AREVA

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Washington, D.C. 20555-0001

Response to U.S. EPR Design Certification Application RAI No. 197

Ref. 1: E-mail, Getachew Tesfaye (NRC) to Ronda Pederson, et al (AREVA NP Inc.), "U.S. EPR Design Certification Application RAI No. 197 (2202), FSAR Ch. 19," March 11, 2009.

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 197 Response US EPR DC.pdf" provides technically correct and complete responses to 9 of the 10 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 197 Questions 19-274, 19-277, 19-279, 19-281, 19-282 and 19-283.

The following table indicates the respective pages in the response document, "RAI 197 Response US EPR DC.pdf" that contain AREVA NP's response to the subject questions.

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RAI 197 — 19-274	2	4
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A complete answer is not provided for 1 of the 10 questions. The schedule for a technically correct and complete response to this question is provided below.

Question #	Response Date
RAI 197 — 19-275	May 15, 2009

D077
NRO

AREVA NP INC.
An AREVA and Siemens company

3315 Old Forest Road, P.O. Box 10935, Lynchburg, VA 24506-0935
Tel. (434) 832-3000 - Fax: (434) 832-3840

If you have any questions related to this submittal, please contact me at 434-832-2369 or by e-mail at sandra.sloan@areva.com

Sincerely,

Sandra M. Sloan

Sandra M. Sloan, Manager
New Plants Regulatory Affairs
AREVA NP Inc.

Enclosures

cc: G. Tesfaye
Docket No. 52-020

AFFIDAVIT

COMMONWEALTH OF VIRGINIA)
) ss.
COUNTY OF CAMPBELL)

1. My name is Sandra M. Sloan. I am Manager, New Plant Regulatory Affairs for AREVA NP Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA NP to determine whether certain AREVA NP information is proprietary. I am familiar with the policies established by AREVA NP to ensure the proper application of these criteria.

3. I am familiar with the AREVA NP information contained in "Response to U.S. EPR Design Certification Application RAI No. 197" and referred to herein as "Document." Information contained in this Document has been classified by AREVA NP as proprietary in accordance with the policies established by AREVA NP for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA NP and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information".

6. The following criteria are customarily applied by AREVA NP to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA NP's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA NP.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA NP in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA NP, would be helpful to competitors to AREVA NP, and would likely cause substantial harm to the competitive position of AREVA NP.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b) and 6(c) above.

7. In accordance with AREVA NP's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside AREVA NP only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA NP policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Sandra M. Sloan

SUBSCRIBED before me this 10th

day of April, 2009.

Kathleen A. Bennett

Kathleen A. Bennett
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 8/31/2011

KATHLEEN ANN BENNETT
Notary Public
Commonwealth of Virginia
110264
My Commission Expires Aug 31, 2011

Response to

Request for Additional Information No. 197 (2202), Revision 0

03/11/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation
Application Section: 19

QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 1
(AP1000/EPR Projects) (SPLA)

Question 19-274:

(Follow-up to Question 19-39) The response to Question 10.04.09-1 describes a design change to maintain the emergency feedwater system (EFWS) supply header isolation valves closed during operation, but does not evaluate the effect of this change on the probabilistic risk assessment (PRA). The staff observes that the interconnection of the EFWS headers is implicit in the "EFW PBF" top event (described in the response to Question 19-39) and contributes to the relative importance of the EFWS tanks in the PRA. Evaluate the effect of the design change on the PRA results and insights and either incorporate it in the PRA or discuss it in Section 19.1.2.4 of the Final Safety Analysis Report (FSAR).

Response to Question 19-274:

The impact on the PRA of the design change which maintains the EFWS supply header isolation valves closed is summarized below:

- If one or more EFW train is unavailable, a manual action would be required to interconnect the four EFW tanks to make the entire EFW inventory available. As discussed in the response to Question 19-39, PRA success criteria require the inventory of the four EFW tanks for a 24-hour mission time.
- In case of a pipe break or a tank leakage in the EFWS (internal flooding), the operators no longer have to isolate the leaking train to avoid losing all EFW inventory because the header valves are already closed. However, one tank inventory may still be lost and it would be necessary to refill one of the intact tanks in order to achieve the 24-hour mission time.

A sensitivity case is performed to assess the impact of this change on the PRA results and insights. The "EFW PBF" top event currently models only a pressure boundary failure of the EFWS. In that sensitivity case, this top event is re-defined to include the need for tank interconnection if one or more EFW train is unavailable. Two modeling cases are defined depending on the pressure boundary integrity:

(1) If one (or more) EFW trains are unavailable for reasons other than a pressure boundary failure, a simple tank interconnection is required. Operator error "OPF-EFW-6H" is defined as the failure to interconnect the tanks following the loss of one EFW train. This is a local action, performed from each of the four Safeguard Buildings, a short distance from the control room. This is a simple action, for which expansive time is available (6 hours). The calculated human error probability (HEP) for this action is 2E-5.

(2) If one EFW train is unavailable due to a pressure boundary failure, tank interconnection is not desirable and the available tank(s) should be refilled instead. The demineralized water distribution system (DWDS) or the fire water distribution system (FWDS) both can be used for that purpose. Operator error "OPF-EFW RF-6H" is defined as the failure to initiate tank refill. The same time is available (6 hours) but this action has increased stress and complexity due to multiple cues. The calculated HEP is 8E-4.

Operator failure to perform any of those two actions is assumed to result in a long-term failure of the EFWS due to insufficient water inventory, eventually requiring feed and bleed cooling. The dependency between failure to initiate feed and bleed and prior failure to interconnect or refill the tanks is assessed. Based on a similar crew, different time, different location and additional cues, a low level of dependency is selected.

Table 19-274-1 summarizes the modeling and human reliability analysis differences between having the valves open or closed.

The results of this sensitivity case are shown in Table 19-274-2. Total CDF increases by 5 percent, driven by a rise in internal event and flooding core damage frequency (CDF). The following PRA insights also can be drawn from this design change.

The rise in internal event and flooding CDF can be explained by the increase in CDF from two specific initiating events: loss of balance of plant (LBOP) and flood in Turbine Building. These two initiating events result in a loss of both main feedwater and startup and shutdown systems. With the EFW header valves initially closed, any EFWS train failure requires an operator action to mitigate these events.

Even though the overall internal flooding CDF increases by about 9 percent (driven by the Turbine Building flood), CDF from the EFW break scenario decreases as a result of this design change, from 7.2E-09/yr to 5.1E-09/yr. This is because there is no longer a need for isolating the break.

The following changes will be made to the U.S. EPR FSAR:

Section 19.1.2.4 of the Final Safety Analysis Report (FSAR) will be updated as follows:

- EFWS supply header isolation valves – This design change consists of maintaining the EFWS supply header isolation valves closed. If one or more EFW train is unavailable, a manual action is required to interconnect the four tanks, so that the entire EFW inventory is available. In case of a pipe break or a tank leakage in the EFWS (internal flooding), the operators no longer have to isolate the leaking train to avoid losing all EFW inventory. One tank inventory may still be lost; therefore, it is necessary to refill one of the intact tanks in order to achieve the 24-hour mission time.

- This change results in a measurable increase in internal event and internal flooding CDF, driven by operator failure to perform the interconnection. PRA insights and assumptions regarding manual isolation of an EFWS pressure boundary failure are also affected, as this isolation is no longer needed. This effect is recognized in U.S. EPR FSAR Tier 2, Table 19.1-108 Item 10, and Table 19.1-109 Item 66.

Table 19.1-108, Item 10 will be updated as follows:

> "The severity of a flooding event from an EFW tank leak or pipe break will be reduced as a result of the design change identified in Section 19.1.2.4, which maintains the EFW suction header isolation valves closed. Manual isolation of an EFW tank leak or pipe break will not be necessary."

Table 19.1-109, Item 66 will be updated as follows:

> "The severity of a flooding event from an EFW tank leak or pipe break will be reduced as a result of the design change identified in Section 19.1.2.4, which maintains the EFW suction header isolation valves closed. Manual isolation of an EFW tank leak or pipe break will not be necessary."

Table 19-274-1

Effect of EFW Header Valve Design Change in Accident Sequence Modeling

	EFW Header valves initially OPEN	**EFW Header valves initially CLOSED**
Response to the loss of 1 EFW train	Not required	Interconnection in 6 hours OPF-EFW-6H (2E-5)
Response to a pressure boundary failure	Isolation in 1 hour OPF-EFW-1H (4E-2)	Tank refill in 6 hours OPF-EFW RF-6H (8E-4)
Feed and Bleed following depletion of EFW inventory	Dependent action on OPF-EFW-1H OPD-FB-90M (0.05)	Dependent action on OPF-EFW-6H and on OPF-EFW RF-6H OPD-FB-90M (0.05)

Table 19-274-2

Results of the Sensitivity Case with EFW Header Valves Initially Closed

Hazard Group	**Base Case CDF (1/yr)**	**Sensitivity Case CDF (1/yr)**	**Delta CDF**
Internal Events	2.9E-07	3.1E-07	6%
Internal Fires	1.8E-07	1.8E-07	1%
Internal Flooding	6.1E-08	6.7E-08	9%
Total	5.3E-07	5.5E-07	5%

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 19.1.2.4, Table 19.1-108 and Table 19.1-109 will be revised as described in the response and indicated on the enclosed markup.

Question 19-275:

(Follow-up to Question 19-158) The new FSAR Section 19.1.6.3.1.4 provided with the response to Question 19-158 states that "the ability to close the hatch is credited" and that "the habitability of the containment (i.e., local temperature no higher than 122°F) is considered to be the most limiting criterion in determining the time available to close the hatch." This assumption is inconsistent with the outage guidelines in NUMARC 91-06, guideline 4.1.1(3), and item 15 in FSAR Table 19.1-8, which state that containment should be closed prior to steaming. The staff requests additional information to clarify the containment closure assumptions.

a. In FSAR Section 19.1.6.3.1.4, document the time to core boiling for plant operating state (POS) CA and CB (based on the outage schedule assumed in the shutdown PRA).

b. Revise and document in the FSAR the probabilities of the operator failing to close containment based on the time available for closure prior to steaming inside containment.

Response to Question 19-275:

A response to this question will be provided by May 15, 2009.

Question 19-276:

(Follow-up to Question 19-158) The new FSAR Section 19.1.6.3.1.2 provided with the response to Question 19-158 states that "[t]he primary system is considered pressurized in states CA and CB"; however, FSAR Table 19.1-87 indicates that the reactor coolant system (RCS) is vented in POS CB. The RCS vent could be large enough to preclude significant RCS re-pressurization given a complete loss of decay heat removal. Discuss the impact of the RCS vent in POS CB on the Level 2 shutdown analysis, and revise the PRA and/or FSAR as appropriate.

Response to Question 19-276:

The RCS openings during plant operating state (POS) CB are considered to reduce the degree of RCS repressurization given a loss of decay heat removal, but not to prevent it, because either they are not large enough or they have flow restrictors. Even though the RCS is identified as vented in U.S. EPR FSAR Tier 2, Table 19.1-87, RCS repressurization is considered in the shutdown Level 1 analysis.

In the shutdown Level 2 analysis, performed in support of the response to Question 19-158, supporting MAAP analyses show significant RCS repressurization in this POS; therefore, initiating events during POS CB are assumed to cause RCS repressurization. This is conservative because of the increased severity of core melts at high pressure. In general, depressurization is considered beneficial because it precludes high pressure RCS ruptures such as induced steam generator tube rupture, direct containment heating or vessel rocketing.

During POS CB, a complete loss of residual heat removal (RHR) could lead to RCS repressurization. While the extent of that repressurization could vary under different plant conditions, the assumption that the RCS is pressurized is conservative.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 19-277:

(Follow-up to Question 19-158) Revised FSAR Section 19.1.6.3.3.4, provided in response to Question 19-158, states that the passive autocatalytic recombiners (PAR) are used for control of hydrogen and oxygen following a severe accident at shutdown. FSAR Table 19.1-23 states that operation of the PARs is "implicitly assumed." Discuss whether this assumption applies to the Level 2 shutdown PRA as well, or whether failures of the PARs are modeled. If the PARs are assumed not to fail, discuss the availability controls that ensure they will function when needed (e.g., not be disabled by a protective covering while maintenance is done in containment). As appropriate, include the importance of the PARs as a risk insight in the FSAR.

Response to Question 19-277:

In the shutdown Level 2 PRA a 100 percent availability of the PARs is assumed for containment failure probabilities calculation. The scenarios leading to partial unavailability of the PARs are described in the following discussion and the impact of low PAR availability on the shutdown Level 2 PRA is discussed.

The probabilities of containment failures due to hydrogen loads are either unchanged or slightly increased under certain conditions with partial availability of the PARs. However, the overall increase in the shutdown large release frequency (LRF) does not exceed 4 percent under the most limiting condition of very low availability of the PARs.

PARs Availability:

Several scenarios can lead to a fraction of the PARs being unavailable during an accident, when the release of hydrogen is the highest. During shutdown, the following cases can lead to a reduced PARs inventory at the beginning of the accident scenario:

- Scheduled maintenance; PARs plates removed, or
- PARs disabled during containment maintenance (e.g. protective covering during maintenance).

Scheduled Maintenance on PARs:

It is expected that no more than three catalytic plates from 20–25 percent of the PARs would be removed for maintenance. There are six small PARS containing several hundred plates and 41 large containing more than a thousand plates. The maximum expected unavailability resulting from such maintenance is less than 5 percent of the total catalytic plates during shutdown. Such a low unavailability is judged to have negligible impact on recombiner efficiency.

PARs Disabled due to Containment Maintenance:

The shutdown Level 2 PRA did not assume that PARs could be partially disabled during containment maintenance due, for example, to a protective covering. Because there are multiple PARs units installed at different locations inside the containment, simultaneous unavailability of multiple PARs due to containment maintenance is judged unlikely and is not

modeled in the PRA. The following assumption will be added to U.S. EPR FSAR Tier 2, Table 19.1-109:

> "The efficiency of the Passive Autocatalytic Recombiners (PAR) during shutdown is assumed to be nominal. Maintenance unavailability, if any, is assumed to be limited to a small fraction of the PARs and would not affect the overall efficiency of the system."

Impact of the PARs Availability on the Shutdown Level 2 PRA:

Deflagration Loads

Two scenarios were chosen to illustrate the impact of PARs availability. MAAP case Ca_4_1c is representative of a transient in state Ca and Ca_4_3 is representative of a loss of coolant accident (LOCA) in state Ca. Both cases were run with 100 percent, 75 percent and 50 percent PARs availability, as shown in Figures 19-277-1 and 19-277-2.

MAAP cases with 75 percent and 50 percent PARs availability show higher quantities of hydrogen in containment than the shutdown base cases with 100 percent PARs availability. These higher quantities are bounded by the mass of hydrogen used in the shutdown Level 2 PRA for the following reasons:

- With 50 percent PARs availability, the maximum quantities of hydrogen present in the containment for transient and LOCA cases are about 700 and 600 kg respectively, as seen in Figures 19-277-1 and 19-277-2.
- The Hydrogen mass of 940 kg used for deflagration load calculations in the shutdown Level 2 analysis was derived following the full power methodology. The full power study considered a bounding range of Zircaloy oxidation between 48 percent and 82 percent and, on the basis of the 82 percent upper bound, assumed a maximum mass of Hydrogen in containment. On this same basis of 82 percent upper bound, the assumed peak mass of hydrogen in containment at shutdown is 940 kg.

The containment failure probabilities following hydrogen deflagration loads derived in the shutdown Level 2 are unchanged in the case of partial unavailability of the PARs.

Flame Acceleration Loads

The probability of containment failure following flame acceleration loads is the product of multiple partial probabilities. One of these is the probability of ignition during the period of high concentration, which relates to the duration of the flame susceptibility period and is impacted by the availability of the PARs.

To account for lower availability of the PARs, the initial probability of ignition (calculated with 100 percent PARs available) is scaled to the longer duration of hydrogen concentration above the flame acceleration limit.

Increasing the partial probability of ignition from 0.86, the value used in the shutdown Level 2 PRA, to 1 (reflecting the maximum value possible with no PARS available) leads to an increase

of the containment failure probability during the in-vessel period of 16.3 percent and an increase in the shutdown LRF of 3.3 percent.

The initial values of the shutdown LRF and the early containment failure due to hydrogen flame acceleration are respectively reported in U.S. EPR FSAR Tier 2, Table 19.1-122 and Table 19.1-122.

The sensitivity calculation presented in this discussion demonstrated that the impact of the PARs availability on the LRF is not significant. Very low availability of the PARs can lead to an increase of less than 4 percent in the shutdown LRF.

Figure 19-277-1

Hydrogen Mass in Containment for Transient Case Ca4_1c

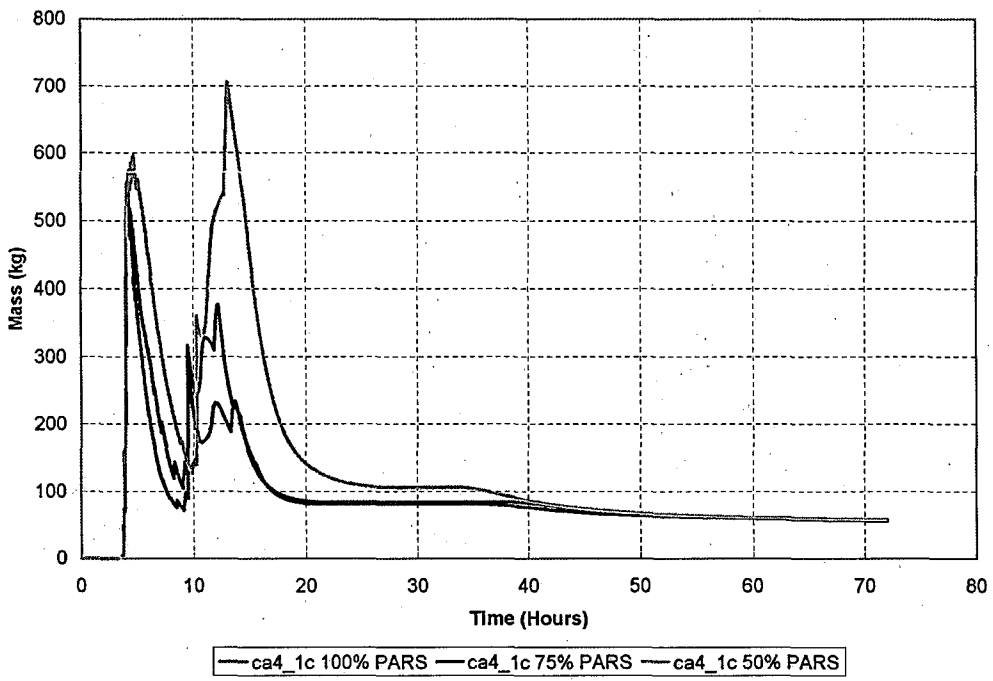
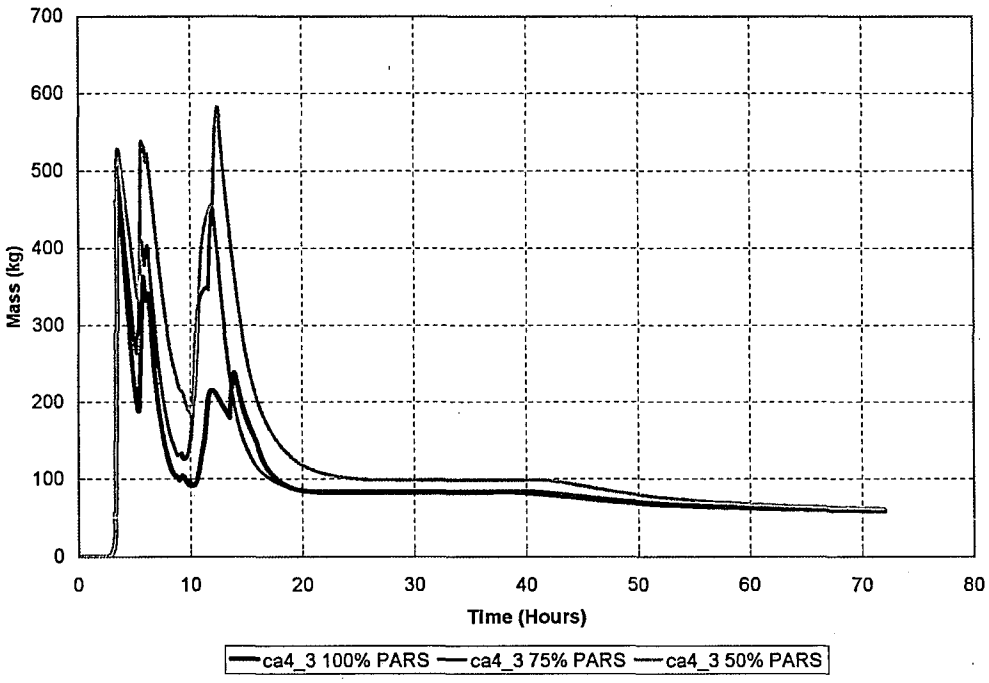


Figure 19-277-2

Hydrogen Mass in Containment for LOCA case Ca4_3



FSAR Impact:

U.S. EPR FSAR Tier 2, Table 19.1-109 will be revised as described in the response and indicated on the enclosed markup.

Question 19-278:

(Follow-up to Question 19-162) In response to Question 19-162, FSAR descriptions of emergency diesel generator (EDG) and station blackout diesel generator (SBODG) diversity were revised. The staff needs additional information related to this diversity assumption to conclude that the PRA treatment of the EDGs and SBODGs is appropriate. Specifically:

a. Since that response, additional Tier 1 information on the EDG bypass exhaust path has been added in response to Question 09.05.08-8. Discuss whether the SBODG has a similar bypass exhaust path and whether common-cause failures (CCF) of the exhaust paths can potentially occur.

b. FSAR Table 14.3-6, which lists PRA input to the development of inspections, tests, analyses, and acceptance criteria (ITAAC), states that "SBO DGs are independent and diverse from the EDGs." However, the ITAAC in Table 2.5.3-2 of Tier 1 require only that the air start systems of the EDGs and SBODGs be independent. Discuss, given the general statement in Table 14.3-6, why only the air start system is addressed specifically, and revise the FSAR as appropriate.

Response to Question 19-278:

Additional information related to SBODG independence and diversity is provided as follows:

a. The SBODG has an exhaust bypass valve and bypass exhaust stack that is similar in function to the EDG exhaust bypass path. However, due to the potential failure modes, common-cause failures of EDG and SBODG exhaust paths requires multiple failures in diverse machines, resulting in an unlikely occurrence.

   Potential failure modes for the exhaust bypass include failing open, and a failure to open when actuated during diesel operation combined with unacceptable exhaust backpressure conditions. Exhaust bypass valve failing open does not adversely affect diesel engine operation for either the EDG or SBODG engines, so this failure mode is not considered.

   The actuation of the exhaust bypass valve occurs when diesel engine exhaust backpressure reaches an unacceptable level. For common-cause failure to adversely affect both an EDG and an SBODG, there would need to be exhaust system failures in the silencer, emission control equipment or piping that could restrict the exhaust gas flow and the subsequent failure of the exhaust bypass valve. Additionally, it is important to note that even following actuation of the exhaust bypass valve and failure of the valve to operate, the existing exhaust path is expected to remain in operation. An exhaust system failure is expected to be a slow degradation of system performance and not a catastrophic failure. In this event an alarm will alert the operators of the abnormal condition, exhaust system back pressure indication will show the severity of the exhaust system degradation and indicate to the operators to manually operate the exhaust system bypass or shutdown the EDG or SBODG in accordance with station procedures. If a catastrophic failure did occur (e.g., external missile) it is not probable it would affect both an EDG and SBODG, and the exhaust bypass valve of the affected EDG would not be affected as it is located within the Seismic Category I Emergency Power Generating Building structure. This physical separation of the EDGs and SBODGs eliminates this common-cause failure potential.

b. The combination of existing ITAAC, and ITAAC added in response to RAIs cited below demonstrate the independence and diversity of the SBODGs from the EDGs in accordance with regulatory guidance. U.S. EPR FSAR Tier 2, Section 8.4 indicates the SBODGs conform to diversity guidance provided by RG 1.155, Appendix B, with reference to RG 1.155 Regulatory Position 3.3.5. RG 1.155 Regulatory Position Part C and RG 1.155 Table 1 indicate NUMARC-8700 is acceptable for satisfying 10 CFR 50.63 requirements. NUMARC-8700, Appendix B, Section B.8 indicates system features to minimize potential for common-cause failures of the alternate AC (AAC) source. U.S. EPR SBODG and EDG system features that minimize the potential for common cause failure by following the guidance provided in NUMARC-8700, Appendix B, Section B.8 and the associated ITAAC that verify these features are as follows:

(1) "The AAC power system shall be equipped with a DC power source that is electrically independent from the blacked-out unit's preferred and Class 1E power system."

The EDG DC power source is from the Class 1E uninterruptible power supply system (EUPS), while the SBODG DC power source is from the 12-hour uninterruptible power supply system (12UPS). The EDG DC control power is verified from the respective division in U.S. EPR FSAR Tier 1, Section 2.5.4, Item 5.1. Verification of this item demonstrates independence between the EDG and SBODG related to DC power sources.

(2) "The AAC power system shall be equipped with an air start system, as applicable, that is independent of the preferred and the blacked-out unit's preferred and Class 1E power supply."

The SBODG air start system is independent from the EDG air start systems. Each diesel engine has a separate air start system associated with that engine. This independence is verified by U.S. EPR FSAR Tier 1, Section 2.5.3, Items 3.1 and 4.5.

(3) "The AAC power system shall be provided with a fuel oil supply, as applicable, that is separate from the fuel oil supply for the onsite emergency AC power system. A separate day tank supplied from a common storage tank is acceptable provided the fuel oil is sampled and analyzed consistent with applicable standards prior to transfer to the day tank."

The SBODG fuel oil system is independent from the EDG fuel oil system. Each SBODG has an independent fuel oil storage tank and day tank. The U.S. EPR FSAR was revised in response to RAI 116, Question 14.3.6-7 to verify this independence by adding Tier 1, Section 2.5.3 Items 3.2 and 3.3. Additionally, U.S. EPR FSAR Tier 1, Section 2.5.4, Items 3.9 and 3.10 verifies that each EDG has a fuel oil storage tank and fuel oil day tank.

(4) "If the AAC power source is an identical machine to the emergency onsite AC power source, active failures of the emergency AC power source shall be evaluated for applicability and corrective action taken to reduce subsequent failures."

The response to RAI 11, Question 08.04-3 describes the large difference in nominal size between the SBODG and the EDG, so the two types of diesel generators will be

different models and not identical machines. The difference in size between the EDG and SBODG will also result in a different size exhaust bypass valve, further reducing probability of common-cause failure of this equipment.

(5) "No single point vulnerability shall exist whereby a likely weather-related event or single active failure could disable any portion of the onsite emergency AC power sources or the preferred power sources, and simultaneously fail the AAC power source(s)."

Minimal potential for common cause failure as a result of a likely weather-related event or single active failure is demonstrated by the physical separation of the SBODGs from the EDGs and the normal separation of the SBODGs from the emergency power supply system (EPSS). These attributes are verified by U.S. EPR FSAR Tier 1, Section 2.5.4, Item 2.2 and Section 2.5.3, Item 4.1.

(6) "The AAC power system shall be capable of operating during and after a station blackout without any support systems powered from the preferred power supply, or the blacked-out unit's Class 1E power sources affected by the event."

The SBODGs are capable of operating during and after an SBO without any support systems powered from the preferred power supply, or the EPSS or EUPS. The SBODG support systems are powered from the normal power supply system or the 12UPS. The portions of these distribution systems that support SBODG operation are reenergized by the SBODG during operation, so there is no reliance on the preferred power supply or the EPSS for SBODG operation.

(7) "The portions of the AAC power system subjected to maintenance activities shall be tested prior to returning the AAC power system to service."

This subsection is related to pos- maintenance testing and not related to design activities identified for ITAAC verification.

Information shown demonstrates SBODGs are independent and diverse from the EDGs. The ITAAC supports U.S. EPR FSAR Tier 2, Table 14.3-6, Item 6-19.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 19-279:

(Follow-up to Question 19-247) The response to Question 19-247 estimates the amount by which core damage frequency (CDF) would decrease if the design change related to reactor coolant pump (RCP) thermal barrier cooling were incorporated in the U.S. EPR PRA. The sensitivity suggests that total CDF would decrease by 16 percent, largely driven by the fire and flood contribution, as a result of the design change. Therefore, while the change represents a decrease in overall risk, insights from the PRA may be affected. In response to Question 19-270, FSAR Section 19.1.2.4.1 was revised to state that, when a design change results in a cumulative impact of more than 10 percent on total CDF or large release frequency (LRF), PRA insights are assessed to see if they remain valid. If the insights are no longer valid, the PRA is updated.

a. Discuss the expected effect of the design change on the PRA insights (such as those documented in Table 19.1-108 of the FSAR), as well as the input to the reliability assurance program (RAP) and the important operator actions provided to the developers of procedures, training, and other human-factors programs.

b. State the planned schedule for incorporating this design change in the PRA.

c. Discuss how this schedule relates to the planned schedule for implementing other programs (e.g., RAP, procedure development) that may be affected by the change.

Response to Question 19-279:

Response to Question 19-279a:

The basic effect of the thermal barrier cooling design change on the PRA insights is the decrease in RCP seal loss of coolant accident (LOCA) contribution to internal events, fire and flooding CDF. For each initiating event group, the percentage contribution of RCP seal LOCA to the CDF can be measured by the Fussel Vesely (FV) importance of the parameter "PROB SEAL LOCA". The change in RCP seal LOCA contribution brought by this design change is shown in Table 19-279-1, by comparing the base case (based on the U.S. EPR PRA) and the sensitivity case performed in the response to Question 19-247.

Table 19-279-1

Seal LOCA Contribution to CDF

Event	Base Case	Sensitivity case performed for RAI 19-247 (CCWS CH cross-tie considered)
Internal Event CDF	11%	7%
Internal Fire CDF	43%	18%
Internal Flooding CDF	30%	2%
Total at-power CDF	24%	10%

One insight in the fire and flood PRA sections of the U.S. EPR FSAR Tier 2, Sections 19.1.5.2.2.8 and 19.1.5.3.2.8, which will change as result of this design change identifies seal LOCAs as dominant contributors to the fire and flood CDF. The most significant decrease is in the contribution of seal LOCAs to flooding CDF, from 30 percent to 2 percent. Flooding in SB1 or SB4 is no longer dominated by seal LOCAs, but instead by ventilation failures.

Seal LOCA contribution to fire CDF is also reduced, but it remains a significant contributor (18 percent). This could be explained by insights from the fire CDF cutsets shown in Group 4 of the U.S. EPR FSAR Tier 2, Table 19.1-66, which include a failure of CH2 and an independent failure of the battery-backed 480V motor control center 31BRA. This electrical failure prevents successful switchover of thermal barrier cooling to CH1.

The thermal barrier design change will affect the PRA insights as discussed previously. Importance measures used as input to the reliability assurance program (RAP) and other programs also will be affected.

The following material will be added to U.S. EPR FSAR Tier 2, Table 19.1-108:

24	**Seal LOCA contribution to fire and flooding CDF**: RCP seal LOCAs are identified as important contributors to both the internal fire and the internal flooding CDF. The thermal barrier cooling design change, identified in Section 19.1.2.4, exhibits a prospective reduction in seal LOCA contribution to fire and flooding CDF.	Tier 2, Section 19.1.5.2.2.8 and 19.1.5.3.2.8

Response to Question 19-279b:

PRA updates will be performed in accordance with the PRA maintenance and upgrade process described in U.S. EPR FSAR Tier 2, Section 19.1.2.4.

Response to Question 19-279c:

PRA provides input to the RAP as well as to the design certification environmental report. PRA input to the RAP and the environmental report will be revised in conjunction with PRA updates performed in accordance with the PRA maintenance and upgrade process described in U.S. EPR FSAR Tier 2, Section 19.1.2.4.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 19.1-108 will be revised as described in the response and indicated on the enclosed markup.

Question 19-280:

(Follow-up to Question 19-248) The response to Question 19-248(d) justifies excluding the switchover to hot leg injection from the PRA, but only addresses boron precipitation. FSAR Section 6.3.2.8, as well as ANP-10299, "Applicability of AREVA NP Containment Response Evaluation Methodology to the U.S. EPR™ for Large Break LOCA Analysis," Revision 0, state that hot leg injection is used to terminate core steaming. Justify the exclusion of this operator action with respect to termination of steaming. In addition, if the operator action (whether modeled in the PRA or not) is important to maintaining a low CDF and/or LRF, this risk insight should be included in the FSAR.

Response to Question 19-280:

Hot leg injection is not credited in the PRA as a means to terminate steaming in a large LOCA. The analyses performed in FSAR Section 6 and in ANP-10299 used conservative assumptions, as required by the Standard Review Plan. Calculations performed with both GOTHIC and MAAP4, without the Standard Review Plan conservatisms for design basis analysis predicted containment pressures below the design pressure limits. Based on these calculations, the PRA estimates that, with or without hot leg injection, containment overpressurization is not likely to occur following a large LOCA.

Incorporation of hot leg injection at 90 minutes in the design basis analysis accelerated steam suppression such that the second containment pressure peak was mitigated by the safety injection switchover to the hot leg at 90 minutes.

When the conservative assumptions are removed, containment pressure response with cold leg injection alone did not result in the long term containment pressurization predicted in the design basis analysis, as discussed below.

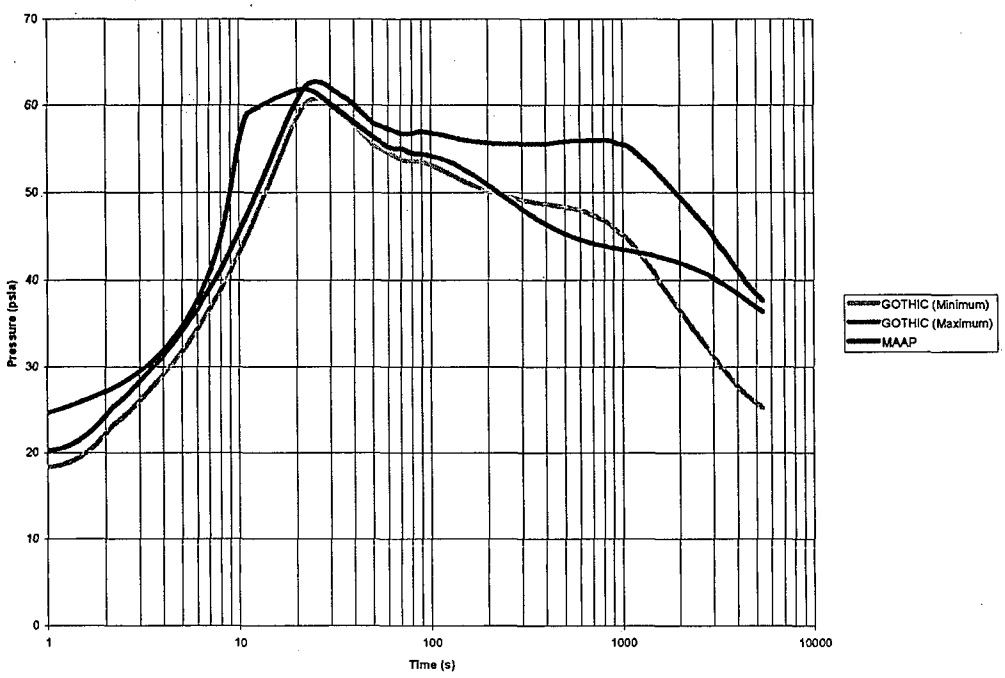
Similar S-RELAP5/GOTHIC and MAAP4 calculations were prepared with many best-estimate assumptions. One difference was that that S-RELAP5 calculation was prepared assuming three operational ECCS trains injecting into the cold legs (one going to the broken loop). MAAP4 is typically not appropriate for LLOCA short term peak clad temperature calculations; however, for long-term, decay heat driven analysis, MAAP4 is acceptable. The MAAP4 calculation modeled a large cold break LOCA with one LHSI train injecting into the intact cold leg (a lumped component in MAAP4). The subsequent containment pressure response from both analyses is

shown in Figure 19-280-1. The figure shows comparable pressure responses between the two calculations. The maximum pressurization occurs during the early pressure peak, and is about 63 psia (49 psig), below the design pressure. Beyond the reflood phase (within a few hundred seconds), the mass and energy releases are dominated by decay heat. Decay heat was modeled consistently in these calculations. The difference in ECCS flows affects the amount of steaming and sensible heat addition and explains why the long term containment response predicted by MAAP is at the higher end of the range of responses predicted by GOTHIC.

It should also be noted that even if the containment design pressure of 62 psig was to be exceeded, this is not likely to result in a failure of the containment. The containment fragility evaluation performed for the Level 2 PRA showed that the probability of containment failure at 62 psig is approximately 1E-6. To attain a probability of failure of one percent, the pressure would need to rise up to approximately 105 psig.

Figure 19-280-1

Containment Pressurization for Representative LLOCA run



FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 19-281:

(Follow-up to Question 19-251) The response to Question 19-251 includes information necessary for the staff to conclude that shutdown-specific fire and flood initiating events do not pose a significant risk. As requested in Question 19-251, add a summary of this information to the FSAR.

Response to Question 19-281:

The U.S. EPR FSAR will be updated to include a summary of the information contained in the response to Question 19-251.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 19.1.6.1.8 will be revised as described in the response and indicated on the enclosed markup.

Question 19-282:

(Follow-up to Question 19-251) The remote shutdown station (RSS) is only required to be operable during MODES 1, 2, and 3 per technical specification (TS) 3.3.3; however, the at-power PRA considers transfer to the RSS following a control room fire. State whether the assessment of internal fires during shutdown assumes that the RSS is available during shutdown. As appropriate, revise FSAR Table 19.1-109 to include this assumption. If applicable, discuss the administrative controls that will ensure the RSS remains available during shutdown.

Response to Question 19-282:

The PRA did not model internal fires in shutdown as separate initiating events. Instead, it is assumed that the at-power fire PRA envelops shutdown conditions. In addition, the response to RAI Question 19-251 considers some potential shutdown-specific internal fire scenarios requested by the NRC. The PRA models a fire in the control room as one of the fire scenarios at power. In that case, the PRA credits operator action to transfer the plant control to the remote shutdown station (RSS). Since the assumption is made that the at-power fire analysis envelops shutdown, it implies that the PRA also credits this transfer in shutdown.

U.S. EPR FSAR Tier 2, Table 19.1-109 will be revised to include this assumption. A new sentence will be added to Assumption 74 in Table 19.1-109, as follows:

No.	Category	PRA General Assumptions
74	Fire	The RSS is assumed to be available in all POS where fuel is loaded in the core.

COL information item 19.1-9, from U.S. EPR FSAR Tier 2, Table 1.8-2, provides that assumptions used in the PRA—including PRA inputs to the reliability assurance program (RAP)—remain valid for the as-built plant.

As indicated in the response to RAI Question 17.04-7, the RSS is included in the RAP. As described in U.S. EPR FSAR Tier 2, Section 17.4.1, inclusion in the RAP provides assurance that the RSS availability will be integrated into relevant existing programs, such as maintenance rule. As indicated in the COL information items in U.S. EPR FSAR Tier 2, Table 1.8-2 that are associated with U.S. EPR FSAR Tier 2, Chapter 17, the COL applicant will provide information on the description, scope, and implementation of these programs.

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 19.1-109 will be revised as described in the response and indicated on the enclosed markup.

Question 19-283:

(Follow-up to Question 19-254) In response to Question 19-254, FSAR Table 19.1-109 was revised to include part of the assumption about nozzle dams identified in the response to Question 19-174. However, the revision does not address other assumptions identified in Question 19-174, specifically:

a. Plant procedures that cover reduced inventory operation govern the installation of nozzle dams and the establishment of adequate venting to prevent pressurization of the RPV upper plenum due to a postulated loss of decay heat removal.

b. Freeze seals are not expected to be used; they will not be part of the maintenance procedures for the U.S. EPR.

c. There are no other temporary reactor coolant system pressure boundaries as defined by NUREG-1449 and NUREG-1512.

Discuss why these assumptions were excluded from the revision to Table 19.1-109, and revise the FSAR as needed.

Response to Question 19-283:

The U.S. EPR FSAR Tier 2, Table 19.1-109, will be revised as follows:

Additional material will be added to No. 82 (LPSD).

> "Plant procedures that cover reduced inventory operation will govern the installation of nozzle dams and the establishment of adequate venting to prevent pressurization of the RPV upper plenum due to postulated loss of decay heat removal.
>
> Nozzle dams are the only U.S. EPR related temporary reactor coolant system boundary as specified by NUREG-1449 and NUREG-1512. Freeze seals are not expected to be used; they will not be part of the maintenance procedures for the U.S. EPR."

FSAR Impact:

U.S. EPR FSAR Tier 2, Table 19.1-109 will be revised as described in the response and indicated on the enclosed markup.