

# ASME/ANS JCNRM Standard RA-S

## Part 5 Code Case

Presentation to USNRC  
11 August 2017 Public Meeting

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on behalf of  
JCNRM, JCNRM SC-SM, SC-SM WG5, and WG5 Part 5 Project Team



# Agenda

- Summary of Code Case Scope and Process
- High Level Changes to Part 5
- SHA Changes
- SFR Changes
- SPR Changes



One, single, concise and accurate slide that describes the 3+ years evolution from Addendum B to the Code Case for Part 5.



# **SUMMARY OF CODE CASE SCOPE AND PROCESS**



# SCOPE

- Address insights from application of Addendum B (lessons-learned)
- Maintain a suitable level of consistency with Addendum B.
- In a limited way, address some of the crosscutting and consistency issues to be incorporated into the next edition (within the constraints of the above).

# Process

- Part 5 Project Team develops the code case.
- Reviewed by WG 5, comments addressed
- Reviewed by SC-SM, comments addressed
- First ballot of JCNRM. Not approved. Comments addressed, discuss and negotiate with negative voters, significant changes.
- Reconsideration ballot of JCNRM. Not approved. Discuss and negotiate with negative voters, few changes.
- Recirculation ballot. Approved with negatives. Discuss and negotiate with negative voters, no changes. Negatives remain. Package submitted to ASME BNCS and ANS SB. In final editing and two-week public review.



# HIGH LEVEL CHANGES TO PART 5



# Changes Affecting all TEs

- Elimination of CC-III. Although this is not intended until next edition, it was deemed too much effort for the volunteers knowing it would disappear.
- Consistency in uncertainty requirements across the TEs.
- Consistency in screening concepts.
- Use of action verbs.
- Use of notes and citations of specific methods.



# SHA CHANGES



# Broad SHA Updates

- Updated Standard to reflect current practice (and current guidance)
- Better integration between Standard (what to do) and SSHAC Guidance (how to do it)
- Combined Capability Categories
  - Recognizes that the required attributes of PSHA are the same regardless of complexity of study methods
- Incorporated use of regional models
- Clarified and separated topics to remove issues covered in multiple places

# Topics in SHA-HLRs

- A – Hazard analysis approach and (SSHAC) study level
- B – Input data
- C – Seismic source characterization
- D – Ground motion characterization
- E – Site response
- F – Evaluation and propagation of uncertainties
- G-Spectral shape and vertical motions
- H – Evaluation of existing studies
- I – Secondary hazards
- J – Documentation

# Integration with NUREG-2117

- The Standard has been updated to separate SSHAC Levels from Capability Categories.
  - A tie between SSHAC level and CC was previously in the introduction. Thinking has evolved past this.
  - Appropriate SSHAC Level must be chosen and justified. The SSHAC level describes HOW a study is conducted.
  - The performance (outcome) requirements of the PSHA is the same, regardless of the SSHAC level. This is true for both the Standard and SSHAC guidance.

# Integration with NUREG-2117

- SHA-A1 now reads:

“JUSTIFY the selected level of PSHA analysis to ensure that the process for developing the PSHA model is appropriate. USE a defined process to develop the PSHA model to ensure that the PSHA represents the center, body, and range of the technically defensible interpretations. “
- There is a footnote to SHA-A1 that references NUREG/CR-6372 and NUREG 2117 and SSHAC levels, and notes that these are an acceptable approach for meeting the requirement.
- Footnotes referencing the NUREG/CR-6372 and NUREG 2117 were added throughout the SRs, as appropriate



# Update to Current Practice

- Removed guidance (that was mostly in the form of footnotes) that was out-of-date and/or is now covered by NUREG-2117 and other guidance
- Removed language related to the earlier EPRI and LBNL PSHAs
- Added allowances for regional models (treating them as existing studies)
- Updated treatment of site response and its increased incorporation in PSHA



# Update to Current Practice

- Incorporated use of regional models
  - Reviewed as existing studies (SHA-H)
- Cleaned up language regarding SHA versus PSHA
  - PSHA is one part of SHA
  - Other elements of SHA are “other hazards” (e.g., liquefaction) and vertical-to-horizontal ratios used to develop vertical spectra

# Update to Current Practice

- Addition of explicit definition of epsilon (number of sigmas) of GMPE used in PSHA
- SHA-A6 now reads

JUSTIFY the specified number of standard deviations (epsilon) from the median of the lognormal distribution of the ground motion value (e.g., spectral acceleration) to be included in the analysis of the ground motion prediction equation such that aleatory variability in the ground motion prediction is properly modeled.

SPECIFY if no truncation to the number of standard deviations analyzed is applied.

# Cleaned up SRs related to input data

- SHA-B (Input data) supporting requirements were reorganized for clarity. 3 SRs became 5. All were updated to reflect current terminology. The SR topics are generally:
  - SHA-B1 – Use up-to-date data in the PSHA
  - SHA-B2 – Make sure the dataset is sufficiently complete for seismic source characterization
  - SHA-B3 – Ensure the data is sufficiently complete for ground motion characterization and site response
  - SHA-B4 – If existing studies are used, make sure new data was compiled sufficient to evaluate the models
  - SHA-B5 – Ensure the seismicity catalog is sufficiently complete and up-to-date

# Update to Current Practice

- SRs for SHA-C, SHA-D and SHA-E were mostly just updated to reflect current terminology used by SHA practitioners
- SHA-F (uncertainties) SRs were reorganized for better clarity and updated slightly to reflect current practice
- SHA-G (spectral shape). One SR was changed to 2 SRs to separate requirements for defining horizontal and vertical spectral shapes.

# Update to Current Practice

- SHA-H (existing models). A second SR was added to address regional models that are treated as existing models in the SHA requirements.
- SHA-I (other hazards) was updated slightly

# Update to Current Practice

- Updated reporting requirements on documentation of uncertainties to be more consistent with PSHA studies
  - Previous language that separated out uncertainties was the same for all disciplines. However, it didn't make sense for reporting of PSHA, which addresses uncertainties as an inherent part of the overall process. (SHA-J3 was redundant for SHA and was, therefore, confusing).
- Updated reporting requirements numerical outputs to better reflect expectations of current practice





# SFR CHANGES



**ANS**



# New HLR Structure for SFR

Designator	Requirement
HLR-SFR-A	The seismic-fragility evaluation shall address seismic fragilities of SSCs whose failure may contribute to core damage or large early release, or both.
HLR-SFR-B	The seismic-fragility evaluation shall be based on a seismic response that the SSC experiences at its failure level.
HLR-SFR-C	If SSCs are screened out, the basis for the screening shall be fully described.
HLR-SFR-D	The seismic-fragility evaluation shall incorporate the findings of walkdowns of the plant focusing on the anchorage, structural support, and potential systems interactions.
HLR-SFR-E	The calculation of seismic-fragility parameters, including median capacity and variabilities, shall be performed for failure modes affecting the functions modeled in the system analysis. Use of generic data and conservative methods shall be justified.
HLR-SFR-F	Documentation of the seismic-fragility evaluation shall be consistent with the applicable supporting requirements.

# HLR Changes

## **HLR-SFR-B**

The new SFR-B corresponds to the old SFR-C, which defines the requirements for building seismic response analysis.

## **HLR-SFR-C**

The new SFR-C corresponds to the old SFR-B, which defines the requirements for screening criteria.

## **HLR-SFR-D**

The new HLR-SFR-D corresponds to the old HLR-SFR-E, which defines the requirements for seismic walkdowns.

## **HLR-SFR-E**

The new HLR-SFR-E corresponds to the old HLR-SFR-F, which defines the requirements for calculating seismic fragilities.

## **HLR-SFR-F**

The new HLR-SFRF corresponds to the old HLR-SFR-G, which defines the requirements for documentation of fragility evaluation.



# Highlighted SRs from the Code Case

SFR-E2 from Addendum B. This SR has been removed from the code case since this is covered in the documentation SR

Designator	Standar	Capability Category I	Capability Category II	Capability Category III
SFR-E2	ASME/AN SRA- Sa-2009	DOCUMENT the walkdown procedures, walkdown team composition and its members' qualifications, walkdown observations, and conclusions.		
	ASME/AN SRA- Sb-2013	Identical to Addendum A		

SFR-D5 in the code case. The new SR primarily addresses identifying and evaluating potential II/I issues and seismic interactions during walkdowns.

SFR-D5	IDENTIFY potential risk significant seismic interactions including proximity impacts, falling hazards, and differential displacements (e.g., failure and falling of non seismically designed SSCs, impact between cabinets, masonry walls, differential building displacements) and EVALUATE the consequences of such interactions on SSC's contained in the systems model.
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SFR-D3 and D4 in the code case. These SRs is an updated version of previous SFR-E4 but specifically addresses only seismic induced fire or flood.

SFR-D3	IDENTIFY credible sources for seismic-induced flood (including spray). INCLUDE the sources identified in SPR-C2.
SFR-D4	IDENTIFY credible sources for seismically-induced fire. INCLUDE the sources identified in SPR-C2.

SFR-F3 in the code case. This is a new SR requiring the clear documentation of sources of model uncertainty in the fragility analysis process.

SFR-F3	DOCUMENT the sources of model uncertainty and related assumptions associated with the fragility analysis.
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# Incorporation of Lesson Learned from SPRA Peer Reviews

**SFR B-1:** This SR is modified to give more specificity on choosing the input response spectra by requiring the spectra to be anchored to risk significant SSCs failure levels.

**SFR B-3:** This SR specifies new building models needs to be developed when existing analysis are not considered realistic or state of practice.

**SFR E-1:** This SR addresses the fragilities of components above the screening level and allows the use of generic/conservative data. There is an emphasis on the need for justifying/demonstrating the usage of generic/conservative data.

**SFR E-2:** This SR specifies the need to identify relevant (to the model) and realistic failure modes for components that are believed to be important in accident sequences or components identified to be significant to CDF and LERF by the systems model.

**SFR E-3:** This SR emphasizes on the use of realistic, plant specific data for important components identified in SFR-E2 and requiring the need to justify the use of generic/conservative data.



Designator	Requirement
HLR-SFR-A	The seismic-fragility evaluation shall address seismic fragilities of SSCs whose failure may contribute to core damage or large early release, or both.

Index No.	Capability Category I	Capability Category II
SFR-A		
SFR-A1	DETERMINE the seismic fragility for SSCs and associated failure modes as identified by the systems analysis (see HLR-SPR-C).	
SFR-A2	INCLUDE information relevant to modeling of fragility correlation of SSCs (for example, similarity of component construction and location) to support SPR-B4.	

- Revised SFR-A1 includes the statement "... and associated failure modes..."
- The intent of this new statement is to ensure consistency between the failure modes evaluated by both fragility and systems analyst.
- Within the context of Seismic PRA, failure mode relates to the mechanism leading to the SSC not being able to perform its intended functions. Failure modes are defined by the systems analyst based on the PRA basic events.
- Examples of failure modes include a valve failing to open on demand, or a circuit breaker failing during operation. The seismic fragility analyst is expected to define the failure mechanism induced by an earthquake to result in such a failure mode. An example of a seismic-induced mechanism could be excessive binding of the valve yoke thus leading to failure to open/close the valve on demand.



Designator	Requirement
HLR-SFR-A	The seismic-fragility evaluation shall address seismic fragilities of SSCs whose failure may contribute to core damage or large early release, or both.

Index No. SFR-A	Capability Category I	Capability Category II
SFR-A1	DETERMINE the seismic fragility for SSCs and associated failure modes as identified by the systems analysis (see HLR-SPR-C).	
SFR-A2	INCLUDE information relevant to modeling of fragility correlation of SSCs (for example, similarity of component construction and location) to support SPR-B4.	

- SFR-A2 is a new requirement
- The intent is to ensure that correlation assumptions used for SSCs are consistent and clearly communicated between systems and fragility analysts.

# HLR-SFR-B

HLR-SFR-B	The seismic-fragility evaluation shall be based on a seismic response that the SSC experiences at its failure level.
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- SFR-B3 addresses development of new structural models, if the existing models are not realistic or not consistent with the state-of-the-art practices
- Only minor changes made to SR's to clarify intent

Designator	Requirement
HLR-SFR-C	Define the basis and methodologies used to establish capacity-based screening for SSCs. (HLR-SFR-C).

Index No. SFR-C	Capability Category I	Capability Category II
SFR-C1	SPECIFY the basis and methodologies established for the capacity-based screening for the level defined in SPR-B6.	
SFR-C2	SPECIFY the basis for screening of inherently rugged components.	

- SFR-C1 corresponds to the previous SFR-B1 and has been revised to emphasize the basis of “screening capacity” for a particular component and the process of comparing such capacity with the screening level.
- It is important to distinguish the difference between the requirements in SPR-B6 and SFR-C1. SPR-B6 refers to the definition of a screening level. This screening level should be high enough that the contribution to seismic core damage frequency and seismic large early release frequency from the screened components is not significant. SFR-C1 requires that the SPRA provide the basis and methodology for justifying that the capacity of certain SSCs exceed the screening level.

Designator	Requirement
HLR-SFR-C	Define the basis and methodologies used to establish capacity-based screening for SSCs. (HLR-SFR-C).

Index No. SFR-C	Capability Category I	Capability Category II
SFR-C1	SPECIFY the basis and methodologies established for the capacity-based screening for the level defined in SPR-B6.	
SFR-C2	SPECIFY the basis for screening of inherently rugged components.	

- SFR-C2 is a new requirement
- It was deemed necessary to include since it was noted from peer reviews that not much documentation was provided for the screening of inherently rugged components.
- The term inherently rugged refers to seismic capacities well beyond the risk-significant level. Typical items include manual valves, check valves, and small, in-line strainers.

## Designator

## Requirement

HLR-SFR-D The seismic-fragility evaluation shall incorporate the findings of walkdowns of the plant focusing on the anchorage, structural support, and potential systems interactions.

Index No. SFR-D	Capability Category I	Capability Category II
SFR-D1	CONFIRM that SSCs screened out from further fragility analysis meet the screening criteria established in HLR-SFR-C. DEMONSTRATE that the component anchorage capacity also meets the screening criteria.	
SFR-D2	EVALUATE as-designed, as-built, and as-operated plant conditions via a walkdown.	
SFR-D2a	IDENTIFY seismic vulnerabilities and ENSURE that assumptions and the use of generic seismic fragilities are conservative.	IDENTIFY seismic vulnerabilities and ENSURE that the seismic fragilities are realistic and plant specific.
SFR-D2b	FOCUS on potential functional and structural failure modes, equipment anchorage, and support load-path.	
SFR-D3	IDENTIFY credible seismic-induced failures (including spray) for the flood sources provided in SPR-C2.	
SFR-D4	IDENTIFY credible seismic-induced failure for the fire sources provided in SPR-C2a.	
SFR-D5	IDENTIFY potential risk significant seismic interactions including proximity impacts, falling hazards, and differential displacements (e.g., failure and falling of non-seismically designed SSCs, impact between cabinets, masonry walls, differential building displacements) and EVALUATE the consequences of such interactions on SSC's contained in the systems model and on the credited operator actions (see SPR-D6)	



## Designator

## Requirement

HLR-SFR-D The seismic-fragility evaluation shall incorporate the findings of walkdowns of the plant focusing on the anchorage, structural support, and potential systems interactions.

Index No. SFR-D	Capability Category I	Capability Category II
SFR-D1	CONFIRM that SSCs screened out from further fragility analysis meet the screening criteria established in HLR-SFR-C. DEMONSTRATE that the component anchorage capacity also meets the screening criteria.	

- SFR-D1 is a new requirement since the previous Add B did not include a walkdown assessment of screened-out components.



## Designator

## Requirement

HLR-SFR-D The seismic-fragility evaluation shall incorporate the findings of walkdowns of the plant focusing on the anchorage, structural support, and potential systems interactions.

Index No.	Capability Category I	Capability Category II
SFR-D SFR-D2a	IDENTIFY seismic vulnerabilities and ENSURE that assumptions and the use of generic seismic fragilities are conservative.	IDENTIFY seismic vulnerabilities and ENSURE that the seismic fragilities are realistic and plant specific.

- SFR-D2a is a new requirement which was included to distinguish between a detailed walkdown (CCII) and a more flexible walkdown (CCI).
- For CCII, SSC's that are significant contributors to core damage frequency or large early release frequency must have realistic fragility curves. This involves review of functional capacity (including assessment of clearance with adjacent items) characteristics, load path/structural features, anchorage strength and ductility, as well as failure modes resulting from seismic interactions.
- For CCI, it is acceptable in the fragility analysis to use assumptions and generic seismic data to estimate fragilities, so long as the resulting capacities are conservative. Thus for CCI the walkdown team only needs to ensure that the estimated fragilities are conservative.

## Designator

## Requirement

HLR-SFR-D The seismic-fragility evaluation shall incorporate the findings of walkdowns of the plant focusing on the anchorage, structural support, and potential systems interactions.

Index No.	Capability Category I	Capability Category II
SFR-D		
SFR-D3	IDENTIFY credible seismic-induced failures (including spray) for the flood sources provided in SPR-C2.	
SFR-D4	IDENTIFY credible seismic-induced failure for the fire sources provided in SPR-C2a.	

- The action verb in these SRs have been changed from EVALUATE to IDENTIFY. The reason for this is because evaluation falls within a fragility effort rather than a walkdown effort. Now the requirement to EVALUATE seismically-induced fire and flooding scenarios has been included in SFR-E6.
- Another point of discussion is how are flooding/fire sources included in the SEL. This can be a shared responsibility between the systems analyst (based on which systems are important in the fire and flooding PRAs) and the walkdown team (based on which scenarios could lead to a fire or flooding in the event of an earthquake. In general, it is expected for the systems analyst to set the starting point for all seismic-induced fire and flooding scenarios under the expectation that the walkdown team can either add new scenarios or screen out specific ones based on seismic ruggedness.

## Designator

## Requirement

HLR-SFR-D The seismic-fragility evaluation shall incorporate the findings of walkdowns of the plant focusing on the anchorage, structural support, and potential systems interactions.

Index No.	Capability Category I	Capability Category II
SFR-D SFR-D5	IDENTIFY potential risk significant seismic interactions including proximity impacts, falling hazards, and differential displacements (e.g., failure and falling of non-seismically designed SSCs, impact between cabinets, masonry walls, differential building displacements) and EVALUATE the consequences of such interactions on SSC's contained in the systems model and on the credited operator actions (see SPR-D6)	

- The SR related to interactions have been revised to reflect two key items.
- First, it adds the statement "...potential risk significant seismic interactions...". This was deemed necessary since it was noticed that walkdowns were taken as a QA/QC procedure rather than a confirmatory exercise between the failure modes included in the SPRA model and the as-built, as-operated conditions. Therefore this statement intends to guide the walkdown team to focus on components or scenarios that are important to the SPRA.
- Recent SPRA walkdowns have shown that operator path ways may not be available immediately after an earthquake event, mainly because of unanchored items or structurally unstable structures. This walkdown requirement was not mentioned in Add B and has been included in the new revision.

# SPR CHANGES



**ANS**



# Summary

- SPR changed to accommodate
  - Cross Cutting Issues (e.g., consistency in HRA, action verbs, documentation SRs reshuffling, mission time, back-references, removing commentary, etc.)
  - Lessons learned from recent S-PRA wave
- Overview looks at the philosophy behind the changes (does not discuss the specific wording changes)
- Next few slides jump between Addendum B and the Code Case. If we are talking of an SR that is from the Code Case is in **Green**, if it is from the Addendum B is in **Red**

# SPR HLR STRUCTURE





## ADDENDUM B

**Table 5-2.3-1 High Level Requirements for Seismic Probabilistic Risk Assessment: Technical Requirements for Systems Analysis (SPR)**

Designator	Requirement
HLR-SPR-A	The seismic-PRA systems models shall include seismic-caused initiating events and other failures including seismically induced SSC failures, nonseismically induced unavailabilities, and human errors that give rise to significant accident sequences and/or significant accident progression sequences.
HLR-SPR-B	The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model.
HLR-SPR-C	The seismic-PRA systems model shall reflect the as-built and as-operated plant being analyzed.
HLR-SPR-D	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

Addendum B – Part 5 – SPR HLR structure was revised to accommodate Cross Cutting Issues, and to Incorporate Lessons Learned from recently performed S-PRAs and associated peer reviews



## ADDENDUM B

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HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

**HLR-SPR-A** remains dedicated to a systematic identification and subsequent modeling of seismic-induced initiators. Emphasis is added on seismic-induced non-internal events

## ADDENDUM B

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HLR-SPR-B	The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model.
HLR-SPR-C	The seismic-PRA systems model shall reflect the as-built and as-operated plant being analyzed.
HLR-SPR-D	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

**HLR-SPR-B** remains dedicated to adding specific modeling of seismic-specific failure on top of an existing (internal events, fire, flood) model. Back-references are expanded and clarified. Critical ties with the fragility analysis are emphasized. Seismic HRA items have been removed from this HLR and given a dedicated one.

## ADDENDUM B

**Table 5-2.3-1 High Level Requirements for Seismic Probabilistic Risk Assessment: Technical Requirements for Systems Analysis (SPR)**

Designator	Requirement
HLR-SPR-A	The seismic-PRA systems models shall include seismic-caused initiating events and other failures including seismically induced SSC failures, nonseismically induced unavailabilities, and human errors that give rise to significant accident sequences and/or significant accident progression sequences.
HLR-SPR-B	The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model.
HLR-SPR-C	The seismic-PRA systems model shall reflect the as-built and as-operated plant being analyzed.
HLR-SPR-D	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

**HLR-SPR-C** was eliminated as it is redundant with specific supporting requirements in Part 2 that is now more-explicitly referenced.



## ADDENDUM B

**Table 5-2.3-1 High Level Requirements for Seismic Probabilistic Risk Assessment: Technical Requirements for Systems Analysis (SPR)**

Designator	Requirement
HLR-SPR-A	The seismic-PRA systems models shall include seismic-caused initiating events and other failures including seismically induced SSC failures, nonseismically induced unavailabilities, and human errors that give rise to significant accident sequences and/or significant accident progression sequences.
HLR-SPR-B	The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model.
HLR-SPR-C	The seismic-PRA systems model shall reflect the as-built and as-operated plant being analyzed.
HLR-SPR-D	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

**HLR-SPR-D** was moved up as **SPR-C**. It is still dedicated to the SEL development but more details are added.

## ADDENDUM B

**Table 5-2.3-1 High Level Requirements for Seismic Probabilistic Risk Assessment: Technical Requirements for Systems Analysis (SPR)**

Designator	Requirement
HLR-SPR-A	The seismic-PRA systems models shall include seismic-caused initiating events and other failures including seismically induced SSC failures, nonseismically induced unavailabilities, and human errors that give rise to significant accident sequences and/or significant accident progression sequences.
HLR-SPR-B	The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model.
HLR-SPR-C	The seismic-PRA systems model shall reflect the as-built and as-operated plant being analyzed.
HLR-SPR-D	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

**HLR-SPR-E** remains dedicated to the quantification of the S-PRA. Back-references to part 2 have been clarified.

## ADDENDUM B

**Table 5-2.3-1 High Level Requirements for Seismic Probabilistic Risk Assessment: Technical Requirements for Systems Analysis (SPR)**

Designator	Requirement
HLR-SPR-A	The seismic-PRA systems models shall include seismic-caused initiating events and other failures including seismically induced SSC failures, nonseismically induced unavailabilities, and human errors that give rise to significant accident sequences and/or significant accident progression sequences.
HLR-SPR-B	The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model.
HLR-SPR-C	The seismic-PRA systems model shall reflect the as-built and as-operated plant being analyzed.
HLR-SPR-D	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review.

**HLR-SPR-F** remains dedicated to the documentation



## NEW CODE CASE PART 5

**Table 5-2.3-1 High Level Requirements for Seismic Probabilistic Risk Assessment: Technical Requirements for Seismic Plant-Response (SPR) Analysis**

Designator	Requirement
HLR-SPR-A	The seismic PRA shall include seismically induced initiating events that cause significant accident sequences and/or significant accident progression sequences.
HLR-SPR-B	The seismic PRA systems model shall include seismically induced SSC failures and nonseismically induced unavailabilities as well as human actions that represent the as-built and as-operated plant.
HLR-SPR-C	The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic PRA systems model.
HLR-SPR-D	Human actions credited in the seismic PRA shall consider seismic-specific challenges to operator performance.
HLR-SPR-E	The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects.
HLR-SPR-F	Documentation of the seismic PRA analysis shall be consistent with the applicable supporting requirements.

**HLR-SPR-A** – Identify and model initiators

**HLR-SPR-B** – Add seismic failure to underlying model(s)

**HLR-SPR-C** – SEL Development

**HLR-SPR-D** – Seismic HRA

**HLR-SPR-E** – S-PRA quantification

**HLR-SPR-F** – System modeling and quantification documentation





# HLR-SPR-A

**Identify seismic-induced initiators**



## ADDENDUM B

**Table 5-2.3-2 Supporting Requirements for HLR-SPR-A**

The seismic-PRA systems model shall include seismic-caused initiating events and other failures including seismic-induced SSC failures, non-seismic-induced unavailabilities, and human errors, that give rise to significant accident sequences and/or significant accident progression sequences (HLR-SPR-A).

Index No. SPR-A	Capability Category I	Capability Category II	Capability Category III
SPR-A1 [Note (1)]	ENSURE that earthquake-caused initiating events that give rise to significant accident sequences and/or significant accident progression sequences are included in the seismic-PRA system model using a systematic process.		
SPR-A2 [Note (2)]	In the initiating-event selection process, DEVELOP a hierarchy to ensure that every earthquake greater than a certain defined size produces a plant shutdown within the systems model.		
SPR-A3 [Note (3)]	USE the accident sequences and the systems logic model from the at-power, internal-event PRA model as the basis for the seismic-PRA model.		
SPR-A4 [Note (4)]	Under special circumstances based on the judgment of the analyst, DEVELOP an ad hoc systems model tailored especially to the seismic-PRA configurations or issues being modeled, instead of starting with the internal-events model and adapting it, as in Requirement SPR-A3. If this approach is used, ENSURE that the resulting model is consistent with the internal-events systems model regarding plant response and the cause-effect relationships of the failures.		
SPR-A5 [Note (3)]	ENSURE that the PRA systems models reflect earthquake-caused failures and nonseismically induced unavailabilities and human errors that give rise to significant accident sequences or significant accident progression sequences.		

**SPR-A1** remains the core SR in this HLR (i.e., identification and modeling of seismic-induced initiating events). More details are added and the Addendum B **SPR-A1** resulted in Code Case **SPR-A1, S2, A3** and **A4**



**ANS**



## ADDENDUM B

Table 5-2.3-2 Supporting Requirements for HLR-SPR-A

The seismic-PRA systems model shall include seismic-caused initiating events and other failures including seismic-induced SSC failures, non-seismic-induced unavailabilities, and human errors, that give rise to significant accident sequences and/or significant accident progression sequences (HLR-SPR-A).

Index No. SPR-A	Capability Category I	Capability Category II	Capability Category III
SPR-A1 [Note (1)]	ENSURE that earthquake-caused initiating events that give rise to significant accident sequences and/or significant accident progression sequences are included in the seismic-PRA system model using a systematic process.		
SPR-A2 [Note (2)]	In the initiating-event selection process, DEVELOP a hierarchy to ensure that every earthquake greater than a certain defined size produces a plant shutdown within the systems model.		
SPR-A3 [Note (3)]	USE the accident sequences and the systems logic model from the at-power, internal-event PRA model as the basis for the seismic-PRA model.		
SPR-A4 [Note (4)]	Under special circumstances based on the judgment of the analyst, DEVELOP an ad hoc systems model tailored especially to the seismic-PRA configurations or issues being modeled, instead of starting with the internal-events model and adapting it, as in Requirement SPR-A3. If this approach is used, ENSURE that the resulting model is consistent with the internal-events systems model regarding plant response and the cause-effect relationships of the failures.		
SPR-A5 [Note (3)]	ENSURE that the PRA systems models reflect earthquake-caused failures and nonseismically induced unavailabilities and human errors that give rise to significant accident sequences or significant accident progression sequences.		

**SPR-A2** was removed as it was an “how to” requirement explaining how to address **SPR-A1**. A hierarchy is helpful in ensuring that all possible seismic initiators are addressed (i.e., either modeled or disposed of in some way, for example subsuming them in others) but it is not the only way of doing this. The hierarchy is also less of a need now that different quantification tools exist.



## ADDENDUM B

**Table 5-2.3-2 Supporting Requirements for HLR-SPR-A**

The seismic-PRA systems model shall include seismic-caused initiating events and other failures including seismic-induced SSC failures, non-seismic-induced unavailabilities, and human errors, that give rise to significant accident sequences and/or significant accident progression sequences (HLR-SPR-A).

Index No. SPR-A	Capability Category I	Capability Category II	Capability Category III
SPR-A1 [Note (1)]	ENSURE that earthquake-caused initiating events that give rise to significant accident sequences and/or significant accident progression sequences are included in the seismic-PRA system model using a systematic process.		
SPR-A2 [Note (2)]	In the initiating-event selection process, DEVELOP a hierarchy to ensure that every earthquake greater than a certain defined size produces a plant shutdown within the systems model.		
<b>SPR-A3 [Note (3)]</b>	<b>USE the accident sequences and the systems logic model from the at-power, internal-event PRA model as the basis for the seismic-PRA model.</b>		
SPR-A4 [Note (4)]	Under special circumstances based on the judgment of the analyst, DEVELOP an ad hoc systems model tailored especially to the seismic-PRA configurations or issues being modeled, instead of starting with the internal-events model and adapting it, as in Requirement SPR-A3. If this approach is used, ENSURE that the resulting model is consistent with the internal-events systems model regarding plant response and the cause-effect relationships of the failures.		
SPR-A5 [Note (3)]	ENSURE that the PRA systems models reflect earthquake-caused failures and nonseismically induced unavailabilities and human errors that give rise to significant accident sequences or significant accident progression sequences.		

**SPR-A3** was moved in **HLR-SPR-B (SPR-B1)**

## ADDENDUM B

**Table 5-2.3-2 Supporting Requirements for HLR-SPR-A**

The seismic-PRA systems model shall include seismic-caused initiating events and other failures including seismic-induced SSC failures, non-seismic-induced unavailabilities, and human errors, that give rise to significant accident sequences and/or significant accident progression sequences (HLR-SPR-A).

Index No. SPR-A	Capability Category I	Capability Category II	Capability Category III
SPR-A1 [Note (1)]	ENSURE that earthquake-caused initiating events that give rise to significant accident sequences and/or significant accident progression sequences are included in the seismic-PRA system model using a systematic process.		
SPR-A2 [Note (2)]	In the initiating-event selection process, DEVELOP a hierarchy to ensure that every earthquake greater than a certain defined size produces a plant shutdown within the systems model.		
SPR-A3 [Note (3)]	USE the accident sequences and the systems logic model from the at-power, internal-event PRA model as the basis for the seismic-PRA model.		
SPR-A4 [Note (4)]	Under special circumstances based on the judgment of the analyst, DEVELOP an ad hoc systems model tailored especially to the seismic-PRA configurations or issues being modeled, instead of starting with the internal-events model and adapting it, as in Requirement SPR-A3. If this approach is used, ENSURE that the resulting model is consistent with the internal-events systems model regarding plant response and the cause-effect relationships of the failures.		
SPR-A5 [Note (3)]	ENSURE that the PRA systems models reflect earthquake-caused failures and nonseismically induced unavailabilities and human errors that give rise to significant accident sequences or significant accident progression sequences.		

**SPR-A4** was removed. This was a relic of the fact that the S-PRA standard was a separate standard. Back-references to Part 2 and SR **SPR-B8** ensure that any added logic to the underlying PRA model is consistent with Part 2 requirements.



## ADDENDUM B

**Table 5-2.3-2 Supporting Requirements for HLR-SPR-A**

The seismic-PRA systems model shall include seismic-caused initiating events and other failures including seismic-induced SSC failures, non-seismic-induced unavailabilities, and human errors, that give rise to significant accident sequences and/or significant accident progression sequences (HLR-SPR-A).

Index No. SPR-A	Capability Category I	Capability Category II	Capability Category III
SPR-A1 [Note (1)]	ENSURE that earthquake-caused initiating events that give rise to significant accident sequences and/or significant accident progression sequences are included in the seismic-PRA system model using a systematic process.		
SPR-A2 [Note (2)]	In the initiating-event selection process, DEVELOP a hierarchy to ensure that every earthquake greater than a certain defined size produces a plant shutdown within the systems model.		
SPR-A3 [Note (3)]	USE the accident sequences and the systems logic model from the at-power, internal-event PRA model as the basis for the seismic-PRA model.		
SPR-A4 [Note (4)]	Under special circumstances based on the judgment of the analyst, DEVELOP an ad hoc systems model tailored especially to the seismic-PRA configurations or issues being modeled, instead of starting with the internal-events model and adapting it, as in Requirement SPR-A3. If this approach is used, ENSURE that the resulting model is consistent with the internal-events systems model regarding plant response and the cause-effect relationships of the failures.		
SPR-A5 [Note (3)]	ENSURE that the PRA systems models reflect earthquake-caused failures and nonseismically induced unavailabilities and human errors that give rise to significant accident sequences or significant accident progression sequences.		

**SPR-A5** was moved to SPR-B (in **SPR-B1**).

## NEW CODE CASE PART 5

**Table 5-2.3-2 Supporting Requirements for HLR-SPR-A**

The seismic PRA shall include seismically induced initiating events that cause significant accident sequences and/or significant accident progression sequences (HLR-SPR-A).

Index No. SPR-A	Capability Category I	Capability Category II
SPR-A1 [Note (1)]	Using a systematic process, IDENTIFY seismically induced initiating events caused directly by the seismic event (e.g., LOOP, LOCA, LOOP-LOCA, LOCA-ATWS).	
SPR-A2	Using a systematic process, IDENTIFY seismically induced initiating events caused by secondary hazards (e.g., seismically induced internal flooding, external flooding, and fire) including those identified in SHA-I2.	
SPR-A3	REVIEW plant-specific response to past seismic events, as well as other available seismic risk evaluations for nuclear plants, to ensure that the list of initiating events included in the evaluation encompasses industry experience.	
SPR-A4	INCLUDE in the plant-response analysis the events identified in SPR-A1 and SPR-A2 above.	

NOTE:

(1) The intent of this requirement is to ensure the entire spectrum of seismically induced initiators is systematically evaluated from major structural collapse to a manual or automatic trip due to seismic event above operational limits and including combination of events (such as LOOP coincident with LOCA).

**SPR-A1** – Identification of seismic-induced internal events. Note the emphasis on the combinations of initiators that are stand-alone in IE (e.g., LOOP-LOCA)

**SPR-A2** – Identification of seismic-induced non-internal events (i.e., external, fires, floods and anything identified in the hazard evaluation). Fires, floods and externals were less consistently identified and carried through in S-PRAs, this added emphasis addresses this observation.

**SPR-A3** – New SR. Address operating history as available.

**SPR-A4** – New SR. Include seismic-induced initiators in the model. Intent is to allow not explicitly modeling EVERYTHING discussed in **SPR-A1/2/3**.





# HLR-SPR-B

**Model seismic-induced failures**



## ADDENDUM B

Table 5-2.3-3 Supporting Requirements for HLR-SPR-B

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B1 [Note (1)]	In each of the following aspects of the seismic-PRA systems-analysis work, SATISFY the corresponding requirements in Part 2, except where they are not applicable or where this Part includes additional requirements. SPECIFY a basis to support the claimed nonapplicability of any exceptions. The aspects governed by this requirement are (a) initiating-event analysis (b) accident-sequence analysis (c) success-criteria analysis (d) systems analysis (e) data analysis (f) human-reliability analysis (g) use of expert judgment		

**SPR-B1** evolved into multiple SRs (i.e., **SPR-B1, B2** and **SPR-B8**). The intent is to ensure the non-seismic portion meets the requirements of Part 2.

## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B2	<p>INCLUDE the following seismic impacts on performance-shaping factors (PSFs) for the control room and ex-control room post-initiator actions as appropriate to the human reliability analysis (HRA) methodology used:</p> <ul style="list-style-type: none"> <li>(a) additional post-earthquake workload and stress that can increase the likelihood of human errors or inattention</li> <li>(b) seismic failures that impact access</li> <li>(c) cue availability</li> </ul>		<p>INCLUDE the following seismic impacts on performance-shaping factors (PSFs) for the control room and ex-control room post-initiator actions as appropriate to the human reliability analysis (HRA) methodology used:</p> <ul style="list-style-type: none"> <li>(a) additional post-earthquake workload and stress that can increase the likelihood of human errors or inattention</li> <li>(b) seismic failures that impact access</li> <li>(c) cue availability</li> </ul> <p>When calculating the human error probabilities (HEPs) for seismic PRA, USE detailed HRA analysis in accordance with the applicable HRA requirements in Part 2.</p>

**SPR-B2** was moved to the seismic HRA specific HLR (i.e., **SPR-D3**)



**ANS**



## ADDENDUM B

Table 5-2.3-3 Supporting Requirements for HLR-SPR-B

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B3 [Note (2)]	PERFORM an analysis of seismic-caused correlations in a way so that any screening of SSCs appropriately accounts for those correlations. USE bounding or generic correlation values and PROVIDE the basis for such use.		PERFORM an analysis of seismic-caused correlations in a way so that any screening of SSCs appropriately accounts for those correlations. USE plant-specific correlation values throughout.

**SPR-B3** was modified but retained. It is now **SPR-B4** (that discusses both correlation and grouping). Note that emphasis was added on the fact that correlation and grouping is not really a decision that the SPR analyst can take without making fragility consideration, thus the link with the new **SFR-A2**.



## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B (Cont'd)**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B4 [Note (3)]	INCLUDE the effects of the chatter of relays and similar devices in the systems model.		
SPR-B4a [Note (4)]	If screening out on the basis of seismic capacity is performed in the systems model, SPECIFY the screening criterion.		
SPR-B4b [Note (4)]	If post-earthquake recovery actions are included in the systems model, INCLUDE them on a documented basis.		
SPR-B5 [Note (5)]	In the systems-analysis models, for each basic event that represents a significant seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC, and SPECIFY the criteria used for the term "significant" in this activity.	In the systems-analysis models, for each basic event that represents a seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC.	
SPR-B6 [Note (6)]	EVALUATE the possibility that a large earthquake can cause damage that blocks personnel access to safety equipment or controls, thereby inhibiting operator actions that might otherwise be credited.		

**SPR-B4** it is now **SPR-B6**. Modified language but same intent.

## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B (Cont'd)**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B4 [Note (3)]	INCLUDE the effects of the chatter of relays and similar devices in the systems model.		
SPR-B4a [Note (4)]	If screening out on the basis of seismic capacity is performed in the systems model, SPECIFY the screening criterion.		
SPR-B4b [Note (4)]	If post-earthquake recovery actions are included in the systems model, INCLUDE them on a documented basis.		
SPR-B5 [Note (5)]	In the systems-analysis models, for each basic event that represents a significant seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC, and SPECIFY the criteria used for the term "significant" in this activity.	In the systems-analysis models, for each basic event that represents a seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC.	
SPR-B6 [Note (6)]	EVALUATE the possibility that a large earthquake can cause damage that blocks personnel access to safety equipment or controls, thereby inhibiting operator actions that might otherwise be credited.		

**SPR-B4a** it is now **SPR-B5**. There is in general more emphasis on the fact that the definition and management of the screening level needs to be a shared responsibility between SPR and SFR.

## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B (Cont'd)**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B4 [Note (3)]	INCLUDE the effects of the chatter of relays and similar devices in the systems model.		
SPR-B4a [Note (4)]	If screening out on the basis of seismic capacity is performed in the systems model, SPECIFY the screening criterion.		
SPR-B4b [Note (4)]	If post-earthquake recovery actions are included in the systems model, INCLUDE them on a documented basis.		
SPR-B5 [Note (5)]	in the systems-analysis models, for each basic event that represents a significant seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC, and SPECIFY the criteria used for the term "significant" in this activity.	in the systems-analysis models, for each basic event that represents a seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC.	
SPR-B6 [Note (6)]	EVALUATE the possibility that a large earthquake can cause damage that blocks personnel access to safety equipment or controls, thereby inhibiting operator actions that might otherwise be credited.		

**SPR-B4b** is eliminated. There was an artificial differentiation between recoveries and other operator actions or seismic failures that is now eliminated.



## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B (Cont'd)**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B4 [Note (3)]	INCLUDE the effects of the chatter of relays and similar devices in the systems model.		
SPR-B4a [Note (4)]	If screening out on the basis of seismic capacity is performed in the systems model, SPECIFY the screening criterion.		
SPR-B4b [Note (4)]	If post-earthquake recovery actions are included in the systems model, INCLUDE them on a documented basis.		
SPR-B5 [Note (5)]	In the systems-analysis models, for each basic event that represents a significant seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC, and SPECIFY the criteria used for the term "significant" in this activity.	In the systems-analysis models, for each basic event that represents a seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC.	
SPR-B6 [Note (6)]	EVALUATE the possibility that a large earthquake can cause damage that blocks personnel access to safety equipment or controls, thereby inhibiting operator actions that might otherwise be credited.		

**SPR-B5** is now **SPR-E2**. The original language was "how to". The intent is to ensure the limitations of the min-cut-upper bound quantification approach are considered. There are multiple ways of doing this. Using explicit success logic is ONE way.

## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B (Cont'd)**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B4 [Note (3)]	INCLUDE the effects of the chatter of relays and similar devices in the systems model.		
SPR-B4a [Note (4)]	If screening out on the basis of seismic capacity is performed in the systems model, SPECIFY the screening criterion.		
SPR-B4b [Note (4)]	If post-earthquake recovery actions are included in the systems model, INCLUDE them on a documented basis.		
SPR-B5 [Note (5)]	In the systems-analysis models, for each basic event that represents a significant seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC, and SPECIFY the criteria used for the term "significant" in this activity.	In the systems-analysis models, for each basic event that represents a seismically caused failure, INCLUDE the complementary "success" state where applicable to a particular SSC.	
SPR-B6 [Note (6)]	EVALUATE the possibility that a large earthquake can cause damage that blocks personnel access to safety equipment or controls, thereby inhibiting operator actions that might otherwise be credited.		

**SPR-B6** is an HRA item (i.e., addressed now under **SPR-D**). **SPR-D3** addresses this issue.

## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B7 [Note (7)]	DO NOT INCLUDE recoveries that are specially tailored to the fact that the initiator is an earthquake. It is acceptable to include recoveries embedded in the internal-events systems model unless they would be precluded by conditions introduced by the seismic event.	EVALUATE the likelihood that system recoveries modeled in the internal-events PRA may be more complex or even not possible after a large earthquake, and ADJUST the recovery models accordingly. It is acceptable to use generic or conservative recovery values.	EVALUATE the likelihood that system recoveries modeled in the internal-events PRA may be more complex or even not possible after a large earthquake, and ADJUST the recovery models accordingly. USE plant-specific recovery values where available.

**SPR-B7** is eliminated, see discussion for **SPR-B4b**.



## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B8 [Note (8)]	ASSUME the existence of an earthquake-caused “very small loss-of-coolant accident” in the seismic-PRA accident sequences and system modeling, unless it is demonstrated that such a LOCA can be excluded, based on a walkdown or on another examination of the possible sources of such a LOCA.		INCLUDE the fragility (i.e., probability of failure) of an earthquake-caused “very small loss-of-coolant accident,” and incorporate the effects into the seismic-PRA accident sequences and system modeling, unless it is demonstrated that such a LOCA can be excluded, based on a walkdown or on another examination of the possible sources of such a LOCA.
SPR-B9 [Note (9)]	If the seismic-PRA walkdown (see Requirement SFR-E4) identifies the potential for seismically induced fires and flooding, INCLUDE potential significant contributions to accident sequences in the systems model.		

**SPR-B8** is now part of **SPR-A1**.

## ADDENDUM B

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic-PRA systems model shall be adapted to incorporate seismic-analysis aspects that are different from corresponding aspects found in the at-power, internal-events PRA systems model (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II	Capability Category III
SPR-B8 [Note (8)]	ASSUME the existence of an earthquake-caused “very small loss-of-coolant accident” in the seismic-PRA accident sequences and system modeling, unless it is demonstrated that such a LOCA can be excluded, based on a walkdown or on another examination of the possible sources of such a LOCA.		INCLUDE the fragility (i.e., probability of failure) of an earthquake-caused “very small loss-of-coolant accident,” and incorporate the effects into the seismic-PRA accident sequences and system modeling, unless it is demonstrated that such a LOCA can be excluded, based on a walkdown or on another examination of the possible sources of such a LOCA.
SPR-B9 [Note (9)]	If the seismic-PRA walkdown (see Requirement SFR-E4) identifies the potential for seismically induced fires and flooding, INCLUDE potential significant contributions to accident sequences in the systems model.		

**SPR-B9** is removed. The entire approach to seismic-induced fires and floods is now split in multiple SRs. The identification of these items starts in **SPR-A2**, the components resulting in possible seismic-induced fires/floods are added to the SEL in **SPR-C3/4**, then they become walkdown items and needs to be addressed for fragility considerations as any other SEL item. Any fire/flood specific consideration and modeling is done through the appropriate part of the Standard, as discussed in **SPR-B9/10/11**.



## NEW CODE CASE PART 5

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic PRA systems model shall include seismically induced SSC failures and nonseismically induced unavailabilities as well as human actions that represent the as-built and as-operated plant (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II
SPR-B1	USE the accident sequences and the systems logic model from the at-power, internal-event PRA model as the basis, such that the seismic PRA plant-response models represent <ul style="list-style-type: none"> <li>• nonseismically induced unavailabilities, and</li> <li>• human errors.</li> </ul>	
SPR-B2	ENSURE that the peer review findings for the internal events and other hazard PRAs that are relevant to the seismic PRA are dispositioned, and that the disposition does not adversely affect the development of the seismic PRA plant response model.	
SPR-B3	INCLUDE seismically induced failures representing the failure modes of interest in the seismic PRA plant-response model (e.g., tank rupture, pump failure to start/run, etc.). (See SPR-C4.)	
SPR-B4	MODEL the grouping and fragility correlation of seismically induced SSC failures consistently with information provided in SFR-A2.	

**SPR-B1** – Start from an appropriate underlying model so that random failures are included.

**SPR-B2** – This SR is similar to Fire PRA SR **PRM-B2** and is being added to all the non IE hazards.

**SPR-B3** – Include appropriate seismic failures in the system model. Note the link to the SEL requirements that requires to discuss what failure modes are of interest as seismically induced. They may be new failure modes for IE SSCs.

**SPR-B4** – Model seismic correlation. Link to **SFR-A2** adds emphasis on the need to consider fragility input for modeling grouping and correlations.





## NEW CODE CASE PART 5

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic PRA systems model shall include seismically induced SSC failures and nonseismically induced unavailabilities as well as human actions that represent the as-built and as-operated plant (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II
SPR-B6	USE a systematic approach to INCLUDE in the system analysis the effects of those relays or similar devices whose contact chatter results in the unavailability or spurious actuation of SSCs with a significant contribution to CDF or LERF.	
SPR-B7	ASSESS the safe and stable end state of the seismic-induced accident sequences in accordance with SC-A5 CCI to confirm that sustained impacts on plant accessibility and emergency response capability do not invalidate the assumed mission time.	ASSESS the safe and stable end state of the seismic-induced accident sequences in accordance with SC-A5 CCII to confirm that sustained impacts on plant accessibility and emergency response capability do not invalidate the assumed mission time.

**SPR-B6** – Relay chatter.

**SPR-B7** – New SR that discusses the need to consider whether the mission time needs to change. Points back to **SC-A5**. Given that **SC-A5** has CCI and CCII differentiation, the same differentiation is applicable to the S-PRA. This approach is carried through the entire new code case in multiple other SRs.

## NEW CODE CASE PART 5

**Table 5-2.3-3 Supporting Requirements for HLR-SPR-B**

The seismic PRA systems model shall include seismically induced SSC failures and nonseismically induced unavailabilities as well as human actions that represent the as-built and as-operated plant (HLR-SPR-B).

Index No. SPR-B	Capability Category I	Capability Category II
SPR-B8	<p>If new logic is added to the seismic PRA (e.g., new system modeling, new or modified accident sequences),</p> <ul style="list-style-type: none"> <li>• SATISFY the requirements HLR-AS-A and B for accident-sequence analysis, HLR-SC-A and B for success-criteria analysis, HLR-SY-A and B for systems analysis, HLR-DA-A, B, C, and D for data analysis and HLR-HR-D for human reliability analysis (specifically for pre-initiators), except where they are not applicable or where this Part includes different requirements; and</li> <li>• DEVELOP a basis to support the claimed nonapplicability of any exceptions.</li> </ul>	
SPR-B9	For any seismic-induced internal flood retained in the seismic PRA, ENSURE the model is consistent with HLR-IFSN-A, IFQU-A1, A2, A3, and A4.	
SPR-B10	For any seismic-induced internal fire retained in the seismic PRA, ENSURE the model is consistent with HLR-PRM-A and B.	
SPR-B11 [Note (2)]	For all other secondary hazards explicitly retained in the seismic PRA, USE Part 8 or Part 9 in this Standard for applicable supporting requirements.	

NOTES:

(2) It is expected that only the fragility and plant-response-model technical elements from Part 8 and Part 9 are needed to cover the explicit modeling aspects.

**SPR-B8** – Use Part 2 requirements for any non seismic specific additional modeling that is needed.

**SPR-B9/10/11** – Use Part 3/4/8/9 for any flooding (internal or external), fire or other hazards that is seismically induced and needs to be modeled in the S-PRA. Back references are limited to SRs or HLRs of interest.



# HLR-SPR-C

**Define the Seismic Equipment List**



## ADDENDUM B

Table 5-2.3-5 Supporting Requirements for HLR-SPR-D

The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic-PRA systems model (HLR-SPR-D).

Index No. SPR-D	Capability Category I	Capability Category II	Capability Category III
SPR-D1	USE the PRA systems model as the basis for developing the seismic equipment list to support the fragility analysis of 5-2.2. INCLUDE structures and passive components that may not be present in the internal-events model but that require consideration in the seismic PRA. SUPPLEMENT the list based on the review of industry seismic-PRA seismic equipment lists (SELs), if available.		

**SPR-D1** evolved into multiple SRs (i.e., **SPR-C1/2/3/4/5**). The additional granularity helps in peer reviews and it does not change the original intention of the SR, which was to include in the SEL all the components addressed in the S-PRA.



## NEW CODE CASE PART 5

**Table 5-2.3-4 Supporting Requirements for HLR-SPR-C**

The list of SSCs selected for seismic-fragility analysis shall include the SSCs that participate in accident sequences included in the seismic PRA systems model (HLR-SPR-C).

Index No. SPR-C	Capability Category I	Capability Category II
SPR-C1	USE the internal-events systems model as the basis for developing a seismic equipment list (SEL) to support the fragility analysis of 5-2.2.	
SPR-C2	INCLUDE additional components (e.g., structures, passive components, panels, and cabinets that house PRA components) that may not be present in the internal-events model (or that may have been screened out in the internal-events model) but that require evaluation in the seismic PRA.	
SPR-C3	INCLUDE in the SEL, internal flood sources (as defined in Part 3) that have been identified in SPR-A2.	
SPR-C4	INCLUDE in the SEL, internal ignition sources (as defined in Part 4) that have been identified in SPR-A2.	
SPR-C5	INCLUDE in the SEL, SSCs that are inducing or are affected by the initiators resulting from the secondary hazards identified in SPR-A2.	
SPR-C6	For the SSCs identified in SPR-C1, SPR-C2, SPR-C3, SPR-C4, and SPR-C5, IDENTIFY the failure mode(s) of interest for the fragility analysis to be performed.	

**SPR-C1** – SEL should address all equipment modeled in IE. Note, not all equipment needs fragility evaluation (e.g., some equipment may not be credited, meaning the component is assumed failed). An appropriate story needs to be provided to avoid crediting components for which fragility considerations are not provided. **SPR-C2** – Add passive equipment or equipment that were screened from IE model

**SPR-C3** – Add flood sources

**SPR-C4** – Add fire sources

**SPR-C5** – Add any equipment and structure identified in the hazard analysis

**SPR-C6** – Specify the failure mode of interest. This is a new requirement that adds emphasis on the interaction with the fragility analysis. Failure modes of interest needs to be identified to ensure an appropriate fragility analysis is performed.





# HLR-SPR-D

## Seismic HRA



## NEW CODE CASE PART 5

**Table 5-2.3-5 Supporting Requirements for HLR-SPR-D**

Human actions credited in the seismic PRA shall consider seismic-specific challenges to operator performance. (HLR-SPR-D).

Index No. SPR-D	Capability Category I	Capability Category II
SPR-D1	IDENTIFY the human failure events (including recovery actions) from the internal-events PRA that are relevant in the context of the seismic PRA in accordance with HR-E1 and CCI requirement of HR-H1 in Part 2 of this Standard	IDENTIFY the human failure events (including recovery actions) from the internal-events PRA that are relevant in the context of the seismic PRA in accordance with HR-E1 and CCII requirement of HR-H1 in Part 2 of this Standard.
SPR-D2	If additional actions are credited in the seismic model (i.e., not already included in the PRA system or accident sequence models), IDENTIFY and DEFINE the HFE consistently with the SRs for 2-2.5 in Part 2 of this Standard for HLR-HR-E, HLR-HR-F, and HLR-HR-H at the Capability Category I level.	If additional actions are credited in the seismic model (i.e., not already included in the PRA system or accident sequence models), IDENTIFY and DEFINE the HFE consistently with the SRs for 2-2.5 in Part 2 of this Standard for HLR-HR-E, HLR-HR-F, and HLR-HR-H at the Capability Category II level.

**SPR-D1** – New SR that provides a more structured approach to seismic HRA. This SR essentially asks to consistently look at IE HFES and decide which one is carried forward in the S-PRA. Back-references are more explicit and they carry through the CCI/CCII differentiation.

**SPR-D2** – New SR that provides a more structured approach to the definition of new, seismic-specific HFE (e.g., relay re-set) in accordance with the Part 2 HR Technical Element for post-initiator HFES.

## NEW CODE CASE PART 5

**Table 5-2.3-5 Supporting Requirements for HLR-SPR-D**

Human actions credited in the seismic PRA shall consider seismic-specific challenges to operator performance. (HLR-SPR-D).

Index No. SPR-D	Capability Category I	Capability Category II
SPR-D3	CALCULATE the HEPs for all HFEs taking into account relevant seismic-related effects on control room and ex-control room post-initiator actions in accordance with the SRs for HLR-HR-G in Part 2 of this Standard as set forth under Capability Category I. In addressing influencing factors and the timing considerations covered in SRs HR-G3, HR-G4, and HR-G5 in Part 2, attention is to be given to how the seismic event alters any previous assessments in nonseismic analyses including: additional workload and stress; effects of the seismic event on mitigation, required response, timing, accessibility, and potential for physical harm; and seismic-specific job aids and training.	CALCULATE the HEPs for all HFEs taking into account relevant seismic-related effects on control room and ex-control room post-initiator actions in accordance with the SRs for HLR-HR-G in Part 2 of this Standard as set forth under Capability Category II. In addressing influencing factors and the timing considerations covered in SRs HR-G3, HR-G4, and HR-G5 in Part 2, attention is to be given to how the seismic event alters any previous assessments in nonseismic analyses including: additional workload and stress; effects of the seismic event on mitigation, required response, timing, accessibility, and potential for physical harm; and seismic-specific job aids and training.

**SPR-D3 – Address seismic-specific PSFs**

## NEW CODE CASE PART 5

**Table 5-2.3-5 Supporting Requirements for HLR-SPR-D**

Human actions credited in the seismic PRA shall consider seismic-specific challenges to operator performance. (HLR-SPR-D).

Index No. SPR-D	Capability Category I	Capability Category II
SPR-D4	<p>Based on a review of procedures with plant operations or training personnel and recognizing the sequence of events and expected seismic conditions, CONFIRM for the response actions</p> <ul style="list-style-type: none"> <li>(a) the time at which operators are expected to receive relevant indications,</li> <li>(b) the time available to complete actions, and</li> <li>(c) the time required to complete actions.</li> </ul>	<p>For significant HFEs, ESTIMATE the timing aspects of the response actions (i.e., time of relevant indication, time available to complete action, and time required to complete action) recognizing the sequence of events and expected seismic conditions based on one or a combination of the following approaches:</p> <ul style="list-style-type: none"> <li>(a) Walk-throughs or talk-throughs of procedures with plant operations or training personnel</li> <li>(b) Simulator observations</li> <li>(c) Plant-specific thermal-hydraulic analyses</li> <li>(d) Realistic and applicable generic or similar plant thermal-hydraulic analyses.</li> </ul> <p>Based on a review of procedures with plant operations or training personnel and recognizing the sequence of events and expected seismic conditions, CONFIRM for nonsignificant HFEs the timing aspects of the response actions.</p>

**SPR-D4** – New SR with explicit requirement to perform walkdowns and walkthrough. Even though this requirement was not there before, it captures the standard practice at this time as meeting the original **SPR-B2** has always been understood to need walkdowns and walkthrough.



## NEW CODE CASE PART 5

**Table 5-2.3-5 Supporting Requirements for HLR-SPR-D**

Human actions credited in the seismic PRA shall consider seismic-specific challenges to operator performance. (HLR-SPR-D).

Index No. SPR-D	Capability Category I	Capability Category II
SPR-D5	USE screening values for the HEPs for all HFEs included in the seismic PRA model.	PERFORM a detailed analysis for significant HFEs in the seismic PRA. Screening values can be used for nonsignificant HFEs.

**SPR-D5** – This new SR addresses a change in practice as HEPs global multipliers are considered screening values and a more refined analysis (which may include PSF-specific multipliers) is needed for operator actions that are important in the quantification.



# HLR-SPR-E

Quantify the S-PRA



**ANS**



## ADDENDUM B

Table 5-2.3-6 Supporting Requirements for HLR-SPR-E

The analysis to quantify core damage frequency and large early release frequency shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II	Capability Category III
SPR-E1 [Note (1)]	In the quantification of core damage frequency and large early release frequency, PERFORM the integration using the seismic hazard, fragility, and systems analyses.		
SPR-E2 [Note (2)]	PERFORM seismic-sequence quantification in accordance with the applicable requirements described in 2-2.7.		
SPR-E3 [Note (3)]	USE the quantification process to confirm and support the screening of SSCs (refer to Requirement SFR-B1).		
SPR-E4 [Note (4)]	In the integration/quantification analysis, INCLUDE the significant correlations that affect the results. It is acceptable to use generic correlation values. If used, SPECIFY the basis for such use.	In the integration/quantification analysis, INCLUDE all significant correlations that affect the results. USE plant-specific correlation values throughout.	

**SPR-E1** Remains essentially as is.

## ADDENDUM B

**Table 5-2.3-6 Supporting Requirements for HLR-SPR-E**

The analysis to quantify core damage frequency and large early release frequency shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II	Capability Category III
SPR-E1 [Note (1)]	In the quantification of core damage frequency and large early release frequency, PERFORM the integration using the seismic hazard, fragility and systems analyses.		
SPR-E2 [Note (2)]	<b>PERFORM seismic-sequence quantification in accordance with the applicable requirements described in 2-2.7.</b>		
SPR-E3 [Note (3)]	USE the quantification process to confirm and support the screening of SSCs (refer to Requirement SFR-B1).		
SPR-E4 [Note (4)]	In the integration/quantification analysis, INCLUDE the significant correlations that affect the results. It is acceptable to use generic correlation values. If used, SPECIFY the basis for such use.		In the integration/quantification analysis, INCLUDE all significant correlations that affect the results. USE plant-specific correlation values throughout.

**SPR-E2** Remains as single SR (i.e., **SPR-E3**) but wording is greatly expanded (and CCI/II is now differentiated) to address back-references.

## ADDENDUM B

**Table 5-2.3-6 Supporting Requirements for HLR-SPR-E**

The analysis to quantify core damage frequency and large early release frequency shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II	Capability Category III
SPR-E1 [Note (1)]	In the quantification of core damage frequency and large early release frequency, PERFORM the integration using the seismic hazard, fragility, and systems analyses.		
SPR-E2 [Note (2)]	PERFORM seismic-sequence quantification in accordance with the applicable requirements described in 2-2.7.		
SPR-E3 [Note (3)]	USE the quantification process to confirm and support the screening of SSCs (refer to Requirement SFR-B1).		
SPR-E4 [Note (4)]	In the integration/quantification analysis, INCLUDE the significant correlations that affect the results. It is acceptable to use generic correlation values. If used, SPECIFY the basis for such use.		In the integration/quantification analysis, INCLUDE all significant correlations that affect the results. USE plant-specific correlation values throughout.

**SPR-E3** Remains essentially as is (i.e., **SPR-E4**). It was not merged with **SPR-B5** (even though the topic is similar) to ensure that the screening value is maintained under control during the evolution of the S-PRA. In other words, something needs to be in place to ensure that the screening level does not become a problem when CDF/LERF change over the time to reflect further analysis or design changes.



## ADDENDUM B

**Table 5-2.3-6 Supporting Requirements for HLR-SPR-E**

The analysis to quantify core damage frequency and large early release frequency shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II	Capability Category III
SPR-E1 [Note (1)]	In the quantification of core damage frequency and large early release frequency, PERFORM the integration using the seismic hazard, fragility, and systems analyses.		
SPR-E2 [Note (2)]	PERFORM seismic-sequence quantification in accordance with the applicable requirements described in 2-2.7.		
SPR-E3 [Note (3)]	USE the quantification process to confirm and support the screening of SSCs (refer to Requirement SFR-B1).		
SPR-E4 [Note (4)]	In the integration/quantification analysis, INCLUDE the significant correlations that affect the results. It is acceptable to use generic correlation values. If used, SPECIFY the basis for such use.		In the integration/quantification analysis, INCLUDE all significant correlations that affect the results. USE plant-specific correlation values throughout.

**SPR-E4** Eliminated. The quantification does not affect the correlation approach used (which is a modeling topic, thus discussed in SPR now).



## ADDENDUM B

Table 5-2.3-6 Supporting Requirements for HLR-SPR-E

The analysis to quantify core damage frequency and large early release frequency shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II	Capability Category III
SPR-E5 [Note (5)]	USE the mean hazard, composite fragilities, and the systems analysis to generate point estimates for core damage frequency (CDF) and large early release frequency (LERF). ESTIMATE the uncertainties in overall CDF and LERF.	In the integration/quantification analysis, INCLUDE in the uncertainties in core damage frequency and large early release frequency results that arise from each of the several inputs (the seismic hazard, the seismic fragilities, and the systems-analysis aspects).	In the integration/quantification analysis, QUANTIFY the uncertainties in core damage frequency and large early release frequency results that arise from each of the several inputs (the seismic hazard, the seismic fragilities, and the systems-analysis aspects).
SPR-E6 [Note (6)]	In the analysis of LERF, SATISFY the LERF requirements in 2-2.8, where applicable.		

**SPR-E5** Remains as single SR (i.e., **SPR-E5**)

## ADDENDUM B

Table 5-2.3-6 Supporting Requirements for HLR-SPR-E

The analysis to quantify core damage frequency and large early release frequency shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II	Capability Category III
SPR-E5 [Note (5)]	USE the mean hazard, composite fragilities, and the systems analysis to generate point estimates for core damage frequency (CDF) and large early release frequency (LERF). ESTIMATE the uncertainties in overall CDF and LERF.	In the integration/quantification analysis, INCLUDE in the uncertainties in core damage frequency and large early release frequency results that arise from each of the several inputs (the seismic hazard, the seismic fragilities, and the	In the integration/quantification analysis, QUANTIFY the uncertainties in core damage frequency and large early release frequency results that arise from each of the several inputs (the seismic hazard, the seismic fragilities, and the
SPR-E6 [Note (6)]	In the analysis of LERF, SATISFY the LERF requirements in 2-2.8, where applicable.		

**SPR-E6** Remains as single SR (i.e., **SPR-E6**) but wording is greatly expanded (and CCI/II is now differentiated) to address back-references.

## NEW CODE CASE PART 5

**Table 5-2.3-6 Supporting Requirements for HLR-SPR-E**

The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II
SPR-E1	In the quantification of core damage frequency and large early release frequency on a reactor-year basis, INTEGRATE the hazard, fragility, and systems analyses in the PRA model.	
SPR-E2	CORRECT for any overestimation of risk due to rare event approximation at higher hazard spectrum (i.e., where fragilities approach 1.0).	
SPR-E3	QUANTIFY the seismic sequences in accordance with the following supporting requirements from Part 2 of this Standard, which are applicable to the seismic hazard for CCI: QU-A2, A3, A4, and A5; QU-B1, B2, B3, B5, B6, B7, B8, B9, and B10; QU-C1, C2, and C3; QU-D1, D2, D3, D5, D6, and D7.	QUANTIFY the seismic sequences in accordance with the following supporting requirements from Part 2 of this Standard, which are applicable to the seismic hazard for CCII: QU-A2, A3, A4, and A5; QU-B1, B2, B3, B5, B6, B7, B8, B9, and B10; QU-C1, C2, and C3; QU-D1, D2, D3, D5, D6, and D7.
SPR-E4	USE the quantification process to ensure that the components screened out, based on the screening level defined in SPR-B5, do not become a significant contributor or do not invalidate the dominant sequence insights of the seismic PRA.	

**SPR-E1** – Same as before. Language on reactor-year correction eliminates the need for a back-reference to Part 2 equivalent SR.

**SPR-E2** – This is where the real concern discussed in the old **SPR-B8** is now discussed.

**SPR-E3** – Same as the old **SPR-E2** but with more explicit back-references.

**SPR-E4** – Same as the old **SPR-E3**.





## NEW CODE CASE PART 5

**Table 5-2.3-6 Supporting Requirements for HLR-SPR-E**

The analysis to quantify core damage and large early release frequencies shall appropriately integrate the seismic hazard, the seismic fragilities, and the systems-analysis aspects (HLR-SPR-E).

Index No. SPR-E	Capability Category I	Capability Category II
SPR-E5	USE the mean hazard, mean fragilities, and the systems analysis to generate point estimates for core damage frequency (CDF) and large early release frequency (LERF).	QUANTIFY the mean core damage frequency and large early release frequency and propagate the uncertainty that results from each input (i.e., the seismic hazard, the seismic fragilities, and the systems analysis).
SPR-E6 [Note (1 and 3)]	In the analysis of LERF, SATISFY the following LERF requirements in 2-2.8 as they are applicable to the seismic hazard for CCI: LE-A2; LE-C2, C3, C4, and C13; LE-D3; LE-E3; LE-F1 and F2.	In the analysis of LERF, SATISFY the following LERF requirements in 2-2.8 as they are applicable to the seismic hazard for CCII: LE-A2; LE-C2, C3, C4, and C13; LE-D3; LE-E3; LE-F1 and F2.
SPR-E7 [Note (2)]	PERFORM the uncertainty analysis consistent with HLR-QU-E of Part 2 addressing key assumptions in the hazard analysis (see SHA-J2), fragility analysis (refer to SFR-F3), and system modeling for CCI.	PERFORM the uncertainty analysis consistent with HLR-QU-E addressing key assumptions in the hazard analysis (refer to SHA-J2), fragility analysis (refer to SFR-F3), and system modeling for CCII.

**SPR-E5** – Same as before. Language on reactor-year correction eliminates the need for a back-reference to Part 2 equivalent SR.

**SPR-E6** – Same as before but with more explicit back-references.

**SPR-E7** – New SR that adds emphasis on the performance of sensitivity analysis to address model uncertainties (per QU in Part 2). Note the pointer to SFR and SHA requirements to ensure that SFR and SHA assumptions be assessed for their impact on the RISK PROFILE, and not only on the fragility or hazard portion. Note that assumptions from the entire SHA (not only the PSHA) are of interest. This SR also captures the concept of the original **SPR-C1**





# HLR-SPR-F

**Document the modeling and quantification portions of the S-PRA**



## ADDENDUM B

Table 5-2.3-7 Supporting Requirements for HLR-SPR-F

The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review (HLR-SPR-F).

Index No. SPR-F	Capability Category I	Capability Category II	Capability Category III
SPR-F1 [Note (1)]	DOCUMENT the seismic plant response analysis and quantification in a manner that facilitates PRA applications, upgrades, and peer review.		
SPR-F2 [Note (2)]	DOCUMENT the process used in the seismic plant response analysis and quantification.		
SPR-F3 [Note (2)]	DOCUMENT the sources of model uncertainty and related assumptions associated with the seismic plant response model development.		

**SPR-F1** Same as before

## ADDENDUM B

Table 5-2.3-7 Supporting Requirements for HLR-SPR-F

The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review (HLR-SPR-F).

Index No. SPR-F	Capability Category I	Capability Category II	Capability Category III
SPR-F1 [Note (1)]	DOCUMENT the seismic plant response analysis and quantification in a manner that facilitates PRA applications, upgrades, and peer review.		
SPR-F2 [Note (2)]	DOCUMENT the process used in the seismic plant response analysis and quantification.		
SPR-F3 [Note (2)]	DOCUMENT the sources of model uncertainty and related assumptions associated with the seismic plant response model development.		

**SPR-F2** Same as before but with added details to be consistent with other similar documentation SRs.

## ADDENDUM B

Table 5-2.3-7 Supporting Requirements for HLR-SPR-F

The seismic-PRA analysis shall be documented in a manner that facilitates applying the PRA and updating it, and that enables peer review (HLR-SPR-F).

Index No. SPR-F	Capability Category I	Capability Category II	Capability Category III
SPR-F1 [Note (1)]	DOCUMENT the seismic plant response analysis and quantification in a manner that facilitates PRA applications, upgrades, and peer review.		
SPR-F2 [Note (2)]	DOCUMENT the process used in the seismic plant response analysis and quantification.		
SPR-F3 [Note (2)]	DOCUMENT the sources of model uncertainty and related assumptions associated with the seismic plant response model development.		

**SPR-F3** Same as before but with a better linkage to the quantification SRs.



## NEW CODE CASE PART 5

**Table 5-2.3-7 Supporting Requirements for HLR-SPR-F**

Documentation of the seismic PRA analysis shall be consistent with the applicable supporting requirements (HLR-SPR-F).

Index No. SPR-F	Capability Category I	Capability Category II
SPR-F1	DOCUMENT the seismic plant-response analysis and quantification in a manner that facilitates PRA applications, upgrades, and peer review.	
SPR-F2	DOCUMENT the process used in the seismic plant-response analysis and quantification. For example, this documentation typically includes a description of (a) SEL; (b) the specific modifications made in the internal-events PRA model to produce the seismic PRA model and their basis; (c) those seismic-related influences that affect methods, processes, or assumptions used, as well as the identification and quantification of the HFEs/HEPs; and (d) the major outputs of a seismic PRA, such as mean CDF, mean LERF, uncertainty distributions on CDF and LERF, results of sensitivity studies, and significant risk contributors.	
SPR-F3	DOCUMENT the sources of model uncertainty and related assumptions consistently with SPR-E7 above.	

**SPR-F1** – Standard wording for the first documentation SR in each technical element.

**SPR-F2** – Added example of items to be documented. Follows the same style of the second documentation SR in all technical elements.

**SPR-F3** – Focuses on documentation of uncertainties.