ArevaEPRDCPEm Resource

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Sent:	Friday, May 15, 2009 7:17 PM
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Subject:	Draft - U.S. EPR Design Certification Application RAI No. 227 (2564, 2598), FSAR Ch. 19
Attachments:	Draft RAI_227_SPLA_2564_2598.doc

Attached please find draft RAI No. 227 regarding your application for standard design certification of the U.S. EPR. If you have any question or need clarifications regarding this RAI, please let me know as soon as possible, I will have our technical Staff available to discuss them with you.

Please also review the RAI to ensure that we have not inadvertently included proprietary information. If there are any proprietary information, please let me know within the next ten days. If I do not hear from you within the next ten days, I will assume there are none and will make the draft RAI publicly available.

Thanks,
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AREVA NP Inc.
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QUESTIONS for PRA Licensing, Operations Support and Maintenance Branch 1 (AP1000/EPR Projects) (SPLA)

19-284

(Follow-up to Question 19-68) The staff needs additional information on the software common-cause failures (CCF) modeled in the U.S. EPR probabilistic risk assessment (PRA) to conclude that the low postulated failure rates do not result in an over-optimistic estimation of risk. Specifically:

a. The assumed software CCF probabilities can be found in Final Safety Analysis Report (FSAR) Table 19.1-13, but not in the text of Section 19.1.4.1.1.3 where digital instrumentation and control (I&C) modeling is discussed. Revise the FSAR to state the software CCF probabilities assumed.

b. Page 19.1-34 of the FSAR states that the TELEPERM XS (TXS) “operating history…is used to generate a bounding value” for the operating system CCF probability. Interim Staff Guidance (ISG) DI&C-ISG-03 cautions that “extrapolation of statistical data of the same system used in a different operating environment or profile is not necessarily meaningful.” Discuss how this bounding value was developed, including a justification of the applicability of operating history to a new environment in which a different set of input parameters could reveal a fault not exposed in the previous operating history. Revise the FSAR to include a summary of this information, and confirm that all important assumptions implicit in the operating system CCF value are included in FSAR Table 19.1-109.

c. Page 19.1-34 states that application software CCF probabilities are “based on comparison of the software development…process and the TXS platform design characteristics with applicable international standards.” Revise the FSAR to describe the specific process and design characteristics that contribute to the low application software CCF probability. Discuss how the software development process supports the assumption that the application software in diversity groups A and B can be considered independent in the PRA, given the use of “qualified software functional blocks from a controlled library.” Confirm that all important assumptions implicit in the application software CCF value are included in FSAR Table 19.1-109.

d. Confirm whether the error factor of five used for digital I&C equipment (stated in FSAR Section 19.1.4.1.2.7) was also applied to the operating system and application software CCFs. Justify the uncertainty parameters applied to software CCFs given the limited state of knowledge about these failures. Revise the FSAR to include a summary of this information.

e. The sensitivity studies performed in response to Question 19-68 provide useful information on the effect of modeling uncertainty on the at-power core damage frequency (CDF). However, the effect of these sensitivity cases on both CDF and large release frequency (LRF) resulting from all modes of operation is unclear. Provide CDF and LRF results from the fourth sensitivity case for both at-power and shutdown modes.

f. In the sensitivity studies performed in response to Question 19-68, the operating system and application software CCF probabilities are increased by one order of magnitude (to 1E-6 and 1E-4, respectively). So that the staff can understand the importance of low software CCF probabilities to the overall risk profile, provide the CDF and LRF results from a sensitivity study in which these probabilities are increased to demonstrably conservative values (e.g., 1E-4 and 1E-3).

19-285

(Follow-up to Question 19-125) The significant sequences (i.e., those with a sequence frequency greater than 1 percent of internal events or shutdown core damage frequency (CDF) or those that have an aggregate contribution of 95 percent of CDF when ranked by frequency) provided in response to Question 19-125 yield different insights than the cutset groups listed in FSAR Table 19.1-7. For example:

- The response to Question 19-125 states that sequence 14 in the loss-of-offsite-power (LOOP) event tree has a sequence frequency of 8.58E-8 per year (/yr), about 30 percent of the internal events point estimate for CDF. In comparison, the first cutset group in FSAR Table 19.1-7 includes cutsets from this sequence that are included in the top 100 cutsets, and represents only about 19 percent of the internal events CDF.

- The top five cutset groups based on the percent contributions listed in FSAR Table 19.1-7 are 1 (LOOP-14), 9 (SLOCA-17), 17 (ATWS-12), 8 (SLOCA-34), and 18 (GT-15). In contrast, the top five sequences based on the response to Question 19-125 are LOOP-14, GT-15, SLOCA-17, SLOCA-34, and LOOP-45.

The staff uses the significant cutsets and sequences to communicate important scenarios both to other reviewers and to the public in the Safety Evaluation Report (SER). In addition, the staff uses individual cutsets to understand the modeling of systems and operator actions. Therefore, the staff needs to see both cutsets and sequences and understand the reasons for any discrepancies in the rankings.

a. Revise the FSAR to include a ranking of significant sequences (those provided in response to Question 19-125), with a description of each. The representative cutsets and sequence descriptions currently provided in FSAR Table 19.1-7 are one way of describing the sequences.

b. Provide (in the RAI response only) the top 10 cutsets for each significant sequence, or the cutsets contributing 95 percent to the sequence frequency, whichever is less.

c. Provide (in the RAI response only) the top 200 core damage cutsets for internal events, internal fire, internal flooding, shutdown, and the total at-power and shutdown model.

19-286

(Follow-up to Question 19-143) The response to Question 19-143 states that "JNG10AA192 injection safety valve is screened [for spurious operation and flow diversion during shutdown] because this is a 1-inch line downstream of the low head safety injection (LHSI) minflow orifice." However, cutset group 13 in Table 19.1-92 includes event "JNG10AA192SPO," premature opening of safety valve JNG10AA192. Clarify why this failure event appears in the shutdown PRA. Discuss how the screening approach described in the response to Question 19-143 was communicated to the PRA developers, and discuss whether any similar discrepancies exist.

19-287

(Follow-up to Question 19-259) The response to Question 19-259 discusses the undeveloped basic events used for the process automation system (PAS) and safety automation system (SAS). It appears that, other than the sensors that may provide input to both the protection system (PS) and these systems, no dependency is assessed between the PS and PAS or SAS. The descriptions of all three systems, as well as that of severe accident (SA) I&C, in FSAR Section 7.1 state that they include "subracks, I/O modules, function processors, and communication modules, and optical link modules." The staff needs additional information to understand how these systems are modeled in the PRA.

a. List the systems or functions (e.g., EDG actuation, partial cooldown) that the PRA assumes are actuated by each I&C system. For systems or functions actuated by the PS, state which diversity group is assumed to support the actuation.

b. Describe all scenarios that include independent failures of both PS and another digital I&C system (e.g., PAS, SAS, SA I&C).

c. Discuss whether CCFs of I&C components, which are modeled in detail for the PS, could be expected to affect PAS or SAS as well. If so, how is this dependence modeled in the PRA?

19-288

Page 19.1-45 of the FSAR states that "[t]he model is solved by using a 1E-20 truncation limit, and a 1E-6 relative truncation limit. The CDF quantification, for Level 1 at power, all events, resulted in over 73,000 cutsets." The staff needs additional information on these truncation limits to determine that the reported CDF adequately represents the U.S. EPR design. Specifically, address the following topics and revise the FSAR as appropriate.

a. Describe the evaluation performed to determine that these truncation limits were appropriate (e.g., results had converged).

b. Define the "relative truncation limit."

c. Justify the 1E-6 relative limit given the high level of redundancy in the U.S. EPR design, which would yield many low-frequency cutsets with different combinations of independent failures.

19-289

(Follow-up to Questions 19-4 and 19-258) FSAR Section 19.1.4.1.4 and the response to Question 19-4 provide the data sources and failure data used in the U.S. EPR PRA. However, the rationale for selecting the specific data source used for each failure in the PRA is not provided. For example, the response to Question 19-258 states that failures from European sources are "sometimes based on standby failure rates" without discussing whether standby or demand failure rates are appropriate for the failures being modeled. Provide a detailed discussion of the U.S. EPR failure database development process, including (a) a rationale for the data sources used for the failures identified in Table 19-04-1, and (b) a discussion of how failure models (e.g., standby versus demand) were selected for the basic events.

19-290

(Follow-up to Questions 19-126 and 19-260) The response to Question 19-260 identifies a beta factor of 2.81E-2 for failure of the two station blackout diesel generators (SBODG) to run, using CCF data for emergency diesel generators (EDG). The basic event data provided in response to Question 19-126 indicates that the SBODG failure probability over the mission time is 5.44E-2, about twice the EDG failure probability. As a result, the independent failure of both SBODGs appears to have a higher probability than a CCF, resulting in the cutset presented in group 4 of Table 19.1-7. Typically, CCFs are more likely than independent failures. Justify this treatment or revise the PRA as appropriate. Discuss whether similar discrepancies exist for other components modeled in the PRA.

19-291

(Follow-up to Question 19-249) The sensitivity study performed in response to Question 19-249 demonstrates a significant difference in both CDF (nearly 40 percent reduction) and the overall risk profile when component cooling water system (CCWS) trains 2 and 3 are operating rather than trains 1 and 4. This difference demonstrates the importance of the assumption that the CCWS common header switchover fails following a ventilation failure, leading to failure of CCWS-cooled ventilation in a second safeguard building (SB) and thereby failure of that building's equipment.

FSAR page 19.1-37 indicates that the heat-up of electrical rooms in the affected SB is "relatively slow" and that equipment is lost after about two hours. The operators' ability to start a maintenance train of ventilation or to recover room cooling is credited in the PRA. However, no automatic or operator actions related to the CCWS system (e.g., swapping to a standby train before the running train fails) are credited.

FSAR page 19.1-61 states that "[s]ensitivity studies did not identify any events where a design change would lead to a significant reduction in the CDF." The staff views this ventilation dependence, which page 19.1-37 indicates is a conservative assumption in a PRA model designed to be realistic, as a candidate for a significant reduction in CDF. How were the effects of the current ventilation and CCWS model on the PRA results communicated to plant designers? Discuss any design changes, such as automatic actions or procedural steps (operator actions), that were considered to eliminate or reduce the likelihood of this scenario in the PRA. Justify why these changes were not implemented.

19-292

(Follow-up to Question 19-203) The response to Question 19-203 states that the general transient (GT) initiating event includes spurious actuation of the PS. How are I&C failures (e.g., software CCF) that could both cause an initiating event and affect mitigation considered in the PRA?

19-293

(Follow-up to Question 19-260) The table of CCF parameters provided in response to Question 19-260 shows separate CCF groups for processors in seven different actuation logic units (ALU) and acquisition and processing units (APU). Even if these processors perform different functions, they could be of the same type with common manufacturing, maintenance, or installation errors. Therefore, justify the use of separate CCF groups. Revise the FSAR to document any important assumptions related to CCF of these processors.

19-294

(Follow-up to Question 19-260) The table of CCF parameters provided in response to Question 19-260 shows separate CCF groups for many similar sensors (e.g., different groups for each steam generator's level and pressure sensors, different groups for pressurizer and hot leg level sensors). Justify each group of sensors with reference to the function, operating environment, and potential for manufacturing, maintenance, and installation errors. Revise the FSAR to document any important assumptions related to CCF of these sensors.

19-295

(Follow-up to Question 19-260) The table of CCF parameters provided in response to Question 19-260 does not include CCFs of analog or digital input and output modules, for which failure data was provided in response to Question 19-4. Clarify whether CCFs of these modules were postulated; if not, justify their exclusion.

19-296

(Follow-up to Question 19-274) The response to Question 19-274 describes the use of the demineralized water distribution system (DWDS) or fire water distribution system (FWDS) to refill an emergency feedwater system (EFWS) tank. An operator action with a human error probability (HEP) of 8E-4 is postulated. The staff needs additional information to understand this operator action.

a. Describe how the HEP of 8E-4 was estimated.

b. Clarify the procedural steps required to refill the tank(s). Describe which system is used first and the cues for detecting a failure in the system and deciding to use another system. Discuss how the HEP accounts for these actions.

c. Discuss which valves, pumps, and other equipment must be manipulated to enable injection from DWDS or FWDS. For example, the DWDS injection point is unclear. FSAR Figure 10.4.9-1 Sheet 2 shows a manual valve separating EFWS from DWDS (30LAR10 AA318) on the "typical" train. FSAR Tier 1 Table 2.2.4-1 shows one DWDS isolation valve (30LAR04AA001) in building 4, and FSAR Tier 1 Figure 2.2.4-1 indicates that the DWDS communicates with all four trains via this input. Clarify how the operator ensures that makeup flow is not lost via the tank with a pressure boundary failure.

d. If failures of the DWDS and FWDS that prevent refill of the tank(s) are not modeled in the PRA, provide a quantitative justification for their exclusion. Describe how components from these systems were considered for input to the reliability assurance program (RAP) and other programs that receive input from the PRA.

19-297

(Follow-up to Question 19-274) For the sensitivity study performed in response to Question 19-274, it is unclear how the logic representing "[i]f one (or more) EFW[S] trains are unavailable" and "[i]f one EFW[S] train is unavailable due to a pressure boundary failure" was developed. Provide revised EFWS fault trees that show the changes made, as well as any other relevant PRA changes, so that the staff can understand the effect on the model. If the eventual PRA update will be implemented differently from the sensitivity study, discuss how it will be implemented.

19-298

(Follow-up to Question 19-277) In response to Question 19-277, AREVA evaluated hydrogen deflagration loads in containment assuming 75 and 50 percent passive autocatalytic recombiner (PAR) availability. The staff also noted that AREVA also added an insight to FSAR Table 19.1-109 recommending PAR availability during shutdown. However, PAR availability is not required by technical specifications. Thus, the staff requests information concerning how many PAR units have to be out of service to reach the containment hydrogen mass of 940 kg which was used for deflagration load calculations in the shutdown Level 2 analysis.

19-299

(Follow-up to Question 19-282) In response to Question 19-282, the assumption that the remote shutdown station (RSS) is available was added to FSAR Table 19.1-109. However, because fires during shutdown are not modeled in the PRA, the risk impact of MCR fires during shutdown is unclear. The staff observes that the low CDF from main control room (MCR) fires occurring at power depends on a fire frequency of 4.2E-4/yr and an HEP for the transfer action of 7E-5. The response to Question 19.01-34 states that MCR fires are assumed to cause a loss of balance of plant (LBOP), after which 90 minutes are available to take action; the HEP is based on these assumptions. The staff requests additional information on MCR fires during shutdown, specifically:

a. Discuss whether the at-power HEP for transfer to the RSS is also applicable to shutdown scenarios, assuming that the RSS is available during shutdown. In the response, discuss the initiating event assumed to occur following a MCR fire during shutdown and how long the operator has to respond.

b. Discuss whether the MCR fire frequency assumed in the at-power model is also applicable to shutdown.

c. Justify the lack of technical specifications (TS) for the RSS during shutdown MODES 4, 5, and 6. The staff observes that other systems were added to TS during shutdown based on risk arguments (see the response to Question 19-269b). Although the mitigation credit (based on realistic availability of the RSS and the associated HEP) is not currently known, MCR fires without the RSS available would lead directly to core damage using the assumptions from the at-power PRA.

d. Revise the FSAR to include a summary of this information, which is needed for the staff to conclude that the risk from MCR fires during shutdown is insignificant or enveloped by the at-power estimate.

19-300

Follow-up to Question 19-223 of RAI 97 - The following findings and questions relate to the sensitivity study discussed in the response to Question 19-223.

1. Please provide the number of each ignition source in each PFA and the total number of items per equipment type in the generic locations that were used to establish the ignition source weighting factor.
2. Provide the bases for the fire frequency reductions shown in Column 3 “PFA frequency adjusted for fire severity (1/yr)” of Table 19-223-2.
3. Provide the basis for the exclusion of air compressors, dryers, hydrogen tanks/fires from the fire frequency estimate and justify the impacts of these components on the fire frequency.
4. Justify the exclusion of cable fires (including self-ignited cable fires) from the fire frequencies and why cable fire impacts can be neglected from the fire PRA.
5. Which PFA does the fire scenario “Cabinet fires resulting in a loss of single bus” in Table 19-223-2 belong to?
6. Provide details on how the weighting factors for ignition frequency bins involving transient combustibles/ activities were estimated and distribued.

19-301

The use of either NUREG/CR-6850 main control board fire frequency or RES/OERAB/S02-01 control room fire frequency to represent EPR control room fire may not be appropriate. The fire ignition frequencies provided in these documents are primarily derived from the existing power plants equipped with analog technology. However, per design, the EPR main control room is a compact cockpit-style; a workstation which is entirely driven by digital computers and visual display monitors rather than analog hardware. Thus, please demonstrate that using MCR ignition frequency of either 7.2E-3/yr or 2.6E-3/yr is realistic and practical for EPR design.

19-302

Follow-up to Question 19.01-29 of RAI 66 - The response to Question 19.01-29 states that “Due to the large size and small combustible loading of the PFA, a fire that would affect all components is not postulated. Instead, a specific analysis of vulnerable locations is performed.

Reactor coolant pump fires due to oil leakage have been the source of most fires in-containment in operating history. Due to the specific oil collecting system described in U.S. EPR FSAR Tier 2, Section 5.4.1.2.2, it was concluded that this event could not occur in the U.S. EPR. Reactor coolant pump fires are therefore not analyzed as a credible fire scenario."

The staff could not find sufficient design information regarding the specific oil collecting system in EPR FSAR Section 5.4.1.2.2 concluding that reactor coolant pump fires could not occur. The staff needs detailed design information to understand how EPR oil collecting system would prevent RCP fires. Also, the RCP fire frequency of 6.1E-3/yr provided in NUREG/CR-6850 was derived from the RCPs that are also equipped with oil collection systems. Thus, neglecting this frequency and using 1.9E-5/yr for containment fires is not practical; please revise fire area PFA-CNTMT frequency to correctly address RCP and containment fires or provide further justification for the exclusion.

In addition, provide the justification for excluding containment transients and hotwork (Bin 3 of NUREG/CR-6850 Table 6-1). Note that, the response to Question 19.01-29 does not address justification for the exclusion of transient ignition frequency as requested.

19-303

Please clarify whether the biological events are included in the loss of condenser heat sink frequency, loss of balance of plant frequency, and/or loss of main feedwater frequency used in the US EPR PRA or not.