

KHNPDCRAIsPEm Resource

From: Ciocco, Jeff
Sent: Tuesday, February 23, 2016 10:48 AM
To: apr1400rai@khnp.co.kr; KHNPDCRAIsPEm Resource; Andy Jiyong Oh; James Ross; Young H. In (yhin@enercon.com)
Cc: Nakanishi, Tony; Mrowca, Lynn; Steckel, James; Lee, Samuel
Subject: APR1400 Design Certification Application RAI 418-8348 (19 - Probabilistic Risk Assessment and Severe Accident Evaluation)
Attachments: APR1400 DC RAI 418 SPRA 8348.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, the following RAI question response times. We may adjust the schedule accordingly.

19-43: 180 days
19-44: 180 days
19-45: 45 days
19-46: 45 days
19-47: 45 days
19-48: 45 days
19-49: 45 days
19-50: 45 days
19-51: 60 days
19-52: 60 days

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

Jeff Ciocco
New Nuclear Reactor Licensing
301.415.6391
jeff.ciocco@nrc.gov



Hearing Identifier: KHNP_APR1400_DCD_RAI_Public
Email Number: 468

Mail Envelope Properties (f642403cc84642ba8a975baea394146f)

Subject: APR1400 Design Certification Application RAI 418-8348 (19 - Probabilistic Risk Assessment and Severe Accident Evaluation)
Sent Date: 2/23/2016 10:47:56 AM
Received Date: 2/23/2016 10:47:59 AM
From: Ciocco, Jeff

Created By: Jeff.Ciocco@nrc.gov

Recipients:

"Nakanishi, Tony" <Tony.Nakanishi@nrc.gov>
Tracking Status: None
"Mrowca, Lynn" <Lynn.Mrowca@nrc.gov>
Tracking Status: None
"Steckel, James" <James.Steckel@nrc.gov>
Tracking Status: None
"Lee, Samuel" <Samuel.Lee@nrc.gov>
Tracking Status: None
"apr1400rai@khnp.co.kr" <apr1400rai@khnp.co.kr>
Tracking Status: None
"KHNPDCDRAIsPEM Resource" <KHNPDCDRAIsPEM.Resource@nrc.gov>
Tracking Status: None
"Andy Jiyong Oh" <jiyong.oh5@gmail.com>
Tracking Status: None
"James Ross" <james.ross@aecom.com>
Tracking Status: None
"Young H. In (yhin@enercon.com)" <yhin@enercon.com>
Tracking Status: None

Post Office: HQPWMSMRS07.nrc.gov

Files	Size	Date & Time
MESSAGE	816	2/23/2016 10:47:59 AM
APR1400 DC RAI 418 SPRA 8348.pdf		108717
image001.jpg	5040	

Options

Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

REQUEST FOR ADDITIONAL INFORMATION 418-8348

Issue Date: 02/23/2016

Application Title: APR1400 Design Certification Review – 52-046

Operating Company: Korea Hydro & Nuclear Power Co. Ltd.

Docket No. 52-046

Review Section: 19 - Probabilistic Risk Assessment and Severe Accident Evaluation

Application Section:

QUESTIONS

19-43

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section “II. Acceptance Criteria,” states that the staff determines whether, “...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant’s PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200).”

To allow the staff to reach a reasonable assurance finding on APR1400 PRA technical adequacy of the PRA, please provide the following information related to cutsets, accident sequences, and truncation by updating the DCD and supporting documents, as necessary, for the items below.

a) Additional cutset and accident sequence information

1. For each combination of hazard group (e.g., internal, fire, flooding), operational mode (e.g., at-power, low power and shutdown), and PRA Level (e.g., Level 1, Level 2) analyzed in the APR1400 design certification PRA, please update the DCD cutsets tables to include the basic event probabilities.
2. In addition, please include in the DCD, tables of accident sequence information, similar to Table 19.1-18 “Level 1 Internal Events Top Accident Sequences,” (e.g., sequence ID, frequency, cumulative contribution, sequence cutsets, sequence summary description), for the other PRA models.
3. For each combination of hazard group (e.g., internal, fire, flooding), operational mode (e.g., at-power, low power and shutdown), and PRA Level (e.g., Level 1, Level 2) analyzed in the APR1400 design certification PRA, please update the cutsets tables to cover a sufficiently comprehensive portion (e.g., 95 percent) of the corresponding cumulative core damage frequency and large release frequency. Also, please include the basic event probabilities in these tables.

b) Truncation limit justification

For each combination of hazard group (e.g., internal, fire, flooding), operational mode (e.g., at-power, low power and shutdown), and PRA Level (e.g., Level 1, Level 2) analyzed in the APR1400 design certification PRA, please specify and justify the chosen truncation limit, with the exception of LPSD Level 1 analyses (internal events, fire, and flooding).

REQUEST FOR ADDITIONAL INFORMATION 418-8348

19-44

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

To allow the staff to reach a reasonable assurance finding on APR1400 PRA technical adequacy of the PRA, please include an evaluation of the parametric uncertainty intervals in the DCD for: Level 1 and Level 2 PRA models for at-power internal fire and at-power internal flooding.

19-45

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design-specific PRA. SRP Chapter 19.0, Revision 3, Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

It also states that, "...the applicant's uncertainty analysis identifies major contributors to the uncertainty associated with the estimated risks."

SRP Chapter 19.0, Revision 3, Section "III. Review Procedures," states:

"The staff will determine that the applicant has performed sensitivity studies sufficient to gain insights about the impact of uncertainties (and the potential lack of detailed models) on the estimated risk. The objectives of the sensitivity studies should include (1) determining the sensitivity of the estimated risk to potential biases in numerical values, such as initiating event frequencies, failure probabilities, and equipment unavailabilities, (2) determining the impact of the potential lack of modeling details on the estimated risk, and (3) determining the sensitivity of the estimated risk to previously raised issues (e.g., motor-operated valve reliability)."

It also states:

"...it is acceptable to make bounding-type assumptions consistent with the guidelines in RG 1.200. However, the risk models should still be able to identify vulnerabilities as well as design and operational requirements such as ITAAC and COL action items. In addition, the bounding assumptions should not mask any risk-significant information about the design and its operation."

To allow the staff to reach a reasonable assurance finding on the scope, level of detail, and technical adequacy of the APR1400 design certification PRA, the staff needs to understand how uncertainties in key assumptions impact risk quantification and risk insights. The staff notes that NUREG-1855, Revision 1, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking," discusses the three types of uncertainty: completeness, parametric, and modeling. Based on review of the DCD, the staff finds that both the identification of key assumptions and the assessment of uncertainty in the stated key assumptions may not be complete. For low power and shutdown, the staff noted the statement in DCD Sections 19.1.6.1.2.7 and 19.1.6.3.2.4 that, "Modeling uncertainty is not represented in the shutdown model."

REQUEST FOR ADDITIONAL INFORMATION 418-8348

The staff reviewed Table 19.1-4 of the DCD which lists the key assumptions used in the PRA. However, Table 19.1-4 does not identify any key assumptions related to several PRA models (e.g., internal fire at power, internal flooding at power, as well as low power and shutdown). Furthermore the staff finds that in some areas, the DCD does not document the evaluation of uncertainties associated with the key assumptions in Table 19.1 4. Identification of key assumptions in the DC application is important as the staff would need to validate this information for a future COL application referencing the DC.

Below are some example assumptions that should be evaluated for uncertainty:

- conditional core damage and large release probability associated with main control room abandonment scenarios
- fire ignition frequencies (e.g., consideration of more recent at-power and LPSD fire ignition frequency estimates)
- fraction of the room volume filled by equipment for internal flooding analysis
- RCP seal failure probability and model
- human error probabilities

To address the issues described above:

1) Update the DCD with a comprehensive assessment (not limited to these examples) of the impact of uncertainties in key assumptions:

- risk insights, such as risk-significant equipment or operator actions, and important accident sequences, and
- risk quantifications (of CDF and LRF)

2) Ensure that the uncertainty assessment considers all PRA models included in the APR1400 DC PRA (i.e., all operating modes, hazards, and PRA levels).

3) Ensure that any key assumptions related to any PRA model are identified in DCD Table 19.1 4.

19-46

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section II. "Acceptance Criteria," states that the staff determines whether "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

The staff reviewed DCD, Tier 2, Figure 9.5A-3, and found that the large emergency diesel engine fuel oil system storage tanks appear to be located in or adjacent to the auxiliary building. The staff is not clear if these fuel oil storage tanks have been evaluated as potential combustible sources that can significantly exacerbate a potential fire scenario occurring in their vicinity. Therefore, in order for the staff to reach a reasonable assurance finding, please address the following items:

a) Include in the DCD, an assessment of the potential combustible source's impact to the APR1400 internal fire risk

REQUEST FOR ADDITIONAL INFORMATION 418-8348

- b) Justify the exclusion of the potential for an ignition source to cause a secondary ignition of oil that might leak from the tank, either randomly or as a result of the tank being heated and possibly breached
- c) Identify any communication paths between the rooms housing the fuel oil storage tanks and other rooms housing important equipment
- d) Clarify the possibility of fire, smoke, gas, etc., to affect nearby compartments, including the remote shutdown panel and the main control room
- e) Describe the potential consequence of such a scenario, irrespective of the likelihood of such scenario involving the large fuel oil storage tank.

19-47

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

To allow the staff to reach a reasonable assurance finding on APR1400 PRA technical adequacy, please:

- a) Include in the design control document (DCD) the basis for excluding the fire-induced opening of POSRVs as an initiating event
- b) If power is removed from certain valves to prevent the inadvertent opening of the POSRVs, discuss in the DCD how this configuration and relevant procedures are addressed in the PRA models and in the HRAs for the feed and bleed operation.

19-48

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

REQUEST FOR ADDITIONAL INFORMATION 418-8348

The staff reviewed the applicant's human reliability analysis (HRA) performed to support the internal fire PRA, for both at-power and LPSD conditions, and found that a sufficient description of the HRA is not available in the DCD. Please include in the DCD a summary of the HRA performed to support the internal fire analysis for both at-power and LPSD conditions, and include any relevant assumptions used.

19-49

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

The staff noted that the PRA documentation (APR1400-K-P-NR-013503-P) considered flooding initiating events caused by inadvertent operation or erroneous operation of a plant component during maintenance.

The applicant concluded that these scenarios do not contribute significantly to the overall initiating event frequency. Please justify this conclusion in the DCD, for both at-power and LPSD conditions.

19-50

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

According to the DCD, in cases where there is a potential for more than one fire-induced initiator to occur in a given fire compartment, the applicant established a hierarchy of initiating events "wherein perceived worst-case initiators were given preference over lesser initiators." Please provide additional basis in the DCD for establishing this hierarchy and how this assumption may impact the PRA.

REQUEST FOR ADDITIONAL INFORMATION 418-8348

19-51

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3 (Draft), Section "II. Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

The PRA documentation (APR1400-K-P-NR-013759-P) indicates that subjects such as flood area definition, identification of flood sources and propagation paths, and plant operating states are largely unchanged from the at-power internal flooding analysis. To ensure that the potential flood propagation paths for LPSD conditions have been properly evaluated, please describe in the DCD, how flood barriers assumed to be intact during at-power conditions that may not necessarily be intact during LPSD conditions are addressed in the LPSD analysis.

19-52

10 CFR 52.47(a)(27) requires that a standard design certification applicant provide a description of the design specific PRA.

SRP Chapter 19.0, Revision 3, Section II, "Acceptance Criteria," states that the staff determines whether, "...the technical adequacy of the PRA is sufficient to justify the specific results and risk insights that are used to support the DC or COL application. Toward this end, the applicant's PRA submittal should be consistent with prevailing PRA standards, guidance, and good practices as needed to support its uses and applications and as endorsed by the NRC (e.g., RG 1.200)."

To ensure that the potential flood sources (systems) for both at-power and LPSD conditions are properly evaluated, please include the following in the DCD for both at-power and LPSD conditions: 1) the flood sources that were screened out and associated basis for screening, and 2) the flood sources that were screened in (i.e., explicitly modeled in the PRA). For each screened in flood source, please provided the estimated liquid volume that could be released.



U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment