COMBUSTION ENGINEERING OWNERS GROUP

CE NPSD-1045-A

Joint Applications Report

for

Modifications To The Containment Spray System Technical Specifications

Approved Final Report

CEOG TASK 849

prepared for the

C-E OWNERS GROUP
March 2000

ABB Combustion Engineering Nuclear Power, Inc.

Legal Notice

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Windsor, Connecticut 06095

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 21, 1999

Mr. Ralph Phelps, Chairman
CE Owners Group
Omaha Public Power District
P.O. Box 399
Ft. Calhoun, NE 68023-0399

SUBJECT: ACCEPTANCE FOR REFERENCING OF CE NPSD-1045, "JOINT APPLICATIONS REPORT, MODIFICATIONS TO THE CONTAINMENT SPRAY SYSTEM, AND THE LOW PRESSURE SAFETY INJECTION SYSTEM TECHNICAL SPECIFICATIONS" (TAC NO. MA1956)

Dear Mr. Phelps:

We have concluded our review of the subject Joint Applications Report (JAR) of April 6, 1998, submitted by the Combustion Engineering Owners Group. The proposed changes would allow an extension of the allowed outage time (AOT) to seven days for one containment spray system (CSS) train.

The report also requested modifications to the low pressure safety injection (LPSI) system and CSS action statement end states. The staff did not complete its review of the modifications to the LPSI and CSS technical specifications (TS) end states. Subsequent to the CEOG's submittal of the Joint Applications Report, the industry undertook an initiative to review the end states of all of the TS limiting conditions for operation (LCOs) in an effort to identify the most risk-beneficial end state for each LCO. The CEOG is leading this initiative. Therefore, the staff concluded, after discussion with the CEOG, that the review of all end state issues should be deferred until the industry submits its generic request for changes to TS end states.

The CSS AOT extension to seven days portion of the report is acceptable for referencing in licensing applications for ABB-CE plants except for the Calvert Cliffs units, subject to the limitations specified in the report and in the associated NRC safety evaluation, which is enclosed. The evaluation defines the basis of acceptance of the report.

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

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," we request that ABB Combustion Engineering publish an accepted version of this topical report within 3 months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed safety evaluation between the title page and the abstract.

It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, and original report pages that were replaced. The accepted version shall include an "A" (designating accepted) following the report identification symbol.

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

Sincerely,

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

Project No. 692

Enclosure: Safety Evaluation

cc w/encl: See next page

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO COMBUSTION ENGINEERING OWNERS GROUP, CE NPSD-1045, "JOINT APPLICATIONS REPORT, MODIFICATIONS TO THE CONTAINMENT SPRAY SYSTEM, AND THE LOW PRESSURE SAFETY INJECTION SYSTEM TECHNICAL SPECIFICATIONS"

1.0 INTRODUCTION

1.1 Background

In April 1998, the Combustion Engineering Owners Group (CEOG) submitted for staff review, a Joint Application Report (JAR) to modify the technical specifications (TS) of the containment spray system (CSS) (Reference 1). The proposed changes would allow an extension of the allowed outage time (AOT) to seven days for one CSS train. The JAR provided risk-informed and deterministic arguments to justify the AOT extension. It provided a summary of the results of risk assessments for all of the Combustion Engineering (CE) plants, except for the Calvert Cliffs units. The conclusions are applicable to all CE plants except for the Calvert Cliffs units.

The JAR also requested modifications to the low pressure safety injection (LPSI) system and CSS action statement end states. The staff did not complete its review of the modifications to the LPSI and CSS TS end states. Subsequent to the CEOG's submittal of the Joint Application Report, the industry undertook an initiative to review the end states of all of the TS Limiting Conditions for Operation (LCOs) in an effort to identify the most risk-beneficial end state for each LCO. The CEOG is leading this initiative. Therefore, the staff concluded, after discussion with the CEOG, that the review of all end state issues should be deferred until the industry submits its generic request for changes to TS end states. The staff believes that this deferral will provide the most efficient and effective review of all TS end state issues and will ensure that they are reviewed in a consistent manner.

The staff requested Scientech, Inc., to evaluate the Joint Application Report focusing on the risk-informed analyses performed to support the AOT extension requests. The findings document the results of the review activities performed for the risk-informed portion of the submittal. The review activities were based on the requirements of the statement of work (SOW) (Reference 2) and the guidance provided by the staff. The review was also carried out, to the extent consistent with the SOW, by the guidance contained in the standard review plan (SRP) (References 3 and 4) and regulatory guides (References 5 and 6), with the results largely extracted from the resulting Scientech Technical Evaluation Report (Reference 7).

1.2 Compliance of Review Process with SRPs

The general guidance for evaluating the technical bases for a risk-informed modification to a licensing basis is provided in Chapter 19 of the SRP (Reference 3). The specific guidance for the evaluation of changes to AOTs and surveillance test intervals is contained in Chapter 16.1 of the SRP (Reference 4). Chapter 19 of the SRP requires the review activities to address five key principles that collectively govern the staff's risk-informed decision-making process. These principles are listed below and are depicted in Figure 1.

I. The proposed TS change meets the current regulations.

II. The impact of the proposed TS change is consistent with the defense-in-depth philosophy.

III. The proposed TS change maintains sufficient safety margin.

IV. The incremental risk associated with the proposed change is small and consistent with the intent of the Commission's Safety Goal Policy Statement (Reference 8). (Since the AOTs are entered infrequently and are considered temporary in nature, the SRP for TS provides specific acceptance guidelines applicable only to AOT risk).

V. The licensee has the ability to monitor the impact of the proposed change using performance measurement strategies and then commits to such a program.

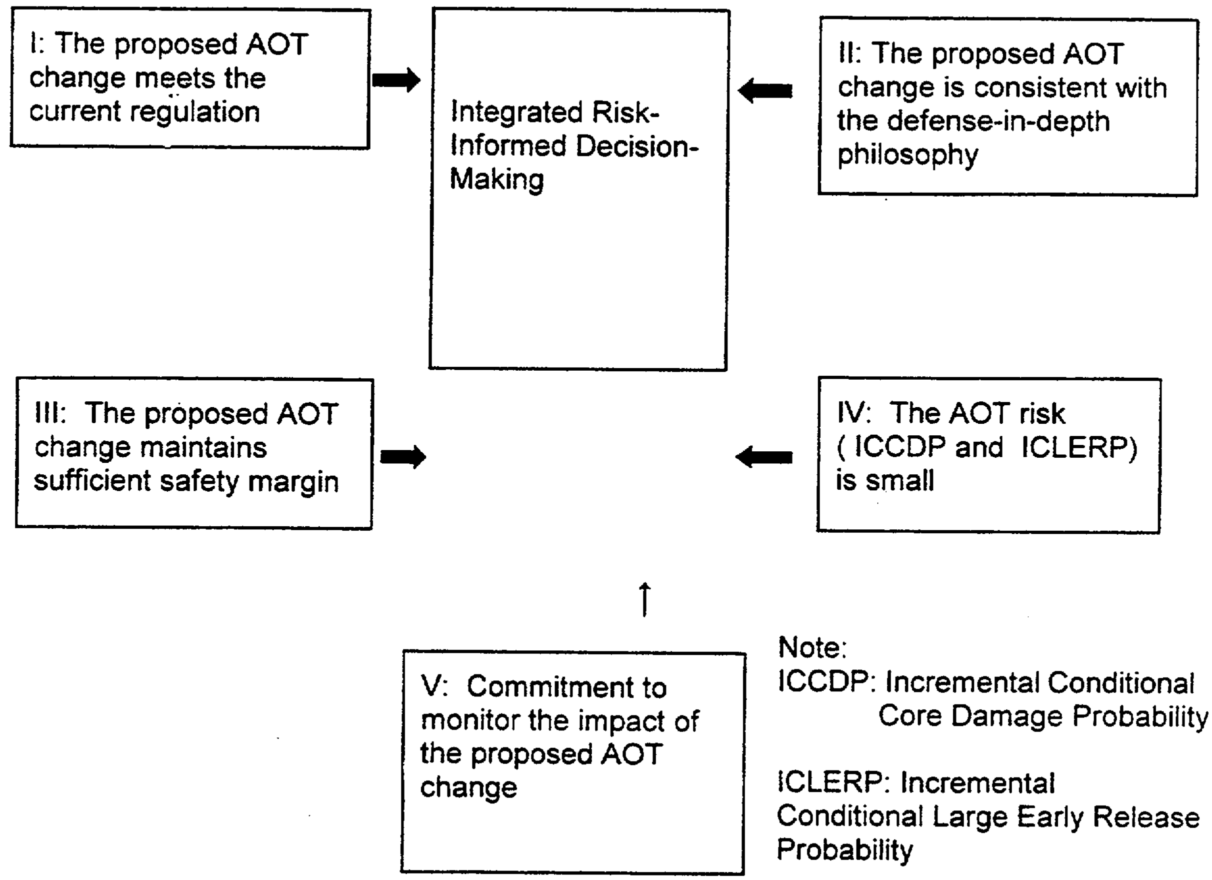

Figure 1: Principles of Risk-Informed Integrated Decision-Making

The staff decision in granting any requested change is guided by a process that requires the determination of whether a licensing basis change meets the set of key principles shown above. In risk-informed TS AOT applications, Principles I, compliance with the regulations is met. Compliance with the regulations is not affected by changing an AOT. The regulations do not require specific AOTs, but, rather, require "remedial actions" when an LCO cannot be met. With regard to Principle III, the proposed AOT change maintains sufficient safety margins because, for all types of plant designs reviewed, the loss of one CS train is well within the design basis analyses of the plants. The intent of Principles II, IV, and V is met by a three-tiered approach (Reference 4) as discussed below.

In Tier 1, an individual licensee is expected to determine the change in plant operational risk specifically with respect to core damage frequency (CDF and ICCDP) as a result of the proposed TS modification. In addition, in order to get a better understanding of the impact of the TS change on containment performance, the licensee is expected to perform an analysis of the large early release frequency (LERF and ICLERP) under the modified TS conditions and then discuss the results. Accordingly, the attributes of Principle IV are met directly by the assessment needs of Tier 1. The evaluation of the probabilistic analyses performed by the CEOG demonstrates conformance with Principle IV.

In Tier 2, an individual licensee is expected to evaluate and understand the plant's status with respect to defense-in-depth when proposing an AOT change. The licensee should provide reasonable assurance that risk-significant plant equipment outage configurations will not occur when specific plant equipment is out of service consistent with the proposed TS change. An effective way to perform such an assessment is to evaluate equipment according to its contribution to plant risk while the equipment covered by the proposed AOT change is out of service. Once plant equipment is so evaluated, an assessment can be made as to whether certain enhancements to the TS or procedures are needed to avoid risk-significant plant configurations. In addition, compensatory actions that can mitigate any corresponding increase in risk should be identified and evaluated. Any changes made to the plant design or operating procedures as a result of such a risk evaluation should be incorporated into the analyses utilized for TS changes under Tier 1. Thus, the Tier 2 evaluation satisfies the intent of Principle II to ensure the proposed change is consistent with the defense-in-depth philosophy. A probabilistic analysis can be used to support and augment traditional engineering evaluations performed to justify conformance with Principle II (Tier 2).

In Tier 3, the licensees assure that the risk impact of out-of-service equipment is appropriately evaluated in anticipation of a configuration and in response to an evolving plant configuration condition. This is expected to be an intrinsic part of all maintenance scheduling. Again, Tier 3 generally meets the intent of Principle V. This review evaluates whether the licensees have the ability to predict high-risk configurations, and if so, whether they commit to a risk-informed configuration control system.

This review draws from the individual plant examination probabilistic risk assessments (PRAs) submitted by the CE plants and the corresponding PRA evaluations performed by the staff and their contractors. Recognizing that a common methodology was employed by the CEOG to quantify AOT risk, and because CE plants generally have similar design characteristics[1], it is expected that the variation in AOT risk results is caused by the differences in the underlying PRA models. This evaluation attempts to highlight those modeling differences. The variability in PRA models can be attributed to factors such as:

- minor design or operational differences
- PRA assumptions (e.g., success criteria)

1.3 Scope and Structure of Report

The purpose of Reference 7 is to establish the validity of the conclusions drawn in the CEOG joint applications report for TS modifications related to the CSS. It provides a technical basis for the staff's safety evaluation (SE) on the joint application report. Reference 7 primarily addresses the PRA aspects of the joint applications to determine that each individual licensee meets the attributes of Principle IV. The approach taken relies on comparative studies to identify factors that cause variations in risk profiles. The PRA evaluation focuses on:

- comparing AOT risk results among CE plants to identify variations
- identifying modeling assumptions in the underlying PRA models that affect the AOT risk results
- establishing the basis for the reported AOT risk results

Reference 7 also addresses the concept of defense-in-depth (Principle II), probabilistically by using the AOT risk results and programmatically by determining the licensee's commitment to Tier 2. The individual licensee's commitment to meet Principle V, by committing to a risk configuration control system, is also addressed.

Section 2 provides a summary of the proposed TS changes. Section 3 summarizes the general risk-informed strategy employed by the CEOG to justify the TS change. In Section 4, the AOT risk results (from the CDF point of view) are compared relative to the guideline value. Section 5 examines the mitigating strategies credited in the PRA for the CSS in the prevention and mitigation of the core damage sequences. The ability of other systems to perform the function of the CSS is also discussed to set the stage of the evaluation of the defense-in-depth. Section 5 also examines the impact of the AOT change on LERF. Section 6 addresses the licensees' ability to meet Tier 2 and 3 elements. The Evaluation Summary is presented in Section 7, followed by the conclusions in Section 8, configuration risk management in Section 9, and References in Section 10.

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[1]Notable design differences are: (1) several CE plants do not have power-operated relief valves (PORVs), and (2) the Palo Verde units do not have a diverse containment cooling system.

2.0 CURRENT AND PROPOSED TECHNICAL SPECIFICATIONS

The proposed AOT change would extend the AOT for one train of the CSS (including the shutdown cooling (SDC) heat exchanger) from 1, 2, or 3 days to 7 days during Mode 1, 2 or 3[2].

3.0 METHODOLOGY USED FOR ASSESSMENT OF AOT RISK

The at power AOT risk analysis approach employed by the CEOG is consistent with the methods described in Reference 11; estimates for single AOT risk and yearly AOT risk are obtained. Consistent with the guidelines of NUREG/CR-6141 (Reference 11), common cause failures received different treatment in the AOT analysis for corrective maintenance (CM) and preventive maintenance (PM). When the LCO Action Statement is prompted by the need for CM (i.e., equipment failure), the redundant active component in service is assigned the β-factor which is the conditional failure probability given one component has already failed. The AOT risk for CM is directly proportional to the value chosen for β. The AOT risk predicted for CM can be interpreted as the upper bound for the AOT risk associated with the LCO configuration. For PM (i.e., no equipment failure), the failure probability of the redundant component in service is not adjusted and it includes both independent and common cause failure rates. It should be noted that, by far, AOTs are used for PM.

4.0 AOT RISK RESULTS FOR AT POWER CONFIGURATIONS

Each licensee evaluated the AOT-induced change in the CDF, which also allowed for the determination of the single AOT-induced risk. In estimation of the yearly AOT risk, the licensees assumed that with the AOT extension, the average number of entries in an LCO Action Statement per year would not change relative to present practices, a conservative assumption. With the exception of Arkansas Nuclear One, Unit 2 (ANO-2) and Palo Verde, the single AOT risk for CE plants is low and below the incremental conditional core damage probability guideline value of 5.0E-7 for both PM and CM.

5.0 BASIS OF AOT RISK RESULTS

5.1 Validity of PRA Models

An initial screening was performed to determine the validity of the PRAs used in the TS modification application. To gain confidence that the risk model used by each licensee to support this application was technically suitable, a quick and limited review of each individual plant examination model was completed. The review focused on (1) the accident scenarios for which the function of CSS and SDC is credited, and (2) the diverse systems credited to perform the function of CSS and SDC. This exercise provided the basis to compare the reported AOT risk results.

Based on this initial screening, it was determined that the PRAs have no apparent large defects and that they generally model CSS and SDC in a similar manner.

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[2]These operation modes are known as Mode 1: at power; Mode 2; start-up; and Mode 3: hot standby. In these modes, steam generator (SG) cooling is available.

The proposed AOT for CSS affects the risk by impacting:

- Accident sequences that can be prevented from leading to core damage, and
- Accident sequences that can be mitigated following core damage.

The CSS therefore, affects both CDF and the frequency of releases given the occurrence of core damage. This is because the CSS performs the critical function of controlling containment temperature and pressure to:

- Cool the RCS inventory that is spilled in the sump as a result of a loss-of-coolant accident (LOCA) event (core damage prevention role), and
- Prevent the release of radionuclides subsequent to a core damage sequence (core damage mitigation role).

The proposed TS also impact the long-term cooling function that can be provided by the shutdown cooling system (SDCS) following a small break LOCA, a steam generator tube rupture (SGTR), or a main steamline break (MSLB). In the normal alignment, the SDCS has only a core damage prevention role and, as such, primarily impacts CDF.

The pumps and shutdown cooling (SDC) heat exchanger require cooling by the service water system directly or through an intermediate cooling loop of the component cooling water system (CCWS). If entry into an LCO is caused by the CS pump outage, the plants with the ability to use the SDC as a backup to the spray pump can still preserve the spray function of the affected train. If, however, the heat exchanger is removed from the service, both the spray and SDC capability of the affected train would be lost completely unless cross-connect capability with systems such as service water (SW) are credited. Some plants have such capability, but it is generally not credited in the PRA unless proceduralized.

5.2 Success Paths

When a plant with a diverse containment heat removal capability enters into an LCO, only one success path may be affected. In the worst case, if one assumes both trains of the CSS are impacted due to common cause phenomena (i.e., corrective maintenance) four additional success paths are still available. The remaining success paths (four or five, depending on the condition) translate into a very high availability for the "containment cooling" function as long as the support systems to these success paths are available. This is the reason that the majority of the CE plants' PRAs predict a negligible risk impact while in the LCO condition. The exceptions are ANO-2 and Palo Verde. The ANO-2 IPE assumes fan coolers require a relatively high humidity environment for effective operation. The IPE conservatively assumes that without the atmosphere wetting function of the CSS, the fan coolers cannot effectively cool the containment. In effect, the ANO-2 IPE does not credit the fan coolers. Assuming that the ANO-2 fan coolers are of the same design as other CE plants, one can conclude that the AOT risk for the ANO-2 should be as low as the others. This is not true for the Palo Verde units because fan coolers are not part of the plants' design. In response to the request for additional information No. 4 (Reference 9), the CEOG argues that the ability of the Palo Verde units to align the SDC pump to a spray train increases the redundancy of the CSS when in the LCO. This is only true if the cause of the entry into the LCO is not related to the heat exchanger.

The following representative CSS related LCO configurations could be postulated for the Palo Verde units:

- ❑ One CSS pump is out-of-service for PM. The licensee can still claim that both trains are available if the SDC pump is aligned to the affected train.
- ❑ One CSS pump is out-of-service for CM. The licensee may claim the availability of the backup SDC pump for the affected train but also must recognize that the pump of the unaffected CSS train may be inoperable due to a common cause failure.
- ❑ One SDC heat exchanger is out-of-service for PM. The licensee can only claim the availability of one backup CSS train.
- ❑ One SDC heat exchanger is out-of-service for CM. The licensee has lost one train of the CSS and the remaining backup train may potentially be impacted as well.

The risk impact of the above postulated configurations varies. The risk impact is lowest for the first configuration and highest for the last one.

5.3 How the CEOG Intends to Evaluate Defense-in-Depth When in an LCO Condition Related to the CSS

In Response to Question 5 of the RAIs, the CEOG states:

"The risk assessment is to be performed in accordance with the Configuration Risk Management Program (CRMP). The key elements of the CRMP will be consistent with those required by the technical specification regulatory guide. For the CSS the risk assessment will consider the status of the redundant spray capability and/or the availability of safety grade fan coolers. The risk impact of the maintenance action will be established via reference to an applicable, pre-existing Probabilistic Safety Assessment (PSA), a risk matrix, or an "on-line" risk monitor."

<u>Evaluation of Defense-in-Depth When in an LCO Condition (Palo Verde Units)</u>

When the Palo Verde units remove a CSS train from service without the potential for recovery (removal of the heat exchanger), one backup capability for the available train remains. From a risk point of view, the loss of defense-in-depth can be tolerated for a short time. This is because the CSS is challenged to respond to LOCAs which are rare events. If, however, the LCO condition is caused by the removal of a pump, the functionality of the affected train can still be preserved assuming the procedural requirements exist to align the SDC pump to the affected train. In this case, two success paths for containment cooling functions can be credited.

Evaluation of Defense-in-Depth When in an LCO Condition (Balance of CE Plants)

When CE plants remove a CSS train from service, with or without the potential for recovery, there are several other means of achieving the containment cooling function (the backup train and diverse fan coolers). From a risk point of view, there is essentially no impact on the defense-in-depth for these plants. The high level of redundancy and diversity for the containment cooling function offsets the risk impact caused by the loss of the mitigation capability of the affected train for challenges associated with transient events when the secondary coolant is lost (i.e., the need for "feed and bleed").

5.4 Core Damage Mitigation

The effect of removing a train of the CS on the ability of the subject CE plants to mitigate the consequences of core damage is measured by ΔLERF or by ICLERP {ICLERP = (CLERF-LERF)X(duration of single AOT under consideration)}. The guidance measure for incremental conditional large early release probability (ICLERP) is 5.0E-8. Specifically, the TS regulatory guide states:

"The licensee has demonstrated that the TS AOT modification has only a small quantitative impact on plant risk. An incremental conditional core damage probability (ICCDP) of less than 5.0E-7 is considered small for a single TS AOT modification. An incremental conditional large early release probability (ICLERP) of 5.0E-8 or less is also considered small. Also, the ICCDP contribution should be distributed in time such that any increase in the associated conditional risk is small and within the normal operating background (risk fluctuations) of the plant (Tier 1)."

Considering all the above, the following assessment was performed:

The LERF is made up of contributions from bypass, loss-of-containment-isolation, and early failure of the containment. According to the Palo Verde IPE PRA, the respective conditional probabilities for early "failure" are 4 percent (for bypass), less than 0.1 percent (for loss-of-containment-isolation) and 10 percent (for actual early failure of the containment). A recent NRC report, NUREG/CR-6475 (Reference 12), states that the actual probability of early failure of the containment for the Palo Verde units is at least an order of magnitude smaller than the 10 percent value determined in the IPE PRA. Thus, it can be said that the LERF is conservatively about 5 percent of the CDF for Palo Verde. Since the baseline CDF for Palo Verde is 4.74E-5/year [Table 6.3.2-1 of (Reference 1)], then the LERF is 2.37E-6/year. The $\Delta LERF_1$ is then just the "change factor" [Table 6.3.2-1 of (Reference 1)] of 1.5 times the LERF minus 2.37E-6, or $\Delta LERF_1$ = 1.2E-6/year. This translates into an $ICLERP_1$ value of 2.2E-8. However, there may be contributions to the ICLERP from containment response to the core damage events, i.e., $\Delta LERF_2$. The three parts of $\Delta LERF_2$ are:

- Contribution from a change in the release from containment bypass. This will be zero, since the CS systems have no effect on bypass events.
- Contribution from a change in the release from the "loss of containment integrity" events. This will be small and will not contribute, although the absence of a spray train

might increase the release, the increase will be small since the baseline probability is small.

- Contribution from a change in the release from early containment failure. Although the absence of a CS system will not increase the probability of early containment failure, its absence could increase the released source term if and when the containment does fail. However, the IPE PRA for Palo Verde apparently does not give any credit for containment sprays (see Figure 11.7-1, page 11-170, of the IPE PRA) for the base-case assessment. Thus, as with the other two contributions, this contribution is small and negligible.

The conclusion that can be drawn for the three Palo Verde units is that the $\Delta LERF_2$ is negligible and that a conservative estimate of the $\Delta LERF$ is $\Delta LERF_1$ = 1.2E-6year, or the ICLERP = 2.2E-8; a value below the guideline of 5.0E-8. All other CE plants should have an ICLERP value considerably below the value for Palo Verde.

6.0 TIER 2 AND 3 CAPABILITIES

Tier 2 Capability

The main principle of the Tier 2 program is to establish whether each licensee is evaluating defense-in-depth when proposing an AOT change. The review process for the individual plant-specific amendments will include an assessment of the each licensees' evaluation with respect to Tier 2.

Tier 3 Capability

The main principle of the Tier 3 program is to establish whether the licensees have:

a. a predetermined knowledge of high risk configurations (e.g., risk matrix or an online risk monitor), and

b. the ability to evaluate the risk of LCO conditions as they evolve.

Each licensee's ability to meet the Tier 3 principles will have to be submitted along with the AOT relaxation request.

7.0 EVALUATION SUMMARY

Modeling differences reflect assumptions that are based upon individual or team judgment. During each modeling step, this judgment must weigh the conservative estimate against the best estimate and arrive at a system logic. If this system logic is not embedded in the plant system itself (e.g., resulting from thermal-hydraulic analyses), but is based on an assumption (e.g., based on design basis documents or expert judgment), it should be viewed in a different light. With this in mind, it should be noted that the level of conservatism and/or detail in the PRA might distort the projected AOT risk at a plant.

The staff has identified the important modeling assumptions that affected the AOT risks in the JAR. They are presented in the following table:

Table 1: Effect of Various Hypothetical Modeling Assumptions on Calculated Risks

	Effect on Baseline CDF	Effect on AOT Risk
1. Apply stringent success criteria to downed system (using licensing base success criterion)	↑	↑
2. Crediting downed system in multiple mitigation strategies (crediting CSS to support mitigation of LOCA and transient events (feed and bleed operation)	↓	↑
3. Crediting diverse system as alternative to downed system (CE plants with diverse containment cooling credited fan coolers for sump cooling function)	↓	↓

With these relationships in mind, the review of the CEOG individual plant examination PRAs highlighted the following factors that significantly affected the AOT risk results:

- All PRAs, with the exception of the Palo Verde units and ANO-2, credited a single (or a pair of) fan cooler units(s) to be functionally equivalent to a containment spray train. That is, a fan cooler (or a pair of fan coolers) can cool the containment and the sump in a post-LOCA accident. With these success criteria, the impact of the LCO configuration is bound to be negligible for plants other than the Palo Verde units and ANO-2 as is evident from the reported risk results (related to items 1 and 3 of the above table). That is, the single AOT risk values are well below the SRP guideline value (i.e., 5.0E-7). In the case of Palo Verde, the single AOT risk is comparable to the acceptance guideline. For ANO-2 the single AOT risk is higher (by a factor of close to two) than Palo Verde because of credit taken by ANO-2 for the feed and bleed operation (see next two observations).

- The ANO-2 IPE conservatively assumes that without the atmosphere wetting function of the CSS, the fan coolers cannot effectively cool the containment. In effect, the ANO-2 IPE did not credit the fan coolers (related to items 1 and 3 of the above table).

- Many CE plants credited the once-through-cooling capability (related to Item 2 of the above table). The risk impact of the LCO configuration on the feed and bleed operation is low (with the exception of ANO-2) because the containment cooling function required in the feed and bleed operation is supported by the diversity provided by the fan coolers.

- Since the CEOG advocates on-line maintenance of both the SDCS and the CSS, it is important that "at power" maintenance of these systems is not scheduled for the same time because the SDC pumps are credited as backup to the CSS pumps in supporting the containment spray function. Similarly, the maintenance of the CSS pumps in the lower modes of operation should be performed so that at least one CSS pump remains operable as a backup to the SDC pumps.

- The risk impact of the LCO configuration is dependent on which component of the CSS is affected. If the SDC heat exchanger is removed from service, one train of the SDCS and the CSS train that uses the affected SG are lost. If, however, the LCO configuration is caused by the removal of a CSS pump, the affected train can still be operational if a SDC pump can be aligned to the affected train.

- Regarding the impact of the LCO configuration on large early release, the ICLERPs for all the plants including the Palo Verde units are below the SRP guideline value (i.e., 5.0E-8). This is due to the ineffectiveness of the CSS in changing the LERF.

- The ICCDPs for all the plants are in an acceptable range, particularly since, by far, the primary AOT usage is for preventive maintenance. The proposed average CDFs/yr are unchanged except for those for the Palo Verde units and ANO-2, which increase by 3 percent and 6 percent, respectively.

8.0 CONCLUSIONS REGARDING CEOG LICENSEES PROBABILISTIC RISK ASSESSMENTS USED TO SUPPORT THE PROPOSED AMENDMENTS

Based on the three-tiered approach, the staff finds/requires the following:

a. The proposed CSS AOT modifications have only a minimal quantitative impact on plant risk. The calculated ICCDPs are small, primarily because of the redundancy in CSS configuration and fan cooler backup for most plants.

b. The licensees' submittals shall discuss implementation of procedures that prohibit entry into an extended CSS AOT for scheduled maintenance purposes if external event conditions or warnings are in effect. The licensees' procedures will also include compensatory measures and normal plant practices that help avoid potentially high risk configurations during the proposed extended CSS AOT.

c. The licensees' submittals shall describe a risk-informed configuration risk management program to assess the risk associated with the removal of equipment from service during the extended CSS AOT. The program provides the necessary assurances that appropriate assessments of plant risk configurations are sufficient to support the proposed AOT extension request for CSSs.

The NRC staff concludes that the CSS AOT extension will result in very small increases in plant risk. The licensees have/shall have processes for scheduling and controlling maintenance activities into which plant risk is incorporated; this compensates for the small risk increases and uncertainties associated with the proposed CSS AOT changes. The staff finds, therefore, that if b. and c. above are provided by a licensee, the PRA insights provided support the proposed

CSS AOT extension for all the plants with the exception, at this time of Calvert Cliffs, Units 1 and 2.

9.0 CONFIGURATION RISK MANAGEMENT PROGRAM

The licensees shall propose a "Configuration Risk Management Program" in the form of a new TS or other administratively controlled documents that the staff finds acceptable, if such a program has not been approved in a previous TS amendment. The Configuration Risk Management Program (CRMP) provides a proceduralized risk-informed assessment to manage the risk associated with equipment inoperability. The programs apply to technical specification structures, systems, and components for which a risk-informed allowed outage time has been granted. The proposed programs include the following elements:

a. Provisions for the control and implementation of a Level 1, at power, internal events, PRA-informed methodology. The assessment shall be capable of evaluating the applicable plant configuration.

b. Provisions for performing an assessment prior to entering the LCO condition for preplanned activities.

c. Provisions for performing an assessment after entering the LCO condition for unplanned entry into the LCO condition.

d. Provisions for assessing the need for additional actions after the discovery of additional equipment out-of-service conditions while in the LCO condition.

e. Provisions for considering other applicable risk significant contributors such as Level 2 issues and external events, qualitatively, or quantitatively.

As stated above, the CRMPs are acceptable in that the programs provide the necessary assurances that appropriate assessments of plant risk configurations using software, matrices, or PRA analyses augmented by appropriate engineering judgment, are sufficient to support the proposed AOT extension requests for CSSs.

In addition, the CRMPs are used to assess changes in core damage frequency resulting from applicable plant configurations. The CRMPs use software, matrices, or if necessary, the full PRA to aid in the risk assessment of online maintenance and to evaluate the change in risk from a component failure.

The CRMP will be used when a CSS train is intentionally taken out-of-service for a planned activity excluding short duration activities. In addition, the CRMP is used for unplanned maintenance or repairs of the CSS.

The licensee has committed/will have committed to implementation of the CRMP (Regulatory Guide 1.177) as described below.

The Configuration Risk Management Program (CRMP) includes the following key elements:

Key Element 1. Implementation of CRMP

The intent of the CRMP is to implement (a)(3) of the Maintenance Rule (10 CFR 50.65) with respect to on-line maintenance for risk-informed technical specifications, with the following additions and clarifications:

- The scope of the structures, systems and components (SSCs) to be included in the CRMP will be those SSCs modeled in the licensee's plant PRA in addition to those SSCs considered risk significant in accordance with the plant maintenance rule program that are not modeled in the PRA.

- The CRMP is PRA informed, and may be in the form of either a matrix, and on-line assessment, or a direct PRA assessment.

- CRMP will be invoked as follows for:

  Risk-Informed Inoperability: A risk assessment shall be performed prior to entering the LCO condition for preplanned activities. For unplanned entry into the LCO condition, a risk assessment will be performed in accordance with plant procedures, utilizing the maintenance configuration matrix, augmented by appropriate engineering judgement.

  Additional SSC Inoperability and/or Loss of Functionality: When in the risk-informed completion time, if an additional SSC within the scope of the CRMP becomes inoperable/non-functional, a risk assessment shall be performed in accordance with plant procedures.

- Tier 2 commitments apply for planned maintenance only, but will be evaluated as part of the Tier 3 assessment for unplanned occurrences.

Key Element 2. Control and Use of the CRMP

- Plant modifications and procedure changes will be monitored, assessed, and dispositioned as part of the normal PRA update process:

- Evaluation of changes in plant configuration or PRA model features can be dispositioned by implementing PRA model changes or by the qualitative assessment of the impact of the changes on the CRMP. This qualitative assessment recognizes that changes to the PRA take time to implement and that changes can be effectively compensated for without compromising the ability to make sound engineering judgments.

- Limitations of the CRMP are identified and understood for each specific completion time extension.

- Procedures exist for the control and application of CRMP, including description of the process when outside the scope of the CRMP.

Key Element 3. Level 1 Risk-Informed Assessment

The CRMP is based on a Level 1, at power, internal events PRA model. The CRMP assessment may use any combination of quantitative and qualitative input. Quantitative assessments can include reference to software, pre-existing calculations, or new PRA analyses.

- Quantitative assessments should be performed whenever necessary for sound decision making.
- When quantitative assessments are not necessary for sound decisionmaking, or are beyond the scope of the PRA model, qualitative assessments will be performed. Qualitative assessments will consider applicable, existing insights from quantitative assessments previously performed.

Key Element 4. Level 2 Issues/External Events

External events and Level 2 issues are treated qualitatively and/or quantitatively.

If a licensee requests a TS change consistent with this JAR after the revision to the maintenance rule, 10 CFR 50.65, becomes effective (64 FR 38551, July 19, 1999), then implementation of a plant CRMP will not be necessary. The licensee's implementation of the provisions of 10 CFR 50.64(a)(4) will provide adequate configuration risk management.

The staff expects the licensees to implement these TS changes or other administratively controlled documentation in accordance with the three-tiered approach described above. The AOT extension will allow efficient scheduling of online maintenance within the boundaries established by implementing the maintenance rule. The licensee will monitor CSS performance in relation to the maintenance rule performance criteria. Therefore, application of implementation and monitoring strategies will help to ensure that extension of the TS CSS AOT does not degrade operational safety over time and that the risk incurred when a CSS train is taken out of service is acceptable. In this manner, conformance with the attributes of Principle V will be achieved.

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EXECUTIVE SUMMARY

In response to the NRC's initiative to improve plant safety by developing risk-informed technical specifications, the CEOG has undertaken a program for defining and obtaining risk-informed technical specification modifications. As part of this program, several technical specification Allowed Outage Times (AOT), Surveillance Test Intervals and ACTION STATEMENTS were identified for joint action.

This report provides support for modifying Technical Specifications concerning the Containment Spray System (CSS) in order to provide an AOT of up to 7 days for one "INOPERABLE" CSS train. The intent of this AOT extension is to enhance overall plant safety by avoiding potential unscheduled plant shutdowns and allowing greater availability of safety significant components during shutdown. In addition, this extension provides for increased flexibility in scheduling and performing maintenance and surveillance activities in order to enhance plant safety and operational flexibility during lower modes of operation. *(Note: CSS and LPSI Tech Spec ACTION STATEMENT modifications[1], originally discussed in Section 7 and Attachment A, have been deleted since they were not reviewed by the NRC as part of this report. This activity has been subsumed into the risk-informed technical specification development initiative.)*

Generic information supporting these changes are provided, as well as the necessary plant specific information to demonstrate the impact of these changes on an individual plant basis. All C-E NSSS plants are participating in this activity; CEOG members consider the supporting and/or analytical material contained within this document to be applicable to all CEOG member utilities regardless of the category of their Plant Technical Specifications. Relevant plant-specific differences or exceptions are noted within the report.

Risk assessments provided in this report are based upon plant-specific PSA models that reflect the respective plant configuration during normal operation.

Justification of the requested modifications to Technical Specifications is based on an integrated review and assessment of a) plant operations, b) deterministic and/or design basis factors and c) plant risk. Results of this study demonstrate that the proposed AOT extension provides plant operational flexibility with negligible impacts on overall yearly plant risk in all cases.

The proposed increase in the Containment Spray System AOT to 7 days was evaluated from the perspective of various risks associated with plant operation. For the evaluated plants, incorporation of the extended AOT into the technical specifications results in negligible increases in the "at power" risk.

Based on considerations of transition risk, use of the extended AOT for on-line maintenance of a CSS train is risk-beneficial to the plant for both corrective maintenance situations including both random and non-random equipment failures.

An assessment of Level 2 PSA issues indicates that the unavailability of one CSS train does not significantly impact the three classes of events that give rise to large early releases. These include a) containment bypass sequences, b) severe accidents accompanied by loss of containment isolation and c) containment failure due to energetic events in the containment. Any decrease in availability of the CSS that might result from the requested technical specification modifications would result in a negligible impact on the large early release probability for C-E NSSS PWRs.

[1] CSS and LPSI Tech Spec modifications are not approved via this report.

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* Note: Section 7 and Attachment A were not reviewed by the NRC and have been deleted from this report.

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Modifications To The Containment Spray System Technical Specifications

1.0 PURPOSE

This report provides an evaluation of proposed modifications to Technical Specifications for the systems and components associated with Containment Spray System (CSS). Specifically, the approved modifications include changes to allowed outage times for the CSS. Additional changes to the required actions corresponding to specific conditions for both the containment spray and LPSI systems, discussed in the original version of this report, are not preserved in this Approved report. These activities will be subsumed into the risk-informed Technical Specification development initiative. A companion AOT extension request for the LPSI Technical Specification was previously requested by the CEOG in Reference 1. Each of the proposed modifications is described in the following section.

The proposed AOT extension is consistent with the objectives and intent of the Maintenance Rule, Reference 2. The Maintenance Rule will be the means to control the actual maintenance cycle by defining unavailability performance criteria and assessing maintenance risk.

2.0 SCOPE OF PROPOSED CHANGES TO TECHNICAL SPECIFICATION

Specifically, the proposed modifications that will be addressed are the following:

1. **Extension of the present Allowed Outage Time (AOT) to a maximum of 7 days for conditions that include an inoperable Containment Spray train (including a Shutdown Cooling Heat Exchanger) while other containment spray and containment cooling trains remain OPERABLE during either Mode 1, 2 or 3.**

The proposed AOT extension will provide needed flexibility in the performance of both corrective and preventive maintenance of Containment Spray System (CSS) components during power operation. For C-E PWRs with diverse containment heat removal capability maintenance of this system "at power" poses a negligible plant risk. Furthermore, since CSS components are utilized in configuring the Shutdown Cooling System (SDC), maintenance of the CSS "at power" may also increase the availability of SDC System and associated backup components during shutdown.

The design of each of the Palo Verde Units relies entirely on the containment spray system for both containment heat removal and post-accident iodine removal. For these units, the primary intent of the AOT extension is to provide adequate time for corrective maintenance situations. This proposed AOT extension results in a small acceptable incremental risk, which is offset by avoidance of unscheduled plant transitions.

The technical justifications for this proposed modification are discussed in Section 6.0 of this report.

The following modifications (items 2 – 5) were discussed in the original report but are not included in the scope of the enclosed NRC Safety Evaluation. These issues have been subsumed into the risk-informed technical specification effort.

2. ***Modification of the associated Required Actions when the AOT for the conditions described in proposed modification #1 has been exceeded. The proposed modification would allow sustained operation in Mode 4 once the plant has transitioned to that Mode.***

The intent of this proposed modification is to allow sustained operation in either Mode 4 or Mode 5 during the repairs that are limited to the repair of the inoperable containment spray train (possibly including an inoperable shutdown cooling heat exchanger). Mode 4 is a more advantageous end-state because it includes diverse and redundant means of RCS heat removal. This is particularly significant when the reason for the entry into lower mode operation is caused by inoperable or non-functional Shutdown Cooling System (SDC) components.

The technical justifications for this proposed modification are discussed in Section 7.0 of this report.

3. ***Modification of the associated Required Actions when the AOT for a single inoperable ECCS train due to an inoperable LPSI subtrain has been exceeded. This modification would allow continued operation in Mode 3 below a specific pressure (and temperature) or continuous operation in Mode 4 once the plant has transitioned to Mode 3 within 6 hours and transitioned to pressure of less than the specified pressure within 12 hours.***

The intent of this proposed modification is to allow continued operation at RCS temperatures greater than those of Mode 5 during the repairs that are limited to the repair of a single inoperable Low Pressure Safety Injection train. Components of the LPSI system are integral to the Shutdown cooling system which is required for deliberate entry into Mode 5. Therefore, maintaining plant operation in Mode 4 during conditions where SDC system are less than fully functional enhances plant safety by operating the plant in a Mode with diverse RCS heat removal capabilities.

The technical justifications for this proposed modification are discussed in Section 7.0 of this report.

4. ***Modification of mode-transition Required Actions associated with conditions that include two inoperable containment spray trains while other independent, redundant systems remain operable in either Mode 1, 2 or 3.***

This proposed modification provides technical specification required actions that provide flexibility for continued power operation in Mode 4 when both trains of CSS system are INOPERABLE. Mode 4 operation allows for RCS heat removal via the steam generators.

The technical justifications for this proposed modification are discussed in Section 7.0 of this report.

5. ***Modification of mode-transition Required Actions associated with conditions that include two inoperable ECCS trains due to only inoperable LPSI subtrains in either Mode 1, 2 or 3.***

This proposed modification provides technical specification required actions that provide flexibility for continued power operation in Mode 4 when both subtrains of LPSI system are INOPERABLE. Mode 4 operation allows for RCS heat removal via the steam generators. Deliberate entry into Mode 5 under conditions that include INOPERABILITY of all LPSI pumps would be prohibited due to the INOPERABILITY of all SDCS trains.

The technical justifications for this proposed modification are discussed in Section 7.0 of this report.

3.0 BACKGROUND

In response to the NRC's initiative to improve plant safety by developing risk-informed technical specifications, the CEOG has undertaken a program for defining and obtaining risk-informed technical specification modifications. As part of this program, several technical specification modifications, involving AOTs, Surveillance Test Intervals (STIs) and specific ACTIONS were identified for joint application.

A previous CEOG joint application submittal, Reference 1, supported a request for the extension of the LPSI system AOT to seven days. This report provides support for specific modifications of the Technical Specifications governing the Containment Spray System (CSS). These modifications include an extension of the CSS AOT. The intent of the proposed CSS AOT extension is to enhance overall plant safety by a) avoiding potential unscheduled plant shutdowns, b) minimizing plant transitions and c) providing for increased flexibility in scheduling and performing maintenance and surveillance activities.

This report provides generic information supporting these changes, as well as the necessary plant specific information to demonstrate the impact of these changes on an individual plant basis. All CEOG members consider the supporting and/or analytical material contained within this document to be applicable to their respective member utilities regardless of the category of their Plant Technical Specifications.

Risk assessments provided in this report are based on plant PSA models that adequately reflects the respective plant configuration during normal operation.

4.0 SUMMARY OF APPLICABLE TECHNICAL SPECIFICATIONS

There are three distinct categories of Technical Specifications at C-E NSSS plants.

The first category is called the Standard Technical Specifications. Through February 1996, NUREG-0212, Revision 03, commonly referred to as "Standard Technical Specifications," has provided a model for the general structure and content of the approved technical specifications for many of the domestic C-E NSSS plants.

The second category corresponds to the Improved Standard Technical Specifications (ISTS) guidance that is provided in NUREG-1432, Revision 0, dated September 1992 and NUREG-1432, Revision 1, dated April 1995. A licensing amendment submittal to change the Technical Specifications for San Onofre Nuclear Generation Station Units 2 & 3 so as to implement this guidance was submitted to the NRC in December 1993. (The NRC has issued a Safety Evaluation Report on that submittal). Additionally, licensing amendment submittals are being developed for the implementation of ISTS guidance for several other C-E NSSS units.

The third category includes those Technical Specifications that have structures other than those that are outlined in either NUREG-0212 (Reference 3) or NUREG-1432 (Reference 4). These Technical Specifications are generally referred to as "customized" technical specifications and are associated with the early C-E PWR designs. The C-E NSSS plants that currently have "customized" technical specifications are Palisades and Fort Calhoun.

Both of these categories of Technical Specifications include operating requirements for Containment Spray and Containment Cooling Systems and LPSI subsystem trains.

4.1 Standard Technical Specifications

The Limiting Conditions for Operation (LCO) requirements for Containment Spray System trains and Containment Cooling Units are combined in the generic Technical Specifications of NUREG-1432 (Section 3.6.6A and 3.6.6B). The combination of these requirements addresses the fact that these systems compliment each other in the performance of the containment temperature and pressure control safety function. As a result, any evaluation of the condition of containment spray system trains must also include consideration of the condition of safety-related containment cooling units and vice-versa. [Effectively, NUREG-1432 combines the separate LCO requirements concerning containment spray systems from NUREG-0212 (3.6.2.1 LCOs) and the separate LCO requirements for safety-related containment cooling units (3.6.2.3 LCOs).]

In some C-E NSSS designs, the Containment Spray System (CSS) also provides the fundamental function of removing iodine isotopes from the containment atmosphere during accident scenarios. As a result, both sets of Standard Technical Specifications provide separate LCO requirements concerning CSS for the C-E NSSS units where the iodine removal function of CSS is assumed in design bases accident analyses. Separate LCO requirements concerning CSS are provided for the C-E NSSS units where design base accident analyses does not credit operation of CSS in the removal of iodine from the containment atmosphere.

In general for both NUREG-0212 and NUREG-1432, the AOTs for conditions with inoperable CSS trains while Containment Cooling Units remain fully operable are generally longer for the designs that do not credit containment spray in containment iodine removal. (When a single Containment Spray System is INOPERABLE while other containment temperature and pressure control systems are OPERABLE, the AOT for the inoperable train is 7 days, if containment iodine removal does not have to be considered. When iodine removal must be considered, the AOT for the same condition is reduced to 72 hours. For the condition where all CSS trains are INOPERABLE but all safety-related Containment Cooling Units are OPERABLE, the AOT for restoring at least one containment spray train to operability is 72 hours, when containment iodine removal does not have to be considered. If containment iodine removal must be considered, there is no corresponding AOT for this same condition; and a shutdown to MODE 3, with an ultimate MODE 5 end-state, must be initiated.)

The wording of "Containment Spray and Cooling Systems" Technical Specifications of NUREG-1432 (3.6.6A and 3.6.6B) is designed to provide additional clarity on these interrelationships concerning containment temperature and/or pressure control and containment iodine removal.

4.2 "Customized" Technical Specifications

Customized technical specifications for the CSS (including Shutdown Cooling Heat Exchangers) differ from those in the two versions of STS. The allowed outage times for the containment spray pump and the shutdown cooling heat exchanger for plant employing Customized Technical Specifications are as defined in Table 4.2-1.

Table 4.2-1

COMPARISON OF CONTAINMENT SPRAY AND CONTAINMENT COOLING COMPONENT AOTs AMONG C-E PWRs WITH CUSTOMIZED TECHNICAL SPECIFICATIONS

PLANT	ALLOWED OUTAGE TIME	
	CSS PUMP	SDC Heat Exchanger
Fort Calhoun	7 days	24 hrs
Palisades	7 days	24 hrs

5.0 SYSTEM DESCRIPTION AND OPERATING EXPERIENCE

In many C-E PWRs, the CSS shares, or can share, components with the Emergency Core Cooling System. Specifically, valves can be positioned to allow the CSS pumps to perform the functions of the Low Pressure Safety Injection and/or Shutdown Cooling Pumps. In addition, for many C-E NSSSs the Low Pressure Safety Injection and/or Shutdown Cooling Pumps can provide the functions of containment spray pumps.

In all C-E NSSS designs, the shutdown cooling heat exchangers are used to remove heat from containment spray water during recirculation from the containment sump. These same heat exchangers are also integral components of the shutdown cooling system. The design of the C-E NSSS units is such that there are no expected event recovery strategies that would require simultaneous functioning of the containment spray and shutdown cooling systems.

Section 5.1 provides an overview description of the CS and SDC systems and the scope of system capabilities for plants with C-E NSSSs.

5.1 System Descriptions

5.1.1 Containment Spray System

The role(s) of the Containment Spray System (CSS) varies among the various C-E NSSSs. In all cases, the Containment Spray system works either alone or in conjunction with the air recirculation fan cooler system to control containment pressure following design basis accidents. In some C-E PWRs, the containment spray system is also credited with iodine removal.

The containment spray system consists of a) two or more containment spray pumps, b) associated valves and piping, c) two Shutdown Cooling Heat exchangers (alternatively called Residual Heat Removal Heat Exchangers in some plants) and d) Spray Ring(s). For some C-E NSSSs, the CSS interfaces with the Iodine Removal System (IRS) which consists of one spray chemical addition tank and associated metering devices. The spray system functions in an injection or recirculation mode. In the injection mode, each containment spray (CS) pump takes suction from a stored source of borated water located outside of the containment. In the recirculation mode, each CS pump draws water from the containment emergency sump. The discharge flow from the containment spray pumps is then directed through the SDC heat exchangers. The flow then discharges into containment via an injection isolation valve and a set of specially designed spray nozzles.

The Containment Spray Actuation Signal (CSAS) may be initiated manually or automatically on a high containment pressure signal in conjunction with a Safety Actuation Injection Signal (SIAS). In most CS systems, the containment spray pumps are actuated on SIAS and operate in a mini-flow recirculation mode until the CSAS opens the spray isolation valve.

If offsite power sources are lost to the CSS, CS pumps automatically receive power from the EDGs.

In order to ensure high reliability and availability of containment spray system functions, several C-E NSSS plants have procedures available to allow use of LPSI pumps as backup pumps for containment spray functions. Additionally, several C-E NSSSs have installed spare CS pumps.

Containment Temperature and Pressure Control (Containment Heat Removal)

All but four C-E NSSS units provide containment heat removal via a diverse and redundant combination of containment sprays and safety-grade emergency cooling units. In this design, the plant typically has two (2) spray pump trains and two (2) cooling unit trains (with two fan coolers per unit). These systems are typically designed so that containment pressure and temperature control are adequately provided by any of the following combinations of subsystems:

1. Three of four containment cooling fan units
2. Two subtrains of Containment Spray
3. One subtrain of containment spray and two containment cooling fan units

This design basis is generally described on Page B 3.6-48 of NUREG-1432, Rev 01.

C-E NSSS units that do not include design basis containment cooling units are Palo Verde Units 1, 2 and 3. Table 5.1-1 summarizes the important features of the containment heat removal systems for CEOG PWRs.

Failure of the combined containment spray and containment cooling systems to perform functions during a plant challenge may result in the containment pressure and temperature exceeding the design basis limits and possible containment failure.

TABLE 5.1-1
COMPARISON OF CONTAINMENT HEAT REMOVAL FEATURES FOR C-E PWRS

Plant	Safety Grade Air Recirculation Cooling Fans Available	No. and Capacity (%) of Spray Train		Spray System Credited For Iodine Removal
Palisades	✓	2	50%*	✓
Fort Calhoun	✓	2	50%	No
Calvert Cliffs Units 1 & 2	✓	2	50%	No
Millstone Unit 2	✓	2	50%	✓
St. Lucie Unit 1	✓	2	100%	✓
St. Lucie Unit 2	✓	2	50%	✓
ANO-2	✓	2	100%*	✓
San Onofre Unit 2 & 3	✓	2	100%*	✓
Waterford 3	✓	2	100%*	✓
Palo Verde 1, 2 & 3	No	2	100%*	✓

* One spray train is capable of meeting iodine removal requirements.

Severe Accident analyses for representative C-E NSSSs provided in the plant IPEs (cf., References 5, 6 and 7) indicate that containment integrity following severe accidents can be accomplished with less than the design basis complement of containment heat removal equipment. These studies demonstrate that containment integrity protection can be provided with either one CS subtrain or one fan cooling unit.

Inability of containment cooling systems to provide their designed functions during either the injection phase or recirculation phase of accident response can impact the plant core damage frequency in two ways. First, during the recirculation phase, failure of the heat removal capability of the shutdown cooling heat exchanger may result in the temperature of water in the containment emergency sump exceeding an equipment qualification limit for ECCS equipment. If this should occur, the high temperature of the water in the containment sump could result in cavitation induced failure of the safety injection pumps. Failure of safety injection pumps during post-LOCA sump recirculation operation will eventually result in a core damage. Second, if the containment atmosphere is inadequately cooled following a successfully mitigated medium or large LOCA and no containment heat removal is available, the containment can pressurize and containment failure may result. The ensuing rapid containment decompression following containment failure would produce significant void formation in the emergency sump that may result in cavitation induced failure of the operable safety injection pumps. Again, the resulting failure of the safety injection pumps during LOCA will eventually result in a core melt condition. Such sequences have been included in C-E NSSSs PSAs when applicable. These accident scenarios are generally low probability and were below the screening criteria of many of the PSAs performed for C-E NSSS units.

Fission Product Removal

Design basis capability for fission product removal is based on the removal of iodine from the containment atmosphere. The acceptability of the plant to provide this function is based on the ability of the plant to meet the requirements of 10 CFR 100 plant siting criteria (Reference 8) and GDC 19 of 10 CFR 50 Appendix A for allowable control room doses (Reference 9). The systems associated with the primary responsibility of fission product removal vary among the C-E Units.

Some plants include dedicated iodine removal systems consisting of recirculation filter units. These units consist of a) an induced draft fan, b) HEPA filters for particulate removal and c) activated charcoal filters for removal of elemental iodine. For plants with this system, the CS often takes on an ancillary role in the removal of particulate fission products, and the control of containment temperature.

Some C-E PWR designs included chemical addition systems to enhance removal of elemental iodine. These systems provide either a sodium hydroxide or hydrazine additive to the containment spray water. The purpose of these additives is to reduce the partial pressure of iodine around the spray droplet and thereby increase the ability of the spray to remove elemental iodine. The designs for Palo Verde Units 1, 2 and 3 rely solely on the borated water spray system to accomplish the iodine removal function. For these plants, each train of the Containment Spray System provides adequate spray coverage to meet 100% of the iodine removal design bases.

Another fission product control function of the containment spray systems at some C-E PWRs is pH control of the containment sump water. Maintaining the sump pH above 7 will effectively prevent significant re-evolution of elemental iodine from sump water. Several C-E NSSSs are licensed to use containment spray from the borated water source with no other direct chemical additive to perform this function. In this configuration, to ensure effective iodine retention in the sump water, soluble solid chemical additives (such as trisodium phosphate (TSP) pellets) are strategically stored at lower levels of the containment. Other C-E NSSSs units include NaOH chemical additive systems to both enhance the "scrubbing" of elemental iodine and to directly control the sump pH (thereby limiting potential iodine re-evolution). The sodium hydroxide additive provides assurance that the water solution in the containment sump will remain alkaline with pH values typically on the order of 8 or more.

Recent research (Reference 10) into the post-LOCA fission product composition for the Maximum Hypothetical Accident (MHA) indicates that the fraction of iodine released into the containment in elemental form is more than an order of magnitude lower than that defined in the current plant design basis evaluation methodology (Reference 11). Therefore, spray additives that were intended to facilitate the removal of elemental iodine from the containment atmosphere is of much less importance when the realistic fission product composition is considered. It is now known that during a severe accident, most iodine released to the containment atmosphere is particulate in nature (predominately CsI) which can effectively be removed from the containment atmosphere without the use of spray additives.

Other

In addition to providing Containment Temperature and Pressure Control and Fission Product Removal, for many C-E NSSS units, the capability exists to use CS pumps as backup to the shutdown cooling system or LPSI System.

5.1.2 Shutdown Cooling System

The Shutdown Cooling System (SDCS) is designed to provide heat removal from the RCS when the plant is shutdown in a relatively low pressure and low temperature mode (MODES 4, 5 and 6). Typically SDC Systems operate at temperatures of below 400 F and pressures less than 350 psig. The typical C-E SDCS uses a heat removal flow circuit that: 1) takes suction from the RCS hot leg, 2) cools the RCS fluid as it passes through a shutdown cooling heat exchanger and 3) returns the fluid into the RCS cold leg. When the SDCS is operating, a portion of flow can be re-directed from this flow circuit into a parallel path through the filtration and ion exchange units that are part of the Chemical and Volume Control System (CVCS). Components of the shutdown cooling system can also be aligned to provide water transfers between the refueling water storage tank and the combined RCS/refueling cavity while the decay heat removal flow circuit is continued.

With very specific exceptions described in plant-specific Technical Specifications, continuous operation of the shutdown cooling system (or its equivalent) is required in Modes 5 and 6. In Mode 4, operation of the shutdown cooling system is required only if RCS heat removal is not being provided via steam generator. The SDCS may be used in Mode 4 even if a steam generator heat sink is available.

When the Shutdown Cooling System (SDCS) is operating, LPSI components that were part of the Emergency Core Cooling System (ECCS) during MODES 1, 2 and 3 (high pressure) are components of the SDCS. In a similar fashion, the shutdown cooling heat exchangers that were components of the Containment Spray System during MODES 1, 2 and 3 are components of the SDCS during its operation.

As was stated in the previous section, for most C-E NSSS PWRs, containment spray pumps can be aligned as backup shutdown cooling system pumps. This would depend upon the accident and/or plant operating mode and would require a manual alignment.

5.2 <u>Operating Experience</u>

5.2.1 Preventive Maintenance

For most C-E PWRs, in order to perform preventive maintenance (PM) during power operation for CSS components, the plant must voluntarily enter into a Limiting Condition for Operation (LCO) action statement. An NRC Inspection Manual (Reference 12), provides the general safety principles that the NRC inspectors use to assess the appropriateness of the utilities "on-line" maintenance activities to ensure the proper use of the plant AOTs. In response, many nuclear utilities have voluntarily adopted administrative guidelines for voluntary entry into an LCO ACTION statement. This administrative guidance typically requires that a plan must exist for completing the associated maintenance within a period that is considerably shorter than the duration of the allowed outage time (AOT) specified in the LCO ACTION statement. In addition, the risk associated with such maintenance is also assessed.

Many types of preventive maintenance on CSS train components (including post-maintenance verifications and tests) require a period of less than 24 hours. Typical activities associated with preventive maintenance for a CSS pump include:

- change of oil and filter
- lubrication
- replacement and/or tightening of seals
- bearing replacement

Important valves in the CSS include:

* Pump discharge check valves,
* SDC heat exchanger isolation valves,
* Minimum flow recirculation valves,
* Injection motor-operated valves (MOVs),
* Containment Sump Recirculation valves.

Preventive maintenance activities associated with valves within the Containment Spray system include:

- valve overhaul
- valve repacking

Typically, pump and valve PMs require less than 24 hours to complete. When performed properly, preventive maintenance on single CS System components can be completed within the 72 hour AOT that is currently available to most C-E NSSS PWRs.

Maintenance associated with the shutdown cooling heat exchangers primarily includes tube cleaning, repair and replacement.

5.2.2 Surveillance and/or Testing of CS System Valves

Testing of valves (MOVs, AOTs and Check Valves) in the CSS system occurs as a result of post-maintenance testing and in-service inspections. The scope of these tests vary based on the type of valve, specific activity and utility procedures. The interval for in-service testing is defined via the technical specifications. This testing may be performed either at power or during a plant shutdown. In the case of dynamic testing of the MOVs at power, it is required that the MOV stroke time be within a specified band and that the valve operator performance be within defined limits. Testing times for a single MOV can vary from under one hour to more than 8 hours. (Failure of tested valves to meet dynamic response criteria can result in considerably longer outages.) For the majority of plants the test is conducted so as to not disable the valve's ability to receive and respond to an Engineered Safety Features Actuation Signal, and for all plants the actual time interval that the tested valve is either not functional, or in its design-base event response position, is small.

At many plants, valve testing requires system tagout and entry into the LCO ACTION STATEMENT. An extended AOT would also provide additional time to correct any problems found as a result of any particular surveillance and/or dynamic test.

5.2.3 Corrective Maintenance

Corrective maintenance (CM) in the CS System includes pump, heat exchanger and valve repair. In practice, the term corrective maintenance is typically used for the repair of a component resulting from an observable malfunction which may or may not compromise the ability of the system or component to perform its safety function. This terminology typically places corrective maintenance on CS pumps due to small oil and/or water leaks (which do not necessarily impair pump function) into the same category as more extreme failures such as a debilitating pump motor failure. The terminology also includes the repairs performed in response to conditions observed during the surveillance tests that were discussed in the previous section of this report.

All utilities involved in this task have indicated mean CS pump repair times of under 24 hours with the longer repairs taking in excess of 72 hours (See Table 5.2-1). It is expected that failures that render the CS pump, or other components, non-functional will be skewed to the higher repair times. Parts accessibility may also impact the repair time.

As was discussed in the previous section, Section 5.2.2, during MOV dynamic testing, the applicable system train is "INOPERABLE" by definition; and the associated system AOT is applicable. In order for the tested valve and the system to be returned to an OPERABLE condition, the valve characteristics must be measured to be within a specified band of torque and flow. If these parameters fall outside the defined bands during testing, the MOV and the system remain INOPERABLE. The remainder of the system AOT can be used to perform corrective maintenance and retesting to return the valve and the system to an OPERABLE condition. An inability to complete this corrective maintenance and determination of the OPERABILITY of the valve within the remainder of the AOT would result in the applicability of other Technical Specification requirements to bring the plant to a mode where the affected valve does not need to be OPERABLE.

In at least one past case at a C-E NSSS unit, the combination of on-line dynamic testing following corrective maintenance for such an MOV resulted in restoration of system OPERABILITY within only one hour of the expiration of the 72 hour AOT. In one recent instance a C-E PWR was required to shutdown due to the inability to repair an MOV in the required 72 hour completion time (Reference 13). These examples illustrate the need for a longer AOT.

Corrective maintenance associated with the SDC (or RHR) heat exchanger typically will involve correction of leaks in the CSS attached piping and leaks in the heat exchanger piping.

5.2.4 Related Licensing Actions

Over the past two years the industry has been applying results from PRA sensitivity studies as a basis for eliminating requirements that are marginal to safety. Elimination of requirements marginal to safety includes the relaxation of Technical Specifications (Tech Spec). Recently

South Texas Project (STP) proposed 22 Tech Spec changes to the NRC for relaxation (Reference 14).

The Tech Spec changes requested by STP were of two types; extending allowed outage time (AOT) and extending Surveillance Test Intervals (STI). Of the 22 proposed Tech Spec changes, 6 were withdrawn by STP. Quantitative evaluations were performed by STP in support of 11 of the remaining 16, using the plant PSA model. Qualitative explanations were presented by STP for the remaining 5 to support the proposed extensions. The systems for which Tech Spec relaxation was sought included the ECCS, including LPSI, HPSI and SIT, RHR (Residual Heat Removal) and CS Systems. The AOT for these systems were requested to be extended from 72 hours to 10 days; the NRC granted the extension to 7 days. In the evaluation of extensions to the RHR and CS systems, the NRC noted that the extended AOTs have a negligible impact on plant risk (Reference 14). It was further concluded that such modifications would "provide the operational flexibility where resources can be spent on risk significant aspects" of plant operation.

Table 5.2-1
COMPARISON OF MAINTENANCE REPAIR TIMES FOR CONTAINMENT SPRAY PUMPS*

PLANT	MEAN TIME TO REPAIR (HR)	RANGE OF REPAIR TIMES(HR)
Fort Calhoun	13	1→ 23
Palisades	‡	‡
Calvert Cliffs 1 & 2	11.8	3 → 27
Millstone 2	4.7	‡
St. Lucie 1 & 2	7.6	< 1 → 64
ANO-2	‡	< 1 → 72
Waterford 3	34	3.5 - 70
San Onofre 2 & 3	‡	‡
Palo Verde 1, 2 & 3	3.6	1.6 → 46.5
Generic	11.1	--

* Data is based on repair information for LPSI and CS pumps

‡ Data not available at time of report preparation

6.0 TECHNICAL JUSTIFICATION FOR THE CSS AOT EXTENSION

This section presents an integrated assessment of the proposed AOT extensions. The assessment includes discussion of a) motivation and need for technical specification change, b) the impact of the change on the plant design basis and c) probabilistic risk assessment.

Section 6.1 presents a summary statement of the need for the AOT extension (the supporting information for this section has been previously presented in Section 5). Section 6.2 provides an assessment of deterministic factors, particularly those associated with the plant design basis. The following sections generally follow the NRC guidance set forth in Reference 15 for risk-informed changes to Technical Specifications. The probabilistic risk assessment for this AOT extension is contained in Section 6.3, including consideration of risks of mode transition and plant shutdown.

Compensatory actions that may be applicable to this AOT extension are summarized in Section 6.4.

6.1 Statement of Need

As previously stated, the primary roles of the Containment Spray System (CSS) are (1) control of containment pressure and temperature following an accident, and (2) removal of fission products from the containment atmosphere. The CSS consists of two pumps, many valves, two heat exchangers (shared with the SDCS system) and, for some C-E NSSS units, a chemical addition system. Based on a review of the maintenance requirements on the CSS for C-E PWRs, it was determined that a 7-day AOT for one containment spray system train would provide sufficient margin to effect most anticipated preventive, and corrective maintenance activities (including "on-line" valve surveillance tests). The proposed 7 day AOT will provide consistency with the proposed AOT for LPSI trains (Reference 1) and existing AOTs governing containment heat removal equipment. It will also provide consistency between for the AOT for containment spray for use in heat removal and radiological protection.

Corrective maintenance of CSS components "at power" will avert the risks and costs associated with an unscheduled plant shutdown. Preventive maintenance of the CSS components during "at power" operation will reduce the maintenance burden during the shutdown and allow increased availability of shutdown significant components (SDC heat exchanger, CS pump as a backup for SDC) during lower mode plant operation.

6.2 Assessment of Deterministic Factors

6.2.1 Thermal-Hydraulic Considerations

All C-E PWRs with the exception of Palo Verde Units 1, 2 and 3 use both containment spray trains and containment cooling units as diverse and redundant means of limiting and maintaining post-accident containment pressure below design limits. The Palo Verde units use only safety grade containment spray systems for containment cooling following accidents.

The limiting events that govern the design of the CSS are the Main Steam Line Break (MSLB), and the Loss of Coolant Accident (LOCA). Design Basis (DB) events are analyzed assuming the worst single active failure. Limiting design basis transients involve large double ended breaks in the secondary and primary piping respectively. Large breaks of these types have never been seen for operating nuclear reactors (Reference 16). Leak before break considerations render the probability of these events to be negligible (on the order of 10^{-14} per year for C-E PWRs). Large breaks have been assessed to have initiating frequencies that vary between 10^{-3} per year for Main Steam and/or Main Feedwater Lines to between and 10^{-4} to 10^{-8} per year for the large LOCA (cf., References 16 and 17).

The worst single active failure analyzed for design basis containment pressure evaluations typically results in one subtrain of containment cooling equipment (sprays and coolers) unavailable. The plant design ensures that operation of a single train of Containment Heat Removal (CHR) equipment is sufficient to guarantee adequate containment performance. In C-E NSSS designs with a safety grade containment air cooler, operability of 3 of 4 containment fan coolers are sufficient to meet DBE requirements on containment pressure (that is, no containment sprays are required to be operable, cf., Reference 18). For plants that provide containment cooling via the Containment Spray System, operation of one train of containment spray system is sufficient to meet design basis requirements. For plants with diverse containment heat removal, standard technical specifications allow removal of one train of the containment spray system out of service for a period of 7 days when the inoperability affects the containment heat removal function of the CSS only.

Another role of the containment spray systems is to control containment pressure and temperature conditions within the plant equipment qualification (EQ) limits. This issue is of consequence in containment for a large main steam line break, where significant containment atmosphere superheating is possible. Exceeding EQ limits of equipment within the containment may compromise the capability of the equipment and/or instrumentation used to mitigate an accident and complicate recovery procedures. Transients that challenge the EQ limits are expected to generate automatic mitigative responses in advance of violating the EQ limit. Failure of equipment may complicate event recovery actions, however, core damage is not anticipated. EQ limits can be maintained provided one CSS spray system is functional.

6.2.2 Radiological Release Considerations

6.2.2.1 Containment Spray System

The Containment Spray System (CSS) serves an important function in limiting radiological releases to the environment. The CSS accomplishes this function by (1) providing heat removal to ensure containment integrity and (2) providing an active means for accelerating the removal of fission product aerosols and elemental iodine from the containment atmosphere. These functions are reflected in the design basis of most C-E PWRs. All C-E PWRs include the containment spray system as, at least part of the design basis system for containment heat removal. In that role the CSS (possibly in conjunction with other heat removal systems) is designed to maintain the containment pressure below the plant design pressure following large LOCAs and "in containment" ruptures of the main feedwater and main steam lines. Ability to maintain the containment pressure within design pressure limits ensues that containment integrity is not threatened. PSA and/or IPE studies throughout the industry over the past 5 years have consistently demonstrated that assurance of containment integrity (and isolation) will ensure that any post-accident radiation releases to the public will be low.

In many instances, the CSS aerosol scrubbing capability is separately credited within the design basis for contributing to the control of post-accident radiation releases. Plants that rely on containment spray for this function have CSS designs such that plant design allowable limits will not be exceeded provided one train of CS is OPERABLE. A few C-E NSSS units use the containment spray, in conjunction with a chemical addition system to enhance elemental iodine removal from the containment atmosphere. The design bases for these plants also include acceptable radioiodine removal with a single CSS train.

Radiological Design Basis

Acceptability of the post-accident radiological control systems are derived from the 10 CFR 100.11 siting criteria and regulatory interpretations of GDC 19. In meeting these design criteria C-E PWRs follow Regulatory Guide 1.4 (Reference 11) which utilizes the TID-14844 (Reference 19) source term as the basis of the design basis post-accident LOCA dose assessments.

The philosophy in designing iodine removal system and removing fission products from the containment atmosphere has evolved over time. A few early iodine removal systems within the containment relied upon air recirculation and filtering units, including HEPA filters and an activated charcoal bed to remove fission products. Later designs eliminated the recirculation iodine filter units within the containment and relied on the sprays in conjunction with a chemical additive (such as NaOH or Hydrazine) to facilitate elemental iodine removal. Later investigations supported removal of these additives and noted that borated water alone would be sufficient to ensure adequate iodine removal capability in accordance with the design and performance criteria of 10 CFR 100 and GDC 19.

It should be noted that in establishing the iodine removal system design basis, the NRC has biased the requirements of the system by selecting a DBE release which is in no way connected to the ECCS licensing DBA associated with 10 CFR 50.46. Thus, even the complete unavailability of containment spray trains does not necessarily imply that these functions cannot be adequately served for a wide range of recoverable plant accidents. This apparent dichotomy emerges from differences in the definition of the 10 CFR 50.46 Design Basis LOCA used in the establishment of Emergency Core Cooling System (ECCS) performance and the 10 CFR 100 Design Basis LOCA established for Reactor Siting. The Reference 19 source term tacitly assumes an accident has occurred that releases 100% of the fuel inventory of noble gases and 50% of the fuel inventory of iodine (subsequently 50% of that iodine is assumed removed from the containment atmosphere). These releases are furthermore assumed to be instantaneous and predominately include elemental iodine. The releases are typical of a core melt event and far exceed those releases commensurate with a Design Basis LOCA. In establishing the ECCS design basis for the complete spectrum of LOCAs, it must be demonstrated that following conservatively biased set of rules and assumptions (1) the peak cladding temperature in the core is less than 2200 F, (2) on a local basis, the extent of cladding oxidation is less than 17% reacted, and (3) on a core-wide basis, less than 1% of the fuel cladding is reacted. Using this limiting criteria, the core would remain integral with few fuel rods experiencing clad ballooning and rupture. Gaseous fission products (including between 3 to 5% of the iodine) trapped in the fuel rods could be released into the RCS. At these temperatures, significant fuel melting would not occur. Even with the large LOCA scenario, experimental evidence suggests that the release of the gap fission product material to the containment would take on the order of 30 minutes. Thus, design basis ECCS performance at the very worst would result in a modest fission product release to the containment; well below the releases associated with the 10 CFR 100.11 Maximum Hypothetical Accident (MHA).

In conclusion, the 10 CFR 100 design basis LOCA methodology as adopted in the SRPs provides a very conservative approach for the evaluation of fission product consequences for accidents not resulting in extensive core damage. Furthermore, while the DBA LOCA regulatory criteria are intended to cope with events with a probability of occurrence between 10^{-3} to 10^{-4} per year, the 10 CFR 100 MHA has a probability of occurrence on the order of approximately two orders of magnitude lower. Level 3 PSAs performed for various Westinghouse and C-E PWRs (cf., References 7, 20 and 21) confirm that, provided that the containment remains integral and is not bypassed, radiological releases from even these low probability severe accidents provide no significant health risks to the general public.

Summary

The impact of unavailability of the CS system is summarized in Table 6.2-1, and discussed below.

In the event one train of containment spray is INOPERABLE, the remaining train is sufficient to meet all CSS necessary design requirements. When two trains of CS are INOPERABLE (e.g. due to a CS failure preceded by one CS out for repair, or a common cause failure of both spray units) plants with diverse containment cooling systems can assure containment integrity is maintained provided a single fan cooler train is operable. For plants that rely solely on containment sprays for containment cooling, unavailability of both CS trains will compromise the ability of the plant to respond to events with large RCS inventory losses (i.e. large LOCAs). This will be reflected by a small increase in the plant long term containment failure probability.

Unavailability of a single containment spray train will not compromise the ability of the plant to meet design basis requirements. These requirements ensure that even under limited core melt conditions, radiation releases to the environment will be controlled to within acceptable limits. Under situations where two containment sprays are inoperable, but containment integrity is otherwise ensured (via operable containment air coolers) Level 3 PSA assessments (cf., NUREG-1150) of fission product releases to the public will not be risk significant. If Sprays are unavailable, and containment integrity is not assured, fission product releases for a limited class of LOCAs will increase above their current estimated values in the IPEs.

TABLE 6.2-1
IMPACT OF CONTAINMENT SPRAY SYSTEM UNAVAILABILITY

	PLANTS WITH DIVERSE CONTAINMENT HEAT REMOVAL AND IODINE FILTER SYSTEMS	PLANTS WITH DIVERSE CONTAINMENT HEAT REMOVAL SYSTEMS AND CSS FOR IODINE REMOVAL	PLANTS RELYING ON CSS SOLELY FOR BOTH CONTAINMENT COOLING AND IODINE REMOVAL.
ONE CS TRAIN UNAVAILABLE	WITHIN DESIGN BASIS	WITHIN DESIGN BASIS	WITHIN DESIGN BASIS.
TWO CS TRAINS UNAVAILABLE	AVAILABILITY OF FAN COOLERS MAINTAIN CONTAINMENT INTEGRITY BELOW DESIGN PRESSURE LIMITS DURING DESIGN BASIS EVENTS	CHR WITHIN DESIGN BASIS	RESPONSE OF PLANT TO LARGE INVENTORY LOSS EVENTS COMPROMISED. LOSS OF CONTAINMENT HEAT REMOVAL WILL LEAD TO A SMALL INCREASE IN CDF, SEE SECTION 6.3).
	REALISTIC IMPACT ON EXCEEDING 10 CFR 100 LIMITS FOR A 10 CFR 50 DBA SMALL	REALISTIC IMPACT ON EXCEEDING 10 CFR 100 LIMITS FOR A 10 CFR 50 DBA SMALL	EVENT IS OUTSIDE OF DBA. LIKELIHOOD OF EXCEEDING 2 AND 8 HOURS DOSE LIMITS OF 10 CFR 100 SMALL. LONG TERM LIMITS MAY BE EXCEEDED IF CONTAINMENT FAILS.
	NEGLIGIBLE INCREASE IN ENVIRONMENTAL RELEASES FOLLOWING SEVERE CORE DAMAGE EVENTS	NEGLIGIBLE INCREASE IN ENVIRONMENTAL RELEASES FOLLOWING SEVERE CORE DAMAGE EVENTS	SMALL INCREASE IN ENVIRONMENTAL RELEASES FOLLOWING A LIMITED RANGE OF SEVERE CORE DAMAGE SEQUENCES.
	EQUIPMENT QUALIFICATION (EQ) LIMITS MAY BE EXCEEDED IF BOTH CS UNITS FAIL TO FUNCTION DURING A DESIGN BASIS MSLB.	EQUIPMENT QUALIFICATION (EQ) LIMITS MAY BE EXCEEDED IF BOTH CS UNITS FAIL TO FUNCTION DURING A DESIGN BASIS MSLB.	EQUIPMENT QUALIFICATION (EQ) LIMITS MAY BE EXCEEDED IF BOTH CS UNITS FAIL TO FUNCTION DURING A DESIGN BASIS MSLB.

6.2.2.2 SDC System

The role of the SDC system in limiting fission product releases to the environment is indirect. Components of the SDC system (in particular the SDC heat exchanger) are utilized in the containment spray system and thus can influence containment integrity with the consequences as discussed above. In addition the SDCS is included in many FSARs as the end state for terminating a SGTR. Therefore, the availability of the SDCS may result in increased activity releases if its unavailability requires steaming of the affected steam generator to remove decay heat. This situation is likely only when, the unaffected steam generator is for some reason unable to remove heat from the RCS, or SGTRs have occurred in both SGs simultaneously. Both these situations are well beyond the plant design basis. Unavailability of the SDCS is therefore considered to have an insignificant impact on plant fission product releases.

6.3 Assessment of Risk

6.3.1 Overview

The purpose of this section is to provide an integrated assessment of the overall plant risk associated with the adoption of the proposed AOT extension. The methodology used to evaluate the Containment Spray System (CSS) AOT extension was based in part on a draft version of the "Handbook of Methods for Risk-Based Analyses of Technical Specifications," Reference 15 and related industry guidance. As guidance for the acceptability of a Technical Specification modification, Reference 15 noted that any proposed Technical Specification change (and the ultimate change package) should either:

1) be risk neutral, OR
2) result in a decrease in plant risk (via "risk trade-off considerations"), OR
3) result in a negligible (to small) increase in plant risk.

AND

4) be needed by the utility to more efficiently and/or more safely manage plant operations.

A statement of need has been provided in Section 6.1. This section addresses the risk aspects of the proposed AOT extension.

In this evaluation, a risk assessment of the CSS AOT extension is performed with respect to consideration of associated "at power," "transition" and "shutdown" risks.

Section 6.3.2 provides an assessment of the increased risk associated with continued operation with a single CSS train out of service (OOS). The evaluation of the "at power" risk increment resulting from the extended CSS AOT were evaluated on a plant specific basis using the most current individual plant PSAs as their respective baselines. Plant specific evaluations were performed by each participating utility. Results of these evaluations were then compared using appropriate risk measures as prescribed in Reference 15.

Section 6.3.3 provides an assessment of risk of transitioning the plant from Mode 1 into a lower mode (e.g. Mode 4). The "at power" risk assessment presented in Section 6.3.2 provides an evaluation of continued operation of the plant with an extended CSS AOT for the purpose of performing corrective maintenance on the CSS. However, that assessment provides only one facet of the plant risk. For this evaluation, continuation of at power operation within the LCO ACTION statement is compared with the risk of proceeding with a plant shutdown. An estimate of this risk was evaluated by modifying the reactor trip core melt scenario for a representative C-E NSSS PWR. Based on this analysis, an approximate core damage probability for the plant transition action was established and compared to the single AOT risk associated with continued operation.

The risk comparison of CSS PM for "at power" and "at shutdown" conditions is provided in Section 6.3.4. Recent experience has shown that the risk of maintaining the reactor in a shutdown condition can rival that of power operation. This observation has resulted in a need to reassess maintenance practice to more appropriately apportion maintenance between power and shutdown operation. One goal of this particular AOT extension is to allow preventive maintenance and extended surveillances of the CSS while the plant is at power. This would include on-line maintenance of the containment spray pumps (which may provide backup to the SDCS), shutdown cooling heat exchangers (common components to both the Containment Spray System and the Shutdown Cooling System) which are used as the primary means of heat removal from the RCS during lower plant operating modes, and associated valves. For the most part, the role of the CSS at power is limited to responding to low probability events.

For completeness, the impact of the extended AOT on the plant large early release fraction and late containment failure frequency are qualitatively assessed. These assessments include evaluations of the events leading to early and late fission product releases and the role of the CHR in the initiation and/or mitigation of those events. These assessments are presented in Section 6.3.5.

6.3.2 Assessment of "At Power" Risk

6.3.2.1 Methodology

This section provides an assessment of the increased risk associated with continued operation with a single CSS train out of service (OOS). The evaluation of the "at power" risk increment resulting from the extended CSS AOT was evaluated on a plant specific basis using the most current individual plant's (Probabilistic Safety Analysis) PSA model for their respective baselines. For consistency in comparison of results, Core Damage Frequencies (CDFs) presented represent internal events only, excluding internal floods. Plant specific evaluations were performed by each participating utility. Results of these evaluations were then compared using the following risk measures (from Reference 15).

Average Core Damage Frequency (CDF): The average CDF represents the frequency of core-damage occurring. In a PSA, the CDF is obtained using mean unavailabilities for all standby-system components.

Core Damage Probability (CDP): The CDP represents the probability of core-damage occurring. Core-damage probability is approximated by multiplying core-damage frequency by a time period.

Conditional Core-Damage Frequency (CCDF): The Conditional CDF is the Core Damage Frequency (CDF) conditional upon some event, such as the outage of equipment. It is calculated by re-quantifying the cutsets after adjusting the unavailabilities of those basic events associated with the inoperable equipment.

Increase in Core Damage Frequency (ΔCDF): The increase in CDF represents the difference between the CCDF evaluated for one train of equipment unavailable minus the CCDF evaluated for one train of equipment <u>not out for test or maintenance</u>. For the CHR:

$$\Delta CDF = \text{Conditional } CDF_{(1 \text{ CSS train unavailable})} - \text{Conditional } CDF_{(1 \text{ CSS train not out for T/M})}$$

where CDF = Core Damage Frequency (per year)

Single AOT Risk Contribution: The Single AOT Risk contribution is the increment in risk associated with a train being unavailable over a period of time (evaluated over either the full AOT, or over the actual maintenance duration). In terms of core damage, the Single AOT Risk Contribution is the increase in probability of core-damage occurring during the AOT, or outage time, from the baseline. The value is obtained by multiplying the increase in the CDF by the AOT or outage time.

$$\textit{Single AOT Risk} = \Delta CDF \times \tau$$

where, ΔCDF = Increase in Core Damage Frequency (per year), and
τ = full AOT or actual maintenance duration (years)

Yearly AOT Risk Contribution: The Yearly AOT risk contribution is the increase in average yearly risk from a train being unavailable accounting for the average yearly frequency of the AOT. It is the frequency of core-damage occurring per year due to the average number of entries into the LCO Action Statement per year. The value is estimated as the product of the Single AOT Risk Contribution and the average yearly frequency (f) of entering the associated LCO Action Statement. Therefore:

$$\textit{Yearly AOT Risk} = \textit{Single AOT Risk} \times f$$

where f = frequency (events/year)

Incremental changes in these parameters are assessed to establish the risk impact of the Technical Specification change.

The methodology used to calculate the above risk measures is presented below. For plants with PSAs that were quantified using RISKMAN methodology, equivalent steps were taken to meet the intent of the methodology presented below.

6.3.2.2 Calculation of Conditional CDF, Single and Yearly AOT Risk Contributions

Each CEOG utility used its current PSA to assess the Conditional CDF based on the condition that one Containment Spray Train is unavailable. Each plant verified that the appropriate basic events are contained in the PSA cutsets used to determine the AOT risk contributions. This verification was performed as the first task in calculating the Conditional CDFs. If basic events had been filtered out of the PSA cutsets, one of the two methods described below were used to ensure the calculation of Conditional CDF was correct or conservative:

1. Select the basic event for the failure mode of the component with the highest failure probability and set that basic event's probability to 1.0 if the test and/or maintenance failure mode of the component had been filtered out; or
2. Retrieve cutsets containing relevant basic events at the sequence level and merge them with the final PSA cutsets.

The Conditional CDF given 1 CSS train is unavailable was obtained by performing the following steps:

1. Set the basic event probability for the failure mode for a component in the unavailable CSS train equal to 1.0.
2. Set any basic event probabilities for other failure modes for that train equal to 0.0.
3. Set the basic event probability for the other train unavailable due to test and/or maintenance equal to 0.0.
4. For Preventive Maintenance (i.e. no equipment failure), set the failure rate of the train remaining in service to the total single train failure rate (including both independent and common cause failure data).
5. For the case where the LCO Action Statement was prompted by need for Corrective Maintenance (i.e. equipment failure), adjust the basic event common cause failure unavailability corresponding to the train remaining in service to the probability of failure given one train has failed (i.e. equal to the beta factor, β, for the Multiple Greek Letter Method).
6. Requantify the PSA cutsets.

This Conditional CDF was therefore assessed for both PM and CM. The difference between the two values is a result of the aforementioned difference in treating common cause failure. It should be noted that the definition of CM for use in the PSA is considerably more stringent than the pragmatic TAGGED INOPERABLE definition of CM used in Section 5.0. For the purposes of this PSA evaluation, CM refers to maintenance performed on a component that cannot otherwise perform its safety function.

The Conditional CDF given 1 CSS train is not out for test or maintenance was obtained by setting the basic event probability for the failure mode for one CHR train equal to 0.0 and requantifying the PSA cutsets. No adjustment was made to common cause failure from the value used in the baseline PSA.

This Conditional CDF was effectively equal to the baseline CDF for the Containment Spray and Cooling Systems for all C-E plants.

It was expected that the results would be symmetric for selecting either containment spray train to be out for maintenance. However, in cases where different modeling assumptions or data were associated with each containment spray train, the Conditional CDFs were evaluated for each train, and the most conservative result was used.

The Conditional CDF was then used to calculate the increase in CDF. The Single AOT Risk Contribution for each plant was calculated for the following cases:

- Current full AOT,
- Proposed full AOT,
- Mean downtime for CM, and
- Mean downtime for PM.

A value of 24 hours was selected as an upper bound for the mean downtime for CSS train CM (see Table 5.2-1). The mean downtime for PM was conservatively assumed to be 168 hours/year/train (one full AOT) unless actual plant information was available. The mean proposed downtimes are presented in Table 6.3.2-1 and 6.3.2-2 for each plant.

The overall Yearly AOT Risk Contribution is the sum of the Yearly AOT Risk Contribution due to PM and the Yearly AOT Risk Contribution due to CM. Tables 6.3.2-1 and 6.3.2-2 provide the Conditional CDFs and the Single and Yearly AOT Risk Contributions for each plant for PM and CM, respectively.

6.3.2.3 Calculation of Average CDF

In order to calculate the Average CDF for the extended CSS AOT, a new value for CSS train unavailability due to test and/or maintenance was established. This unavailability was based on a maintenance duration of 24 hours for performing on-line corrective maintenance (conservatively estimated based on actual plant data for C-E PWRs from Table 5.2-1), and a preventive maintenance program equal to the equivalent of a full proposed AOT of 7 days per train. This resulted in a bounding yearly unavailability of 0.022 per train. For plants with a maintenance schedule already in place or defined, then actual plant information was used in lieu of the above assumptions.

The impact on the PSA was then calculated to obtain the Average CDF for this new CSS unavailability. This new Average CDF was then compared to the base case value in the plant's PSA. Table 6.3.2-3 provides the proposed Average CDF and the base average CDF for each plant.

Table 6.3.2-1

CEOG AOT CONDITIONAL CDF CONTRIBUTIONS FOR CSS - Preventative Maintenance

PARAMETER	ANO 2	CC 1 & 2	FCS	MP 2	PAL 1	PVNGS	SCE	SL 1	SL 2	WSES 3
PREVENTIVE MAINTENANCE										
Present AOT, days	3	3	1	2	1	3	3	3	3	3
Proposed AOT, days	7	7	7	7	7	7	7	7	7	7
Baseline CDF, per yr.	3.28E-05	2.11E-04	1.18E-05	3.49E-05	5.15E-05	4.74E-05	2.41E-05	2.14E-05	2.35E-05	1.63E-05
Conditional CDF for PM, per yr. (1 CHR train unavail)	7.90E-05		1.18E-05	3.49E-05	5.22E-05	7.13E-05	2.46E-05	2.15E-05	2.35E-05	1.63E-05
Change Factor	2.41	0.00	1.00	1.00	1.01	1.50	1.02	1.00	1.00	1.00
Increase in CDF for PM, per yr.	4.62E-05	0.00E+00	0.00E+00	0.00	7.00E-07	2.39E-05	4.00E-07	1.00E-07	0.00E+00	0.00E+00
Single AOT Risk (based on Current AOT) for PM	3.80E-07	0.00E+00	0.00E+00	5.48E-10	1.92E-09	1.96E-07	3.29E-09	8.22E-10	0.00E+00	0.00E+00
Single AOT Risk (based on Proposed AOT) for PM	8.86E-07	0.00E+00	0.00E+00	1.92E-09	1.34E-08	4.58E-07	7.67E-09	1.92E-09	0.00E+00	0.00E+00
Downtime Frequency for PM, events/yr./CHR train	1.50	1.50	1.50	1.50	1.50	7.00	2.00	1.50	1.50	1.50
Yearly AOT Risk (based on Current full AOT) for PM, per yr.	5.70E-07	0.00E+00	0.00E+00	8.22E-10	2.88E-09	1.38E-06	6.58E-09	1.23E-09	0.00E+00	0.00E+00
Yearly AOT Risk (based on Proposed AOT) for PM, per yr.	1.33E-06	0.00E+00	0.00E+00	2.88E-09	2.01E-08	3.21E-06	1.53E-08	2.88E-09	0.00E+00	0.00E+00
Proposed Downtime for PM, hrs/yr./CHR train	168	160	160	160	160	168	224	160	160	160
Mean Duration for PM, hrs/event	112	107	107	107	107	24	112	107	107	107
Single AOT Risk (based on Mean Duration) for PM	5.91E-07	0.00E+00	0.00E+00	1.22E-09	8.52E-09	6.55E-08	5.11E-09	1.22E-09	0.00E+00	0.00E+00
Yearly AOT Risk (based on Mean Duration) for PM, per yr.	8.86E-07	0.00E+00	0.00E+00	1.83E-09	1.28E-08	4.58E-07	1.02E-08	1.83E-09	0.00E+00	0.00E+00

Table 6.3.2-2

CEOG AOT CONDITIONAL CDF CONTRIBUTIONS FOR CSS - Corrective Maintenance

PARAMETER	ANO 2	CC 1 & 2	FCS	MP 2	PAL 1	PVNGS	SCE	SL 1	SL 2	WSES 3
CORRECTIVE MAINTENANCE										
Present AOT, days	3	3	1	2	1	3	3	3	3	3
Proposed AOT, days	7	7	7	7	7	7	7	7	7	7
Baseline CDF, per yr.	3.28E-05	2.11E-04	1.18E-05	3.49E-05	5.15E-05	4.74E-05	2.41E-05	2.14E-05	2.35E-05	1.63E-05
Conditional CDF for CM, per yr. (1 CHR train T/M = 1.0, CCF = beta)	9.40E-05		1.18E-05	3.76E-05	5.80E-05	1.18E-04	2.48E-05	2.15E-05	2.35E-05	1.63E-05
Change Factor	2.87	*	1.00	1.08	1.13	2.49	1.03	1.00	1.00	1.00
Conditional CDF for CM, per yr. (1 CHR train T/M = 0)	3.28E-05	*	1.18E-05	3.48E-05	5.15E-05	4.74E-05	2.41E-05	2.14E-05	2.35E-05	1.63E-05
Increase in CDF for CM, per yr.	6.13E-05	*	0.00E+00	2.80E-06	6.50E-06	7.06E-05	7.00E-07	1.00E-07	0.00E+00	0.00E+00
Single AOT Risk (based on Current AOT) for CM	5.04E-07	*	0.00E+00	1.53E-08	1.78E-08	5.80E-07	5.75E-09	8.22E-10	0.00E+00	0.00E+00
Single AOT Risk (based on Proposed AOT) for CM	1.18E-06	*	0.00E+00	5.37E-08	1.25E-07	1.35E-06	1.34E-08	1.92E-09	0.00E+00	0.00E+00
Downtime Frequency for CM, events/yr.	1.00	*	1.00	1.00	1.00	0.17	0.40	1.00	1.00	1.00
Yearly AOT Risk (based on Current AOT) for CM, per yr.	5.04E-07	*	0.00E+00	1.53E-08	1.78E-08	9.86E-08	2.30E-09	8.22E-10	0.00E+00	0.00E+00
Yearly AOT Risk (based on Proposed AOT) for CM, per yr.	1.18E-06	*	0.00E+00	5.37E-08	1.25E-07	2.30E-07	5.37E-09	1.92E-09	0.00E+00	0.00E+00
Mean Duration for CM, hrs/event	24	*	24	24	24	22	40	24	24	24
Single AOT Risk (based on Mean Duration) for CM	1.68E-07	*	0.00E+00	7.67E-09	1.78E-08	1.77E-07	3.20E-09	2.74E-10	0.00E+00	0.00E+00
Yearly AOT Risk (based on Mean Duration) for CM, per yr.	1.68E-07	*	0.00E+00	7.67E-09	1.78E-08	3.01E-08	1.28E-09	2.74E-10	0.00E+00	0.00E+00

Table 6.3.2-3
CEOG PROPOSED AVERAGE CDFs FOR CSS

PARAMETER	ANO 2	CC 1 & 2	FCS	MP 2	PAL 1	PVNGS	SCE	SL 1	SL 2	WSES 3
Present AOT, days	3	3	1	2	1	3	3	3	3	3
Proposed AOT, days	7	7	7	7	7	7	7	7	7	7
Baseline CDF, per yr.	3.28E-05	2.11E-04	1.18E-05	3.49E-05	5.15E-05	4.74E-05	2.41E-05	2.14E-05	2.35E-05	1.63E-05
Proposed Downtime, hrs/yr./CHR train (CM + PM)	192	*	192	192	192	192	240	192	192	200
Proposed Average CDF, per yr.	3.48E-05	*	1.18E-05	3.49E-05	5.16E-05	4.88E-05	2.41E-05	2.14E-05	2.35E-05	1.63E-05
Change Factor	1.06	*	1.00	1.00	1.00	1.03	1.00	1.00	1.00	1.00

* Values to be provided later

6.3.2.4 Discussion of Results of "At Power" Analyses

This section provides a comparison and assessment of the PSA results presented in the preceding sections. It is an objective of the CEOG effort to support the adequacy of the PSA results by performing meaningful cross comparisons of PSA analyses across the C-E fleet. This cross comparison process provides a unique opportunity to compare and contrast PSA results based on (1) plant similarities and differences, (2) modeling assumptions and (3) use of data.

The results from each plant were assembled, and the Single AOT and Yearly AOT Risks were calculated for each plant and are presented in Tables 6.3.2-1 through 6.3.2-3. The results of these cases are presented on a plant specific basis, and summarize the CSS AOT CDF contributions for each plant. These risk contributions include the Conditional CDFs, Increase in CDF, Single AOT and Yearly AOT risks for both PM and CM, based on full AOT and mean downtime, and current Average CDF and proposed Average CDF.

Comparison of Preventive Maintenance Results

An important measure of incremental risk associated with removing equipment from service for maintenance is the Change Factor (CF). In this document, the CF for maintenance is the ratio of the instantaneous CDF when the selected equipment is removed from service to the baseline CDF. Figure 6.3-1 illustrates the calculated change factors associated with removing the most limiting CSS train component for preventive maintenance. This information is obtained from Table 6.3.2-2 by dividing the Conditional CDF for Preventive Maintenance (PM) by the baseline CDF. For PM, the component in the CSS train having the greatest impact on Conditional CDF is the CSS pump for all domestic C-E plants.

Inspection of Figure 6.3-1 indicates that all change factors fall within a range of 1.00 to 2.41. The range of results is quite narrow, and provides confidence that the PM maintenance risk is small for all domestic C-E NSSSs.

The calculated sensitivity of ANO-2 to the unavailability of a single CS train was a result of an conservatively biased success criteria which required both the containment fan coolers and a single functional spray pump to ensure adequate cooling of the containment sump water. Alteration of this success criteria to that typical of plants with diverse containment heat removal equipment will result in ANO-2 predicted sensitivity to the removal of a CSS train consistent with predictions of plants with similar CHR system designs.

The risk changes associated with the CSS train AOT extension varies based on the plants reliance on CS sprays for heat removal and any interactions between the CS system and the ECCS. For plants with diverse containment cooling systems the increase in SAOT risk is negligible. Given the unavailability of one CSS train, these plants show a negligible to small change in the Conditional CDF.

Palo Verde Units 1, 2 and 3 rely entirely on the CSS for heat removal. For these plants the CCDF associated with unavailability of the CSS results in a change factor of 1.5 for scheduled preventive maintenance activities. This increase is due to the fact that, without containment heat removal, the water in the sump is always at or near saturation at the surface. For LOCAs without containment heat removal, the containment will pressurize and ultimately fail. It is at this point that the sump water becomes superheated and boils. Suction is assumed lost and ECCS fails. (Recovery of ECSS components is conservatively neglected.) As a result of this dependency between loss of the containment spray and loss of ECCS all events that contributed to the increased CDF will also proceed to a late containment failure. In any event, the risk increases incurred by performing "at power" repair of the CS components are considered small.

Comparison of Corrective Maintenance Results

Corrective Maintenance (CM) analyses are performed with the explicit assumption that the cause of the initial component failure may be common to all similar components in that system (i.e. common cause failure). Thus, it is inherently assumed in this assessment that maintenance on one CSS pump implies a significant component failure probability on the remaining in-service component. Thus, *the CM case is a bounding case and should be interpreted accordingly*.

For maintenance on a CSS component without such a postulated common cause failure, results would be identical to that of preventive maintenance as presented above. As with the above analysis, the most limiting CSS train component was assumed to be removed from service.

Figure 6.3-2 presents the calculated change factors for the assumption that a component is removed from service for CM. Potential risks of CM slightly exceed those of PM. The change factors for CM range from 1.00 to 2.87. The same trends noted and discussed for PM in the previous section are also applicable to CM, with the difference in change factors being the assumption of common cause failure for CM. ANO-2 is also shown to be to have a high CCDF due to CM. In this instance, these calculated results are an outcome of a conservative modeling assumption for the CHR success criteria (see PM discussion above).

Comparison of Proposed Average CDFs

Figure 6.3-3 presents the change factors for the average CDF predictions for the CEOG plants (specific average CDFs are presented in Table 6.3.2-3). Most plants based the average CDF on yearly train out-of-service (OOS) times of 192 hours. Plant specific evaluations at San Onofre indicated an expectation for an OOS time of 240 hours per train per year.

On a yearly basis the average CDFs are predicted to increase 3% for the Palo Verde units and 6% for ANO-2. The increase in the CDF for Palo Verde is reflective of the need for containment spray to support recirculation mode operation of the ECCS. The 6% increase in CDF for ANO-2 is a result of a conservatively biased success criteria regarding the need for both the containment spray system and fan cooler heat removal to accomplish containment heat removal. A more realistic assessment, which considers the redundant nature of these systems, would show the impact of the increased maintenance on CDF to be negligible (consistent with the predictions of the majority of C-E PWRs).

Figure 6.3-1
CHANGE FACTOR FOR CSS PM

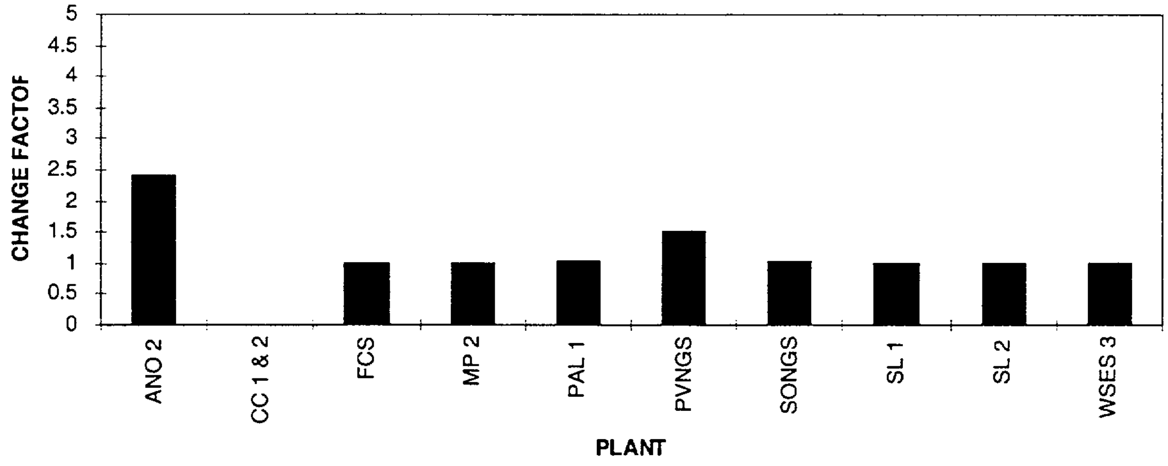


Figure 6.3-2
CHANGE FACTOR FOR CSS CM

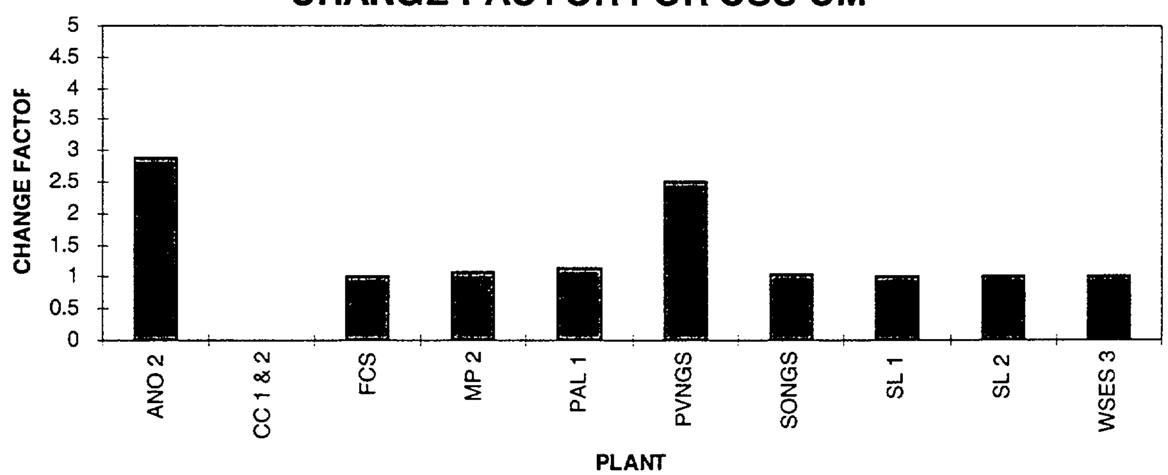
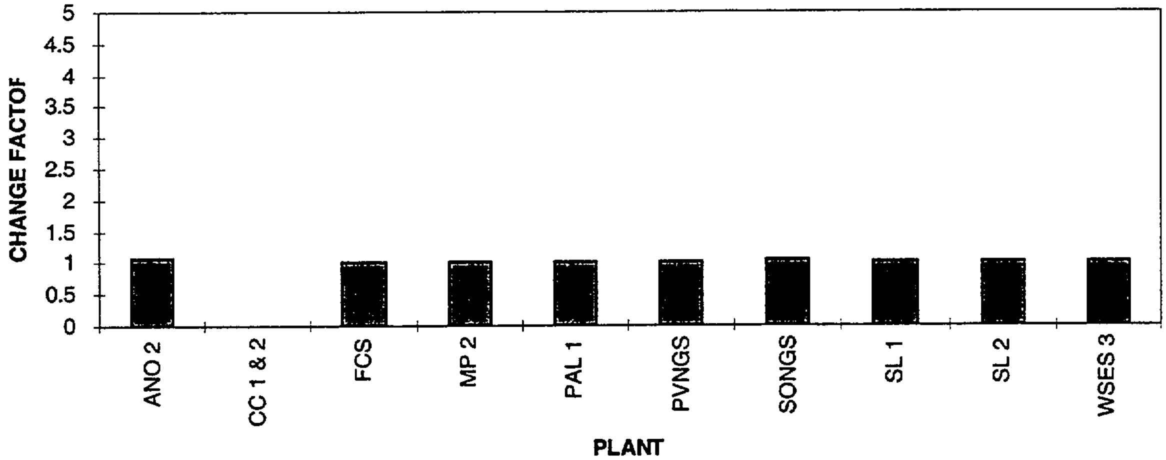


Figure 6.3-3
CHANGE FACTOR FOR CSS AVERAGE CDF



6.3.3 Assessment of Transition Risk

There is an "at power" increase in risk associated with any given AOT extension. This increase may be negligible or significant. A complete approach to assessing the change in risk accounts for the effects of avoided shutdown, or "transition risk". Transition Risk represents the risk associated with changing the operating mode of an LWR from its nominal full power operating state to a lower shutdown mode following equipment failure, in this case, one CSS train being inoperable. Transition risk is of interest in understanding the tradeoff between shutting down the plant and restoring the CSS train to operability while the plant continues operation. The risk of transitioning from "at power" to a shutdown mode must be balanced against the risk of continued operation and performing corrective maintenance while the plant is at power.

Methodology

Transition risk is defined as the core damage probability associated with the transition of the plant from normal full power operation to plant shutdown and then back to full power. For this analysis, transition risk specifically considers three Plant Operating States (POSs):

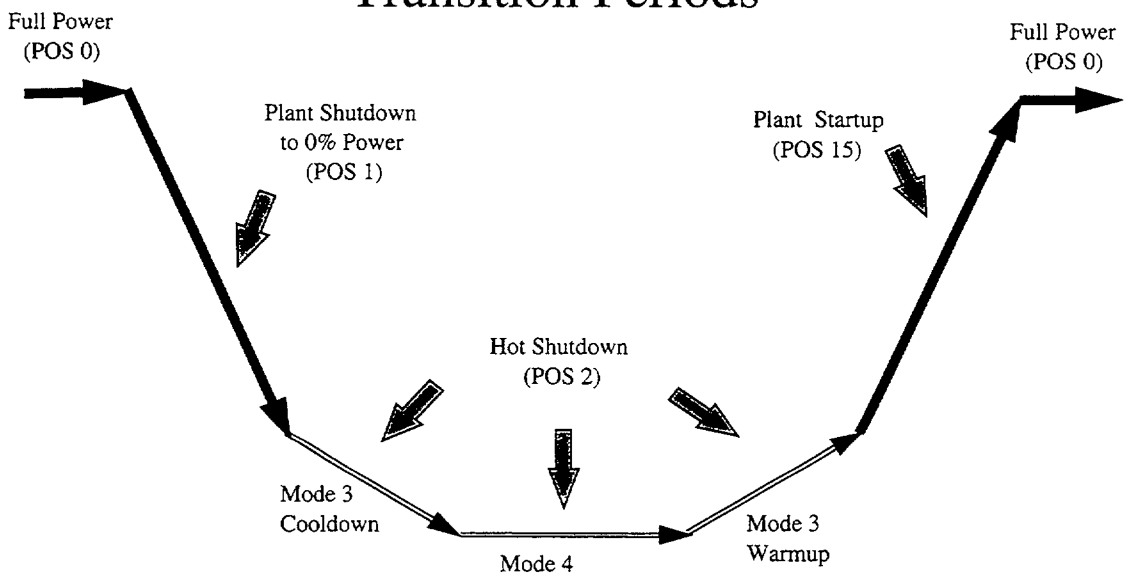
1) a short duration plant shutdown from full power operation to either a mode 3 or mode 4 steaming condition,
2) operation in the mode 3 or mode 4 steaming condition while repairs are made to the inoperable equipment are completed, and
3) return to full power operation.

In the CEOG methodology, transition risk is defined as the cumulative risk incurred while the plant is in each state. These POSs are equivalent to the standard technical specification modes 1, 2, 3 and 4 (with SG cooling). Figure 6.3.3-1 illustrates the relationship between these POSs.

The methodology for evaluating transition risk makes use of the existing full power PSA models with minimum changes beyond changing component failure rates and initiating event frequencies. This methodology calculates a transition risk that is realistic with respect to the known elements of transition risk and to the calculation of the risk of remaining at power.

Figure 6.3.3-1

Transition Periods



Results of Transition Risk Assessment

Instances arise in plant operation when unanticipated failures of equipment occur. At that time the plant staff is confronted with a decision whether to repair the component "at power" or begin preparations for a plant shutdown. Many factors contribute to that decision. Comparing the "at power" risk of the new configuration with the risk of transitioning the plant with the impaired configuration can provide valuable insight into the decision making process. This section compares results of plant-specific transition and "at power" risk evaluations to gain insight into the issues involving continues "at power" maintenance of CSS components.

The results of the transition risk analyses performed by each CEOG utility are tabulated in Table 6.3.3-1. Most CM repairs of the CSS are expected to be completed in a time interval of less than 15 hours (see Table 5.2-1). In some unusual instance a complication may prevent completion of maintenance in that interval. This report provides an illustrative example of a hypothetical transition risk scenario. Transition risk values are developed following the methodology defined in Section 6.3.3 and assume a transition from full power to a Mode 3 or Mode 4 repair state for a period of 4 days and subsequent return to power. In all transition risk analyses the repair is performed in Mode 4.

For the purpose of comparison, Table 6.3.3-1 also presents the risk associated with remaining at power to perform maintenance on the failed equipment for two cases:

1. Maintenance on the most limiting CSS component following a random failure, and

2. Maintenance on the most limiting CSS component following the occurrence of a non-random failure within the component (i.e. common cause failure).

Both cases represent bounding constructs for their respective condition.

The methodology used for the transition risk study is described fully in Reference 22.

Table 6.3.3-1

ESTIMATED TRANSITION RISK - ONE CS TRAIN UNAVAILABLE

PLANT	Estimated Transition Risk Contribution (ΔCDP)	CS train unavailable due to a random component failure	CS train unavailable due to a non-random component failure
ANO-2	Not Available	8.65E-7	1.03E-6
Calvert Cliffs 1 & 2	Not Available	Not Available	Not Available
Fort Calhoun	1.06 E-7	1.29E-7	1.29E-7
Millstone 2	2.44E-6	3.81E-7	4.12E-7
Palisades	Not Available	Not Available	Not Available
Palo Verde 1, 2 & 3	3.24E-6	7.81E-7	1.29E-6
St. Lucie 1	Not Available	2.36E-7	2.36E-7
St. Lucie 2	Not Available	2.58E-7	2.58E-7
San Onofre 2 & 3	1.64E-6	2.70E-7	2.72E-7
Waterford 3	< 2.53E-7**	1.69E-7	1.69E-7

* Assumes plant transitions to and remains in Mode 3 for repair.

** Based on transition risk result for one HPSI unavailable and knowledge that CSS result would be less than HPSI result

Discussion of Transition Risk Results

When comparing the absolute values of delta CDP for transition risk given one CSS train is unavailable among the C-E plants, those plants at the high end have dependencies with the CSS and the ECCS. The plants at the low end have highly reliable feedwater systems, such as the availability of startup feedwater pumps or dedicated diesel powered pumps, and thus yield lower risk during the transition. For Palo Verde, in the event of a large or medium LOCA, loss of the containment sprays is assumed to cause both loss of sump water temperature control and ultimately containment failure. Upon containment failure the previously saturated ECCS sump water becomes superheated and boils. At this point that suction is assumed lost and ECCS is assumed to fail.

While it is not the intent of the transition risk calculation to be used as a scale by which to define criteria or establish specific maintenance guidance, the transition estimates do provide valuable insight into the factors contributing to transition risks and its general magnitude. These calculations have been intended to provide a lower bound to the transition risk and may exclude some possible events. Furthermore, the calculations do not consider human errors of commission that may occur during a shutdown.

When comparing the results of transition risk with the risk of remaining at power, the results indicate that for most CEOG plants, the risk of transitioning the plant from "at power" to lower modes of operation is greater than the risk of remaining at power for both cases of random and non-random (i.e. common cause failure) failure. Plants with lower transition risks typically reflect highly reliable feedwater systems due to the availability of startup feedwater pumps. Fort Calhoun shows that the risk of transition is slightly less than, but comparable to, the risk of remaining at power. This is due to the highly reliable feedwater system at FCS, with a dedicated diesel driven pump.

6.3.4 Assessment of Shutdown Risk

The Containment Spray System *per se* has no assigned role during Mode 5 operation or Mode 4 operation while the plant is on Shutdown Cooling. Components of the containment spray however, can significantly contribute to shutdown safety. The SDC heat exchanger, shared by the containment spray system and the shutdown cooling system provides the only licensed mechanism for RCS heat removal in the plant shutdown MODES 5 and 6. The containment spray pumps for most C-E PWRs can be aligned with the SDCS to provide backup for the LPSI pumps. Thus, any maintenance performed on these components while the plant is "at power" and the demand for these systems (and their importance to plant risk) is low will likely increase the system availability while in shutdown modes. The actual safety benefits associated with increased availability will vary from plant-to-plant and outage-to-outage.

A numerical example is used to illustrate the value of an additional CSS pump available at shutdown. In this example two shutdown situations are contrasted.

Situation A: CSS Maintenance Performed During Shutdown

The plant has entered Mode 5 operation with a full RCS inventory. SDCS provides RCS heat removal via one SDC train. As required by plant guidelines a second LPSI pump is available in standby. One CSS pump is also operable, and can be manually aligned in the event of a loss of residual heat removal (RHR) event.

Situation B: CSS Maintenance Performed At Power

The plant has entered Mode 5 operation with a full RCS inventory. SDCS provides RCS heat removal via one SDC train. As required by plant guidelines a second LPSI pump is available in standby. Two CSS pumps are operable, and can be manually aligned in the event of a loss of RHR accident.

In both the above situations, complete loss of shutdown cooling is assumed to result in core damage. It is further assumed that the difference in plant risk for the two states can be approximated by the difference in the CDF for situations A and B associated with the complete loss of RHR due to **independent and common cause** failures of the LPSI and CSS pumps.

Two fault tree models were constructed to represent a simple shutdown cooling system consisting of two trains with two pumps, one shutdown cooling pump and one containment spray pump, per train. The data used for the analyses was obtained from References 7 and 23 and is presented in Table 6.3.4-1. For the Situation A PSA model, both shutdown cooling pumps and one of the two containment spray pumps were assumed to be available. The success criterion for the Model A analysis was that one of the three pumps had to deliver flow. For the Situation B PSA model, both shutdown cooling pumps and both containment spray pumps were assumed to be available. The success criterion for the Model B analysis was that one of the four pumps had to deliver flow. For both models it was assumed that at T=0, one of the two shutdown cooling pumps was running. These two models were quantified for mission times of 24 hours (1 day), 72 hours (3 days) and 168 hours (7 days). Table 6.3.4-2 presents the results of these quantification. As can be seen from the results in this table, the risk during shutdown for Situation B, two shutdown cooling and two containment spray pumps available, is lower than the shutdown risk for Situation A, two shutdown cooling pumps and one containment spray pump available, by about 1.0E-06 per day of mission time. This level of risk is generally equivalent to the risk of CS maintenance during power operation. In other words, the availability of a second CS pump at shutdown (when the plant is on SDC), as a backup has a greater risk significance than, the availability of the containment spray pump at power for containment integrity control.

For C-E plants that are not able to realign the CS pump to support shutdown cooling, the associated benefit for on line preventive maintenance is lower.

TABLE 6.3.4-1
DATA USED FOR SHUTDOWN RISK COMPARISON

PARAMETER*	DATA VALUE	REFERENCE(S)
Independent failure of LPSI pump to run	4.03×10^{-4}/day	7
Independent failure of standby LPSI pump or backup CS pump to start	1.73×10^{-3}/demand	7
Independent failure of the standby LPSI pump or backup CS pump to start	4.03×10^{-4}/day	7
Common Cause failure of 2 of 2 standby/backup pumps to start	2.44×10^{-4}/demand (β =0.14)	7, 23
Common Cause failure of 3 of 3 standby/backup pumps to start	1.25×10^{-4}/demand (β =0.12, γ =0.6)	7, 23
Common cause failure of 3 of 3 standby/backup pumps to run	6.45×10^{-6}/day (β=0.04, γ =0.41)	7, 23
Common cause failure of 4 of 4 pumps to run	5.42×10^{-6}/day (β=0.04, γ= 0.41, δ=0.84)	7, 23
Operator fails to align operational CS pump	0.01	7
Operator fails to start standby SDC train	0.01	7

* Either the LPSI or the CS is assumed to be used to support shutdown cooling.

TABLE 6.3.4-2
PARAMETRIC COMPARISON OF SHUTDOWN RISK FOR TWO SYSTEM CONFIGURATIONS

Mission Time	Probability of Core Damage due to Loss of Shutdown Cooling		
	Model A (2 LPSI pumps, 1 CS pump)	**Model B** (2 LPSI pumps, 2 CS pumps)	**Delta (Model A-Model B)**
24 hours (1 day)	6.82E-06	5.71E-06	1.11E-06
72 hours (3 days)	2.05E-05	1.71E-05	3.40E-06
168 hours (7 days)	4.80E-05	4.01E-05	7.90E-06

6.3.5 Assessment of Large Early Radiologic Releases

The containment spray system serves an important role in the protection of the public from exposure to radiation following reactor accidents. This section considers the impact of the AOT extension on the short term large early releases of radionuclides following loss of containment integrity following the onset of severe core damage events.

A review of large early release scenarios for the C-E PWRs indicates that early releases arise as result of one of the following class of scenarios:

1. Containment Bypass Events

   These events include interfacing system LOCAs and steam generator tube ruptures (SGTRs) with a concomitant loss of SG isolation (e.g. stuck open MSSV)

2. Severe Accidents accompanied by loss of Containment Isolation

   These events include any severe accident in conjunction with an initially unisolated containment.

3. Containment Failure associated with Energetic events in the Containment.

   Events causing containment failure include those associated with the High Pressure Melt Ejection (HPME) phenomena including direct containment heating (DCH), and hydrogen conflagrations and/or detonations.

Of the three release categories, Class 1 tends to represent a large early release with potentially direct, unscrubbed fission products, to the environment. Class 2 events encompass a range of releases varying from early to late that may or may not be scrubbed. Class 3 events may result in a high pressure failure of the containment, immediately upon or slightly after reactor vessel failure. Level 2 analyses for CEOG member plants indicate that post-accident operation of one containment fan cooler or one containment spray train is sufficient to ensure containment integrity.

In this assessment, the impact of the unavailability of a single train of CS on the plant large early release fraction (LERF) is established by evaluating the role of the CS system in defining the probability and extent of the fission product release for the above event categories. The results of the aforementioned assessments are presented below.

6.3.5.1 Containment Bypass Events

Events contained in this category include the Large Interfacing System LOCA (i.e. failure of an SDC line) and SGTRs with loss of isolation. Both these events pose significant risk of radiation release to the public. For these events energy releases bypass the containment. Therefore, the availability of the CSS has no impact on these releases.

6.3.5.2 Severe Accidents accompanied by Loss of Containment Isolation

Another event contributing to large early fission product releases could occur when a severe accident occurs in conjunction with an initially unisolated containment. These events typically represent a very small contribution (less than 1%) to the total containment failure probability. The probability of containment isolation failure used in the CEOG varied from about 1.0×10^{-4} to 1.0×10^{-3} per year (cf., References 5, 24 and 25). The upper limit was selected in Reference 24 to be a bounding value for event vulnerability screening purposes.

Maintenance on the CS system may increase the probability of the loss of the CSS function for containment fission product scrubbing and heat removal. The probability of this event remains unchanged regardless of the containment spray status. However, for situations in which the containment is not isolated and the CSS is completely unavailable the magnitude of the fission product release would increase. The contribution of this scenario to the containment large early release fraction is small. An estimate of this probability that this contribution would be realized can be established using the following bounding assumptions:

1. A typical CEOG core damage frequency is 3×10^{-5} per year. This value is representative of the average C-E PWR with diverse heat removal capability. This value tacitly assumes that the contribution of the CS train unavailability on the CDF is negligible.

   For C-E PWRs without diverse heat removal, unavailability of the CS train increases the likelihood of loss of ECCS and therefore increases the CDF. Given the unavailability of the CS train, the increase in the instantaneous CDF is less than a factor of 5, see Figures 6.3.-1 and 6.3-2. Under these conditions the instantaneous CDF of these plants is bounded by 5.0×10^{-6} per day ($\sim 2 \times 10^{-4}$ per year).

2. A core damage event occurs concurrently with an unisolated containment. This has a probability of less than 0.001.

3. One CS train is out for corrective maintenance due to a system failure. This may be quantified by conservatively assuming that a CS train is unavailable for corrective maintenance 7 days per year per train. This results in a yearly unavailability of ~0.04 (14 days/365 days)

4. The second CS train is subject to the same non-random failure mechanism. This is conservatively represented by assuming the probability of failure of the second CS train, given the unavailability of the first CS train is 0.17 (cf., Reference 23)

Thus, the probability of large early fission product release due to loss of containment isolation and exacerbated by unavailability of the CSS due to maintenance on a single CS train can be bounded as follows:

$$P_{LERF}=P_{CD} \times (P_{CI}) \times (P_{CSM}) \times (P_{CSF})$$

where:

P_{CD} = probability of core damage
P_{CI} = probability containment unisolated
P_{CSM}= probability CS maintenance
P_{CSF} = probability remaining CS fails

Then, P_{LERF} becomes 2×10^{-10} per year for plants with diverse heat removal and is less than 1×10^{-9} per year for plants without diverse heat removal. Typical values for LERF are in the range of 10^{-6} per year. Therefore, the contribution of the CS train maintenance to LERF is negligible.

6.3.5.3 Containment Failure associated with Energetic events in the Containment

Events that result in energetic containment failures are dominated by RCS transients that fail the reactor vessel at high pressure. For many C-E PWRs the CS serves no significant role in mitigating the core damage scenario, nor does it play a significant role in preventing containment failure. In fact, for certain transients, the availability and use of sprays following periods of significant hydrogen accumulation may result in an increased containment threat by maintaining the containment de-inerted. Severe accident studies have also been reported in Reference 26, which suggest that the availability of sprays have minimal impact on averting high pressure melt ejection induced threats. Therefore, provided the spray unavailability does not increase the plant CDF, these events will not significantly impact the plant's calculated LERF. For plants where the increase in CDF is expected, i.e. Palo Verde Units 1, 2 and 3, the LERF increase can be conservatively bounded by assuming that the energetic containment failure events due to DCH and hydrogen burn are increased by the relative CDF increase (less than 1.05). These events typically represent approximately 5% or less of the containment failure probability and less than twenty percent of the large early release frequency. The resultant increase in LERF would be below 3×10^{-7} per year or about a 1% increase.

It should be noted that the calculation of the LERF due to highly energetic events is highly uncertain. In performing the IPE assessment most CEOG PWRs typically took conservative positions in establishing the DCH and hydrogen combustion threats. Recent analyses performed by the national laboratories (cf., References 27 and 28) suggest the very strong likelihood of RCS piping failure prior to vessel breach during conditions when the core is damaged and the RCS is at high pressure. Failure of RCS piping (e.g. a hot leg or surge line) would depressurize the RCS and avert a high pressure melt ejection scenario. This sequence of events virtually eliminates the potential energetic containment threat due to direct containment heating.

6.3.6 Summary of Risk Assessment

The proposed increase in the AOT for a single CSS train to 7 days was evaluated from the perspective of various risks associated with plant operation. For the plants evaluated, incorporation of the extended AOT into the Technical Specification results in negligible increases in the "at power" risk. However, when the full scope of plant risk is considered, the risks incurred by extending the AOT for corrective maintenance are offset by associated plant benefits associated with avoiding unnecessary plant transitions. In addition, the extended AOT will also allow the plant to respond to system failures while remaining at power.

The unavailability of one train of CSS was found to not significantly impact the three classes of events that give rise to large early releases. These include a) containment bypass sequences, b) severe accidents accompanied by loss of containment isolation and c) containment failure due to energetic events in the containment. It is therefore concluded that increased unavailability of the CSS (as requested via Section 2) will result in a negligible impact on the large early release probability for C-E PWRs.

Specific discussions of individual risk assessments are provided in Sections 6.3.2.4, 6.3.3, 6.3.4 and 6.3.5. Based on the analyses presented in these sections, and discussion of the results obtained from each analysis, it is concluded that the overall impact on risk will be risk beneficial for a CSS train AOT extension to 7 days.

6.4 Compensatory Measures

As part of implementing the Maintenance Rule, each C-E PWR utility have developed various methods and procedures for configuration control during maintenance. These methods supplement the Maintenance Rule (10 CFR 50.65) and specifically addresses Subparagraph A(3). That is, when maintenance is planned on a system and/or train while another risk significant system is inoperable, the impact on risk on the anticipated combination of inoperable system trains will be evaluated prior to voluntarily the first system train in an INOPERABLE state. Some plants perform this process via procedures which require that PSA evaluation is performed prior to performing maintenance. Other plants utilize a matrix showing the risk associated with different combinations of systems and/or trains inoperable. These methods are typically used in planning the rolling maintenance schedule as well as in assessing the impact of emergent (unplanned) work.

The significance of the compensatory measures discussed below will vary among plant designs. Most C-E plants rely on diverse means of containment cooling for containment heat removal. Hence, the impact of maintenance on components in the CS train on the potential for core damage and/or containment failure is very low. One plant design, Palo Verde, utilizes containment sprays for heat removal and fission product scrubbing. For the Palo Verde Units, the Containment Spray system provides essential cooling of the emergency sump water and ensures containment integrity. Loss of the containment spray system for these units would cause failure of ECCS during recirculation and increase the plant CDF. These dependencies are well understood by the various utilities and contingency actions associated with CS maintenance will be established accordingly on a plant specific basis. Example contingency actions are identified below:

For plants with Diverse Containment Heat Removal:

1. While performing maintenance on the CS train components, do not disable other components that are used for the containment heat removal.
2. Prior to performing maintenance on one CS equipment train, assure that the backup train is properly aligned and would be expected to perform its function if required.
3. Conduct a briefing with appropriate plant personnel to ensure that they are aware of the impact associated with unavailable components and flowpaths.

4. If a maintenance action or repair is to be performed, pre-stage parts and tools to minimize outage time.
5. Consider actions which could be taken to return the affected train to functional use, if not full operability, if the need arises or plan for backup systems (e.g. containment fan coolers) to be available.
6. In repairing and/or testing components (particularly valves), define the appropriate valve position (open/closed) that provides the greater level of safety and "if practical" establish that position for the repair.

For plants with no independent backup to the spray system, additional contingency actions may be desirable.

7.0 TECHNICAL JUSTIFICATIONS FOR OTHER MODIFICATIONS TO THE TECHNICAL SPECIFICATIONS

Sections 7.0, 7.1 and 7.2, submitted to document modifications to CSS and LPSI Technical Specifications, were not reviewed by the NRC and have been deleted from this Approved report. This deletion brings the Approved report in compliance with the enclosed NRC Safety Evaluation. Material originally provided in this section will be found in Attachment C.

7.1 Surveillance Test Interval Extensions

Section 7.1 has been deleted.

7.2 LCO Required Actions and Completion Times

7.2.1 LCO Required Actions and Completion Times Concerning One Inoperable Containment Spray Train (with or without credit for use in containment iodine removal)

Section 7.2.1 has been deleted.

7.2.2 LCO Required Actions and Completion Times Concerning One INOPERABLE ECCS Train Due To INOPERABLE LPSI subtrain

Section 7.2.2 has been deleted.

7.2.3 LCO Required Actions and Completion Times Concerning Conditions that Include Two INOPERABLE Containment Spray Trains

Section 7.2.3 has been deleted.

7.2.4 LCO Required Actions and Completion Times Concerning Conditions that include Two INOPERABLE ECCS Trains due to Only INOPERABLE LPSI subtrains

Section 7.2.4 has been deleted.

8.0 PROPOSED MODIFICATIONS TO NUREG-1432

The "Mark-up" of NUREG-1432 sections corresponding to the proposed changes, originally submitted as Attachment A to CE NPSD-1045, has been superseded. Information contained in this Attachment will be developed via the Improved Standard Technical Specifications Task Force.

9.0 SUMMARY AND CONCLUSIONS

This report provides the results of an evaluation of the extension of the Allowed Outage Time (AOT) for a single Containment Spray System (CSS) Train contained within the current C-E plant technical specifications, from its present value, to seven days. This AOT extension is sought to provide needed flexibility in the performance of both corrective and preventive maintenance during power operation. Justification of this request was based on an integrated review and assessment of plant operations, deterministic and/or design basis factors and plant risk. Results of this study demonstrate that the proposed AOT extension provides plant operational flexibility while simultaneously reducing overall plant risk.

The proposed increase in the CSS AOT to 7 days was evaluated from the perspective of various risks associated with plant operation. For the plants evaluated, incorporation of the extended AOT into the technical specifications potentially results in negligible increases in the "at power" risk. However, when the full scope of plant risk is considered the risks incurred by extending the AOT for either corrective or preventive maintenance will be substantially offset by associated plant benefits associated with avoiding unnecessary plant transitions and/or by reducing risks during plant shutdown operations and/or implementing the appropriate contingency actions.

The unavailability of one train of CSS was found to not significantly impact the three classes of events that give rise to large early releases. These include a) containment bypass sequences, b) severe accidents accompanied by loss of containment isolation and c) containment failure due to energetic events in the containment. It is concluded that increased unavailability of the CSS (as requested via Section 2) will result in a negligible impact on the large early release probability for C-E PWRs.

The impact of CSS train unavailability on long term containment integrity was also evaluated. For C-E plants with diverse containment heat removal systems the impact of CSS train unavailability on containment failure probability was negligible. For Palo Verde Units 1, 2 and 3, which does not include diverse containment heat removal capability, increased unavailability of the CS can results in a small incremental risk of long term containment failure.

It is the overall conclusion of this evaluation that the plant impact for the requested AOT extension and requested modifications to the associated ACTION STATEMENTS would be risk beneficial.

10.0 REFERENCES

1. CE-NPSD-995, "Low Pressure Injection System AOT Extension," ABB Combustion Engineering, Inc., July 1995.
2. 10 CFR 50.65, Appendix A, "The Maintenance Rule".
3. NUREG-0212, Revision 3, "Standard Technical Specifications for Combustion Engineering Pressurized Water Reactors," July 9, 1982.
4. NUREG-1432, "Standard Technical Specifications: Combustion Engineering Units," Revision 1, NRC, April 1995.
5. Waterford Unit 3 Probabilistic Risk Assessment, Entergy Operations, Inc, August 28, 1992, Docket No. 50-382.
6. Millstone Point Unit 2 IPE, Northeast Utilities, June 1994.
7. Fort Calhoun Station IPE, Omaha Public Power District, December, 1993.
8. 10 CFR 100, "Reactor Site Criteria," USNRC, 1991.
9. 10 CFR 50, "Appendix A: General Design Criteria," USNRC, 1991.
10. NUREG-1465, "Accident Source Terms for Light Water Reactors" February, 1995.
11. USNRC, Regulatory Guide 1.4, "Assumptions used for Evaluating the Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors."
12. NRC Inspection Manual Part 9900 Technical Guidance, "Maintenance-Voluntary Entry into Limiting Conditions for Operation Action Statements to Perform Maintenance," 1991.
13. LER 94-005-01, Palo Verde Unit 2.
14. "Technical Evaluation of South Texas Project (STP) Analysis for Technical Specification Modifications," P. Samantra, G. Martinez-Guridi, and W. Vesely, Technical Report #L-2591, dated 1-11-94.
15. NUREG/CR-6141, Handbook of Methods for Risk Based Analyses of Technical Specifications, Samantra, P., et. al., July 1994.
16. NUREG/CR-3663, "Probability of Pipe Failure in the Reactor Coolant Loops of Combustion Engineering PWR Plants: Vol. 1: Summary Report," Holman, G. S., Lo, T., Chou, C. K., Lawrence Livermore National Laboratory, October, 11, 1984.
17. Component External Leakage and Frequency Estimates, S. A. Eide, et al., Idaho National Engineering Laboratory, PSA93, Volume 2, January 26-29, 1993, Clearwater Beach, Fla.
18. Waterford Unit 3 Updated FSAR.
19. TID 14844, "Calculation of Distance Factors for Power Reactor Sites," USAEC, 1962.
20. NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," USNRC, October, 1990.
21. Deleted.
22. CE-NPSD-1041-P, "Joint Applications Report for High Pressure Safety Injection System Technical Specification Modifications," CEOG,

23. EPRI Report, Advance Light Water Reactor Utility Requirements Document, Volume II, Evolutionary ALWR, Chapter 1, Appendix A, "PSA Key Assumptions and Groundrules," Revision. 3, Nov. 1991.

24. Millstone Point Unit 2 Individual Plant Examination for Severe Accident Vulnerabilities, Northeast Utilities Service Company, December, 30, 1993, Docket 50-336.

25. Palo Verde Nuclear Generating Station Units 1, 2 and 3 IPE for Severe Accident Vulnerabilities, Arizona Public Service Corp, April 28, 1992, Docket Nos. 50-528/529/530.

26. NUREG/CR-5567, "PWR Dry Containment Issue Characterization," Yang, J. W., Brookhaven National Laboratory, July, 1990.

27. INEL Report, "Best Estimate CE SCDAP/ RELAP5 Analysis," Knudson, D. L., Quick, K.S., INEL, 1995.

28. NUREG/CR-6338, "Resolution of Direct Containment Heating Issue for All Westinghouse Plants with Large Dry Containments or Subatmospheric Containments," Pilch, M. M., et. al., Sandia National Laboratories, January, 1996.

29. NUREG/CR-4450, "Analysis of Core Damage Frequency: Surry Unit 1, Internal Events," Vol. 3 , Revision 1 , Part 2, Bertuccio, R.C., Julius, J. A., April, 1990.

Attachment A

"Mark-up" of NUREG-1432 Standard Technical Specifications for Section 3.5.2 and B 3.5.2, Section 3.6.6A and B3.6.6A, and Section 3.6.6.B and B3.6.6.B

Information on revisions to Standard Technical Specifications, provided as Attachment A in Rev 00 of this report, has been superseded and was not reviewed by the staff. This information will be developed later under the auspices of the Improved Standard Technical Specifications Task Force.

For consistency, the original material provided in this attachment is retained as Attachment A.

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.2 ECCS—Operating

LCO 3.5.2 Two ECCS trains shall be OPERABLE.

APPLICABILITY: MODES 1 and 2,
MODE 3 with pressurizer pressure ≥ [1700] psia.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more trains inoperable. <u>AND</u> At least 100% of the ECCS flow equivalent to a single OPERABLE ECCS train available.	A.1 Restore train(s) to OPERABLE status.	72 hours
B. Required Action and associated Completion Time [of Condition A] not met. [INSERT A]	B.1 Be in MODE 3. <u>AND</u> B.2 Reduce pressurizer pressure to < [1700] psia.	6 hours 12 hours

INSERT A

C. Less than 100% of ECCS flow equivalent to a single OPERABLE ECCS train available due to two or more inoperable LPSI subtrains.	C.1 Be in MODE 3. AND C.2 Reduce pressurizer pressure to < [1700] psia. AND C.3 Be in MODE 4 with reliance upon steam generator for heat removal.	6 hours 12 hours 36 hours
D. Less than 100% of ECCS flow equivalent to a single operable ECCS train available due to condition(s) other than Condition C.	D.1 Enter LCO 3.0.3.	Immediately

3.6 CONTAINMENT SYSTEMS

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

LCO 3.6.6A Two containment spray trains and two containment cooling trains shall be OPERABLE.

APPLICABILITY: MODES 1, 2, [and] 3[, and 4].

ACTIONS

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. One containment spray train inoperable.	A.1	Restore containment spray train to OPERABLE status.	7 days ~~72 hours~~ <u>AND</u> 10 days from discovery of failure to meet the LCO
B. Required Action and associated Completion Time of Condition A not met.	B.1 <u>AND</u> B.2	Be in MODE 3. Be in MODE ~~5~~ 4.	6 hours ~~84~~ 12 hours
C. One containment cooling train inoperable.	C.1	Restore containment cooling train to OPERABLE status.	7 days <u>AND</u> 10 days from discovery of failure to meet the LCO

(continued)

Containment Spray and Cooling Systems (Atmospheric and Dual)
3.6.6A

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
D. Two containment cooling trains inoperable.	D.1 Restore one containment cooling train to OPERABLE status.	72 hours
E. Required Action and associated Completion Time of Condition C or D not met.	E.1 Be in MODE 3. AND E.2 Be in MODE 5.	6 hours 36 hours
F. Two containment spray trains inoperable. INSERT B → OR Any combination of three or more trains inoperable.	F.1 Enter LCO 3.0.3.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.6A.1	Verify each containment spray manual, power operated, and automatic valve in the flow path that is not locked, sealed, or otherwise secured in position is in the correct position.	31 days

(continued)

3.6 CONTAINMENT SYSTEMS

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

LCO 3.6.6B Two containment spray trains and two containment cooling trains shall be OPERABLE.

APPLICABILITY: MODES 1, 2, [and] 3[, and 4].

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One containment spray train inoperable.	A.1 Restore containment spray train to OPERABLE status.	7 days AND 14 days from discovery of failure to meet the LCO
INSERT C →		
~~B~~ C. One containment cooling train inoperable.	~~B~~ C.1 Restore containment cooling train to OPERABLE status.	7 days AND 14 days from discovery of failure to meet the LCO
INSERT D →		
~~C~~ E. Two containment spray trains inoperable.	~~C~~ E.1 Restore one containment spray train to OPERABLE status.	72 hours

(continued)

INSERT C

B. Required Action and associated Completion Time of Condition A not met.	B.1 Be in MODE 3. AND B.2 Be in MODE 4.	6 hours 12 hours

INSERT D

D. Required Action and associated Completion Time of Condition C not met.	D.1 Be in MODE 3. AND D.2 Be in MODE 5.	6 hours 36 hours

ACTIONS (continued)

INSERT E

CONDITION	REQUIRED ACTION	COMPLETION TIME
G ~~F~~. One containment spray train and one containment cooling train inoperable.	G ~~F~~.1 Restore containment spray train to OPERABLE status.	72 hours
	OR	
	G ~~F~~.2 Restore containment cooling train to OPERABLE status.	72 hours
H ~~G~~. Two containment cooling trains inoperable.	H ~~G~~.1 Restore one containment cooling train to OPERABLE status.	72 hours
I ~~H~~. Required Action and associated Completion Time of Condition A, B, C, D, or E not met.	I ~~H~~.1 Be in MODE 3.	6 hours
	AND	
	I ~~H~~.2 Be in MODE 5.	36 hours
J ~~I~~. Any combination of three or more trains inoperable.	J ~~I~~.1 Enter LCO 3.0.3.	Immediately

INSERT E

F. Required Action and associated Completion Time of Condition E not met.	F.1 Be in MODE 3.	6 hours
	AND	
	F.2 Be in MODE 4.	12 hours

BASES

ACTIONS

A.1 (continued)

OPERABLE status within 72 hours. The 72 hour Completion Time is based on an NRC study (Ref. 4) using a reliability evaluation and is a reasonable amount of time to effect many repairs.

An ECCS train is inoperable if it is not capable of delivering the design flow to the RCS. The individual components are inoperable if they are not capable of performing their design function, or if supporting systems are not available.

The LCO requires the OPERABILITY of a number of independent subsystems. Due to the redundancy of trains and the diversity of subsystems, the inoperability of one component in a train does not render the ECCS 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. The intent of this Condition is to maintain a combination of OPERABLE equipment such that 100% of the ECCS flow equivalent to 100% of a single OPERABLE train remains available. This allows increased flexibility in plant operations when components in opposite trains are inoperable.

An event accompanied by a loss of offsite power and the failure of an emergency DG can disable one ECCS train until power is restored. A reliability analysis (Ref. 4) has shown that the impact with one full ECCS train inoperable is sufficiently small to justify continued operation for 72 hours.

Reference 5 describes situations in which one component, such as a shutdown cooling total flow control valve, can disable both ECCS trains. With one or more components inoperable, such that 100% of the equivalent flow to a single OPERABLE ECCS train is not available, the facility is in a condition outside the accident analyses. Therefore, LCO 3.0.3 must be immediately entered.

B.1 and B.2

If the inoperable train cannot be restored to OPERABLE status within the associated Completion Time, the plant must

(continued)

BASES

ACTIONS

B.1 and B.2 (continued)

be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and pressurizer pressure reduced to < 1700 psia within 12 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required unit conditions from full power in an orderly manner and without challenging unit systems.

INSERT AA →

SURVEILLANCE REQUIREMENTS

SR 3.5.2.1

Verification of proper valve position ensures that the flow path from the ECCS pumps to the RCS is maintained. Misalignment of these valves could render both ECCS trains inoperable. Securing these valves in position by removing power or by key locking the control in the correct position ensures that the valves cannot be inadvertently misaligned or change position as the result of an active failure. These valves are of the type described in Reference 5, which can disable the function of both ECCS trains and invalidate the accident analysis. A 12 hour Frequency is considered reasonable in view of other administrative controls ensuring that a mispositioned valve is an unlikely possibility.

SR 3.5.2.2

Verifying the correct alignment for manual, power operated, and automatic valves in the ECCS flow paths provides assurance that the proper flow paths will exist for ECCS operation. This SR does not apply to valves that are locked, sealed, or otherwise secured in position, since these valves were verified to be in the correct position prior to locking, sealing, or securing. A valve that receives an actuation signal is allowed to be in a nonaccident position provided the valve automatically repositions within the proper stroke time. This Surveillance does not require any testing or valve manipulation. Rather, it involves verification that those valves capable of being mispositioned are in the correct position.

(continued)

INSERT AA

C.1, C.2, C.3, and D.1

With one or more components inoperable such that 100% of the equivalent flow to a single OPERABLE ECCS train is not available, the facility is in a condition outside the accident analysis of record. (Reference 5 describes situations in which one component, such as shutdown cooling total flow valve, can disable both ECCS trains.) If this condition is the result of inoperable components that effect sets of ECCS subsystems including subsystems other than LPSI subtrains, then LCO 3.0.3 must be entered immediately.

For cases where 100% of the equivalent flow to a single OPERABLE ECCS train is not available due only to inoperable LPSI subtrains, Reference 6 demonstrates that "MODE 4 with reliance upon steam generator for heat removal" is an acceptable end-state. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and pressurizer pressure reduced to < 1700 psia within 12 hours and MODE 4 with reliance upon steam generator for heat removal within 36 hours.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.5.2.10

Periodic inspection of the containment sump ensures that it is unrestricted and stays in proper operating condition. The 18 month Frequency is based on the need to perform this Surveillance under the conditions that apply during an outage, on the need to have access to the location, and on the potential for unplanned transients if the Surveillance were performed with the reactor at power. This Frequency is sufficient to detect abnormal degradation and is confirmed by operating experience.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 35.
2. 10 CFR 50.46.
3. FSAR, Chapter [6].
4. NRC Memorandum to V. Stello, Jr., from R. L. Baer, "Recommended Interim Revisions to LCOs for ECCS Components," December 1, 1975.
5. IE Information Notice No. 87-01, January 6, 1987.

INSERT AB

INSERT AB

6. CE NPSD-1045-A, "CEOG Joint Applications Report for Modifications to the Containment Spray System Technical Specifications," March 2000

BASES (continued)

LCO

During a DBA, a minimum of two containment cooling trains or two containment spray trains, or one of each, is required to maintain the containment peak pressure and temperature below the design limits (Ref. 5). Additionally, one containment spray train is also required to remove iodine from the containment atmosphere and maintain concentrations below those assumed in the safety analysis. To ensure that these requirements are met, two containment spray trains and two containment cooling units must be OPERABLE. Therefore, in the event of an accident, the minimum requirements are met, assuming that the worst case single active failure occurs.

Each Containment Spray System typically includes a spray pump, spray headers, nozzles, valves, piping, instruments, and controls to ensure an OPERABLE flow path capable of taking suction from the RWT upon an ESF actuation signal and automatically transferring suction to the containment sump.

Each Containment Cooling System typically includes demisters, cooling coils, dampers, fans, instruments, and controls to ensure an OPERABLE flow path.

APPLICABILITY

In MODES 1, 2, 3, and 4, a DBA could cause a release of radioactive material to containment and an increase in containment pressure and temperature, requiring the operation of the containment spray trains and containment cooling trains.

In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Thus, the Containment Spray and Containment Cooling systems are not required to be OPERABLE in MODES 5 and 6.

ACTIONS

A.1

With one containment spray train inoperable, the inoperable containment spray train must be restored to OPERABLE status within ~~72 hours~~ 7 days. In this Condition, the remaining OPERABLE spray and cooling trains are adequate to perform the iodine removal and containment cooling functions. The ~~72 hour~~ 7 days Completion Time takes into account the redundant heat

(continued)

BASES

ACTIONS

A.1 (continued)

removal capability afforded by the Containment Spray System, reasonable time for repairs, and the low probability of a DBA occurring during this period.

INSERT AC

The 10 day portion of the Completion Time for Required Action A.1 is based upon engineering judgment. It takes into account the low probability of coincident entry into two Conditions in this Specification coupled with the low probability of an accident occurring during this time. Refer to Section 1.3, "Completion Times," for a more detailed discussion of the purpose of the "from discovery of failure to meet the LCO" portion of the Completion Time.

B.1 and B.2

If the inoperable containment spray train cannot be restored to OPERABLE status within the required Completion Time, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 84 hours. The allowed Completion Time of 6 hours is reasonable, based on operating experience, to reach MODE 3 from full power conditions in an orderly manner and without challenging plant systems. The extended interval to reach MODE 5 allows additional time for the restoration of the containment spray train and is reasonable when considering that the driving force for a release of radioactive material from the Reactor Coolant System is reduced in MODE 3.

INSERT AD

C.1

With one required containment cooling train inoperable, the inoperable containment cooling train must be restored to OPERABLE status within 7 days. The components in this degraded condition provide iodine removal capabilities and are capable of providing at least 100% of the heat removal needs after an accident. The 7 day Completion Time was developed taking into account the redundant heat removal capabilities afforded by combinations of the Containment Spray System and Containment Cooling System and the low probability of a DBA occurring during this period.

(continued)

INSERT AC

and the findings of Reference 7.

INSERT AD

To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and MODE 4 within 12 hours. The allowed Completion Times for entry into MODE 3 and MODE 4 are reasonable, based on operating experience, to reach these MODEs from full power conditions in an orderly manner and without challenging plant systems. Reference 7 provides justification for sustained operation in MODE 4 during restoration of the operability of the affected containment spray train.

BASES

ACTIONS

C.1 (continued)

The 10 day portion of the Completion Time for Required Action C.1 is based upon engineering judgment. It takes into account the low probability of coincident entry into two Conditions in this Specification coupled with the low probability of an accident occurring during this time. Refer to Section 1.3 for a more detailed discussion of the purpose of the "from discovery of failure to meet the LCO" portion of the Completion Time.

D.1

With two required containment cooling trains inoperable, one of the required containment cooling trains must be restored to OPERABLE status within 72 hours. The components in this degraded condition provide iodine removal capabilities and are capable of providing at least 100% of the heat removal needs after an accident. The 72 hour Completion Time was developed taking into account the redundant heat removal capabilities afforded by combinations of the Containment Spray System and Containment Cooling System, the iodine removal function of the Containment Spray System, and the low probability of a DBA occurring during this period.

E.1 and E.2

If the Required Actions and associated Completion Times of Condition C or D of this LCO are not met, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

F.1 and G.1

With two containment spray trains or any combination of three or more Containment Spray System and Containment Cooling System trains inoperable, the unit is in a condition

(continued)

BASES

ACTIONS

F.1 (continued) and G.1

outside the accident analysis. ~~Therefore, LCO 3.0.3 must be entered immediately.~~

INSERT AE

SURVEILLANCE REQUIREMENTS

SR 3.6.6A.1

Verifying the correct alignment for manual, power operated, and automatic valves in the containment spray flow path provides assurance that the proper flow paths will exist for Containment Spray System operation. This SR does not apply to valves that are locked, sealed, or otherwise secured in position since these were verified to be in the correct position prior to being secured. This SR also does not apply to valves that cannot be inadvertently misaligned, such as check valves. This SR does not require any testing or valve manipulation. Rather, it involves verifying, through a system walkdown, that those valves outside containment and capable of potentially being mispositioned are in the correct position.

SR 3.6.6A.2

Operating each containment cooling train fan unit for ≥ 15 minutes ensures that all trains are OPERABLE and that all associated controls are functioning properly. It also ensures that blockage, fan or motor failure, or excessive vibration can be detected and corrective action taken. The 31 day Frequency of this SR was developed considering the known reliability of the fan units and controls, the two train redundancy available, and the low probability of a significant degradation of the containment cooling train occurring between surveillances and has been shown to be acceptable through operating experience.

SR 3.6.6A.3

Verifying a service water flow rate of ≥ [2000] gpm to each cooling unit provides assurance that the design flow rate assumed in the safety analyses will be achieved (Ref. 2). Also considered in selecting this Frequency were the known reliability of the Cooling Water System, the two train

(continued)

INSERT AE

If this condition is the result any combination of three or more inoperable Containment Spray System and inoperable Containment Cooling System trains, then LCO 3.0.3 must be entered immediately.

For cases where this condition is the result of only inoperable containment spray trains, Reference 7 demonstrates that MODE 4 is an acceptable end-state. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and MODE 4 within 12 hours.

BASES

REFERENCES (continued)

4. FSAR, Section [ ].
5. FSAR, Section [ ].
6. ASME, Boiler and Pressure Vessel Code, Section XI.

INSERT AF

INSERT AF

7. CE NPSD-1045-A, "CEOG Joint Applications Report for Modifications to the Containment Spray System Technical Specifications," March 2000

BASES

LCO (continued)

taking suction from the RWT upon an ESF actuation signal and automatically transferring suction to the containment sump.

Each Containment Cooling System typically includes demisters, cooling coils, dampers, fans, instruments, and controls to ensure an OPERABLE flow path.

APPLICABILITY

In MODES 1, 2, 3, and 4, a DBA could cause a release of radioactive material to containment and an increase in containment pressure and temperature requiring the operation of the containment spray trains and containment cooling trains.

In MODES 5 and 6, the probability and consequences of these events are reduced due to the pressure and temperature limitations of these MODES. Thus, the Containment Spray and Containment Cooling systems are not required to be OPERABLE in MODES 5 and 6.

ACTIONS

A.1

With one containment spray train inoperable, the inoperable containment spray train must be restored to OPERABLE status within 7 days. The components in this degraded condition are capable of providing greater than 100% of the heat removal needs (for the condition of one containment spray train inoperable) after an accident. The 7 day Completion Time was developed taking into account the redundant heat removal capabilities afforded by combinations of the Containment Spray System and Containment Cooling System ~~and the low probability of a DBA occurring during this period~~.

INSERT AG

The 14 day portion of the Completion Time for Required Action A.1 is based upon engineering judgment. It takes into account the low probability of coincident entry into two Conditions in this Specification coupled with the low probability of an accident occurring during this time. Refer to Section 1.3, "Completion Times," for a more detailed discussion of the purpose of the "from discovery of failure to meet the LCO" portion of the Completion Time.

INSERT AH

(continued)

INSERT AG

and the findings of Reference 7.

INSERT AH

B.1 and B.2

If the Required Action and associated Completion Time for Condition A are not met, the plant must be brought to a MODE in which the LCO does not apply. For this situation, to achieve this status, the plant must be brought to MODE 3 within 6 hours and MODE 4 within 12 hours. The allowed Completion Times for entry into MODE 3 and MODE 4 are reasonable, based on operating experience, to reach these MODEs from full power conditions in an orderly manner and without challenging plant systems. Reference 7 provides justification for sustained operation in MODE 4 during restoration of the operability of the affected containment spray train.

INSERT AI

The 7 day Completion Time was developed taking into account the redundant heat removal capabilities afforded by combinations of the Containment Spray System and Containment Cooling System and the low probability of a DBA occurring during this period.

INSERT AJ

D.1 and D.2

If the Required Action and associated Completion Time for Condition C are not met, the plant must be brought to a MODE in which the LCO does not apply. For this situation, to achieve this status, the plant must be brought to MODE 3 within 6 hours and MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach these MODEs from full power conditions in an orderly manner and without challenging plant systems.

INSERT AK

F.1 and F.2

If the Required Action and associated Completion Time for Condition E are not met, the plant must be brought to a MODE in which the LCO does not apply. For this situation, to achieve this status, the plant must be brought to MODE 3 within 6 hours and MODE 4 within 12 hours. The allowed Completion Times for entry into MODE 3 and MODE 4 are reasonable, based on operating experience, to reach these MODEs from full power conditions in an orderly manner and without challenging plant systems. Reference 7 provides justification for sustained operation in MODE 4 during restoration of the operability of the affected containment spray trains.

BASES

ACTIONS (continued)

H.1

With two containment cooling trains inoperable, one of the required containment cooling trains must be restored to OPERABLE status within 72 hours. The components in this degraded condition are capable of providing greater than 100% of the heat removal needs after an accident. The 72 hour Completion Time was developed based on the same reasons as those for Required Action E.1.

I.1 and I.2

If ~~any of~~ the Required Actions and associated Completion Times of ~~this LCO~~ INSERT AM are not met, the plant must be brought to a MODE in which the LCO does not apply. To achieve this status, the plant must be brought to at least MODE 3 within 6 hours and to MODE 5 within 36 hours. The allowed Completion Times are reasonable, based on operating experience, to reach the required plant conditions from full power conditions in an orderly manner and without challenging plant systems.

INSERT AM: Condition G or Condition H

J.1

With any combination of three or more Containment Spray System and Containment Cooling System trains inoperable, the unit is in a condition outside the accident analysis. Therefore, LCO 3.0.3 must be entered immediately.

SURVEILLANCE REQUIREMENTS

SR 3.6.6B.1

Verifying the correct alignment for manual, power operated, and automatic valves, excluding check valves, in the Containment Spray System provides assurance that the proper flow path exists for Containment Spray System operation. This SR also does not apply to valves that are locked, sealed, or otherwise secured in position since these were verified to be in the correct positions prior to being secured. This SR also does not apply to valves that cannot be inadvertently misaligned, such as check valves. This SR does not require any testing or valve manipulation. Rather, it involves verification, through a system walkdown, that

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.6.6B.8 (continued)

experience. See SR 3.6.6B.6 and SR 3.6.6B.7, above, for further discussion of the basis for the [18] month Frequency.

SR 3.6.6B.9

With the containment spray inlet valves closed and the spray header drained of any solution, low pressure air or smoke can be blown through test connections. Performance of this SR demonstrates that each spray nozzle is unobstructed and provides assurance that spray coverage of the containment during an accident is not degraded. Due to the passive design of the nozzle, a test at [the first refueling and at] 10 year intervals is considered adequate to detect obstruction of the spray nozzles.

REFERENCES

1. 10 CFR 50, Appendix A, GDC 38, GDC 39, GDC 40, GDC 41, GDC 42, and GDC 43.
2. FSAR, Section [ ].
3. FSAR, Sections [ ].
4. FSAR, Section [ ].
5. FSAR, Section [ ].
6. ASME, Boiler and Pressure Vessel Code, Section XI.

INSERT AN

INSERT AN

7. CE NPSD-1045-A, "CEOG Joint Applications Report for Modifications to the Containment Spray System Technical Specifications," March 2000

Attachment B

Response to Request For Additional Information

Regarding CE NPSD-1045

Question No 1:

The submittal chooses the CDF as the risk measure to analyze the AOT risk for the containment spray (CS) system. We recognize that the CS system interacts with the ECCS and its unavailability affects the CDF, but the primary function of the CS is to mitigate consequences of accidents including core damage accidents. The AOT risk analysis of the CS system should have addressed frequency of releases quantitatively. Section 4.3 of the draft Regulatory Guide DG-1065 proposes evaluation of incremental conditionals core damage probability (ICCDP) and incremental conditional large early release probability (ICLERP). The latter measure is more appropriate for systems such as the containment spray system.

Please explain why the submittal did not choose the "frequency of releases" as a risk measure to analyze the AOT risk of the CS system.

Response:

The report considers both CDF and LERF as risk measures for CSS. For plants with non-diverse containment heat removal systems, the CSS has a direct impact on the ECCS performance, hence the need for CDF risk measures. For plants with diverse containment heat removal, the CDF is not significantly impacted by the unavailability of a CSS train.

The LERF risk was estimated for the above two categories by performing a risk assessment for a typical CE plant with a CDF of 3E-5/yr.

This assessment was presented in section 6.3.5 of the submittal. This section evaluates the ICLERP by assessing the impact of CS system unavailability on the scenarios which contribute to LERF. The scenarios which contribute to LERF are severe accidents induced by containment bypass events, severe accident occurring in the presence of an unisolated containment, and severe accidents resulting from energetic failure of the reactor vessel. The sum of the incremental LER probabilities associated with CS unavailability represents the ICLERP risk measure. Due to the small value of the ICLERP contributors, the results of the summation were not presented in the report. The summation is provided in Table B-1, for completeness.

The ICLERP for all the CE plants is $< 1.2 \times 10^{-8}$. These total values are well below the guidelines cited in the Regulatory Guide 1.177 (and SRP Chapter 16.1).

TABLE B-1 ICLERP FOR C-E PWRs WITH ONE CSS TRAIN INOPERABLE+		
LERF Release Scenario	**Non-Diverse CHR** **Palo Verde**	**Diverse CHR** **Bounding Values for all other CE PWRs**
Containment Bypass***	0	0
Loss of Containment Isolation+,**	1.48 E-9	< 5 E-10
Energetic Containment Failures*	< 1 E-8	< 2 E-9
Total	< 1.2 E-8	< 3 E-9

** See Discussion in Section 6.3.5.2 of this report.
*** ibid., Section 6.5.3.1
Note: ICLERP = ICCDP x Probability of LOCI

+ **Calculation of the Contribution of the Loss of Containment Isolation scenario to the ICLERP Parameter**

For plants with non-diverse CHR (i.e. Palo Verde)

Palo Verde: ICCDP = 4.58×10^{-7}
(Single AOT Risk, based on proposed unavailability, Table 6.3.2-1)
Probability of Loss of Containment Isolation (LOCI) = 0.00323

ICLERP = 1.48×10^{-9}

For plants with diverse CHR

Bounding Values: ICCDP = $< 1 \times 10^{-7}$
(See Table 6.3.2-1; assumes ANO 2 ICCDP typical of other C-E plants, see response to question 11)
Probability of LOCI < 0.005
ICLERP = $(1 \times 10^{-7})(0.005) = 5 \times 10^{-10}$

ICLERP = 5×10^{-10}

* **Calculation of the Contribution of the Energetic RV failure Scenarios to the ICLERP Parameter**

For plants with non-diverse CHR the unavailability of containment spray results in an ICCDP of 4.58×10^{-7}. Recent assessment of DCH induced containment threats performed by Sandia (see Reference) concluded that the probability of a high pressure melt ejection event resulting in containment failure is < 0.01 for Palo Verde Units 1,2 and 3 (See Table 7.2 of Reference). That is, fewer than 1% of those events would result in a high pressure RV failure scenario which would fail the containment. Thus the ICLERP would be less than 1×10^{-8}.

For plants with diverse containment heat removal the potential ICCDP due to unavailability of sprays is on the order of 1.5×10^{-8} or less. Likewise, Sandia report indicates that all C-E PWRs have conditional containment failure probabilities less than 0.10. Thus, the net ICLERP would similarly be below 2×10^{-9}. (Note, the large ANO-2 ICCDP is due to a conservative modeling assumption. With consistent modeling assumptions, ANO-2 results would be similar to those of the other C-E PWRs in that class. See response to Question 8)

<u>Reference:</u>
NUREG/CR-6475, "Resolution of the Direct Containment Heating Issue for Combustion Engineering Plants and Babcock & Wilcox Plants," M.M. Pilch, et. al., Sandia National Laboratory, November, 1998.

Question No 2:

Related to Question No. 1, in Section 6.3.5, as in Section 6.3.5 of your CEOG HPSI report, you present an "Assessment of Large Early Radiological Releases." While, as with the HPSI report, some of the qualitative arguments appear reasonable, these justifications need to be judged against LERF values, consistent with the (draft) Regulatory Guide 1.174 (DG-1061). Please provide LERF and delta LERF values for each of the CEOG NPPs or arguments that they are not needed, consistent with the staff guidelines for LERF and delta LERF (See Section 2.4.2.2 of DG-1061).

Please state your definition of large early release and the implications of any differences in your definition compared to the NRC definition.

Response:

The NRC uses LERF as a surrogate for the Qualitative Health Objective (QHO). LERF is defined as the frequency of those accidents leading to significant, unmitigated release of radioactivity from containment in a time frame prior to effective evacuation of the close-in population such that there is a potential for early health effects. Such events include events, which lead to early containment failure at or shortly after vessel breach, containment bypass events and loss of containment isolation. The definition used by the CEOG utilities varied somewhat in detail, however in practice the utility definitions are consistent with that of the NRC, in that LERF is evaluated by summing all core damage events leading to:

1. Containment Bypass Events
2. Core damage events occurring in conjunction with loss of containment isolation
3. Early Containment Failure (containment failure concurrent with RV breach).

For an event to be considered an **early** containment failure, and contribute to the Large Early Release Frequency, the containment must either be bypassed or unisolated prior to the onset of core melt, must fail as a near term consequence of RV lower head failure. Basemat melt-through events and gradual overpressurization events were not classified as early containment failures. These events were considered to result in a sufficiently gradual challenge that evacuation of people in the low population zone surrounding the plant may be accomplished prior to RV failure. Specific LERF definitions for each plant may be found in that plant's IPE.

LERF and incremental ICLERP values are provided for the task participants below. LERF values are directly provided by each utility and correspond to the associated CDF and data provided in Section 6 of the report. Incremental LERP values are established in one of two manners. Plants with automated LERF models have provided incremental LERF estimates conditional on unavailability of a CSS train directly. The remainder of the plants have bounding LERP estimates based on the evaluation provided in response to question 1:

TABLE B-2
LERF and ICLERP Values

PLANT	LERF (BASELINE) (per year)	ICLERP DUE TO REMOVAL OF ONE CS PUMP	COMMENTS
San Onofre Units 2 & 3	4.3 E-7	3 E-11	Plant Specific PSA Evaluation
Waterford Unit 3	5.7 E-6 +	< 3 E-9	Bounding Values*
Arkansas Nuclear One-Unit 2	2 E-6+++++	< 3 E-9	Bounding Values*
Palo Verde Units 1, 2 &3	2.13 E -6 +++	< 1.2 E-8	Bounding Values*
Millstone Unit 2	2.83 E-7	< 3 E-9	Bounding Values*
Calvert Cliffs Units 1 & 2	Not Available	< 3 E-9	Bounding Values*
St. Lucie Unit 1	2.9 E-6 +	1.4 E-9	Plant Specific PSA Evaluation**
St. Lucie Unit 2	3.8 E-6 +	2.7 E-9	Plant Specific PSA Evaluation**
Palisades	5 E-6 ++	< 3 E-9	Bounding Values*
Fort Calhoun	2 E-6++++	< 3 E-9	Bounding Values*

* See Response to Question 1

** Based on a conditional containment failure probability due to High Pressure Core Melt Ejection (HPME) of 0.10

+ Includes sum of bypass and early containment failure from IPE.

++ Estimated based on post-IPE modification to containment sump. This modification resulted in eliminating the LERF contribution due to core relocation to the auxiliary building.

+++ Based on 1994 PSA update. Current update uses a modified approach and results may be somewhat different. Current values are not presently available.

++++ Most recent estimate

+++++ Value established from review of existing IPE

Question No 3:

While recognizing that the main focus of containment-capability issues is on the conditional and absolute LERF values, it is also true that the probability of late containment failure is usually much larger than the probability of early containment failure. It is also true that the containment heat removal capability plays an important role in keeping the containment from failing. Please discuss the impact of taking a CS train out for PM or CM on the change in late containment failure probability and large late release frequency.

Response:

For plants with diverse CHR, removal of a CSS train for PM or CM has a negligible impact on both the late containment failure probability and large late release frequency. This is because the availability of a single fan cooler is sufficient to maintain long term containment integrity.

For plants with non-diverse CHR, assuming the unavailable CS train cannot be returned to operable status prior to containment failure, the resulting core damage sequences due to the unavailability of one CSS train will also result in containment failure. Thus, the impact of taking a CS train out for PM or CM will impact the late containment failure probability and the large late release frequency in a manner directly proportional to the increase in CDF.

A small impact of spray unavailability is also present for core damage sequences which are independent of containment spray status. In these scenarios a core damage event occurs when one spray is unavailable due to maintenance. If the event is not an SGTR or containment bypass the RCS would steam the containment until the containment would fail. For the spray unavailability to incrementally impact the containment failure probability, the event cannot be one in which both sprays would otherwise be inoperable (such as a station blackout). The contribution of the spray unavailability for a 7 day AOT, to the containment failure probability may be approximated by multiplying the PVNGS mean core damage frequency of 4.74×10^{-5} /yr. by the exposure time of 7 days (0.019 yr.) and the probability that the CS train fails in the next 24 hours (and is unable to deliver water to the Containment Spray header) is less than 0.01. Thus, the net incremental on containment failure during the AOT is less than 10^{-8}.

Question No. 4:

The AOT risk results presented in the submittal are based on the IPE models that generally analyze the progression of accidents for a mission time of 24 hours. This assumption can impact the AOT risk results for systems whose performance is needed beyond the IPE mission time (e.g. CS). Please address how the CE plant IPEs handled accident scenarios whose end states were judged to be "OK" at the end of the mission time but had a potential to challenge the reactor vessel and containment integrity.

Response:

The following points should be made. First, since all CSS components have been qualified for operation in a severe accident environment for at least 30 days following the onset of an accident, premature failure of the components due to harsh environments is not expected.

Second, the selection of a 24 hour mission time reflects a common assumption that the 24 hour time frame is sufficient to allow potential non-credited plant recovery actions. For example, in the case of the Palo Verde Units, unavailability of the CS pump (or other component) could be accommodated by repair of the failed CS train or replacement of the CS train removed for maintenance. In addition, Palo Verde also has the capability (not modeled) of realigning a LPSI pump to the CS line and using it for CHR.

Third, for plants with diverse CHR, containment challenges that persist for times greater than 24 hours are typically due to unavailability of power. Therefore, the outcome of the event would be the same regardless of the availability of CS.

Question No. 5:

In Section 5.2.1 (page 14, last sentence of the 1st paragraph), you referenced the administrative guidance, which requires the performance of risk assessment for PM maintenance. Please elaborate on the scope and nature of the risk assessment.

Response:

The risk assessment is to be performed in accordance with the Configuration Risk Management Program (CRMP). The key elements of the CRMP will be consistent with those required by the technical specification regulatory guidance. For the CSS the risk assessment will consider the status of the redundant spray capability and/or the availability of safety grade fan coolers. The risk impact of the maintenance action will be established via reference to either applicable pre-existing PSA assessments, a risk matrix, or an "On-Line" risk monitor.

Question No. 6:

In Section 5.2, you referenced LER # 94-005-01 (your references 13, page 67) which forced Palo Verde Unit 2 to shutdown due to inability to repair an MOV valve within the present AOT. The same LER is referenced in the HPSI submittal. Are you referencing the same valve? Please clarify.

Response:

Yes, the same valve is referenced. The point being made is that the repair time for a MOV (from the time the component is tagged INOPERABLE to the time it is tagged OPERABLE) can require more than 72 hours (the present AOT for most C-E PWRs).

Question No 7:

In Section 6.1, page 19, "Statement of Need" you state:

"Preventative maintenance of the CS components during 'at power' operation will reduce the maintenance burden during the shutdown and allow increased availability of shutdown significant components (SDC exchanger, CS pump as a backup for SDC) during lower mode plant operation."

This statement implies that the risk of mode 4 and 5 is high enough that it warrants four levels of redundancy for SDC pumping function (two LPSI pump and two CS pumps). If the proposed AOT extension is approved, are you implementing programmatic procedures to ensure availability of these four pumps during modes 4 and 5?

Response:

No formal program beyond the CRMP is proposed. However, during high risk modes of plant shutdown operation, (e.g. mid loop) the risk significance of this equipment will be considered prior to performing planned maintenance. It should be noted that for all plants with diverse heat removal capability, the small risk benefit associated with the added redundancy of using the spray pumps as backup to the SDC pumps, at the lower modes, more than compensates for the risk increase associated with the removal of a spray pump during power operation.

Question No. 8:

Your submittal highlights the unique design features of the CS system for Palo Verde units. As evident in the risk results reported in Tables 6.3.2-1 and 6.3.2-2, these design features are responsible for higher vulnerability of Palo Verde units to increase in unavailability of CS as a result of the new proposed AOT. The Single AOT risk for Palo Verde units (both PM and CM) exceeds the numerical guidelines of DG-1065. Please provide your rationale for including Palo Verde in the joint application.

Response:

Incremental single allowed outage time (AOT) risk and potential yearly increases in CDF associated with the AOT extension are acceptably low for all participants. For this application, entry into the AOT for a PM condition (maintenance performed in the absence of a non-random common cause condition) for the full 7 days results in an ICCDP (Incremental Conditional Core Damage Probability) variation from negligible to 8.86×10^{-7} [See Table 6.3.2.1 "Single AOT Risk (Based on Proposed AOT) for PM"]. Plants with negligible CDF increments are associated with diverse containment heat removal systems and SI pumps with the ability to pump saturated sump water. ANO-2 displays the greatest incremental Single AOT risk. This is due to a conservative assumption of an assumed dependency between the CSS and Containment Fan Cooler. Without this conservative assumption, it is expected that the incremental risk of the extended AOT for ANO-2 would be an order of magnitude less.

Palo Verde is noted to be the plant with the next greatest Conditional CDP increment (4.58×10^{-7}). This increase is due to a design difference between Palo Verde and the other units. The Palo Verde Units are designed typical of our more recent PWRs that rely on sprays alone for containment Heat removal (CHR). While these plants do not have CHR diversity, the plants are designed with the ability to use the plant LPSI pumps for containment cooling. Such procedures are in place at the Palo Verde Units. This results in increased system redundancy. Currently, the Palo Verde PRAs (even in the current update) **do not credit** these pumps as backup to the containment spray pumps (see Response to Question 12). Furthermore, it is expected that CSS maintenance at power will be short duration maintenance. This is reflected by the 24 hour mean expected PM downtime identified in Table 6.3.2-1 of the submittal.

In addition to the above, recent improvements to the Palo Verde PSA have resulted in many model changes which has the overall impact of decreasing the plant CDF by a factor of eight (8) and decreasing the importance of the CSS. The specific changes made to the Palo Verde PSA, important to the CSS include:

- Large LOCA IE frequency decreased by a factor of 5,
- Medium LOCA IE frequency decreased by a factor of 10
- Small LOCA IE frequency increased by a factor of 1.03,

The net contribution of these three changes is to decrease the overall plant CDF by more than a factor of 6. (Palo Verde will provide updated incremental conditional CDP values at the time of the Final Technical Specification Change Submittal.)

It should be noted that the above discussion centered upon the PM values reported in the report. The basis for using PM (rather than CM) values is that the CM calculations assume that a common mode failure has occurred (See Table 6.3.2-2). Common mode failures will be diagnosed early in the repair process (typically less than 24 hours). Therefore, the calculated risk impact of an extended AOT for repairing a component with a common mode failure is an artificial calculation and could not be realized in practice.

In conclusion, despite the physical differences among the C-E units, all C-E plants have acceptably low incremental risks, sufficient to support the request for this AOT extension. Furthermore, we believe that including plants with variations in specific design features strengthens the joint application submittal. A wide range of risk impact of the plant change is demonstrated and the AOT relaxation is justified in a robust manner for all CEOG members.

Question No. 9:

In Section 6.3.1, page 27, you state:

"For this evaluation, continuation of at power operation with the LCO ACTION statement is compared with the risk of proceeding with a plant shutdown. An estimate of this risk was evaluated by modifying the reactor trip core melt scenario for a representative CE NSSS PWR ...."

This statement implies that a ratio technique was employed to predict the transition risk for other CE plants. This observation contradicts the data presented in Table 6.3.3-1, page 47 of the submittal. In this table, the estimates of transition risk appear to be plant specific. Please address this apparent discrepancy.

Response:

The statement should be modified to note that where the values are provided in the table, they are plant specific. We expect the relative core damage probabilities associated with the mode transition to be on the order of 10^{-6} for plants where information was not provided.

Question No. 10:

Please describe the process of predicting the new average CDF based on the assumption of the new average unavailability of 0.022 per a single CS train (Section 6.3.2.3). In your response, please provide the following for each IPE:

- ***What is the baseline unavailability estimate assumed for a CS train?***
- ***Are there any cutsets in the master list of core damage cutsets that relate to the unavailability of CS due to maintenance?***
- ***How did you account for maintenance unavailability of the second CS train in the requantification process?***

Response:

The process used to calculate the new average CDF presented in Table 6.3.2-3 of the CSS report was to assume a generic and bounding proposed downtime of 192 hours per year per train, or greater if a plant had a higher proposed downtime specified in their plant specific Maintenance Rule Program (CS train unavailability target). The value of 192 hours equates to an unavailability of 0.022 (192 hrs/yr. 8760 hrs/yr.). From the table, several plants used a higher unavailability per train.

The generic bounding value of 192 hours was determined based on 24 hour downtime for corrective maintenance, and 168 hour (7 days) for preventative maintenance.

Each plant PRA then used the new value for unavailability <u>for both CS trains</u>, by changing the basic event for each CS train that represents "unavailability due to maintenance" to a value of 0.022 (or higher for plant specific cases) found in the plant cutsets. The cutsets representing unavailability due to maintenance basic events do not get truncated because maintenance basic events are preserved in the cutset generation by artificially setting them to a higher value so they will not be truncated. Thus the results are valid.

Note: the proposed downtime entries used in Tables 6.3.2-1 and 6.3.2-2 were based on plant specific Maintenance Rule targets and represent actual, not bounding values. These were presented in order to show the expected risks associated with the implementation of the extended AOT. The Single AOT risk is based on removal of the equipment from service for the full duration of the AOT. This condition is expected to be a rare occurrence for this component. In contrast, when calculating the resulting new average CDF for Table 6.3.2-3, a bounding approach was used and hence the proposed downtimes do not necessarily correlate with those cited in Tables 6.3.2-1 and 6.3.2-2.

Question No. 11:

In Section 6.3.2.4, page 36, the submittal justifies the high AOT risk of ANO-2 on the rigid success criterion assumed in the ANO-2 IPE. With respect to the CS system, the success criterion is the same for all CE plants. That is, one of the two trains needs to be functional. The AOT risk calculation analyzes the risk impact associated with the unavailability of one train of CS train. The AOT risk does not affect the assumptions of the IPE for the fan coolers. Therefore, the change in CDF should only reflect the change in CS unavailability. One plausible justification for this behavior is that the cutsets

related to containment systems failures were not truncated in the ANO-2 IPE. This is because ANO-2 IPE assumed a more rigid success criterion for containment cooling than other IPEs. Please address the affect of truncation on AOT risk results.

Response:

The issue was not associated with truncation, but rather a conservative assumption that required containment sprays to be operable in order for containment fan coolers to perform their safety function. Analyses of containment fan cooler capability were performed by representative C-E PWRs using the MAAP 3.0B computer code. These analyses confirm that following a severe accident, a single containment air recirculation cooler will provide adequate containment heat removal to avert containment overpressurization failure.

Question No. 12:

In Section 6.3.2.4, page 37, in discussing the interaction of CS system with the ECCS for Palo Verde, the submittal references the ability for ECCS recovery that was not credited in the IPE. Please elaborate further.

Response:

At Palo Verde, the CS and LPSI pumps can back each other up for either containment heat removal or the low pressure injection function. It is also possible to line up a cross-train flow path to allow the pump of one train to force flow through the opposite train's Shutdown Cooling Heat Exchanger. Since LPSI is not required for long-term core cooling, even if an entire train of ECCS and/or CS is unavailable, the opposite train LPSI can be aligned to supply CS flow. All of these contingencies are included in the Functional Recovery Procedure. None of these were modeled in the PRA.

Question No. 13:

In Table 6.3.4-2, submittal attempts to rationalize that a system with four levels of redundancy is more reliable that a system with three levels of redundancy. This concept can easily be conveyed qualitatively without a need to resort to building a simple model of shutdown operations that are complex in nature.

Response:

Agreed.

Question No. 14:

On page 11, you state that, "These studies (assuming that you mean the three IPE studies - your references 5, 6 & 7) demonstrate that containment protection can be provided with either one CS subtrain or one fan cooling unit." Do all the CEOG IPE

studies demonstrate this (with, of course, the exception of Palo Verde)? In this context, what do you mean by "containment protection"?
Is containment protection assured for Palo Verde with one CS subtrain?

Response:

MAAP computer code analyses performed for Palo Verde confirm that a single operational train of containment spray is sufficient to control containment pressure following a severe accident. MAAP analyses performed for the various CEOG utilities with diverse containment heat removal capabilities (i.e., containment sprays and safety grade containment fan coolers) likewise confirm that containment integrity will be protected provided either a single train of the containment spray system or a single emergency grade fan cooler is operational. This conclusion is considered generic and is applicable to all C-E PWRs. Thus, overpressure containment failure is averted when either one subtrain of the CS system or one safety grade fan cooler is operable. Overpressure containment failure is averted when the containment pressure remains well below the ultimate strength of the containment. In responding to a severe accident containment pressures above the containment design level are possible.

Attachment C

Revised Topical Report Pages

(Pgs. i, 1, 4, 59 – 65)

EXECUTIVE SUMMARY

In response to the NRC's initiative to improve plant safety by developing risk-informed technical specifications, the CEOG has undertaken a program for defining and obtaining risk informed technical specification modifications. As part of this program, several technical specification AOTs, STIs and ACTION STATEMENTS were identified for joint action.

This report provides support for modifying Technical Specifications concerning the Containment Spray System (CSS) and Low Pressure Safety Injection System (LPSI) in order to provide an AOT for up to 7 days for one "INOPERABLE" CSS train. The intent of this AOT extension is to enhance overall plant safety by avoiding potential unscheduled plant shutdowns and allowing greater availability of safety significant components during shutdown. In addition, this extension provides for increased flexibility in scheduling and performing maintenance and surveillance activities. Additionally, this report proposes modifications to the CSS and LPSI ACTION STATEMENTS. This is intended to enhance plant safety and operational flexibility during lower modes of operation.

Generic information supporting these changes, as well as the necessary plant specific information to demonstrate the impact of these changes on an individual plant basis are provided. All CE NSSS plants are participating in this activity; and all CEOG members consider the supporting/analytical material contained within this document to be applicable to all CEOG member utilities regardless of the category of their Plant Technical Specifications. Relevant plant-specific differences or exceptions are noted within the report.

Risk assessments provided in this report are based upon plant-specific PSA models that reflect the respective plant configuration during normal operation.

Justification of the requested modifications to Technical Specifications is based on an integrated review and assessment of: a) plant operations, b) deterministic/design basis factors and c) plant risk. Results of this study demonstrate that the proposed AOT extension provides plant operational flexibility with negligible impacts on overall yearly plant risk in all cases.

The proposed increase in the Containment Spray System AOT to 7 days was evaluated from the perspective of various risks associated with plant operation. For the evaluated plants, incorporation of the extended AOT into the technical specifications will result in negligible increases in the "at power" risk.

Based on considerations of transition risk, use of the extended AOT for on-line maintenance of a CSS train is risk beneficial to the plant for both corrective maintenance situations including both random and non-random equipment failures.

An assessment of Level 2 PSA issues indicates that the unavailability of one CSS train does not significantly impact the three classes of events that give rise to large early releases. These include: a) containment bypass sequences, b) severe accidents accompanied by loss of containment isolation and c) containment failure due to energetic events in the containment. Any decrease in availability of the CSS that might result from the requested technical specification modifications would result in a negligible impact on the large early release probability for CE NSSS PWRs.

Modifications To The Containment Spray System, and Low Pressure Injection System Technical Specifications

1.0 PURPOSE

This report provides an evaluation of proposed modifications to Technical Specifications for the systems and components associated with Containment Spray (CS), Shutdown Cooling (SDC), and Low Pressure Safety Injection (LPSI) systems. The proposed modifications include changes to allowed outage times for the CS system and changes to the required actions corresponding to specific conditions for both the CS and LPSI systems. A companion AOT extension request for the LPSI Technical Specification was previously requested by the CEOG in Reference 1. Each of the proposed modifications is described in the following section.

The proposed AOT extension is consistent with the objectives and intent of the Maintenance Rule (Reference 2). The Maintenance Rule will be the means to control the actual maintenance cycle by defining unavailability performance criteria and assessing maintenance risk.

2.0 SCOPE OF PROPOSED CHANGES TO TECHNICAL SPECIFICATION

Specifically, the proposed modifications that will be addressed are the following:

1. **Extension of the present Allowed Outage Time (AOT) to a maximum of 7 days for conditions that include an inoperable Containment Spray train (including a Shutdown Cooling Heat Exchanger) while other containment spray and containment cooling trains remain OPERABLE during either Mode 1, 2 or 3.**

The proposed AOT extension will provide needed flexibility in the performance of both corrective and preventive maintenance of Containment Spray System (CSS) components during power operation. For CE PWRs with diverse containment heat removal capability maintenance of this system "at power" poses a negligible plant risk. Furthermore, since CSS components are utilized in configuring the Shutdown Cooling System (SDC), maintenance of the CSS "at power" may also increase the availability of SDC System and associated backup components during shutdown.

The design of each of the Palo Verde Units rely entirely on the containment spray system for both containment heat removal and post accident iodine removal. For these units, the primary intent of the AOT extension is to provide adequate time for corrective maintenance situations. This proposed AOT extension results in a small acceptable incremental risk which is offset by avoidance of unscheduled plant transitions.

The technical justifications for this proposed modification are discussed in Section 6.0 of this report.

3.0 BACKGROUND

In response to the NRC's initiative to improve plant safety by developing risk-informed technical specifications, the CEOG has undertaken a program for defining and obtaining risk informed technical specification modifications. As part of this program, several technical specification modifications, involving AOTs, Surveillance Test Intervals (STIs) and specific ACTIONS were identified for joint application.

A previous CEOG joint application submittal supported a request for the extension of the AOT for LPSIS (Reference 1) to seven days. This report provides support for specific modifications of the Technical Specifications governing the Containment Spray (CS), and Low Pressure Safety Injection (LPSI) systems. These modifications include an extension of the CSS AOT and modifications to the CSS and LPSIS ACTION STATEMENT end states. The intent of the proposed CSS AOT extension is to enhance overall plant safety by: a) avoiding potential unscheduled plant shutdowns, b) minimizing plant transitions and c) providing for increased flexibility in scheduling and performing maintenance and surveillance activities. Additionally, this report justifies specific modifications to the CSS and ECCS Technical Specifications ACTION STATEMENTS for conditions where the COMPLETION TIME for the LPSIS and CSS have been exceeded. The report also provides justifications for specific modifications to ACTION STATEMENTS for conditions that include either INOPERABLE redundant Containment Spray Trains or INOPERABLE redundant LPSI subsystem trains. These later changes enhance plant safety by defining MODE 4 as an acceptable and preferred end state for the respective ACTION STATEMENTS. Mode 4 operation provides a diverse and redundant means for RCS heat removal. Required entry into lower mode operation with an INOPERABLE LPSI and/or CS systems may result in the undesirable consequence of MODE 5 operation with less than fully functional SDC systems.

This report provides generic information supporting these changes, as well as the necessary plant specific information to demonstrate the impact of these changes on an individual plant basis. All CEOG members consider the supporting/analytical material contained within the document to be applicable to their respective member utilities regardless of the category of their Plant Technical Specifications.

Risk assessments provided in this report are based on plant PSA models that adequately reflects the respective plant configuration during normal operation.

7.0 TECHNICAL JUSTIFICATIONS FOR OTHER MODIFICATIONS TO THE TECHNICAL SPECIFICATIONS

7.1 STI Extensions

The scope of this report does not include proposed extensions of any STI in Technical Specifications.

7.2 LCO Required Actions and Completion Times

7.2.1 LCO Required Actions and Completion Times Concerning One Inoperable Containment Spray Train (with or without credit for use in containment iodine removal)

As discussed in Section 2.0 of this report, this proposed modification consists of the following Required Action when the AOT for the condition of a single inoperable Containment Spray train in either Mode 1, 2 or 3 (other Containment Spray and Containment Cooling trains remain OPERABLE) has been exceeded:

A) Transition plant to Mode 4 within 12 hours.

This contrasts with Required Action F.2 of NUREG-1432 LCO 3.6.6A and Required Action G.2 of NUREG-1432 LCO 3.6.6B which direct transition to MODE 3 in 6 hours and MODE 5 within 36 hours

The intent of these proposed modifications is to allow continued operation in Mode 4 rather than Mode 5 during the repairs that are limited to the repair of the inoperable containment spray train.

With every plant transition from Mode 4 to Mode 5, there is an expected future transition from Mode 5 to Mode 4 with the inherent re-start surveillance requirements for LCO verification. If a Mode transition to Mode 5 is made solely for the repair of the system trains associated with the proposed modifications, the extensive surveillance testing needed to reenter Mode 4 would increase the potential for human errors and direct resources that could have remained available for more safety-significant uses.

Additionally, continued operation in Mode 4 result in maintaining more diverse OPERABLE safety systems for core heat removal and containment integrity in a higher state of OPERABILITY.

If the inoperability of the affected containment spray train is the result of an inoperable shutdown cooling heat exchanger, existing Standard Technical Specifications, acknowledge that steam generators must remain as viable heat sinks during transition to Mode 5 and while in Mode 5 (From NUREG-0212: the combination of LCO 3.0.4 and LCO 3.4.1.4.1. From NUREG-1432, the combination of LCO 3.0.4 and LCO 3.4.7). With such conditions, the manual control of steam generators by plant operators is facilitated by remaining at Mode 4 temperatures rather than entry into Mode 5.

Additionally, with continued operation in Mode 4, reactor coolant temperatures can be maintained above temperatures requiring Low Temperature Over Pressure Protection (LTOP). The lack of a need for LTOP would result in fewer required entries into containment and a consequential reduction in radiation exposure. The lack of a need for LTOP during system repairs would also result in a reduction in the number of potential challenges to LTOP relief valves during the lifetime of the subject plant and a corresponding reduction in the potential for small LOCAs under shutdown cooling conditions.

7.2.2 LCO Required Actions and Completion Times Concerning One INOPERABLE ECCS Train Due To INOPERABLE LPSI subtrain

As discussed in Section 2.0 of this report, this modification consists of the following Required Actions when the AOT for a single inoperable ECCS train due to an inoperable LPSI subtrain in either Mode 1, 2 or 3 has been exceeded.

A) Transition to Mode 3 within 6 hours
B) Transition below a specific reactor coolant system pressure within 12 hours (while remaining in either Mode 3 or Mode 4)

Plant operation in Mode 3 at low pressure is anticipated to result in a lower exposure of the plant to LOCAs (Reference 29). Hence, many Technical Specifications already relax the definition of an OPERABLE ECCS train during Mode 4 and 5 to a single HPSI train. The specific intent of these proposed modifications is to allow continued operation at RCS temperatures greater than those of Mode 5 during the repairs that are limited to the repair of the inoperable Low Pressure Safety Injection train.

With every plant transition from Mode 4 to Mode 5, there is an expected future transition from Mode 5 to Mode 4 with the inherent re-start surveillance requirements for LCO verification. If a Mode transition to Mode 5 is made solely for the repair of the system trains associated with the proposed modifications, the extensive surveillance testing needed to reenter Mode 4 would increase the potential for human errors and direct resources that could have remained available for more safety-significant uses.

Additionally, continued operation in Mode 4 would result in maintaining more diverse OPERABLE safety system for core heat removal and containment integrity.

If the inoperability of the affected LPSI subtrain results in an inoperable shutdown cooling system (as would be the case with an inoperable LPSI pump), existing Standard Technical Specifications acknowledge that steam generators must remain as viable heat sinks during transition to Mode 5 and while in Mode 5 (From NUREG-0212: the combination of LCO 3.0.4 and LCO 3.4.1.4.1. From NUREG-1432, the combination of LCO 3.0.4 and LCO 3.4.7). With such conditions, the manual control of steam generators by plant operators would be facilitated by remaining at Mode 4 temperatures rather than entry into Mode 5.

Additionally, the proposed modifications are consistent with Required Actions B.1 and B.2 for LCO 3.5.2 in NUREG-1432.

7.2.3 LCO Required Actions and Completion Times Concerning Conditions that Include Two INOPERABLE Containment Spray Trains

The Standard Technical Specifications requirements of NUREG-0212 and NUREG-1432 distinguish between containment spray systems that are credited in containment iodine removal and containment spray systems that are not credited in containment iodine removal. In both sets of generic Standard Technical Specifications, the required actions for recovery from INOPERABLE containment spray systems that are not credited for iodine removal are less stringent than the requirements for containment spray systems that are credited for iodine removal.

Specifically, for designs that do not credit containment spray in containment iodine removal, the standard technical specifications provide an allowed outage time of 72 hours in the existing MODE for recovery from these conditions. In contrast, the standard technical specification requirements for this condition for the other plants, require the immediate start of preparations for plant shutdown.

The proposed modifications to Required Actions and Completion times that are discussed in this section would effectively modify the following requirements from NUREG-1432:

A) Containment Spray credited in Containment Iodine Removal: NUREG 1432 LCO 3.6.6A Required Action E.1 (Proposed modification effectively replaces this required action and its completion time).

B) Containment Spray not credited in Containment Iodine Removal: NUREG-1432 LCO 3.6.6B Combination of Required Action E.1, Required Action G.1, and Required Action G.2. (Proposed modification effectively replaces the Required Actions G.1 and G.2 upon the expiration of the existing plant-specific allowed outage time for this condition.)

These Required Actions and Completion Times have the following contrasts with the corresponding implementation of LCO 3.0.3 that is directed in Required Action E of NUREG-1432 LCO 3.6.6A:

Rather than requiring transition to MODE 5 as is stated in LCO 3.0.3, MODE 4 is proposed as an acceptable MODE for recovery and repair of one or both of the inoperable containment spray trains

These Required Actions and Completion Times have the following contrasts with Required Actions G.1 and G.2 of NUREG-1432 LCO 3.6.6B:

Rather than requiring transition to MODE 5 as is stated in LCO 3.0.3, MODE 4 is proposed as an acceptable MODE for recovery and repair of one or both of the containment spray trains

These proposed modifications provide recommended technical specification required actions that provide flexibility for continued power operation in Mode 4.

Maintaining the plant in Mode 4 averts risks associated with transitioning to Mode 5 requiring LTOP.

For all units, the flexibility for continued operation in Mode 4 also allows the plant to remain in a state where the diversity of core heat removal success paths results in a smaller contribution to risk of core damage than would be the case if the same repairs were conducted at Mode 5 conditions. In fact, in the cases where the inoperable containment spray trains result in the inoperability of both shutdown cooling trains, existing Standard Technical Specifications require that the plant remain in Mode 4 until the OPERABILITY of one shutdown cooling train is restored (From NUREG-0212: the combination of LCO 3.0.4 and LCO 3.4.1.4.1. From NUREG-1432, the combination of LCO 3.0.4 and LCO 3.4.7).

Extended Mode 4 operation maintains the plant in a more controlled state which will result in a lower potential for human errors and which would require fewer surveillance evolutions during a return to power operation.

7.2.4 LCO Required Actions and Completion Times Concerning Conditions That Include Two INOPERABLE ECCS Trains Due To Only INOPERABLE LPSI subtrains

As discussed in Section 2.0 of this report, the proposed modification consists of the following Required Actions and Completion Times for two inoperable ECCS trains due to inoperable LPSI subtrains in either Mode 1, 2 or 3. The intent of this modification is to provide flexibility for continued operation in Mode 3 at relatively low RCS pressure or Mode 4.

The basis for extended Mode 4 operation under these conditions is the same as that provided in support of a similar modification request for two CSS trains INOPERABLE (Section 7.2.3). As with the previous discussion, this Technical Specification modification enhances plant safety.

The flexibility for continued operation in either Mode 3 below a specific pressure or Mode 4 allows the plant to remain in a state where the diversity of core heat removal success paths results in a smaller contribution to risk of core damage than would be the case if the same repairs were conducted at Mode 5 conditions. This is particularly consistent with the Standard Technical Specification requirements that address cases where both shutdown cooling trains are rendered inoperable due to inoperable LPSI subtrains (which could be the case with multiple inoperable LPSI pumps). In such cases, the existing Standard Technical Specifications prohibit a transition from Mode 4 to Mode 5 before at least one of the Shutdown Cooling trains is restored to an OPERABLE condition.

8.0 PROPOSED MODIFICATIONS TO NUREG-1432

Attachment A includes a "mark-up" of the sections of NUREG-1432 corresponding to these proposed changes and cumulative recommendations of previously submitted Joint Application Reports.

9.0 SUMMARY AND CONCLUSIONS

This report provides the results of an evaluation of the extension of the Allowed Outage Time (AOT) for a single Containment Spray System (CSS) Train contained within the current CE plant technical specifications, from its present value, to seven days. This AOT extension is sought to provide needed flexibility in the performance of both corrective and preventive maintenance during power operation. Justification of this request was based on an integrated review and assessment of plant operations, deterministic/design basis factors and plant risk. Results of this study demonstrate that the proposed AOT extension provides plant operational flexibility while simultaneously reducing overall plant risk.

The proposed increase in the CSS AOT to 7 days was evaluated from the perspective of various risks associated with plant operation. For the plants evaluated, incorporation of the extended AOT into the technical specifications potentially results in negligible increases in the "at power" risk. However, when the full scope of plant risk is considered the risks incurred by extending the AOT for either corrective or preventive maintenance will be substantially offset by associated plant benefits associated with avoiding unnecessary plant transitions and/or by reducing risks during plant shutdown operations and/or implementing the appropriate contingency actions.

The unavailability of one train of CSS was found to not significantly impact the three classes of events that give rise to large early releases. These include: a) containment bypass sequences, b) severe accidents accompanied by loss of containment isolation and c) containment failure due to energetic events in the containment. It is concluded that increased unavailability of the CSS (as requested via Section 2) will result in a negligible impact on the large early release probability for CE PWRs.

The impact of CSS train unavailability on long term containment integrity was also evaluated. For CE plants with diverse containment heat removal systems the impact of CSS train unavailability on containment failure probability was negligible. For Palo Verde Units 1, 2 and 3, which does not include diverse containment heat removal capability, increased unavailability of the CS can results in a small incremental risk of long term containment failure.

This report also requests modifications to several CSS and LPSI ACTION STATEMENTS which redefine Mode 4 as acceptable end states following conditions in which either the both CSS or LPSI subtrains are individually unavailable or when their respective LCO COMPLETION TIME is violated. For all units, continued operation in Mode 4 allows the plant to remain in a state where the diversity of core heat removal success paths results in a smaller contribution to risk of core damage than would be the case if the same repairs were conducted at Mode 5 conditions. Furthermore, extended Mode 4 operation maintains the plant in a state which reduces the probability of human error due to fewer surveillance tests. Thus, considerations of safety and economy both support the technical specification modification for extended Mode 4 operation.