Response to

Request for Additional Information No. 67 (1175), Revision 0

9/09/2008

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: 19.1.6.1
SPLA Branch

Question 19-213:

The modeling of loss-of-offsite-power (LOOP) events outlined in Appendix 19A of the U.S. EPR Final Safety Analysis Report (FSAR) does not appear to match the plant design described in Chapter 8 of the FSAR. Specifically, if a station blackout (SBO) occurs (i.e., the four emergency diesel generators (EDG) fail to operate), followed by a reactor coolant pump (RCP) seal loss-of-coolant accident (LOCA), the LOOP event tree credits fast cooldown (FCD), injection by both the accumulators and low head safety injection (LHSI), and cooling of the in-containment refueling water storage tank (IRWST) by the severe accident heat removal system (SAHRS). However, Tables 8.4-1 and 8.4-2 of the FSAR do not include LHSI or SAHRS as loads supported by the SBO diesel generators (SBODG). Revise Chapters 8 and/or 19 of the FSAR, as well as the probabilistic risk assessment (PRA) model, as necessary, to ensure that the PRA reflects the U.S. EPR design for all modeled initiating events and operating modes. In addition:

a. State which electrical buses are assumed in the PRA to power LHSI, SAHRS, and the FCD function (including power to needed support systems).

b. State which divisions of LHSI and emergency feedwater (EFW) are supported by the SBODGs.

c. If loads listed in Tables 8.4-1 and 8.4-2 of the FSAR must be removed from the SBODGs to allow LHSI and SAHRS to function, describe how the operator action is modeled in the PRA and discuss any associated assumptions (e.g., inclusion in emergency procedures).

Response to Question 19-213:

U.S. EPR FSAR Tier 2, Chapter 19 and Chapter 8 are consistent with one another regarding their respective purposes. The SBO mitigation strategy described in U.S. EPR FSAR Tier 2, Chapter 8 is deterministic. Since the PRA considers failure sequences that are beyond the deterministic design basis, U.S. EPR FSAR Tier 2, Chapter 19 contains additional components and functions that are not included in U.S. EPR FSAR Tier 2, Chapter 8. For instance, U.S. EPR FSAR Tier 2, Chapter 19 outlines the use of FCD for SBO sequences that include RCP seal LOCA.

a) As shown in U.S. EPR FSAR Tier 2, Figure 8.3-2—Emergency Power Supply System Single Line Drawing, LHSI pumps trains 1 through 4 are powered by 6.9kv AC buses 31BDC, 32BDA, 33BDA, and 34 BDC respectively. Control power is from 250V DC buses 31BUC, 32BUC, 33BUC, 34BUC respectively. The SAHRS pump is powered by AC bus 34BDC and control power from DC bus 34BUC.

   Buses 31BDC, 32BDA, 33BDA, and 34 BDC are emergency AC buses powered by the EDG. The train 1 and 4 buses, 31BDC and 34BDC, can also be powered by the SBODG. AC buses 32BDA and 33BDA are not powered by the SBODG.

   Power for the support systems of the LHSI pumps is derived from the same buses as the LHSI pumps themselves. For LHSI trains 2 and 3, this includes component cooling water system (CCWS) pumps on buses 32BDA and 33BDA, which are not powered during an SBO event. Cooling water for LHSI trains 1 and 4 is provided by safety chilled water system (SCWS) compressors, which are powered from SBODG-backed buses 31BDC and 34BDC via intermediate buses 31BDB and 34BDB. (Note that the residual heat removal (RHR) heat exchangers are not credited for this scenario. The SAHRS and its dedicated cooling chain are credited for long-term IRWST cooling.)

The SAHRS pump is supported by a dedicated cooling chain. The dedicated cooling chain includes a dedicated CCWS pump supported by AC bus 34BDC and a dedicated essential service water system (ESWS) pump that derives its power from AC bus 34BDA.

FCD requires opening of the main steam relief train (MSRT) valves, which are powered by 480V AC buses 31/32/33/34BRA backed by DC buses 31/32/33/34BUC. Any train of MSRT, including main steam relief control valve (MSRCV) and main steam relief isolation valve (MSRIV) is capable of opening with power from either divisional pair (e.g., Division 1 and 2; or Division 3 and 4). The divisional pair concept is described in U.S. EPR FSAR Tier 2, Section 8.3.1.1.1.

U.S. EPR FSAR Tier 2, Figure 8.3-2 and Figure 8.3-5—Class 1E Uninterruptible Power Supply System Single Line Drawing show single line diagrams of the buses discussed above.

b) SBO mitigation relies on the pump trains in divisions 1 and 4. EFW pumps in divisions 1 and 4 are supported by the SBODG and are included on the list of SBO continuous loads shown in U.S. EPR FSAR Tier 2, Table 8.4-1—Station Blackout Continuous Loading – Train 1 Estimated and Table 8.4-2—Station Blackout Loading – Train 2 Estimated.

LHSI pumps in divisions 1 and 4 are powered by the same buses as the EFW pumps and are supported by the SBODG; however, they are not credited in the deterministic SBO mitigation strategy and are therefore not listed in U.S. EPR FSAR Tier 2, Tables 8.4-1 and 8.4-2.

Emergency DC buses 31/32/33/34BUC are powered by two-hour batteries. The battery chargers for Division 1 and 4 are re-powered when the SBODG are aligned to the emergency power supply system (EPSS) switchgear 31BDC and 34BDC, respectively. Connecting the SBODG to EPSS switchgear 32BDB and 33BDB provides the capability to re-power a battery charger in Division 2 and Division 3, respectively. Depending on the initial battery charger in service at the time of the event, battery chargers in Division 2 and/or 3 may need to be realigned to maintain the respective battery charged. If needed, this evolution requires manual operator action and is expected to occur prior to the depletion of the battery. Therefore, all of the essential valves for the four trains of MSRT and EFW are backed by the SBODG buses and remain in service throughout the event.

c) Use of FCD, LHSI, and SAHRS is not part of the deterministic SBO mitigation strategy required by RG 1.155. Therefore LHSI and SAHRS pumps are not normal SBODG loads. The PRA credits these as a defense-in-depth measure that is beyond the deterministic licensing basis.

The PRA credits an operator action to use an LHSI pump in conjunction with performing the FCD action. For FCD, an EFW pump must be secured in order to accommodate the load of an LHSI pump on the SBODG. The time allowed in the PRA for starting FCD (i.e., open MSRTs) is 40 minutes. It is assumed that a LHSI pump must be running by the time reactor coolant system (RCS) pressure reaches LHSI delivery pressure a few minutes later.

A human error probability (HEP) of 0.5 is assumed for this operator action. This is a conservative HEP assignment for the time allowed because the procedures and specific method for swapping the EFW and LHSI pumps during a FCD in the SBO conditions have not been developed.

After the FCD is complete, then another operator action is required for starting the SAHRS pump and its dedicated cooling chain for long-term IRWST cooling. This may also include removing loads from the train 4 SBODG that are no longer needed. The PRA allows about four hours for performing this operator action.

The PRA assumes a HEP of 0.1 for this operator action. This is a conservative HEP assignment for the time allowed because the procedures and specific method to connect the dedicated ESWS pump to the SBODG bus have not been developed.

In addition, for sequences where SBODG-backed DC power is needed beyond two hours, an HEP of 0.069 is assumed for the manual action to realign the division 2 and 3 battery chargers before the batteries deplete.

If the FCD action in the SBO condition is not credited, an increase in the total core damage frequency (CDF) at power would be 1 percent (risk achievement worth (RAW) for OPE-FCD-40MSBO is equal to 1.01).

The HEPs for the operator actions discussed above are assumed values. If necessary, updates to the PRA are performed in accordance with the PRA maintenance and upgrade process described in U.S. EPR FSAR Tier 2, Section 19.1.2.4. COL item 19.1-9 listed in U.S. EPR FSAR Tier 2, Table 1.8-2—U.S. EPR Combined License Information Items is provided to confirm that assumptions used in the PRA remain valid for the as-to-be-operated plant.

FSAR Impact:

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

Question 19-214:

(Follow-up to Question 19-175) The response to Question 19-175 states that, during automatic mid-loop level control, the “charging pump must be in operation and the volume control tank (VCT) must not be bypassed.” What are the consequences of the failure of either function? If the failures are not modeled in the PRA, document the assumptions that justify their exclusion.

Response to Question 19-214:

The charging pump and the VCT alignment, in conjunction with letdown, is part of the reactor coolant system (RCS) level control function for normal operations at mid-loop. If the charging pump and VCT are not aligned properly or they fail, then normal inventory addition and removal capability to the RCS is lost. Failure to provide charging does not result in imminent loss of RCS loop level, because the level control function will close the letdown valves.

In addition, the RCS loop level limitation function will terminate letdown when the water level falls below a dedicated setpoint that is below the operational setpoint. Furthermore, high and low control and limitation-band alarms are also provided.

Therefore, failure of the charging pump and VCT alignment will not result in a significant consequence unless there are also failures of the letdown valves or closure commands to the valves (i.e., RCS loop level control function, RCS loop level limitation function, and operator response to alarms). If the RCS water level continues to fall, then the safety-related low RCS loop level function will start the medium head safety injection (MHSI) pumps to restore inventory.

With respect to the probabilistic risk assessment (PRA), the uncontrolled level drop (ULD) initiating event for mid-loop operation includes mechanical failure of the associated letdown valves and failure of the operator to establish automatic level control. Failure of the charging function could result in the ULD initiating event if there are subsequent failures of the level control function, the limitation function, and the alarm function as discussed above. However, the initiating event frequency for ULD does not include these failure modes. Failure of the charging pump and associated VCT alignment are not included because the failure probability of the instrumentation that provides the level control and limitation signals is small in comparison to these other failure modes.

FSAR Impact:

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