June 4, 2003

MEMORANDUM TO: William D. Beckner, Program Director
Operating Reactor Improvements
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

FROM: Michael D. Tschiltz, Chief/**RA/** R. Dennig for
Probabilistic Safety Assessment Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: TECHNICAL REVIEW AND SAFETY EVALUATION INPUT OF TOPICAL REPORT CE NPSD-1208, JUSTIFICATION FOR RISK-INFORMED MODIFICATIONS TO SELECTED TECHNICAL SPECIFICATIONS FOR CONDITIONS LEADING TO EXIGENT PLANT SHUTDOWN (TAC# MB1257)

Reference: Memorandum from William D. Beckner to Richard J. Barrett, dated February 28, 2001.

In response to your request, the Probabilistic Safety Assessment Branch (SPSB) has performed a technical review of the referenced topical report. The findings of this review are documented in the attached input to the safety evaluation report.

The proposed TS changes are typically associated with plant conditions where both trains of a two-train redundant system are declared inoperable and at the same time there is either no specified action in the TS for the condition (requiring a default LCO 3.0.3 entry) or conditions exist where the defined action includes one hour shutdown requirement (explicit LCO 3.0.3 entry). The intent of the proposed TS changes is to provide a risk-informed alternative to the current LCO 3.0.3 requirements such that the plant staff has adequate time to fully evaluate the situation or restore loss of function while the plant remains operating at power, thus avoiding unnecessary unscheduled plant shutdowns and minimizing transition and realignment risks. In addition, several TS changes are proposed to allow a Mode 4 (hot shutdown) end state, for repair purposes, when the proposed extended time to initiate plant shutdown is not met.

CONTACT: Nick Saltos, SPSB/DSSA/NRR
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In the attached safety evaluation (SE), SPSB concludes that the requested TS changes are acceptable. Our finding is based on material contained in CE-NPSD-1208, supplemented by responses to requests for additional information (RAIs).

Attachment: Safety Evaluation

cc: Robert L. Dennig
Theodore R. Tjader
Kerri Kavanagh

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Attachment: Safety Evaluation

cc: Robert L. Dennig
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SAFETY EVALUATION OF CE NPSD-1208, “JUSTIFICATION FOR RISK-INFORMED MODIFICATIONS TO SELECTED TECHNICAL SPECIFICATIONS FOR CONDITIONS LEADING TO EXIGENT PLANT SHUTDOWN”

1.0 INTRODUCTION AND OBJECTIVES

The required action for conditions that imply a loss of function, related to a system or component included within the scope of the plant technical specifications (TS), is entry into limiting condition of operation (LCO) 3.0.3. Currently, upon entering LCO 3.0.3, one hour is allowed to prepare for an orderly shutdown before initiating a change in plant operation. This includes time to permit the operator to coordinate the reduction in electrical generation with the load dispatcher to ensure the stability and availability of the electrical grid. The Combustion Engineering Owners Group (CEOG) is proposing to define and/or modify various TS Required Action statements to accommodate extension of the currently required time of one hour to initiate plant shutdown. The proposed extension, related to specific systems or components, is based on the system’s risk significance and varies from 4 hours to 72 hours. In addition, a proposal is included to modify several action statements, related to specific systems or components, to allow for a Mode 4 (hot shutdown) end state for repair purposes when the time requirements of the action statement for staying at power cannot be met.

The proposed changes are typically associated with plant conditions where both trains of a two-train redundant system are declared inoperable and at the same time there is either no specified action in the TS for the condition (requiring a default LCO 3.0.3 entry) or conditions exist where the defined action includes one hour shutdown requirement (explicit LCO 3.0.3 entry). The intent of the proposed TS changes is to provide a risk-informed alternative to the current LCO 3.0.3 requirements such that the plant staff has adequate time to fully evaluate the situation or restore loss of function while the plant remains operating at power, thus avoiding unnecessary unscheduled plant shutdowns and minimizing transition and realignment risks. In support of the proposed TS changes, the CEOG submitted topical report CE-NPSD-1208 (Ref. 1) entitled “Justification for Risk-Informed Modifications to Selected Technical Specifications for Conditions Leading to Exigent Plant Shutdown.”

The topical report CE-NPSD-1208 (Ref.1) provides also system-specific integrated justifications (i.e., risk and defense-in-depth arguments) for several proposed TS action statement changes to allow a Mode 4 (hot shutdown) end state, for repair purposes, when the proposed extended time to initiate plant shutdown cannot be met. These justifications are based on generic risk assessments documented in topical report CE-NPSD-1186 (Ref. 2), entitled “Technical justification for the Risk-Informed Modification to Selected Required Action End States for CEOG PWRs” which has been reviewed by the staff.

The intent of the proposed TS changes is to provide needed flexibility in the performance of corrective maintenance during power operation and at the same time enhance overall plant safety by:

- avoiding unnecessary unscheduled plant shutdowns,

- minimizing plant transitions and associated transition and realignment risks,

- providing increased flexibility in scheduling and performing maintenance and surveillance activities, and

- providing explicit guidance in areas that currently does not exist.

It should be noted that many of the proposed TS changes affect the existing plant shutdown requirements for plant conditions where the plant operation is not in explicit compliance with the plant design basis. The proposed actions provide a risk-informed process for establishing shutdown priorities aiming at reducing overall plant risk and increasing public health and safety protection.

The proposed TS changes, including end state changes, are summarized in Table 1 of this safety evaluation report (SER). Such changes cover a diverse range of systems and components with essentially four separate impacts on plant risk. They are:

- TS changes related to systems or components contributing to accident prevention. The removal of these systems/components has the potential to increase the plant risk through the increased potential for plant upsets (i.e., potential for increased initiated event frequencies). A typical example in this category are the pressurizer heaters whose unavailability could complicate the complexity of plant pressure control and lead to a plant trip.

- TS changes related to systems or components contributing to accident mitigation. These systems are in standby during normal plant operation and are intended to function during accidents to prevent core damage. Typical examples in this category are the Emergency Core Cooling System (ECCS) and the Pressurized Power Operated Relief Valves (PORVs).

- TS changes related to systems or components contributing to large early release prevention. The primary role of these systems is to function during a core damage accident to prevent large releases of radioactive materials. A typical example in this category is the containment (the only component in this category for which a TS change is proposed).

- TS changes related to systems/components contributing to control of delayed radiation releases to the environment. The primary role of these systems is to prevent radiation releases above TS limits and meet design basis requirements. Thus, the unavailability of these systems has no impact on the surrogate risk metrics associated with core damage and large early releases. Typical examples in this category are the ECCS room ventilation system and the containment iodine cleanup system.

Although the improved standard technical specification (ISTS) numbering system (Ref. 3) is used for convenience in Table 1, the analyses provided in the submitted report (Ref. 1) support these changes for all CEOG Pressurized Water Reactor (PWR) plants.

Table 1 Summary of Proposed Modifications to Technical Specifications.

ISTS #	SYSTEM	INOPERABILITY CONDITION	CURRENT ACTION AND ASSOCIATED COMPLETION TIME (CT)	PROPOSED CHANGES: COMPLETION TIME(CT) AND END STATE
LCO 3.1.9 (Non-ISTS)	Boration System	System inoperable	No condition defined. Default LCO 3.0.3 entry.	24 hrs CT for restoring one path. Allow Mode 3 end state.
LCO 3.4.9	Pressurizer Heaters	Both groups of class 1E heaters inoperable	No condition defined. Default LCO 3.0.3 entry.	24 hrs CT for restoring one group. Allow Mode 4 end state.
LCO 3.4.11	Pressurizer Power Operated Relief Valves (PORVs) and Associated Block Valves (BVs)	<u>ISTS CONDITION E (or equivalent)</u>: Two PORVs inoperable and not capable of being manually cycled. <u>ISTS CONDITION F (or equivalent)</u>: Two BVs inoperable.	Varies with plant. <u>ISTS CONDITION E (or equivalent)</u>: Immediate shutdown if the PORVs are not isolated and one PORV is not restored within one hour. <u>ISTS CONDITION F (or equivalent)</u>: Immediate shutdown if the PORVs are not placed in manual control within 1 hour and one BV is not recovered within 2 hours.	<u>ISTS CONDITION E (or equivalent)</u>: Allow 8 hours CT to restore one PORV, assuming they are both isolated within 1 hour. No end state change. <u>ISTS CONDITION F (or equivalent)</u>: Allow 8 hours to restore one BV, assuming PORVs are placed in manual control within 1 hour. No end state change.
LCO 3.5.1	Safety Injection Tanks (SITs)	Two or more SITs inoperable (ISTS CONDITION D)	Explicit 3.0.3 entry	24 hours CT for restoring one SIT. Allow Mode 4 end state.
LCO 3.5.2	Low Pressure Safety Injection (LPSI)	Two LPSI trains inoperable (ISTS CONDITION D)	Explicit 3.0.3 entry	24 hours CT for restoring one train. Allow Mode 4 end state.
LCO 3.5.2	High Pressure Safety Injection (HPSI)	Two HPSI trains inoperable (ISTS CONDITION D)	Explicit 3.0.3 entry	4 hours CT for restoring one train. No end state change requested.
LCO 3.6.6A	Containment Spray System (CSS)	Two CSS trains inoperable (w/o and with containment air recirculation coolers or CARC)	Explicit 3.0.3 entry	12 hrs [72 hrs] CT for restoring one train if CARC is not [is] available.

Table 1 Summary of Proposed Modifications to Technical Specifications (Continued).

ISTS #	SYSTEM	INOPERABILITY CONDITION	CURRENT ACTION AND ASSOCIATED COMPLETION TIME (CT)	PROPOSED CHANGES: COMPLETION TIME(CT) AND END STATE
LCO 3.6.10	Iodine Cleanup System (ICS)	Two ICS trains inoperable	Default 3.0.3 entry (no condition defined)	24 hours CT for restoring one train. Allow Mode 4 end state.
LCO 3.6.1	Containment (CTMT)	Inoperable	Defined 1 hour shutdown (Mode 5 in 36 hours)	8 hours CT for restoring one train. Allow Mode 4 end state.
LCO 3.6.13	Shield Building Exhaust Air Cleanup System (SBEACS)	Two trains inoperable	Default 3.0.3 entry (no condition defined)	24 hours CT for restoring one train if containment cooling is available and containment is intact (default to LCO 3.6.1 otherwise). Allow Mode 4 end state.
LCO 3.7.11	Control Room Emergency Air Cleanup System (CREACS)	Two trains inoperable	Explicit 3.0.3	24 hours CT for restoring one train (applicable to nuclear hazard only). Allow Mode 4 end state.
LCO 3.7.12	Control Room Emergency Air Temperature Control System (CREATCS)	Two trains inoperable	Explicit 3.0.3	24 hours CT for restoring one train. Allow Mode 4 end state.
LCO 3.7.13	Emergency Core Cooling System (ECCS) Pump Room Exhaust Air Cleanup System (ECCS Pump Room EACS)	Two trains inoperable	Default 3.0.3 entry (no condition defined)	24 hours CT for restoring one train. Allow Mode 4 end state.
LCO 3.7.15	Penetration Room Exhaust Air Cleanup System (Penetration Room EACS)	Two trains inoperable	Default 3.0.3 entry (no condition defined)	24 hours CT for restoring one train. Allow Mode 4 end state.

The CEOG report (Ref. 1) documents a risk-informed analysis of the proposed TS changes. Probabilistic Risk Assessment (PRA) results and insights are used, in combination with results of deterministic assessments, to identify and justify the proposed TS changes for all CEOG PWR plants. This is in accordance with guidance provided in Regulatory Guides (RGs) 1.174 and 1.177 (Refs 4 and 5, respectively).

The approach used to assess the risk impact of the proposed changes is discussed and evaluated in Section 2. Section 3 evaluates the results of the risk assessment. Section 4 provides integrated justifications (i.e., both probabilistic and deterministic arguments) for each of the proposed system-specific TS changes. Finally, section 5 summarizes the staff's conclusions from the review of the proposed TS changes.

2.0 RISK ASSESSMENT APPROACH

The objective of the CEOG's risk assessment was to show that the implementation of the proposed TS changes are not expected to lead to any significant risk increases. In performing the risk-informed assessments and interpreting the results, the following two assumptions are tacitly made:

- A condition resulting in the inoperability of a system or component which currently results in the need for an immediate shutdown is an infrequent event. This is evidenced by the fact that plant shutdowns due to entries into LCO 3.0.3 conditions are rare. Furthermore, when such a condition does arise, the actual cause of the inoperability is often due to an incomplete "paper trail" or a partial system failure rather than a deleterious common-cause failure of critical components leading to a functional failure of an entire system.

- The risk incurred by increasing the required shutdown action time is controlled to acceptable levels using a risk informed approach that considers the component risk worth and offsetting benefits of avoiding plant transitions.

The risk impact of the proposed TS changes was assessed following the three-tiered approach recommended in RG 1.177 for evaluating proposed extensions in currently allowed Completion Times (CTs):

- The first tier involves the assessment of the change in plant risk due to the proposed TS change. Such risk change is expressed (1) by the change in the average yearly core damage frequency (ΔCDF) and the average yearly large early release frequency (ΔLERF) and (2) by the incremental conditional core damage probability (ICCDP) and the incremental conditional large early release probability (ICLERP). The assessed ΔCDF and ΔLERF values are compared to acceptance guidelines, consistent with the Commission's Safety Goal Policy Statement as documented in RG 1.174, so that the plant's average baseline risk is maintained within a minimal range. The assessed ICCDP and ICLERP values are compared to acceptance guidelines provided in RG 1.177 which aim at ensuring that the plant risk does not increase unacceptably during the period the equipment is taken out of service.

- The second tier involves the 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 equipment testing were also involved. The objective is to ensure that appropriate restrictions are in place to avoid any potential high-risk configurations.

- The third tier involves the establishment of an overall configuration risk management program (CRMP) to ensure that potentially risk-significant configurations resulting from maintenance and other operational activities are identified. The objective of the CRMP is to manage configuration-specific risk by appropriate scheduling of plant activities and/or appropriate compensatory measures.

The approach used in implementing the three-tiered approach of RG 1.177 to support the proposed TS changes is summarized and evaluated in the following Sections 2.1 to 2.3.

2.1 Risk Impact

This section summarizes and evaluates the approach used to assess the risk impact of the proposed extensions of the time interval for initiating plant shutdown when a safety system or function are unavailable. These conditions are associated with LCO 3.0.3 which currently requires initiating plant shutdown within one hour from the time such conditions are discovered. The risk impact measures, and associated success criteria, which are used in the risk-informed decision making process are defined and evaluated in Section 2.1.1. The methodology which was used to assess the various risk impacts of changes, covering a diverse range of systems and components with different impacts on plant risk, are discussed and evaluated in Sections 2.1.2 to 2.1.4.

2.1.1 Risk Impact Measures and Acceptance Criteria

The guidance provided in RG 1.177 addresses only systems/components contributing to core damage frequency (CDF) and/or large early release frequency (LERF). However, in the risk-informed analysis provided by the CEOG, the philosophy of the three-tiered approach was extended to encompass also TS changes involving systems/components contributing to radiation release prevention other than large early release. For this purpose, appropriate risk measures (similar to ΔLERF and ICLERP) and acceptance criteria were introduced for systems whose function is to prevent radiation releases other than large early release.

The ICCDP associated with the proposed extension of the time interval for initiating plant shutdown when a system is declared inoperable, a condition which currently requires an immediate plant shutdown (within one hour), is expressed by the following equation:

$$ICCDP = \Delta R_{CDF} \cdot d = (R_{1,CDF} - R_{o,CDF}) \cdot d \qquad (1)$$

where:

ΔR_{CDF} = the conditional risk increase, in terms of CDF, caused by the specified system's unavailability,

d = the proposed extension of the time interval during which the plant is allowed to keep operating at power given the condition,

$R_{1,CDF}$ = the plant CDF with the system (or component) permanently unavailable,

$R_{o,CDF}$ = the plant CDF without the proposed time extension.

A similar expression is used for ICLERP by substituting the appropriate measure of risk, i.e., LERF instead of CDF.

$$ICLERP = \Delta R_{LERF} \cdot d = (R_{1,LERF} - R_{o,LERF}) \cdot d \qquad (2)$$

where:

ΔR_{LERF} = the conditional risk increase, in terms of LERF, caused by the specified system's unavailability,

d = the proposed extension of the time interval during which the plant is allowed to keep operating at power given the condition,

$R_{1,LERF}$ = the plant LERF with the system (or component) permanently unavailable,

$R_{o,LERF}$ = the plant LERF without the proposed time extension.

The changes in CDF and LERF (i.e., ΔCDF and ΔLERF, respectively) for each system or component are obtained by multiplying the respective ICCDP and ICLERP values by the yearly frequency, f, the system or component is expected to be declared inoperable:

$$\Delta CDF = ICCDP \cdot f \qquad (3)$$

$$\Delta LERF = ICLERP \cdot f \qquad (4)$$

For TS changes related to systems or components contributing to accident initiation and/or core damage prevention, the risk impact is measured in terms of both CDF and LERF. For these systems values for ICCDP and ΔCDF as well as for ICLERP and ΔLERF were assessed. For TS changes related to systems or components contributing to large early release prevention, the risk impact is measured only in terms of LERF. Therefore, for these systems only values for ICLERP and ΔLERF were assessed.

Risk impact measures similar to ICLERP and ΔLERF were introduced for systems and components whose function is to prevent radiation releases other than large early release. These risk impact measures are (1) the incremental conditional radiation release (above TS limits) probability, ICRRP, and (2) the change in the radiation release (above TS limits) frequency, ΔRRF. A similar expression as the ones used for ICCDP and ICLERP (equations 1 and 2, respectively) can be used for ICRRP by substituting the appropriate measure of risk, i.e., radiation release (above TS limits) frequency (RRF) instead of CDF:

$$ICRRP = \Delta R_{RRF} \cdot d = (R_{1,RRF} - R_{o,RRF}) \cdot d \qquad (5)$$

where:

ΔR_{RRF} = the conditional risk increase, in terms of RRF, caused by the specified system's unavailability, d = the proposed extension of the time interval during which the plant is allowed to keep operating at power given the condition,

$R_{1,RRF}$ = the plant RRF with the system permanently unavailable,

$R_{o,RRF}$ = the plant RRF without the proposed time extension.

The change in RRF (i.e., ΔRRF) for each system or component is obtained by multiplying the respective ICRRP value by the yearly frequency, f, the system or component is expected to be declared inoperable:

$$\Delta RRF = ICRRP \cdot f \qquad (6)$$

The assessed ICRRP and ΔRRF values are compared to acceptance criteria similar to the ones reported in RGs 1.177 and 1.174 for core damage and large early release risks, respectively. The results of the risk assessments, in terms of the various risk measures, and their comparison to acceptance criteria are discussed in Section 3 of the SER.

The acceptance criteria for core damage and large early release risks are selected based on guidance provided in RGs 1.174 and 1.177. Regulatory Guide 1.174 indicates that a ΔCDF smaller than 1E-6/year and a ΔLERF smaller than 1E-7/year are considered very small. Therefore, the length of the extended time intervals which are proposed to replace the one hour action statement in LCO 3.0.3 were selected to satisfy these criteria.

Acceptance guidelines provided in Regulatory Guide 1.177 for evaluating the core damage and large early release risks associated with a "single AOT entry" are also considered. These guidelines, which are based on traditionally acceptable levels of risk increases during equipment outages for maintenance activities, indicate that an ICCDP smaller than 5E-7/year and an ICRERP smaller than 5E-8/year are considered very small. The length of the extended time intervals, which are proposed to replace the one hour action statement in LCO 3.0.3, are selected to satisfy also these criteria. However, small deviations are allowed in some cases in agreement with the following statements included in Regulatory Guide 1.177:

- The acceptance guidelines are intended to provide an indication in numerical terms of what is considered acceptable and, therefore, should not be interpreted as being overly prescriptive.

- The intent in comparing the PRA results with the acceptance guidelines of RG 1.177 is to demonstrate, with reasonable assurance, consistency with the Commission's Safety Goal Policy Statement so that the plant's average baseline risk is maintained within a minimal range (i.e., meet the acceptance criteria for ΔCDF and ΔLERF). In this case, since the entry into LCO 3.0.3 is a significantly less frequent event than LCO entries on which the numerical values mentioned in RG 1.177 are based, the acceptance criteria for ΔCDF and ΔLERF can be met with reasonable assurance even when the numerical values of the acceptance guidelines provided in RG 1.177 are not strictly met. The frequency of events leading to LCO 3.0.3 is not expected to increase significantly following the proposed change because such events are reportable, require a licensee event report (LER) and are used in performance indicators and the reactor oversight program.

- The numerical guidelines should be taken into account along with other considerations, including operating experience and practical considerations associated with test and maintenance practices. An important such consideration, related to LCO 3.0.3 entry, is the need for adequate time for plant staff to diagnose a condition resulting in the inoperability of a system and restore its function and, thus, avoid transition to shutdown risk.

As shown by the results discussed below in Section 3, the above mentioned RG 1.177 criteria are strictly met for most of the proposed TS-specific changes. For a few cases, small deviations are used in accordance with the above listed statements. As discussed in Section 3, even in such cases the RG 1.177 criteria would most likely be strictly met if the avoided shutdown risk and the effect of the various conservative assumptions had been taken into account.

The staff's evaluation of the use of the acceptance criteria, in determining the proposed extension of the time interval for initiating plant shutdown when a system is declared inoperable, is discussed in Section 3 of this SER where risk assessment results are presented and discussed.

Acceptance criteria for radiation release risks, other than large early release risks, are also defined. It is conservatively assumed that a ΔRRF value smaller than 1E-7 per year (i.e., the same as for a large release) is considered very small and, therefore, acceptable. In addition, in order to ensure that the acceptance criterion for ΔRRF will be met, the ICRRP value for each entry is required to be smaller than 5E-7 (i.e., the same value used in the criterion for ICCDP). It should be noted that the conservative acceptance criteria for radiation release risks, other than large early release risks, are introduced for the purposes of this evaluation and should not be generalized or interpreted as NRC guidance for other risk-informed applications.

2.1.2 Approach for Assessing Core Damage Risk Impact

The proposed TS changes involve two categories of systems and components which require different approaches for assessing the risk impact, in terms of core damage, associated with the unavailability of such systems and components. The first category includes standby safety systems and components which contribute to accident mitigation and core damage prevention. The second category refers to systems and components whose unavailability contributes to core damage through the initiation of accidents.

<u>Systems Contributing to Accident Mitigation</u>

A bounding generic approach for evaluating the ICCDP and ΔCDF values, for each of the proposed TS changes associated with systems and components in this category, is used. The conditional core damage risk increase, ΔR_{CDF}, which is used to assess the value of ICCDP according to equation (1) and the value of ΔCDF according to equation (3) of Section 2.1.1, is conservatively assumed to be the same as the system's (or component's) yearly challenge frequency. This assumption is conservative because in many cases plants have the capability to mitigate a range of events using alternative equipment and procedures or using available equipment which are less than the optimal set. An example of an alternative success path, for which no credit is taken in the assessment when two HPSI trains are unavailable, is the ability to use an aggressive reactor coolant system (RCS) cooldown to minimize inventory loss and allow alternative makeup capability using the charging pumps or the LPSI pumps. An example of using available equipment which are less than the optimal set, for which no credit is taken in the assessment when two or more SITs are unavailable, is the ability to use the available SITs together with the LPSI pumps to mitigate a significant range of large LOCAs.

Table 2 Challenge Frequency of Mitigating System or Component by Accident Initiating Event.

System/ Component Unavailable	Event Frequency (per year)						Component Challenge Frequency (per year)
	LOCA	SGTR	Stuck Open PORV	Stuck Open PSV	Transients with F&B	ATWS	
SIT	5.0E-6	0.0	0.0	0.0	0.0	0.0	5.0E-6
LPSI	4.5E-5	~0.0	0.0	0.0	0.0	0.0	4.5E-5
HPSI (plants with PORVs)	5.5E-4	7.0E-5	1.0E-3	2.5E-3	1.0E-3	0.0	5.1E-3
HPSI (plants w/o PORVs)	5.5E-4	7.0E-5	0.0	2.5E-3	0.0	0.0	3.1E-3
CS (plants w/o CARCS)	5.5E-4	~0.0	~0.0	~0.0	~0.0	~0.0	5.5E-4
PORV	0.0	0.0	0.0	0.0	1.0E-3	8.4E-6	1.0E-3
Boration System	0.0	0.0	0.0	0.0	0.0	1.7E-5	1.7E-5

A system's or component's challenge frequency was assessed quantitatively by considering all accident sequences by accident initiating event, modeled in the probabilistic risk assessment (PRA) of representative CEOG plants, that require operation of the specific system or component to mitigate the accident. The assessed challenge frequencies, for all systems and components contributing to accident mitigation that are associated with the proposed TS changes, are reported in Table 2.

It should be noted that only internal initiating events are considered in estimating a system's or component's challenge frequency. However, the risk assessment results would not be significantly different to impact any conclusions had external initiating events been considered, for two reasons. First, the system's (or component's) challenge frequency used in the risk assessments was estimated conservatively. The staff's review indicated that, for the most limiting cases, the challenge frequency estimates used in the assessments are as much as two times higher than estimates found in most PRA applications using internal events only. Second, the proposed TS changes will be implemented with certain Tier 2 requirements (discussed in Section 4 of this report). The purpose of these Tier 2 requirements is to limit the challenge frequency of an inoperable system or component and ensure that appropriate compensatory measures are in place. Such Tier 2 requirements are expected to reduce the challenge frequency of an inoperable system or component from all initiating events, including external events.

In addition to the total challenge frequency, Table 2 also reports contributions to a system's (or component's) total challenge frequency that are associated with important accident categories analyzed in PRAs, such as LOCAs and Transients with stuck open PORVs. The total challenge frequency of a system or component is the sum of all contributions associated with the various accident categories.

In addition to the conservatism introduced by assuming that a system's or component's challenge frequency equals the conditional core damage risk increase, ΔR, when the system or component is unavailable, the challenge frequency values themselves are assessed conservatively. For example, the value of the challenge frequency of the feed-and-bleed (F&B) function, which is calculated as the product of the frequency of loss of main feedwater (MFW) and the unavailability of auxiliary feedwater (AFW), is based on bounding values for both the frequency of initiating events leading to loss of MFW (0.5/yr) and the unavailability of the AFW (2E-3).

The change in CDF, ΔCDF, for each system or component is obtained by multiplying the respective ICCDP value by the yearly frequency, f, the system or component is expected to be declared inoperable (i.e., $\Delta CDF = ICCDP \cdot f$). For the purpose of this study, the value of the yearly frequency, f, is conservatively assumed to be equal to 0.2 (i.e., once every five years) and the same for all systems and components associated with the proposed TS changes. The assumed frequency value is based on an industry review of licensee event reports (LERs) which concluded that entry into LCO 3.0.3 due to any inoperability of multiple trains or components has occurred with a frequency of less than once per five years. This average value is conservative for two reasons. First, the actual LCO 3.0.3 entry frequencies associated with the inoperability of risk important systems contributing to core damage and/or large early release frequency, such as the HPSI system, are significantly smaller than the 0.2 per year value which is an average for all systems and components. Second, experience indicates that when an entry into an LCO 3.0.3 is required, the system is often partially functional (e.g., an ECCS inoperability that occurred on February 5,1998 at SONGS-2 affected the recirculation mode of operation only) and the condition can be corrected in a short time (e.g., less than one hour).

The staff concludes that the approach used to assess the core damage risk impact, for systems and components contributing to accident mitigation, is acceptable.

<u>Systems Contributing to Accident Initiation</u>

The proposed TS changes include only one system in this category, the Class 1E pressurizer heaters. ISTS LCO 3.4.9 includes requirements for both groups of safety-related pressurizer heaters to have minimum heating power and emergency power supply capability. The safety-related pressurizer heaters have two primary functions. One function is to keep the reactor coolant in a subcooled condition with natural circulation following a loss of offsite power (LOOP) event during which the normally available station powered non-safety related heaters become unavailable. Although no credit is taken in design basis accident analyses for the pressurizer heaters, they have been included in the TS because they are needed to maintain long term subcooling during a LOOP event. However, pressurizer heaters are not required to achieve a post-trip plant cooldown since successful cooldown can be achieved, with minimal impact on plant risk, due to the availability of reactor vessel and pressurizer vents. Consequently, the pressurizer heaters do not have a significant role in the mitigation of core damage events.

A second function of the safety-related pressurizer heaters is to back up the station powered non-safety related heaters which are normally available to control reactor coolant pressure during steady state operation. The unavailability of these heaters would reduce the plant's ability to control the normal operating parameters and consequently will increase the potential of plant trip. The approach used to assess the risk associated with this increased plant trip potential is described below.

The conditional core damage risk increase, ΔR_{CDF}, which is used to assess the value of ICCDP according to equation (1) and the value of ΔCDF according to equation (3) of Section 2.1.1, is calculated as the product of the increase in the initiating event (reactor trip) frequency, ΔIE, associated with the unavailability of the safety-related heaters and the probability of core damage given a normal plant high or low pressure trip, CDP_{trip} (i.e., $\Delta R_{CDF} = \Delta IE \cdot CDP_{trip}$). Bounding values of ΔIE (0.05 plant trip events/day or, equivalently, 18.3 plant trip events/year) and CDP_{trip} (6E-6) are used in the assessment. The value of ΔIE was calculated by assuming that the plant trip frequency increases by over an order of magnitude (from 0.004 to 0.05 events/day) when the safety-related pressurizer heaters are unavailable. This assumption is conservative because the normal station powered (non-class 1E) heaters are available for reactor coolant pressure control. It should be noted that the availability of the non-class 1E heaters will be required for extending plant shutdown initiation, as proposed. The assumed value of CDP_{trip} (6E-6) is based on previous PRA results and bounds the assessed values for CEOG plants.

The change in CDF, ΔCDF, is obtained by multiplying the respective ICCDP value by the yearly frequency, f, the class 1E pressurizer heaters are expected to be declared inoperable (i.e., $\Delta CDF = ICCDP \cdot f$). The value of the yearly frequency, f, is conservatively assumed to be equal to 0.2. The rationale is the same as for the case of systems and components contributing to accident mitigation discussed in this section.

The staff concludes that the approach used to assess the core damage risk impact, for systems and components contributing to accident initiation, makes use of conservative assumptions and is acceptable.

2.1.3 Approach for Assessing Large Early Release Risk Impact

The proposed TS changes involve two categories of systems and components which require different approaches for assessing the risk impact, in terms of large early release frequency, associated with the unavailability of such systems and components. The first category includes safety systems and components whose unavailability leads to a CDF increase and, therefore, also to a LERF increase. The second category refers to systems and components whose function is to mitigate the effects of a core damage and prevent large early releases (i.e., their unavailability leads to a direct LERF increase).

Systems Contributing to Accident Initiation and/or Core Damage Prevention

A bounding generic approach is used to assess the ICLERP and ΔLERF values for each of the proposed TS changes associated with systems and components in this category. The conditional large early release risk increase, ΔR_{LERF}, which is used to assess the value of ICLERP according to equation (2) of Section 2.1.1, is calculated as the product of two terms: The system's or component's conditional core damage risk increase, ΔR_{CDF} (which is conservatively assumed to be equal to the system's or component's yearly challenge frequency as discussed in Section 2.1.2) and the conditional large early release probability given core damage, CLERP (i.e., $\Delta R_{LERF} = \Delta R_{CDF} \cdot \text{CLERP}$). The staff noted that there could be an additional contribution to ΔR_{LERF} which has been ignored in the assessment. Such contribution is associated with core damage sequences where the containment's ability to retain the damaged core is impacted by the system's or component's unavailability without a corresponding CDF increase. However, the staff's review has determined that, for the systems and components impacted by the proposed changes, the impact of this omission on the results of the risk assessment (i.e., the assessed value of ΔR_{LERF}) is too small to change any conclusions.

The approach used to assess the CLERP values for all applicable systems and components associated with the proposed TS changes is discussed below in this section.

A large early release is defined as the significant and unmitigated release of radioactivity from the containment in a time frame prior to effective evacuation of population such that there is a potential for early health effects. Such a release results from events which lead to containment failure at or shortly after vessel breach, containment bypass events and loss of containment isolation. A CEOG review of large early release scenarios for the Combustion Engineering (CE) designed pressurized water reactors (PWRs) indicated that early releases arise as a result of one of three classes of scenarios: (1) containment bypass events; (2) severe accidents accompanied by loss of containment isolation; and (3) containment failure associated with energetic events in the containment. The first class of scenarios includes interfacing system loss of coolant accidents (ISLOCAs) and steam generator tube ruptures (SGTRs) with a concomitant loss of steam generator (SG) isolation (e.g., due to stuck open main steam isolation valves). The second class of scenarios includes any severe accident in conjunction with failure to isolate the containment. The third class of scenarios includes high-pressure melt ejection (HPME) phenomena, including direct containment heating (DCH), and hydrogen conflagrations and detonations. A simplified large early release (LER) event tree was developed and used to assess conservatively the contributions to CLERP from each of these three classes of scenarios which are likely to result in a large early release. The sum of such contributions is the total plant CLERP.

The CLERP value is the fraction of the conditional core damage risk increase, ΔR_{CDF}, which propagates into a large early release event. Bounding CLERP values were assessed, for each system and component associated with the proposed TS changes, using a simplified LER event tree with the following top events:

- Containment isolation following core damage;
- High reactor coolant system (RCS) pressure at core damage;
- Secondary side depressurization of the SGs;
- Thermally-induced SGTR; and
- Containment failure due to reactor pressure vessel (RPV) lower head failure.

The assessed CLERP values are based on conservative assumptions and data, such as the following:

- The probability of containment isolation failure was assumed to be 3E-3. This value is based on containment isolation failure data used in PRAs performed by CEOG member utilities which range between 1E-4 and 3E-3.

- All incremental CDF arising from PORV or boration system unavailability results in a high RCS pressure plant damage state with no possibility of operator actions to depressurize the RCS prior to failure of the reactor vessel lower head.

- 20% of incremental CDF arising from HPSI system unavailability results in a high RCS pressure plant damage state. This is a conservative assumption since the HPSI system is primarily used to mitigate moderate and low pressure events.

- 50% of incremental CDF arising from a reactor trip induced by the unavailability of the safety-related pressurizer heaters results in a high RCS pressure plant damage state.

- The probability of SG tube failure (prior to failure of the RCS) when exposed to high pressure core damage states is assumed to be 50% (assuming secondary side depressurization). This probability is associated with severely degraded SG tubes and therefore is conservative. In addition, it is assumed that all thermally-induced SGTR events are large early releases.

- The probability of SG depressurization, via operator action or failure of a main steam safety valve (MSSV) to close, is assumed to be 10% (successful SG isolation is needed to maintain SG tube integrity for high RCS pressure plant damage states). It should be noted that sensitivity studies were performed with the probability of SG depressurization increased to 30% which is very conservative.

- The conditional containment failure probability due to high pressure melt injection (HPMI) is assumed to be 1%.

The quantification of the simplified LER event tree, with the above mentioned conservative assumptions, resulted in the following five large early release scenarios (labeled CLERP-1 to CLERP-5) assuming a core damage event:

CLERP-1: High RCS pressure plant damage state, the containment is isolated, the SG is depressurized due to a stuck open MSSV and thermally-induced SG tube rupture occurs resulting in a large early release.

CLERP-2: High RCS pressure plant damage state, the containment is isolated and the SG is depressurized due to a stuck open MSSV with the SG tubes intact but an HPME failure occurs resulting in a large early release.

CLERP-3: High RCS pressure plant damage state, the containment is isolated and the SG pressurized but thermally-induced SG tube rupture occurs resulting in a large early release.

CLERP-4: High RCS pressure plant damage state, the containment is isolated and the SG pressurized with tubes intact but an HPME failure occurs resulting in a large early release.

CLERP-5: Failure to isolate the containment which results in a large early release.

The assessed conditional large early release probabilities, given core damage, for these scenarios are summarized in Table 3 for each applicable system or component associated with the proposed TS changes. The sum of such contributions is the total plant CLERP.

Table 3 Conditional Large Early Release Probability (CLERP) Estimates, Given Core Damage, Due to Unavailability of Mitigating Systems and Components.

	CLERP-1	CLERP-2	CLERP-3	CLERP-4	CLERP-5	CLERP
SIT	0.0	0.0	0.0	0.0	3.0E-3	3.0E-3
LPSI	0.0	0.0	0.0	0.0	3.0E-3	3.0E-3
HPSI (plants with PORVs)	1.0E-2	1.1E-4	1.8E-3	2.0E-3	3.0E-3	1.7E-2
HPSI (plants w/o PORVs)	1.0E-2	1.1E-4	1.8E-3	2.0E-3	3.0E-3	1.7E-2
CS (plants w/o CARCS)	1.0E-2	1.1E-4	1.8E-3	2.0E-3	3.0E-3	1.7E-2
PORV	5.0E-2	5.5E-4	9.0E-3	9.9E-3	3.0E-3	7.2E-2
Boration System	5.0E-2	5.5E-4	9.0E-3	9.9E-3	3.0E-3	7.2E-2
Pressurizer Heaters	2.5E-2	2.7E-4	4.5E-3	4.9E-3	3.0E-3	3.8E-2

Even though the assessed CLERP values are based on conservative assumptions and data, a sensitivity study was performed on two key parameters which are dominant CLERP contributors. These parameters are: (a) the probability that a thermally-induced SGTR will occur in advance of another RCS structure failure, and (b) the probability that an MSSV will fail open depressurizing one SG. The objective of the sensitivity study is to provide reasonable assurance that there are no areas of uncertainty, in modeling assumptions and data, which could have a significant impact on results and conclusions. The results of the sensitivity study are discussed and evaluated in Section 3.

The staff finds that conservative assumptions and data were used to assess the values of the quantities (e.g., ΔR_{CDF}, LERP and f) needed to estimate the change in LERF (i.e., ΔLERF). The bounding nature of the approach used to assess the large early release risk impact, in combination with the performance of a sensitivity study on two key parameters which are dominant CLERP contributors, provide adequate assurance about the robustness of the results used to support the proposed TS changes.

Systems Contributing to Large Early Release Prevention Given Core Damage

This category refers to systems and components whose function is to mitigate the effects of a core damage and prevent large early releases (i.e., their unavailability leads to a direct LERF increase). The only component in this category which is associated with the proposed TS changes is the containment. Since large early releases result from a gross opening in the containment, such as a stuck open purge valve, it is assumed that all core damage events proceed to a large early release. Thus, the conditional large early release risk increase, ΔR_{LERF}, which is used to assess the values of ICLERP and ΔLERF according to equations (2) and (4) of Section 2.1.1, respectively, is equal to the plant's CDF (assumed to be 1E-4/year). The staff review finds that this approach is bounding because it is conservatively assumed that (1) any containment inoperability will completely degrade the containment and (2) a plant's CDF is 1E-4/year (for most plants the CDF at power operation from internal and external events is less than1E-4/year).

2.1.4 Approach for Assessing Non-Large Early Release (Non-LER) Risk Impact

This category refers to systems and components whose function is to prevent radiation releases other than large early release. Availability of such equipment is typically required to meet design basis dose limits. The conditional non-LER risk increase, ΔR_{RRF}, which is used in assessing the value of ICRRP according to equation (5) as well as the value of and ΔRRF according to equation (6) of Section 2.1.1, is equal to the plant's CDF (assumed to be 1E-4/year) except for the emergency core cooling system (ECCS) penetration room emergency air cleanup system (PREACS). The value of ΔR_{RRF} for the ECCS PREACS was assessed to be 4.5E-5/year since the challenge of this system is limited to core damage events associated with large and medium LOCAs only. The staff review finds that this approach is bounding because it is conservatively assumed that (1) equipment in this category, except for the ECCS PREACS, are challenged for sure (i.e., with probability of 1) during a core damage event and (2) a plant's CDF is 1E-4/year (for most plants the CDF at power operation from internal and external events is less than1E-4/year). The staff also finds that the challenge frequency of 4.5E-5/year assumed for the ECCS PREACS is bounding because this system will not be challenged unless the core damage event is associated with large and medium LOCAs only.

2.1.5 Uncertainty/Sensitivity Evaluation

As stated in sections 2.1.2 to 2.1.4, the performed risk assessments in support of the proposed TS changes are based on many conservative assumptions. Nevertheless, areas of potential uncertainty, in both data and modeling assumptions, were identified which could have an impact on results and conclusions. Some of these areas of uncertainty are associated with design and operational variability among the various CEOG plants. The following areas of potential uncertainty were identified (all associated with systems or components whose loss of function contributes to CDF or LERF):

- The system's or component's challenge frequency,

- The system's or component's average loss of function frequency,

- The probabilities of two key parameters which are dominant CLERP contributors: (a) the probability of occurrence of a thermally-induced SGTR in advance of another RCS structure failure (event TI-SGTR); and (b) the probability that an MSSV will fail open depressurizing one SG (event SGD).

These areas of uncertainty were evaluated, by performing the following two sensitivity studies (for each system or component), to determine how they impact the results and conclusions of the risk assessments:

- In sensitivity case #1, the risk impact was re-assessed with simultaneous changes of the values of three parameters as follows:

  - The probability of occurrence of a thermally-induced SGTR in advance of another RCS structure failure (event TI-SGTR) was increased from 50% (base case) to 100%;

  - the probability that an MSSV will fail open depressurizing one SG (event SGD) was increased from 10% to 30%;

  - the frequency of loss of function was increased from once every five years to once every three years.

- In sensitivity case #2, the risk impact was re-assessed using the upper 95th percentile value of the system's or component's challenge frequency.

The staff concludes that the performed sensitivity studies, in conjunction with the many conservative and bounding assumptions and data used in the base case analyses (discussed in sections 2.1.2 to 2.1.4), provide adequate information regarding the robustness of the risk assessment results.

2.2 Identification of Potentially High Risk Configurations

The second tier of the three-tiered approach recommended in RG 1.177 involves the identification of potentially high-risk configurations that could exist if equipment, in addition to that associated with the TS change, were to be taken out of service simultaneously. Insights from the risk assessments, in conjunction with important assumptions made in the analyses and defense-in-depth considerations, were used to identify such configurations. To avoid these potentially high-risk configurations, specific restrictions to the implementation of the proposed TS changes are proposed. For example, when the safety-related pressurizer heaters are unavailable, the availability of the non-class 1E heaters will be required for extending plant shutdown initiation, as proposed. These restrictions, labeled "Tier 2 Restrictions," are discussed in Section 5 of the CEOG Topical Report CE NPSD-1208 (Ref. 1) and are evaluated in Section 4 of this SER where integrated justifications (i.e., justifications using both risk and defense-in-depth arguments) are provided for each of the proposed system-specific TS changes.

2.3 Configuration Risk Management

The third tier of the three-tiered approach recommended in RG 1.177 involves the establishment of an overall configuration risk management program (CRMP) to ensure that potentially risk-significant configurations resulting from maintenance and other operational activities are identified. The objective of the CRMP is to manage configuration-specific risk by appropriate scheduling of plant activities and/or appropriate compensatory measures. This objective is met by licensee programs to comply with the Maintenance Rule 10 CFR 50.65 (a)(4) requirement to assess and manage risk resulting from maintenance and other operational activities. These programs can support licensee decision making regarding the appropriate actions to control risk whenever a risk-informed TS is entered.

3.0 RISK ASSESSMENT RESULTS AND INSIGHTS

The risk assessment approach, documented in section 2, was implemented to the system-specific technical specifications listed in Table 1 (Section 1). In addition to the base case risk assessments, two sensitivity cases (discussed below) were performed to draw insights regarding the robustness of the results. The core damage and large early release risk impacts (base case) are summarized in Tables 4 and 5, respectively. In addition to the base case results, the results of two sensitivity cases are reported in Tables 6 and 7, for proposed TS changes related to systems and components contributing to core damage and/or large early release. Finally, the assessed risk impacts for systems and components which contribute to non-LER, only, are summarized in Table 8. As discussed below, no sensitivity analyses were necessary for systems and components contributing to non-LER due to the consistently conservative assumptions used in the analysis in conjunction with the conservative interpretation of the risks associated with such systems and components.

Table 4 summarizes the risk impact, in terms of CDF change, ΔCDF, for each of the proposed TS changes related to systems and components contributing to core damage and/or large early release. The first column lists the systems and components for which a TS change is proposed. The second column lists the new proposed completion time (CT) to restore the system's or component's function before initiation of plant shutdown is required according to LCO 3.0.3. The third column is the conditional risk increase, in terms of CDF, ΔR_{CDF}, caused by the system's or component's loss of function. As discussed in section 2 above, ΔR_{CDF} was conservatively assumed to be the same as the system's or component's challenge frequency. The fourth column lists the ICCDP values for continued plant operation at power for the entire proposed CT given loss of the system's or component's function. The ICCDP values are obtained by multiplying the proposed CT value (column 2) by ΔR_{CDF} (column 3). The fifth column lists the assessed average expected CDF changes, ΔCDF, associated with the proposed CT extensions. The ΔCDF values are obtained by multiplying the corresponding ICCDP value by the average frequency of loss of function (which in the base case risk assessment was assumed to occur once every five years for all the systems and components listed in the first column).The assessed ΔCDF values (fifth column of Table 4) indicate that all proposed TS changes for the systems and components listed in Table 4 would have an insignificant risk impact with respect to core damage (significantly less than the acceptance criterion of 1E-6/year for core damage frequency based on guidance provided in RGs 1.174 and 1.177). This conclusion is true without any credit for the averted risk associated with avoiding plant shutdown or any consideration for the many conservative assumptions used in the risk assessment.

The assessed ICCDP values (fourth column of Table 4) are also within RG 1.177 acceptance guidelines. With the exception of HPSI and PORVs, the ICCDP is smaller than 5E-7 which is considered very small and acceptable. Based on the arguments presented in section 2 above, where the "acceptance criteria" are discussed, the small ICCDP deviations from the numerical guideline of 5E-7 shown for HPSI and PORVs in Table 1 are in agreement with guidance provided in RG 1.177 and, therefore, acceptable. It should be noted that the intent of the numerical guideline for ICCDP is to ensure that the acceptance criterion for ΔCDF is met. In this case, since the entry into LCO 3.0.3 is a significantly less frequent event than LCO entries on which the numerical values mentioned in RG 1.177 are based, the acceptance criterion for ΔCDF can be met with reasonable assurance even when the numerical value of the acceptance guideline for ICCDP provided in RG 1.177 is not strictly met. Furthermore, the RG 1.177 numerical guideline of 5E-7 would most likely be strictly met also for HPSI and the PORVs if the avoided shutdown risk and the effect of the various conservative assumptions had been taken into account.

Table 4 Core Damage Risk Impact Results.

Component/System	Proposed CT (hrs)	ΔR_{CDF}/yr or Challenge Frequency/yr	ICCDP	ΔCDF
SIT	24	5.0E-6	1.3E-8	2.6E-9
LPSI	24	4.5E-5	1.2E-7	2.4E-8
HPSI (Plants w/ PORVs)	4	5.1E-3	1.7E-6	3.5E-7
HPSI (Plants w/o PORVs)	4	3.1E-3	1.1E-6	2.1E-7
CS (no CARC available)	12	5.5E-4	6.9E-7	1.4E-7
PORV	8	1.0E-3	8.1E-7	1.6E-7
Boration System	24	1.7E-5	4.5E-8	9.0E-9
Pressurizer Heaters	24	1.0E-4	2.9E-7	5.8E-8
Containment	8	1.0E-4	N/A	N/A

The frequency of events leading to LCO 3.0.3 is not expected to increase significantly following the proposed change because such events are reportable, require a licensee event report (LER) and are used in performance indicators and the reactor oversight program. An observation of the values of the conditional risk increase (in terms of CDF, ΔR_{CDF}), listed in the third column of

Table 4, indicates that the loss of function for any of the systems/components listed in column 1 would be found by the significance determination process (SDP) to be a risk significance event. Therefore, licensees will have no incentive to allow the current low frequency of these events to increase after the proposed extensions are granted.

Table 5 summarizes the risk impact, in terms of LERF change, ΔLERF, for each of the proposed TS changes related to systems and components contributing to large early release. The first three columns are identical with those in Table 4. The fourth column lists the total plant CLERP values (from Table 3) given the unavailability of the corresponding system or component listed in the first column. The fifth column is the conditional risk increase, in terms of LERF, ΔR_{LERF}, caused by the corresponding system's or component's loss of function. The ΔR_{LERF} value for each system and component list in the first column is obtained by multiplying the ΔR_{CDF} value (column 3) by the corresponding CLERP value(column 4). The sixth column lists the ICLERP values for continued plant operation at power for the entire proposed CT given loss of the system's or component's function. The ICLERP value for each system and component listed in the first column is obtained by multiplying the proposed CT value (column 2) by the corresponding ΔR_{LERF} value (column 3). Finally, the seventh column lists the assessed average expected LERF changes, ΔLERF, associated with the proposed CT extensions. The ΔCDF values are obtained by multiplying the corresponding ICLERP value by the average frequency of loss of function (which in the base case risk assessment was assumed to occur once every five years for all the systems and components listed in the first column).

Table 5 Large Early Release Risk Impact Results.

Component/System	Proposed CT (hrs)	ΔR_{CDF}/yr	CLERP	ΔR_{LERF}/yr	ICLERP	ΔLERF/yr
SIT	24	5.0E-6	3.0E-3	1.5E-08	4.1E-11	9.0E-12
LPSI	24	4.5E-5	3.0E-3	1.4E-07	3.7E-10	7.4E-11
HPSI (Plants w/ PORVs)	4	5.1E-3	1.7E-2	8.6E-05	3.9E-08	7.8E-09
HPSI (Plants w/o PORVs)	4	3.1E-3	1.7E-2	5.2E-05	2.4E-08	4.8E-09
CS (Plants w/o CARC)	12	5.5E-4	1.7E-2	9.3E-06	1.3E-08	2.5E-09
PORV	8	1.0E-3	7.2E-2	7.3E-05	6.7E-08	1.3E-08
Boration System	24	1.7E-5	7.2E-2	1.2E-06	3.4E-09	6.7E-10
Pressurizer Heaters	24	1.0E-4	3.8E-2	3.8E-06	1.1E-08	2.3E-09
Containment	8	1.0E-4	1.0	1.0E-04	9.0E-08	1.8E-08

The assessed ΔLERF values indicate that all proposed TS changes, for the systems and components listed in the first column, would have an insignificant risk impact with respect to large early release (significantly less than the acceptance criterion of 1E-7/year based on guidance provided in RGs 1.174 and 1.177). This conclusion is true without any credit for the averted risk associated with avoiding plant shutdown or any consideration for the many conservative assumptions used in the risk assessment.

The assessed ICLERP values are also within RG 1.177 acceptance guidelines. With the exception of the PORVs, the ICLERP is smaller than 5E-8 which is considered very small and acceptable. Based on the arguments presented in section 2 above, where the "acceptance criteria" are discussed, the small ICLERP deviation from the numerical guideline of 5E-8 shown for the PORVs in Table 5 are in agreement with guidance provided in RG 1.177 and, therefore, acceptable. What is stated above with respect to ICCDP is also valid for ICLERP (i.e., the intent of the numerical guideline for ICLERP is to ensure that the acceptance criterion for ∆LERF is met). In this case, since the entry into LCO 3.0.3 is a significantly less frequent event than LCO entries on which the numerical values mentioned in RG 1.177 are based, the acceptance criterion for ∆LERF can be met with reasonable assurance even when the numerical value of the acceptance guideline for ICLERP provided in RG 1.177 is not met. Furthermore, the RG 1.177 numerical guideline of 5E-8 would most likely be met also for PORVs if the avoided shutdown risk and the effect of the various conservative assumptions had been taken into account.

Table 6 summarizes the results of sensitivity case #1. The risk impact was re-assessed with more conservative assumptions and data which were determined to be associated with areas of potential uncertainty that could have a significant impact on results and conclusions.

Table 6 Sensitivity Case #1 Risk Impact Results (SGD=0.3 and TI-SGTR =1 and f= 1/3).

Component/System	Proposed CT (hrs)	ICCDP	∆CDF/yr	ICLERP	∆LERF/yr
SIT	24	1.3E-8	4.4E-9	1.3E-10	4.4E-11
LPSI	24	1.2E-7	3.9E-8	1.2E-09	4.0E-10
HPSI (Plants w/ PORVs)	4	1.7E-6	5.8E-7	1.3E-07	4.2E-08
HPSI (Plants w/o PORVs)	4	1.1E-6	3.5E-7	7.7E-08	2.6E-08
CS (Plants w/o CARC)	12	6.9E-7	2.3E-7	5.0E-08	1.7E-08
PORV	8	8.1E-7	2.7E-7	2.6E-07	8.7E-08
Boration System	24	4.5E-8	1.5E-8	1.4E-08	4.8E-09
Pressurizer Heaters	24	2.9E-7	5.8E-8	4.8E-08	1.6E-08
Containment	8	N/A	N/A	9.0E-08	3.0E-08

Even though it is believed that the CLERP values for the base case were assessed conservatively, the probabilities of two key parameters which are dominant CLERP contributors have been increased to or close to their upper bounds. The probability of occurrence of a thermally-induced SGTR in advance of another RCS structure failure (event TI-SGTR) was increased from 50% (base case) to 100% and the probability that an MSSV will fail open depressurizing one SG (event SGD) was increased from 10% to 30%. In addition, the frequency of loss of function was increased from once every five years to once every three years. The objective of this sensitivity study was to provide additional assurance that there are no areas of uncertainty, in modeling assumptions and data, which could have a significant impact on results and conclusions.

The results of sensitivity case #1 indicate an insignificant risk impact, with respect to both core damage and large early release (the ΔCDF and the ΔLERF values for all proposed TS changes are smaller than 1E-6/yr and 1E-7/yr, respectively), even for such "bounding" assumptions. Furthermore, this conclusion is true without any credit for the averted risk associated with avoiding plant shutdown.

Table 7 summarizes the results of sensitivity case #2. Even though the base case risk impact is based on several conservative assumptions, as discussed in section 2.1.2 above, the risk impact was re-assessed using the upper bound 95th percentile value of the challenge frequency for each system or component listed in the first column of Table 7. The objective of this sensitivity study was to provide additional assurance that there are no areas of uncertainty, associated with the challenge frequency estimates, which could have a significant impact on results and conclusions. The 95th percentile values of the challenge frequency are listed in column 3 (as discussed in section 2, the conditional core damage risk increase was conservatively assumed to be the same as the system's or component's challenge frequency).

Table 7 Sensitivity Case #2 Risk Impact Results (95% Challenge Frequency Distribution Limit).

Component/System	Proposed CT (hrs)	ΔR_{CDF}/yr	ICCDP	ΔCDF/yr	ICLERP	ΔLERF/yr
SIT	24	1.0E-5	2.6E-8	5.2E-9	8.2E-11	1.6E-11
LPSI	24	1.1E-4	2.9E-7	5.8E-8	9.0E-10	1.8E-10
HPSI (Plants w/ PORVs)	4	1.4E-2	4.8E-6	9.2E-7	1.1E-07	2.2E-08
HPSI (Plants w/o PORVs)	4	9.6E-3	3.3E-6	6.6E-7	7.4E-08	1.5E-08
CS (Plants w/o CARC)	12	1.1E-3	1.4E-6	2.8E-7	2.5E-08	5.1E-09
PORV	8	2.5E-3	2.0E-6	4.0E-7	1.6E-07	3.3E-08
Boration System	24	2.5E-5	6.8E-8	1.4E-8	5.0E-09	1.0E-09

The results of sensitivity case #2 indicate an insignificant risk impact, with respect to both core damage and large early release (the ΔCDF and the ΔLERF values for all proposed TS changes are smaller than 1E-6/yr and 1E-7/yr, respectively), even for such "bounding" assumptions.

Furthermore, this conclusion is true without any credit for the averted risk associated with avoiding plant shutdown.

Table 8 summarizes the risk impact, in terms of radiation release frequency (RRF) change, ΔRRF, for each of the proposed TS changes related to systems and components contributing to radiation release (non-LER). Availability of such equipment is typically required to meet design basis dose limits.

The first column lists the systems and components for which a TS change is proposed. The second column lists the new proposed completion time (CT) to restore the system's or component's function before initiation of plant shutdown is required according to LCO 3.0.3. The third column is the conditional radiation release (non-LER) risk increase, ΔR_{RRF}, caused by the

Table 8 Radiation Release (Non-LER) Risk Impact.

Component/System	Proposed CT (hrs)	ΔR_{RRF}/yr, or Challenge Frequency/yr	ICRRP	ΔRRF/yr (f = 1/5)	ΔRRF/yr (f = 1/3)
Iodine Cleanup System (ICS)	24	1.0E-4	2.6E-7	5.0E-8	8.3E-8
Shield Building Exhaust Air Cleanup System (SBEACS)	24	1.0E-4	2.6E-7	5.0E-8	8.3E-8
Control Room Emergency Air Cleanup System (CR-EACS)	24	1.0E-4	2.6E-7	5.0E-8	8.3E-8
Control Room Emergency Air Temperature Control System (CR-EATCS)	24	1.0E-4	2.6E-7	5.0E-8	8.3E-8
Penetration Room Exhaust Air Cleanup System (PR-EACS)	24	1.0E-4	2.6E-7	5.0E-8	8.3E-8
Emergency Core Cooling System Pump Room Exhaust Air Cleanup System (ECCS-PREACS)	24	4.5E-5	1.1E-7	2.0E-8	3.3E-8
Containment Spray (for plants w/ CARC)	72	1.0E-4	8.0E-7	1.6E-7	2.7E-7

system's or component's loss of function (conservatively assumed, except for the ECCS PREACS, to be challenged for sure during a core damage event). The fourth column lists the ICRRP values for continued plant operation at power for the entire proposed CT given loss of the system's or component's function. The ICRRP values are obtained by multiplying the proposed CT value (column 2) by ΔR_{RRF} (column 3). The last two columns list the assessed average expected RRF changes, ΔRRF, associated with the proposed CT extensions, for two different loss of function frequencies (i.e., the base case frequency of once very five years and the more conservative case of once every three years). The ΔRRF values are obtained by multiplying the corresponding ICRRP value by the average frequency of loss of function (i.e., by 0.2 and 0.33, respectively).

The assessed ICRRP values (fourth column) as well as the ΔRRF values for both the base and the sensitivity case (last two columns of Table 8) are within the acceptance guidelines for radiation release (non-LER) risks. Such acceptance guidelines are discussed in section 2.1.1 where conservative acceptance criteria for radiation release risks, other than large early release risks, are defined in analogy to the criteria documented in RGs 1.174 and 1.177 for CDF and LERF (i.e.,1E-7 per year for ΔRRF and 5E-7 for ICRRP). With the exception of Containment Spray (for plants with containment air recirculation coolers or CARC), all proposed changes meet the acceptance criteria. The small deviations from the numerical guidelines for Containment Spray (for plants w/CARC) also support the proposed change, especially when credit for the averted core damage and large early release risk associated with avoiding plant shutdown is taken into consideration. No sensitivity analyses were necessary for systems and components contributing to radiation releases (non-LER) due to the consistently conservative assumptions used in the analysis in conjunction with the conservative interpretation of the risks associated with such systems and components.

As for systems and components contributing to core damage and large early release, licensees will have no incentive to allow the current low frequency of loss of function for systems and components contributing to non-large early release to increase significantly after the proposed extensions are granted. Loss of function events are reportable, even for systems and components whose function is to mitigate radiation release (non-LER). Such events also require a licensee event report (LER) and are used in performance indicators and the reactor oversight program.

The staff finds that the risk assessment results support the proposed changes. The risk increases associated with the proposed TS changes, if any, will be insignificant based on guidance provided in RGs 1.174 and 1.177. Furthermore, the sensitivity studies and the many conservative assumptions used in the analyses provide adequate assurance about the robustness of the results used to support the proposed TS changes.

4.0 EVALUATION OF SYSTEM-SPECIFIC INTEGRATED JUSTIFICATIONS

There are two categories of proposed system-specific TS changes. The first category includes changes associated with plant conditions requiring entry into LCO 3.0.3 to extend the time for restoring the system's or component's loss of function, thus avoiding unnecessary unscheduled plant shutdowns and minimizing transition and realignment risks. The generic risk assessment for such changes is documented in topical report CE-NPSD-1208 (Ref. 1) which is the subject of this safety evaluation report. The second category includes changes to TS action statements to allow a Mode 4 (hot shutdown) end state, for repair purposes, when the proposed extended time to initiate plant shutdown cannot be met. The generic risk assessment for such changes is documented in topical report CE-NPSD-1186 (Ref. 2) which has been reviewed and approved by the staff. While all proposed system-specific TS changes include changes to extend the time for restoring the system's or component's loss of function (first category changes), most proposed system-specific TS changes include, also, changes to modify the end state (second category changes). Therefore, the integrated justifications, discussed in this section, include insights from the generic risk assessments documented in both topical reports CE-NPSD-1208 (Ref. 1) and CE-NPSD-1186 (Ref. 2).

Due to the nature of the plant conditions associated with the proposed TS changes (i.e., loss of a system's or component's function), the redundancy and diversity typically associated with ensuring the deterministic aspect of defense-in-depth position is not always strictly possible. In these cases defense-in-depth is considered by (1) controlling the outage time for related equipment, (2) restricting activities which may challenge the unavailable systems or functions, (3) allowing only small time intervals for plant operation at power with a system or function unavailable, (4) using, whenever possible, contingency actions to limit concurrent unavailabilities appropriately, and (5) evaluating repair activities and alternatives. Defense-in-depth is evaluated in conjunction with the generic risk assessment results which conclude that the proposed system-specific TS changes would lead to insignificant risk increases and in most cases to net risk reductions. This conclusion is a consequence of the low expected challenge frequency of the systems or functions associated with the proposed TS changes, the very short proposed exposure times to the specified plant conditions and the offsetting benefits of avoiding plant transitions.

4.1 Boration System (LCO 3.1.9)

The boration system is required to control reactivity and to ensure sufficient shutdown margin to bring the plant to cold shutdown with the most reactive control element assembly (CEA) stuck out and without credit for xenon. This system is also intended to mitigate possible return to power scenarios following a main steam line break (MSLB) or reactor coolant pump (RCP) restart. The boration system is also needed to ensure power reduction and mitigate ATWS events.

Plant Applicability: ANO-2, Milstone 2, SONGS 2&3, St Lucie 1&2, Waterford 3

Limiting Condition for Operation (LCO): Two reactor coolant system (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 the respective feed paths to the charging pumps. Default entry into LCO 3.0.3 when both boration paths are unavailable in Modes 1, 2, 3 and 4.

Condition Requiring Entry into Shutdown Required Action: Both boration paths inoperable. That is (1) the RWST and its feed to the charging pumps and (2) both BAMU tanks with the respective feed paths are inoperable (default entry into LCO 3.0.3 is required).

Proposed Modification to Shutdown Required Actions: (1) Increase the time available to take action to restore one boration flow path to 24 hours for the cases in which both boration paths are inoperable; (2) Allow Mode 3 as the final end state for the cases in which both boration paths are inoperable to repair conditions where the boric acid source tank volume, temperature or concentration are out of limits.

Assessment: The staff evaluated the justification of the proposed system-specific TS changes by reviewing the risk assessment results and defense-in-depth arguments, documented in References 1 and 2, for each of the two proposed changes. The risk impact and defense-in-depth arguments associated with the proposed extension of the time to initiate plant shutdown is discussed first, followed by a similar discussion of the arguments in support of allowing Mode 3 as the end state for repairing an inoperable boration system.

The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one boration path before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The risk impact of the proposed 23-hour extension was assessed to be well within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) the probability of core damage when the boration system is inoperable will increase by less than 5E-8 (the acceptance guideline for ICCDP is 5E-7); (2) the CDF will increase by less than 1E-8/year (the acceptance guideline for ΔCDF is 1E-6/year); (3) the large early release probability when the boration system is inoperable will increase by about 3.4E-9 (the acceptance guideline for ICLERP is 5E-8); and (4) the LERF will increase by less than 1E-9/year (the acceptance guideline for ΔLERF is 1E-7/year). It should be noted that the assessed risk impact does not take credit for avoiding the transition to shutdown risk by allowing adequate time to restore at least one boration path. Based on operational experience, there is a good likelihood that such restoration will be successful within the proposed 24 hour period, thus avoiding the transition risk. Although the transition to shutdown risk was not specifically quantified, insights from various risk assessment studies indicate that the avoided transition risk could be larger than the assessed risk increase resulting from allowing the plant to operate at power for 24 hours with the boration system inoperable. Thus, there are good indications that the proposed time extension to initiate shutdown may actually be risk neutral or result in a decrease in risk. The risk impact argument is consistent with the fact that the contribution of the boration system in mitigating accidents other than ATWS events (e.g., LOCA and SGTR accidents) is very small because the HPSI system can perform the same function. Thus, the availability of HPSI during the time the plant is allowed to operate at power with the boration system inoperable ensures that defense-in-depth is maintained for many events. Although for ATWS events the HPSI system is not an effective backup to the boration system, the challenge probability of the boration system during the proposed 23-hour time extension is extremely small (less than 1E-7).

References 1 and 2 state 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. These statements are based on the fact that most of the time the moderator temperature coefficient (MTC) is negative. With a negative MTC, increased boration is required at lower temperatures. Thus, Mode 3 is the end state with the least boration demand and greater shutdown margin. In addition, maintaining the plant in Mode 3 eliminates concurrent transient risk associated with plant Mode changes.

Finding: The requested changes to (1) increase the time available to take action to restore one boration flow path to 24 hours for the cases in which both boration paths are inoperable and (2) allow Mode 3 as the end state for cases where the tank contents are out of limits, are acceptable.

4.2 Pressurizer Heaters (LCO 3.4.9)

The pressurizer provides a point in the RCS where the liquid and vapor water phases are maintained in equilibrium under saturated conditions for pressure control purposes to prevent bulk boiling in the remainder of the RCS. The pressure control components addressed by this LCO include the pressurizer, the required groups of heaters and their controls and the Class 1E power supplies. The liquid to vapor interface permits RCS pressure control by using the sprays and heaters during normal operation and in response to anticipated design basis accidents. The unavailability of Class 1E presssurizer heaters covered by the TS may complicate steady state plant pressure control and, thus, increase the potential for an unplanned reactor trip.

Another function of the Class 1E presssurizer heaters is to maintain plant subcooling during post accident cooldown by natural circulation. Although the unavailability of presssurizer heaters during natural circulation cooldown will extend the time to reach the shutdown cooling system (SCS) entry conditions, heat removal will be adequately established via steam generator (SG) cooling.

Plant Applicability: All CEOG plants except ANO-2 and St Lucie-2

Limiting Condition for Operation (LCO): Two groups of pressurizer heaters, capable of being powered from an emergency power supply, must be operable in Modes 1, 2 and 3.

Condition Requiring Entry into Shutdown Required Action: Two safety-related pressurizer heater groups inoperable (default entry into LCO 3.0.3 is required).

Proposed Modification to Shutdown Required Actions: (1) Increase the time available to take action to restore one group of safety-related heaters before entry into LCO 3.0.3 to 24 hours; (2) Allow Mode 4 as the final end state.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one group of safety-related pressurizer heaters before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The risk impact of the proposed 23-hour extension was assessed to be well within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) the probability of core damage when the safety-related pressurizer heaters are inoperable will increase by about 3E-7 (the acceptance guideline for ICCDP is 5E-7); (2) the CDF will increase by about 6E-8/year (the acceptance guideline for ΔCDF is 1E-6/year); (3) the large early release probability when the safety-related pressurizer heaters are inoperable will increase by less than 1E-8 (the acceptance guideline for ICLERP is 5E-8); and (4) the LERF will increase by about 2E-9/year (the acceptance guideline for ΔLERF is 1E-7/year). Furthermore, the proposed time extension may actually be risk neutral or result in a decrease in risk if credit for avoiding the transition to shutdown risk is taken.

The risk impact argument is consistent with the following observations. TS include requirements for both groups of safety-related pressurizer heaters to have minimum heating power and emergency power supply capability. The safety-related pressurizer heaters have two primary functions. One function is to keep the reactor coolant in a subcooled condition with natural circulation following a loss of offsite power (LOOP) event during which the normally available station powered non-safety related heaters become unavailable. Although no credit is taken in design basis accident analyses for the pressurizer heaters, they have been included in the TS because they are needed to maintain long term subcooling during a LOOP event. However, pressurizer heaters are not required to achieve a post-trip plant cooldown since successful cooldown can be achieved, with minimal impact on plant risk, due to the availability of reactor vessel and pressurizer vents. Consequently, the pressurizer heaters do not have a significant role in the mitigation of core damage events. A second function of the safety-related pressurizer heaters is to back up the station powered non-safety related heaters which are normally available to control reactor coolant pressure during steady state operation. The unavailability of these heaters would reduce the plant's ability to control the normal operating parameters and consequently will increase the potential of plant trip.

The presence of both safety-related and non-safety-related heaters provides considerable defense-in-depth for many transient events, except following a LOOP event. For LOOP events and without the safety-related pressurizer heaters, a natural circulation cooldown may be required. Such cooldowns can be conducted via use of reactor vessel and pressurizer vents or SG venting via the atmospheric dump valves (ADVs).

The intent of the proposed time extension is to extend plant operation at power when the ability to control normal plant operation is not significantly degraded. Therefore, the proposed extension should not be utilized when there is reason to believe that plant pressure and level cannot be controlled within operating bounds, as is the case when both the safety and non-safety pressurizer heaters are unavailable. This restriction should be reflected in the TS bases.

The above discussion also supports the proposed end-state change (i.e., be allowed to stay in Mode 4 to repair the heaters instead of being required to go to Mode 5). Since the plant is tripped, there is no risk associated with pressure control problems and the pressurizer heaters do not have a significant role in the mitigation of core damage events, as is the case for power operation.

<u>Finding</u>: The requested changes to (1) increase the time available to take action to restore one pressurizer heater group to 24 hours for cases when both groups are inoperable and (2) allow Mode 4 as the final end state, are acceptable.

<u>Tier 2 Restrictions</u>: The extension of the time to take action to restore one pressurizer heater group to 24 hours will be allowed only after verification that the plant can be controlled via backup equipment. In case it is found that additional equipment failures are present which increase significantly the likelihood of plant trip, a controlled plant shutdown should be initiated.

4.3 Pressurizer PORVs and Associated Block Valves (LCO 3.4.11)

PORVs are automatically opened at a specific set pressure when the pressurizer pressure increases and automatically close on decreasing pressure. The PORVs may be manually operated using controls installed in the control room. An electric, normally open, block valve (BV) is installed between the pressurizer and the PORV. The function of the BV is to ensure RCS integrity by isolating a leaking or stuck-open PORV to permit continued power operation. Most importantly, the BV is used to isolate a stuck open PORV and terminate the RCS depressurization and coolant inventory loss.

Plant Applicability: Calvert Cliffs, St Lucie 1&2 (block valves), Millstone 2, Palisades, Ft. Calhoun Station.

Limiting Condition for Operation (LCO): Each PORV and associated block valve shall be operable in Modes 1,2 and 3.

Condition Requiring Entry into Shutdown Required Action: Two PORVs inoperable and not capable of being manually cycled (ISTS Condition E or equivalent) or two BVs inoperable (ISTS Condition F or equivalent). There is a variability in LCO entry requirements among CEOG plants for conditions with both PORVs inoperable or both BVs inoperable. Typically, immediate shutdown is required if the PORVs are not isolated and one PORV is not restored within one hour (ISTS Condition E or equivalent) or when the PORVs are not placed in manual control within one hour and one BV is not recovered within two hours (ISTS Condition F or equivalent).

Proposed Modification to Shutdown Required Actions: Allow an 8-hour completion time (CT) to restore one PORV, assuming they are both isolated within one hour (ISTS Condition E or equivalent). Also, allow 8 hours to restore one BV, assuming the PORVs are placed in manual control within one hour (ISTS Condition F or equivalent).

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 8-hour completion time for the actions required by TS (i.e., actions associated with ISTS conditions E and F or equivalent) before entering LCO 3.0.3 will not lead to a significant increase in risk and, actually, may decrease risk by avoiding the risk associated with the transition to shutdown. The risk impact of the proposed 7-hour extension, without credit for avoiding the transition to shutdown risk, was assessed to be within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) the probability of core damage will increase by about 8E-7, which is close to the numerical guideline of 5E-7 for ICCDP used in RG 1.177; (2) the CDF will increase by about 2E-7/year, which is significantly less than the acceptance guideline of 1E-6/year for ΔCDF; (3) the large early release probability will increase by less than 7E-8, which is close to the numerical guideline of 5E-8 for ICLERP and (as explained in Section 3.0 of this report) in agreement with guidance provided in RG 1.177; and (4) the LERF will increase by about 1E-8/year, which is significantly less than the acceptance guideline of 1E-7/year for ΔLERF. Furthermore, the proposed time extension may actually be risk neutral or result in a decrease in risk if credit for avoiding the transition to shutdown risk is taken.

The risk impact argument is consistent with the following defense-in-depth argument where the impact of ISTS Conditions E and F on defense-in-depth is discussed. The primary purpose of this LCO (i.e., LCO 3.4.11) is to ensure that the PORVs and the BVs are operable so the potential for a small break LOCA through the PORV pathway is minimized, or if a small LOCA were to occur through a failed open PORV, the block valve could be manually operated to isolate the path. In addition, one of the functions of the PORVs is to limit the number of pressure transients that may challenge the primary safety valves (PSVs) since the PSVs, unlike the PORVs, cannot be isolated.

When both PORVs are found inoperable (i.e., ISTS Condition E or equivalent), the BVs are manually closed, within one hour, to isolate both PORV paths but none of the PORVs are available to open and, therefore, the PSVs could be challenged to provide overpressure protection. However, a challenge to the PSVs during the proposed 7-hour extension of the CT to restore one PORV is extremely unlikely and the PSVs are available and highly reliable (i.e, even if they are challenged, they would close properly when the pressure is reduced below their setpoint). It should be noted that overpressure protection is provided by the PSVs in the design basis analyses, without any credit for PORV opening for accident mitigation (in fact there are some plants built without PORVs). For these reasons, there is defense-in-depth against LOCA accidents through the PORV and the PSV paths as well as against overpressure accidents during the very short time interval when ISTS Conditions E is proposed to be allowed with the plant operating at power.

When both BVs are found inoperable (i.e., ISTS Condition F or equivalent), the PORVs are placed in manual control, within one hour, to ensure that they do not open automatically in the unlikely event they are challenged. Therefore, there is defense-in-depth against small LOCA accidents through the PORV paths. However, in the unlikely event of a pressure transient during the proposed 7-hour CT extension, the PSVs could be challenged to provide overpressure protection. This is the same scenario discussed above for ISTS Condition E. For these reasons, there is defense-in-depth against LOCA accidents through the PORV and the PSV paths as well as against overpressure accidents during the very short time interval when ISTS Conditions F is proposed to be allowed with the plant operating at power.

The PORV paths provide an alternative means of core cooling by feed and bleed (once-through core cooling) in the case of multiple equipment failure events that are not within the design basis, such as a total loss of feedwater. The unavailability of feed and bleed for core cooling, during ISTS Conditions E and F, is the dominant contributor to risk associated with the proposed changes to LCO 3.4.11. As discussed above, such risk is very small.

<u>Finding</u>: The requested change to allow 8 hours for completing the actions required by TS (i.e., actions associated with ISTS conditions E and F or equivalent) to avoid plant shutdown, is acceptable.

<u>Tier 2 Restrictions</u>: The proposed change does not apply to (a) PORVs that are leaking, (b) PORVs that cannot be isolated by block valves, and (c) PORVs that are not expected to be isolable following a demand.

4.4 Safety Injection Tanks (LCO 3.5.1)

The Safety Injection Tanks (SITs) are pressurized passive injection devices whose primary safety function is to inject large quantities of borated water into the reactor vessel during the blowdown phase of a large loss-of-coolant accident (LOCA) and to provide inventory to help accomplish the refill phase that follows the blowdown phase.

<u>Plant Applicability</u>: Applicable to all CEOG plants.

Limiting Condition for Operation (LCO): All SITs shall be operable during Modes 1 and 2 as well as during Mode 3 when the pressurizer pressure is above 700 psia.

Condition Requiring Entry into Shutdown Required Action: When two or more SITs are inoperable (Condition D), immediate entry into LCO 3.0.3 is required.

Proposed Modification to Shutdown Required Actions: (1) Increase the time available to take action to restore one SIT before entry into LCO 3.0.3 to 24 hours; and (2) Allow Mode 4 as the repair end state when the LCO for one or more inoperable SITs is not met.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one SIT before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The risk impact of the proposed 23-hour extension, without credit for avoiding the transition to shutdown risk, was assessed to be well within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) the probability of core damage will increase by about 1E-8, which is less than the numerical guideline of 5E-7 for ICCDP; (2) the CDF will increase by about 3E-9/year, which is significantly less than the acceptance guideline of 1E-6/year for ΔCDF; (3) the large early release probability will increase by about 4E-11, which is much less than the numerical guideline of 5E-8 for ICLERP; and (4) the LERF will increase by about 9E-12/year, which is much less than the acceptance guideline of 1E-7/year for ΔLERF. Furthermore, the proposed time extension would, most likely, result in a risk reduction if credit for avoiding the transition to shutdown risk is taken.

The risk impact argument is also supported by the following defense-in-depth discussion. The SITs are needed primarily to mitigate large LOCAs. The unavailability of two or more SITs will compromise the ability of the plant to respond to a large LOCA. However, as discussed above, even if it is conservatively assumed that all large LOCAs proceed to core damage, the risk impact is negligible (much less than the risk estimated to incur during plant transition to shutdown). On the other hand, the unavailability of two or more SITs may alter the progression of some smaller break size LOCAs and the extent of core damage but their impact on the core damage potential is negligible. In addition, long term core cooling, provided via the plant’s LPSI and HPSI systems, partially offsets the impact of SIT unavailability.

A Mode 4 end state is proposed when the LCOs associated with **one or more** inoperable SITs are not met. This is acceptable because the SITs are not required to mitigate accidents in Mode 4 and the plant risk was shown to be, in general, smaller in Mode 4 than in Mode 5 (Reference 2).

Finding: The requested change to increase the time available to take action to restore all SITs (from one to 24 hours) for cases when **two or more** SITs are inoperable, is acceptable. The requested change to allow Mode 4 as the repair end state, when the LCOs associated with **one or more** inoperable SITs are not met, is acceptable.

Tier 2 Restrictions: Compensatory actions will be taken to ensure both LPSI and all HPSI trains are available to partially offset the impact of SIT unavailability.

4.5 Low Pressure Safety Injection (LCO 3.5.2)

The low pressure safety injection (LPSI) system is part of the emergency core cooling system (ECCS). The function of the ECCS is to provide core cooling and negative reactivity to ensure that the reactor core is protected following certain accidents, such as LOCAs, SGTRs and loss of feedwater. There are two phases of ECCS operation: injection and recirculation. In the injection phase, borated water is injected into the reactor coolant system (RCS) via the cold legs. After the blowdown stage of the LOCA stabilizes injection flow is split equally between the hot and cold legs. After the refueling water storage tank (RWST) is depleted, the ECCS recirculation phase is entered as the ECCS suction is automatically transferred to the containment sump. TS require that in Modes 1,2 and 3, with pressurizer pressure above 1700 psia, both redundant (100% capacity) ECCS trains must be operable. Each ECCS train consists of a high pressure safety injection (HPSI) subsystem, a low pressure safety injection (LPSI) subsystem and a charging subsystem.

Plant Applicability: Applicable to all CEOG plants.

Limiting Condition for Operation (LCO): Two redundant, 100% capacity LPSI trains must be operable in Modes 1 and 2 as well as in Mode 3 when the pressurizer pressure is above 1,700 psia.

Condition Requiring Entry into Shutdown Required Action: When both LPSI trains are inoperable, the design basis assumptions for the large break LOCA analyses are not met and a default entry into LCO 3.0.3 is required.

Proposed Modification to Shutdown Required Actions: Add separate condition for both LPSI trains inoperable and ECCS flow equivalent less than 100% to allow the immediate shutdown requirement be extended to 24 hours. Explicit definition of this TS condition will result in a default to Mode 4 as the final end state.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one LPSI train before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The risk impact of the proposed 23-hour extension, without credit for avoiding the transition to shutdown risk, was assessed to be well within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) the probability of core damage will increase by about 1E-7, which is less than the numerical guideline of 5E-7 for ICCDP; (2) the CDF will increase by about 2E-8/year, which is significantly less than the acceptance guideline of 1E-6/year for ΔCDF; (3) the large early release probability will increase by about 4E-10, which is much less than the numerical guideline of 5E-8 for ICLERP; and (4) the LERF will increase by about 8E-11/year, which is much less than the acceptance guideline of 1E-7/year for ΔLERF. Furthermore, the proposed time extension would, most likely, result in a risk reduction if credit for avoiding the transition to shutdown risk is taken.

The risk impact argument is also supported by the following defense-in-depth discussion. The primary impact of the unavailability of the LPSI system will be the reduction in the capability of the plant to provide RCS inventory makeup to mitigate a large LOCA. However, the unavailability of the LPSI system will impair the ability of the plant to maneuver to shutdown cooling. Therefore, the proposed 24-hour CT to repair one LPSI train is reasonable due to the very small incremental risk associated with the continued plant operation at power and the inadvisability of a plant shutdown without the LPSI pumps which are needed for shutdown cooling (SDC).

Finding: The requested changes are acceptable.

Tier 2 Restrictions: For conditions when the LPSI system is unable to support SDC, availability of the AFW system should be assured. SIT availability should also be assured to offset the large LOCA risks associated with LPSI system inoperability.

4.6 High Pressure Safety Injection (LCO 3.5.2)

The high pressure safety injection (HPSI) system is part of the emergency core cooling system (ECCS). The function of the ECCS is to provide core cooling and negative reactivity to ensure that the reactor core is protected following certain accidents, such as LOCAs, SGTRs and loss of feedwater. There are two phases of ECCS operation: injection and recirculation. In the injection phase, borated water is injected into the reactor coolant system (RCS) via the cold legs. After the blowdown stage of the LOCA stabilizes injection flow is split equally between the hot and cold legs. After the refueling water storage tank (RWST) is depleted, the ECCS recirculation phase is entered as the ECCS suction is automatically transferred to the containment sump. TS require that in Modes 1,2 and 3, with pressurizer pressure above 1700 psia, both redundant (100% capacity) ECCS trains must be operable. Each ECCS train consists of a high pressure safety injection (HPSI) subsystem, a low pressure safety injection (LPSI) subsystem and a charging subsystem.

Plant Applicability: Applicable to all CEOG plants.

Limiting Condition for Operation (LCO): In Modes 1 and 2 as well as in Mode 3 when the pressurizer pressure is above 1700 psia, both trains of HPSI must be operable.

Condition Requiring Entry into Shutdown Required Action: When both HPSI trains are inoperable, a default entry into LCO 3.0.3 is required.

Proposed Modification to Shutdown Required Actions: Increase the time for restoring one HPSI train, before initiating shutdown per LCO 3.0.3, to four hours.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 4-hour completion time for the actions required by TS (i.e., actions associated with ISTS conditions E and F or equivalent) before entering LCO 3.0.3 will not lead to a significant increase in risk and, actually, may decrease risk by avoiding the risk associated with the transition to shutdown. The risk impact of the proposed 3-hour extension, without credit for avoiding the transition to shutdown risk, was assessed to be in agreement with the acceptance guidelines reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) An ICCDP of 1.7E-6 for plants with PORVs and 1.1E-6 for plants without PORVs, which are close to the numerical guideline of 5E-7 for ICCDP used in RG 1.177; (2) A ΔCDF of 3.5E-7/year for plants with PORVs and 2.1E-7 for plants without

PORVs, which are significantly less than the acceptance guideline of 1E-6/year for ∆CDF; (3) An ICLERP of about 4E-8 for plants with PORVs and less than 3E-8 for plants without PORVs, which are less than the numerical guideline of 5E-8 for ICLERP; and (4) A ∆LERF of about 8E-9/year for plants with PORVs and about 5E-9 for plants without PORVs, which are much less than the acceptance guideline of 1E-7/year for ∆LERF. Furthermore, the proposed time extension may actually be risk neutral or result in a decrease in risk if credit for avoiding the transition to shutdown risk is taken.

The risk impact argument is also supported by the following defense-in-depth discussion. The subject LCO requires the operability of a number of independent subsystems. In many instances due to the redundancy of trains and the diversity of subsystems, the inoperability of one component in a train does not necessarily render the HPSI incapable of performing its function. Neither does the inoperability of two different components, each in a different train, necessarily result in a loss of function for the ECCS. Examples of typical inoperabilities would include the unavailability of a single header injection valve or degradation of HPSI delivery curves below minimum design basis levels. The proposed 3-hour CT extension allows for potential resolution of minor HPSI system inoperabilities and provides time to prepare for a controlled plant shutdown without increasing the plant's risk significantly.

<u>Finding</u>: The requested change to allow four hours to resolve the inoperability and restore one train of HPSI capability before required to commence a plant shutdown per LCO 3.0.3, is acceptable.

<u>Tier 2 Restrictions</u>: Ensure at least two charging pumps are available during TS entry. Charging pumps may be used to support accident responses to smaller sized pipe failure events and for events with one or more stuck open PORVs or PSVs and for SGTRs. Good maintenance practices minimize the simultaneous unavailability of similar equipment (e.g., SITs, LPSIs, and swing HPSIs if available). In addition, appropriate measures should be taken to protect the AFW system from both internal and external events (e.g., fires) during TS entry in order to minimize the challenge probability to the inoperable HPSI system.

4.7 Containment (LCO 3.6.1)

The requirements stated in this LCO define the performance of the containment as a fission barrier. Specifically, LCO 3.6.1 requires that the containment maximum leakage rate 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 which assure that the post accident whole body and thyroid dose limits of 10CFR100 are satisfied following a Maximum Hypothetical Accident (MHA) initiated from full power. Inability to meet this leakage limit renders the containment inoperable.

<u>Plant Applicability</u>: Applicable to all CEOG plants.

<u>Limiting Condition for Operation (LCO)</u>: Containment shall be operable in modes 1, 2, 3 and 4.

Condition Requiring Entry into Shutdown Required Action: 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. Declaration results in an implicit LCO 3.0.3 3ntry.

Proposed Modification to Shutdown Required Actions: Define a specific action to allow 8 hours to restore an inoperable containment to operability. 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 paths.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 8-hour completion time for restoring an inoperable containment to operability will not lead to a significant increase in risk and may actually decrease risk. The risk impact of the proposed 7-hour extension was assessed to be well within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following conservatively assessed risk increases: (1) the large early release probability will increase by about 9E-8, which is close to the numerical guideline of 5E-8 for ICLERP; and (2) the LERF will increase by about 2E-8/year, which is significantly less than the acceptance guideline of 1E-7/year for ΔLERF. Furthermore, the proposed time extension may actually be risk neutral or result in a decrease in risk if credit for avoiding the transition to shutdown risk is taken.

The proposed changes apply to containment conditions where containment integrity is essentially maintained and adequate ECCS net positive suction head (NPSH) is expected following an event. Containment "leakage" at or near design basis levels is not explicitly modeled in probabilistic risk assessments (PRAs). The PRA implicitly requires that containment "gross" integrity must be available to ensure adequate NPSH for ECCS pumps. Even though the PRA models do not consider that containment "leakage" contributes to a large early release, the assessed risk impact of the proposed 7-hour CT extension is based on the assumption that all core damage events will proceed to a large early release.

The requirement for an immediate (within one hour) shutdown is based on the philosophy that inoperability of the containment is a violation of the plant design basis and, therefore, a plant shutdown must be initiated as soon as possible. The selection of one hour was based on the requirement for "immediate shutdown" and the assumption that one hour is adequate time for operators to effect shutdown plans. The goal was to place the plant in a condition where the health and safety of the public could be better assured. No specific risk assessments were performed. In fact it is more appropriate from the health and safety objective viewpoint to consider the risk of continued plant operation as well as that introduced by the shutdown. In consideration of the total plant risk, it is more risk beneficial to allow a small increase in risk at power to resolve a TS inoperability rather than to undertake an immediate (within one hour) shutdown.

In addition to the CT extension, it is also proposed that Mode 4 be allowed as the end state to repair the containment. This is supported by the following arguments. If accidents were to occur in Mode 4, resulting containment pressures would be significantly less than the design basis accident (DBA) conditions. Hence, leakage would be further reduced. While in Mode 4, the probability of LOCA or MSLB is significantly reduced from Mode 1 levels. The implied licensing basis assumption that Mode 5 is inherently of lower operational risk than Mode 4 is not supported by risk evaluations (Ref. 2). Mode 5 risks are either about equal to or likely greater than equivalent risks in Mode 4, and therefore produce radiation releases to containment on par with those of Mode 4. Thus, remaining in Mode 4, while the containment excess leakage condition is being corrected, is an appropriate action.

The TS 3.6.1 requirement that the plant be brought to Mode 5 end state is not based on consideration of risks. Accidents initiated from Mode 4 are far less challenging to the containment than those initiated from Mode 1. The lower energy content in Mode 4 results in containment pressures and potential 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, Mode 4 leakage in excess of that allowed in Mode 1 can be safely allowed for a limited time sufficient to resolve the inoperability and return the plant to power operation.

From a deterministic perspective, Mode 4 with steam generator (SG) heat removal would maintain more mitigating systems available, as compared to Mode 5, to respond to loss of RCS inventory or decay heat removal events and therefore reduce the overall public risk. In Mode 4, the Safety Injection Actuation Signal (SIAS) and the Containment Isolation Actuation Signal (CIAS) will be available to aid the operators in responding to events that threaten the reactor or containment integrity. Therefore, the proposed TS end state change does not adversely affect the plant defense-in-depth.

Finding: The requested changes to (1) increase the time available to take action to restore the containment to 8 hours and (2) allow Mode 4 as the repair end state, are acceptable.

Tier 2 Restrictions: Limitation on containment leakage is still required to ensure that a gross containment inoperability is avoided. This is accomplished by limiting the 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.

4.8 Containment Spray System (ISTS LCO 3.6.6 A & B)

The containment spray (CS) and containment cooling (CC) systems provide containment atmosphere cooling to limit post accident pressure and temperature in containment to less than the design values. For most CEOG plants the containment sprays represent a portion of a diverse and redundant heat removal system. In addition to containment heat removal, CSs enhance post-accident fission product removal.

Plant Applicability: Applicable to all CEOG plants.

Limiting Condition for Operation (LCO): Two containment spray trains and two containment cooling (Containment Air Recirculation Coolers or CARC) trains shall be operable in Modes 1, 2, 3 and 4.

Condition Requiring Entry into Shutdown Required Action: Inoperability of both CS trains.

Proposed Modification to Shutdown Required Actions: (1) Increase the time available for restoring one CS train to 72 hours when at least one CC train is available for containment heat removal; (2) Increase the time available for restoring one CS train to 12 hours when the CC system is unavailable for containment heat removal.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 12-hour completion time for restoring one CS train when the CC system is unavailable for containment heat removal (i.e., no CARC available) before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The risk impact of the proposed 11-hour extension was assessed to be well within the acceptance criteria reported in Regulatory Guides 1.174 and 1.177. Specifically, the proposed time extension would lead to the following risk increases: (1) the probability of core damage will increase by less than 7E-7 which is close to the numerical guideline of 5E-7 for ICCDP used in RG 1.177; (2) the CDF will increase by about 1.4E-7/year (acceptance criteria for ΔCDF about 1E-6/year); (3) the large early release probability during the condition will increase by about 1E-8 (acceptance criteria for ICLERP is 5E-8); and (4) the LERF will increase by about 2.5E-9/year (acceptance criteria for ΔLERF is 1E-7/year). Furthermore, the proposed time extension may actually be risk neutral or result in a decrease in risk if credit for avoiding the transition to shutdown risk is taken.

When at least one CC train is available for containment heat removal (i.e., CARC available), the risk impact in terms of CDF and LERF is insignificant. However, credit is taken for post accident fission product removal by the CS system. The radiation release "Non-LER" risk impact associated with the proposed increase of the time available for restoring one CS train to 72 hours was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 71-hour time extension would lead to the following "Non-LER" risk increases: (1) the probability of a "Non-LER" release during the 71-hour extension would increase by about 8E-7; and (2) the "non-LER" frequency would increase by 1.6E-7/year. These increases in "Non-LER" risk are slightly above the values used in the criteria discussed in Section 2.1.1 of this report. However, such increases in "Non-LER" risk are still comparable in magnitude to what is considered acceptable for increases in the much higher consequence risks associated with core damage and large early release. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

In addition to the risk argument, the proposed 72-hour extension is selected for compatibility with improved standard technical specification (ISTS) 3.6.6B. ISTS 3.6.6B calls for a Completion Time (CT) of 72 hours when two CS trains are inoperable (Condition C) and is applicable to conditions where the sprays are not credited for fission product removal.

Inoperability of the CS or CC will degrade the capability of the plant to respond to a containment threat. However, provided the other system is available the plant remains capable of controlling pressure. The loss of sprays will expose some plant equipment to beyond environmental qualification temperature limits should a main steam line break occurs. However, the probability of such an event during the proposed 71-hour extension is very small (about 1E-3/year or less than 1E-5 per 71 hours). Furthermore, the ability of the plant to cope with a main steam line break event is not compromised.

Finding: The requested changes are acceptable.

Tier 2 Restrictions: None.

4.9 Iodine Cleanup System (LCO 3.6.10)

The purpose of the ICS is to remove elemental iodine from the post-accident containment atmosphere. These systems were initially incorporated into plants in the belief that radiological iodine releases would be predominantly in elemental form. However, extensive research has indicated that most iodine will be released in the form of Cesium Iodine (CsI) particulates. Consequently, the actual impact of system functionality on actual public doses is negligible. ICS consists of two 100% capacity trains.

Plant Applicability: Calvert Cliffs, St Lucie 1 & 2.

Limiting Condition for Operation (LCO): Two ICS trains shall be operable in Modes 1, 2, 3 and 4.

Condition Requiring Entry into LCO 3.0.3: Both ICS trains inoperable. Currently a default entry into LCO 3.0.3 is required.

Proposed Modification to Shutdown Required Actions: Revise LCO to (1) allow 24 hours to take action before entry into LCO 3.0.3 for both ICS trains unavailable, and (2) allow Mode 4 as the final end state for repairing the inoperable system.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one train of ICS before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The proposed 23-hour extension will not contribute to any risk increases, in terms of core damage and large early release. The radiation release “Non-LER” risk impact associated with the proposed time increase was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 23-hour time extension would lead to the following “Non-LER” risk increases: (1) the probability of a “Non-LER” release during the 23-hour extension would increase by about 2.6E-7; and (2) the “non-LER” frequency would increase by about 5.0E-8/year. These increases in “Non-LER” risk, which are comparable in magnitude to what is considered acceptable for core damage and large early release risk increases, are very small. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

The proposed change to allow Mode 4 as the final end state for repairing the inoperable system is supported by risk assessments (Ref. 2) which indicated that, in general, there is less risk associated with staying in Mode 4 to repair the inoperable system than proceeding to Mode 5. This is due to the fact that there are more systems available in Mode 4 than in Mode 5 to mitigate accidents initiated at shutdown and the risk of transition between Modes 4 and 5 is avoided.

The ICS functions together with the containment spray (CS) and the containment cooling (CC) systems following a design basis accident (DBA) that causes failure of the fuel cladding, and release of radioactive material (principally iodine) to the containment. The ICS is specifically designed to respond to the maximum hypothetical accident (MHA) with a large assumed contribution due to elemental iodine. The DBAs that result in a release of radioactive iodine within containment are loss of coolant accident (LOCA) and main steam line break (MSLB) or a control element assembly (CEA) ejection accident. In the analysis for each of these accidents, it is assumed that adequate containment leak tightness is present at event initiation to limit potential leakage to the environment. Additionally, it is assumed that the amount of radioactive iodine release is limited by reducing the iodine concentration in the containment atmosphere via use of containment sprays. The unavailability of the ICS will have no significant impact on anticipated radiological releases to the public or the control room. This is due to the fact that: (1) iodine releases are predominantly particulate and removal via sprays and precipitation is effective, (2) availability of elemental iodine is low so that ICS has limited utility, and (3) containment leak tightness significantly limits potential releases. Significant release events that contribute to large early release, such as containment bypass and SGTR with loss of secondary isolation events, will bypass these filters regardless of their availability.

Finding: The requested changes to (1) increase the time available to take action to restore one ICS train to 24 hours and (2) allow Mode 4 as the final end state, for cases when both ICS trains are inoperable, are acceptable.

Tier 2 Restrictions: None.

4.10 Shield Building Exhaust Air Cleanup System (LCO 3.6.13)

The shield building exhaust air cleanup system (SBEACS) provides radionuclide removal capability for fission products leaked into the shield building. The SBEACS consists of two separate and redundant trains. Each train includes a heater, cooling coils, a prefilter, a moisture separator, a high efficiency particulate air (HEPA) filter, an activated charcoal absorber section for removal of radionuclides and a fan. Ductwork, valves and/or dampers and instrumentation also form part of the system.

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

Limiting Condition for Operation (LCO): Two SBEACS trains shall be operable in Modes 1, 2, 3 and 4.

Condition Requiring Entry into Shutdown Required Action: Both SBEACS trains inoperable. Currently a default entry into LCO 3.0.3 is required.

Proposed Modification to Shutdown Required Actions: Revise LCO to (1) allow 24 hours to take action before entry into LCO 3.0.3 for both SBEACS trains unavailable, and (2) allow Mode 4 as the final end state for repairing the inoperable system.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one train of SBEACS before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The proposed 23-hour extension will not contribute to any risk increases, in terms of core damage and large early release. The radiation release “Non-LER” risk impact associated with the proposed time increase was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 23-hour time extension would lead to the following "Non-LER" risk increases: (1) the probability of a "Non-LER" release during the 23-hour extension would increase by about 2.6E-7; and (2) the "non-LER" frequency would increase by about 5.0E-8/year. These increases in "Non-LER" risk, which are comparable in magnitude to what is considered acceptable for core damage and large early release risk increases, are very small. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

The proposed change to allow Mode 4 as the final end state for repairing the inoperable system is supported by risk assessments (Ref. 2) which indicated that, in general, there is less risk associated with staying in Mode 4 to repair the inoperable system than proceeding to Mode 5. This is due to the fact that there are more systems available in Mode 4 than in Mode 5 to mitigate accidents initiated at shutdown and the risk of transition between Modes 4 and 5 is avoided.

The proposed changes are also supported by the following qualitative discussion. The SBEACS is required to ensure that the radioactive material leaking from the primary containment of a dual containment into the Shield Building (secondary containment) following a DBA are filtered and absorbed prior to exhausting to the environment. Loss of the SBEACS could cause site boundary doses, in the event of a DBA, to exceed the values given in the licensing basis. However, containment "leakage" at or near design basis levels is not explicitly modeled in probabilistic risk assessments (PRAs). PRAs implicitly require that containment "gross" integrity must be available to ensure net positive suction head (NPSH) for ECCS pumps. In the PRA Level 2 models, containment "leakage" is not considered to contribute to large early release. If accidents were to occur in Mode 4, resulting containment pressures would be significantly less than the DBA conditions. Hence, leakage would be further reduced. In addition, while in Mode 4, the probability of LOCA and MSLB is significantly reduced from Mode 1 levels. By keeping the plant in Mode 4, operator actions required for entry into shutdown cooling (SDC) and which introduce potential containment bypass risks are avoided.

Finding: The requested changes to (1) increase the time available to take action to restore one SBEACS train to 24 hours and (2) allow Mode 4 as the final end state, for cases when both SBEACS trains are inoperable, are acceptable.

Tier 2 Restrictions: None.

4.11 Control Room Emergency Air Cleanup System (LCO 3.7.11)

The control room emergency air cleanup system (CR-EACS) provides a protected environment from which operators can control the plant following an uncontrolled release of radioactivity, chemicals or toxic gas. Alternate designations of this system include the acronyms CREACUS, CREACS, CREVAS, CREVS, or CREAFS. The current TS require operability of CR-EACS from Mode 1 through Mode 4 to support operator response to a DBA. The system's operability in Modes 5 and 6 may also be required at some plants for chemical and toxic gas concerns. The CR-EACS is needed to protect the control room (CR) in a wide variety of circumstances.

Plant Applicability: Applicable to all CEOG Plants.

Limiting Condition for Operation (LCO): Two CR-EACS trains shall be operable in Modes 1, 2, 3 and 4 and during movement of recently irradiated fuel assemblies in Modes 5 and 6.

Condition Requiring Entry into Shutdown Required Action: Both trains inoperable and not returned to service prior to the TS CT.

Proposed Modification to Shutdown Required Actions: Revise LCO to (1) increase the time available to take action under LCO 3.0.3 to 24 hours for the cases in which both CR-EACS trains are unavailable, and (2) allow Mode 4 as the final end state for repairing the inoperable system.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one train of CR-EACS before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The proposed 23-hour extension will not contribute to any risk increases, in terms of core damage and large early release. The radiation release "Non-LER" risk impact associated with the proposed time increase was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 23-hour time extension would lead to the following "Non-LER" risk increases: (1) the probability of a "Non-LER" release during the 23-hour extension would increase by about 2.6E-7; and (2) the "non-LER" frequency would increase by about 5.0E-8/year. These increases in "Non-LER" risk, which are comparable in magnitude to what is considered acceptable for core damage and large early release risk increases, are very small. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

The proposed change to allow Mode 4 as the final end state for repairing the inoperable system is supported by risk assessments (Ref. 2) which indicated that, in general, there is less risk associated with staying in Mode 4 to repair the inoperable system than proceeding to Mode 5. This is due to the fact that there are more systems available in Mode 4 than in Mode 5 to mitigate accidents initiated at shutdown and the risk of transition between Modes 4 and 5 is avoided.

Finding: The requested changes to (1) increase the time available to take action to restore one CR-EACS train to 24 hours and (2) allow Mode 4 as the final end state, for cases when both CR-EACS trains are inoperable, are acceptable.

Tier 2 Restrictions: Using configuration risk management program (CRMP) ensure plant staff is aware of the system inoperability and that respiratory units and control room pressurization systems are available and operational and that leakage pathways are properly controlled. Equipment must be available to identify the onset of a radiological release (or if applied to non-radiation atmospheric cleanup, a toxic gas release). Also, ensure availability of alternate shutdown panels and local shutdown stations should remote actions become necessary.

4.12 Control Room Emergency Air Temperature Control System (LCO 3.7.12)

The control room emergency air temperature control system (CR-EATCS) provides temperature control for the control room (CR) following isolation of the CR. The CR-EATCS consists of two independent, redundant trains that provide cooling and heating of recirculated CR air. Each train consists of heating coils, cooling coils, instrumentation and controls to provide for CR temperature control.

Plant Applicability: Applicable to Calvert Cliffs 1 & 2, Palisades, PVNGS 1, 2, & 3, Waterford 3 and ANO 2. It is noted that cooling for the St Lucie units are included in the air cleanup system discussed in TS 3.7.11 but the cooling system arguments contained in this section apply to St Lucie Units 1 & 2).

Limiting Condition for Operation (LCO): Two CR-EATCS trains shall be operable in Modes 1, 2, 3 and 4 and during movement of irradiated fuel assemblies.

Condition Requiring Entry into Shutdown Required Action: Both trains inoperable.

Proposed Modification to Shutdown Required Actions: Revise LCO to (1) increase the time available to take action under LCO 3.0.3 to 24 hours for the cases in which both CR-EACS trains are unavailable, and (2) allow Mode 4 as the final end state for repairing the inoperable system.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one train of CR-EATCS before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The proposed 23-hour extension will not contribute to any risk increases, in terms of core damage and large early release. The radiation release "Non-LER" risk impact associated with the proposed time increase was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 23-hour time extension would lead to the following "Non-LER" risk increases: (1) the probability of a "Non-LER" release during the 23-hour extension would increase by about 2.6E-7; and (2) the "non-LER" frequency would increase by about 5.0E-8/year. These increases in "Non-LER" risk, which are comparable in magnitude to what is considered acceptable for core damage and large early release risk increases, are very small. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

The proposed change to allow Mode 4 as the final end state for repairing the inoperable system is supported by risk assessments (Ref. 2) which indicated that, in general, there is less risk associated with staying in Mode 4 to repair the inoperable system than proceeding to Mode 5. This is due to the fact that there are more systems available in Mode 4 than in Mode 5 to mitigate accidents initiated at shutdown and the risk of transition between Modes 4 and 5 is avoided.

Several short term actions associated with cooling the CR may be implemented to mitigate risk consequences further. These actions include use of portable fans and propping open doors. Several plants have such actions procedurilized.

Finding: The requested changes to (1) increase the time available to take action to restore one CR-EATCS train to 24 hours and (2) allow Mode 4 as the final end state, for cases when both trains are inoperable, are acceptable.

Tier 2 Restrictions: Administrative actions should be taken to ensure plant staff is aware of the system inoperability and that respiratory units and CR pressurization systems are available and operational and that leakage pathways are properly controlled. Temporary cooling may also be established via use of portable fans, propping open doors, or similar actions. Also, availability of alternate shutdown panels and local shutdown stations should be ensured.

4.13 Emergency Core Cooling System (ECCS) Pump Room Exhaust Air Cleanup System (LCO 3.7.13)

The ECCS pump room exhaust air cleanup system (ECCS-PREACS) is an emergency system that filters air from the area of the active Engineered Safety Features (ESF) components during the recirculation phase of a LOCA. The ECCS-PREACS consists of two independent, redundant trains of equipment that provide filtering of air in the ECCS pump rooms during post-LOCA recirculation cooling.

Plant Applicability: Calvert Cliffs 1 & 2, St Lucie 1 & 2, Waterford 3. It is noted that at Waterford 3 the functions of the ECCS-PREACS and Penetration Room Exhaust Air Cleanup System (PR-EACS), which is discussed below under LCO 3.7.15, are combined within the Controlled Ventilation Area System (CVAS) TS.

Limiting Condition for Operation (LCO): Two CR-EATCS trains shall be operable in Modes 1, 2, 3 and 4.

Condition Requiring Entry into Shutdown Required Action: Both trains inoperable.

Proposed Modification to Shutdown Required Actions: Revise LCO to (1) increase the time available to restore one train before entry into LCO 3.0.3 to 24 hours, and (2) allow Mode 4 as the final end state for repairing the inoperable system.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one train of ECCS-PREACS before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The proposed 23-hour extension will not contribute to any risk increases, in terms of core damage and large early release. The radiation release “Non-LER” risk impact associated with the proposed time increase was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 23-hour time extension would lead to the following “Non-LER” risk increases: (1) the probability of a “Non-LER” release during the 23-hour extension would increase by about 1.1E-7; and (2) the “non-LER” frequency would increase by about 2.0E-8/year. These increases in “Non-LER” risk, which are comparable in magnitude to what is considered acceptable for core damage and large early release risk increases, are very small. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

The proposed change to allow Mode 4 as the final end state for repairing the inoperable system is supported by risk assessments (Ref. 2) which indicated that, in general, there is less risk associated with staying in Mode 4 to repair the inoperable system than proceeding to Mode 5. This is due to the fact that there are more systems available in Mode 4 than in Mode 5 to mitigate accidents initiated at shutdown and the risk of transition between Modes 4 and 5 is avoided.

The unavailability of the ECCS-PREACS only impacts radiation releases to the public when the ECCS recirculation is in progress during a LOCA. Since successful recirculation also implies successful event mitigation, the releases this system is designed to mitigate are relatively low.

Finding: The requested changes to (1) increase the time available to take action to restore one ECCS-PREACS train to 24 hours and (2) allow Mode 4 as the final end state, for cases when both trains are inoperable, are acceptable.

Tier 2 Restrictions: None.

4.14 Penetration Room Exhaust Air Cleanup System (LCO 3.7.15)

The Penetration Room Exhaust Air Cleanup System (PR-EACS) filters air from the penetration area between the containment and the auxiliary building. The PR-EACS 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. It is noted that at Waterford 3 the functions of the PR-EACS and ECCS-PREACS, which is discussed above under LCO 3.7.13, are combined within the Controlled Ventilation Area System (CVAS) TS.

Limiting Condition for Operation (LCO): Two CR-EACS trains shall be operable in Modes 1, 2, 3 and 4.

Condition Requiring Entry into Shutdown Required Action: Both trains inoperable.

Proposed Modification to Shutdown Required Actions: Revise LCO to (1) increase the time available to restore one train before entry into LCO 3.0.3 to 24 hours, and (2) allow Mode 4 as the final end state for repairing the inoperable system.

Assessment: The risk assessment results, documented in Section 3 of the SER, indicate that the proposed 24-hour completion time for restoring one train of PR-EACS before entering LCO 3.0.3 will not lead to a significant increase in risk and may actually decrease risk. The proposed 23-hour extension will not contribute to any risk increases, in terms of core damage and large early release. The radiation release "Non-LER" risk impact associated with the proposed time increase was conservatively assessed, as discussed in Chapter 3. Specifically, the proposed 23-hour time extension would lead to the following "Non-LER" risk increases: (1) the probability of a "Non-LER" release during the 23-hour extension would increase by about 2.6E-7; and (2) the "non-LER" frequency would increase by about 5.0E-8/year. These increases in "Non-LER" risk, which are comparable in magnitude to what is considered acceptable for core damage and large early release risk increases, are very small. Furthermore, the proposed time extension is definitely risk beneficial when the averted core damage and large early release risks associated with avoiding plant shutdown are taken into consideration.

The proposed change to allow Mode 4 as the final end state for repairing the inoperable system is supported by risk assessments (Ref. 2) which indicated that, in general, there is less risk associated with staying in Mode 4 to repair the inoperable system than proceeding to Mode 5.

This is due to the fact that there are more systems available in Mode 4 than in Mode 5 to mitigate accidents initiated at shutdown and the risk of transition between Modes 4 and 5 is avoided.

Finding: The requested changes to (1) increase the time available to take action to restore one PR-EACS train to 24 hours and (2) allow Mode 4 as the final end state, for cases when both trains are inoperable, are acceptable.

Tier 2 Restrictions: None.

5.0 SUMMARY AND CONCLUSIONS

The required action for conditions that imply a loss of function, is entry into limiting condition of operation (LCO) 3.0.3. Currently, upon entering LCO 3.0.3, one hour is allowed to prepare for an orderly shutdown before initiating a change in plant operation. The CEOG is proposing to define or modify various TS action statements to accommodate extension of the currently required time of one hour to initiate plant shutdown. The proposed extension, related to specific systems or components, is based on the system's risk significance. In addition, a proposal is included to modify several action statements, related to specific systems or components, to allow for a Mode 4 (hot shutdown) end state for repair purposes when the time requirements of the action statement for staying at power cannot be met.

The intent of the proposed TS changes is to provide needed flexibility in the performance of corrective maintenance during power operation to fully evaluate the situation or restore loss of function and at the same time enhance overall plant safety by:

- avoiding unnecessary unscheduled plant shutdowns,
- minimizing plant transitions and associated transition and realignment risks,
- providing increased flexibility in scheduling and performing maintenance and surveillance activities, and
- providing explicit guidance in areas that currently does not exist.

It should be noted that many of the proposed TS changes affect the existing plant shutdown requirements for plant conditions where the plant operation is not in explicit compliance with the plant design basis. The proposed actions provide a risk-informed process for establishing shutdown priorities aiming at reducing overall plant risk and increasing public health and safety protection. In performing the risk-informed assessments and interpreting the results, the following assumptions were made:

- A condition resulting in the inoperability of a system or component which currently results in the need for an immediate shutdown is a low frequency event.
- The frequency of events leading to LCO 3.0.3 is not expected to increase significantly following the proposed change because such events are reportable, require a licensee event report (LER) and are used in performance indicators and the reactor oversight

program. Therefore, licensees will have no incentive to allow the current low frequency of these events to increase after the proposed extensions are granted.

- The risk incurred by increasing the required shutdown action time is controlled to acceptable levels using a risk informed approach that considers the component risk worth and offsetting benefits of avoiding plant transitions.

The risk impact of the proposed TS changes was assessed following the three-tiered approach recommended in RG 1.177 for evaluating proposed extensions in currently allowed Completion Times (CTs):

- The first tier involves the assessment of the change in plant risk due to the proposed TS change;

- The second tier involves the 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;

- The third tier involves the implementation of the proposed changes in conjunction with a configuration risk management program (CRMP).

The impact of each proposed system-specific TS change on defense-in-depth was evaluated in conjunction with the risk assessment results. Due to the nature of the plant conditions associated with the proposed TS changes (i.e., loss of a system's or component's function), the redundancy and diversity typically associated with ensuring the deterministic aspect of defense-in-depth position is not always strictly possible. In these cases defense-in-depth was considered by identifying specific restrictions to the implementation of the proposed changes. Such restrictions, labeled "Tier 2 Restrictions," aim at (1) controlling the outage time for related equipment, (2) restricting activities which may challenge the unavailable systems or functions, (3) allowing only small time intervals for plant operation at power with a system or function unavailable, (4) using, whenever possible, contingency actions to limit concurrent outages, and (5) evaluating repair actip-vities and alternatives.

Based on this integrated evaluation, the staff concludes that the proposed system-specific TS changes would at most lead to acceptably small risk increases. In addition, defense-in-depth is taken into consideration. This conclusion is a consequence of the low expected challenge frequency of the systems or functions associated with the proposed TS changes, the very short proposed exposure times to the specified plant conditions, the offsetting benefits of avoiding plant transitions, and the identification of specific restrictions (Tier 2 Restrictions) to the implementation of the proposed changes.

The staff approval applies only to operation as described in the CEOG requests documented in Reference 1 and acceptably justified in References 1 and 2. To be consistent with the staff's approval, licensees interested in implementing these changes should commit to operate in accordance with the following stipulations:

1. Appropriate plant procedures and administrative controls will be used to implement the "Tier 2 Restrictions," discussed in Section 5 of the CEOG Topical Report CE NPSD-1208 (Ref. 1) and evaluated in Section 4 of this SER.

2. Licensees should implement the proposed changes, which include increases in required shutdown Completion Times as well as changes in shutdown action statement end states, in accordance with an overall configuration risk management program (CRMP) to ensure that potentially risk-significant configurations resulting from maintenance and other operational activities are identified and avoided. This objective is met by licensee programs to comply with the Maintenance Rule 10 CFR 50.65 (a)(4) requirement to assess and manage risk resulting from maintenance and other operational activities.

3. Entry into shutdown Mode 4 shall be for the primary purpose of accomplishing short-duration repairs which necessitated exiting the original operating mode. The requested changes in end state for repair purposes do not prohibit licensees from entering cold shutdown if they wish to do so for operational reasons or maintenance requirements.

REFERENCES

1. CE NPSD-1208, "Justification for Risk-Informed Modifications to Selected Technical Specifications for Conditions Leading to Exigent Plant Shutdown," CE Owner's Group, December 2000.

2. CE-NPSD-1186, "Technical Justification for the Risk-Informed Modification to Selected Required Action End States for CEOG PWRs," CE Owner's Group, April 2000.

3. NUREG-1432, "Standard Technical Specifications, Combustion Engineering Plants," Revision 1, USNRC, April 1995.

4. Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decision Making on Plant Specific Changes to the Licensing Basis," USNRC, August 1998.

5. Regulatory Guide 1.177, "An Approach for Pant Specific Risk-Informed Decision Making: Technical Specifications," USNRC, August 1998.