CEOG COMBUSTION ENGINEERING OWNERS GROUP

CE Nuclear Power LLC	Baltimore Gas & Electric Calvert Cliffs 1, 2	Entergy Operations, Inc. ANO 2 WSES Unit 3	Korea Electric Power Corp. YGN 3, 4 Ulchin 3,4	Omaha Public Power District Ft. Calhoun
Arizona Public Service Co. Palo Verde 1, 2, 3	Consumers Energy Co. Palisades	Florida Power & Light Co. St. Lucie 1, 2	Northeast Utilities Service Co. Millstone 2	Southern California Edison SONGS 2,3

November 21, 2000
CEOG-00-328

NRC Project 692

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: 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"

The purpose of this letter is to submit the attached responses to staff questions provided during recent telephone conversations regarding the subject report. This letter documents the responses for use by the staff. Following staff approval, these responses will be incorporated in the approved version of the subject report. Westinghouse and the CEOG utilities are prepared to discuss these responses and will meet with the staff, if necessary, in order to facilitate this review.

Please do not hesitate to call me at 623-393-5882 or Gordon Bischoff, CEOG Project Office, at 860-285-5494 if you have any questions.

Sincerely,

Richard A. Bernier

Richard Bernier
Chairman, CE Owners Group

Attachment: As Stated
cc: J. S. Cushing (OWFN, 4D-7)

cc: G. Bischoff, W
V. Paggen, W
PSA Subcommittee
Licensing Subcommittee
CEOG Library Task 1115

D047
Add: Jack Cushing
to rids

TECHNICAL JUSTIFICATION FOR THE RISK INFORMED MODIFICATION TO SELECTED REQUIRED ACTION END STATES FOR CEOG PWRS

REPLACE W/ UPDATED
TITLE PAGE
AND
Copyright Notice

CE NPSD-1186, Revision 00

Technical Justification for the Risk-Informed Modification to Selected Required Action End States for CEOG PWRs

CEOG Task 1115
April 2000

Author: ______________________________
(Ray Schneider / Department)

Approved: ______________________________
(Name / Department)

CE Nuclear Power LLC
2000 Day Hill Road
Windsor, CT 06095

operator's inadvertent rapid transfer of 9000 gallons of reactor coolant to the RWST while the plant was pressurized at 340 psig and at a temperature of 300 F (typical of hot shutdown SDC entry conditions). The event was precipitated by the concurrent performance of two incompatible activities which, taken together, opened two isolations valves creating a flow path that allowed the inadvertent draindown. Unmitigated, this event could have had significant consequences including a potential for containment bypass.

On May 28, 1998, the NRC issued Generic Letter 98-02 concerning the "Loss of Reactor Coolant Inventory and Associated Potential for Loss of Emergency Mitigation while in a Shutdown Condition," (Reference 10). The intent of this letter was to have the licensees evaluate the susceptibility of their Residual Heat Removal and Emergency Core Cooling systems to a common cause failure as a result of a reactor coolant system draindown while in a shutdown condition. The staff was specifically concerned with the conduct of activities during hot shutdown that may affect safety related functions of the RHR and ECCS, for example methods utilized to verify valve position, controls in place to assure compliance with plants surveillance, maintenance, modification of operating procedures and adequacy of operator training.

Additional loss of RCS inventory events occurred at Quad Cities Unit 2, Arkansas Nuclear One Unit 2, Fitzpatrick and Salem Unit 2. Information Notice 99-14 (Reference 11) was issued to alert utilities to the potential for personnel errors during infrequently performed evolutions. The IN addressed the first three incidents which resulted in unanticipated reactor water draindowns. The safety significance of these events was low because the draindowns were terminated with water level well above the top of the active fuel. The Salem event consisted of a loss of inventory event resulting from an RCS heatup with an unexpected challenge to the LTOP relief valve at an RCS pressure in the vicinity of 370 psig. The relief valve challenge resulted in a substantial RCS leakage (between 350 and 500 gpm). The challenge appeared to be due to operator error resulting from a weakness in procedural guidance.

In summary, 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 require SDC entry only when it is a risk beneficial alternative to other actions.

3.2 PROBABILISTIC ASSESSMENT OF SHUTDOWN RISKS

PRA techniques have been developed to consider risks associated with plant operation in transition and shutdown modes (hot standby, hot shutdown and cold shutdown). Shutdown mode models have been developed by Southern California Edison (SCE) over the past several years. These models focus on the risks associated with quasi-steady state operation under shutdown conditions. Transition risks arise as a result of transitory mode changes. In considering issues associated with repair of plant equipment, three mode transition risks are of interest: transition risk from Mode 1 (at power) to Mode 3 (hot standby), transition risk from Mode 3 to Mode 4 (hot shutdown) and transition risk from Mode 4 using steam generators for heat removal to either Mode 5 (cold shutdown) or to Mode 4 on SDC and the associated risks for return to power. As discussed in Section 3.1, transition risks are important since the risk of transition is often not negligible and there is an increased probability of events occurring during plant transitions. This is particularly true when plant configuration changes are required as a result of the mode change.

Transition risk models have been developed by Mankamo ~~for Boiling Water Reactors~~ (BWRs, References 12a, b) and more recently by the Combustion Engineering Owners Group (CEOG) for Pressurized Water Reactors (PWRs, Reference 13). The CEOG methods were primarily focused on the risks of transition from power operation to hot standby. The CEOG models are restricted in use to the low power, hot

Moreover,

contained within the RCS in this mode, ~~and that~~ restrictions included in the proposed change reduce the potential of significant increases in leakage. Because of the importance of containment integrity, appropriate use of this end state condition will be carefully controlled via (a)(4) of the revised Maintenance Rule through implementation of the plant's Configuration Risk Management Program.

TS 3.6.4 and 3.6.5 involve limitations intended to support the Mode 1 containment design basis and the adequacy of environmental qualification limits on safety related equipment. In both Mode 4 and Mode 5, the core energy released during a core damage event would be much lower than in Mode 1, due to the rapidly decreasing decay heat. This decay heat is the same, whether in Mode 4 or Mode 5. In Mode 4, the plant is shutdown and RCS coolant temperatures are reduced to values in the neighborhood of at most 350 to 375 °F. At this level the stored energy contained within the RCS coolant, structure and fuel are well below that available for release to the containment during Mode 1 operation. This reduction in stored energy more than compensates for any credible potential increase in containment pressure or temperature beyond the Mode 1 design basis analysis limit. Thus, the potential for violation of the plant design basis containment limits is negligible. In addition, a loss of cooling event in Mode 4 would potentially progress slower than a loss of cooling event in Mode 5, steam generator inventory, is available in Mode 4 and may not be available in Mode 5. This additional inventory increases the time to core uncovery. This potentially slower progression in Mode 4 allows the operators additional time to prevent both core damage and release from containment.

TS 3.5.4 involves control of the boric acid concentration in the RWST. RWST inoperabilities due to boron concentration out of limits have negligible risk impact on the public while the plant is in a shutdown mode. Boron dilution concerns are mitigated by the fact that the plant is shutdown . Over-boration concerns are addressed by acknowledging the fact that the large LOCA event (which is the origin of the concern) is of very low probability. Also, the event progression is slower than at power (making operator misalignments less likely), and the concentrating process associated with the core boil-off is slower. It is also noted that the need for boration increases with reducing temperature. Thus, a Mode 3 shutdown end state for this TS is preferred.

5.3 SAFETY MARGINS (GENERAL)

Implementation of the proposed changes described in this change request should result in a net reduction in plant risk. In general, plant risks are reduced as a combined consequence of allowing plant operation in the resource rich environment (from the perspective of core and RCS heat removal), and ~~that~~ by not forcing the plant to cold shutdown for these TS required actions, plant realignment (and risks) associated with SDC entry may be avoided. The proposed recommendations for replacing the cold shutdown (Mode 5) required action with a recommendation to allow continued operation at hot shutdown (Mode 4) or hot standby (Mode 3) for a large number of TSs will also provide the plant operators the flexibility to optimize longer term equipment repairs in order to both reduce plant risks and reduce plant unavailability. Therefore, in the aggregate, this change involves an increase in safety, and not a reduction in plant safety margins.

Deterministically, plant safety margins are unaffected because the proposed change does not affect the plant design basis as governed by the DBA and transient analyses requirements set forth in the UFSAR. The proposed change is limited in scope to risk-informing those end state required actions (resulting from condition entries associated with one train or component out of service), whose modification to an alternate end state would either be risk-neutral or result in an overall safety benefit and a reduction in plant unavailability. Consistent with the current TS philosophy as required by 10CFR50.36, the recommended end state in the required action is taken to be a plant shutdown condition: either hot standby or hot or cold shutdown. The intent of the deterministic assessment herein is not to evaluate or provide information to support a permanent change of the plant design basis, but rather to identify that sufficient capability (and hence, sufficient safety margin) exists such that a short term temporary component repair outage may be conducted in a higher temperature mode than that currently specified

Table 5.4-1
Comparison of "At Power" and "Shutdown" Initiating Events

Initiating Event	Event Considered "At Power"	Event Considered in Mode 4	Event Considered in Mode 5	Comment
ATWS	Y	N	N	Event not possible during shutdown.
Large LOCA	Y	Y	N	Frequency of event significantly lower for low pressure operational conditions. Lesser stored energy results in slower heatup, requiring less mitigation capability.
Medium LOCA	Y	Y	N	Alignment to SDC increases potential for Loss of Inventory events due to induced flow diversions.
Small LOCA	Y	Y	N	
Main Steam Line Break	Y	N	N	Large catastrophic main steam line breaks are not credible in shutdown modes. In Mode 4, small failures of steam lines are possible during TDAFW operation. No consequence for core melt except if SLB is an initiator for a Loss of feedwater event.
Steam Generator Tube Rupture	Y	Y	N	Risk of spontaneous steam generator tube rupture is less than at full power for Mode 4 low pressure operation. SGTRs are negligible when on SDC. SGTRs at shutdown proceed slowly, and the time required to transition to SDC is short.
Loss of Offsite Power	Y	Y	Y	Loss of offsite power event frequency is expected to be greater during shutdown due to increased switchyard activity and potentially less stable electrical grid.[d]
Loss of Load	Y	N	N	No load present in shutdown.
Loss of Vital Bus	Y	Y	Y	Event considered in all modes.
Loss of Component Cooling Water	Y	Y	Y[a]	For Modes 4 and 5 this event is considered within context of loss of SDC, as CCW is relied upon as the primary means (and in some plants the only means) for SDC heat removal.
Loss of Feedwater	Y	Y[b]	N	Loss of FW in shutdown modes varies based on an assumed FW source, type and operational mode. Considered in Modes 3 and 4.
Boron Dilution	Y	N	N	At power, boron dilution events are considered trip initiators. Slowly progressing event with ample time for operator action. Not considered a core damage scenario.[3] At shutdown, rapid boron dilution events are not considered due to high level of control of non-borated water sources.
Loss of Inventory	N	Y[c]	Y	Event results in loss of inventory during plant realignments associated with transitioning into SDC.
Loss of SDC	N	N	Y	Loss of SDC not considered in Mode 4 with SG HR. Events that lead to loss of SDC are considered in Modes 4 and 5

Notes:

(a) CCW is assumed to provide cooling to SDC HXs. The designation or this system may vary among plants.
(b) Both TD and MD AFW pumps conditions analyzed.
(c) Considered during realignment from SG HR to SDC entry.

[3] Core damage due to introduction of an unborated water slug into the RCS is unlikely due to maintenance and pump restart procedures which ensure a borated water source.

(d) This assumes that in the lower temperature mode the plant may take advantage of the longer anticipated shutdown time to perform "scheduled" maintenance, potentially increasing switchyard activity. In addition the shutdown plant may result in a potentially less stable grid.

While the shutdown RCS is subject to many of the same accident initiating events as might occur at power, their frequency of occurrence is different and the event progression is typically slower. Events that are driven by energetic failures of the RCS (e.g. large LOCAs) are expected to be much reduced in probability due to the lower pressure operation associated with some of the shutdown modes. In addition, experience has shown that events associated with loss of power are more frequent due to potential for increased switchyard maintenance and lower grid stability. As can be seen from Table 5.4-1, the accident initiators during shutdown modes include: LOCAs, Steam Generator Tube Ruptures (SGTRs), Loss of Feedwater Events (LOFW), Loss of Offsite Power Events (LOOP), Loss of Shutdown Cooling (LOSDC), Loss of Inventory (LOI) and Loss of Component Cooling Event and Boron Dilution Events. These event classes are discussed in additional detail below.

<u>ATWS and Boron Dilution Events</u>

Events not considered in the Mode 4 or Mode 5 assessments include ATWS and core damage initiated via slow or rapid boron dilution. ATWS is precluded in this assessment as it is assumed the core has achieved an unremarkable shutdown with all rods inserted. Slow boron dilution events are typically not analyzed in "at power" PSAs due to the relatively long time required to initiate core damage, close control of unborated water sources and the availability of adequate nuclear instrumentation to trend approach to criticality following post-trip events. Slow boron dilution events have similarly not been considered as core damage initiation for shutdown conditions. Rapid boron dilution events may be postulated to occur as a result of maintenance on standby systems. Particular systems of concern would be the ECCS and other systems which are directly connected to the RCS. Boron concentration of water in these lines is assessed via maintenance procedures and may be sampled via the normal sampling system. In any event, the expected impact of any boron dilution incident would be similar in shutdown in Modes 4 and 5.

<u>LOCAs and SGTRs</u>

LOCAs and SGTRs are to a large extent pressure driven initiating events, and are expected to decrease in frequency as the RCS transitions from Modes 3 to 4 and are entirely negligible once SDC is entered. For most plants entry into Mode 4 results in RCS pressure restrictions which would decrease the random pipe failure frequency associated with these events. Should a SGTR event occur~~ring~~ Mode 4, the cooldown response to a SGTR event is significantly shortened and RWST inventory requirements are reduced in Mode 4. These features decrease the likelihood that a Mode 4 SGTR would result in core damage. As discussed below, the process of SDC entry increases the potential for events causing a decrease in RCS inventory due to inadvertent flow diversions. While these events are not defined as LOCA, extended flow diversions may result in core uncovery and fuel damage.

<u>LOOP and Loss of Vital Bus</u>

Loss of Vital Bus and the Loss of Offsite Power (LOOP) are important initiating events at all plant modes. Based on an (INEL) review of LOOP precursors at shutdown, shutdown modes will likely experience an increase in LOOP frequency. This was attributed to a decrease in grid stability and an increased potential of power loss due to maintenance-related human errors as switchyard activities and maintenance on switchyard components increase.

Table 5.4-2
Typical Summary of Plant Systems Available in Shutdown Modes 3 to 5

System	Modes		
	3 (Hot Standby)	4 (Hot Shutdown)	5 (Cold Shutdown)
MFW	(b)	(b)	-
Condensate	√	√	√
MDAFW	√	√	(g)
TDAFW (a)	√	√	(d), (g)
HPSI & PORV	√ (f)	√ (f)	(e)
SDC	(c)	√ (c)	√ (h)

(a) RCS heat removal not dependent on offsite power, (DC power supports SG level instrumentation).
(b) MD MFW may be available at some plants.
(c) Potential for SDC operation following event provided Mode changes to 4 or 5 implemented. SDC is optimal in Mode 4.
(d) TDAFW may be established following an event in Mode 5, however, heatup into Mode 4 conditions would be required. This may be restricted as an unplanned mode change and would be avoided by operating staff.
(e) OTCC may be accomplished via use of HPSI and LTOP system, however; guidance may not be in place and this recovery is not credited.
(f) Not available to SONGS Units 2 & 3, PVNGS Units 1, 2 & 3 and Waterford Unit 3.
(g) May be used to backup SDC providing RCS is not vented to support CS backup.
(h) CS pumps may be used to backup LPSI as an SDC pump provided RCS is vented.

5.4.2.2.3 Summary of Qualitative Assessment

In summary, for plant conditions that do not compromise the effectiveness of AFW, plant operation in Mode 4 typically offers the greatest robustness to plant upsets due to its greater diversity and redundancy of components or systems to effect RCS heat removal. These factors, coupled with the reduced initiating event frequencies for RCS LOCAs and SGTRs, result in anticipated plant risks that are similar to, or lower than Mode 5 risks, dependent on which mode of heat removal is selected in Mode 4 and if the RCS is vented in Mode 5. Section 5.4.3.4 provides an example quantification of these concepts.

5.4.2.3 Comparison of CEOG RCS Heat Removal Capabilities at Shutdown

Section 5.2.1.2 presented a discussion of representative plant capabilities available during shutdown Modes 3, 4 and 5. This section provides a comparison of shutdown mode entry conditions/restrictions and system availabilities among the CE PWRs. This information is summarized in Table 5.4-3 and discussed below.

5.4.2.3.1 Mode 4 Entry Conditions

Table 5.4-3 shows general agreement with Mode 4 entry conditions, reflecting a relatively common definition of the Mode 4 state. The FCS Technical Specifications are customized and have no formal definition for hot shutdown. One operational mode spans the entire region from low power to cold shutdown.

Of the plants with standardized Technical Specifications, entry into Mode 4 typically occurs between 300 °F and 350 °F. The Mode 4 pressure restrictions are less consistent among the units. Upper Mode 4 pressures are typically limited by the Reactor Vessel P-T curve, however these limits are variable among units and tend to allow potentially increased pressures, including pressures to near operating pressures. In ~~two specific~~ one instance~~s~~ (Calvert Cliffs Unit 2 ~~and San Onofre Units 2 & 3~~) the maximum Mode 4 pressures were identified as 170 psia ~~and 400 psia respectively~~. Units with low event, would affect the MDAFW pumps in a similar manner to the SDC pumps. The SDC requirement of CCW and other support systems would make SDC slightly more vulnerable than AFW, since SDC and its support systems rely on electrical power for heat removal. The AFW system includes the TDAFW pump which may be operated for a time without electrical power. The ability of the TDAFW to provide "long-term" heat removal is dependent on the ability of the plant staff to utilize the TDAFW pump following the loss of SG level indication.

When the TDAFW pump is credited, then the vulnerability of Mode 4 operation to external events would be less than Mode 5 operation. Additionally, with lower decay heat during shutdown, the Mode 4 vulnerability will be less than full power.

Based on the above discussion, it can be concluded that the risk due to external events in Mode 4 is either lower or about the same as Mode 5 operation.

The SONGS PRA evaluation presented in Section 5.4.3 includes consideration of dominant risks associated with fire and seismic events. Qualitatively, the major impact of external events is to disable a large variety of mitigating safety equipment. The risks associated with the equipment disabled from these events will depend on the equipment location and protective barrier placement, and dependencies of the equipment on support systems such as power. Thus, from a pragmatic sense, plant safety is largely tied to issues of redundancy and diversity. For CE PWRs, Mode 4 offers the greatest variety of equipment. Thus, the susceptibility to the loss of all heat removal capability is lower than it would be in Mode 5, where the plant is entirely dependent upon motor driven pumps and strongly dependent on the energy removal systems connecting the RCS to the plant's ultimate heat sink.

5.4.3.4 Assessment of Mode Dependent Plant Risks

As discussed in Section 5.5, in aggregate, the impact of the proposed TS change will either be risk neutral or result in a reduction in plant risk. Therefore, the risk acceptance criteria associated with increases in CDF and LERF, which are provided in Regulatory Guide 1.174, are inherently met.

The risk profile of the various modes can best be understood by relating the plant risk to the dominant risk initiators and plant recovery capability (See Figure 5-1). Mode 3 is the first shutdown mode encountered as the plant is transitioned to a shutdown state. As Mode 3 is entered the TDMFW pump becomes unavailable. This results in a sharp (~2E-5/yr) increase in the plant CDF. The impact of the mode change on all other initiating event core damage contributions is small (~20% of the at-power CDF) and primarily reflects the impact of control rod insertion on the elimination of ATWS events from the plant initiating event challenges. As the RCS temperature is decreased to 350 °F (300 °F for ANO), Mode 4 is entered. The primary difference between the Mode 3 and Mode 4 SG heat removal states is the RCS thermal-hydraulic condition (temperature and pressure). Pressure restrictions, such as those associated with ~~SONGS procedures~~, result in a decrease in the contribution of LOCA and SGTR to core damage. The lower core decay heat associated with Mode 4 results in increased operator performance due to increases in the overall time available for the operator to complete specific actions. The net impact of these effects is to decrease the CDF by ~ 2 E-5/yr. In this mode the dominant risk comes from loss of FW, contributing about 80% of the total CDF. Mode 4 risks are lower than Mode 3 risks since either AFW or SDC may be used in Mode 4.

Entry into SDC from an initial Mode 3 state would be delayed by the need to first maneuver the plant to Mode 4. However, when in Mode 4, plant capability to operate in either SDC or SG heat removal modes is available and proceduralized. Analyses also show that the risks of the two Mode 4 plant operational states (AFW backed up by SDC; or SDC backed up by AFW), are relatively close, however the risk becomes somewhat larger once SDC is entered. This is caused by the following:

Calvert Cliffs

Mode 5 per TSs, but may be useful in Mode 5 as part of a shutdown risk management program. It should be noted that at SONGS, a boration flow path (either from RWST or BAMU) must be operable in Mode 5 per LCO 3.1.10.

The RWST supplies two ECCS trains by separate, redundant supply headers. Each header also supplies one train of the CS System. A motor operated isolation valve is provided in each header to allow the operator to isolate the usable volume of the RWST from the ECCS after the ESF pump suction has been transferred to the containment sump following depletion of the RWST during a LOCA. A separate header is used to supply the Chemical and Volume Control System (CVCS) from the RWST. Use of a single RWST to supply both trains of the ECCS is acceptable since the RWST is a passive component, and passive failures are not assumed to occur coincidentally with the Design Basis Event during the injection phase of an accident. Not all the water stored in the RWST is available for injection following a LOCA; the location of the ECCS suction piping in the RWST will result in some portion of the stored volume being unavailable.

Condition A of this LCO ensures that:

a. The RWST contains sufficient borated water to support the ECCS during the injection phase and that

b. The reactor remains sub-critical following a LOCA. Improper boron concentrations could result in a reduction of SDM or excessive boric acid precipitation in the core following a LOCA.

c. Post LOCA boron precipitation concerns diminish in Modes 3 and 4 since: (1) inventory/boric acid injection into the RCS is reduced due to the less severe inventory depletion and a (2) lesser rate of injection is required to mitigate the LOCA. ~~(3)~~ Post-LOCA reactivity concerns are diminished since SDM is larger in Mode 3 and 4 (than in Mode 1) due to the prior insertion of control rods.

Condition Requiring Entry into End State

When the Refueling Water Storage Tanks are 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 end state when boron concentration is outside of the operating band for a period greater than 8 hours and to create a new action (e.g. 3.5.4 D.2) to maintain the current end state for other inoperabilities.

Basis for Proposed Change

The RWST is considered an injection source for HPSI, LPSI and CVCS (the latter also considers BAMU) for all modes for LOCAs (large, medium, small and small-small), SGTR and other transients in which pressurizer safeties lift and fail to re-close. This change addresses the condition when the RWST is inoperable due to the boron concentration being outside the TS limits. Once in a shutdown mode, inoperability of this type would most likely not have any impact on plant safety, when best estimate conditions are considered. This change does not address the event that the RWST is truly unavailable. In that case, the loss of functionality would lead directly to core damage in cases in which ECCS injection is required and not otherwise recovered.

Ideally, boron concentration anomalies in the RWST should be corrected while the plant is at power. Once a shutdown has commenced, continued operation in Mode 3 results in an increased risk above that incurred by plant operation. However, since the time expected to correct this anomaly is small (< 1 day) the incremental risk of Mode 3 operation is negligible (< 1 x 10^{-7}) Since the primary concern with RWST boron concentration arises from the large LOCA event and the event is of very low probability, the impact from marginally high or low concentrations has a negligible risk impact.

This TS modification provides for a Mode 3 operation end state for conditions associated with RWST boron concentration out of limits. Mode 3 provides a safe shutdown mode for completing necessary actions to correct the malfunction. By completing adjustments in Mode 3, additional mode transitions and their associated risks are averted.

Defense-in-Depth Consideration

RWST inoperabilities due to boron concentration out of limits have negligible impact on plant risk. Boron dilution concerns are mitigated by the fact that the plant is shutdown making a return to recriticality unlikely. The slower event progression associated with a LOCA shutdown will afford the plant staff with the opportunity to utilize other boric acid sources to makeup for lower RWST concentrations.

Over-boration concerns are addressed by acknowledging the fact that the large LOCA event (which is the origin of the concern) is of very low probability, the event progression is slower than that at power, so that added time exists to implement hot side/cold side injection, and operator misalignments are less likely. The boric acid concentrating process associated with the core boiloff is slower due to the reduced makeup requirements. Therefore, the proposed TS end state change does not affect the plant Defense-in-Depth.

Tier 2 Restrictions

None.

5.5.5 T.S. 3.3.8 (DIGITAL) CONTAINMENT PURGE ISOLATION SIGNAL[5]

The Containment Purge Isolation Signal (CPIS) provides automatic or manual isolation of any open containment purge valves upon indication of high containment airborne radiation. TS for Modes 1 through 4 allow plant operation with the containment mini-purge valves open. These valves receive closure signals on SIAS and CIAS. A CPIS is not required for (nor is it credited for) Mode 1 design basis accidents. During normal plant operation, the containment purge is used in Modes 1 through 4 only for instances of unusual buildup of containment radiation levels due to operating leakage.

Following an accident, unavailability of the CPIS in Mode 4 would prevent automatic ~~generation of the~~ containment purge isolation ~~signal~~. Without automatic isolation, the operator must manually isolate the containment purge. 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. For accidents initiated at power, confirmation of isolation of the containment purge system is included in the plant's Emergency Operating Instructions (EOIs) or (EOPs). Thus, limited duration operation in Mode 4 without the CPIS poses no significant risk to the health and safety of the public.

<u>Plant Applicability</u>

SONGS 2 & 3

<u>Limiting Condition for Operation (LCO)</u>

Two CPIS channels shall be OPERABLE in Modes 1, 2, 3 and 4, during CORE ALTERATIONS, and during movement of irradiated assemblies within containment.

<u>Licensing Basis for LCO</u>

The CPIS is a backup to the CIAS systems in Modes 1, 2, 3 and 4 and will close the containment purge valves in the event of high radiation levels resulting from a primary leak in the containment.

CPIS provides automatic or manual isolation of any open containment purge valves upon indication of high containment airborne radiation. For Modes 1 through 4, only the containment mini-purge valves may be open. These valves receive closure signals on SIAS and CIAS. CPIS is not required for (nor is it credited for) design basis accidents. It would be used in Modes 1 through 4 only for instances of unusual buildup of containment radiation levels due to operating leakage.

<u>Condition Requiring Entry into End State</u>

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.

<u>Proposed Modification for End State Required Actions</u>

Modify Mode 5 end state required action to allow component repair in Mode 4. Entry time into Mode 4 is proposed at 12 hours.

[5] Also known as Containment Purge Isolation Actuation Signal (CPIAS).

Defense-in-Depth Consideration

The requirements stated in the LCO define the performance of the containment as a fission product barrier. Specifically, this LCO requires that the containment leakage rates be limited in accordance with 10CFR50 Appendix J. Other LCOs place additional restrictions on containment air locks and containment isolation valves. The integrated effect of these TSs is to ensure that the containment leakage is well controlled within limits that assure that the post accident whole body and thyroid dose limits of 10CFR100 are satisfied following a Maximum Hypothetical Event initiated from full power. Inability to meet this leakage limit renders the containment inoperable.

The applicability of the TS 3.6.1 requirement to Mode 4 is rooted in tradition rather than consideration of risks. Accidents initiated from Mode 4 are far less challenging to the containment than those initiating from Mode 1. The lower energy content in Mode 4 results in containment pressures and potential leakage approximately one half of that associated Mode 1 releases. Furthermore, by having the plant in a shutdown condition in advance, fission product releases are significantly reduced. Thus, while leakage restrictions should be maintained, Mode 4 leakage in excess of that allowed in Mode 1 can be safely allowed for a limited time sufficient to effect repair of the leak and return the plant to power operation. Additionally, Mode 4 on SGHR (vs. Mode 5) would maintain more mitigating systems available to respond to loss of RCS inventory or decay heat removal events and therefore reduce the overall public risk. In Mode 4, SIAS and CIAS will be available to aid the operators in responding to events that threaten the reactor and/or containment integrity. Therefore, the proposed TS end state change does not affect the plant Defense-in-Depth.

Tier 2 Restrictions

Limitation on 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 may be formally Inoperable) and have the capability to perform their containment isolation function. Conditions where containment isolation 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.

5.5.15 T.S. 3.6.6 CONTAINMENT COOLING SYSTEMS

Containment cooling is required to ensure both long term containment integrity and sump cooling. 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, LCO 3.6.6B - Credit not taken for Iodine Removal by Containment Spray.

The design basis of the Containment Spray (CS) and cooling systems varies among the CE units. Most CE plants credit the CS and cooling systems for containment pressure and temperature control and one of the two systems for radio-iodine removal. In these plants typically, one train of CS is sufficient to effect radio-iodine 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 become increasing conservative (and restrictive) as the lower temperature shutdown modes are traversed. Plants that do not require containment cooling in Mode 4 include St. Lucie Units 1 & 2 and Palo Verde Units 1, 2 & 3. SONGS Units 2 & 3, ANO 2 and St. Lucie 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 will require transition to Mode 5. This end state transition was originally based on the expectation of very low Mode 5 risks when compared to alternate operating states. Mode 4 is generally the more robust (and lower risk) of the operating modes. Furthermore, when considering the Mode 4 containment challenge, the lower stored energy and decay heat of the reactor coolant system support the proposed use of a less robust 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 as documented in the SONGS 2 & 3 IPE (Reference 19). 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 assures 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.

Plant Applicability

ANO 2, Calvert Cliffs 1 & 2, Ft Calhoun, SONGS 2 & 3, Waterford 3

Limiting Condition for Operation (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 & 3 unavailability of one or more CS train(s) will require the plant to transition to Mode 4 in 84 hrs.

Licensing Basis for LCO

The TS notes that in Modes 1, 2, 3 and 4, a DBA could cause a release of radioactive material to containment and an increase in containment pressure and temperature, requiring the operation of the CS and containment fan coolers.

capability. Based on representative plant analyses performed in support of PRA containment success criteria, containment integrity may be ensured via use of a single fan cooler. Qualitatively similar conclusions could be drawn for one train of CS. Consequently, in Mode 4 one train of containment coolers or one train of CS assures adequate heat removal capability. Furthermore, ~~iodine removal by CS,~~ accidents initiated in Mode 4 may be adequately supported via one operable spray pump. Therefore, 84 hrs 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 that the driving force for a release of radioactive material from the RCS is reduced in Mode 3.

The requested 36 hrs 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.

Availability of SIAS and CCAS in Mode 4 also supports the operators in responding to events that threaten the reactor and/or containment integrity. Hence, modification of the end state of this TS to allow a Mode 4 end state allows plant operation in a condition of increased redundancy and diversity of core heat removal equipment without compromising Defense-in-Depth.

<u>Tier 2 Restrictions</u>

None.

levels. When Condition A of this TS can no longer be met, the plant must be shutdown and transitioned to Mode 5.

Section 5.4.3.4 indicates that the implied licensing basis assumption that Mode 5 is inherently of lower operational risk than in Mode 4 is not supported by risk evaluations. Mode 5 risks are either about equal to and likely greater than equivalent risks in Mode 4 and therefore produce radiation releases to containment on par with those of Mode 4. Furthermore, plant shutdown actions that require entry into SDC introduce the potential for LOCAs and RCS flow diversions. Thus, based on these PRA insights, remaining in Mode 4 (vs. Mode 5) while the Shield Building leakage condition is corrected is an appropriate action. This end state would maintain more mitigation systems available to respond to any event that could lead to a loss of RCS inventory or decay heat removal. Furthermore, in Mode 4 the SIAS and CIAS will be available to aid the operator in responding to events that threaten the reactor and/or containment integrity.

Inoperability of the Shield Building during Mode 4 implies leakage rates in excess of permissible values. Containment conditions following a LOCA in Mode 4 would result in containment pressures only marginally higher than in Mode 5. Since leakage from containment is controlled via TS 3.6.1, and no major leak paths are unisolable, there is no contribution to an increased LERF.

Defense-in-Depth Consideration

The requirements stated in the LCO define the performance of the Shield Building as a fission product barrier. Specifically, this LCO requires that the containment design leakage rate, L_a, is limited in accordance with 10CFR50 Appendix J. In addition, this TS places restrictions on containment air locks and containment isolation valves. The integrated effect of these TSs is to ensure that the containment leakage is well controlled within limits that assure that the post accident whole body and thyroid dose limits of 10CFR100 are satisfied following a Maximum Hypothetical Event initiated from full power. Inability to meet Shield Building and Containment leakage limits renders the containment inoperable.

The applicability of the TS 3.6.1 requirement to Mode 4 is rooted in tradition rather than consideration of risks. Accidents initiated from Mode 4 are far less challenging to the containment than those initiating from Mode 1. The lower energy content in Mode 4 results in containment pressures and leakage approximately one half of that associated with Mode 1 releases. Furthermore, by having the plant in a shutdown condition in advance, fission product releases are significantly reduced. Thus, while leakage restrictions should be maintained in Mode 4, leakage in excess of that allowed in Mode 1 should be allowed to effect repair of the leak and return the plant to power operation. Additionally, Mode 4 (vs. Mode 5) would maintain more mitigating systems available to respond to loss of RCS inventory or decay heat removal events. In Mode 4, SIAS and CIAS will be available to aid the operators in responding to events that threaten the reactor and/or containment integrity. Therefore, the proposed TS end state change does not affect the plant Defense-in-Depth.

Tier 2 Restrictions

None. Shield building inoperability should not result in a "large" radiation release pathway (See TS 3.6.1).

In Mode 5, the steam generators are not normally used for decay heat removal, and the AFW System is not required.

AFW is required for steam generator heat removal when MFW is not available. In Modes 1, 2 and 3, all three AFW pumps are required to be operable. In the Mode 4 base risk analysis of Section 5.4, the turbine-driven AFW pump is assumed to be unavailable due to low steam pressure.

In the SONGS Units 2 & 3 TSs, both motor-driven pumps are required to ensure that at least one train is available, given a single failure. However, in Mode 4, SONGS TS 3.7.5 states that only one pump is required.

Condition Requiring Entry into End State

1. One steam supply to turbine driven AFW pump inoperable, or
2. One AFW train inoperable [for reasons other than the above condition], or
3. Two AFW trains with two motor driven pumps inoperable, or
4. Two AFW trains with one motor driven pump and one steam driven pump inoperable and equipment not returned to service within the associated AOT/CT.

Proposed Modification for End State Required Actions

Mode 4 with heat removal via the SDC system with an 18 hour entry requirement.

Basis for Proposed Change

For cases in which both motor-driven pumps are available, remaining in Mode 4 should be a lower risk condition than continuing to Mode 5 because more diversity of heat removal and injection sources remain available. With impaired SG heat removal capability, and a fully operational SDC system, core heat removal via SDC is the preferred mode of heat removal when in the shutdown modes. NUREG-1432 also allows staying in Mode 4 if RCS heat removal requirements are fully met by the use of SDC trains. SDC on Mode 4 is preferred to Mode 5 since AFW remains a proceduralized backup (albeit impaired).

The eighteen hour time frame provides sufficient time for the plant staff to enter Mode 4 and place the plant in SDC. This time requirement is consistent with the current ISTS required action.

Defense-in-Depth Consideration

The AFW system provides feedwater to the steam generators to remove RCS decay heat upon loss of normal feedwater supply. The typical AFW system consists of 3 pumps (one turbine-driven and two motor-driven). One pump at full flow is sufficient to remove decay heat and cool the plant to SDC system entry conditions. The proposed modification to the end state of the TS to Mode 4 without reliance on SG heat removal is consistent with NUREG-1432 which allows staying in Mode 4 if RCS heat removal requirements are fully met by the use of SDC trains. Unavailability of AFW pumps limits the usefulness of SG heat removal. Hence SDC operation in Mode 4 under the TS conditions provides sufficient Defense-in-Depth for RCS heat removal.

Tier 2 Restrictions

None.

5.5.20 T. S. 3.7.9 ULTIMATE HEAT SINK[8]

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 DBA. The primary function of the UHS system is to remove heat from the CCW system. In this manner the UHS system also supports the SDC system. 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 will degrade the plant's capability to remove heat via the affected SDC heat exchanger. A Mode 4 end state with the RCS on SG heat removal is preferred to Mode 5 with RCS on SDC heat removal.

<u>Plant Applicability</u>

All CE PWRs except SONGS 2 & 3.

<u>Limiting Condition for Operation (LCO)</u>

Two UHS trains shall be OPERABLE in Modes 1, 2, 3 and 4.

<u>Licensing Basis for LCO</u>

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.

At least one UHS train must be able to operate to remove decay heat loads following a design basis accident. UHS is also used to provide heat removal during normal operating and shutdown conditions. Two 100% trains of UHS are provided to ensure adequate UHS flow assuming the worst single failure.

<u>Condition Requiring Entry into End State</u>

One UHS train inoperable and not restored to operability in TS AOT/CT.

<u>Proposed Modification for End State Required Actions</u>

Modify Condition B of TS to accommodate a Mode 4 end state with a 12 hour entry requirement.

<u>Basis for Proposed Change</u>

When the plant is in Mode 5, UHS is required to support Shutdown Cooling. So, the one operable UHS train (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. While design basis accidents are less likely and less severe in Mode 5, more mitigating systems are available in Mode 4 to respond to an event. As shown earlier, the risk of plant operation in Mode 4 is less than or similar to that for Mode 5.

<u>Defense-in-Depth Consideration</u>

The UHS system provides a heat sink for the removal of process and operating heat from the safety-related components during a transient or DBA. The primary function of the UHS system is to remove

---

[8] Calvert Cliffs designates the system as the Salt Water System; SWCS ~~is~~ performs the function of the ultimate heat sink at SONGS Units 2 & 3.

5.5.21 T.S. 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. The ECWS is actuated on SIAS and provides water to the HVAC units of the Emergency Safety Feature (ESF) equipment areas (e.g. main control room, electrical equipment room, safety injection pump area). The Applicability of this system is defined as Modes 1 through 4. The likelihood of a LOCA in Mode 4 and the heat loading on the system in Mode 4 are much reduced over the other applicable modes. Extended inoperability of this system in Mode 4 due to a single train out of service would not significantly impact Mode 4 risks. The remaining train is sufficient to maintain HVAC cooling. Repair of the ECW system in Mode 4 poses an overall lower plant 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.

<u>Plant Applicability</u>

PVNGS 1, 2 & 3, SONGS 1 & 2, Waterford 3

<u>Limiting Condition for Operation (LCO)</u>

Two ECW trains shall be OPERABLE in Modes 1, 2, 3 and 4.

<u>Licensing Basis for LCO</u>

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.

In Mode 5, potential heat loads are smaller and the probability of accidents requiring the ECW System is low.

ECW provides cooling to safety-related HVAC units to provide cooling to equipment required to operate during/following a design basis accident. 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.

<u>Condition Requiring Entry into End State</u>

Mode 5 entry is required when one ECW train is inoperable and not returned to service in the TS AOT/CT.

<u>Proposed Modification for End State Required Actions</u>

Modify Condition B of TS to accommodate a Mode 4 end state with a 12 hour entry requirement.

<u>Basis for Proposed Change</u>

ECW and normal HVAC are modeled in the PRA for all modes. ECW provides cooling to safety related HVAC. Because normal HVAC would be available in all non-LOOP situations, cooling to most plant equipment would remain available. Should an event occur during Mode 4, the post-accident heat loads would be significantly reduced (allowing more time for manual recovery actions, including alternate ventilation measures).

These measures include opening doors/vents and or provision for temporary alternate cooling equipment. Extended operability of the ECW in Mode 4 due to a single train out of service would not significantly impact Mode 4 risks. The remaining train is sufficient to maintain HVAC cooling. Repair of the ECW in Mode 4 poses an overall lower plant risk of core damage due to the robustness of Plant RCS heat removal

5.5.25 T.S. 3.7.15 PENETRATION ROOM EXHAUST AIR CLEANUP SYSTEM (PREACS)

The PREACS* filters air from the penetration area between the containment and the auxiliary building The PREACS consists of two independent, redundant trains. Each train consists of a heater, demister or prefilter, HEPA filter, activated charcoal absorber and a fan.

Plant Applicability

Calvert Cliffs 1 & 2, Waterford 3

Limiting Condition for Operation (LCO)

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

Licensing Basis for LCO

In Modes 1, 2, 3, 4, the PREACS must be OPERABLE to ensure that the penetration room filtering capability is within the 10CFR100 design basis assumptions. MHA assumptions and analyses are based on Mode 1 initiated events.

Condition Requiring Entry into End State

One PREACS train inoperable and required Action and associated Completion Time of Condition A not met in Modes 1, 2, 3 or 4.

Proposed Modification of 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 4 hours.
12

Basis for Proposed Change

Operation of penetration room PREACS has no direct impact on CDF and LERF as analyzed in the PRA. Regardless of the system status, the risk of Mode 4 is lower (or equivalent) to the similar Mode 5 operating state (See Section 5.4.3.4), since more mitigating systems are available in Mode 4 to respond to an event and there are additional risks associated with the transition to Mode 5 from Mode 4.

Since the risk of a transition to SDC and subsequent Mode 5 operation are greater than that incurred by continued operation in Mode 4, repairing the system while in Mode 4 is preferred.

Defense-in-Depth Consideration

The PREACS provides filtration for the penetration room area. This protects the public from radiological exposure resulting from containment leakage through penetrations. The current TS requires operability of PREACS from Modes 1 through 4. The need for the PREACS 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 ample capability to perform the function.

---

* At WSES the functions of the ECCS PREACS and PREACS is combined within the Controlled Ventilation Area (CVAS) Technical Specification.

with a proposed Mode 4 end state is less than the risk associated with the current Mode 5 end state. In Mode 5, it is likely that increased plant maintenance activities (particularly those involving the switchyard) will make the plants more susceptible to LOOP events.

The qualitative comparison of plant risk, as a measure of CDF and LERF, indicates that it is more risk significant to transition the plant to, and operate in, the current Mode 5 end state rather than remain in Mode 4 if the completion time for the required LCO actions cannot be met. Hence, Mode 4 is the preferred end state for this TS.

Defense-in-Depth Consideration

Entry into Mode 4 or remaining in Mode 4 as the end state when an LCO completion time cannot be met provides several advantages for the plant operating staff. Mode 4 operation ensures that the plant is shutdown and is at reduced temperature. Maintaining the plant in Mode 4 with degradation in the AC power sources is less risk significant than during Mode 5. Depending on the RCS conditions, the steam generators may or may not be available for RCS heat removal following an AOO or a design basis accident.

During Mode 4 with the steam generators available, plant risk is dominated by a Loss of Offsite Power (LOOP) initiating event. There are several redundant and diverse means available for removing heat from the RCS during this mode of operation. LCO entry resulting from the inoperability of both onsite AC sources (i.e. EDGs) followed by LOOP causes a station blackout event. For this event, the turbine driven auxiliary feedwater pump, which does not rely on the AC power sources to operate, is available for RCS heat removal via the steam generators during Mode 4. For all other LCO entries which do not lead to station blackout following LOOP during Mode 4, Feed and Bleed (for non 3410 MWt CE PWRs) capability is also 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.

During Mode 5 operation, the steam generators are not available for RCS heat removal. The SDC system is the only means available for removing heat from the RCS. Since the SDC system depends on the AC power sources to perform its function, RCS heat removal cannot be accomplished following a station blackout event during Mode 5 operation. This is similar to the case in Mode 4 with the unavailability of the steam generators during a station blackout event. Without RCS heat removal, boil-off of reactor coolant will occur much sooner, thus, reducing the time for recovery and consequently increasing plant risk. The plant configuration during Mode 5 involves the switching and realignment of AC buses (ESF and non-ESF) to offsite sources. The changing of transformer taps and other significant switchyard activities are performed during Mode 5. These activities degrade or eliminate the redundancy of electrical equipment that is available during Mode 4. Thus, the plant configuration in Mode 5 increases the likelihood of losing offsite power. This in turn increases the plant risk due to LOOP during Mode 5 operation. The risk of transitioning the plant to the current Mode 5 end state if the completion time for the LCO required action cannot be met also increases the overall plant risk associated with Mode 5.

Therefore, the proposed modification of the TS end state from Mode 5 to Mode 4 with SG heat removal provides several advantages for the plant operating staff such as more time to perform repair/recovery actions, provides diverse methods of RCS heat removal, results in a lower plant risk configurations and retains sufficient Defense-in-Depth.

5.5.27 T.S. 3.8.4 DC SOURCES – OPERATING

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. The DC system varies among CE PWRs. The risk assessment applies to all DC power configurations. For purposes of discussion, the description of the SONGS DC system is presented.

In Modes 1, 2, 3 and 4 the DC electrical power subsystems provide motive and control power to selected ESF equipment, which are required for shutting down the reactor and maintaining it in a safe condition following an AOO or postulated design basis accident. If an inoperable DC electrical power subsystem cannot be restored to operability within the required completion time, the plant operators must transition the plant to the Mode 5 end state. The risk associated with a proposed Mode 4 end state is less than the risk associated with the current Mode 5 end state.

For CE PWRs (with the exception of the San Onofre, Palo Verde, Calvert Cliffs and Waterford Units), 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 change(s) for each battery, and all the associated control equipment and interconnecting cables.

The 125 VDC electrical power system at SONGS consists of four independent and redundant safety related Class 1E DC electrical power subsystems (Train A, Train B, Train C and Train D). Each subsystem consists of one 125 VDC battery, a battery charger for the battery, and all the associated control equipment and interconnecting cabling.

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.

The 125 VDC loads vary among the CE 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 NSSS control power and DC power to Train C and Train D inverters, respectively. Train C DC subsystem also provides DC power to the Auxiliary Feedwater Pump inlet valve HV-4716 and the AFWP electric governor.

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. Each battery charger also has sufficient capacity to restore the battery to its fully charged state within the specified time period while supplying power to the connected loads. The DC sources are required to be operable during Modes 1, 2, 3 and 4 and connected to the associated DC buses. Consequently, Mode 5 is the current state for not restoring an inoperable DC electrical subsystem to operable status within 2 hours. Entry into the LCO for DC power sources implies that the DC power sources have been degraded.

Plant Applicability

All

battery charger also has sufficient capacity to restore the battery to its fully charged state within the specified time period while supplying power to the connected loads. The DC sources are required to be operable during Modes 1, 2, 3 and 4 and connected to the associated DC buses. Consequently, Mode 5 is the current state for not restoring an inoperable DC electrical subsystem to operable status within 2 hours. Entry into the LCO for DC power sources implies that the DC power sources have been degraded.

With a DC electrical power subsystem inoperable during Mode 4, the 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 advantages. For station blackout cases, the turbine-driven auxiliary feedwater pump is available for RCS heat removal when steam pressure is adequate. If this pump becomes unavailable, the lack of RCS heat removal initiates boiling 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 a significant amount of time to perform the necessary repair and/or recovery of offsite 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. Should the remaining train(s) fail, Feed and Bleed capability is available for certain CE PWRs to provide RCS heat removal. Units with Feed and Bleed capability when one DC power source is inoperable include those non 3410 MWt plants with sufficient bleed capability via one of the two PORV paths. All remaining units, including the 3410 MWt, will be incapable of RCS heat removal via Feed and Bleed because of design features or insufficient capacity via the remaining PORV path. Loss of the remaining train(s) of auxiliary feedwater and Feed and Bleed capability will ~~initiate~~ boiling in the steam generators, similar to the station blackout cases. Mode 4 operation with an inoperable DC power source provides the plant operators with the advantages of diverse means of RCS heat removal and significant amount of time to perform repairs and recovery before core uncovery occurs.

With a DC electrical power subsystem inoperable during Mode 5, the plant risk is also dominated by LOOP events. The plant configuration during this mode makes it much more likely than Mode 4 for a LOOP event to occur. The plant configuration during Mode 5 involves the switching and realignment of AC buses (ESF and non-ESF) to offsite sources. The changing of transformer taps and other significant ongoing switchyard activities are performed during Mode 5. These activities degrade or eliminate the redundancy of electrical equipment that is available during Mode 4. The increased LOOP challenges also increase the plant risk during Mode 5 operation. Should the RCS be vented in Mode 5 to establish CS pump backup for the SDC system, only the remaining train of SDC will be available for RCS heat removal. If the SDC system train becomes unavailable due to equipment failure or as a consequence of a station blackout, there are no redundant (independent) means of removing heat from the RCS. The lack of RCS heat removal via steam generators under such conditions leads to core uncovery in a much shorter time period because there is less total inventory to boil-off. The shorter time makes it less likely for the operators to perform the necessary repairs and recovery, thus increasing the plant risk during this mode of operation. The risk of transitioning the plant to the current Mode 5 end state when one inoperable DC power source cannot be restored to operability within 2 hours also increases the overall plant risk associated with this mode of operation.

Therefore, the proposed modification of the TS end state from Mode 5 to Mode 4 on SG heat removal provides several advantages for the plant operating staff such as more time to perform repair/recovery actions, provides diverse methods of RCS heat removal, results in a lower plant risk configuration, and retains sufficient Defense-in-Depth.

<u>Tier 2 Restrictions</u>

None.

5.5.28 *T.S. 3.8.7 INVERTERS – OPERATING*

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. The DC system varies among CE PWRs. The risk assessment applies to all DC power configurations. For purposes of discussion the description of the SONGs DC system is presented.

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 Protective System (RPS) and the Engineered Safety Feature Actuation System (ESFAS). The inverters ensure the availability of AC power for the systems instrumentation required to shutdown the reactor and maintain it in a safe condition after an Anticipated Operational Occurrence (AOO) 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. If an inoperable inverter cannot be restored to operability within the required 24 hour completion time, the plant operators must bring the plant to the Mode 5 end state. The risk associated with a proposed Mode 4 end state is comparable to or less than the risk associated with the current Mode 5 end state. The inoperability of an inverter during Mode 4 or 5 does not preclude the actuation of operable ESF equipment.

The 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 ensure 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 of no impact on plant risk. The inoperable inverter causes a loss of power to the associated bistable channel of RPS. Tripping of the reactor has already been accomplished prior to Mode 4 entry and the inoperability of an inverter will have no impact on the RPS. The inoperable inverter also causes a loss of power to one of the four ESFAS trip paths. This has no impact on the ability of the ESFAS to perform its function. Thus, there is no impact on the plant risk during this mode of operation.

The plant risk due to an inoperable inverter during Mode 5 is similar to the plant risk during Mode 4. However, the plant configuration during Mode 5 makes the unit more susceptible to a LOOP event due to the potential for ongoing switchyard activities. When the transition risk and the increased likelihood of a LOOP are considered, the overall plant risk associated with Mode 5 is larger than the plant risk associated with Mode 4. Hence, Mode 4 is the preferred end state for this TS.

Plant Applicability

Calvert Cliffs 1 & 2, Palisades, PVNGS 1, 2 & 3, SONGS 2 & 3, St. Lucie 2*

Limiting Condition for Operation (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.

* St. Lucie Unit 2 TS is 3.8.3.1

Table 5.5–1
Technical Specification End State Assessment

Technical Specification Action	Title	Current End State	Proposed End State	Plant Applicability	Proposed Basis	
					Relative Risk Assessment	**Deterministic Assessment**
3.7 Plant Systems						
SONGS 3.7.5 E.2 ISTS 3.7.5 C.2	Auxiliary Feedwater System	Mode 4 - 12 hrs	Mode 4 - 18 hrs without reliance upon SG for heat removal	All	Existing NUREG-1432 allows staying in Mode 4 if the RCS heat removal requirements are fully met by the use of SDC trains. It appears that flexibility already exists.	Unavailability of AFW limits usefulness of SG HR. In this situation, SDC operation in Mode 4 provides sufficient defense depth for RCS heat removal.
3.7.7 B.2	Component Cooling Water System (See App. C)	Mode 5 - 36 hrs	Mode 4 – 12 hrs	All except ANO 2	Component cooling needed for RCS heat removal in SDC (RCS heat removal). Vulnerable to SBO. Higher Mode 5 risk Mode 4 is lower risk than mode 5 since Mode 4 operation allows for non-CCW based RCS heat removal paths.	In addition to providing cooling to SDC heat exchangers, CCW supports the cooling of ECCS equipment, and cooling of RCPs. It also supports normal and emergency cooling of containment and post-accident heat removal during the recirculation mode. Unavailability of CCW reduces ability in one or more of the following areas: (1) Energy removal during SDC (2) RCP cooling during SG Heat Removal (3) Post-accident containment cooling, and (4) ECCS equipment cooling Availability of redundant train of CCW maintains design basis capability during repair.
3.7.8 B.2	Salt Water Cooling System / Service Water System / Essential Spray Pond System / Auxiliary CCW (See App. C)	Mode 5 -36 hrs	Mode 4 – 12 hrs on SGHR	All	Mode 4 is lower risk than mode 5 since Mode 4 operation allows for non-SDC based RCS heat removal paths Needed to support SDC heat removal function	The service water system supports the CCW system. It also supports required AC power sources (Emergency Diesel Generators) Availability of redundant train of equipment maintains design basis capability during repair.

Table 5.5–1
Technical Specification End State Assessment

Technical Specification Action	Title	Current End State	Proposed End State	Plant Applicability	Proposed Basis	
					Relative Risk Assessment	**Deterministic Assessment**
3.7.9 B.2	Ultimate Heat Sink (see App. C)	Mode 5 -36 hrs	Mode 4 – 12 hrs on SGHR	All except SONGS 2 & 3	Mode 4 is lower risk than mode 5 since Mode 4 operation allows for non-SDC based RCS heat removal paths Needed to support SDC heat removal function	The UHS supports the SWS system. Availability of redundant train maintains design basis capability during repair.
3.7.10 B.2	Emergency Chilled Water (see App. C)	Mode 5 -36 hrs	Mode 4 – 12 hrs	PVNGS 1,2 &3 SONGS 2 & 3 Waterford 3	Mode 4 is lower risk state than Mode 5 due to increased redundancy and diversity of equipment. Low RCS pressure restriction (PVNGS) further reduces potential for LOCAs and minimizes need for ECW system cooling.	In Modes 1, 2, 3 & 4, the ECW System is required to be OPERABLE when a LOCA or other accident would require ESF operation. The design basis of the ECW System is to remove the post-accident heat load from ESF spaces following a DBA coincident with a loss of offsite power. Availability of redundant train maintains design basis capability during repair.
3.7.11 B.2	CREACUS	Mode 5 - 36 hours	Mode 4 – 12 hrs	All	Mode 4 operation has greater system redundancy & diversity than mode 5 and hence results in lower operational risks. Also, the frequency of radiation challenges to CREACUS are lower in Mode 4 than Mode 5 due to the lesser Mode 4 CDF.	The CREACUS provides airborne radiological protection for the control room operators and protection from releases of toxic gases and chemicals. The redundant train of CREACUS remains operable. Mode 4 extended operation is allowable due to the low likelihood of an event requiring operator action that simultaneously challenges the CREACUS along with the unavailability of the redundant train.
3.7.12 B.2	CREATCS	Mode 5 -36 hrs	Mode 4 – 12 hrs	Calvert Cliffs 1 & 2 Palisades PVNGS 1,2 &3 Waterford 3	Mode 4 operation has greater system redundancy & diversity than mode 5 and hence results in lower operational risks.	The CREATCS is an emergency system which provides CR temperature control . The redundant train of CREATCS remains operable.

5.6 IMPLEMENTATION AND MONITORING PROGRAM

A three-tiered approach has been identified for licensees to evaluate the risk associated with TS changes. Per Regulatory Guide 1.177:

"Tier 1 is an evaluation of the impact on plant risk of the proposed TS change as expressed by the change in Core Damage Frequency (ΔCDF), the Incremental Conditional Core Damage Probability (ICCDP), and when appropriate, the change in Large Early Release Frequency (ΔLERF) and the Incremental Conditional Large Early Release Probability (ICLERP). Tier 2 is an identification of potentially high-risk configurations that could exist if equipment in addition to that associated with the change were to be taken out of service simultaneously, or other risk-significant operational factors such as concurrent system or equipment testing were also involved. The objective of this part of the evaluation is to ensure that appropriate restrictions on dominant risk-significant configurations associated with the change are in place. Tier 3 is the establishment of an overall configuration risk management program to ensure that other potentially lower probability, but nonetheless risk-significant, configurations resulting from maintenance and other operational activities are identified and compensated for."

5.6.1 TIER 1: PRA CAPABILITY AND INSIGHTS

The risk changes associated with the TS changes proposed in this report will be risk-neutral or risk beneficial. In order to ensure that the proposed TS changes, once implemented will not result in a significant increase in plant risk (i.e. CDF and LERF) plant risk will be assessed and monitored regularly.

5.6.2 TIER 2: AVOIDANCE OF RISK-SIGNIFICANT PLANT CONFIGURATIONS

For some risk-informed TSs, specific Tier 2 restrictions may be required. These restrictions are intended to provide a "defense in depth" approach to the risk-informed process. The Tier 2 restrictions are intended to preclude scheduled preventive maintenance on risk significant equipment combinations and operational activities. Tier 2 items apply only to planned maintenance situations or planned operational activities, but will be evaluated as part of the Tier 3 assessment for unplanned situations. Tier 2 items for the various proposed TS changes are discussed in Section 5.5.

The occurrence of Tier 2 equipment combinations during unplanned maintenance situations is not restricted. The presence of Tier 2 issues will be identified shortly upon entry in the Tier 2 condition(s), and actions to exit that condition should be expeditiously identified and implemented. In constructing the proposed end states, several required actions were established with specific heat removal requirements (e.g. SGHR or on SDC). These restrictions were developed to ensure the end state risk is controlled. In modifying TS 3.6.1, limitations were provided to ensure containment remains essentially functional. No other specific Tier 2 items were identified to support the proposed Mode 4 changes. However, in several instances enhanced guidance is provided. This additional guidance is intended to be administratively controlled within the scope of the plant Maintenance Rule or Analogous Program.

5.6.3 TIER 3: RISK-INFORMED CONFIGURATION RISK MANAGEMENT

At present, a formal commitment to the Configuration Risk Management Program (CRMP) is required on the part of the utility, prior to implementation of risk-informed TS. This CRMP commitment statement is currently included in Administrative Section of the respective plant's Technical Specification. In the future this commitment may be subsumed within the programs used to comply with 10CFR50.65 A(4).

The purpose of the CRMP is to ensure that a proceduralized PRA-informed process is in place to assess the overall impact of plant maintenance and operations on plant risk. The CRMP commitment applies whenever a risk-informed TS is entered and risk-informed TS components are out of service. The primary focus of the CRMP is to ensure that PRA based risk insights are considered in the planning of operations and maintenance on plant equipment, structures and components. The overall objective of these actions is to control the instantaneous plant risk at acceptable levels.

To comply with the requirements of the CRMP, an additional Action Requirement will be added to each TS as described in Section 5.4.4 to invoke the CRMP within 24 hours of entering the action to shutdown below Mode 3. Among other features, the CRMP program will ensure the availability of the redundant TS component via a common cause assessment.

5.6.4 MONITORING PROGRAM

A plant specific program for monitoring the utilization of these end state changes will be developed by the respective utilities. A description of this program will be provided at the time of the submittal.

Replace with INSERT (A)

Insert A

5.6.3 Tier 3: RISK-INFORMED CONFIGURATION RISK MANAGEMENT

Entry and use of the proposed changes will be performed in accordance with the requirements of 10 CFR 50.65(a)(4). This regulation requires licensees to assess and manage the risk that may result from maintenance activities and applies to all modes of reactor operation.

6.0 REFERENCES

1. NUREG-1432, "Standard Technical Specifications, Combustion Engineering Plants," Rev. 1, April 1995, USNRC.
2. RG 1.174, USNRC, "An Approach for using Probabilistic Risk Assessment in Risk Informed Decision on Plant Specific Changes to the Licensing Basis," USNRC, July 1998.
3. RG 1.177, "An Approach for Plant Specific Risk Informed Decision Making: Technical Specifications," USNRC, August 1998.
4. USNRC, 10CFR50.36, "Technical Specifications," Federal Register, 60FR36953, July 19, 1995.
5. NUREG-1449, "Shutdown and Low-Power Operation at Commercial Nuclear Power Plants in the United States," USNRC, September 1993.
6. AEOD/S95-01, "Reactor Coolant System Blowdown at Wolf Creek on September 17, 1994," USNRC-AEOD, March 1995.
7. GL 88-17, "USNRC Generic Letter 88-17: Loss of Decay Heat Removal," USNRC, October 17, 1988.
8. IN 95-03, "USNRC Information Notice 95-03: Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition," USNRC, January 18, 1995.
9. IN 95-03 (Supplent 1), "USNRC Information Notice 95-03: Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition," USNRC, March 25, 1996.
10. GL 98-02, "USNRC Generic Letter 98-02: Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition," USNRC, May 28, 1998.
11. IN 99-14, "USNRC Information Notice 99-14: Unanticipated Reactor Water Draindown at Quad Cities Unit 2, Arkansas Nuclear One Unit 2, and Fitzpatrick," USNRC, May 5, 1999.
12a. L-2289, Technical Report, "Analyses of Action Requirements for Failures in the Auxiliary Feedwater System of a PWR," T. Mankamo, I.S. Kim and P.K. Samanta, August 26, 1994.
13. CE NPSD-1045, "Joint Application Report: Modifications to Containment Spray System, and the Low Pressure Safety Injection System Technical Specifications," CE Owner's Group, March 1998.
14. Daily Event Report 35127, Salem: "Excessive Reactor Coolant Leakage...," USNRC, 12/09/98.
15. NUMARC 91-06, "Guidance for Industry Actions to Assess Shutdown Management," Nuclear Energy Institute, December 1991.
16. OPPD Letter FC-431-75A / LIC-75-0087 to NRC, "Loss of Component Cooling Water to Reactor Coolant Pump Seals," from T.E. Short, OPPD Division Manager-Production Operations, dated June 26, 1975.
17. GS-1520, "Report on Loss of Component Cooling Water Test on Nuclear Reactor Coolant Pump," Byron Jackson, April 9, 1979.
18. CEN-259, "An Evaluation of the Natural Circulation Cooldown Test Performed at The San Onofre Nuclear Generating Station: Compliance with the Testing Requirements of Branch Technical Position RSB 5-1," Combustion Engineering, January, 1984.
19. SONGS Units 2 & 3, "Individual Plant Examination," SCE, May 1993.
20. SONGS Units 2 Technical Specifications Bases, Amendment No. 127, 9/9/1999 (page B.3.6-28).

12b NUREG/CR-5995, Mankamo, T, et. al., "Technical Specification Statements requiring shutdown: A Risk Perspective with application to RHR/SSW systems of a BWR," prepared for USNRC, November, 1993.