ArevaEPRDCPEm Resource

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Sent: Wednesday, June 02, 2010 7:12 AM
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Subject: U.S. EPR Design Certification Application RAI No. 389 (4615), FSAR Ch. 6
Attachments: RAI_389_SPCV1_4615.doc

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on April 12, 2010, and discussed with your staff on April 22, 2010 and May 6, 2010. Drat RAI Question 06.02.02-49 was modified as a result of those discussions. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
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Hearing Identifier: AREVA_EPR_DC_RAIs
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Request for Additional Information No. 389(4615), Revision 1

6/2/2010

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 06.02.02 - Containment Heat Removal Systems
Application Section: FSAR Chapter 6

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

06.02.02-47

In the revised GOTHIC model the fluid entering the core is limited to that which is boiled away by decay heat plus 5% of the total ECCS flow. The 5% of ECCS fraction is assumed to be carried out of the core as liquid. One quarter of this liquid flow is assumed to be turned to steam as the remaining sensible heat is removed from the reactor system metal above the reactor vessel nozzles and from the broken loop steam generator metal and fluid. This steam flows into the containment building and acts to pressurize the containment. The remaining three quarters of the liquid flow is assigned to the intact loops where any steam produced is condensed by the ECCS water injected in the cold legs. The NRC staff requested additional justification for the 5% of total ECCS flow entrainment assumption. See RAI 221 06.02.01-35a. The NRC staff questioned the validity of the assumed equal flow split. See RAI 221 06.02.01-35b.

AREVA responded to these RAIs by comparing the integrated heat flow to the steam and to the liquid in the reactor system between the GOTHIC reactor system model and that calculated by RELAP5-BW. The RELAP5-BW analysis does not assume the loop seals to be blocked and calculates its own liquid entrainment and flow split. The staff has not accepted the M&E results from RELAP5 beyond the time when AREVA assumes that the intact loop seals could be blocked in ANP-100299P Rev. 2. This is because RELAP5-BW may calculate the steam source to the containment to be too low because of non-conservative assumptions for steam condensation in the cold legs beyond the time when the intact loop seals could be blocked.

The staff therefore requests that AREVA calculate the M&E source for cold leg breaks using phenomenological considerations for two phase level swell in the core and to assume that all steam and water carried out of the reactor vessel travels out of the broken loop after the time when the loop seals in the intact cold legs are blocked. With the revised M&E source, calculate the containment pressure for cold leg breaks using AREVA's multi-noded GOTHIC containment model.

06.02.02-48

FOLLOW-UP TO RAI 297, QUESTION 06.02.01-49.

Redundancy and diversity of the mixing damper opening signal is briefly mentioned in Response to RAI 297, Question 06.02.01-49; namely:

"The opening signal is provided by diverse means – either eight redundant delta pressure sensors or two redundant absolute pressure measurements sensors"

The CONVECT system is a safety-related system. The mixing dampers are part of the CONVECT system. Provide to the following additional information:

a. Has a failure mode analysis of the mixing dampers been performed? Where is the failure mode analysis documented? Describe these evaluations.

b. What is the actuation logic of the eight delta pressure sensors? What signal is needed to open the dampers? Is the delta pressure signal one directional?

c. Will the delta pressure signal open dampers if the break is in the annular space? What restrictions are placed on plant operation if one of the absolute pressure sensors is out of order?

d. Have potential common mode failure of the mixing dampers been addressed? Where is the common mode failure analysis documented? Describe these evaluations.

06.02.02-49

In case of a postulated DBA, containment heat removal is a major safety function. Appropriate systems must be provided, and the capacity of the systems must be evaluated. Section 6.2.2 of the FSAR is the appropriate place for description of the containment heat removal systems, the performance evaluation of the systems and the demonstration of compliance with GDC 38.

U.S. EPR, Tier 2, Section 6.2.2 provides only a general description of containment heat removal following DBAs. It references Section 6.2.1 for containment pressure and temperature response calculations, and Section 6.3 for the design, inspection and testing of the SIS, and for sump screen blockage. This is important information, but not sufficient for an independent evaluation of the containment heat removal systems. More detail is needed

The FSAR should have, preferably in Section 6.2.2, the following information. If some of the information is provided in another section of the FSAR, this section should be referenced. Conclusions reached on containment heat removal systems should be summarized in Section 6.2.2. Safety systems frequently perform more than one function, in Section 6.2.2 the emphasis should be on short and long term containment cooling.

Provide the following information in the FSAR in accordance with RG 1.206:

a. General description of containment heat removal, identification of safety systems performing this function.

b. Detailed description of each system, safety classification of components of the system.

c. Identification of potential single active and single passive failures of the system, including common mode failures. Evaluation of the effects of these failures on containment heat removal.

d. Specification of design features of the heat removal systems that permit periodic inspection of components and periodic testing of the systems.

e. Analysis of the heat removal capacity of each system.
f. Evaluation of potential surface fouling of the LHSI heat exchangers in the recirculation system.

Among other information, Section 6.2.2 should address or reference the following items:

1. Design and operation of the ECCS including the IRWST as they function as containment heat removal system including the deliverance of cooled ECCS in a manner that will condense significant amounts of steam.

2. Long term water source for the ECCS. Design principle used to prevent water accumulation in the containment. Flow path for gravity flow, draining of rooms with solid floors. Prevention of flow blockage in restricted places.

3. Design features to retain debris: weirs, trash racks, retaining baskets, sump strainers.

4. Quantitative evaluation of containment related input to the NPSH calculations: water holdup in the containment, head loss caused by debris blocking sump strainers, air ingestion based on sump hydraulic characteristics, downstream effects of debris passing the sump strainers. Availability of sufficient NPSH for short and long term cooling of the containment.

5. Potential for surface fouling of heat exchangers. The effect of fouling on heat removal. Justification of fouling factors used. Verification of GOTHIC heat exchanger model.

6. Description and operation of the CONVECT system. Safety classification of the system, corresponding ITAAC and Tech. Spec., initial testing of the system.

7. Testing of components of the CONVECT system.

8. Redundancy and diversity in the control of the mixing dampers. Single failure and common mode failure analysis.

9. Performance of the CONVECT system in case of large and small LOCAs and large and small MSLBs, breaks located in equipment space, breaks located in annular space.

06.02.02-50

One of the main mechanisms for containment heat removal is the concrete heat structures within the containment building.

a. The amount of heat transferred to these structures depends on the assumed thermal conductivity and heat capacity of the concrete. Structural concrete used at different sites differ in properties which may change as the concrete ages. The change in properties with aging is a function of the environment to which the concrete is exposed.

The GOTHIC containment calculations used a conductivity of 1.012 BTU/hr-ft-F for concrete and a heat capacity of 0.22928 BTU/lbm-°F. Document the source of this information. Justify the selection of the concrete properties used in the GOTHIC calculations cover all potential construction sites in the U.S. Describe the inspections which will be conducted to ensure that the containment concrete for each site will adsorb at least as much heat as assumed in the FSAR. Describe the surveillances which will be performed to ensure that the concrete properties do not change with time so as to provide less heat absorption capability than that assumed in the FSAR.

b. The amount of heat transferred to the containment concrete shell is dependent on the gap thickness between the liner and the concrete. A value of 3 mm was listed in the FSAR Table 6.2.1-4. Justify the selection of this gap thickness. Describe the inspections which will be conducted to ensure that the liner to concrete gap thickness at each site will not exceed that assumed in the GOTHIC calculations. Describe the surveillances which will be performed to ensure that the gap thickness does not change with time so as to provide less heat absorption capability as that assumed in the GOTHIC calculations.

06.02.02-51

Interim FSAR Revision 2 Table 6.2.1-25, “MSLB Reactor Trip and Isolation Signal Summary” includes steam generator isolation on high containment pressure to mitigate small steam line breaks. Include this signal in the steam generator isolation discussions of FSAR Chapter 7.3 “Engineered Safety Features Systems”.