July 17, 2001

Mr. Richard Bernier, Chairman
CE Owners Group
Mail Stop 7868
Arizona Public Service Company
Palo Verde Nuclear Generating Station
P.O. Box 52034
Phoenix, Arizona 85072-2034

SUBJECT: SAFETY EVALUATION OF CE NPSD-1186, REV. 00, "TECHNICAL JUSTIFICATION FOR THE RISK INFORMED MODIFICATION TO SELECTED REQUIRED ACTION END STATES FOR CEOG MEMBER PWRS" TAC NO. MA8858

Dear Mr. Bernier:

On April 28, 2000, the Combustion Engineering Owners Group (CEOG) submitted CE NPSD-1186, Rev. 00 for NRC staff review. Since then several supplemental communications have been received, and a new version was submitted on February 13, 2001, and was supplemented by letter dated July 3, 2001. CE NPSD-1186, Rev. 00 requests changes in the end state technical specification (TS) for numerous allowed outage time (AOT) requirements. Most of the requested TS changes are to permit an end state of hot shutdown (Mode 4) rather than cold shutdown (Mode 5) end state that is contained in the current TSs.

The staff has found that CE NPSD-1186, Rev. 00, "Technical Justification for the Risk Informed Modification to Selected Required Action End States for CEOG Member PWRs," dated February 13, 2001, as supplemented by letter dated July 3, 2001, is acceptable for referencing in licensing applications for Combustion Engineering designed pressurized water reactors to the extent specified and under the limitations delineated in the report and in the associated NRC safety evaluation (SE). The SE defines the basis for acceptance of the report.

Licensees requesting a license amendment to revise their end states will need to include in their amendment requests plant-specific information addressing the stipulations identified in Section 6.0 of the SE.

We do not intend to repeat our review of the matters described in the subject report, and found acceptable, when the report appears as a reference in license applications, except to ensure that the material presented applies to the specific plant involved. Our acceptance applies only to matters approved in the report.

In accordance with procedures established in NUREG-0390, the NRC requests that the CEOG publish an accepted version, within 3 months of receipt of this letter. The accepted version shall incorporate (1) this letter and the enclosed SE between the title page and the abstract, and (2) an "-A" (designating "accepted") following the report identification symbol.

Should our criteria or regulations change so that our conclusions as to the acceptability of the report are invalidated, the CEOG and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

Sincerely,

/RA by S. Dembek for/

Stuart A. Richards, Director
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 692

Enclosure: Safety Evaluation

cc w/encl: See next page

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/RA by Stephen Dembek/
Stuart A. Richards, Director
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO TOPICAL REPORT CE NPSD-1186, REV. 00

"TECHNICAL JUSTIFICATION FOR THE RISK INFORMED MODIFICATION

TO SELECTED REQUIRED ACTION END STATES FOR CEOG MEMBER PWRS"

PROJECT NO. 692

1.0 INTRODUCTION

By letter dated April 28, 2000 (Reference 1), the Combustion Engineering Owners Group (CEOG) submitted Topical Report CE NPSD-1186, Rev. 00, "Technical Justification for the Risk Informed Modification to Selected Required Action End States for CEOG PWRs" (Reference 2), for review by the NRC staff. The CEOG supplemented the topical report by letters dated September 19 and November 21, 2000 (References 3 and 4). On February 13, 2001 (References 5 and 6), the CEOG submitted an additional supplement, that in addition to clarifying technical issues also made editorial changes, one of which was adding "Member" to the title of the report. By letter dated July 3, 2001, the CEOG provided clarifying information regarding Technical Specifications (TS) 3.6.3 and 3.7.5 (Reference 7).

The Code of Federal Regulations, 10 CFR 50.36, "Technical Specifications," states that "When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shutdown the reactor or follow the remedial action permitted by the technical specification until the condition can be met." TS provide an allowed outage time (AOT) for the plant to meet the limiting condition for operation (LCO). If the LCO or the remedial action cannot be met then the reactor is required to be shutdown. When the individual plant technical specifications were written, the shutdown condition or end state specified was usually cold shutdown.

This topical report provides the technical basis to change certain required end states when the TS AOTs for remaining in power operation are exceeded. Most of the requested technical specification (TS) changes are to permit an end state of hot shutdown (Mode 4) rather than an end state of cold shutdown (Mode 5) contained in the current TSs. The request was limited to: (1) those end states where 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 technical specification, and (3) the primary purpose is to correct the initiating condition and return to power operation as soon as is practical.

2.0 BACKGROUND

The TSs for Combustion Engineering (CE) plants define six operational modes. In general, they are:

- Mode 1- Power Operation.
- Mode 2 - Reactor Startup.
- Mode 3 - Hot Standby. Reactor coolant system (RCS) temperature above ~300°F (TS specific) and RCS pressure that can range up to power operation pressure. Shutdown cooling (SDC) systems can sometimes be operated in the lower range of Mode 3 temperature and pressure.
- Mode 4 - Hot Shutdown. RCS temperature can range from the lower value of Mode 3 to the upper value of Mode 5. Pressure is generally (but not always) low enough for SDC system operation.
- Mode 5 - Cold Shutdown. RCS temperature is below 200°F and RCS pressure is consistent with operation of the SDC system.
- Mode 6 - Refueling. Operation is in Mode 6 if one or more reactor vessel head bolts have been de-tensioned. RCS temperature is below 200°F and RCS pressure is generally equal to containment pressure.

Criticality is not allowed in Modes 3 through 6, inclusive.

The CEOG request generally is to allow a Mode 4 end state rather than a Mode 5 end state for selected initiating conditions.

The Reference 6 request states that "... preventing plant challenges during shutdown conditions has been, and continues to be, an important aspect of ensuring safe operation of the plant. Past events demonstrate that risk of core damage associated with entry into, and operation in, shutdown cooling is not negligible and should be considered when a plant is required to shutdown. Therefore, the TS should encourage plant operation in the steam generator heat removal mode whenever practical, and <u>require</u> SDC entry only when it is a risk beneficial alternative to other actions."

Controlling shutdown risk encompasses control of conditions that can cause potential initiating events and response to those initiating events that do occur. Initiating events are a function of equipment malfunctions and human error. Response to events is a function of plant sensitivity, ongoing activities, human error, defense-in-depth, and additional equipment malfunctions. In the end state changes under consideration here, a component or train has generally resulted in a failure to meet a TS and a controlled shutdown has begun because a TS AOT requirement is not met.

Most of today's shutdown TS and the design basis analyses were developed under the perception that putting a plant in cold shutdown would result in the safest condition and the

design basis analyses would bound credible shutdown accidents. In the late 1980s and early 1990s, the NRC and licensees recognized that this perception was incorrect and took corrective actions to improve shutdown operation. At the same time, standard TSs were developed and many licensees improved their TS. Since a shutdown rule was expected, almost all TS changes involving power operation, including a revised end state requirement were postponed in anticipation of enactment of a shutdown rule (see, for example, Reference 8). However, in the mid 1990s, the Commission decided a shutdown rule was not necessary in light of industry improvements.

In practice, the realistic needs during shutdown operation are often addressed via voluntary actions and application of 10 CFR 50.65 (Reference 9), the maintenance rule.

3.0 ASSESSMENT APPROACH

Section 50.65(a)(4) states, "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 10) provides guidance on implementing the provisions of 10 CFR 50.65(a)(4) by endorsing a revised Section 11 to NUMARC 93-01 (Reference 11)[(1)]. 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." Although all of the general guidance of Section 11.3.2 is applicable, the following are specifically referenced with respect to our review of the CEOG request:

"8. Emergent conditions may result in the need for action prior to conduct of the assessment, or could change the conditions of a previously performed assessment. Examples include plant configuration or mode changes, additional SSCs (structures, systems and components) out of service due to failures, or significant changes in external conditions (weather, offsite power availability). The following guidance applies to this situation:

- The safety assessment should be performed (or re-evaluated) to address the changed plant condition on a reasonable schedule commensurate with the safety significance of the condition. Based on the results of the assessment, ongoing or planned maintenance activities may need to be suspended or rescheduled, and SSCs may need to be returned to service.

- Performance (or re-evaluation) of the assessment should not interfere with, or delay, the operator and/or maintenance crew from taking timely actions to restore the equipment to service or take compensatory actions."

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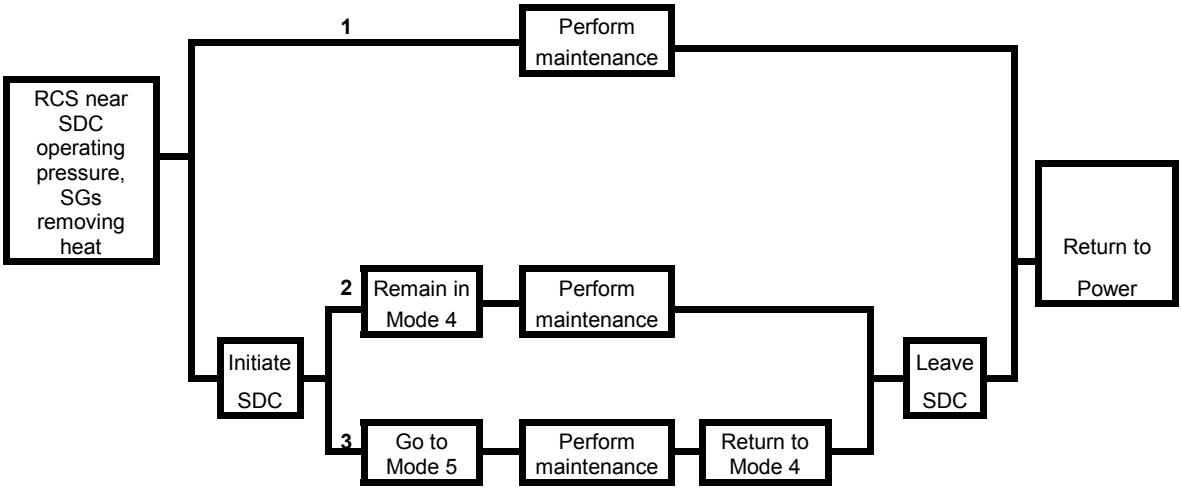
[1]Reference 11 is, to the staff's knowledge, the most recent, complete revision to NUMARC 93-01 but it does not include the revised Section 11. Attachment 2 to Reference 12 is the revised Section 11 referenced in this SE.

All licensees must operate in accord with 10 CFR 50.65 and licensees have voluntary initiatives in place to ensure sufficient equipment, procedures, and contingency plans to provide defense-in-depth. Realistic comparisons take this into account.

The staff noticed several general statements throughout the report, associated with rather unrealistic system configurations and or plant conditions, which favor mode 4 on steam generator (SG) cooling in its comparison to mode 5. For example, it is stated in the report that containment integrity is required in mode 4 but not in mode 5. Licensees do not normally make containment unavailable, especially when shut down for a short term repair and subsequent return to power. These statements do not necessarily reflect the manner in which the risk is managed in accordance with 10 CFR 50.65 when performing maintenance on plant equipment. However, the staff's review has determined that such statements are not part of the assumptions made in the deterministic and probabilistic assessments used to support the proposed TS end state changes. The staff finds that the topical report uses realistic assumptions regarding plant conditions and the availability of the various mitigative systems (including transitions requiring operator actions) in the risk analysis as well as in the defense-in-depth and safety margin considerations. Thus, the staff concludes that the topical report uses realistic assumptions to justify the change in end states.

To assess the Reference 6 request and conclusions, the staff first considered the generalized outage path illustrated in Figure 1 that starts with the plant in Mode 4, with decay heat removed by SGs, and with RCS pressure relatively close to SDC operating conditions.

Figure 1. Potential Outage Paths



Three paths are illustrated in Figure 1:

1. Remain at these conditions, perform maintenance, and return to power,

2. Initiate SDC, generally remain in Mode 4, perform maintenance, leave SDC, and return to power, or

3. Initiate SDC, enter Mode 5, perform maintenance, return to Mode 4, leave SDC, and return to power.

In Path 1, conditions are normally such that SDC can be initiated if needed. In Paths 2 and 3, there is a high likelihood that (1) SG cooling can be initiated if there is a loss of SDC, and (2) plant conditions will continue to support this capability. This means, for example, that there is no breaching of the RCS pressure boundary and at least one train of auxiliary feedwater (AFW) is available. TS specify the minimum allowable makeup/emergency core cooling system (ECCS) capability during Mode 4, and voluntary actions, 10 CFR 50.65(a)(4), and commitments address this capability during Modes 4 and 5. The result of these combinations is that the overall risk associated with the "Perform maintenance" box should be similar for many maintenance operations, regardless of path, although there are perturbations as discussed in the next paragraph.

Path 1 is generally preferred over path 2 and path 2 is preferred over path 3. There are no transitions, and in many cases no delays, prior to performing maintenance in Path 1. Paths 2 and 3 require additional steps to initiate SDC as well as to leave SDC, steps that typically extend shutdown time by 8 to 16 hours (Reference 6). There are some short-term transitional risks as well. Selection of Path 3 means an additional transition from Mode 4 to Mode 5 in which the plant is placed in an increased cooldown rate condition to "step" quickly across the Mode 4/Mode 5 "boundary" to avoid an inadvertent re-entry into Mode 4. Path 3 also introduces potential conditions where an operator may cause a TS violation if he allows the plant to move from Mode 5 to Mode 4 while addressing problems with SDC. Finally, additional actions are necessary to move from Mode 5 to Mode 4 following completion of maintenance, with associated delays. Consequently, Path 1 will generally take the shortest time and may expose the plant to the lowest risk provided all other plant conditions are the same. Similarly, Path 2 will generally be preferred over Path 3 if Path 1 cannot be followed.

With this perspective, we address each of the critical safety functions identified in Reference 6 that must be maintained during shutdown operation:

- Heat removal
- Inventory control
- Reactivity control
- Containment control
- Electrical power

Since the purpose of the requested TS changes is to correct a malfunction and promptly return to power, the staff's consideration is limited to repairs that: (1) maintain the RCS pressure boundary, and (2) maintain containment integrity, heat removal and electrical capability unless directly involved in the deficiency that is to be corrected.[(2)]

Heat removal is routinely accomplished by the SGs or the SDC system. SGs are effective whenever the RCS pressure boundary is intact, heat is transported from the core to the SG

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[2]Deviations may be considered provided they are fully evaluated as identified in Items 1 - 7 of Section 6.

tubes via an adequate RCS inventory, there is adequate secondary side inventory, and a steaming path is provided to transport heat from the SGs.[3] SGs are typically used during Mode 3 and in the higher temperature region of Mode 4. The SDC system may sometimes be used in the lower temperature region of Mode 3, and is used during much of Mode 4 and during Mode 5. Sufficient SG water level should be maintained to ensure that if feedwater is lost, the plant can be cooled down and placed on SDC. Similarly, if the SDC system is in operation during Mode 4 and is lost, SG cooling can be initiated. If SDC system is lost in Mode 5 then, provided the steam generators have been maintained available, the RCS will heat up to the point at which SG cooling can be established. Elective maintenance should be appropriately curtailed whenever the heat removal capability is impacted during the AOT.

Heat removal may also be accomplished by injecting water into the RCS. For most conditions under consideration here, the RCS pressure boundary will be intact, which limits this process. Some plant designs permit water to flow out the pressurizer power (or pressure) operated relief valves (PORVs) at a relatively low RCS pressure, thus removing heat from the RCS, and one plant has a large vent valve that will accomplish the same result. It may also be possible to inject water via all charging pumps with heat removed via fluid flow out of the pressurizer safety valves and high point vents.[4] However, low temperature - high pressure restrictions may limit this once-through cooling capability. Injection is discussed further under **RCS inventory control**, immediately below.

RCS inventory control is accomplished by balancing letdown and makeup to maintain pressurizer level within desirable limits for most of the anticipated conditions that are within the scope of the TS change requests. Uncontrolled loss of inventory events are to be minimized by in-depth planning and configuration control. In-depth event response capability, such as inventory addition capability, procedures, and training, are to be provided.

Traditionally, loss of inventory control has been assessed using postulated loss-of-coolant accidents (LOCAs), which have a low likelihood of occurrence because of reduced RCS temperature and pressure. Traditional LOCAs are not the concern. The concern, as clearly established by operating experience, is mispositioned valves and valve failures.

Reactivity control is maintained by ensuring rods and boration provide adequate shutdown margin in conjunction with appropriate procedures, training, and controls. Appropriate instrumentation and monitoring are necessary to identify off-normal conditions. In general, the staff does not anticipate reactivity control issues will be a dominant concern because: (1) the likelihood of steam and feed line breaches causing a significant cooldown event is low, and (2)

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[3]In the short term because CE SGs are relatively large, heatup of the secondary side inventory without boiling can provide a substantial heat removal capability for transients that initiate with a cold secondary side inventory. Similarly, substantial heat can be removed by boiling the secondary side inventory with no secondary side feedwater. Long term heat removal requires feedwater.

[4]Vent valves are small and will only vent a small fraction of the decay heat. They are identified here only because they contribute to heat removal.

fuel movement operations and similar activities cannot be performed in the modes addressed by this safety evaluation (SE).

Containment control should be provided in any of the shutdown modes under consideration here. Containment integrity is required during Mode 4 and, if containment integrity or one of the barriers[5] to release radioactive material has been lost, then optional maintenance activities should be carefully scrutinized to ensure adequate defense-in-depth if the choice is made to remain in Mode 4 during the AOT. Containment closure, or the ability to accomplish containment closure, is normally sufficient during Mode 5 operation. Containment cooling capability may be adjusted consistent with the reduced energy removal conditions expected during shutdown operation.

Sufficient AC and DC **electrical power** capability should be provided to support equipment relied upon for shutdown operation under normal or off-normal conditions. The minimum requirement is normally four sources of AC power (two onsite, two offsite) during Mode 4, the same as for power operation. The typical TS requirement for Mode 5 is one onsite and one offsite. For conditions applicable to the AOT request, the normal power sources should be available unless there are extenuating circumstances, such as a reduced capability being the reason for entering the AOT. Elective maintenance should be appropriately curtailed whenever electrical capability is diminished during the AOT.

The defense-in-depth associated with **safety functions** is potentially affected by internal plant conditions as well as by external conditions. For example, a SDC pump that just meets operating vibration requirements but is deteriorating is unlikely to be as reliable as an identical pump that easily meets requirements and exhibits no degradation trend. An approaching hurricane, an ice storm, or likely thundershower or tornado activity may curtail operator local operation flexibility, impact safety functions such as electrical power, and reduce outside resources available to address emergencies. Such conditions are to be considered during post-AOT operation planning.

Reference 6 provided an assessment of each proposed end state with the following qualification:

> "In performing the Defense-in-Depth assessment, it is assumed that the purpose of the TS Required Action to enter shutdown is to complete a short duration repair of the component under consideration."

This statement is reflected in the requirements listed in Section 6.0 of this SE.

In Reference 7, the CEOG clarified the topical report to state "ISTS [improved standard technical specifications] already affords the proper end state considerations or conditions when one or more AFW pumps are inoperable. Therefore, no change is requested for this technical specification."

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[5]The traditional barriers are containment, the RCS pressure boundary, and the fuel cladding.

The staff agrees that standard technical specifications have a Mode 4 end state and further evaluation by the staff is not necessary. The staff has evaluated the AFW system as it applies to the risk and the deterministic analyses for the other TS end state changes.

Additionally in Reference 7, the CEOG clarified TS 3.6.3 to reflect that the Mode 4 end state applies to the inoperability of penetrations with a single containment isolation valve (CIV) inoperable. This means that containment will still have one boundary remaining to the release of fission products. The proposed modification is:

> Modify SONGS [San Onofre Nuclear Generating Station] TS (and their equivalents) to accommodate a Mode 4 for any penetration(s) having only one inoperable valve.

4.0 RISK ASSESSMENT

4.1 Objectives and Approach

The objective of the CEOG's risk assessment was to show that the risk changes due to changes in TS end states are either negative (i.e., a net decrease in risk) or neutral (i.e., no risk change).

Reference 6 documents a risk-informed analysis of the proposed TS changes. Probabilistic risk analysis (PRA) results and insights are used, in combination with results of deterministic assessments, to identify and propose changes in "end states" for all CEOG plants. This is consistent with guidance provided in RG 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," and 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications." The three-tiered approach documented in RG 1.177 was followed. The first tier includes the assessment of the risk impact of the proposed change for comparison to acceptance guidelines consistent with the Commission's Safety Goal Policy Statement (RG 1.174). In addition, the first tier aims at ensuring that 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. The second tier addresses the need to preclude potentially high risk configurations which could result if equipment is taken out of service during implementation of the proposed TS change. The third tier addresses the application of 10 CFR 50.65 for identifying risk significant configurations resulting from maintenance or other operational activities and taking appropriate compensatory measures to avoid such configurations. The scope of the topical report and this SE was limited to identifying changes in end state conditions that excluded continued power operation as an acceptable end state, regardless of the risk.

The risk assessment approach followed by the CEOG includes the following tasks:

- Performance of a generic qualitative risk assessment,
- Performance of a generic (applicable to several TS changes) quantitative risk assessment for a pilot plant:

- Performance of sensitivity studies to investigate the robustness of the results to uncertainties in data and modeling assumptions, and

- Performance of sensitivity studies to ensure that the conclusions of the quantitative assessment for the pilot plant apply to other CEOG plants,

- Performance of specific TS assessments using risk insights from both the qualitative and quantitative risk assessments, and

- Use of risk insights in the implementation of the proposed change to identify risk-significant plant configurations and compensatory measures.

The objective of the CEOG's generic qualitative risk assessment was to show that the proposed TS end state changes result in an increase in defense-in-depth for expected initiating events. This was achieved by performing qualitative risk comparisons between Mode 5, the current end state, and the proposed end state, such as Mode 3 on SG cooling, Mode 4 on SG cooling, and Mode 4 on SDC. Such comparisons include risk parameters, such as initiating events and mitigating systems, associated with each critical safety function at the CEOG plants. The objectives of the quantitative risk assessment are (1) to substantiate the conclusion of the qualitative risk assessment by providing numerical results for a representative plant, (2) to investigate the robustness of the results to uncertainties in data and modeling assumptions through sensitivity analyses, and (3) to assess the applicability of the results to other CEOG plants through sensitivity analyses accounting for design and operational differences. In addition, specific assessments for each proposed TS end state change were also performed, using risk insights from both the qualitative and 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 staff finds that the CEOG's risk assessment approach is comprehensive and follows staff guidance as documented in RGs 1.174 and 1.177.

4.2 Evaluation of the Quality of the Risk Assessment

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

- The low temperature overpressure protection (LTOP) and SDC are not aligned when the plant operates in Mode 4 on SG cooling.

- Procedures require that both LTOP and SDC be invoked when the plant operates in Mode 4 on SDC and in Mode 5.

- 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.

- The RCS remains at its nominal inventory and the RCS boundary strength is not compromised (e.g., via installation of nozzle dams).

These restrictions are consistent with typical entries into Mode 4 for short duration repairs, which is the intended use of the TS end state change, and are reflected in the stipulations in Section 6 of this SE. Such restrictions will be implemented by: (1) following existing procedures and administrative controls, and (2) configuration risk management as required by 10 CFR 50.65(a)(4) concerning risks associated with repair of equipment.

The quality of the risk assessment is an important part of any risk-informed license amendment review. In this case, both the qualitative and quantitative risk assessments must be of adequate quality and completeness to support their intended purposes. Regarding the qualitative risk assessment, the comparisons between current and proposed end states for the CEOG plants must be of adequate quality and completeness to ensure confidence in the robustness of the conclusion that the proposed TS end state changes do not decrease defense-in-depth for expected initiating events and that all expected initiating events were addressed in the analysis. Regarding the quantitative risk assessment, the various models (including assumptions and data) and sensitivity studies must be of adequate quality and completeness (e.g., with respect to initiating events and failure modes) to provide confidence in the robustness of the conclusion that the risk will be within the guidance provided in RGs 1.174 and 1.177 if the proposed new TS end states are approved and implemented. The review findings for the qualitative and quantitative risk assessments are documented below.

4.2.1 Qualitative Risk Assessment

The CEOG qualitative risk assessment is a comparison between Mode 3, Mode 4 and Mode 5 operation at the various CEOG plants. This comparison, which assesses qualitatively the means that exist at each CEOG plant to maintain critical safety functions for expected initiating events, contains the following three parts:

- Assessment of critical safety functions at shutdown,
- Generic comparison of risks at shutdown, and
- Comparison of safety and operational features at shutdown among CEOG plants.

The shutdown critical safety functions of core decay heat removal, inventory control, reactivity control, containment integrity control, and electric power availability were identified from previous risk studies. Performance of the critical functions at the CEOG plants is primarily discussed and used in the context of a generic risk comparison between Mode 4 (either on SG cooling or on the SDC system) and Mode 5 by discussing the likelihood of initiating events and the availability of mitigating systems. This generic risk comparison is complemented by a comparison of safety and operational features among CEOG plants, a step needed to ensure that the conclusions of the generic qualitative risk assessment are valid for each CEOG plant.

The staff finds that the CEOG qualitative risk assessment supports a conclusion that the proposed TS end state changes do not decrease defense-in-depth based on examination of the following:

- Challenges and mitigating capabilities of each CEOG plant and comparison between current and proposed end states;

- Documentation of the design and operational features used to mitigate shutdown accidents at each CEOG plant; and

- Proper use of results and insights from previous deterministic and probabilistic studies.

4.2.2 Quantitative Risk Assessment

A quantitative risk assessment of several potential end states was performed for SONGS Units 2 and 3. Both mode transition risks and comparative risks of short-term continued operation in Mode 3, Mode 4 on SG cooling, Mode 4 on SDC, and Mode 5 were addressed to demonstrate the impact of equipment redundancy and diversity. Variability in safety and operational features among CEOG plants was addressed by sensitivity studies to ensure that the conclusions of the quantitative assessment for SONGS apply to all CEOG plants.

The 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 CEOG plants were identified and appropriate sensitivity studies were performed which show that the conclusions of the quantitative risk assessment apply to all CEOG plants.

The quantitative risk assessment was performed using the latest available models for the transition and shutdown modes included in the SONGS risk monitor.[(6)] In addition to internal initiating events, the quantitative risk assessment includes consideration of dominant risks associated with fire and seismic events and presents qualitative arguments to support the conclusion that the risk from external events in Mode 4 is either lower or about the same as in Mode 5 operation.

The CEOG and the staff identified several important assumptions in the transition and shutdown models which could impact the results and conclusions, including the following:

- Risk results are based on initial plant conditions following shutdown (i.e., the results are conservative because heat generation rate decreases with time following shutdown);

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[6] The risk monitor transition modes include Mode 2, Mode 3, and Mode 4 on SG cooling. The shutdown modes include Mode 4 on SDC as well as Modes 5 and 6. The transition model is based on a modified version of the at-power model which accounts for mode specific features and initiating event challenges. The shutdown model is based on the SONGS shutdown PRA which has been used since 1994 to analyze outage risk at the site.

- No credit is taken in the quantitative risk assessment for using the turbine-driven auxiliary feedwater (TDAFW) pump in Mode 4 (a conservative assumption);

- The contribution from the loss of component cooling water (CCW) initiating event, while transitioning through Mode 3 to Mode 4, and while in Mode 4 on SG cooling, is assumed to be negligible (which appears to be reasonable in comparison to other contributions);

- All LOCA, steam line break (SLB), and steam generator tube rupture (SGTR) frequencies are assumed to be smaller in Mode 4 than at power by a factor of 20 (a potential non-conservative assumption);

- The loss-of-offsite power (LOOP) frequency is assumed to be higher in Modes 3, 4, and 5 than at power by a factor of 3.45 to account for the potentially increased switchyard maintenance and decreased grid stability associated with a plant shutdown (a conservatism in well controlled outages as discussed in Section 3);

- The probability of not recovering offsite power in time to avoid core damage is assumed to be smaller at shutdown than at power by a factor of 3.7 to account for the extra time available at shutdown (which may or may not be conservative, depending on conditions); and

- No credit was taken in the risk assessment for using motor-driven main feedwater (MDMFW) pumps in Modes 3 and 4, which may be available in several CEOG plants (a conservative assumption for plants with that capability).

The CEOG and the staff identified several important design and operational differences among the various CEOG plants which could affect the results and conclusions, including the following:

- At several CEOG plants containment spray (CS) is available in Mode 4. However, at others, Mode 4 entry and SDC system entry pressures are above the CS suction piping design pressure and, therefore, no CS pumps are available as backup to the SDC pumps for SDC in parts of Mode 4;

- Some plants have "feed and bleed" capability which is not credited in the quantitative risk assessment;

- At some CEOG plants the RCS is vented in Mode 5 to allow use of the CS pumps as backup to the SDC pumps for SDC;

- Some CEOG plants have MDMFW pumps capable of providing main feedwater in Mode 4 operation (this is not credited in the quantitative risk assessment);

- Several CEOG plants do not have the capability to "cross-tie" power sources between two units;

- There is variability among CEOG plants regarding the number and type of pumps (e.g., motor-driven and TDAFW pumps) that can be used to remove decay heat in Mode 4 on SG cooling;

- The procedures used to depressurize the plant to SDC system entry conditions, following loss of SG cooling in Mode 4, vary among plants.

Such assumptions and design and operational differences were evaluated to determine how they impact the results and conclusions of the quantitative risk assessment. The evaluation included, whenever necessary, the performance of sensitivity studies.

The 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 CEOG plants.

4.3 Risk Insights from the Qualitative Risk Assessment

The CEOG report documents a generic qualitative comparison of shutdown risks in Modes 3, 4 and 5 which aims to show that the proposed TS end state changes do not decrease defense-in-depth. The comparison is focused on risks between Mode 4 (either on SG cooling or on SDC) and Mode 5. Mode 4 and Mode 5 risks are qualitatively compared by discussing (1) the means used at CEOG plants to address each of the critical functions, and (2) the likelihood of the initiating events and the availability of mitigating systems. This generic risk comparison is complemented by a comparison of safety and operational features among CEOG plants, a comparison needed to ensure that the conclusions of the generic qualitative risk assessment are valid for each CEOG plant.

Important insights of the means used to address each of the critical functions are listed below:

- Several CEOG plants use similar means to achieve inventory control, reactivity control, containment integrity control, and power availability in Modes 4 and 5.

- More means are available to perform the core decay heat removal critical function while the plant is operating in Mode 4 than when it is operating in Mode 5. In Mode 4, all CEOG plants, except Fort Calhoun Station (FCS), can use the motor-driven condensate pumps or the AFW pumps (both turbine-driven and motor-driven) or can enter SDC using the low pressure safety injection (LPSI) pumps. However, at FCS a diesel driven AFW pump and three MDMFW pumps are available and can be used as an alternate means of injecting feedwater to the SGs. Therefore, the conclusions of the qualitative risk assessment, which assumes availability of condensate pumps, are valid for each CEOG plant. Additional means are available at many CEOG plants.

  In Mode 5 operation, heat removal is limited to SDC via the LPSI pumps. The CS pumps back up the LPSI pumps, however use of the CS pumps often require that the RCS be vented to prevent overpressurizing the CS pump suction line. Use of the TDAFW pumps requires that the SG be capable of producing steam which cannot occur if the RCS is vented. Since the use of CS pumps typically requires the RCS to be vented, credit cannot generally be given for CS pumps and for TDAFW pumps.

- Also, SDC operation is entirely dependent on AC power while SG cooling via a TDAFW pump can be established without AC power.[7]

The potentially significant accident initiating events and available mitigating systems for LOCAs, SGTRs, loss of feedwater, LOOP, loss of SDC, loss of inventory, loss of CCW, and boron dilution, were evaluated to establish the acceptability of Mode 4 end states as the default action for most TSs where partial equipment availability is assured and short-term repair is possible. Important insights are:

- The risk impact of any rapid boron dilution incident postulated to occur as a result of maintenance on standby systems such as the ECCS is expected to be low due to the high level of control of non-borated water sources and is of approximately the same magnitude in Modes 4 and 5.

- The risk impact of LOCAs (excluding flow diversions) and SGTRs as pressure driven initiating events is not significant in Modes 4 and 5.

- LOOP and loss of a vital bus are important initiating events at all shutdown modes with approximately the same frequencies. Therefore, their risk impact is lower when there is more redundancy and diversity of the mitigating systems, as is the case when the plant is operating in Mode 4 on SG cooling.

- Loss of feedwater (in Mode 4 on SG cooling) and loss of SDC (in Mode 4 on SDC and Mode 5) are important initiating events of about the same frequency. Since there is more redundancy and diversity of the mitigating systems when the plant is operating in Mode 4 on SG cooling, the risk impact associated with the loss of feedwater initiating event (occurring in Mode 4 on SG cooling) is lower than the risk impact associated with the loss of SDC initiating event (occurring in Mode 4 on SDC and Mode 5).

- The risk impact associated with loss of CCW in Modes 4 and 5 was not analyzed separately from other initiating events for two reasons. First, loss of CCW causes loss of SDC and/or loss of feedwater, which were addressed elsewhere. Second, the potential for a gross reactor coolant pump (RCP) seal failure, due to lack of cooling, is low for seals used on the CEOG pumps (especially at the low temperatures and pressures generally present during Modes 4 and 5).

- Much of the risk impact associated with the loss of inventory initiating event is related to the initial alignment for SDC in Mode 4 or to plant operation near the LTOP setpoint in Mode 4. This risk is, therefore, reduced by not requiring transition to SDC. Otherwise, inventory sources and injection paths are typically controlled by shutdown configuration control programs and are not substantially different in Modes 4 and 5.

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[7]On CE plants, SG inventory is usually sufficient for several hours of cooling without feedwater. Long term operation requires addition of water to the SGs.

Important insights from the comparison of safety and operational features among CEOG plants which ensure that the conclusions of the generic qualitative risk assessment are valid for each specific CEOG plant are listed below:

- All CEOG units have three or more feedwater pumps (combined motor, turbine and diesel driven auxiliary). Since the qualitative risk assessment was performed assuming one MDAFW pump and one TDAFW pump, which is a common feature to all units, its conclusions are valid for each CEOG plant.

- All CEOG plants, with the exception of FCS, can remove heat through the SGs using the condensate pumps. However, at FCS a diesel driven AFW pump and three MDMFW pumps are available and can be used as an alternate means of injecting feedwater to the SGs. Therefore, the conclusions of the qualitative risk assessment, which assumes availability of condensate pumps, are valid for each CEOG plant.

- Many CEOG plants have "feed and bleed" capability which can be used in Mode 4 as an alternate (backup) means of cooling the core. This was not credited in the qualitative risk assessment.

- All CEOG plants use LPSI pumps to provide SDC. The alternate means of heat removal used varies among the units, as does the redundancy. All SDC systems require AC power for operation. About half of the CEOG plants may utilize CS pumps to backup LPSI pumps for SDC. However, CS pumps are also dependent on AC power and their use as backup typically requires venting the RCS so that SG inventory (if available) may not be useful in delaying accident progression. Despite these differences, the conclusions of the qualitative risk assessment are still valid for each specific CEOG plant.

- There are some differences in the RCS pressures allowed while the plant is in Mode 4 on SG cooling at the CEOG plants since the pressures are limited by the plant pressure-temperature curves and/or operational procedures. As a consequence, following a total loss of AFW event, some plants may enter SDC from higher pressures than others. All plants have means to depressurize the RCS to SDC entry conditions (e.g., PORVs, pressurizer spray water, atmospheric dump valves, and the steam bypass control system). Plants with PORVs also may have the option to use feed-and-bleed recovery. Despite these differences, the conclusions of the qualitative risk assessment are still valid for each specific CEOG plant.

The above insights lead to the following generic conclusions:

- For plant conditions that do not compromise the effectiveness of the AFW system, plant operation in Mode 4 on SG cooling offers at least the same robustness to plant upsets as operation in Mode 4 on SDC or Mode 5.

- When an AFW pump is found to be inoperable, plant operation in Mode 4 on either SDC or SG cooling offers at least the same robustness to plant upsets as operation in Mode 5.

The insights gained from the quantitative risk study (discussed below) substantiate these conclusions.

4.4 Risk Insights from the Quantitative Risk Assessment

The objectives of the quantitative study were to: (1) substantiate the conclusion of the qualitative risk assessment by providing numerical results for a representative plant, (2) investigate the robustness of the results to uncertainties in data and modeling assumptions through sensitivity studies, and (3) assess the applicability of the results to other CEOG plants through sensitivity studies accounting for design and operational differences. The quantitative risk assessment was performed for SONGS which, in addition to internal initiating events, includes consideration of dominant risks from fires and seismic events.

The relative plant risks, in terms of core damage frequency (CDF), associated with operation in Mode 3, Mode 4 on SG cooling, Mode 4 on SDC, and Mode 5 were assessed and compared to each other. Also, the CEOG report includes an interpretation of the risk results by relating them to the dominant risk initiators and the plant recovery capability. Important results and insights which substantiate the conclusions of the qualitative risk assessment by providing numerical results for a representative plant are listed below:

- As Mode 3 is entered from Mode 2, the CDF increases by about a factor of two (from about 2E-5/yr to about 4E-5/yr). This increase is primarily due to unavailability of the two TDMFW pumps in Mode 3. However, Mode 3 risk is still calculated to be lower than the risks associated with plant operation in Mode 4 on SDC and Mode 5.

- As Mode 4 is entered from Mode 3, the CDF decreases by about a factor of two (from about 4E-5/yr to about 2E-5/yr). This is primarily due to:

  - pressure restrictions associated with Mode 4 on SG cooling which result in a decrease in the contribution of LOCA and SGTR to core damage. Although the likelihood for operator error can increase, the likelihood of loss-of-inventory events is small because the capability to operate in either SDC or SG heat removal modes is available and proceduralized.

  - the lower decay heat associated with Mode 4 which results in larger time windows for operators to complete specific actions (a small effect), and

  - the lower probability of failure to enter SDC from Mode 4 on SG cooling as compared to Mode 3 (entry into SDC from an initial Mode 3 state may be delayed by the need to first maneuver the plant to Mode 4 while entry into SDC from an initial Mode 4 state is available and proceduralized).

- As Mode 4 on SDC is entered from Mode 4 on SG cooling, the CDF increases about two and one half times (from about 2E-5/yr to about 5E-5/yr). This is primarily due to:

  - less cooling redundancy when on SDC than SG cooling (if AFW is lost when on SG cooling, the operators can either switch to SDC or provide SG cooling using

the condensate or other means; if SDC is lost when on SDC, the operators could switch to AFW but the condensate system may be unavailable), and

- loss of inventory is more likely when SDC is aligned since (1) a misalignment can result in an RCS diversion, and (2) a pressure spike or LTOP drift can cause an LTOP valve lift.

- As Mode 5 is entered from Mode 4 on SDC, the CDF remains approximately unchanged assuming the RCS is not vented in Mode 5 (which means that CS pumps typically cannot be used for SDC) and SG inventory is available. This means that the risk associated with Mode 5 (assuming the RCS is not vented) is at least 2.5 times higher than the risk associated with Mode 4 on SG cooling. This is primarily due to the fact that once in Mode 5, in order to regain the ability of the SG to remove heat, the operators will have to either allow boiling in the RCS or raise RCS pressure and temperature. At some plants, operators may hesitate to perform this action because it is considered to lead to an uncontrolled Mode change. This could result in a higher operator failure probability for this action.

- As Mode 5 is entered from Mode 4 on SDC, the CDF almost doubles when the RCS is vented in Mode 5 to ensure that pressurization events do not threaten the CS piping and, thus, allows use of the CS pumps for SDC (as is the case for SONGS). This means that the risk associated with Mode 5, with the RCS vented, is almost five times higher than the risk associated with Mode 4 on SG cooling. This is primarily due, in addition to the reasons listed above for the unvented case, to the fact that venting results in loss of effective use of the SG for heat removal since a pressure increase in the RCS is not possible unless the vent can be closed.

- Important results associated with Mode 4 on SG cooling are:

  - the risk profile is similar to Mode 1 (operation at power) with traditional LOCAs being less important and operator error and loss of SG cooling being more important,

  - risk is dominated by combinations of mechanical and electrical failures and, with the exception of loss of inventory events, with few human errors, and

  - the most important human error is failure to recover offsite power.

- Important results associated with Mode 5 are:

  - risk is dominated by combinations of mechanical and electrical failures and human errors, and

  - although there is no single human error which dominates the results, the most important human errors are: (1) failure to start standby equipment, (2) failure to recover offsite power, and (3) failure to isolate a loss of inventory.

- The primary risk contributor, when the plant is in Mode 4 on SG cooling, is the loss of feedwater (about 80 percent contribution to CDF).

- CCW and salt water cooling (SWC) (equivalent to service water at many plants) are vital for heat removal when SDC is used during Mode 4 or Mode 5 and hence their loss would impact the plant's ability to remove heat via SDC operation. This would increase the risk associated with Mode 4 on SDC and Mode 5. Therefore, Mode 4 on SG cooling must usually be entered when CCW/SWC are found to be unavailable.

Important insights from the investigation of the robustness of the results to uncertainties in data and modeling assumptions, through sensitivity studies, are listed below:

- The probabilistic risk assessment (PRA) model used by SONGS assumes that all LOCA, SLB, and SGTR frequencies are smaller in Mode 4 than at power by a factor of 20. A sensitivity study was performed with these frequencies decreased by a factor of 2 instead of 20. The result was an increase of about 20 percent in the Mode 4 (on SG cooling) CDF. This result does not impact the conclusions of the risk studies because the risk associated with Mode 4 on SG cooling is still lower than the risks associated with Mode 4 on SDC or Mode 5.

- The SONGS PRA model assumes that the LOOP frequency is higher in Modes 3, 4, and 5 than at power by a factor of 3.45. A sensitivity study was performed with the LOOP frequency increased by a factor of 10 instead of 3.45. The result was a net increase of about 15 percent in the Mode 4 (on SG cooling) CDF risk with respect to Mode 4 on SDC and Mode 5 risks. This result does not impact the conclusions of the risk studies because the risk associated with Mode 4 on SG cooling is still lower than the risks associated with Mode 4 on SDC or Mode 5.

- The SONGS PRA model assumes that the probability of not recovering offsite power in time to avoid core damage is higher at power than it is at shutdown by a factor of 3.7 (i.e., 0.1 at shutdown and 0.37 at power) to account for the extra time available at shutdown. A sensitivity study was performed with the LOOP non-recovery probability at shutdown doubled (0.2 instead of 0.1). The result was an increase in risk of less than 10 percent for any plant operational state. This result does not impact the conclusions of the risk studies because the risk associated with Mode 4 on SG cooling is still lower than the risks associated with Mode 4 on SDC or Mode 5.

- The robustness of the results, as they impact the conclusions of the risk assessment, is reinforced by conservative assumptions such as the results are based on initial plant conditions following shutdown and no credit was taken for using the TDAFW pump in Mode 4.[(8)]

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[8] A sensitivity study found that if credit is taken for a TDAFW pump, the CDF for Mode 4 on SG cooling would decrease by as much as 90%.

These insights indicate that the results of the quantitative risk assessment are robust and the conclusions of both the qualitative and quantitative risk assessments do not change when uncertainties in data and modeling assumptions are considered.

Important insights from the assessment of the applicability of the SONGS results to other CEOG plants, through sensitivity studies accounting for design and operational differences, are listed below:

- The PRA model used by SONGS assumes capability to "cross-tie" power sources between the two units. A sensitivity study assuming no such capability showed an increase of about 10 percent in the CDF for all modes. This result does not change the conclusions of the risk study.

- The PRA model used by SONGS assumes two MDAFW pumps. However, there is variability among CEOG plants regarding the number and type of pumps that can be used. A review of CEOG plants indicated that those plants with only one MDAFW pump have additional AFW capability beyond the TDAFW capability (e.g., diesel-driven pump, non-1E MDAFW pump or cross-tie to second unit). In addition, the TDAFW pump, while not credited in the base case analysis, is expected to be functional when the plant is above SDC entry conditions. For these reasons, this design difference does not change the conclusions of the SONGS risk study.

- The procedures used to depressurize the plant to SDC entry conditions, following loss of SG cooling in Mode 4, vary among plants. As a consequence of this variability, following a total loss of AFW event, some plants may enter SDC from higher pressures than others. All plants have means to depressurize the RCS to SDC entry conditions (e.g., PORVs, pressurizer spray water, atmospheric dump valves and steam bypass control system). These differences were found to have little impact on risk associated with Mode 4 on SG cooling and, therefore, do not change the conclusions of the SONGS study.

- The robustness of the results, as they impact the conclusions of the risk assessment, is reinforced by the existence of additional design and operational features at some CEOG plants which were not credited in the SONGS analysis. Examples are: (1) use of MDMFW pumps for SG cooling in Modes 3 and 4 (would decrease Mode 3 and 4 risks by about 10 percent); (2) feed-and-bleed capability (would decrease Mode 3 and 4 risks by about 10 percent); (3) greater dependency of CS pumps and LPSI pumps on support systems than at SONGS (would increase Mode 5 risk by as much as 20 percent).

These insights indicate that the results of the quantitative risk assessment are robust and that the conclusions of both the qualitative and quantitative risk assessments do not change when the impact of design and operational differences among CEOG plants is considered.

The quantitative risk assessment did not calculate or compare large early release frequency (LERF) for the shutdown operational states. However, qualitative arguments are provided to support the conclusion that the proposed TS end state changes will not significantly increase the plant LERF. (It may actually be decreased.) These arguments are summarized below:

- The likelihood of the major LERF contributors (i.e., energetic containment failure at high pressure, containment bypass, and containment isolation failure) resulting from Mode 4 operation is low as compared to at-power operation because of the lower RCS stored energy, reduced initial fission product inventory, and decay heat load.

- Energetic containment failures, which are the dominant LERF contributors next to bypass events at power operation, are less likely at shutdown due to the lower core decay heat, lower RCS stored energy, and lower RCS pressure.

- The contribution to LERF from containment bypass during operation in Mode 4 on SG cooling is less than at power. SGTR events are less likely than at power due to the smaller differential pressures across the SG tubes. Inter-system LOCA events, such as backflow from the RCS at high pressure into the LPSI system, are less likely due to the low initial RCS pressure.

- The contribution to LERF from loss of inventory outside of containment is more likely during Mode 4 on SDC and Mode 5 than Mode 4 on SG cooling operation provided no maintenance activities are in progress that could cause containment bypass.

- The contribution to LERF due to loss of containment is more likely in Mode 5 if containment integrity is not maintained.

The staff believes that the above listed insights substantiate the generic conclusions that (1) for plant conditions that do not compromise the effectiveness of the AFW system, plant operation in Mode 4 on SG cooling offers at least the same robustness to plant upsets as operation in Mode 4 on SDC or Mode 5, and (2) for plant conditions involving the AFW system, the ISTS already afford the proper end state considerations. In addition, for some plant conditions, plant operation in Mode 3 may offer similar robustness to plant upsets as operation in Mode 5. (See TS 3.1.9 [Section 5.1] regarding boration systems and TS 3.5.4 [Section 5.2] regarding the refueling water storage tank).

Finally, risk insights from both the qualitative and quantitative risk assessments were used in specific TS assessments. Such assessments are documented in Section 5.5 of the CEOG report. They provide an integrated discussion of deterministic and probabilistic issues, focusing on specific technical specifications, which are used to support the proposed TS end state and associated restrictions. The staff finds that the risk insights support the conclusions of the specific TS assessments.

4.5 Risk Assessment Conclusions

Our review finds that the CEOG's risk assessment approach is comprehensive and follows 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 need for some restrictions and enhanced guidance was determined by the specific TS assessments (documented in Section 5.5 and Table 5.5-1 of the CEOG report). These restrictions and guidance are intended to (1) preclude preventive maintenance and operational activities on risk significant equipment combinations, and (2) identify actions to exit expeditiously a risk-significant configuration should it occur. The licensees are expected to include these restrictions and guidance in appropriate plant procedures and administrative controls to preclude high risk plant configurations when the plant is at the proposed end states. The staff finds that the proposed restrictions and guidance are adequate 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 decisionmaking regarding the appropriate actions to control risk whenever a risk-informed TS is entered.

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

- The LTOP and SDC are not aligned when the plant operates in Mode 4 on SG cooling.

- Procedures require that both LTOP and SDC be invoked when the plant operates in Mode 4 on SDC and Mode 5.

- 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.

- The RCS remains at its nominal inventory and the RCS boundary strength is not compromised (e.g., via installation of nozzle dams).

These restrictions are consistent with typical entries into Mode 4 for short duration repairs, which is the intended use of the TS end state change. Such restrictions shall be implemented by (1) following existing procedures and administrative controls, and (2) configuration risk management as required by 10 CFR 50.65(a)(4).

5.0 ASSESSMENT OF EACH REQUESTED CHANGE[9]

In general, the CEOG retained the Improved Standard Technical Specifications (ISTS) timing philosophy in establishing required mode entry times. That is, an action taken from a Mode 1 condition should result in a Mode 3 entry within 6 hours and an action taken from a Mode 1

[9]When applicable, Section 5 descriptive material is copied from Reference 6.

condition should result in a Mode 4 entry within 12 hours. These replace the previous 36 hour time to enter Mode 5 following an action taken from a Mode 1 condition.

The requested TS changes are reviewed below in the order they are discussed in Reference 6.

5.1 TS 3.1.9 (SONGS) - Boration Systems - Operating

Boration systems are provided to control reactivity and to ensure sufficient shutdown margin to bring the plant to Mode 5 with the worst control element assembly stuck out without credit for xenon.

Plant Applicability: Arkansas Nuclear One, Unit 2 (ANO-2), Millstone 2, SONGS 2 and 3, St. Lucie 1 and 2, and Waterford 3

LCO: Two RCS boron injection flow paths shall be operable in Modes 1, 2, 3, and 4, with the contents of the boric acid makeup (BAMU) tanks in accordance with the LCO. Two boration paths that are to remain available are: (1) the refueling water storage tank (RWST) and its feed to the charging pumps, and (2) one or both BAMU tanks with their respective feed paths to the charging pumps.

Condition Requiring Entry into End State: If a boration path is unavailable for more than 72 hours, then the plant must proceed to Mode 3. If the path cannot be restored within the next 7 days, then the plant must proceed to Mode 5.

Proposed Modification for End State Required Actions: Modify action statement to allow Mode 3 or Mode 4[10] operation during the time one train of the boration system is inoperable.

Assessment: Reference 6 states that the risk importance of the boration system is low during shutdown operation and, from a shutdown margin perspective assuming a specific boron concentration, Mode 3 will usually have a greater shutdown margin than Mode 4, and either mode would have greater shutdown margin than Mode 5. If boration was required, then Mode 3 would place less importance on boration capability than Mode 4, etc. Overall, however, the staff anticipates the required boration will have been achieved via the remaining boration path and there is little difference between the end modes.

Finding: The requested change, modified to allow operation in Mode 4 as identified above, is acceptable.

5.2 TS 3.5.4 - Refueling Water Storage Tank

The RWST is a source of borated water for the ECCS.

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[10]Reference 6 specified a Mode 3 end state for both TS 3.1.9 and 3.5.4, but did not identify a Mode 4 end state. Yet the applicability is Modes 1, 2, 3, and 4. Thus, if one were operating in Mode 4, the original wording might imply an inappropriate return to Mode 3. Mode 4 was added to avoid a perceived requirement to move from Mode 4 to Mode 3.

Plant Applicability: All

LCO: The RWST shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: When the RWST is inoperable in Modes 1, 2, 3, and 4 due to boron concentration not being within limits and not corrected within 8 hours.

Proposed Modification for End State Required Actions: Modify Bases* to allow for Mode 3 or Mode 4[10] end state when boron concentration is outside of the operating band for a period greater than 8 hours and create a new action (e.g., 3.5.4 D.2) to maintain the current end state for other inoperabilities. *CEOG requested modification to the Bases. This is actually a request for a modification of the action statement and not a modification of the TS Bases.

Assessment: The requested change appears unlikely to have a significant impact on safety because deviations are likely to be small. Most of the need for a large volume of water from the RWST in Mode 3 is due to low likelihood events such as LOCA, and avoiding equipment transitions associated with some mode changes avoids risk associated with those changes.

Finding: The requested change is acceptable.

5.3 TS 3.3.5 (SONGS) - Engineered Safety Feature Actuation System Instrumentation - Recirculation Actuation Signal

The engineered safety feature actuation system (ESFAS) provides an automatic actuation of the engineered safety features (ESFs) which are required for accident mitigation. The recirculation actuation signal (RAS) initiates automatic actions to open and close valves for commencement of recirculation from the containment emergency sump.

Plant Applicability: ANO-2, SONGS 2 and 3, and Waterford 3

LCO: Four ESFAS trip and bypass removal channels for each function in TS Table 3.3.5-1 shall be operable in modes specified in that Table.

Condition Requiring Entry into End State: The required actions of the TS are entered upon:

1. Failure to place an inoperable RAS channel in trip or bypass within 1 hour, or

2. Failure to restore an inoperable channel to operable prior to entering Mode 2 following the next Mode 5 entry.

Proposed Modification for End State Required Actions: Allow the plant to remain in Mode 4 until the inoperable RAS channel is restored to service. Mode 4 entry is required in 12 hours.

Assessment: RAS is implemented prior to depletion of water in the RWST by aligning the containment emergency sump to recirculate water from the containment. RAS is particularly important for a LOCA occurring during Mode 1, when typically two high pressure safety injection (HPSI), two LPSI, and two CS pumps are used to send water into the reactor vessel and into

containment. Under these conditions, RAS will actuate in about 20 minutes. In Mode 4, water injection rates into the containment are likely to be reduced and RAS will be delayed.

Mode 4 ensures that RCS temperature is less than 350° F and it provides a resource-rich environment for continued RCS heat removal. While not specifically required, low temperature operation is often associated with low pressure operation. As a result, loss of cooling or loss of inventory events are characterized by lower initial fuel temperatures and, because of the time that has elapsed since power operation, there is a lower decay heat generation rate. These characteristics enhance both a reduced likelihood of events and the ability to respond to events should they occur.

Several TSs relating to actuation signal generation currently require that upon the inability to restore the affected signal within the allotted outage time, the plant must transition to Mode 5.

Most of the ESFAS functions are required to be operable only in Modes 1 through 3. The end state for these functions is therefore Mode 4, which is acceptable. In the SONGS TS, the RAS is required to be operable in Mode 4 as well, so the current end state for this ESFAS function is Mode 5. The recommendation to remove Mode 4 applicability reflects the understanding that RAS is less likely in Mode 4 and that instrumentation is available to alert the operator for manual switchover of safety injection from the injection to the recirculation mode with ample time available to accomplish the switchover.

Finding: The requested change is acceptable.

5.4 TS 3.3.6 (SONGS) - ESFAS Logic and Manual Trip - (Digital)

As previously stated, ESFAS provides an automatic actuation of the ESFs which are required for accident mitigation. A set of two manual trip circuits is also provided, which uses the actuation logic and initiation logic circuits to perform the trip function.

Plant Applicability: All CEOG Member PWRs except Palisades

LCO: Six channels of ESFAS matrix logic, four channels of ESFAS initiation logic, two channels of actuation logic and two channels of manual trip shall be operable for the safety injection actuation signal (SIAS), containment isolation actuation signal (CIAS), containment cooling actuation signal (CCAS), RAS, containment spray actuation signal (CSAS), main steam isolation signal, and emergency feedwater actuation system EFAS-1 and EFAS-2. The LCO is applicable in Modes 1, 2, and 3 for all functions for all components and in Mode 4 for initiation logic, actuation logic, and manual trip for SIAS, CIAS, CCAS, and RAS. (The specific applicability of CCAS or equivalent systems (e.g., CSAS) may vary among utilities.)

Condition Requiring Entry into End State: Condition F of the TS is entered when:

1. One manual trip circuit, initiating logic circuit, or actuation logic circuit is inoperable for RAS, SIAS, CIAS, or CCAS, for more than 48 hours (Conditions A, B & D), or,

2. Two initiating logic circuits in the same trip leg for RAS, SIAS, CIAS, or CCAS are inoperable for more than 48 hours (Condition C).

Proposed Modification for End State Required Actions: Modify the Mode 5 end state required action to allow component repair in Mode 4 of all functions of the CCAS and RAS initiation/logic function of the SIAS and CIAS. Entry into Mode 4 is proposed at 12 hours. No change was requested for TS 3.5.3, ECCS-shutdown.

Assessment: The primary objective of the ESFAS logic and manual trip in Mode 4 is to provide a SIAS to the operable HPSI train and CIAS to ensure containment isolation. For TS 3.5.3, ECCS–Shutdown, to be met, the manual trip and actuation logic associated with that train of HPSI must be available in Mode 4. No other Mode 4 restrictions are required. By including the actuation logic in Mode 4, the effort in establishing HPSI following a LOCA or other inventory loss event is minimized. Similarly, by requiring one CIAS manual trip and actuation relay group to be operable, the plant operating staff does not have to operate every containment penetration manually following an event that may lead to radiation releases to the containment.

In general, the CCAS is used to automatically actuate the containment heat removal systems (containment recirculation fan coolers) to prevent containment overpressurization during a range of accidents which release inventory to the containment, including large break LOCAs, small break LOCAs, or main steam line breaks or feedwater line breaks inside containment. This signal is typically actuated by high containment pressure. The CEOG states that, based on the lower stored energy in the RCS and lesser core heat generation, short term containment pressure following a LOCA or main steam line break would be less than the current design containment strength. Ample instrumentation is available to the operator to diagnose the onset of the event and to take appropriate mitigating actions (actuation of the containment fan coolers and/or sprays) prior to a potential containment threat.

Following a LOCA, the RAS is used to automatically perform the switchover from the SI mode of heat removal to the sump recirculation mode of heat removal. RAS times in Mode 4 are expected to be longer than those associated with Mode 1 and available instrumentation is sufficient to alert the operator to the need for switchover.

Since the SIAS and CIAS signals perform numerous actions, manual trip and actuation for these signals should be retained in Mode 4. In particular, the operability of a single train of HPSI is required in Mode 4. Therefore, the associated actuation circuit and manual trip circuit for SIAS should be maintained available so that automatic lineup of HPSI can be established following a LOCA. Both isolation valves in the appropriate containment penetrations are required to be operable during Mode 4. However, the large number of actions required to isolate these penetrations, given an event, indicates that an extended unavailability of CIAS is not desired. We conclude from a comparison of plant conditions, event response, and risk characteristics, including the discussions of Sections 3 and 4, that there is no net benefit from requiring a Mode 5 end state as opposed to a Mode 4 end state.

Finding: The requested change is acceptable.

5.5 TS 3.3.8 - (Digital) Containment Purge Isolation Signal

The containment purge isolation signal (CPIS) provides automatic or manual isolation of any open containment purge valves upon indication of high containment airborne radiation.

Plant Applicability: SONGS 2 and 3

LCO: Two CPIS channels shall be operable in Modes 1, 2, 3, and 4, during core alterations, and during movement of irradiated assemblies within containment.

Condition Requiring Entry into End State: CPIS [manual trip actuation logic], or one or more required channels of radiation monitors is inoperable and the required actions associated with the TS AOT or completion time (CT) have not been met.

Proposed Modification for End State Required Actions: Modify Mode 5 end state required action to allow component repair in Mode 4. Entry time into Mode 4 is proposed at 12 hours.

Assessment: TS for Modes 1 through 4 allow plant operation with the containment mini-purge valves open. Following an accident, unavailability of the CPIS in Mode 4 would prevent automatic containment purge isolation. Without automatic isolation, the operator must manually isolate the containment purge. The CEOG states that, since Mode 4 core damage events will evolve more slowly than similar events at Mode 1, the operator has adequate time and plant indications to identify and respond to an emergent core damage event and secure the containment purge. The staff generally agrees.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4, above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

The CEOG recommended that, when the CPIS is disabled, the operating staff should be alerted and operation of the containment mini-purge should be restricted. It further recommended consideration should be given to maintain availability of CIAS during the CPIS Mode 4 repair. The staff endorses these recommendations and licensees must commit to incorporate them into operating documentation.

Finding: The requested change is acceptable.

5.6 TS 3.3.9 - (Digital) Control Room Isolation Signal

The control room isolation signal (CRIS) initiates actuation of the emergency radiation protection system and terminates the normal supply of outside air to the control room to minimize operator radiation exposure.

Plant Applicability: Calvert Cliffs 1 and 2, Palo Verde Nuclear Generating Station (PVNGS) 1, 2 and 3, and Waterford 3

LCO: One channel of CRIS shall be operable. The channel consists of manual trip, actuation logic, and radiation monitors for iodine/particulates and gases.

Condition Requiring Entry into End State: Both channels of CRIS are inoperable [and one control room emergency air cleanup system train is not realigned to the emergency mode within one hour]. A channel consists of actuation logic, manual trip, and particulate/iodine and gaseous radiation monitors.

Proposed Modification for End State Required Actions: It is proposed that the existing TS be modified to change the Mode 5 end state required action to allow component repair in Mode 4. Entry time into Mode 4 is 12 hours.

Assessment: The CRIS includes two independent, redundant subsystems, including actuation trains. Control room isolation also occurs on a SIAS. The CRIS functions must be operable in Modes 1, 2, 3, and 4 [5, 6], [during core alterations], and during movement of irradiated fuel assemblies to ensure a habitable environment for the control room operators.

The CEOG claims that this system responds to radiation releases from fuel, that adequate in-plant radiation sensors (for example, containment high area radiation monitors, [CHARMs]) are available to identify the need for control room (CR) isolation or shield building filtration (if appropriate), and that in Mode 4, the transient will unfold more slowly than at power. It therefore concludes that sufficient time exists for the operator to take manual action to realign the control room emergency air cleanup system (CREACUS). The staff generally agrees.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

The CEOG states that it would be prudent to minimize unavailability of SIAS and alternate shutdown panel and/or remote shutdown capabilities during Mode 4 operation with CRIS unavailable. The staff agrees. Licensees must commit to incorporate suitable guidance into their operational documentation to accomplish this.

Finding: The requested change is acceptable.

5.7 TS 3.3.9 - (Analog) Chemical Volume Control Isolation Signal

The chemical volume control system (CVCS) isolation signal provides protection from radioactive contamination, as well as personnel and equipment protection in the event of a letdown line rupture outside containment.

Plant Applicability: Calvert Cliffs 1 and 2

LCO: Four channels of west penetration room/letdown heat exchanger room pressure sensing and two actuation logic channels shall be operable.

Condition Requiring Entry into End State: The Mode 5 end state entry (Condition D) is required when:

1. One actuation logic channel is inoperable, or

2. One CVCS isolation instrument channel is inoperable for a time period in excess of the plant AOT/CT (48 hours).

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state when the required actions are not completed in the specified time.

Assessment: Transition to lower temperature states requires the CVCS. Thus, by the time the plant is placed in Mode 4, the system should have successfully operated to borate the RCS. The CEOG stated that, consequently, there is adequate time to identify the need for CVCS isolation and for the operator to terminate letdown and secure charging.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

5.8 TS 3.3.10 (Analog) - Shield Building Filtration Actuation Signal

The shield building filtration actuation signal (SBFAS) is required to ensure filtration of the air space between the containment and shield building during a LOCA.

Plant Applicability: Millstone 2

LCO: Two channels of SBFAS automatic and two channels of manual trip shall be operable.

Condition Requiring Entry into End State: Shutdown condition B of TS 3.3.10 requires transition to Mode 5. This required action is to be taken when one Manual Trip or Actuation Logic channel is inoperable for a time period exceeding the TS AOT/CT (48 hours).

Proposed Modification for End State Required Actions: Modify Mode 5 end state required action to allow component repair in Mode 4.

Assessment: The CEOG states that with one SBFAS channel inoperable, the system may still provide its function via its redundant channel. These systems provide post-accident radiation protection to on-site staff and/or the public. Since these systems respond to radiation releases from fuel, adequate in-plant radiation sensors (CHARMs) are available to identify the need for CR isolation or shield building filtration (if appropriate).

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further,

there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

5.9 TS 3.4.6 - RCS Loops – Mode 4

An RCS loop consists of a hot leg, SG, crossover pipe between the SG and an RCP, the RCP, and a cold leg. The operational meaning with respect to this TS is that water flows from the reactor vessel into a hot leg, either into a SG or a SDC system where it is cooled, and is returned to the reactor vessel via one or more cold legs. The flow rate must be sufficient to both cool the core and to ensure good boron mixing.

Plant Applicability: All

LCO: Two loops or trains consisting of any combination of RCS loops and SDC trains shall be operable and at least one loop or train shall be in operation while in Mode 4.

Condition Requiring Entry into End State: Condition B of the TS requires that with one required SDC train inoperable and two required RCS loops inoperable for 24 hours, the plant be maneuvered into Mode 5. The short completion time and the low temperature end state reflect the importance of maintaining these paths for heat removal.

Proposed Modification for End State Required Actions: When RCS loops are unavailable due to inoperability of one train of SDC, and at least one SG heat removal path can be established, modify the TS to change the end state from Mode 5 to Mode 4 with RCS heat removal accomplished via the steam generators.

Assessment: This TS requires that two loops or trains consisting of any combination of RCS cooling loops or SDC trains shall be operable and at least one loop or train shall be in operation to provide forced flow in the RCS for decay heat removal and to mix boron. LCO action 3.4.6 A addresses the condition when the two SDC trains are inoperable. In that condition, the ISTS recognizes that Mode 5 SDC operation is not possible and continued Mode 4 operation is allowed until the condition may be exited. Condition B is concerned with the unavailability of forced circulation in two RCS loops and the inoperability of one train of SDC. Upon failure to satisfy the LCO, the current ISTS drives the plant to Mode 5.

The requested change for Condition B reflects the risk of Mode 5 operation with one SDC system train inoperable and two RCS loops inoperable. The change will allow heat removal to be achieved in Mode 4 using either SDC or, if available, the steam generators with RCS/core heat removal driven by natural convection flows. The CEOG states that reactivity concerns are addressed by requiring natural circulation prior to RCP restart. Furthermore, as already noted in the ISTS Bases, if unavailability of RCS loops is due to single SDC train unavailability, staying in a state with minimal reliance on SDC is preferred (Mode 4) due to the diversity in RCS heat removal modes during Mode 4 operation. The staff agrees.

Finding: The requested change is acceptable.

5.10 TS 3.6.1 - Containment

The containment building is one of the three primary boundaries to the release of radioactive material. (The other two are the fuel cladding and the RCS pressure boundary.)

Plant Applicability: All

LCO: Containment shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: Containment is declared to be inoperable due to excessive leakage (including leakage from airlocks and isolation valves) for a time period greater than one hour.

Proposed Modification for End State Required Actions: Modify TS to allow Mode 4 to become a designated end state for correcting containment impairments for conditions where the containment leakage is excessive due to reasons other than the inoperability of two or more containment isolation valves (CIVs) in the same flow path.

Assessment: Containment systems TSs are primarily focused on ensuring containment integrity and limiting offsite exposures due to events leading to core damage. The requirements stated in the LCO define the performance of the containment as a fission product barrier. Specifically, LCO 3.6.1 requires that the containment allowable leakage rate be limited in accordance with 10 CFR Part 50 Appendix J. Other LCOs place restrictions on containment air locks and containment isolation valves. The integrated effect of these TSs is to ensure that containment leakage is controlled within limits. Inability to meet this leakage limit renders the containment inoperable.

Inoperability of the containment during Mode 4 has been traditionally based on the restrictions associated with Mode 1 operation. That is, leakage rates in excess of permissible values would require plant transition to Mode 5. The proposed change addresses inoperability of the containment during Mode 4 due to leakage rates in excess of permissible values, with the qualification that the containment is still functional under conditions anticipated to be credible during Mode 4 operation. Since the applicability of this change is limited to isolable penetrations that are partially functional and penetrations not included within TS 3.6.2 and 3.6.3, only small changes in containment integrity are considered.

Limitation on total containment leakage is still required. This is accomplished in this proposed change by limiting applicability of the TS to conditions where CIVs or air locks are essentially functional (although they may be inoperable) and have the capability to perform their containment function. Conditions where containment capability cannot be met will continue to result in a Mode 5 end state. This division is based on consideration of defense-in-depth. Temporary operation of the plant in Mode 4 (as opposed to Mode 5) with an “impaired” containment is not a risk significant action. Entrance into this TS is not intended to suggest the acceptability of long term gross containment leakages.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk

benefits are realized by averting the risks associated with the alignment of the SDC system. In this case, those benefits are obtained with essentially little realistic degradation in containment capability.

Finding: The requested change is acceptable.

5.11 TS 3.6.2 - Containment Air Locks

Containment air locks provide a controlled personnel passage between outside and inside the containment building with two doors/door-seals in series with a small compartment between the doors. When operable, only one door can be opened at a time, thus providing a continuous containment building pressure boundary. The two doors provide redundant closures.

Plant Applicability: All

LCO: [Two] containment air lock[s] shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: Entry into a Mode 5 end state is required when:

1. One or more containment air locks with one containment air lock door inoperable or,

2. One or more containment air locks with containment air lock interlock mechanism inoperable, or

3. One or more containment air locks inoperable for other reasons, and

4. The required action not completed within the specified AOT/CT.

Proposed Modification for End State Required Actions: Modify TS to accommodate Mode 4 end state within the Condition D required Action. Mode 4 entry is proposed within 12 hours of expiration of the specified AOT for the conditions that require entry into Mode 4.

Assessment: The TS requirements apply to Modes 1, 2, 3, and 4. Containment air locks are not required in Mode 5. The requirements for the containment air locks during Mode 6 are addressed in LCO 3.9.3, "Containment Penetrations."

Operability of the containment air locks is defined to ensure that leakage rates (defined in TS 3.6.1) will not exceed permissible values. These TSs are entered when containment leakage is within limits, however, some portion of the containment isolation function is impaired. The issue of concern is the appropriate action/end state for extended repair of an inoperable air lock where air lock doors are not functional. Changes to the TS are only requested for conditions when containment leakage is not expected to exceed that allowed in TS 3.6.1. This means that the containment air locks are still functional under conditions anticipated to be credible during Mode 4 operation.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further,

there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

5.12 TS 3.6.3 - Containment Isolation Valves

For systems that communicate with the containment atmosphere, two redundant isolation valves are provided for each line that penetrates containment. For systems that do not communicate with the containment atmosphere, at least one isolation valve is provided for each line.

Plant Applicability: All

LCO: Each containment isolation valve shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: A required action to maneuver the plant into Mode 5 will occur when one or more penetration flow paths exist with one or more containment isolation valves inoperable [except for purge valve leakage and shield building bypass leakage not within limit] and the affected penetration flow path cannot be isolated within the prescribed AOT/CT.

Proposed Modification for End State Required Actions: Modify SONGS TS (and their equivalents) to accommodate a Mode 4 end state for any penetration having one CIV inoperable.

Assessment: Operability of the containment isolation valves ensures that leakage rates will not exceed permissible values. This LCO is entered when containment leakage is within limits but some portion of the containment isolation function is impaired (e.g., one valve in a two valve path inoperable or containment purge valves have leakage in excess of TS limits). The issue of concern in this TS is the appropriate action/end state for extended repair of an inoperable CIV when one CIV in a single line is inoperable.

The assessment discussed in Section 5.11 above, is applicable here.

Finding: The requested change is acceptable.

5.13 TS 3.6.4 - Containment Pressure

Plant Applicability: All

LCO: Containment pressure shall be controlled within limits during Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: A Mode 5 end state is required to be initiated (Condition B) when the containment pressure is not within limits and the condition is not corrected within one hour.

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state when the required actions are not completed in the specified time. Mode 4 entry is proposed at 12 hours.

Assessment: The upper limit on containment pressure in this LCO results from a containment designed to respond to Mode 1 design basis accidents while remaining well within the structural material elastic response capabilities. This effectively maintains the containment design pressure about a factor of two or more below the minimum containment failure pressure. Consequently, small containment pressure challenges at the design basis pressure have a negligible potential of threatening containment integrity.

The vacuum lower limit on containment pressure is typically set by the plant design basis and ensures the ability of the containment to withstand an inadvertent actuation of the CS system. The lower limit is of particular concern to plants with steel shell containment designs – plants with steel containment control the impact of CS actuation via use of vacuum breakers. Therefore, for plants with steel shell containments, if the lower limit pressure specification is violated, the operators are to confirm operability of the vacuum breakers. For all plants, when entering this action statement for violation of low containment pressure limit for a period projected to exceed one day, one containment spray pump is to be secured.

Aspects of the assessment discussed in Section 5.11 above, are applicable here and will not be repeated.

Finding: The requested change is acceptable.

5.14 TS 3.6.5 - Containment Air Temperature

Plant Applicability: All

LCO: Containment average air temperature shall be ≤ 120°F in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: Condition B of this TS requires a Mode 5 shutdown when containment temperature is not within limits and is not corrected within the specified AOT/CT.

Proposed Modification for End State Required Actions: Modify condition B of TS to accommodate a Mode 4 end state with a 12 hour entry time.

Assessment: The upper limit on containment temperature is based on Mode 1 design basis analyses for containment structures and equipment qualification. As discussed previously, the Mode 4 energy release is less than the maximum that could occur in Mode 1 and, consequently, initial Mode 4 post-accident containment temperature will be below the containment temperature limit employed in the plant design basis. Thus, temporary operation outside the bounds of the LCO would not be expected to challenge containment integrity.

Aspects of the assessment discussed in Section 5.11 above, are also applicable here and will not be repeated.

Finding: The requested change is acceptable.

5.15 TS 3.6.6 - Containment Cooling Systems

The containment building is typically provided with containment spray and containment cooling trains to control containment conditions following accidents that cause containment pressure or temperature upsets.

Plant Applicability: ANO 2, Calvert Cliffs 1 and 2, Ft. Calhoun, SONGS 2 and 3, and Waterford 3

LCO: Two CS trains and two containment cooling trains shall be operable in Modes 1, 2, [and] [3 and 4]. The time required for Mode 5 entry varies from 30 to 36 hours for one component of the containment cooling system out of service. For SONGS Units 2 and 3, unavailability of one or more CS train(s) will require the plant to transition to Mode 4 in 84 hours.

Condition Requiring Entry into End State: Condition C requires Mode 5 entry when the affected train is not returned to service within the TS AOT/CT. For SONGS 2 and 3 only, conditions 3.6.6.1 B and 3.6.6.1 F require Mode 4 entry within 84 hours.

Proposed Modification for End State Required Actions: Modify condition B and F of TS to accommodate a Mode 4 end state. Entry time requirements are as follows:

Inoperability	**Required Actions**
CS one train	Mode 4 – 84 hrs
Cont. Coolers two trains	Mode 4 – 36 hrs

Assessment: Containment cooling is required to ensure long term containment integrity. Containment cooling TSs include LCO 3.6.6. - containment spray and cooling systems, LCO 3.6.6A - credit taken for iodine removal by containment spray, and LCO 3.6.6B - credit not taken for iodine removal by containment spray.

The design basis of the CS and cooling systems varies among the CEOG units. Most CEOG plants credit the CS and cooling systems for containment pressure and temperature control and one of the two systems for radioiodine removal. In these plants, typically, one train of CS is sufficient to effect radioiodine control and one train of CS and one train of fan coolers is sufficient to effect containment pressure and temperature control. The Palo Verde units are designed with only the CS system (containing full capacity redundant CS pumps) which it credits for both functions.

Design and operational limits (and consequently the TSs) are established based on Mode 1 analyses. Traditionally, these analyses and limits are applied to Modes 2, 3, and 4. Mode 1 analyses bound the other modes and confirm the adequacy of the containment cooling system to control containment pressure and temperature following limiting containment pipe breaks occurring at any mode. However, the resulting TS requirements generally become increasingly conservative as the lower temperature shutdown modes are traversed. Plants that do not

require containment cooling in Mode 4 include St. Lucie Units 1 and 2 and Palo Verde Units 1, 2 and 3. SONGS Units 2 and 3, ANO 2, and St. Lucie Units 1 and 2 do not require sprays to be operable in Mode 4.

Inability to complete the repair of a single train of cooling equipment in the allotted AOT presently requires transition to Mode 5. This end state transition was based on the expectation of low Mode 5 risks when compared to alternate operating states. As previously discussed in Sections 3 and 4 above, Mode 4 is a robust operating mode when compared to Mode 5. Furthermore, when considering potential Mode 4 containment challenge, the low stored energy and decay heat of the RCS support the proposed use of the containment cooling and radionuclide removal capability. Based on representative plant analyses performed in support of PRA containment success criteria, containment protection may be established via use of a single fan cooler. Qualitatively, a similar conclusion could be drawn for one train of CS. Consequently, in Mode 4, one train of containment coolers or one train of CS should provide adequate heat removal capability. Furthermore, for plants that credit CS for iodine removal, accidents initiated in Mode 4 may be adequately mitigated via one operable spray pump. Therefore, 84 hours requested to transition to Mode 4 with one CS train inoperable allows additional time to restore the inoperable CS train and is reasonable when considering the relatively low driving force for a release of radioactive material from the RCS. Further, the CEOG states that the requested 36 hours to transition to Mode 4 with both trains of containment cooling inoperable is reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems. It also recognizes that at least one train of CS is available as a backup system.

Finding: The requested change is acceptable.

5.16 TS 3.6.11 - Shield Building

The shield building is a concrete structure that surrounds the primary containment in some PWRs. Between the primary containment and the shield building inner wall is an annular space that collects containment leakage that may occur following an accident. Following a LOCA, the shield building exhaust air cleanup system 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.

Plant Applicability: Millstone 2, St. Lucie 1 and 2, and Waterford 3

LCO: Shield building operability must be restored within 24 hours. If the shield building cannot be restored to operable status within the required completion time, the plant must be brought to Mode 5 within 36 hours.

Condition Requiring Entry into End State: A Mode 5 end state is required to be initiated when the shield building is inoperable for more than 24 hours.

Proposed Modification for End State Required Actions: Modify Mode 5 end state required action to allow component repair in Mode 4 with a 12 hour Mode 4 entry requirement.

Assessment: The CEOG stated that the LCO considers the limited leakage design of the containment and the probability of an accident occurring during the transition from Mode 1 to Mode 5. The purpose of maintaining shield building operability is to ensure that the release of radioactive material from the primary containment atmosphere is restricted to those leakage paths and associated leakage rates assumed in the accident analysis.

Shield building "leakage" at or near containment design basis levels is not explicitly modeled in the PRA. The PRA implicitly assumes that containment gross integrity must be available. In the Level 2 model, containment leakage is not considered to contribute to large early release even without a shield building. Were accidents to occur in Mode 4, resulting initial containment pressures would be less than the design basis analysis conditions and the shield building would be available to further limit releases. When Condition A of this TS can no longer be met, the plant must be shut down and transitioned to Mode 5.

Inoperability of the shield building during Mode 4 implies leakage rates in excess of permissible values. Containment conditions following a LOCA in Mode 4 may result in containment pressures somewhat higher than in Mode 5, but since containment leakage is controlled via TS 3.6.1, and no major leak paths should be unisolable, there should be no contribution to an increased LERF.

The requirements stated in the LCO define the performance of the shield building as a fission product barrier. In addition, this TS places restrictions on containment air locks and containment isolation valves. The integrated effect of these TSs is intended to ensure that containment leakage is controlled to meet 10 CFR Part 100 limits following a maximum hypothetical event initiated from full power.

As previously discussed, accidents initiated from Mode 4 are initially less challenging to the containment than those initiating from Mode 1. Furthermore, by having the plant in a shutdown condition in advance, fission product releases should be reduced. Thus, while leakage restrictions should be maintained in Mode 4, a condition in excess of that allowed in Mode 1 is anticipated to meet overall release requirements and should be allowed to effect repair of the leak and return the plant to power operation.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDCS.

Finding: The requested change is acceptable.

5.17 TS 3.7.5 - Auxiliary Feedwater System

By letter dated July 3, 2001, the CEOG deleted the proposed change to TS 3.7.5. The CEOG stated, "ISTS [improved standard technical specifications] already affords the proper end state considerations or conditions when one or more AFW pumps are inoperable. Therefore, no change is requested for this technical specification."

Finding: The staff agrees that the proper end state is addressed in standard technical specifications.

5.18 TS 3.7.7 - Component Cooling Water System[11]

The CCW system provides cooling to critical components in the RCS and also provides heat removal capability for various plant safety systems, both at power and on SDC.

Plant Applicability: All CEOG Member PWRs except ANO 2.

LCO: Two CCW trains shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: One CCW train inoperable and not returned to service in TS AOT/CT.

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state with a 12 hour entry requirement.

Assessment: The appropriate actions to be taken in the event of inoperabilities of the CCW system depend on the particular system function being compromised and the existence of backup water supplies.

In the event of a design basis accident, one train of CCW is required to provide the minimum heat removal capability assumed in the safety analysis for systems to which it supplies cooling water. The CCW system provides heat removal capability to the containment fan coolers, CS, and SDC. In addition, CCW provides cooling to the reactor coolant pumps. Other safety components may be cooled via CCW component flow paths. From an end state perspective, upon loss of part of the CCW, the plant should normally transition to a state where reliance on the CCW system is least significant. For San Onofre Units 2 and 3, loss of one CCW train will degrade the plant's capability to remove heat via the affected SDC heat exchanger. Thus, once on SDC, an unrecovered failure of the second CCW train means no SDC system will remove decay heat and alternate methods, such as returning to SG cooling, must be used to prevent core damage. Provided component cooling is available to the RCPs, a Mode 4 end state with the RCS on SG heat removal is usually preferred to the Mode 5 end state on SDC heat removal, in part for this reason. (As discussed above, the risk of plant operation in Mode 4 on SG cooling may be less than for Mode 5 because the transient risks associated with valve misalignments and malfunctions may be averted by avoiding SDC entry.)

For conditions where CCW flow is lost to the RCP seals, reactor shutdown is required and the RCS loops operating TS is entered. Limited duration natural circulation operation is acceptable, but extended plant operation in the higher Mode 4 temperatures may degrade RCP seal elastomers. Mode 5 operation ensures adequately low RCS temperatures so that RCP seal challenges would be avoided. Prior to entry into Mode 5 due to loss of CCW to RCP seals, the redundant CCW train should be confirmed to be operable and backup cooling water systems

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[11]Terminology for cooling water systems vary between the CEOG plants.

should be confirmed for emergency use. SG inventory should be retained to assure a diverse and redundant heat removal source if CCW should fail.

Finding: The requested change is acceptable.

5.19 TS 3.7.8 - Service Water System/Salt Water Cooling System/Essential Spray Pond System/Auxiliary Component Cooling Water[12]

This TS covers systems that provide a heat sink for the removal of process heat and operating heat from the safety-related components during a transient or design basis accident. This discussion is based on the SONGS 2 and 3 designation of the SWC system.

Plant Applicability: All

LCO: Two SWC trains shall be operable in Modes 1, 2, 3, and 4 (SONGS 2 and 3).

Condition Requiring Entry into End State: One SWC train inoperable and not restored to operability in TS AOT/CT.

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state with a 12 hour entry requirement on steam generator heat removal.

Assessment: The primary function of the SWC system is to remove heat from the CCW system. In this manner the SWC system also supports the SDC system. In some plants the SWC system or its equivalent provides emergency makeup to the CCW system and may also provide backup supply to the AFWS. For many plants, including San Onofre Units 2 and 3, loss of one SWC system train will degrade the plant's capability to remove heat via the affected SDC heat exchanger. In this case, a Mode 4 end state with the RCS on SG heat removal is preferred to Mode 5 with the RCS on SDC heat removal.

At least one SWC train must be operable to remove decay heat loads following a design basis accident. SWC is also used to provide heat removal during normal operating and shutdown conditions. Two 100 percent trains of SWC are provided, which provides adequate SWC flow assuming the worst single failure.

SWC is required to support SDC when the plant is in Mode 4 on SDC or in Mode 5. Therefore, in conditions in which the other SWC train is inoperable, the one operable SWC train must continue to function. The staff notes much of the CCW discussion in Section 5.18, above, is also applicable here since long-term loss of SWC is, in effect, loss of CCW.

Operation in Mode 4 with the steam generators available provides a decay heat removal path that is not directly dependent on SWC, although there are some long-term concerns such as RCP seal cooling. Overall, the proposed Mode 4 TS end state generally results in plant conditions where reliance on the SWC system is least significant.

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[12]Terminology for cooling water systems vary between the CEOG plants.

Finding: The requested change is acceptable.

5.20 TS 3.7.9 - Ultimate Heat Sink[13]

The ultimate heat sink (UHS) system provides a heat sink for the removal of process and operating heat from the safety-related components during a transient or design basis accident. In some plants the UHS system provides emergency makeup to the CCW system and may also provide backup supply to the AFW system. For many plants, loss of one UHS system train such as would occur with the loss of a cooling fan tower, will degrade the plant's capability to remove heat via the affected SDC heat exchanger.

Plant Applicability: All CEOG designed PWRs with cooling towers.

LCO: The UHS shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: One cooling tower inoperable and not restored to operability in TS AOT/CT.

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state with a 12 hour entry requirement.

Assessment: In Modes 1, 2, 3, and 4, the UHS system is a normally operating system which is required to support the OPERABILITY of the equipment serviced by the SWS and required to be operable in these modes. In Mode 5, the OPERABILITY requirements of the UHS are determined by the systems it supports.

When the plant is in Mode 5, UHS is required to support shutdown cooling and the one operable cooling tower (in conditions in which the other train is inoperable) must continue to function. Operation in Mode 4 with the steam generators available provides a decay heat removal path that is not dependent on UHS.

The proposed Mode 4 TS end state results in plant conditions where the direct reliance on the UHS system is the least significant. The rationale applicable to Section 5.19 above, applies to this section as well. Further, we note we addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions.

Finding: The requested change is acceptable.

5.21 TS 3.7.10 - Emergency Chilled Water System

The emergency chilled water (ECW) system provides a heat sink for the removal of process and operating heat from selected safety-related air-handling systems during a transient or accident.

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[13]Calvert Cliffs designates the system as the salt water system; SWC performs the function of the ultimate heat sink at SONGS Units 2 and 3.

Plant Applicability: PVNGS 1, 2, and 3, SONGS 1 and 2, and Waterford 3

LCO: Two ECW trains shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: Mode 5 entry is required when one ECW train is inoperable and not returned to service in the TS AOT/CT.

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state with a 12 hour entry requirement.

Assessment: The ECW system is actuated on SIAS and provides water to the heating, ventilation and air conditioning (HVAC) units of the ESF equipment areas (e.g. main control room, electrical equipment room, safety injection pump area). For most plant equipment, ECW is a backup to normal HVAC. For a subset of equipment, only ECW is available, but cooling is provided by both ECW trains.

In Modes 1, 2, 3, and 4, the ECW system is required to be operable when a LOCA or other accident would require ESF operation. Two trains have not been required in Mode 5 because potential heat loads are smaller and the probability of accidents requiring the ECW system has been perceived as low.

Because normal HVAC would be available in all non-loss of 1E bus situations, cooling to most plant equipment would remain available. Should an event occur during Mode 4, the post-accident heat loads would be reduced, potentially allowing more time for manual recovery actions, including alternate ventilation measures. Such measures could include opening doors/vents and or provision for temporary alternate cooling equipment. Repair of the ECW in Mode 4 poses a low risk of core damage due to the robustness of plant RCS heat removal resources in Mode 4 and the added risks associated with the transition to Mode 5, as discussed in Sections 3 and 4 above.

Finding: The requested change is acceptable.

5.22 TS 3.7.11 - Control Room Emergency Air Cleanup System

The CREACUS[14] consists of two independent, redundant trains that recirculate and filter the control room air. Each train consists of a prefilter and demisters[15], a high efficiency particulate air (HEPA) filter, an activated charcoal adsorber section for removal of gaseous activity (principally iodine), and a fan. Ductwork, valves or dampers, and instrumentation also form part of the system, as do demisters that remove water droplets from the air stream. A second bank of HEPA filters follows the adsorber section to collect carbon fines and to backup the main HEPA filter bank if it fails.

Plant Applicability: All

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[14]Alternate designations include CREACS, CREVAS, CREVS, and CREAFS.

[15]SONGS 2 & 3 do not include a demister as part of CREACUS.

LCO: Two CREACUS trains shall be operable in Modes 1, 2, 3, [or] 4 [5 and 6] and [during movement of irradiated fuel assemblies].

Condition Requiring Entry into End State: Mode 5 operation is required when one CREACUS train is inoperable in Modes 1, 2, 3, or 4 and not returned to service prior to the TS AOT/CT.

Proposed Modification for End State Required Actions: Modify Condition B of TS to accommodate a Mode 4 end state with initial entry in 12 hours.

Assessment: The CREACUS provides a protected environment from which operators can control the plant following an uncontrolled release of radioactivity, chemicals, or toxic gas. The current TS requires operability of CREACUS from Mode 1 through 4 to support operator response to a design basis accident. Operability in Mode 5 and 6 may also be required at some plants for chemical and toxic gas concerns and may be required during movement of fuel assemblies. The CREACUS is needed to protect the control room in a wide variety of circumstances. Plant operation in the presence of degraded CREACUS should be based on placing the plant in a state which poses the lowest plant risk.

Outage planning in response to the Maintenance Rule should ensure that the plant staff is aware of the system inoperability, that respiratory units and control room pressurization systems are available, that operational and leakage pathways are properly controlled, and that alternate shutdown panels and local shutdown stations are available.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

5.23 TS 3.7.12 - Control Room Emergency Air Temperature Control System

The control room emergency air temperature control system (CREATCS) provides temperature control following control room isolation. Portions of the CREATCS may also operate during normal operation. The CREATCS consists of two independent, redundant trains that provide cooling and heating of recirculated control room air. Each train consists of heating coils, cooling coils, instrumentation, and controls. A single train of CREATCS will provide the required temperature control to maintain habitable control room temperatures following a design basis accident.

Plant Applicability: Calvert Cliffs 1 and 2, Palisades, PVNGS 1, 2 , and 3, Waterford 3, and ANO 2. (Cooling for St. Lucie units is included in the air cleanup system discussed in TS 3.7.11. The cooling system arguments contained in this section apply to St. Lucie Units 1 and 2.)

LCO: Two CREATCS trains shall be operable in Modes 1, 2, 3, and 4, and during movement of irradiated fuel assemblies.

Condition Requiring Entry into End State: One CREATCS train inoperable and the required action and associated completion time of TS not met in Mode 1, 2, 3, or 4.

Proposed Modification for End State Required Actions: Modify Mode 5 end state required action to allow component repair in Mode 4 in 12 hours.

Assessment: CREATCS is required to ensure continued control room habitability and ensure that control room temperature will not exceed equipment operability requirements following isolation of the control room. We addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDCS. In this case, there is little impact on risk associated with unavailable CREATCS and the impact is reduced further if the alternate shutdown panel or local plant shutdown and control capability are available. Consequently, for longer outages, licensees should ensure availability of the alternate shutdown panel or local plant shutdown and control capability.

Finding: The requested change is acceptable.

5.24 TS 3.7.13 - ECCS Pump Room Exhaust Air Cleanup System and ESF Pump Room Exhaust and Cleanup System

The ECCS pump room exhaust air cleanup system (ECCS PREACS) and the ESF pump room exhaust air cleanup system (ESF PREACS) filters air from the area of active ESF components during the recirculation phase of a LOCA. This protects the public from radiological exposure resulting from auxiliary building leaks in the ECCS system. The ECCS PREACS consists of two independent, redundant equipment trains. A single train will maintain room temperature within acceptable limits.

Plant Applicability: Calvert Cliffs 1 and 2, St Lucie 1 and 2, and Waterford 3

LCO: Two ECCS PREACS trains shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: One ECCS PREACS train inoperable and required action and associated completion time of TS not met in Modes 1, 2, 3, or 4.

Proposed Modification for End State Required Actions: Modify Mode 5 end state required action to allow component repair in Mode 4. The time for initial entry into Mode 4 is 12 hours.

Assessment: The CEOG bounded the short term need for the PREACS by assuming: (1) the frequency of Mode 4 LOCAs requiring recirculation is bounded by 0.0001 per year, (2) the probability of a significant leak into the ECCS pump room is about 0.1, and (3) the probability that the backup system is unavailable is 0.1. Then, the probability that the system will be needed over a given repair interval (assumed at 7 days or 0.0192 years) becomes 0.0001 x 0.10 x 0.10 x 0.0192 = 1.92×10^{-8}. The CEOG failed to address potential operator errors, as discussed in Section 3 above, in arriving at this estimate. However, the bounding nature of the CEOG estimate and the sensitivity study discussed in Section 4, above, appear to be sufficient

that this failure will not significantly influence the conclusion. Consequently, we conclude that this is a reasonable assessment.

The PREACS is a post-accident mitigation system that is expected to have little or no impact on CDF. The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4, above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDCS.

Finding: The requested change is acceptable.

5.25 TS 3.7.15 - Penetration Room Emergency Air Cleanup System

The penetration room emergency air cleanup system filters air from the penetration area between the containment and the auxiliary building. It consists of two independent, redundant trains. Each train consists of a heater, demister or prefilter, HEPA filter, activated charcoal absorber, and a fan. The penetration room emergency air cleanup system's purpose is to protect the public from radiological exposure resulting from containment leakage through penetrations.

Plant Applicability: Calvert Cliffs 1 and 2, and Waterford 3

LCO: Two PREACS train shall be operable in Modes 1, 2, 3, and 4. Inability to return one PREACS to service in the allotted AOT requires plant shutdown to Mode 5 in 36 hours.

Condition Requiring Entry into End State: One penetration room emergency air cleanup system train inoperable and required Action and associated completion time of Condition A not met in Modes 1, 2, 3, or 4.

Proposed Modification for End State Required Actions: Modify Mode 5 end state required action to allow component repair in Mode 4. Mode 4 entry is proposed to be in 12 hours.

Assessment: The need for the penetration room emergency air cleanup system is of particular importance following a severe accident with high levels of airborne radionuclides. These events are of low probability. (For example, for Mode 1, the plant core damage frequency is on the order of 2×10^{-5} to 1×10^{-4} per year). Furthermore, the redundant train provides capability to perform the function.

The CEOG estimated the short term need for the PREACS by assuming: (1) the frequency of Mode 4 core damage events is on the order of 0.00005 per year, and (2) the probability that the backup system is unavailable is 0.01. Then, the probability that the system will be needed over a given repair interval (assumed at 7 days or 0.0192 years) becomes $5 \times 10^{-5} \times 0.01 \times 0.0192 \sim 1 \times 10^{-8}$. (This assessment assumed a common cause assessment is performed early in the process to ensure availability and functionality of the redundant system, an important assumption because such failures as electrical failures that could lead to core damage may initially affect the penetration room emergency air cleanup system.)

The penetration room emergency cleanup system is an accident mitigation system and it has little to no impact on the likelihood of core damage. The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

5.26 TS 3.8.1 - AC Sources – Operating

The unit Class 1E 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 emergency diesel generators). In addition, many sites, including SONGS Units 2 and 3 and St. Lucie Units 1 and 2, provide a cross-tie capability between units. Palo Verde provides alternate AC power capability via an onsite combustion turbine.

As required by General Design Criterion (GDC) 17 of 10 CFR Part 50 Appendix A, the design of the AC electrical power system provides independence and redundancy. 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 diesel generator.

Offsite power is supplied to the unit switchyard(s) from the transmission network by [two] transmission lines.[16] From the switchyard(s), two electrically and physically separated circuits provide AC power, through [step down station auxiliary transformers], to the [4.16 kV] ESF buses.

Certain loads required for accident mitigation are started in a predetermined sequence in order to prevent overloading the transformer supplying offsite power to the onsite Class 1E distribution system. Within [1 minute] after the initiating signal is received, all automatic and permanently connected loads needed to recover the unit or maintain it in a safe condition are started via the load sequencer.

In the event of a loss of power, the ESF electrical loads are automatically connected to the emergency diesel generators (EDGs) in sufficient time to provide for safe reactor shutdown and to mitigate the consequences of a design basis accident (DBA) such as a LOCA.

Plant Applicability: All

LCO: The following AC electrical sources shall be operable in Modes 1, 2, 3, and 4:

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[16]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 or buses.

1. Two qualified circuits between the offsite transmission network and the onsite Class 1E AC electrical power distribution system; [and]

2. Two EDGs each capable of supplying one train of the onsite Class 1E AC electrical power distribution system.

Condition Requiring Entry into End State: Plant operators must bring the plant to Mode 5 within 36 hours following the sustained inoperability of either or both required offsite circuits, either or both required EDGs, or one required offsite circuit and one required EDG.

Proposed Modification for End State Required Actions: Modify Condition G [Condition F for SONGS] of ISTS to specify a Mode 4 end state on SG heat removal with a 12 hour entry time.

Assessment: Entry into any of the conditions for the AC power sources implies that the AC power sources have been degraded and the single failure protection for ESF equipment may be ineffective. Consequently, as specified by TS 3.8.1, at present the plant operators must bring the plant to Mode 5 when the required action is not completed by the specified time for the associated condition.

The CEOG stated that, during Mode 4 with the steam generators available, plant risk is dominated by a LOOP initiating event. If a LOOP were to occur during degraded AC power system conditions, the number of redundant and diverse means available for removing heat from the RCS may vary, depending upon the cause of the degradation. If the LCO entry resulted from inoperability of both onsite AC sources (i.e., EDGs) followed by LOOP, a station blackout event will occur. For this event, the SG inventory may be sufficient for several hours of RCS cooling without feedwater, and the TDAFW pump, which does not rely on the AC power sources to operate, should be available if needed. Further, there should be time to start any available alternate AC power supplies, such as blackout diesels. For all other LCO entries which do not lead to station blackout following LOOP during Mode 4, feed and bleed (for non 3410 megawatt thermal CE-designed PWRs) capability may also be available for RCS heat removal if the auxiliary feedwater system should fail. If the RCS conditions are such that the steam generators are not available for RCS heat removal during Mode 4, then only the SDC system is available for RCS heat removal for non-station blackout events.

Switchyard activities, other than those necessary to restore power, should be prohibited when AC power sources are degraded. Note that to properly utilize TDAFW pumps the SG pressure should be maintained above the minimum recommended pressure required to operate the TDAFW.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system. In the case of a degraded AC power capability, the likelihood of losing SDC is increased, and the staff judged the plant should be placed in a condition that maximizes the likelihood of avoiding a further plant upset of loss of RCS cooling. This will generally be Mode 4 with SG cooling.

Finding: The requested change is acceptable.

5.27 TS 3.8.4 - DC Sources – Operating

The DC electrical power system:

1. Provides normal and emergency DC electrical power for the AC emergency power system, emergency auxiliaries, and control and switching during all modes of operation,

2. Provides motive and control power to selected safety related equipment, and

3. Provides power to preferred AC vital buses (via inverters).

For CEOG Member PWRs (with the exception of San Onofre, Palo Verde, Calvert Cliffs, and Waterford), the Class 1E 125 VDC electrical power system consists of two independent and redundant safety related subsystems. The Class 1E 125 VDC electrical power system at San Onofre, Palo Verde, and Calvert Cliffs consists of four independent and redundant safety subsystems. At Waterford, these are three 125 VDC safety related subsystems. Each subsystem consists of one battery, the associated battery charger(s) for each battery, and all the associated control equipment and interconnecting cables.

The 125 VDC loads vary among the CE-designed PWRs. At SONGS for example, Train A and Train B 125 VDC electrical power subsystems provide control power for the 4.16 KV switchgear and 480 V load center AC load groups A and B, diesel generator A and B control systems, and Train A and B control systems, respectively. Train A and Train B DC subsystems also provide DC power to the Train A and Train B inverters, as well as to Train A and Train B DC valve actuators, respectively. The inverters in turn supply power to the 120 VAC vital buses.

Train C and Train D 125 VDC electrical power subsystems provide power for nuclear steam supply system control power and DC power to Train C and Train D inverters, respectively. The Train C DC subsystem also provides DC power to the TDAFW pump inlet valve HV-4716 and the TDAFW pump electric governor.

During normal operation, the 125 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 (which is powered from the safety related 480V source), the DC load is automatically powered from the station batteries.

Plant Applicability: All

LCO: All of the DC electrical power subsystems are required to be operable during Modes 1, 2, 3, and 4. At SONGS for example, the Train A, Train B, Train C, and Train D DC electrical power subsystems shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: The plant operators must bring the plant to Mode 5 within 36 hours following the sustained inoperability of one DC electrical power subsystem for a period of 2 hours.

Proposed Modification for End State Required Actions: Modify Condition B of ISTS to a Mode 4 on SG heat removal end state with a 12 hour entry requirement.

Assessment: The CEOG stated that the DC power sources have sufficient capacity for the steady state operation of the connected loads during Modes 1, 2, 3, and 4, while at the same time maintaining the battery banks fully charged. It also stated that each battery charger has sufficient capacity to restore the battery to its fully charged state within a specified time period while supplying power to connected loads. The DC sources are required to be operable during Modes 1, 2, 3, and 4 and connected to the associated DC buses. Mode 5 is the current state for not restoring an inoperable DC electrical subsystem to operable status within 2 hours.

The CEOG stated that with a DC electrical power subsystem inoperable during Mode 4, plant risk is dominated by LOOP events. Such an event with concurrent failure of the unaffected EDG can progress to a station blackout. These events challenge the capability of the ESF systems to remove heat from the RCS. Entry into Mode 4 as the end state when an inoperable DC electrical power subsystem cannot be restored to operability within 2 hours provides the plant staff with several resources. For station blackout cases with one DC power source continuing to operate, the TDAFW pump is available for RCS heat removal when steam pressure is adequate. If this pump becomes unavailable, such as if the other DC sources were lost and the TDAFW pump could not be satisfactorily operated locally, the lack of RCS heat removal initiates a boil-down of the steam generator inventory. Boil-off of steam generator inventory and a certain amount of RCS inventory must both occur in order to uncover the core. Under this condition, the plant operators have significant time to accomplish repair and/or recovery of offsite or onsite power. For non-station blackout cases, the remaining train(s) (motor and/or turbine-driven) of auxiliary feedwater are available for RCS heat removal if steam pressure is adequate as long as the remaining DC power source continues to operate. Should the remaining train(s) fail, feed and bleed capability is available for certain CE-designed PWRs to provide RCS heat removal as long as the remaining DC power source continues to operate. Whether or not DC power remains, Mode 4 operation with an inoperable DC power source provides the plant operators with diverse means of RCS heat removal and significant time to perform repairs and recovery before core uncovery occurs.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions, including those applicable here. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

5.28 TS 3.8.7 - Inverters - Operating

In Modes 1, 2, 3, and 4, the inverters provide the preferred source of power for the 120 V AC vital buses which power the reactor protection system (RPS) and the ESFAS. The inverters are designed to ensure the availability of AC power for the systems instrumentation required to shut down the reactor and maintain it in a safe condition after an anticipated operational occurrence or a postulated DBA. The Class 1E (125 VDC) station batteries via the respective Class 1E 125 VDC buses provide an uninterruptible source of power for the inverters.

Plant Applicability: Calvert Cliffs 1 and 2, Palisades, PVNGS 1, 2, and 3, SONGS 2 and 3, and St. Lucie 2 (TS is 3.8.3.1)

LCO: All of the safety related inverters are required to be operable during Modes 1, 2, 3, and 4. At SONGS for example, the required Train A, Train B, Train C, and Train D inverters shall be operable in Modes 1, 2, 3, and 4.

Condition Requiring Entry into End State: The plant operators must bring the plant to Mode 5 within 36 hours following the sustained inoperability of one required inverter for a period of 24 hours.

Proposed Modification for End State Required Actions: Modify Condition B of ISTS to Mode 4 on SG heat removal within a 12 hour entry requirement.

Assessment: The inverters are included as four independent and redundant trains. Each inverter provides a dedicated source of uninterruptible power to its associated vital bus. An operable inverter requires the associated vital bus to be powered by the inverter and have output voltage and frequency within the acceptable range. In order to be operable, the inverter must also be powered from the associated station battery. Maintaining the inverters operable ensures that the redundancy incorporated in the design of the RPS and ESFAS is maintained. The inverters provide an uninterruptible source of power, provided the station batteries are operable, to the vital buses even if the [4.16] kV ESF buses are not energized. Entry into the LCO required action implies that the redundancy of the inverters has been degraded.

The inoperability of a single inverter during Mode 4 operation will have little or no impact on plant risk. The inoperable inverter causes a loss of power to the associated bistable channel of the RPS. Since reactor trip will have been accomplished as part of the shutdown prior to reaching Mode 4, loss of one inverter should not impact reactor trip. An inoperable inverter also causes a loss of power to one of the four ESFAS trip paths. This single condition should not impact the ability of the ESFAS to perform its function.

The staff addressed Mode 4 versus Mode 5 operation in Sections 3 and 4 above, and concluded there is essentially no benefit in moving to Mode 5 under many conditions. Further, there is a potential benefit to remaining in Mode 4 on SG heat removal because additional risk benefits are realized by averting the risks associated with the alignment of the SDC system.

Finding: The requested change is acceptable.

6.0 CONCLUSIONS

The staff approval applies only to operation as described and acceptably justified in the CEOG References 5 and 6 request.[17] To be consistent with the staff's approval, any licensee requesting to operate in accord with the CEOG request, as approved in this safety evaluation, should commit to operate in accord with the following stipulations:

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[17]The requested end state changes do not preclude licensees from entering cold shutdown should they desire to do so for operational needs or maintenance requirements. In such cases, the specific requirements associated with the requested end state changes do not apply.

1. Entry into the shutdown modes approved in this safety evaluation should be for the primary purpose of accomplishing the short duration repairs which necessitated exiting the original operating mode.

2. Unless exceptions are stated in the individual TS descriptions of Section 5 of Reference 6, operation as approved in this safety evaluation should be limited to an entry that is initiated by inoperability of a single train of equipment or a restriction on a plant operational parameter.[18]

3. Licensees should include the restrictions and guidance documented in Section 5.5 and Table 5.5-1 of Reference 6 in appropriate plant procedures and administrative controls when the plant is being operated in accordance with the proposed end states. Procedures and/or controls should include actions to expeditiously exit a risk-significant configuration in case such actions should be needed.

4. Entry and use of the proposed changes should be performed in accordance with the requirements of 10 CFR 50.65(a)(4). This should include a risk assessment with respect to performance of key shutdown safety functions as described in Section 3 of this safety evaluation.

5. The following conditions should be met unless exceptions are identified in Section 5 of this SE:

    a. Should SG cooling be lost while operating in Mode 4, there should be sufficient water in the SGs and operational procedures shall exist to ensure that long-term SDC can be initiated.

    b. Uncontrolled loss-of-inventory events should be minimized by in-depth planning, maintaining the RCS at its nominal inventory and configuration control. In-depth event response capability, such as inventory addition, procedures, and training, should be provided.

    c. The LTOP and SDC are not aligned when the plant is operated in Mode 4 on SG cooling unless the plant is being transitioned to or from SDC operation. LTOP shall be operational when the SDC system is hydraulically connected to the RCS.

6. The RCS pressure boundary should remain functional and, if isolated from the SDC system, should be capable of operating with pressure relief via the pressurizer safety valves.

7. The primary purpose of the CEOG request is to allow corrective maintenance in an operating mode consistent with safe operation after an AOT has been exceeded and, secondarily, to minimize the correction time so that the plant can be restored to power

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[18]Reference 6 was not consistent. Page 1 stated "... with one train out of service ...," Page 9 stated "... with one train or component out of service ...," and Section 5 contains entries that are broader than either statement. Our findings apply to the stipulation as stated in our SE.

operation. Ordinarily, conditions addressed in this request, and in this SE, involve failures that result in a degraded plant condition. Consequently, with respect to additional licensee outage activities that could affect the safe conduct of operations and that are not directly required for correction of the failure(s) that caused the AOT to be exceeded, a licensee should:

a. Perform a safety assessment in accordance with the maintenance rule prior to undertaking such additional activities.

b. If conditions change so that the safety assessment is no longer valid, to suspend all such additional activities via a process consistent with safety[19] until such time as the assessment has been re-performed and is again valid.

7.0 REFERENCES

1. Phelps, Ralph, "CE Owners Group Submittal of CE NPSD-1186, 'Technical Justification for the Risk Informed Modification to Selected Required Action End States for CEOG PWRs'," Letter to NRC from Chairman, CE Owners Group, CEOG-00-121, April 28, 2000.

2. "Technical Justification for the Risk Informed Modification to Selected Required Action End States for CEOG PWRs," Final Report, Task 1115, ABB C-E Nuclear Power, Inc., CE NPSD-1186, April 2000.

3. Bischoff, Gordon, "Supplementary Information Regarding Topical Report CE NPSD-1186," Letter to NRC from Project Manager, CE Owners Group, Westinghouse Electric Company, CEOG-00-279, September 19, 2000.

4. Bernier, Richard, "Response to Information Request concerning CEOG Topical Report CE NPSD-1186, 'Technical Justification for the Risk-Informed Modifications to Selected Required Action End States for CEOG PWRs'," Letter to NRC from Chairman, CE Owners Group, CEOG-00-328, November 21, 2000.

5. Bernier, Richard A., "Clarifications to Topical Report CE NPSD-1186," Letter to NRC from Chairman, CE Owners Group, CEOG-01-037, February 13, 2001.

6. Schneider, Raymond, "Technical Justification for the Risk-Informed Modification to Selected Required Action End States for CEOG Member PWRs," Final Report, Task 1115, CE Nuclear Power LLC., CE NPSD-1186 Rev 00, January 2001.

7. CEOG letter dated July 3, 2001.

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[19]The staff expects a contingency plan to be available to address this condition. This may require such actions as (1) suspending the activity until conditions are again appropriate, (2) terminating the activity and restarting from the starting point when conditions are again appropriate, or (3) continuing the activity if safety is best ensured by completing the activity. The staff recognizes that such decisions may have to be made on the basis of engineering judgement should an unforseen condition arise.

8. Federal Register, Vol. 58, No. 139, p. 39136, July 22, 1993.

9. Code of Federal Regulations, Title 10, "Energy," January 1, 2000.

10. "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants," USNRC Regulatory Guide 1.182, May 2000."

11. Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, Nuclear Energy Institute, NUMARC 93-01, Revision 2, April 1996.

12 Travers, William D., "Regulatory Guide for Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants," Attachment 2 to Policy Issue Notation Vote for The Commissioners from USNRC Executive Director for Operations, SECY-00-0074, March 28, 2000.

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Date: July 17, 2001