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U. S. EPR Standard Design Certification
AREVA NP Inc.
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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)

19-247

(Follow-up to Question 19-164) The response to Question 19-164 indicates that either the Common 1b or 2b headers of the component cooling water system (CCWS) can provide thermal barrier cooling to all four reactor coolant pump (RCP) seals, but the probabilistic risk assessment (PRA) model assumes that common header 1b cools the thermal barriers of RCPs 1 and 2 and common header 2b cools the thermal barriers of RCPs 3 and 4. This discrepancy is not included in the list of design changes in section 19.1.2.4 of the Final Safety Analysis Report (FSAR). Evaluate the impact of this design change on the PRA results and insights and revise the FSAR accordingly, including addition of the design change to the list in section 19.1.2.4.

19-248

Page 6.3-6 of the FSAR and technical specification (TS) 3.5.2 describe the cross-connection between low head safety injection (LHSI) trains. Following a large loss-of-coolant accident (LOCA), LHSI flow into the cold leg adjacent to the broken cold leg may bypass the core as a result of steam entrainment. Since cold legs 1 and 4 are adjacent (as are 2 and 3), cross-connections are provided between trains 1 and 2 and between trains 3 and 4. However, the large LOCA LHSI success criterion appears to assume that only one train is disabled by the break. The staff needs additional information to understand this phenomenon. Specifically:

a. Discuss how the steam entrainment phenomenon was considered in the development of the PRA success criterion for LHSI following a large LOCA. FSAR Table 19.1-109, provided with the response to Question 19-166, indicates that cold leg 1 is also unavailable because of steam entrainment, but steam entrainment is not discussed in FSAR Chapter 19 or Appendix 19A.

b. Discuss whether the steam entrainment phenomenon also applies to the accumulator success criterion. (Note that no maintenance cross-connection would be expected for the accumulators because of the short TS completion time.)

c. Discuss the rationale for selecting specifically LHSI pumps 1 and 4 to have diverse cooling from pumps 2 and 3, as discussed in section 19.1.3.4.2 of

the FSAR, given the possibility that injection could be degraded in either pair following a large LOCA.

d. Discuss how the PRA models the switchover to hot leg injection following a large LOCA, which is described in FSAR Section 6.3.2.8 as a manual action needed to prevent boron precipitation and mitigate steaming from the break.

19-249

Page 19.1-37 of the FSAR describes the heating, ventilation, and air conditioning (HVAC) dependencies for the U.S. EPR. The importance of these dependencies appears to be driven by the assumption that the CCWS pumps in Divisions 1 and 4 are initially running. Loss of the CCWS common header after HVAC-induced switchover failure results in failure of the CCWS-cooled safety chilled water system (SCWS) equipment in Division 2 or 3. However, if the CCWS pumps in Divisions 2 and 3 were initially running, the air-cooled SCWS divisions could still provide HVAC to safeguard buildings 1 and 4 following failure of the CCWS common header, and only one building would be impacted by the initial HVAC failure. The staff needs additional information to ensure that conservatism in this assumption is not masking important PRA contributors. Specifically:

a. Discuss the rationale for assuming the Divisions 1 and 4 CCWS pumps are initially running.

b. Discuss, with support from sensitivity studies as needed, how the results and insights of the U.S. EPR PRA (e.g., important initiating events, sequences, and failures) would be different if the Divisions 2 and 3 CCWS pumps were initially running.

c. If the U.S. EPR profile is significantly different in the two scenarios, revise the FSAR to include this insight.

d. Discuss whether one configuration would be preferable from a risk perspective and how this information would be communicated to plant operators.

e. Discuss any design changes that have been considered to reduce the importance of this assumption, and why they were not implemented.

19-250

(Follow-up to Question 19-176) The response to Question 19-176 refers to the “small conservatism” that was removed from the shutdown model (not crediting LHSI decay heat removal following MHSI system failure). However, comparison of the risk achievement worth (RAW) values provided in response to Question 19-20 to the factor increases in Table 19-176-1 indicates that the impact of this conservatism was significant (e.g., increases of 8059 versus 49.1 for the safety injection signal). Discuss why the conservatism was included initially and whether removing the conservatism has any impact on the PRA results and insights reported in the FSAR.

19-251

The response to Question 19-20 states that "[t]he risk from floods and fires is not quantified specifically for shutdown, because it was assumed to be enveloped by the flood and fire risk at power operation (calculated for all year)." Various RAI responses have provided information on barrier and transient combustible control related to fires and floods at shutdown. However, it is not clear that the at-power assessment envelops shutdown-specific initiating events induced by an external event (e.g., a hot short that opens one of the flow diversion pathways identified in the response to Question 19-143). Additional information should be added to the FSAR on external events during shutdown so that the staff can perform the evaluation outlined in Appendix A of Standard Review Plan (SRP) Section 19.0. Specifically:

a. For all external events described in section 19.1.5 of the FSAR, discuss whether these external events could cause initiating events during shutdown that were not assessed at power (e.g., level drop or loss of residual heat removal).

b. Compare the frequency of an external-event-induced initiating event to the initiating events already assessed for the internal events shutdown model.

c. Discuss the impact of the external event on mitigating systems assumed available in the internal events shutdown model.

19-252

(Follow-up to Question 19-166) FSAR Table 19.1-108, provided as a markup in response to Question 19-166, indicates several areas (e.g., containment closure during shutdown) where PRA insights should be used as input to procedures, with reference to related combined license (COL) items. Given that the COL items do not refer back to this table, discuss the mechanism (e.g., internal procedure) for communicating these important insights to the procedure developers.

19-253

(Follow-up to Question 19-166) The response to Question 19-138 states that "[s]ensors and isolation signals that will perform this function [essential service water system (ESWS) and demineralized water system (DWS) isolation] are also assumed operable during shutdown" and that COL item 19.1-9 is provided to confirm that this assumption remains valid. However, FSAR Table 19.1-109, which links to COL item 19.1-9, does not include this assumption. Discuss why this assumption was excluded from the table.

19-254

(Follow-up to Question 19-166) The response to Question 19-174 lists several assumptions related to the use of temporary reactor coolant system (RCS) boundaries during shutdown. Changes to these assumptions could affect the set of shutdown initiating events and accident sequences for the U.S. EPR; however,

FSAR Table 19.1-109 does not include these assumptions. Discuss why these assumptions were excluded from the table.

19-255

(Follow-up to Question 19-166) The response to Question 19-213 describes several assumptions about operator actions needed to provide power to safety systems during a station blackout (SBO) and refers to COL item 19.1-9, which is provided to confirm that these assumptions remain valid. However, FSAR Table 19.1-109, which links to COL item 19.1-9, does not include a reference to these assumptions. Similarly, FSAR Table 19.1-108, which indicates several areas where PRA insights should be used as input to procedures, does not refer to these operator actions. Discuss why these assumptions were excluded from the tables.

19-256

(Follow-up to Question 19-4) The table of failure data provided in response to Question 19-4 does not include failure of batteries to run or failure of battery chargers, either on demand or during operation. Provide the data source and values used for these failures in the U.S. EPR PRA.

19-257

(Follow-up to Question 19-4) Table 19-04-1, provided in response to Question 19-4, lists failure rates for various instrumentation and control (I&C) components, but no source is provided for the data. Source data was provided in the response to Question 19-73, but the failure rates match only a subset of the components listed in Table 19-04-1. Provide a source and/or justification for all I&C failure data listed in Table 19-04-1. So that the staff can compare this data to the basic events listed in the tables of importance measures, describe the probability models used for these components in the PRA (e.g., the mean time to repair (MTTR) assumed for each).

19-258

(Follow-up to Question 19-4) Some of the equipment identified as important in the U.S. EPR PRA (e.g., medium head safety injection (MHSI) pumps, MHSI/LHSI common injection check valves) appears to be tested only every 24 months. Industry data is often based on equipment tested much more frequently. For example, in NUREG/CR-6928, the check valve data is based on an average of 6.6 demands per year, and the motor-driven pump data is based on an average of 19.8 demands per year. Studies such as NUREG/CR-5823 indicate that testing policies can have a significant impact on component performance since components fail from both “standby” stresses (e.g., corrosion, oxidation and boron precipitation) and “demand” stresses (e.g., vibration and stressing of shafts). Therefore, for the most important demand-based failures in the PRA, discuss how the test history inherent in the generic data compares to the testing intervals assumed for the U.S. EPR design. Discuss the impact of any differences on the results and insights of the U.S. EPR PRA.

19-259

Page 19.1-32 of the FSAR states that “[f]or the SAS [safety automation system] and PAS [process automation system], simple, high-level models and conservative failure rates are used in the PRA (i.e., undeveloped events) for design certification.” Provide a list of the undeveloped I&C basic events used in the PRA, with descriptions and values for each. Discuss how the failure probabilities were determined. Describe what actions will be taken following design certification to develop these failure events further.

19-260

Page 19.1-41 of the FSAR states that “[t]he CCF [common-cause failure] values used in the U.S. EPR PRA are based on an update to the data collected by the U.S. NRC (Reference 27).” Because the database cited includes a variety of parameters for different systems and plant types, the staff needs additional information on the CCF parameters used for the U.S. EPR PRA. Provide the CCF and uncertainty parameters used in the PRA. If any parameters do not come from the cited database, provide the source(s).

19-261

Justify the exclusion of CCF of I&C communication modules from the U.S. EPR PRA.