]vents, such as a LOCA or a secondary side break, are less likely in Mode 4 due to the limited time in the mode and less severe thermal-hydraulic conditions. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4." The TR applicant also indicates that "proceeding to Mode 5 does not increase the protection available".

CS will still be available to reduce the iodine fission product inventory in the containment. Based on the lower reactor cooling system pressures and temperatures, the ability to maintain the ECCS operation so the criteria of 10 CFR 50.46 are met, the CS systems and containment cooling systems available to depressurize and reduce the airborne radioiodine in containment, the NRC staff finds the proposed change acceptable, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

3.1.15, Item 6.4.22a Recirculation Fluid pH Control System

Description: Some Westinghouse NSSS plants have replaced the spray additive system with a passive ECCS recirculation fluid pH control system. Although the TS for this system is not contained in NUREG- 1431, the end state is Mode 5 if the system is inoperable, and the Required Action and associated CT are not met. The system consists of baskets in the containment sump with a specified amount of trisodium phosphate in each basket.

The trisodium phosphate dissolves when the containment sump level increases to the level of the baskets. It is highly unlikely that all of the baskets would be empty; therefore, an inoperable recirculation fluid pH control system would still provide some pH control. The justification for changing the end state to Mode 4 for TS 3.6.7, "Spray Additive System," is also applicable to the recirculation fluid pH control system, since they perform the same function.

The recirculation fluid pH control system TS currently requires the unit to be in Mode 3 in 6 hours and Mode 5 in 84 hours if the system is inoperable, and the Required Action and associated CT are not met.

Proposed Required Actions: Mode 5 end state is proposed to be changed to require the unit to be in Mode 4 in 60 hours if the Required Action and associated CT are not met.

Assessment: The TR applicant justifies the proposed change by indicating "[e]vents, such as a LOCA or a secondary side break, are less likely in Mode 4 due to the limited time in the mode and less severe thermal-hydraulic conditions. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4." The TR applicant also indicates that "proceeding to Mode 5 does not increase the protection available". The TR applicant also argues that it is highly unlikely that all of the baskets would be empty; therefore, an inoperable recirculation fluid pH control system would still provide some pH control.

CS will still be available to reduce the iodine fission product inventory in the containment. Based on the lower reactor cooling system pressures and temperatures, the ability to maintain the ECCS operation so the criteria of 10 CFR 50.46 is met, the CS systems and containment cooling systems available to depressurize and reduce the airborne radioiodine in containment, the NRC staff finds the proposed change acceptable.

3.1.16 TS 3.6.11 - Iodine Cleanup System (ICS) (Atmospheric and Subatmospheric)

Description: The ICS functions together with the CS and cooling systems following a design basis accident to reduce the potential release of radioactive material, principally iodine, from the containment to the environment.

The ICS consists of two 100% capacity, separate, independent, and redundant trains. Each train includes a heater, [cooling coils,] a prefilter, a demister, a high efficiency particulate air (HEPA) filter, an activated charcoal adsorber section for removal of radioiodine, and a fan. Ductwork, valves and/or dampers, and instrumentation also form part of the system. Each ICS train is powered from a separate ESF bus and is provided with a separate power panel and control panel. During normal operation, the containment cooling system is aligned to bypass the ICS HEPA filters and charcoal adsorbers. For ICS operation following a design basis accident, however, the bypass dampers automatically reposition to draw the air through the filters and adsorbers. The LCO requires that two ICS trains shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 12 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:

Function 1: Reduce the concentration of fission products released to the containment atmosphere following a postulated accident.

Action A states that with one ICS train inoperable the licensee has seven days to restore the ICS train to OPERABLE status. The TR applicant requests that if Action A cannot be accomplished within the seven day limit, Required Action B.1 requires the unit to be in Mode 3 in six hours and in Mode 4 in twelve hours. Two trains of containment spray and the second train of ICS will be available for reduction of the concentration of fission products released to the containment following a postulated accident. The proposed changes to the TS bases were also reviewed. The requirements of GDC Criterion 41 will be met. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change to be acceptable.

3.1.17 TS 3.6.12, Vacuum Relief Valves (Atmospheric and Ice Condenser)

Description: The purpose of the vacuum relief lines is to protect the containment vessel against negative pressure (i.e., a lower pressure inside than outside). Excessive negative pressure inside containment can occur if there is an inadvertent actuation of containment cooling features, such as the CS system. Multiple equipment failures or human errors are necessary to cause inadvertent actuation of these systems.

The containment pressure vessel contains two 100% vacuum relief lines that protect the containment from excessive external loading. The LCO requires that [two] vacuum relief lines shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 12 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:
Function 1: Protect the containment vessel against negative pressure (i.e., a lower pressure inside than outside containment).

Excessive negative pressure inside containment can occur if there is an inadvertent actuation of containment cooling features, such as the CS system. Excessive negative pressure in a dual containment can cause structural damage to the steel pressure containment. Action A states that if one vacuum relief line is inoperable the licensee has 72 hours to restore vacuum relief line to OPERABLE status.

Most containment pressure vessels contain two 100% vacuum relief lines that protect the containment from excessive external loading. This evaluation is applicable only for containment designs with two or more vacuum relief lines. With one vacuum relief line inoperable there will still be one vacuum relief line operable to provide protection for the containment pressure vessel. The proposed changes to the TS bases were also reviewed. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change to be acceptable.

3.1.18 TS 3.6.13, Shield Building Air Cleanup System (SBACS) (Dual and Ice Condenser)

Description: The containment has a secondary containment called the shield building, which is a concrete structure that surrounds the steel primary containment vessel. Between the containment vessel and the shield building inner wall is an annular space that collects any containment leakage that may occur following a LOCA. This space also allows for periodic inspection of the outer surface of the steel containment vessel.

The SBACS establishes a negative pressure in the annulus between the shield building and the steel containment vessel. Filters in the system then control the release of radioactive contaminants to the environment.

The SBACS consists of two separate and redundant trains. Each train includes a heater, [cooling coils,] a prefilter, moisture separators, a HEPA filter, an activated charcoal adsorber section for removal of radioiodines, and a fan. During normal operation, the shield building cooling system is aligned to bypass the SBACS's HEPA filters and charcoal adsorbers. For SBACS operation following a design basis accident, however, the bypass dampers automatically reposition to draw the air through the filters and adsorbers. The LCO requires that two SBACS trains shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 12 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:
Function 1: Collect any containment leakage that leaks into the annular space (annulus) between the shield building and the steel containment vessel following a LOCA.

Function 2: Filter any containment leakage from the annulus before release to the environment.

Action A states that if one SBACS train is inoperable the licensee has seven days to restore SBACS train to OPERABLE status. For both Function 1 and Function 2, a second train of SBCAS will be available to collect any containment leakage from the annulus and to filter that containment leakage before release to the environment. The energy released to containment from a LOCA will be lower than for the maximum design basis accident. CS systems and containment cooling systems, and ECCS will be available. The loads on these systems will be well within their design basis.

If two trains of SBACS are inoperable, LCO 3.0.3 applies since an associated ACTION for two trains of SBACS inoperable is not provided. The proposed changes to the TS bases were also reviewed. On this technical basis, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the NRC staff finds the proposed change acceptable.

3.1.19 TS 3.6.14, Air Return System (ARS) (Ice Condenser)

Description: The ARS is designed to assure the rapid return of air from the upper to the lower containment compartment after the initial blowdown following a design basis accident. The return of this air to the lower compartment and subsequent recirculation back up through the ice condenser assists in cooling the containment atmosphere and limiting the post accident pressure and temperature in containment to less than design values. The ARS provides post accident hydrogen mixing in selected areas of containment. The ARS also functions, after all the ice has melted, to circulate any steam still entering the lower compartment to the upper compartment where the containment spray system can cool it.

The ARS consists of two separate trains of equal capacity, each capable of meeting the design bases. Each train includes a 100% capacity air return fan, associated damper, and hydrogen collection headers with isolation valves. The ARS fans are automatically started and the hydrogen collection header isolation valves are opened by the containment pressure High-High signal 10 minutes after the containment pressure reaches the pressure setpoint. The LCO requires that two ARS trains shall be operable.

Proposed Required Actions: Revise the end state for Required Action B.2 to be in Mode 4 in 12 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:

Function 1: Recirculation of containment air from upper containment to lower containment compartment to assist cooling the containment atmosphere and limiting post accident pressure in containment. Containment air cooling for a LOCA is still required for operation in Mode 4. The CS system will still be operational to provide cooling in the upper containment compartment. The energy released into containment from a LOCA while in Mode 4 is well within the design limits for the containment spray system. CS will be automatically initiated by containment high-high signal or by manual actuation. Adequate cooling will be available to maintain the containment air temperature and containment post accident pressure within the design limits.

Function 2: Provide mixing in select areas of containment to prevent hydrogen gas accumulation. The ECCS and CS system remain operable. ECCS will be automatically initiated by low pressurizer pressure, high containment pressure, or manual actuation. The ECCSs are designed in accordance with 10CFR50, Appendix A, GDC 35, 36, "Inspection of emergency core cooling system," and 37, "Testing of emergency core cooling system."

Criteria 36 and 37 address system inspection and testing. Criterion 35 states:
A system to provide abundant emergency core cooling shall be provided. The system safety function shall be to transfer heat from the reactor core following any loss of reactor coolant at a rate such that (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

With one train of containment air return inoperable the remaining train will be operable to provide air mixing to prevent hydrogen accumulation. LCO 3.6.14 requires "[t]wo ARS [air return systems] trains shall be OPERABLE." With two trains inoperable there will not be any forced ventilation to provide air mixing to prevent hydrogen accumulation. According to 10 CFR 50.36(c)(2) *Limiting conditions for operation*, (i) "Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specifications until the condition can be met." NUREG-1431, Standard Technical Specifications Westinghouse Plants, LCO 3.0.3, states "[w]hen an LCO is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, the unit shall be placed in a MODE or other specified condition in which the LCO is not applicable. Action shall be initiated within 1 hour to place the unit, as applicable, in:

a. MODE 3 within 7 hours,
b. MODE 4 within 13 hours, and
c. MODE 5 within 37 hours."

The proposed changes to the TS bases were also reviewed.

Based on one train of the ARS being operable to help maintain containment cooling and to provide air mixing to prevent hydrogen accumulation along with the CS systems to help provide containment cooling in the event of a LOCA while in MODE 4, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, the change to REQUIRED ACTION B.2 to be in MODE 4 with a CT of 12 hours is acceptable.

3.1.20 TS 3.6.18, Containment Recirculation Drains (Ice Condenser)

Description: The containment recirculation drains consist of the ice condenser drains and the refueling canal drains. [Twenty of the 24] ice condenser bays have a floor drain at the bottom to drain the melted ice into the lower compartment (in the [4] bays that do not have drains, the water drains through the floor drains in the adjacent bays). A check (flapper) valve at the end of each pipe keeps warm air from entering during normal operation, but when the water exerts pressure, the check valve opens to allow the water to spill into the lower compartment. This prevents water from backing up and interfering with the ice condenser inlet doors. The water delivered to the lower containment serves to cool the atmosphere as it drains to the floor and provides a source of borated water at the containment sump for long term use by the ECCS and the CS system during the recirculation mode of operation.

The two refueling canal drains are at low points in the refueling canal. In the event of a design basis accident, the refueling canal drains are the main return path to the lower compartment for containment spray system water sprayed into the upper compartment. The LCO requires that the ice condenser floor drains and the refueling canal drains shall be operable.

Proposed Required Actions: Revise the end state for Required Action C.2 to be in Mode 4 in 12 hours if the Required Action and associated CT are not met. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:

Function 1: Prevent warm air from entering the ice condenser. Action A states that if one ice condenser floor drain is inoperable, the licensee has one hour to restore the ice condenser floor drain to OPERABLE status. If more than one drain is inoperable LCO 3.0.3, states "[w]hen an LCO is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, the unit shall be placed in a MODE or other specified condition in which the LCO is not applicable. Action shall be initiated within 1 hour to place the unit, as applicable, in:

a. MODE 3 within 7 hours,
b. MODE 4 within 13 hours, and
c. MODE 5 within 37 hours."

Since there is no Action for more than one floor drain inoperable LCO 3.0.3 is applicable.

Warm air entering the ice condenser can cause sublimation of the ice and/or obstruction of the air passages due to ice buildup. Sublimation of the ice and buildup of ice that could obstruct the air passageways is a slow process. Two trains of containment spray will be available along with the air return system to cool the containment atmosphere to limit the peak containment temperature and pressure in the event of a LOCA while in Mode 4.

Function 2: Allow water to drain from the ice condenser bays and from the refueling canal to the containment lower compartment to provide a source of borated water at the containment sump for long term use by the ECCS and the CS during the recirculation mode of operation.

Action A states that if one ice condenser floor drain is inoperable, the licensee has one hour to restore ice condenser floor drain to OPERABLE status. Action B states if one refueling canal drain is inoperable there is a one hour limit to restore refueling canal drain to OPERABLE status. If more than one drain is inoperable LCO 3.0.3, states "[w]hen an LCO is not met and the associated ACTIONS are not met, an associated ACTION is not provided, or if directed by the associated ACTIONS, the unit shall be placed in a MODE or other specified condition in which the LCO is not applicable. Action shall be initiated within 1 hour to place the unit, as applicable, in:

a. MODE 3 within 7 hours,
b. MODE 4 within 13 hours, and
c. MODE 5 within 37 hours."

Since there is no Action for more than one floor drain inoperable LCO 3.0.3 is applicable.

In the event of a LOCA while in Mode 4, the remaining floor drains will provide sufficient capacity such that water will drain from the ice condenser bays and from the refueling canal to the containment lower compartment to provide a source of borated water at the containment sump for long term use by the ECCS and the CS during the recirculation mode of operation.

The proposed changes to the TS bases were also reviewed as input to the TS change.

Based on the above assessment, with LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5, of the ability to provide a reasonable assurance that there will be adequate water returned to the containment sump and that there will not be a rapid degradation of the ice condenser due to the in leakage of warm air, the NRC staff finds this proposed change acceptable.

3.1.21 Mode 4 Secondary Side Steam Pressure

TR WCAP-16294-NP, Revision 0, indicated that secondary side steam pressure would be at normal operating pressure. The NRC staff requested that the TR applicant verify the secondary side steam pressure taking into consideration the reduced reactor cooling system average temperature in Mode 4. The TR applicant revised the statement in TR WCAP-16294-NP, Revision 0, to indicate that while in Mode 4, the secondary side steam pressure will be less than normal operating pressure. The TR applicant determined that there will be sufficient pressure available for most plants to operate the turbine driven auxiliary feedwater pumps. This will assure the defense-in-depth will remain available while remaining in Mode 4. The NRC staff finds the revision acceptable.

3.1.22 TS 3.7.7 – Component Cooling Water (CCW) System

Description: The CCW System provides a heat sink for the removal of process and operating heat from safety related components during a Design Basis Accident (DBA) or transient. During normal operation, the CCW System also provides this function for various nonessential components as well as the spent fuel storage pool. The CCW System serves as a barrier to the release of radioactive byproducts between potentially radioactive systems and the Service Water System (SWS), and thus to the environment.

A typical CCW System is arranged as two independent, full capacity cooling loops, and has isolatable non-safety related components. Each safety related train includes a full capacity pump, surge tank, heat exchanger, piping, valves, and instrumentation. Each safety related train is powered from a separate bus. An open surge tank in the system provides pump trip protective functions to ensure that sufficient net positive suction head is available. The pump in each train is automatically started on receipt of an SI signal, and all nonessential components are isolated.

The principal safety related function of the CCW System is the removal of decay heat from the reactor via the RHR System. This may be during a normal or post accident cooldown and shutdown. The LCO requires that two CCW trains be operable

Proposed Required Actions: The end state for Required Action B.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The CDP values listed in Table 3.2.1 of this SE, from the evaluation for the scenarios, show that there is slightly less risk associated with Mode 4 than there is with a cooldown to Mode 5 when a train of CCW is inoperable.

One CCW train will be operating when the unit enters Mode 4. Each train is designed to handle 100 percent of the heat loads during power operation and accident conditions. The heat loads will be significantly less in the shutdown modes and some accidents are less likely to occur. Therefore sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action B.2 so that the plant would be allowed to remain in Mode 4.

3.1.23 TS 3.7.8 – Service Water System (SWS)

Description: The SWS consists of two separate, 100 percent capacity, safety related, cooling water trains. Each train consists of two 100 percent capacity pumps, one CCW heat exchanger, piping, valving, instrumentation, and two cyclone separators. The pumps and valves are remote and manually aligned, except in the unlikely event of a LOCA. The pumps aligned to the critical loops are automatically started upon receipt of an SI signal, and all essential valves are aligned to their post accident positions. The SWS also provides emergency makeup to the spent fuel pool and CCW System and typically is the backup water supply to the AFW system.

The SWS provides a heat sink for the removal of process and operating heat from safety related components during a DBA or transient. During normal operation and a normal shutdown, the SWS also provides this function for various safety related and non-safety related components. The principal safety related function of the SWS is the removal of decay heat from the reactor via the CCW System. The safety related function is covered by this LCO, which requires that two SWS trains shall be operable.

Proposed Required Actions: The end state for Required Action B.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT Condition A are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: Table 3.2.1 of this SE shows that cooldown to Mode 4, rather than cooling down to Mode 5, reduces overall risk of shutdown process when a train of the SWS is inoperable.

One SWS train will be operating when the unit enters Mode 4. Each train is designed to handle 100 percent of the heat loads during power operation and accident conditions. The heat loads will be significantly less in the shutdown modes and some accidents are less likely to occur. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action B.2. so that the plant would be allowed to remain in Mode 4.

3.1.24 TS 3.7.9 – Ultimate Heat Sink (UHS)

Description: The UHS provides a heat sink for processing and operating heat from safety related components during a transient or accident, as well as during normal operation. This is done by utilizing the SWS and the CCW System.

The UHS has been defined as the complex of water sources, including necessary retaining structures (e.g., a pond with its dam, or a river with its dam), and the canals or conduits connecting the sources with, but not including, the cooling water system intake structures as discussed in the Final Safety Analysis Report. If cooling towers or portions thereof are required to accomplish the UHS safety functions, they should meet the same requirements as the sink. The two principal functions of the UHS are the dissipation of residual heat after reactor shutdown, and dissipation of residual heat after an accident.

A variety of complexes are used to meet the requirements for a UHS. A lake or an ocean may qualify as a single source. If the complex includes a water source contained by a structure, it is likely that a second source will be required. This LCO requires that the UHS be operable.

Proposed Required Actions: The end state for Required Action C.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT Condition A or B are not met, or the UHS is inoperable [for reasons other than A or B]. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: TS 3.7.9 addresses degradations to the cooling capability of the ultimate heat sink. The most likely scenario for entering Condition C is that the cooling capability of the UHS is only partially degraded. A cooldown to Mode 4 places the unit in a state where heat loads are significantly less than at full power.

The UHS is designed to remove 100% of the heat loads generated during power operation and accident conditions. The heat load will be significantly less in the shutdown modes. Some accidents are less likely to occur during the shutdown mode. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5 .

The staff accepts the proposed amendment to revise Required Action C.2. so that the plant would be allowed to remain in Mode 4.

3.1.25 TS 3.7.10 – Control Room Emergency Filtration System (CREFS)

Description: The CREFS provides a protected environment from which operators can control the unit following an uncontrolled release of radioactivity, chemicals, or toxic gas. The CREFS consists of two independent, redundant trains that recirculate and filter the control room air. Each train consists of a pre-filter or demister, a high efficiency particulate air (HEPA) filter, an activated charcoal adsorber section for removal of gaseous activity (principally iodines), and a fan. Ductwork, valves or dampers, and instrumentation also form part of the system, as well as demisters to remove water droplets from the air stream. A second bank of HEPA filters follows the adsorber section to collect carbon fines and provides backup in case of failure of the main HEPA filter bank.

The CREFS is an emergency system, parts of which may also operate during normal unit operations in the standby mode of operation. Upon receipt of the actuating signal(s), normal air supply to the control room is isolated, and the stream of ventilation air is recirculated through the system filter trains. The pre-filters or demisters remove any large particles in the air, and any entrained water droplets present, to prevent excessive loading of the HEPA filters and charcoal adsorbers. This LCO requires that two CREFS trains be operable.

Proposed Required Actions: The end state for Required Action C.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT Condition A or B are not met in Mode 1, 2, 3,or 4. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one CREFS train is inoperable, the other train remains available to provide control room filtration. If two CREFS trains are inoperable an independent initiating event and radioactive release must occur for filtration to be required in both Modes 4 and 5. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action C.2. so that the plant would be allowed to remain in Mode 4.

3.1.26 TS 3.7.11 – Control Room Emergency Air Temperature Control System (CREATCS)

Description: The CREATCS is an emergency system, parts of which may also operate during normal unit operations. The CREATCS consists of two independent and redundant trains that provide cooling and heating of recirculated control room air. Each train consists of heating coils, cooling coils, instrumentation, and controls to provide for control room temperature control following isolation of the control room. The LCO requires that two CREATCS trains be operable.

Proposed Required Actions: The end state for Required Action B.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT of Condition A are not met in Mode 1, 2, 3, and 4. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one CREATCS train is inoperable, the other train remains available to provide control room temperature control. The slower nature of accident event progression in the shutdown modes, and increased time for operator actions and mitigation strategies, limit the severity of accidents in the shutdown modes. The inoperability of equipment does not affect the likelihood of an event occurring and some events are less likely to occur in the shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action B.2. so that the plant would be allowed to remain in Mode 4.

3.1.27 TS 3.7.12 – ECCS Pump Room Exhaust Air Cleanup System (PREACS)

Description: The ECCS PREACS filters air from the area of the active ECCS components during the recirculation phase of a LOCA. The ECCS PREACS, in conjunction with other normally operating systems, also provides environmental control of temperature and humidity in the ECCS pump room area and the lower reaches of the Auxiliary Building.

The ECCS PREACS consists of two independent and redundant trains. Each train consists of a heater, a pre-filter or demister, a HEPA filter, an activated charcoal adsorber section for removal of gaseous activity (principally iodines), and a fan. Ductwork, valves or dampers, and instrumentation also form part of the system, as well as demisters functioning to reduce the relative humidity of the air stream. A second bank of HEPA filters follows the adsorber section to collect carbon fines and provide backup in case the main HEPA filter bank fails. The downstream HEPA filter is not credited in the accident analysis, but serves to collect charcoal fines, and to back up the upstream HEPA filter should it develop a leak. The system initiates filtered ventilation of the pump room following receipt of an SI signal.

The ECCS PREACS is a standby system, aligned to bypass the system HEPA filters and charcoal adsorbers. During emergency operations, the ECCS PREACS dampers are realigned, and fans are started to begin filtration. Upon receipt of the actuating Engineered Safety Feature Actuation System signal(s), normal air discharges from the ECCS pump room isolate, and the stream of ventilation air discharges through the system filter trains. The pre-filters remove any large particles in the air, and any entrained water droplets present, to prevent excessive loading of the HEPA filters and charcoal adsorbers.

Proposed Required Actions: The end state for Required Action C.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT of Condition A are not met. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one ECCS PREACS train is inoperable, the other train remains available to provide pump room air filtration. If two trains are inoperable due to an inoperable ECCS pump room boundary, a LOCA must also occur to require the operation of ECCS PREACS. The severity of the accidents in shutdown mode is limited due to the slower pace of the accident even progression and increased time for operator actions and mitigation strategies. In addition, a LOCA is less likely to occur in the shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action C.2. so that the plant would be allowed to remain in Mode 4.

3.1.28 TS 3.7.13 – Fuel Building Air Cleanup System (FBACS)

Description: The FBACS filters airborne radioactive particulates from the area of the fuel pool following a fuel handling accident or a LOCA. The FBACS, in conjunction with other normally operating systems, also provides environmental control of temperature and humidity in the fuel pool area.

The FBACS consists of two independent and redundant trains. Each train consists of a heater, a prefilter or demister, a HEPA filter, an activated charcoal adsorber section for removal of gaseous activity (principally iodines), and a fan. Ductwork, valves or dampers, and instrumentation also form part of the system, as well as demisters, functioning to reduce the relative humidity of the airstream. A second bank of HEPA filters follows the adsorber section to collect carbon fines and provide backup in case the main HEPA filter bank fails. The downstream HEPA filter is not credited in the analysis, but serves to collect charcoal fines, and to back up the upstream HEPA filter should it develop a leak. The system initiates filtered ventilation of the fuel handling building following receipt of a high radiation signal.

The FBACS is a standby system, parts of which may also be operated during normal plant operations. Upon receipt of the actuating signal, normal air discharges from the building, the fuel handling building is isolated, and the stream of ventilation air discharges through the system filter trains. The prefilters or demisters remove any large particles in the air and any entrained water droplets present to prevent excessive loading of the HEPA filters and charcoal adsorbers. The LCO requires that two FBACS trains be operable.

Proposed Required Actions: The end state for Required Action C.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT of Condition A or B are not met in Mode 1, 2, 3, or 4 or if Two FBACS trains are inoperable in Mode 1, 2, 3, or

4 for reasons other than Condition B. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one FBACS train is inoperable, the other train remains available to provide fuel building air filtration. If two FBACS trains are inoperable, a LOCA or fuel handling accident must also occur to require operation of the FBACs. LOCAs are less likely in Mode 4 and Condition E reduces the probability of a fuel handling accident. Therefore, sufficient defense-in-depth is maintained when the end state is changed form Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action C.2. so that the plant would be allowed to remain in Mode 4.

3.1.29 TS 3.7.14 – Penetration Room Exhaust Air Cleanup System (PREACS)

Description: The PREACS filters air from the penetration area between containment and the Auxiliary Building. The PREACS consists of two independent and redundant trains. Each train consists of a heater, a prefilter or demister, a HEPA filter, an activated charcoal adsorber section for removal of gaseous activity (principally iodines), and a fan. Ductwork, valves or dampers, and instrumentation, as well as demisters, functioning to reduce the relative humidity of the air stream, also form part of the system. A second bank of HEPA filters, which follows the adsorber section, collects carbon fines and provides backup in case of failure of the main HEPA filter bank. The downstream HEPA filter, although not credited in the accident analysis, collects charcoal fines and serves as a backup should the upstream HEPA filter develop a leak. The system initiates filtered ventilation following receipt of an SI signal.

The PREACS is a standby system, parts of which may also operate during normal unit operations. During emergency operations, the PREACS dampers are realigned and fans are started to initiate filtration. Upon receipt of the actuating signal(s), normal air discharges from the penetration room, the penetration room is isolated, and the stream of ventilation air discharges through the system filter trains. The prefilters remove any large particles in the air, as well as any entrained water droplets, to prevent excessive loading of the HEPA filters and charcoal adsorbers.

Proposed Required Actions: The end state for Required Action C.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action C.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: If one PREACS train is declared inoperable, the other train remains available to provide penetration room air filtration. If two PREACS trains are inoperable due to an inoperable penetration room boundary, a LOCA and passive failure in the penetration room must occur to require air filtration. A LOCA is less likely to occur in shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5 .

The staff accepts the proposed amendment to revise Required Action C.2. so that the plant would be allowed to remain in Mode 4.

3.1.30 TS 3.8.1 – [Alternating Current] AC Sources - Operating

Descriptions: The unit Class 1E AC Electrical Power Distribution System AC sources consist of the offsite power sources (preferred power sources, normal and alternate(s)), and the onsite standby power sources (Train A and Train B diesel generators (DGs)). The AC electrical power system provides independent and redundant source of power to the ESF system.

The onsite Class 1E AC Distribution System is divided into redundant load groups (trains) so that the loss of any one group does not prevent the minimum safety functions from being performed. Each train has connections to two preferred offsite power sources and a single DG.

An offsite circuit consists of all breakers, transformers, switches, interrupting devices, cabling, and controls required to transmit power from the offsite transmission network to the onsite Class 1E ESF bus(es). Certain required unit loads are returned to service in a predetermined sequence in order to prevent overloading the transformer supplying offsite power to the onsite Class 1E Distribution System.

After the DG has started, it will automatically tie to its respective bus after offsite power is tripped as a consequence of ESF bus undervoltage or degraded voltage, independent of or coincident with an SI signal. The DGs will also start and operate in the standby mode without tying to the ESF bus on an SI signal alone. Following the trip of offsite power, [a sequencer/an undervoltage signal] strips nonpermanent loads from the ESF bus. When the DG is tied to the ESF bus, loads are then sequentially connected to its respective ESF bus by the automatic load sequencer. The sequencing logic controls the permissive and starting signals to motor breakers to prevent overloading the DG by automatic load application.

The LCO requires (1) two qualified circuits between the offsite transmission network and the onsite class 1E AC Electrical Power Distribution System, (2) two diesel generators (DGs) capable of supplying the onsite Class 1E power distribution subsystem(s), and (3) automatic load sequencers for Train A and Train B.

Proposed Required Actions: The end state for Required Action G.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT of Conditions A, B, C, D, E or [F] are not met. A Note is added to Required Action G.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:

For each of the conditions of this TS LCO, Table 3.2.1 of this SE shows that the CDP decreases slightly when the unit is cooled down to Mode 4 instead of Mode 5.

Two trains of DGs are available if two offsite power circuits are inoperable and two offsite power circuits are available if two diesel generators are inoperable. If an offsite power circuit and/or a diesel generator are inoperable, at least one of each remains available. The slower nature of event progression in the shutdown modes provides increased time for operator actions and mitigation strategies if an event were to occur. In addition, some events are less likely to occur in the shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5 .

The staff accepts the proposed amendment to revise Required Action G.2. so that the plant would be allowed to remain in Mode 4.

3.1.31 TS 3.8.4 – [Direct Current] DC Sources - Operating

Description: The station DC electrical power system provides the AC emergency power system with control power. It also provides both motive and control power to selected safety related equipment and preferred AC vital bus power (via inverters). As required by 10 CFR 50,

Appendix A, GDC 17, the DC electrical power system is designed to have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. The DC electrical power system also conforms to the recommendations of Regulatory Guide 1.6, "Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems (Safety Guide 6)."

The typical 125/250 Volts DC (VDC) electrical power system consists of two independent and redundant safety related Class 1E DC electrical power subsystems (Train A and Train B). Each subsystem consists of two 125 VDC batteries (each battery 50 percent capacity), the associated battery charger(s) for each battery, and all the associated control equipment and interconnecting cabling.

The typical 250 VDC source is obtained by the use of the two 125 VDC batteries connected in series. Additionally there is one spare battery charger per subsystem, which provides backup service in the event that the preferred battery charger is out of service. If the spare battery charger is substituted for one of the preferred battery chargers, then the requirements of independence and redundancy between subsystems are maintained.

During normal operation, the 125/250 VDC load is powered from the battery chargers with the batteries floating on the system. In case of loss of normal power to the battery charger, the DC load is automatically powered from the station batteries.

This LCO requires that the Train A and Train B DC electrical power subsystems be operable.

Proposed Required Actions: The end state for Required Action D.2 is revised to be in Mode 4 in 12 hours instead Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action D.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: Quantitative risk evaluation was performed for each condition of this TS by modeling the inoperable equipment. Results are summarized below. The analysis show that the CDP decreases slightly when the unit is cooled down to Mode 4 instead of Mode 5.

There are two redundant trains of DC power; so if one is inoperable, the other is available to provide the necessary DC power. Events progress slower in shutdown modes than in the power modes. This provides increased time for operator actions and mitigation strategies if an event were to occur. In addition, some events are less likely to occur in the shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action D.2. so that the plant would be allowed to remain in Mode 4.

3.1.32 TS 3.8.7 – Inverters - Operating

Description: The function of the inverter is to provide AC electrical power to the vital buses. The inverters can be powered from an internal AC source/rectifier or from the station battery. The station battery provides an uninterruptible power source for the instrumentation and controls for the Reactor Protection System (RPS) and the ESFAS.

The four (two per train) inverters are designed to provide the required capacity, capability, redundancy, and reliability to ensure the availability of necessary power to the RPS and ESFAS instrumentation and controls so that the fuel, RCS, and containment design limits are not exceeded. The LCO requires that the Train A and Train B inverters be operable.

Proposed Required Actions: The end state for Required Action B.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action B.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment:. Results from quantitative risk analysis in Table 3.2.1 of this SE show that the CDP decreases slightly when the unit is cooled down to Mode 4 instead of Mode 5.

There are two redundant trains of inverters; so if one is inoperable, the other train is available to provide the necessary AC power. The slower nature of event progression in the shutdown modes provides increased time for operator actions and mitigation strategies if an event were to occur. In addition, some events are less likely to occur in the shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action B.2. so that the plant would be allowed to remain in Mode 4.

3.1.33 TS 3.8.9 – Distribution Systems - Operating

Description: The onsite Class 1E AC, DC, and AC vital bus electrical power distribution systems are divided by trains into two redundant and independent AC, DC, and AC vital bus electrical power distribution subsystems.

The AC electrical power subsystem for each train consists of a primary Engineered Safety Feature (ESF) 4.16 kV bus and secondary 480 and 120 V buses, distribution panels, motor control centers and load centers. Each 4.16 kV ESF bus has at least one separate and independent offsite source of power as well as a dedicated onsite DG source. Each 4.16 kV ESF bus is normally connected to a preferred offsite source. After a loss of the preferred offsite power source to a 4.16 kV ESF bus, a transfer to the alternate offsite source is accomplished by utilizing a time delayed bus undervoltage relay. If all offsite sources are unavailable, the onsite emergency DG supplies power to the 4.16 kV ESF bus. Control power for the 4.16 kV breakers is supplied from the Class 1E batteries.

The secondary AC electrical power distribution subsystem for each train includes the safety related buses, load centers, motor control centers, and distribution panels shown in Table B on TS page 3.8.9-1. The 120 VAC vital buses are arranged in two load groups per train and are normally powered from the inverters. The alternate power supply for the vital buses are Class 1E constant voltage source transformers powered from the same train as the associated inverter. The DC electrical power distribution subsystem consists of 125 V bus(es) and distribution panel(s).

This LCO requires that Train A and Train B AC, DC, and AC vital bus electrical power distribution subsystems be operable.

Proposed Required Actions: The end state for Required Action D.2 is revised to be in Mode 4 in 12 hours instead of Mode 5 in 36 hours if the Required Action and associated CT are not met. A Note is added to Required Action D.2 stating that LCO 3.0.4.a is not applicable when entering MODE 4 from MODE 5.

Assessment: The electrical distribution systems are modeled in the risk evaluation by modeling inoperable equipment. Table 3.2.1 of this SE, shows that the CDP decreases slightly when the unit is cooled down to Mode 4 instead of Mode 5.

If the inoperable distribution subsystem cannot be restored to operable status within the required CT, the unit must be brought to a MODE in which the LCO does not apply. The proposed allowed CTs are reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging plant systems.

The slower nature of event progression in the shutdown modes provides increased time for operator actions and mitigation strategies if an event were to occur. In addition, some events are less likely to occur in the shutdown modes. Therefore, sufficient defense-in-depth is maintained when the end state is changed from Mode 5 to Mode 4 provided LCO 3.0.4.a is not applicable for entry into Mode 4 from Mode 5.

The staff accepts the proposed amendment to revise Required Action B.2 so that the plant would be allowed to remain in Mode 4.

3.2 Risk Evaluation

As stated in Section 2.0 above, the NRC staff reviewed TR WCAP-16294-NP, Revision 0, using SRP Chapters 19.2 and 16.1, and the five key principles of risk-informed decision making presented in RG 1.174 and RG 1.177. SRP 19.2, consistent with RG 1.177, identifies five key safety principles to be met for risk-informed applications, including changes to TS. Each of these principles is addressed by TR WCAP-16294-NP, Revision 0, as discussed below.

1. <u>The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change</u>.

10 CFR 50.36(c) provides that TSs will include LCOs which are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When an LCO of a nuclear reactor is not met, the licensee will shut down the reactor or follow any remedial action permitted by the TSs until the condition can be met. TR WCAP-16294-NP, Revision 0, proposes only to change the final end state condition applicable when the LCO is not met and the reactor is to be shut down. The LCOs themselves would remain unchanged. Therefore, the proposed changes for the required shutdown end states are consistent with current regulations, and satisfy the first key safety principle of RG 1.177.

2. <u>The proposed change is consistent with the defense-in-depth philosophy</u>.

Consistency with the defense-in-depth philosophy is maintained if:

- A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.
- Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided.
- System redundancy, independence and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties (e.g., no risk outliers).
- Defenses against potential common cause failures are preserved, and the potential for the introduction of new common cause failure mechanisms is assessed.
- Independence of barriers is not degraded.
- Defenses against human errors are preserved.

- The intent of the general design criteria in 10 CFR Part 50, Appendix A, are maintained.

The NRC staff assessment of the proposed changes with respect to defense-in-depth was performed in Section 3.1, above.

3. The proposed change maintains sufficient safety margins.

The NRC staff assessment of the proposed changes with respect to maintenance of safety margins was performed in Section 3.1, above.

4. When proposed changes result in an increase in CDF or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

TR WCAP-16294-NP, Revision 0, concludes that the proposed change in end state from Mode 5 to Mode 4 results in a reduction in CDF. The NRC staff reviewed the qualitative and quantitative analyses documented in TR WCAP-16294-NP, Revision 0, in order to assess the validity of this conclusion. The NRC staff notes that a reduction in CDF achieved by remaining in hot shutdown versus transitioning to and from cold shutdown is consistent with previously reviewed and approved precedents (References 4, 5, and 6). The NRC staff's review of the risk assessment methods, analyses, and conclusions are presented below.

5. The impact of the proposed change should be monitored using performance measurement strategies.

Plant shutdowns due to exceeding TS CTs are infrequent events. The proposed changes would permit a plant to remain in Mode 4 and complete repairs rather than requiring the plant to incur the risk of transition to and from Mode 5, and conducting repairs in Mode 5, which involves higher risk. The impact of the proposed change is therefore a reduction in plant risk. The change has no impact on the operation or performance of plant components, and performance measurement strategies are therefore considered unnecessary.

3.2.1 Risk Approach

The TR's generic qualitative risk assessment shows that the proposed TS end state changes result in an increase in defense-in-depth for the expected initiating events. This is achieved by performing qualitative risk comparisons between Mode 5, the current end state, and the proposed end state, Mode 4 on SG cooling.

The generic quantitative risk assessment (1) substantiates the conclusion of the qualitative risk assessment by providing numerical results for a representative plant, and (2) investigates the robustness of the results to uncertainties in data and modeling assumptions through sensitivity analyses.

In addition, specific assessments for each proposed TS end state change were also performed, using risk insights from the qualitative and, if applicable, quantitative risk assessments, to ensure that the specific condition causing the LCO does not increase the risk when the proposed new end state is implemented. Finally, risk insights are used in the implementation of the proposed change to identify risk-significant plant configurations and compensatory measures.

The NRC staff finds that the risk assessment approach is comprehensive and follows NRC staff guidance as documented in RGs 1.174 and 1.177.

3.2.2 Assumptions

The risk impact of the mode changes was evaluated subject to the following assumptions:

- All equipment is assumed to be available, unless operating procedures direct that equipment be isolated or locked out, or if the equipment is associated with the specific TS LCO being evaluated. Of specific relevance to this analysis is the availability of the turbine-driven AFW pump in Mode 4.
- Entry into the shutdown mode under consideration is for a short interval with the primary intent of that entry being to repair a non-functional component and return the plant to power as soon as is practical.
- Shutdown and cooldown of the plant terminates when the end state mode is entered, and no further cooldown occurs.
- For the Mode 4 end state, SDC is not aligned, and the plant remains on SG cooling, avoiding transition risks associated with SDC alignment.
- For the Mode 5 end state, the RCS remains at its nominal inventory and the RCS boundary strength is not compromised (e.g., via installation of nozzle dams).

These assumptions are consistent with typical entries into shutdown modes for short duration repairs, which are the intended uses of the TS end state change, and are reflected in the Limitations and Conditions in Section 4 of this safety evaluation.

3.2.3 Quality of the PRA Analysis

The quality of both the qualitative and quantitative risk assessments, in terms of scope, level of detail, and technical adequacy, must support the application and the role of the PRA results in the integrated decision process. Per RG 1.174, emphasis on PRA quality can be reduced if the proposed changes result in very small risk increases or in risk decreases. The proposed change to TS end states is evaluated to result in a risk decrease, and so, consistent with RG 1.174, reduced emphasis on PRA quality may be acceptable.

Typically, the quality of the PRA analyses that support plant-specific licensing actions are evaluated based on completion of industry peer reviews of the relevant at-power, plant-specific PRA model, and resolution of the findings from the reviews, along with a focused scope review by the NRC staff of those elements of particular relevance to the application. In this case, the TR generically evaluates the difference in risk between two plant shutdown conditions and, therefore, a plant-specific, at-power PRA model is not relevant to the application.

Although TR WCAP-16294-NP, Revision 0, provides detailed information regarding plant shutdown and mode changes from at-power conditions until cold shutdown (Mode 5), and the heatup and return to power, the only portions relevant to this application cover plant operation at the upper temperature range of Mode 4 and transition to the upper temperature range of Mode 5, and then back to Mode 4. This is because, regardless of the TS end state, a plant must always transition from Mode 1 to Mode 4, and then ultimately return from Mode 4 to Mode 1. Therefore, the NRC staff review did not consider the risk analyses for the common mode transitions (i.e., Mode 1 to upper end of Mode 4 and back to Mode 1), which are applicable to both end states.

The quality of the risk assessments was evaluated by considering 1) the scope and treatment of initiating events based on the plant conditions, 2) the availability of mitigating systems considering TS requirements, operating practices and procedures relevant to the operating mode, and 3) treatment of plant alignment changes required to achieve the particular plant conditions during the plant shutdown and cooldown. In addition for the quantitative risk assessment, the modeling, data sources, and the treatment of human error dependencies, were evaluated, including a review of the specific cutsets generated for each end state.

Initiating events applicable to at-power conditions were considered and modified based on the reduced operating temperatures and pressures which exist in Modes 4 and 5. Specifically, high energy line breaks such as LOCAs, steam generator tube ruptures (SGTRs), and steamline breaks were considered applicable to Mode 4 at a reduced frequency compared to at-power frequencies, and were not considered credible in Mode 5, due to lower temperatures and pressures in the RCS and secondary. Initiating events involving anticipated transient without scram were eliminated for both modes based on the operating restriction requiring the reactor trip breakers to be open. Loss of offsite power events were retained at the same frequency for both modes, based on a review of available data sources applicable to shutdown conditions. Initiating events related to interruption of main feedwater were excluded from both modes, since the system would be out of service once AFW was aligned during the initial plant shutdown. For Mode 5, additional initiating events associated with loss of SDC and inventory loss during alignment of SDC and transition away from and returning to SG cooling were considered, along with events challenging low temperature overpressure protection of the reactor vessel.

The analyses did not address external initiating events, including internal fires. There are no unique mitigation requirements for these events in either Mode 4 or Mode 5, and so the general risk assessment insights and conclusions would be applicable to such initiating events, and the conclusions of the risk analyses would not be affected.

The NRC staff review of the initiating events found the scope of initiators considered in the risk analyses, as well as the treatment of initiators based on differences in plant conditions for the two end states, to be reasonable and comprehensive. The risk analyses considered differences in the availability of mitigating equipment between the two end state modes, based on TS requirements and operating practices. Although the TSs do not require many safety systems to be available in Mode 5, the analyses reasonably assume that, for brief shutdowns required to effect equipment repairs and return the unit promptly to service, those systems would remain available unless required to be isolated or locked out by TS or operating procedures. Since the intent of the analyses is to justify a Mode 4 end state, the availability of safety systems in Mode 5 would conservatively bias the results in favor of a Mode 5 end state, and therefore this represents a conservative assumption. The NRC staff review of the mitigating systems found the assumptions to be reasonable, and the scope of systems evaluated to be appropriate to support this application.

During its review of the equipment availability, the NRC staff questioned the assumption that the turbine-driven AFW pump would be available in Mode 4 when the standard Westinghouse TS only require one motor-driven AFW pump. At the upper temperature range of Mode 4, which is the desired end state, the turbine-driven AFW pump is physically capable of operation. The risk analyses identified the availability of this pump as a key factor in support of the application, and so appropriate controls on its availability must be addressed, as reflected in the Limitations and Conditions in Section 4 of this safety evaluation.

The risk analyses considered the plant alignments necessary to establish SDC during the transition from Mode 4 to Mode 5, and to secure SDC when returning the plant to operation. These alignments are implicitly incorporated as additional initiating events for loss of decay heat removal and loss of inventory applicable to the Mode 5 end state only. No unique alignments were considered for maintaining either Mode 4 or Mode 5 conditions once successfully established. The NRC staff review found that the treatment of transition risk was reasonable and supported the application.

For the quantitative analysis, system models and data were identified as being based on a typical Westinghouse PWR at-power PRA model which had been peer reviewed, and for which the significant review comments had been resolved. The mitigating systems credited in the analysis were reviewed by the NRC staff, and it was concluded that the failure modes and probability would not be significantly changed during shutdown operations. Therefore, the models and failure data are of adequate quality and are acceptable for use in this application.

For the shutdown risk assessment applicable to Mode 5 on RHR cooling, mitigation of accidents and transients typically requires significant operator actions, since the plant design does not provide for automatic actuations of required plant components. For the quantitative risk analyses, it is essential to account for potential dependency between multiple human errors in order to properly assess risk. The NRC staff review identified that a dependency evaluation was performed, but that it appeared to be conservative (i.e., resulted in higher human error probabilities than a more realistic evaluation). For purpose of this application, a conservative dependency evaluation non-conservatively biases the risk analysis conclusions in favor of the proposed Mode 4 end state. In response to an NRC question, the dependency evaluation was reviewed and updated, and sensitivity analyses conducted which validated the analysis. Based upon this updated evaluation, the NRC staff finds that the treatment of human error dependencies for the quantitative risk analysis is acceptable to support this application.

3.2.4 Risk Assessment Results

3.2.4.1 Qualitative Risk Assessment

The qualitative risk assessment compares 1) operation in the upper temperature range of Mode 4 while remaining on SG cooling, and 2) alignment of SDC and continued cooldown through Mode 4 to the upper temperature range of Mode 5, maintaining operation in Mode 5 during equipment repairs, and then heating up to the upper temperature range of Mode 4 and returning to SG cooling. This comparison, which assesses the systems and components available to maintain critical safety functions for postulated initiating events, considered the following:

- Differences in the likelihood and consequences of initiating events due to changes in plant temperatures and pressures,
- Differences in the availability of plant equipment, including containment isolation and cooling capability, and
- Transition risks associated with plant equipment alignment changes for initiating and terminating SDC.

The TR identifies, for the two operational modes, key plant parameters (Tables 6-1, 6-3, 6-4, and 6-5), status of systems (Tables 6-2, 6-4, and 6-5), and plant activities (Table 6-5). The initiating events applicable to each operating mode are presented and evaluated as to their likelihood (Table 6-6).

Since Mode 4 is the preferred end state, assumptions which increase Mode 4 risk or decrease Mode 5 risk are conservative for this application. The key differences between the preferred end state, Mode 4 on SG cooling, compared with the current required transition to Mode 5 on RHR cooling and ultimate return to Mode 4 after equipment repairs, were identified as:

- Reduced RCS and secondary side pressure and temperature in Mode 5.

  In both end states, RCS and secondary side pressure and temperature are significantly reduced compared to nominal at-power conditions, and this reduces the likelihood of LOCAs and high energy line breaks, including steam generator tube ruptures. In Mode 4, the frequency of these events is reduced compared to at-power conditions, and in Mode 5 the analysis eliminates these events from consideration. This conservatively biases the risk analysis in favor of Mode 5 as the preferred end state.

- Increased likelihood of loss of decay heat removal during transfer from SG cooling to SDC.

  The frequency of loss of decay heat removal is greater with Mode 5 as the end state compared to Mode 4 due to the system re-alignments required. Loss of decay heat removal events in Mode 4 can be mitigated with AFW or the RHR system following depressurization of the RCS. In Mode 5, the turbine-driven auxiliary feedwater (TDAFW) pump would be unavailable due to the lack of steam pressure in the secondary. Thus there are additional options for decay heat removal available in Mode 4 that are not available in Mode 5.

- Increased likelihood of loss of inventory during transfer from SG cooling to SDC.

  The frequencies of loss of inventory events can be greater with Mode 5 as the end state compared to Mode 4 due to the system re-alignments required. Loss of inventory events in Mode 4 can be mitigated with the available train of ECCS. In Mode 5, one full train of ECCS is not available, as the SI pumps are out of service and inventory control is dependent upon the charging system. Thus, there are additional options for inventory control available in Mode 4 that are not available in Mode 5.

- Potential for cold overpressurization events in Mode 5.

  Although not identified as a significant source of risk, these events are considered in Mode 5.

- Mitigation of loss of offsite power events.

  Mitigation of loss of offsite power/station blackout events in Mode 4 can be provided by the AFW system including the TDAFW pump. Availability of the TDAFW pump is particularly important in case the event degrades to a station blackout, since the pump is not dependent upon the availability of AC power from the diesel generators. In Mode 5, the turbine-driven AFW pump is unavailable, and the plant will be dependent on restoring electric power to the RHR system. Reactor coolant pump seal LOCAs are not postulated to occur during loss of seal cooling due to station blackout in either mode based on reduced temperatures and pressures in the RCS. Thus there are additional options for mitigation of loss of offsite power events available in Mode 4 that are not available in Mode 5.

- Redundancy and diversity of mitigating and support systems in Mode 4.

  In Mode 4, there are additional TS requirements governing the availability of mitigating systems and support systems, including sources of electric power, compared to Mode 5. Further, there are more potential testing and maintenance activities which take place in

Mode 5 compared to Mode 4 which could result in loss of offsite power. Finally, TS requirements associated with containment isolation and cooling are applicable in Mode 4 and not in Mode 5.

Important insights derived from the qualitative assessment are listed below:

- The frequency of loss of decay heat removal is greater with Mode 5 as the end state compared to Mode 4 due to the system re-alignments required. Loss of decay heat removal events in Mode 4 can be mitigated with AFW (all pumps available), or the RHR system following depressurization of the RCS. In Mode 5, the TDAFW pump will not be available to provide mitigation of similar events, and the automatic AFW start signal would not be available. Therefore, additional options are available for decay heat removal in Mode 4 that are not available in Mode 5.
- The frequency of loss of inventory events is greater with a Mode 5 as the end state compared to Mode 4 due to the system realignments required. Loss of inventory events in Mode 4 can be mitigated with the available train of ECCS. In Mode 5, a full train of ECCS is not required to be available, and SI pumps would be out of service, so inventory control is dependent on the charging system. Therefore, additional options are available for inventory control in Mode 4 compared to Mode 5.
- Mitigation of loss of offsite power/station blackout events in Mode 4 can be provided by the AFW system, including the TDAFW pump. In Mode 5, the TDAFW pump will not be available, and the plant will be dependent upon restoring electric power to the RHR system. Therefore, additional options are available for decay heat removal in Mode 4 compared to Mode 5 in the event of a loss of offsite power or station blackout.
- Risk in the shutdown modes, including Mode 5, is very dependent on electric power availability. There are more required independent sources of electric power in Mode 4 compared to Mode 5, and there are more potential activities in Mode 5 that could cause a loss of offsite power.
- In Mode 4, there is more redundancy and diversity of mitigating and support systems required to be available than there is in Mode 5.

The NRC staff finds the qualitative risk assessment adequate to support an assessment of the differences in the plant status which impact configuration risk. The analysis supports a conclusion that the proposed TS end state changes from Mode 5 to Mode 4 do not increase risk or decrease defense-in-depth based on the following:

- Reasonable and conservative assumptions with regards to the likelihood of initiating events occurring at reduced temperature and pressure conditions in both Modes 4 and 5;
- Availability of additional mitigation capabilities in Mode 4 compared to Mode 5 for postulated initiating events;
- Availability of mitigation capability for loss of offsite power in Mode 4 via the TDAFW pump which is not dependent upon on-site AC sources or restoration of AC power; and
- Avoidance of transition risks associated with SDC alignments when remaining in Mode 4.

3.2.4.2 Quantitative Risk Assessment

The NRC staff reviewed the quantitative risk assessment to ensure that:

- Initiating events, accident sequences, and failures found to be significant contributors to shutdown risk in previous studies have been addressed;
- Important assumptions and data used are reasonable;
- Important uncertainties in data and modeling assumptions were identified and sensitivity studies were performed to provide confidence in the conclusions regarding the proposed TS end states; and
- Design and operational differences among Westinghouse plants were identified and appropriate sensitivity studies were performed which show that the conclusions of the quantitative risk assessment apply to all Westinghouse plants.

A quantitative risk assessment was performed using a generic plant PRA model for a Westinghouse PWR to assess the core damage risk of the two end states. As in the qualitative risk assessment, these end states are 1) operation in the upper temperature range of Mode 4 while remaining on SG cooling, and 2) alignment of SDC and continued cooldown through Mode 4 to the upper temperature range of Mode 5, maintaining operation in Mode 5 during equipment repairs, and then heating up to the upper temperature range of Mode 4 and returning to SG cooling.

3.2.4.2.1 Mitigating Systems models

The model is a generic transition risk model representative of Westinghouse plants addressing internal events. It is based on the information identified in the qualitative risk insights, and is representative of a single unit site with standard two train systems. The generic model employs system configurations common to many Westinghouse plants. The key characteristics of the models of mitigating systems were identified as follows:

- AFW System – two motor-driven pumps and one turbine-driven pump. This design is similar to many Westinghouse plants. Some plant designs include a diesel-driven pump which would provide additional diverse mitigation for loss of offsite power events in either Mode 4 or Mode 5. Such designs would enhance the mitigation of loss of offsite power events, which are larger contributors to the risk profile in Mode 4 compared to Mode 5. Therefore, the analyzed configuration conservatively biases the risk results in favor of a Mode 5 end state.
- ECCS – two train system, each train includes a high pressure and low pressure subsystem. The centrifugal charging pumps are used for high pressure safety injection. Low pressure injection and recirculation is performed by the RHR pumps and heat exchangers. This design is similar to many Westinghouse plants.

  Some plant designs include separate intermediate head safety injection pumps. The assumption of combined charging and high pressure safety injection pumps conservatively bounds this application because it assures that at least one SI pump is available in Mode 5, while the separate pumps design has no requirement for availability in Mode 5, and in some cases requires the SI pumps to be disabled due to potential RCS overpressure concerns. Therefore, the assumption of combined charging and high pressure safety injection pumps conservatively biases the results in favor of a Mode 5 end state.

Some plant designs include separate low pressure safety injection pumps and RHR pumps. The availability of separate low pressure injection and recirculation pumps would reduce risk in Mode 5, which is offset by not crediting RHR cooling as a recovery option in Mode 4. Therefore, the overall conclusions of the report would not be impacted by this assumption.

- RPS – solid state protection system. Some plant designs use relay protection systems; however, the reliability of the two systems was identified as not significantly different, and so the generic model is acceptable as representative of the RPS of all Westinghouse plants.
- CCW System – two trains with one pump per train and a spare pump which can be aligned to either train. This is a common design among Westinghouse plants. The availability of a spare pump is more significant in Mode 5, where the CCW system is required to operate to maintain decay heat removal. Plants with a common CCW header would be expected to have a higher failure probability for the CCW system. This would directly impact decay heat removal in Mode 5, whereas failure of the CCW system in Mode 4 would not directly contribute to a loss of AFW and SG cooling. Therefore, the assumption of separate headers and availability of a spare pump conservatively biases the results in favor of a Mode 5 end state.
- SWS – two trains with one pump per train and a spare pump which can be aligned to either train. This is a common design among Westinghouse plants. The effects of the availability of the spare pump and a common header are similar to these effects on the CCW system previously discussed.
- Electrical Power System – two trains with one emergency diesel generator per train. This is a common design among Westinghouse plants. Some plants have more redundancy in their design, including shared diesels between units. Such designs would enhance the mitigation of loss of offsite power events, which are larger contributors to the risk profile in Mode 4 compared to Mode 5. Therefore, the analyzed configuration conservatively biases the risk results in favor of a Mode 5 end state.

The NRC staff reviewed the assumed mitigating system configurations, and the consideration of alternative designs, and finds them to be reasonable and appropriately justified by the evaluations provided as bounding for all Westinghouse plants.

3.2.4.2.2 Plant Response models

Distinct plant response models are used for Mode 4 and Mode 5, based on the differences in applicable initiating events and the required actions for mitigation of those events in the two modes.

Mode 4

- LOCAs – mitigation requirements are the same as the at-power PRA model, except for the availability of accumulators.
- SGTR – mitigation requirements are the same as the at-power PRA model.

- Secondary Side Breaks – mitigation requirements are the same as the at-power PRA model
- Loss of Decay Heat Removal – mitigation requirements are the same as the at-power PRA model for loss of main feedwater, except that the operating AFW or startup feedwater pump initially in operation is assumed to be failed and unavailable.
- Loss of Offsite Power – mitigation requirements are the same as the at-power PRA model, except that at reduced RCS temperatures, reactor coolant pump seal LOCAs are not assumed to occur.

Mode 5

- Loss of Inventory – this initiator is unique to Mode 5 and is not addressed in the at-power PRA model, as it is postulated to occur due to improper alignment of the RHR system during transition to SDC. The loss of inventory event is mitigated by leak isolation, makeup, and restoration of decay heat removal, and it may include alignment of the recirculation mode of cooling for unisolated leaks.
- Loss of Decay Heat Removal – this initiator is unique to Mode 5 and is postulated to occur due to improper alignment of the RHR system during transition to SDC or due to failures during SDC operation. The loss of decay heat removal event is mitigated either by a motor-driven AFW pump and restoration of SG cooling or by once through cooling (feed-and-bleed) including high pressure recirculation.
- Loss of Offsite Power – this initiator is assumed to interrupt SDC in Mode 5. Mitigation of a loss of offsite power event is similar to a loss of decay heat removal, except that SDC may be restored if power is available either by the emergency diesel generators or by recovery of offsite power.
- Cold Overpressurization – this initiator is mitigated by operator action to control charging and letdown, or if this action is unsuccessful, by relief valve operation. The potential for a failure to close of the relief valve is also considered, and if this occurs, it is assumed that the event is not mitigated. While this conservative treatment biases the results in favor of a Mode 4 end state, this initiator is not a significant contributor to the risk analyses results.
- Boron Dilution – this initiator is mitigated by operator action to terminate the dilution or to initiate boration. While this conservative treatment biases the results in favor of a Mode 4 end state, the contribution of this initiating event is insignificant to the final results, and is, therefore, acceptable.

The NRC staff reviewed the scope and treatment of initiating events in the two end states and considered similar information available in NUREG/CR-6144 Vol. 2 (Reference 18), and finds that the initiating event scope is appropriate and the assumptions regarding mitigation of those events reasonable and conservative for this application.

3.2.4.2.3 Time in End States

In order to employ the models of the two end states including transition between Modes 4 and 5, the expected time spent in each mode must be determined. These times are used in the calculation of initiating event probabilities applicable during operation in a particular mode or plant condition. The TR based these times on the time limits of the TS (applicable during the shutdown), and on information from several Westinghouse plants for startup times following a forced non-refueling outage.

The NRC staff reviewed the assumptions and bases for the times spent in Mode 4 and for a transition to Mode 5 and return to Mode 4 after completion of repairs, and finds them to be reasonable and appropriate for this application.

3.2.4.2.4 Initiating Event Probabilities

The probability of an initiating event is the product of its frequency and the time spent in the particular end state being evaluated. Section 3.2.4.2.3 discussed the basis for the time spent in each end state. The frequencies of some initiators are also varied based on the plant conditions.

LOCAs – The frequency of LOCAs in Mode 4 is assumed to be reduced by a factor of 20 from the typical at-power frequency based on NUREG/CR-6144 (Reference 13). In Mode 5, LOCAs not considered credible due to the reduced temperatures and pressures of the RCS.

Interfacing Systems LOCA – The nominal at-power frequency is maintained for Mode 4, and the events are not considered credible in Mode 5 due to the reduced temperatures and pressures of the RCS. This assumption is conservative for this application, since it increases the risk of Mode 4 compared to Mode 5.

Reactor Vessel Rupture – The nominal at-power frequency is maintained for Mode 4, and the event is not considered credible in Mode 5 due to the reduced temperatures and pressures of the RCS. This assumption is conservative for this application, since it increases the risk of Mode 4 compared to Mode 5.

SGTR – The nominal at-power frequency is maintained for Mode 4, and the event is not considered credible in Mode 5 due to the reduced temperatures and pressures of the RCS. This assumption is conservative for this application, since it increases the risk of Mode 4 compared to Mode 5.

Secondary Side Breaks – The nominal at-power frequency is maintained for Mode 4, and the event is not considered credible in Mode 5 due to the reduced temperatures and pressures of the RCS. This assumption is conservative for this application, since it increases the risk of Mode 4 compared to Mode 5.

Loss of Inventory – This event is only applicable in the transition from Mode 4 to Mode 5, and while in Mode 5. The frequency used is based on a similar treatment found in Reference 14. The total frequency is a combination of operator error resulting in an inadvertent transfer of reactor coolant out of the RCS, events which initiate in systems connected to the RCS, and events resulting from maintenance activities.

Loss of Offsite Power – The nominal at-power frequency is maintained for Modes 4 and 5. This is based on a review of loss of offsite power events in EPRI Technical Report 10029987 (Reference 19) to determine a revised frequency for shutdown conditions. The result was similar to the at-power frequency, and therefore the at-power frequency was retained.

Cold Overpressurization – This event only applies to Mode 5. The frequency is based on WCAP-11737 (Reference 20), which is a higher frequency than Reference 14. Although a higher frequency is not conservative for this application, the contribution of this initiating event is insignificant and, therefore, the frequency used is acceptable.

Boron Dilution – This event is not considered credible in Mode 4, but is considered credible in Mode 5 with a frequency based on Reference 14. Although this is non-conservative for this application, by reducing the risk in Mode 4 compared to Mode 5, the contribution of this initiating event is insignificant and, therefore, the frequency used is acceptable.

3.2.4.2.5 Quantitative Results

The models were quantified to obtain the risk in terms of core damage probability (CDP) for a plant shutdown and restart using a Mode 4 end state compared with a Mode 5 end state, with the following results:

- CDP for Mode 4 end state: 6.02E-6
- CDP for Mode 5 end state: 9.52E-6

The increase in CDP for a Mode 5 end state was attributed to the additional risk incurred during transition from SG cooling to shutdown (RHR) cooling. The quantitative results support a Mode 4 end state over a Mode 5 end state.

The results were further reviewed to obtain qualitative insights of the risk profile for the two end states. Loss of decay heat removal, loss of offsite power, and loss of inventory were the dominant initiating events in both end states. The Mode 5 unique initiating events, cold overpressurization and boron dilution, were not significant contributors and did not influence the results. These insights, and the lower CDP in Mode 4 compared to Mode 5, are consistent with the qualitative risk analysis and insights.

3.2.4.2.6 Containment Considerations

In Mode 4, containment systems, including the structure, isolation valves, and cooling and spray systems, are required to be operable since a design basis accident could cause a release of radioactive material to containment and an increase in containment pressure and temperature that would require the use of these systems for accident mitigation. In Mode 5, the probability and consequences of these events are lesser due to the reduced pressure and temperature of the RCS and secondary systems. However, the risk analyses consider more than the design basis events, and such events occurring in Mode 5 may lead to core damage and cause a challenge to containment.

For the proposed changes to the TSs not involving containment systems, an end state of Mode 4 compared to Mode 5 means that containment and the containment safeguards systems are required to be operable and, therefore, are available to mitigate the consequences of any event. For changes to the TSs for containment safeguards systems, however, a Mode 4 end state maintains the plant in a condition where design basis accidents may occur which would require the availability of the containment boundary. Although the probability and the consequences of these events are significantly reduced in Mode 4, the NRC staff considers that the function of containment as a fission product barrier, which is achieved by compliance with LCOs 3.6.1, 3.6.2, and 3.6.3 for containment integrity and isolation, must be available in Mode 4. Since the scope of the TR, as revised in response to the NRC staff RAI, excludes LCOs 3.6.1, 3.6.2, and 3.6.3, the availability of the containment boundary is assured while a plant is in a Mode 4 end state, and this is acceptable.

3.2.4.2.7 External Events

The quantitative risk analysis does not include consideration of external events, including internal fires and floods. The qualitative risk analysis demonstrated increased redundancy and diversity of available mitigation systems for decay heat removal, inventory control, and electric power. With more options available in Mode 4 compared to Mode 5, any external initiating event would be less likely to result in a loss of all available equipment needed for mitigation. In either mode, the reduced RCS temperatures and pressures eliminate the requirement to maintain seal cooling for the reactor coolant pumps, and loss of seal cooling is one significant impact for internal floods and fires. This reduces the impact of these events in Modes 4 or 5.

With regards to internal flooding, in Mode 4, main feedwater system operation has been terminated and secondary cooling is provided by AFW. Therefore, feedwater system flooding events are not applicable. The flooding events of interest in Modes 4 and 5 involve the CCW and SW systems. The quantitative results show that the risk in Mode 5 is greater when a train of these systems is inoperable than the risk in Mode 4. Thus, the risk impact of an internal flood event involving these systems would exhibit a similar difference in risk and, therefore, inclusion of these events would not change the overall conclusions of the risk analyses.

With regards to internal fire events, the operator response to fires occurring in Mode 4 would be similar to the response to fires occurring in Mode 5. The additional safety equipment available in Mode 4 compared to Mode 5 provides additional assurance of successful mitigation of fires. Therefore, inclusion of fire initiators would not be expected to change the overall conclusions of the risk analyses.

With regards to seismic risk, it is reasonable to assume that the trains of a seismically qualified system will respond to a seismic event in a similar manner regardless of the plant operating mode. Once again, the availability of additional safety-related, seismically qualified systems in Mode 4 compared to Mode 5 provides additional assurance of successful mitigation of seismic events. Further, a seismic event is likely to lead to a loss of offsite power, and there are more independent sources of power required to be available in Mode 4 compared to Mode 5, including the TDAFW pump which can provide decay heat removal without AC power. Therefore, inclusion of seismic events would not change the overall conclusions of the risk analyses.

The NRC staff concludes that the TR WCAP-16294-NP, Revision 0, adequately justifies that external events risk would not impact the overall conclusion of the report favoring a Mode 4 end state over Mode 5.

3.2.4.2.8 TS LCO Specific Quantitative Analyses

The baseline PRA model for transition risk assumes availability of equipment consistent with the assumptions discussed.

For those TS LCOs within the scope of the TR which include equipment modeled in the PRA, additional quantitative analyses were performed assuming unavailability of the equipment as per the TS conditions. The results are shown in the following table.

Table 3.2.1 Core Damage Probability for Various TS LCOs

TS LCO	Condition Modeled	CDP – Mode 4 End State	CDP – Mode 5 End State
3.5.3	ECCS – Shutdown, no available high head SI subsystem	1.32E-5	9.52E-5
3.5.4	Refueling Water Storage Tank, no available tank	3.08E-5	1.13E-4
3.6.6A and 3.6.6B	Containment Spray and Cooling, one train Containment Spray unavailable	6.02E-6	9.52E-6
3.6.6A and 3.6.6B	Containment Spray and Cooling, two trains Containment Spray unavailable	6.02E-6	9.52E-6
3.6.6A and 3.6.6B	Containment Spray and Cooling, one train Containment Cooling unavailable	6.03E-6	9.53E-6
3.6.6A and 3.6.6B	Containment Spray and Cooling, two trains Containment Cooling unavailable	6.36E-6	9.77E-6
3.6.6A and 3.6.6B	Containment Spray and Cooling, one train Containment Spray and one train Containment Cooling unavailable	6.03E-6	9.53E-6
3.7.7	Component Cooling Water, one train unavailable, backup pump unavailable	1.01E-5	2.46E-5
3.7.7	Component Cooling Water, one train unavailable, backup pump available	8.35E-6	2.22E-5
3.7.8	Service Water, one train unavailable, backup pump unavailable	2.41E-5	4.38E-5
3.7.8	Service Water, one train unavailable, backup pump available	8.09E-6	2.71E-5
3.8.1	AC Power – Operating, one offsite circuit unavailable	6.79E-6	1.25E-5
3.8.1	AC Power – Operating, two offsite circuits unavailable	1.12E-3	6.02E-3
3.8.1	AC Power – Operating, one diesel generator unavailable	7.29E-6	1.62E-5
3.8.1	AC Power – Operating, two diesel generators unavailable	2.63E-5	1.15E-4
3.8.1	AC Power – Operating, one offsite circuit and one diesel generator unavailable	1.67E-5	5.11E-5

3.8.1	AC Power – Operating, one load sequencer unavailable	7.48E-6	1.67E-5
3.8.4	DC Power – Operating, one battery charger unavailable	6.02E-6	9.52E-6
3.8.4	DC Power – Operating, one battery unavailable	7.44E-6	1.68E-5
3.8.4	DC Power – Operating, one DC subsystem unavailable	1.31E-4	2.19E-4
3.8.7	Inverters – Operating, train with one inverter unavailable	7.50E-6	1.67E-5
3.8.7	Inverters – Operating, train with two inverters unavailable	7.40E-6	1.62E-5
3.8.9	AC Power Distribution, one subsystem unavailable	3.68E-5	6.64E-5
3.8.9	AC Power Distribution, one vital bus panel unavailable	7.50E-6	1.67E-5
3.8.9	AC Power Distribution, three vital bus panels unavailable	3.22E-5	1.19E-4

The quantitative risk analyses results demonstrate that for each TS LCO condition evaluated, the risk of remaining in Mode 4 is lower than proceeding to Mode 5, which confirms the insights from the qualitative risk assessment.

3.2.4.2.9 Sensitivity Studies

The report investigated important assumptions to determine if their uncertainty would impact the overall conclusion of the analyses.

- Time in Mode 5 Sensitivity

The time spent in Mode 5, including transition to SDC in Mode 4, was assumed as 70 hours based on TS requirements and on operational data from Westinghouse plants. Since this is a higher risk configuration, a sensitivity study was done using 24 hours as the assumed time. This time was chosen based on the time to complete the transition from Mode 4 to Mode 5. While the quantitative results show that there is a dependency on the time spent in Mode 5 and in transition, the conclusion of less risk by remaining in Mode 4 is not changed.

- SGTR Initiating Event Frequency Sensitivity

Westinghouse plants include various types of steam generators. The SGTR initiating event frequency was increased by a factor of four from the base case value to investigate the sensitivity of the results. The TR states that the risk increases only about 14% for the Mode 4 case (SGTR is not modeled in Mode 5); therefore, the model is not sensitive to SGTR frequency in either mode, and the conclusion of less risk by remaining in Mode 4 is not changed.

- Probability of Offsite Power Recovery Sensitivity

The probability of not recovering offsite power within two hours (required in Mode 5) is 0.5, based on Reference 14. A sensitivity case was run assuming the probability of nonrecovery is 0.1, a factor of 5 reduction. The revised case reduced the CDP in Mode 5 by only about 14%; therefore, the model is not sensitive to offsite power recovery probability, and the conclusion of less risk by remaining in Mode 4 is not changed.

Based upon these results, the NRC staff concludes that the risk assessment and associated sensitivity studies are adequate to show that the risk changes associated with the proposed changes are either negative or risk neutral for all Westinghouse plants.

3.2.5 Tier 2 and Tier 3 Assessment

The TR identifies the availability of the TDAFW pump as a general tier 2 requirement in order to remain in Mode 4. This will be addressed by revising the bases of each TS action to which a revised end state is applied. Each individual assessment of TS action included an evaluation of tier 2 requirements; no TS LCO action-specific tier 2 restrictions were identified.

Licensees have programs in place to comply with 10 CFR 50.65(a)(4) to assess and manage the risk from proposed maintenance activities. These programs can support licensee decision making regarding the appropriate actions to control risk due to emergent equipment unavailabilities occurring in Mode 4.

3.2.6 Risk Assessment Summary

The NRC staff finds that the Westinghouse risk assessment approach is comprehensive and follows NRC staff guidance as documented in RGs 1.174 and 1.177. In addition, the analyses show that the criteria of the three-tiered approach for allowing TS changes are met as explained below:

- Risk Impact of the Proposed Change (Tier 1). The risk changes associated with the proposed TS changes, in terms of mean yearly increases in CDF and LERF, are risk neutral or risk beneficial. In addition, there are no time intervals associated with the implementation of the proposed TS end state changes during which there is an increase in the probability of core damage or early release with respect to the current end states.
- Avoidance of Risk-Significant Configurations (Tier 2). The availability of the TDAFW pump is addressed as a general tier 2 restriction. No specific restrictions on equipment availability or other controls were identified for preventing risk-significant plant configurations.
- Configuration Risk Management (Tier 3). Licensees have programs in place to comply with 10 CFR 50.65(a)(4) to assess and manage the risk from proposed maintenance activities. These programs can support licensee decision making regarding the appropriate actions to control risk due to emergent equipment unavailabilities occurring in Mode 4.

In addition, the generic risk impact of the proposed end state mode change was evaluated subject to the following:

- Entry into the shutdown mode under consideration is for a short interval with the primary intent of repairing a non-functional component and returning the plant to power as soon as practical.

- While in Mode 4, SG cooling via the TDAFW pump is available in the event of an interruption of decay heat removal, upon operator action to start the pump. This requires availability of the TDAFW pump, a minimum available pressure in the secondary, an available water supply to the pump, and no maintenance or other activities which would delay establishing SG cooling.

3.3 Technical Evaluation Summary

This section is limited to the NRC staff's evaluation of proposed changes associated with cooldown to Mode 4 instead of Mode 5 for specific TS Required Actions in TR WCAP-16294 based on traditional engineering considerations such as defense-in-depth and safety margins. The proposed changes to the TS end state are consistent with standard practices used in setting the allowed outage times and surveillance test intervals. The reduction in outage time in Mode 4 might provide operational flexibility; the change might allow an increased allocation of the plant personnel's time to more safety-significant aspects of plant operation.

The impact of the proposed changes to the TS end state for the Required Actions is evaluated to determine that the changes are consistent with the defense-in-depth philosophy. Risk insights from both qualitative and quantitative risk assessments were used in the TS change-specific justifications. In addition to the risk arguments, defense-in-depth arguments are used to justify each system-specific TS change, in accordance with the "integrated decision-making" process of Regulatory Guides 1.174 and 1.177.

The codes and standards approved for use by the NRC continue to be met. The proposed revisions provide sufficient margin to account for the analysis and data uncertainties. The proposed TS AOT or end state change does not adversely affect any assumptions or inputs to the safety analysis. The proposed changes do not allow plant operation in a configuration outside the design basis. For the proposed changes Mode 4 offers additional defense-in-depth and a lower risk level. Therefore there is no impact on safety margins.

Based on technical and regulatory evaluation of the proposed changes to TS by the NRC staff, it is concluded that the proposed changes meet the current regulations.

4.0 LIMITATIONS AND CONDITIONS

Licensees requesting the TS changes to operate their plants in accordance with TR WCAP-16294-NP must commit to the following requirements in the TSs or its associated bases. These commitments assure that the implementation of this TR will be consistent with the NRC staff's evaluation:

1. Entry into the shutdown modes approved in this SE shall be for the primary purpose of accomplishing short time repairs to restore inoperable equipment. Appropriate procedures and exemptions should be secured from the NRC if the plants are likely to stay more than the duration stipulated by the amended TS duration.

2. The requested end state changes do not prohibit licensee from entering cold shutdown if they wish to do so for operational reasons or maintenance requirements. In such cases, the specific requirements associated with the requested end state changes do not apply.

3. Appropriate plant procedures and administrative controls shall be used when the plant is operated in the proposed end state.
4. Entry in to the proposed end states shall be in accordance with the requirements of 10 CFR 50.65. The licensee should assess and manage the increase in risk that may result from the proposed maintenance activities.
5. The availability of the TDAFW pump must be assured while the plant is operating in Mode 4 in accordance with the assumptions of the TR.
6. Should the SG cooling be lost while operating in Mode 4, there shall exist operational procedures to ensure long-term decay heat removal.
7. Any plant-specific license amendment request (LAR) which deviates from the NRC-approved TR, will require additional NRC review. The licensee should document its basis for deviating from the approved TR in its LAR to support a detailed review by the NRC technical branches involved in the TR review.

5.0 CONCLUSION

The NRC staff's evaluation approves only the operation as described in References 5 and 6. The NRC staff finds that the TR used realistic assumptions regarding the plant conditions and the availability of various mitigating systems in analyzing the risks and considering the defense-in-depth and safety margins. Thus the NRC staff concludes that the TR uses realistic assumptions to justify the change in the end state. The NRC staff's review was based, in part, on the assumption that while remaining at Mode 4, that plants would be at the lower end of RCS pressure range so that it will reduce the potential for LOCA and will limit coolant inventory loss in the event of a LOCA, as described further in Sections 3.1.4 and 3.1.5 of this SE. For mitigation of several events during potential high risk plant configuration in Mode 4, there should be heightened awareness among plant operators that some protection features are not fully operational. In addition, during potential high risk configuration in Mode 4 where Safety Injection is not available, the plant should be closely monitored using appropriate administrative controls, guidance, appropriate plant procedures, and proper staff training.

In addition, as shown in the November 20, 2009, letter (Reference 21), the NRC staff reviewed the proposed TR WCAP-16294, Rev. 0 changes to the NUREG-1431, Revision 3, "Standard Technical Specifications Westinghouse Plants," TS and Bases, as well as additional markups of TR WCAP-16294-NP. The NRC staff found the proposed revisions to the STS and Bases, as described in the November 20, 2009, letter, acceptable. The industry Technical Specifications Task Force will submit the STS and Bases changes justified in TR WCAP-16294, Rev. 0, (and as shown in Reference 21) as a TSTF Traveler, for NRC staff review and approval for incorporating the TS and Bases changes in the next revision of NUREG-1431.

The NRC staff has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the acceptance of this TR will not be inimical to the common defense and security or to the health and safety of the public.

6.0 REFERENCES

1. Letter from A. Pietrangelo (NEI) to T. Tjader (NRC), " September 9, 2005 (ADAMS Accession Number ML052620374).
2. WCAP-16294-NP, "Risk Informed Evaluation of Changes to Technical Specification Required Action Endstates for Westinghouse NSSS PWRs," Westinghouse, August 2005. (ADAMS Accession No. ML052620374).
3. Letter from T. Mensah (NRC) to B. Bradley (NEI), "Request for Additional Information (RAI) Regarding Nuclear Energy Institute Topical Report (TR) WCAP-16294-NP, Rev. 0, "Risk-Informed Evaluation of Changes to Technical Specification Required Action Endstates for Westinghouse NSSS PWRs," June 13, 2007 (ADAMS Accession No. ML071550116).
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