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NRC Project 692

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

Subject: Supplementary Information Regarding Topical Report CE NPSD-1186

Reference: CE Owners Group Submittal of CE NPSD-1186, "Technical Justification for the Risk Informed Modifications to Selected Required Action End States for CEOG PWRs", letter CEOG-00-121, dated April 28, 2000

The purpose of this letter is to submit written information for use in review of Topical Report CE NPSD-1186. The additional information is in response to NRC staff questions provided during a telephone conversation on July 13, 2000. Subsequent to the telephone conference, the NRC requested that written responses to the questions be provided for use by the NRC staff. Accordingly, please find attached supplementary information regarding topical report CE NPSD-1186 addressing the seven specific items identified during the July 13 conversation.

Please do not hesitate to contact Virgil Paggen at 860-285-4700 or me at 860-285-5494 if you have any questions,

Sincerely yours,

Gordon Bischoff
Project Manager
CE Owners Group

cc: J. S. Cushing (NRC)
R. L. Phelps (OPPD)
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CEOG Library Task 1115

Attachment: 1. Supplementary Information Regarding Topical Report CE NPSD-1186

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SUPPLEMENTARY INFORMATION REGARDING TOPICAL REPORT CE NPSD-1186

CEOG COMBUSTION ENGINEERING OWNERS GROUP

SUPPLEMENTARY INFORMATION REGARDING TOPICAL REPORT CE NPSD-1186 (RISK INFORMED END STATES)

Based on a July 13, telephone conversation with the NRC staff, Nick Saltos indicated the desire for clarification and elaboration on specific elements of CE-NPSD-1186. Seven specific items were identified. The following additional information is provided.

1. In page 14 it is stated:

   The risk impact of the Mode change is evaluated (qualitatively and quantitatively) subject to the following restrictions:

   - *For the purpose of this evaluation, it is assumed that the plant operation in Mode 4 with SG heat removal occurs with LTOP and SDC not aligned*

   - *In assessing risk .... it is assumed that the entry into the shutdown mode under consideration is for a short interval with the primary intent of that entry being to repair a non-functional component and return the plant to power as soon as practical.*

   Please explain how these assumptions/restrictions impact the risk assessment. What kind of controls are currently available to ensure that such restrictions will be implemented if the proposed "end-state" change is approved?

Response

A. The evaluation assumes that Mode 4 AFW operation occurs when LTOP and SDC are not aligned. This is consistent with typical entries into Mode 4 for short duration repair. Under these circumstances the plant will be maintained at the higher temperature end of Mode 4. The impact of reducing temperature to the shutdown entry condition would invoke proceduralized actions to implement LTOP. LTOP entry will have a small impact on the Mode 4 risk as inadvertent opening of the LTOP will add an additional initiator to the Mode 4 AFW operational state.

B. As discussed above, the assumption that entry into Mode 4 will be a short duration action is consistent with the intended use of the TS. That is, the TS end state change is sought to allow the repair of the component in Mode 4, which may be the Mode of applicability for that component. Once the component is repaired the plant will no longer be in that LCO.

C. Plant risks associated with repair of equipment are to be managed in accordance with paragraph a(4) of 10CFR50.65. This requires a risk assessment of the plant configuration to ensure that plant risks are properly managed.

2. On page 29 it is stated that in Mode 4 (SG cooling) ".... the dominant risk comes from loss of feedwater, contributing about 80% of the total CDF." Doesn't this imply that for plants with one MDAFW pump the risk will be higher than SONGS which has two MDAFW pumps? A sensitivity study, taking credit for only one MDAFW pump, could provide useful information.

The base Mode 4-AFW PSA assessment assumed two motor driven AFW pumps were available for core heat removal. The TDAFW pump was conservatively assumed to be unavailable. This configuration was considered to provide a conservatively high risk representation of that plant state. A review of CE PWRs presented in Table 5.4-3 indicates that all CE PWRs have three or more feedwater pumps (combined motor, diesel and turbine driven) dedicated to decay heat removal. While not credited in the base analysis, the TDAFW pump is expected to be functional when the plant is above SDC entry conditions. In a few instances, the decay heat removal feedwater capability is enhanced by motor-driven main feedwater pumps. These features are summarized below.

Summary of Steam Generator Decay Heat Removal Capabilities*

Plant	Class 1E MDAFW	Class 1E TDAFW	Non-1E AFW (MD or Diesel Driven)	Cross Tie to Second Unit MDAFW	MD Main FW	Total number of Pumps available for Decay Heat Removal
ANO-2	1	1	1			3
CC	1	2		1		4
FCS	1	1	1 (Diesel)		3	6
MP2	2	1				3
PAL	2	1				3
PVNGS 1, 2 & 3	1	1	1 (Class 1-E power)			3
SONGS 2 & 3	2	1				3
SL 1	2	1			2	5
SL 2	2	1			2	5
WSES 3	2	1	1			4

*Availability of condensate pumps not considered.

The risks associated with Mode 4 AFW operation are applicable provided two pumps are available in Mode 4. The Mode 4 end state request is contingent upon the availability of at least two pumps.

3. On page 30 (top) it is stated:

A backup cooling mode is not available when on SDC, but is available when on AFW cooling. So in Mode 4 AFW, when AFW is lost, the operators can either switch to SDC using condensate or other means. But when on Mode 4 SDC, the operators could switch to AFW on loss of SDC, but are less likely to use condensate cooling since the initiating event was not a SG cooling.

Please explain in more detail why it is less likely to use condensate cooling when AFW is found to be unavailable following switch from SDC to SG cooling.

Response

When operating in Mode 4 on AFW, the procedure for responding to loss of AFW requires consideration of alternate SG feedwater sources including condensate. Therefore, this action was credited as a recovery for this condition. When the plant is initially operating on SDC, the priority for restoring core cooling changes. In the case of San Onofre, the operator "Loss of Shutdown Cooling" procedure instructs the operator to first try, in the following order (as necessary), the standby SDC pump, and then AFW (with atmospheric dump valves or steam bypass control). If level is lowering (perhaps due to boil-off), the same procedure also instructs the use of HPSI/CVCS injection to 30-50% pressurizer level.

Since the "Loss of Shutdown Cooling" procedure is applicable during all modes where SDC is in operation (including outages), the condensate system may or may not be available. Given it's potential unavailability, the procedure does not provide for the use of condensate as a feedwater source. Therefore, emergency condensate cooling is not credited as a recovery action in the Mode 4 SDC CDF assessment.

4. It appears that an implicit assumption throughout the report is that the "transition" risk, from Mode 4 with SG cooling to Mode 4 with SDC, is not higher when operating in Mode 4 with SG cooling and the AFW system fails to run than it is assuming direct transition to Mode 5 as the "end state." Please describe the actions and associated timing required to switch from Mode 4 with SG cooling to Mode 4 with SDC. How would the different RCS pressures, allowed in Mode 4 with SG cooling at the various CEOG plants, impact the failure probability of the above mentioned actions?

Response

It appears that an implicit assumption throughout the report is that the "transition" risk, from Mode 4 with SG cooling to Mode 4 with SDC, is not higher when operating in Mode 4 with SG cooling and the AFW system fails to run than it is assuming direct transition to Mode 5 as the "end state."

The model presented in the report does show a greater risk in the transition to SDC when the plant is "operating" in Mode 4-AFW and experiences a loss of cooling, than when the plant enters SDC as a result of an orderly shutdown from Mode 1. The primary contribution to the increased risk arises from (1) the reduction in redundancy in backup equipment and (2) human factor differences in responding to a normal shutdown vs an accident condition due to loss of AFW. With respect to item 1, during a normal shutdown, all AFW pumps will be available to support SG cooling. In the case of Mode 4 operation on AFW, system redundancy is reduced with failure of one AFW pump, (as MFW cannot reliably backup AFW at very low decay heat levels). With respect to item 2, a loss of AFW will require immediate actions to restore core heat removal. In this circumstance, alignment of SDC and entry into LTOP (if not already implemented) will be required under higher stress conditions and required to be completed within a narrow time frame. Consequently, these actions would have a lower success probability than a similar SDC entry under normal shutdown procedures.

Please describe the actions and associated timing required to switch from Mode 4 with SG cooling to Mode 4 with SDC.

A sequence of actions for entry into SDC (based on San Onofre) given a loss of AFW is presented in Table 1. For San Onofre, the time needed to transfer to SDC entry given a maximum Mode 4 initial operating state and failure of AFW is approximately 30 minutes (primarily valve alignment actions). An orderly transfer to SDC from maximum Mode 4 temperatures without AFW failure takes several hours.

The procedures to depressurize the plant and implement SG cooling vary among plants. However, all CE plants can depressurize the RCS either by removing steam via the PORVs or by utilizing normal/auxiliary pressurizer spray water to condense steam. The Atmospheric Dump Valves (ADV) and/or Steam Bypass Control System (SBCS) can also be used to cool and depressurize the RCS. For plants with PORVs, the depressurization process may be performed primarily to establish feed and bleed, and not for SDC entry. Since discharges from the RCS will be delivered to the ECCS (or emergency) sump, this cooling can be continued indefinitely. For plants without PORVs, Mode 4 entry temperatures are relatively low (about 350 ^{o}F) and very close to maximum SDC entry conditions (340 ^{o}F, 364 psia for SONGS). At these temperatures, ample SG inventory exists to assure entry into SDC, regardless of the initial Mode 4 temperature.

How would the different RCS pressures, allowed in Mode 4 with SG cooling at the various CEOG plants, impact the failure probability of the above mentioned actions?

Plant procedures include guidance for successfully coping with loss of AFW in Mode 4. Entry conditions into Mode 4 is controlled based on RCS temperature and pressure. RCS pressure is typically limited by the plants PT curves and other operational procedures. As a consequence of this variability, following a total loss of AFW event, some plants may enter SDC from a high RCS pressure while others may opt for a feed and bleed recovery. While these variations exist, they have minimal impact on plant risk in that mode.

Table 1

San Onofre Actions to Transition to SDC Following Total Loss of AFW

1. With the RCS T-cold in the range of 260-340 ^{o}F and RCS Pressure <363 psia and > RCP NPSH pressure, then place SDC in service in accordance with procedure SO23-3-2.6 (attachment for placing SDC in service post accident)

    - Close (and check closed) 12 breakers (All valve manipulations performed from the control room or all breaker operations performed in the 50' control building)
    - Cycle SDCHX bypass flow control valve to verify proper response,
    - Verify the position of 11 valves
    - Open/check open 6 breakers
    - Open two LPSI injection valves
    - Ensure LPSI suction flow path aligned. (Dual flow path 6 valves total)
    - Start a LPSI pump
    - Throttle SDCHX outlet valve to established desired flow through the SDCHX.
    - Throttle the SDCHX bypass valves to establish the desired SDC flow.

(This evolution would take ~ 30 minutes and could be performed with only one train of IE power available.)

2. After S/Gs no longer required for heat removal, secure AFW.

5. Please discuss impact of RCP seal LOCA on the selection of the Mode 4 end state.

Response

While failures of individual RCP seal stages have occurred at CE PWRs, no CE PWR has ever experienced an RCP seal failure. RCP seal stage failures, while undesirable, are low leakage events (<10 gpm) and do not represent a significant risk in any plant operating mode. RCS temperatures and pressures typical of Mode 4 further decrease the potential for, and significance of, RCP seal failure. Three additional points should be understood:

(1) The primary event leading to an RCP seal challenge is the loss of RCP seal cooling. Events leading to loss of cooling to the seals would be likely to also compromise the SDC.
(2) RCP seals are capable of surviving a long term exposure to typical Mode 4 entry temperatures (350-400 F).
(3) The probability of an extended loss of seal cooling (sufficient to cause an RCP seal LOCA) is less than that of a small LOCA, and the event unfolds slowly. This provides ample time for operator action. At low pressure, RCP seal leakage, should it occur, may be made up by one throttled HPSI pump or one charging pump.

Therefore, consideration of RCP seal failures in Mode 4 would have an insignificant impact on the plant Mode 4 risk assessment.

6. Please explain the following related to Figure 5-1:

- What systems/actions were credited in Mode 4 (AFW) risk and Mode 4 (SDC) risk?
- Does the Mode 1 risk take into account the plant condition that caused the LCO?
- It is stated that the sharp (about 2E-5/yr) increase in CDF when Mode 3 is entered is due to the fact that the TD-MFW pumps become unavailable. However, Table 5.4-4 indicates that Mode 3 risks decrease only by 10% when MFW is available in Mode 3. How is this reconciled?

Response

What systems/actions were credited in Mode 4 (AFW) risk and Mode 4 (SDC) risk?

(1) For Mode 4(AFW), one AFW pump is operating. The backup systems include, Emergency Condensate, and LPSI. Operator action would be needed to align and start any of the backup pumps.

(2) For Mode 4(SDC), one SDC pump is operating. The backup systems include LPSI, HPSI, CS, CVCS and AFW.

All backup systems require operator actions to operate.

Does the Mode 1 risk take into account the plant condition that caused the LCO?

The Mode 1 risk shown in Figure 5-1 is simply the annualized average risk, and it does not account for the various plant conditions that may have caused the LCO.

It is stated that the sharp (about 2E-5/yr) increase in CDF when Mode 3 is entered is due to the fact that the TD-MFW pumps become unavailable. However, Table 5.4-4 indicates that Mode 3 risks decrease only by 10% when MFW is available in Mode 3. How is this reconciled?

Operation in Mode 3 with AFW running is believed to be inherently less reliable than operation in Mode 1. This is because the reliability of an operating MFW pump is greater than that of an operating AFW pump. The annualized frequency of loss of feedwater events used in the analysis is 3.5/year when the feedwater is being provided by the AFW system, as opposed to the loss of main feedwater frequency of only 0.53/year in Mode 1. If MFW is available as backup in Mode 3 (e.g. a motor driven MFW pump) then the risk of Mode 3 operation is somewhat improved. This condition was studied parametrically in Table 5.4-4.

7. On page 21 it is stated that "loss of CCW... is not considered an initiating event in Mode 4....due to the relative independence of AFW on CCW." Similar statements are made in page 28 (assumption j), page 81 (T.S. 3.7.7 CCW), and page 83 (T.S. 3.7.8 SWS). These statements need clarification. Don't the motor-driven AFW pumps depend on CCW for cooling? If this is true and the AFW pumps are unavailable, how would the reactor be cooled in Mode 4 with SG cooling? Please explain.

Response

AFW pumps do not require CCW or similar system for direct cooling of the pump motors. In some instances, some plants may have situations where the long term operation of one or more may have an indirect dependency on CCW. Such a dependency may arise from the need for room cooling to ensure a proper pump operating environment.

The SONGS Model used for the analysis included a loss of CCW Initiating Event analysis for full power. The Mode 4 AFW model, however, did not include a loss of CCW Initiating Event, since a loss of CCW did not affect AFW Operation. AFW pump operation is independent of CCW, except for Essential HVAC cooling for AC and DC power electrical rooms. These rooms are normally cooled using normal HVAC. Essential HVAC is used when normal HVAC is not available. Additionally, portable fans can be used if both normal and essential HVAC are failed. Since loss of CCW only affects the normally standby/backup HVAC systems, but does not affect opening of doors or the operation of fans, loss of CCW was not considered as a potential loss of AFW initiating event.

The model used for the Mode 4 analysis does still require CCW for HVAC, and is still important in Loss of Offsite Power sequences. Non-class HVAC is lost on a Loss of Offsite Power. Additionally, CCW is required during LOCA events for pump room cooling and containment cooling, and for SG Tube Rupture events for Shutdown Cooling System Operation.

A review of other CE PWRs indicated that the AFW HVAC dependence was primarily associated with component placement. Pumps mounted in open regions were not susceptible to losses of HVAC (and hence CCW). Several plants indicated one or more of the AFW pumps may be located in rooms with potentially high heat loads such that HVAC is required for continued operation. However, as is the case with SCE alternative means for establishing adequate room cooling (e.g. opening doors, vents or installing portable fans) were noted. Consequently, the Mode 4 CDF contribution associated with not explicitly modeling the HVAC CCW dependency would be small.

It should be further noted that while a weak dependency may exist between the availability of CCW and certain AFW pumps in the AFWS, successful SDCS operation is often entirely dependent upon availability of CCW.

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September 19, 2000

FAX TO: **Jack Cushing**
(301) 415-3061

FROM: **Gordon Bischoff**

SUBJECT: **Supplementary Information Regarding Topical Report CE NPSD-1186**

Jack:

Please see attached for your information. If you should have any questions, please call me at (860) 285-5494. Thank you.

Sincerely,

Gordon

Gordon C. Bischoff
Project Manager
CE Owners Group

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