Response to SDAA Audit Question

Question Number: A-19.1-24

Receipt Date: 05/01/2023

Question:

Sensitivity studies listed in Chapter 19 of the FSAR do not provide sufficient information for the staff to understand how the sensitivity was performed and why it addresses an underlying uncertainty or assumption. The staff needs this information on the docket to support its safety finding on the insights from the PRA. For the following sensitivity studies, provide additional description in the SDA FSAR on the magnitude of the change (e.g., by an order of magnitude, from 4.5E-05 to 1.0E-03) to support use of the results of the sensitivity studies for the staff's safety findings. These sensitivity studies support the uncertainties listed in Tables 19.1-14 and 19.1-15 that staff relies on to determine that the uncertainty was adequately addressed for the uses of an SDA PRA.

For full power, internal events:

- Increase LOOP initiating event frequency
- Decrease LOOP initiating event frequency
- Increase SGTF initiating event frequency
- Increase secondary line break initiating event frequency
- Increase CVCS LOCA initiating event frequency
- Increase CVCS line break outside containment initiating event frequency
- Increase failure probability of passive heat removal
- Increase failure probability of ECCS low differential pressure (RRVs)

For full power, external events:

- Increase fraction of external floods that result in a LOOP –
- Increase probabilities of not recovering offsite power in the hurricane high winds PRA
- Increase frequency of a hurricane induced LOOP

For LPSD:

- Increase failure probability of CES

For Multiple Module:

- Reduce MMAFs so that NPM-equipment is less correlated
- Decrease MMPSF for module-specific HFEs

Response:

NuScale has added the requested information to FSAR Table 19.1-22, Sensitivity Studies, for the events listed in the audit issue. In addition, to support the Staff's safety finding, NuScale added similar information to five other events not identified by the NRC. NuScale also corrected an editorial error in the "Factor Change in LRF" column for one of the identified events (under the Multiple Module heading).

To address a concern that was identified during the May 11, 2023 clarification call on Audit Issue A-19.1-3, NuScale edited the "ECCS low differential pressure opening mode" entry in FSAR Table 19.1-15, Design-Specific Sources of Level 1 Model Uncertainty, to clarify that it corresponds to the "ECCS low differential pressure (RRVs)" event described in FSAR Table 19.1-22.

Markups of the affected changes, as described in the response, are provided below:

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Table 19.1-15: Design-Specific Sources of Level 1 Model Uncertainty

Uncertainty Source	Description	Level 1 Assumption	Effect on Model
General			
Design state	Design changes are likely as the design evolves beyond standard design.	The PRA model reflects the current state of design for the standard design.	The PRA model is updated to remain consistent with the maturing design. As such, this is judged not to be a significant source of model uncertainty.
Initiating Event Analysis			
List of initiating events	Comprehensive list of internal initiating events, including potential initiators from other modules.	The PRA model captures potential initiating events; based on a thorough review of potential initiating events. There is not a size of LOCA that exceeds the capability of the ECCS (e.g., reactor vessel rupture).	The PRA model includes a wide range of initiating events to capture potential accident progression scenarios; the initiators cover LOCAs, SGTFs, secondary line breaks, loss of electric power, and transients. As such, this is judged not to be a significant source of model uncertainty.
Operating experience and data	Frequencies for initiating events with no plant experience.	Generic data and plant-specific analyses are representative of the initiating event frequencies.	It is judged that initiating event frequencies are not higher than generic data; the design reflects opportunities to improve SSC based on operating experience. Although generic data are used, a lognormal distribution with an error factor of 10 is used to bound the uncertainty. Sensitivity studies provided in Table 19.1-22 were performed to address Initiating event frequency uncertainty.
Availability and capacity factor	Initiating event frequency adjustment for capacity factor.	Plant availability is assumed to be 100 percent.	The initiating event frequencies are conservative (i.e., they are not weighted by the fraction of time the plant is at power.)
SGTF	Frequency for an SGTF in a helical steam generator with no plant experience.	A study is performed to estimate the frequency of an SGTF based on a probabilistic physics of failure approach.	A sensitivity study (provided in Table 19.1-22 illustrates that an increase in the frequency of an SGTF has no impact on the results. As such, this is judged not to be a significant source of model uncertainty.
Secondary line breaks	Frequency for a secondary line break with no plant experience.	A study is performed to analyze system design to estimate the frequency of a secondary line break.	A sensitivity study provided in Table 19.1-22 illustrates that an increase in the frequency of a secondary line break has no impact on the results. As such, this is judged not to be a significant source of model uncertainty
Accident Sequence Analysis and Success Criteria			
Passive decay heat removal	Reliability and effectiveness of passive decay heat removal systems with no plant experience.	Experimental testing data and design-specific analysis reflect system success criteria and reliability, including availability of the UHS.	A sensitivity study provided in Table 19.1-22 illustrates that there is little effect on CDF with order of magnitude increase in passive heat removal failure probability.

Table 19.1-15: Design-Specific Sources of Level 1 Model Uncertainty (Continued)

Uncertainty Source	Description	Level 1 Assumption	Effect on Model
ECCS low differential pressure opening mode	Reliability of the ECCS low differential pressure (RRVs) operating mode with no plant experience.	The probability of the ECCS low differential pressure (RRVs) opening mode is assumed to be 0.1.	A sensitivity study provided in Table 19.1-22 evaluated the effect of increasing the failure probability as small. In addition, a sensitivity study addressed uncertainty in ECCS actuation because of CCF.
ATWS and definition of core damage	Power oscillations during ATWS sequences.	Only sequences that exceed peak clad temperature are assumed to result in core damage.	Successful end states in the PRA do not require the core to remain subcritical. Because this is not a safety issue as heat removal is effective, it is not expected to be a source of model uncertainty.
Data Analysis			
Mission time	Use of a 72 hour mission time for a passive design. Standard industry PRA practice uses a 24 hour mission time.	Time-dependent component failures generally modeled using a 72 hour mission time.	Use of a 72-hour mission time is consistent with the guidance for passive reactor designs. This may result in conservative equipment reliability estimates.
Testing scheme	Plant testing scheme.	Standby failure rates assume non-staggered testing.	This is conservative assumption; results are slightly conservative in comparison to a staggered testing assumption.
Test and Maintenance Unavailability	Identification and modeling of test and maintenance unavailability events with no plant experience.	Test and maintenance unavailabilities were identified from draft technical specifications, discussions with operations and design engineers, and other PRA models. Unavailabilities are based on generic data.	The PRA model includes several system test and maintenance unavailabilities; although generic data are used, a lognormal distribution with an error factor of 10 is used to bound the uncertainty.
Component failure data	Reliability data with no plant experience.	Generic data are assumed to better represent reliability of components.	Potential for over or under estimating component reliability; this is captured in the parametric uncertainty results and not expected to be a measurable source of model uncertainty.
Common Cause Events	Only intra-system CCF events considered.	Common cause events are considered for intra-system components, based on common coupling mechanisms. Generic NRC data are used for common cause alpha factor parameters.	The only potential for inter-system CCFs (i.e., between different systems that perform a similar function) is between the CVCS and CFDS (e.g., pumps). Because operation of these systems requires operator action, the uncertainty of any potential inter-system CCF is effectively captured in a sensitivity study provided in Table 19.1-22, which addresses HEP.

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Table 19.1-22: Sensitivity Studies

Sensitivity Description	Factor Change in CDF	Factor Change in LRF
Full Power, Internal Events		
~~Increase~~Double the LOOP initiating event frequency	1.3	1.2
Decrease LOOP initiating event frequency by an order of magnitude	0.8	0.9
Increase steam generator tube failure initiating event frequency by more than an order of magnitude, to the generic data value	1.0	1.0
Increase secondary line break initiating event frequency by more than 2 orders of magnitude, to the generic data value	1.0	1.0
~~Increase~~Double the LODC initiating event frequency	1.0	1.0
~~Increase~~Double the CVCS LOCA initiating event frequency	1.0	1.0
Increase CVCS line break outside containment initiating event frequency by an order of magnitude	1.0	3.9
Increase failure probability of passive heat removal by an order of magnitude	1.0	1.0
Increase failure probability of ECCS low differential pressure (RRVs) by a factor of 5	1.2	1.0
Include ECCS low differential pressure opening for RVVs	0.4	0.3
Decrease probability of post-trip RSV demand by a factor of 50	0.9	1.0
Assume core damage RPV overpressure sequences also result in large release	N/A	1.0
All HEPs set to 5th percentile	0.6	0.4
All HEPs set to 95th percentile	2.8	6.4
All CCF set to 0	0.1	<0.1
All CCF set to 95th percentile	>100[1]	>100[1]
Full Power, External Events		
Credit CVCS makeup in non-RXB internal floods	0.8	1.0
~~Minimize~~Set fire PRA growth to false, which stops~~; stop~~ fires before they damage mitigating equipment	0.1	<0.01
~~Minimize~~Set fire PRA growth to true, which ensures~~; allow~~ fires ~~to~~ damage mitigating equipment	14.3	2.5
~~Increase~~Double the fraction of external floods that result in a LOOP	2.0	2.1
Include ~~ECCS~~possibility of RVV low differential pressure opening ~~for RVVs~~ in the external flood PRA	0.4	0.4
Increase probabilities of not recovering offsite power in the hurricane high winds PRA by 50%	1.5	1.6
~~Increase~~Double the frequency of a hurricane induced LOOP	1.9	2.2
Include ~~ECCS~~possibility of RVV low differential pressure opening ~~for RVVs~~ in the hurricane high winds PRA	0.4	0.4
Low Power and Shutdown		
~~Increase~~Double the failure probability of CES in POS6	1.0	1.0
Multiple Module		
~~Reduce~~Decrease MMAFs by an order of magnitude so that NPM-equipment is less correlated	0.6	0.3~~0~~
Decrease MMPSF for module-specific HFEs by a factor of 5	0.5	<0.01

Note 1: Failures assumed to be "as-is" on loss of MPS