DRAFT

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AREVA NP Inc.
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Application Section: 19

QUESTIONS

19-162

Diversity assumptions for the station blackout diesel generators (SBODG) and the emergency diesel generators (EDG) are stated differently in various sections of the FSAR. For example:

- Table 19.1-102 states that “the SBODGs are diverse from the EDGs in design, manufacturer, cooling, actuation and control, fuel oil and operating environment.”
- Section 8.4.1.1 states that “[t]he SBODGs do not share control power, heating, ventilation and air conditioning (HVAC), engine cooling, or fuel systems with the EDGs.” The section goes on to state that “[t]o minimize the potential for common cause failure with the onsite emergency alternating current power sources, the SBODGs are of a different model than the EDGs.”
- Section 2.5 of Tier 1 states that “[t]he SBODG air start system is independent of the [EDG] air start system.” An ITAAC is provided to verify this statement after construction.

The staff needs further information to conclude that separation of the SBODGs and EDGs into different common cause groups and correlation classes is an appropriate assumption in the probabilistic risk assessment (PRA). For each major subsystem (e.g., starting, control power for startup, fuel, lubrication, cooling, combustion air, exhaust, emission control, and ventilation), provide an engineering assessment of the diversity between the SBODGs and the EDGs and/or how the potential for common cause failures (CCF) is limited. If information on the two models is not yet available and assumptions are necessary, provide specific combined license (COL) items and/or inspections, tests, analyses, and acceptance criteria (ITAAC) in the Final Safety Analysis Report (FSAR) so that these assumptions will be verified in the as-to-be-built, as-to-be-operated plant. Additionally, revise the FSAR so that the diversity discussions in chapters 8 and 19 are consistent.

19-163

(Follow-up to Question 19-71) The response to Question 19-71 states that the process information and control system (PICS) and the safety information and control system (SICS) are implemented on diverse I&C platforms and are not vulnerable to the same CCF. Provide the results of a sensitivity study in which PICS and SICS can fail due to a common cause. Also, include this assumption as an insight in Table 19.1-102 of the FSAR.

19-164

(Follow-up to Question 19-58) Clarify how the PRA models cooling of the reactor coolant pumps (RCP) by the component cooling water system (CCWS) common headers (CH). The response to Question 19-58 indicates that CH1 cools RCPs 1 and 2, while CH2 cools RCPs 3 and 4. However, Section 7.6.1.2.3 states that "[e]ither the Common 1b or 2b headers can provide cooling to the RCP thermal barriers." How is the crosstie between CH1 and CH2 controlled? How many RCPs trip on the loss of a CCWS CH? How many RCPs must trip to cause a reactor trip?

19-165

(Follow-up to Question 19-43) Clarify how electrical dependencies are modeled in the "circular logic equivalent" fault trees in the PRA. Section 19.1.4.1.2.5 of the FSAR and the response to Question 19-43 indicate that the failure of power supplies is not modeled as a failure mode of HVAC, CCWS, and the essential service water system (ESWS). Compare the probability that an electrical bus fails to other failure modes modeled for these systems. Is power to these systems modeled as a zero-probability basic event or as an undeveloped event with a probability derived from the fault tree for that power supply? If the former approach was used, provide the results of a sensitivity study using the latter approach.

19-166

(Follow-up to Question 19-2) The disposition of risk insights added to Table 19.1-102 in response to Question 19-2 is helpful for both staff review and future use of the FSAR. However, the insights should be tied to the portion of the FSAR that provides the strongest assurance that the insight will remain valid in the as-to-be-built, as-to-be-operated plant. In many cases, the revised Table 19.1-102 refers to a portion of FSAR Tier 2 when the insight is also addressed in Tier 1 system descriptions; specific ITAAC; or a specific COL information item. Revise Table 19.1-102 in the FSAR to refer to Tier 1, ITAAC, and COL items where applicable.

19-167

(Follow-up to Question 19-38) The response to Question 19-38 states that the communication of assumptions to COL applicants is achieved by FSAR Table 19.1-102 and actions related to COL items. To ensure that these mechanisms are as useful as possible to COL applicants and the staff, revise Table 19.1-102 to include all key assumptions identified in the PRA documentation (such as in system analyses) and all assumptions alluded to in the FSAR text. For example, the following assumptions are in the FSAR text but not in the table:

- Heating, ventilation, and air conditioning (HVAC) recovery times (see FSAR page 19.1-23)
- Instrumentation and controls (I&C) details (see FSAR page 19.1-32)
- Calibration errors (see FSAR page 19.1-42)
- Additional training for certain evolutions (see FSAR page 19.1-44)
- Station blackout human errors (see FSAR page 19.1-56)
- Chemical and volume control system (CVCS) supply availability (see FSAR page 19.1-56)
- Cooldown operator actions (see FSAR page 19.1-57)

Also, revise the text of COL information item 19.1-9 to add a reference to the insights and assumptions listed in Table 19.1-102.

19-168

(Follow-up to Question 19-59) Question 19-59 asked for additional information on the pressurizer safety relief valve (PSRV) spurious opening frequency indicated in FSAR Table 19.1-4. The staff needs further information in several areas. Note that if the approach is changed in response to sub-part (a), responses to (b) and (c) are not needed.

a. The response appears to discuss failures of safety valves to reseat after opening during a transient, rather than spurious opening while at power. It is unclear how this frequency addresses both spurious opening of a PSRV and its subsequent failure to reseat. It is also unclear how the frequency accounts for all three PSRVs. Discuss how the PSRV spurious opening frequency modeled in the PRA addresses both of these subjects.

b. Provide additional information to support the conclusion that transients such as loss of an electrical bus or a turbine trip would not result in PSRV opening. The safety analyses in Chapter 15 indicate that the PSRVs open in many scenarios, including after a turbine trip.

c. Justify the use of 0.1 failure events over 500 reactor critical years. The value of 5.0E-3/yr listed in NUREG/CR-5750 results from an analysis of two failures over approximately 500 reactor critical years. The update in NUREG/CR-6928 also uses the two failures, but over 866.6 reactor critical years, and uses a simplified constrained noninformative prior distribution with the Jeffreys mean and an alpha value of 0.5. The resulting mean value is 2.88E-3/yr with alpha and beta values of 0.5 and 173.3, respectively. Even if the approach of excluding the two failures as not applicable to the U.S. EPR were appropriate, a similarly updated gamma distribution would be 5.8E-4/yr with alpha and beta values of 0.5 and 866.6, respectively.

19-169

(Follow-up to Question 19-62) The response to Question 19-62 indicates that no single ventilation failure would result in the loss of more than one building and that support system failures would fail the front-line system as well as ventilation. However, the response does not address the impact of individual ventilation component failures (e.g., failure of a ventilation fan in an SBODG building) on equipment in that building. Provide a quantitative justification for exclusion of these ventilation failures, with reference to failure probabilities, room heat-up assumptions, and operator actions that are possible.

19-170

(Follow-up to Question 19-63) The response to Question 19-63 states that the alternate feed connection is credited in some cases as a response to loss of power. The bases for technical specification (TS) 3.8.1 state that “[i]f one EDG is inoperable and the alternate feed is not aligned, certain required safety systems, safety support systems, and components that do not have adequate redundancy to support maintenance, do not have sufficient AC power source availability to ensure the completion of all safety functions for a postulated accident coincident with a single failure and the loss of offsite power.” Provide a quantitative discussion of the risk benefit of the alternate feed connection when an EDG is out of service for maintenance. If the benefit is large, the connection should be modeled in the PRA and included as a risk insight in Table 19.1-102 of the FSAR.

19-171

(Follow-up to Question 19-66) The response to Question 19-66 indicates that pipe break frequencies based on the number of pipe segments and the Electric Power Research Institute (EPRI) TR-102266 Pipe Break Failure Study may be much lower than the initiating event frequencies assumed in the PRA. Has the number of reactor coolant system (RCS) and steam line pipe segments been reduced significantly for the U.S. EPR design compared to operating plants? If so, discuss how using generic initiating event frequencies affects the U.S. EPR risk profile and associated risk insights.

19-172

(Follow-up to Question 19-17) The response to Question 19-17 states that loss-of-offsite-power (LOOP) events recovered in less than one hour are not considered in the analysis. Provide justification for this assumption. Do any LOOP-initiated loss-of-residual-heat-removal (RHR) scenarios result in boiling in the RCS in less than an hour? If so, describe the scenario and provide a description and results of the time-to-boil calculation. Describe procedures and training related to closure of the equipment hatch and other containment penetrations without offsite power. State how long containment closure is expected to take both with and without offsite power.

19-173

(Follow-up to Question 19-32) The response to Question 19-32 states that “containment availability as modeled in the PRA is based on administrative controls” and that “the shutdown PRA uses the same model for containment status as the at power PRA.” Assumptions about containment closure are critical to the assessment of radioactive release during shutdown. Revise Table 19.1-87 for all plant operating states (POS) to include the status of the equipment hatch, personnel airlock, and other permanent and temporary containment penetrations (e.g., open, closed, or an assumed probability of failure following a severe accident during shutdown), and include these assumptions as a risk insight in Table 19.1-102.

19-174

(Follow-up to Question 19-22 and 19-26) Section 6.7 of NUREG-1449 describes instances in which the failure of temporary RCS boundaries (such as freeze seal, which is used to temporarily isolate fluid systems, temporary plugs for neutron instrument housing, and nozzle dams installed in the hot-leg and cold-leg penetrations to steam generators) can lead to a rapid non-isolable loss of reactor coolant. Therefore, the decision to use these temporary boundaries is an important component of the U.S. EPR shutdown risk assessment. (See section 19.3.3 of NUREG-1512, the Final Safety Evaluation Report (FSER) on the AP600 design, for a previous discussion of this topic.) In response to Questions 19-22 and 19-26, AREVA stated that the use of nozzle dams and temporary pressure boundaries, respectively, will be decided by the COL applicant. Postponing this decision means that the shutdown risk assessment is not complete enough for the staff to develop risk insights. Provide the following additional information:

a. Are nozzle dams used in the U.S. EPR steam generators at shutdown?

b. At what point during shutdown will the nozzle dams be installed and removed?

c. What is the design pressure of these nozzle dams? Discuss the analysis performed to calculate this pressure. Compare this pressure to the pressure expected following a loss of RHR in all POS.

d. How are nozzle dams and their impact on steam generator availability modeled in the PRA?

e. Are freeze seals used during shutdown? If so, revise the FSAR to include a COL item for applicants to develop plant-specific guidelines that would reduce the potential for loss of RCS boundary and inventory when using freeze seals.

f. Will any other temporary pressure boundaries, such as plugs in neutron instrument housings, be used?

19-175

(Follow-up to Question 19-74) The response to Question 19-74 is not complete enough for the staff to understand the U.S. EPR shutdown strategy. Describe the approach taken (e.g., tasks performed, systems and equipment used) for each of the following steps:

a. Depressurization before draining the RCS

b. Reduction of RCS level to mid-loop

c. Draining the steam generator tubes (e.g., whether nitrogen is injected to speed draining)

d. Level control during mid-loop

e. Draining the refueling cavity after refueling

f. Vacuum fill of the RCS

19-176

(Follow-up to Question 19-27) The response to Question 19-27 identifies several design features (e.g., safety injection (SI) signal, CVCS letdown isolation, and medium head safety injection) that would increase average shutdown core damage frequency (CDF) to a value comparable to the Commission's safety goals if they were not available during shutdown. Neither the low loop level SI signal nor the medium head safety injection (MHSI) system is required by TS in MODES 5 and 6. The letdown isolation valves are required to be operable by TS 3.1.8, which relates to boron dilution, not loop level. The loop level sensors are used to isolate letdown, stop the low head safety injection (LHSI) pumps, and start makeup with the MHSI pumps on low loop level. Although they were not included in the list of RAW values in response to Question 19-27, Table 19.1-98 indicates that CCF of these sensors is of high importance. The in-containment refueling water storage tank (IRWST) was also not included in this list, but Table 19.1-97 indicates that CCF of the IRWST (because of check valve or strainer failure) is extremely important.

Standard Review Plan (SRP) Section 19.0 states that the design-phase PRA is used to demonstrate whether the plant design, including the impact of site-specific characteristics, represents a reduction in risk compared to existing operating plants. The PRA is also used to identify and support the development of specifications such as ITAAC, reliability assurance program (RAP), TS, and COL items. The staff must be able to make these conclusions in its FSER.

Therefore, as requested in Question 19-27, provide a sensitivity study by specifying guaranteed failure for all operator actions, equipment, and sensors related to systems that are not required to be operable during shutdown. If neither TS nor procedures detailing availability controls are available for the important features discussed above, the staff will need to use the results of this sensitivity study in its safety evaluation.

19-177

Provide the assumed contents of the steam generator tubes during all phases of plant shutdown. Will nitrogen be injected in the steam generator tubes to speed draining? If so, how does the nitrogen content impact the steam condensing surface for reflux cooling and any subsequent repressurization?

19-178

TS 3.9.5, on RHR with low water level during MODE 6, requires containment closure within four hours whenever no RHR loops are available. The bases for this TS state that "[t]he Completion Time of 4 hours allows fixing of most RHR problems and is reasonable, based on the low probability of the coolant boiling in that time." Provide descriptions and results of time-to-boil calculations from the shutdown PRA that support this statement.

19-179

Discuss any design improvements made to the RCS and RHR system to reduce shutdown risk, such as self-venting suction lines, suction nozzle modifications, or vertically offset hot and cold legs.

19-180

Define “mid-loop” for the U.S. EPR. To what elevation will the RCS be drained to allow steam generator maintenance and nozzle dam installation? Provide the location and elevation of the RHR hot leg suction nozzle (e.g., bottom or side of pipe, +X feet).

19-181

Discuss the mass or energy input that would cause the low temperature overpressure (LTOP) PSRV to open when the RCS is water-solid during shutdown. Provide the likelihood that the PSRVs will stick open, and discuss how the shutdown PRA handles this scenario.

19-182

Section 7.3.1.2.1 of the FSAR states that “[a] manual bypass of SIS [safety injection system] actuation on low RCS loop level is provided for protection of personnel working in the RCS components during outages.” Discuss how this manual bypass is controlled during shutdown and when it would be used. Given the high importance of the SI signal cited in response to Question 19-37, control of this bypass is a risk insight that should be documented FSAR Table 19.1-102.

19-183

Provide additional information on the RHR relief valves, including their relief setpoint and capacity. These relief valves are not discussed in detail in FSAR Section 5.4.7 and are not included in the equipment list in Tier 1 Section 2.2.3. Discuss how the relief capacity of these valves designed to protect the RCS pressure boundary during shutdown will be ensured in the as-to-be-built, as-to-be-operated plant. Describe how these valves are modeled in the shutdown PRA.

19-184

What indication of RCS temperature, pressure, and level is available to the operators during shutdown? For each, state the type of sensor, its location in the RCS, any associated alarms and trips, and the controls that ensure the indication is available during shutdown. Discuss whether these sensors are susceptible to errors identified at current plants (e.g., errors in differential pressure caused by RCS inventory swept into the pressurizer, failures of Tygon tubing, and inaccurate hot leg temperature measurement after a loss of flow).

19-185

Discuss whether any gravity-driven sources of borated water are available for injection following a loss of inventory during shutdown. At operating plants, the ability to inject from the refueling water storage tank (RWST) is an important mitigation strategy during shutdown, but the IRWST at the U.S. EPR is below the RCS elevation. Discuss how this design feature, which enhances safety by eliminating the need for recirculation switchover following a loss-of-coolant accident (LOCA), affects shutdown risk.

19-186

Provide the assumed water volume in the IRWST during shutdown and the assumed water volume that is transferred to the refueling cavity. Do LHSI and MHSI draw from the IRWST following a LOCA in POS E? If so, clarify, with supporting drawings as needed, whether the suction point from the IRWST remains covered with water in POS E.

19-187

Clarify the success criteria for RHR in all POS (both in the initiating event assessment and as a mitigating system). Provide a description and results of the calculations performed to justify these success criteria. If the number of trains required is different from the numbers used to support system analyses and/or development of TS, state why.

19-188

The staff needs additional information on the interfacing system LOCA (ISLOCA) analysis in the internal events PRA. It is not clear how the analysis progressed from a set of "ISLOCA systems and associated containment penetrations" to a set of systems requiring detailed modeling (SI, CVCS, and component cooling water system (CCWS)) to the list of initiating events in Table 19.1-4 of the FSAR. Provide a more detailed discussion of this analysis in the FSAR, including:

a. A general discussion of the analysis progression above, including a justification for pathways that were screened out
b. Development of the ISLOCA initiating event frequency for each pathway, including the pipe rupture and other failure rates used, with sources for each
c. The mitigation strategy (e.g., isolation or depressurization) credited for each pathway
d. Key assumptions related to both the initiating event frequencies and the mitigation options
e. Risk insights regarding the preventive design features (such as in-series check valves, motor-operated valves, pipe strength, control room alarms, and control

room indications, as stated on page 19.1-21 of the FSAR) that contribute to the low risk associated with ISLOCA