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10 CFR 50.90
10 CFR 50.69

June 30, 2022

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
ATTN: Document Control Desk

Limerick Generating Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352 and 50-353

Subject: Response to Request for Additional Information
Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Categorization Process in Accordance with the Requirements of 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors"

References:

[1]. Exelon Generation Company, LLC letter to the U.S. Nuclear Regulatory Commission, Limerick Generating Station, Units 1 and 2, "Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Tier 1 Categorization Process in Accordance with the Requirements of 10 CFR 50.69, 'Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors'," dated March 11, 2021 (ADAMS Accession No. ML21070A412).

[2]. Exelon Generation Company, LLC letter to the U.S. Nuclear Regulatory Commission, Limerick Generating Station, Units 1 and 2, "Supplement - Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Tier 1 Categorization Process in Accordance with the Requirements of 10 CFR 50.69, 'Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors'," dated May 5, 2021 (ADAMS Accession No. ML21125A215).

[3]. Email from A. Klett (U.S. Nuclear Regulatory Commission) to G. Stewart (Constellation Energy Generation, LLC), "NRC Request for Additional Information - Limerick License Amendment Request (L-2021-LLA-0042)," dated May 13, 2022 (ADAMS Accession No. ML22136A003).

By letter dated March 11, 2021 (Reference [1]), Exelon Generation Company, LLC (Exelon) submitted an application for amendment of the Renewed Facility Operating License Nos. NPF-39 and NPF-85 for Limerick Generating Station (Limerick), Units 1 and 2, respectively.

The proposed amendments would modify the licensing basis by revising the related License Condition in Appendix C to allow the use of an alternate defense-in-depth categorization process, an alternate pressure boundary categorization process, and an alternate seismic categorization process for implementation of the risk-informed categorization and treatment of structures, systems, and components for Limerick in accordance with the requirements of 10 CFR 50.69. This response rescinds Limerick's initial request under the alternate defense-in-depth process to use an alternate methodology for Containment Large Early Release Frequency (LERF). Limerick will continue to use its currently approved method for Containment LERF defense-in-depth (see question 12 response in Attachment 1).

By letter dated May 5, 2021 (Reference [2]), Exelon submitted a supplement to provide additional information to support the acceptance review of the license amendment request (LAR).

Note: On November 16, 2021, NRC issued an Order approving Exelon's application for the indirect transfer of Limerick's Renewed Facility Operating License Nos. NPF-39 and NPF-85 for Units 1 and 2, respectively, to Constellation Energy Generation, LLC (CEG). By letter dated January 24, 2022, Exelon informed the NRC that all required regulatory approvals necessary to close the transfer had been received and that the transfer would close on February 1, 2022. On February 1, 2022, NRC issued the conforming license amendments following completion of the transfer to CEG.

By email dated May 13, 2022 (Reference [3]), the NRC notified CEG that additional information is needed to complete its review of the LAR. Attachment 1 to this letter provides a response to the request for additional information contained in the email. Attachment 2 provides markups of proposed changes to EPRI 3002015999. Attachment 3 provides PWROG-20015-NP Revision 3 with revision bars.

CEG has reviewed the information supporting the No Significant Hazards Consideration and the Environmental Consideration that was previously provided to the NRC in References [1] and [2]. The information in this response does not impact the conclusion that the proposed license amendments do not involve a significant hazards consideration. The information also does not impact the conclusion that there is no need for an environmental assessment to be prepared in support of the proposed amendments.

There are no regulatory commitments contained in this response.

In accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b), CEG is notifying the Commonwealth of Pennsylvania of this response to request for additional information by transmitting a copy of this letter to the designated State Official.

If you have any questions regarding this submittal, then please contact Steve Flickinger at 267-533-5302.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 30th day of June 2022.

Respectfully,

D. P. Helker

David P. Helker
Sr. Manager - Licensing
Constellation Energy Generation, LLC

Attachment 1: Response to Request for Additional Information - License Amendment Request, Application to Implement Alternate Categorization Processes in Accordance with the Requirements of 10 CFR 50.69.
Appendix A: Revised Proposed FOL Appendix C License Condition Markups
Attachment 2: EPRI 3002015999 Markups
Attachment 3: PWROG-20015-NP, Revision 3 with Revision Bars

cc:	Regional Administrator - NRC Region I	w/ attachments
	NRC Senior Resident Inspector - Limerick Generating Station	"
	NRC Project Manager, NRR - Limerick Generating Station	"
	Director, Bureau of Radiation Protection - Pennsylvania Department of Environmental Protection	"

ATTACHMENT 1

Response to Request for Additional Information
License Amendment Request

Limerick Generating Station, Units 1 and 2
NRC Docket Nos. 50-352 and 50-353

Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Categorization Process in Accordance with the Requirements of 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors"

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RAIs on Alternate Pressure Boundary Components

RAI-01 – Results of the Alternate Pressure Boundary 10 CFR 50.69 Method

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of structures, systems, components (SSCs).
Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The Statement of Consideration (SoC) on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Section 1 of Electric Power Research Institute (EPRI) report 3002015999[1] states that a second report is anticipated, for 2020, that will provide background on additional investigations and providing implementation guidance. The NRC staff is unaware of whether this report has been published. Section 3.1.3 of Enclosure 1 of the LAR states that the alternate EPRI approach was piloted in April 2020 for the entire plant and the results were reasonable and consistent. The NRC staff requests the following information:

A. *Results of the alternate pressure boundary categorization. Include the specific difference in results between the existing approved method and the alternate EPRI 3002015999 method.*

Response

The pilot categorization determined that there are two areas of difference between the existing approved method and the alternate EPRI approach. One difference adds High Safety Significance (HSS) piping segments and one removes HSS piping segments as compared to the approved methodology.

The alternate EPRI approach includes as HSS those segments of piping that correspond to the Break Exclusion Region (BER). This would be an addition to the current methodology since these areas were found to be LSS where they occur outside of Class 1 piping sections at Limerick.

Class 1 Exempt piping would be excluded from HSS with the alternate EPRI approach, through HSS criteria 1 a). This criterion states that Class 1 piping can be exempt from HSS if, “In the event of a postulated failure of the component during normal reactor operation, the reactor can be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system.” The kinds of piping that falls under this exemption from HSS are small 1” instrument tubing, vents, and drains directly connected to the Reactor Coolant System (RCS).

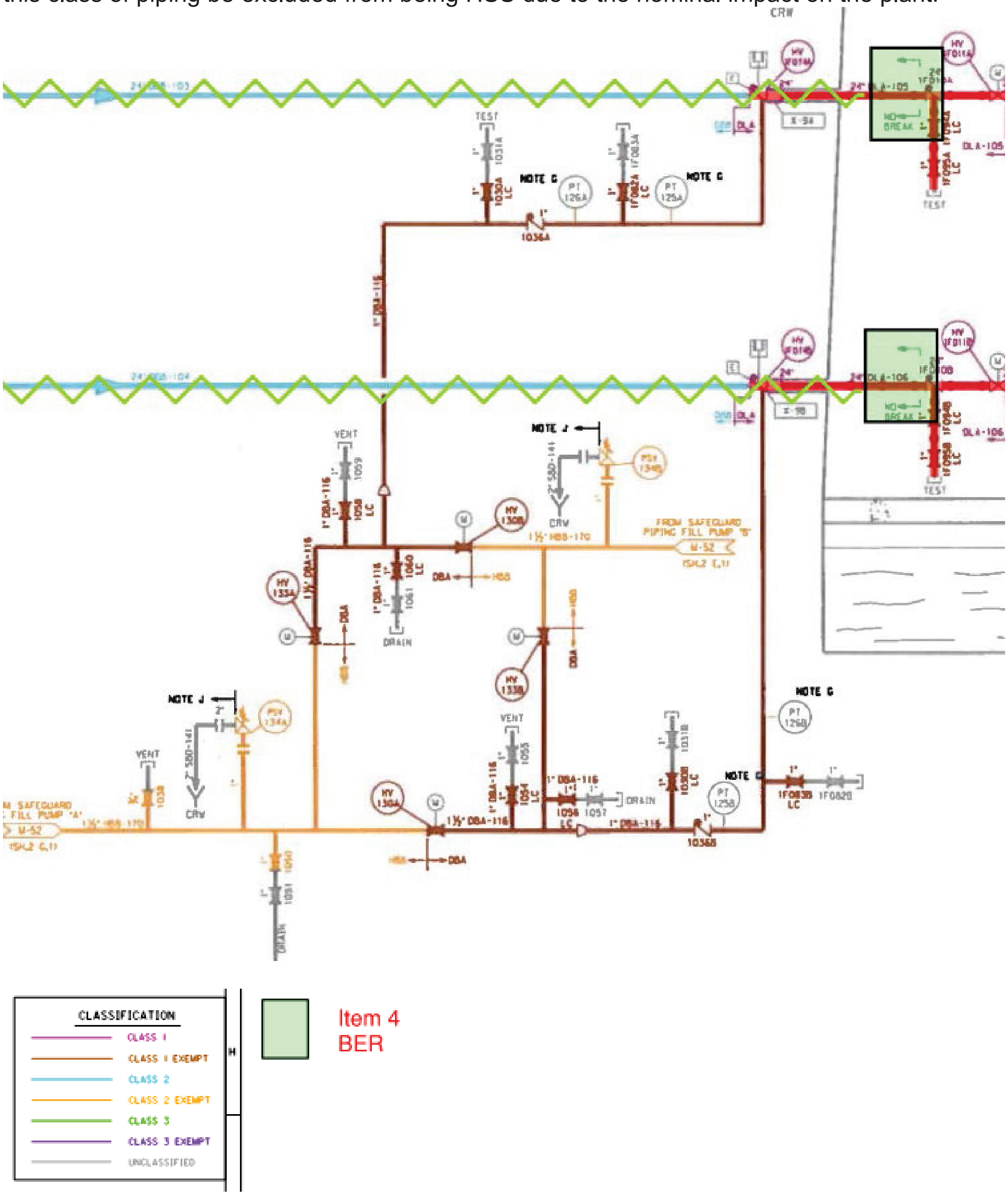
B. *Discussion and justification that support the licensee’s conclusion that the pilot categorization results are reasonable and consistent.*

Response

The HSS portions of piping found in the current methodology were predominately the same as those found in the proposed EPRI methodology. There are two exceptions to this. What was different was the addition of BER piping not found in the current methodology. Constellation considers this is a conservative, acceptable addition to the scope of HSS piping. The reduction in HSS piping segments occurs with small instrument, drain, or supply piping like the example depicted below for Reactor Feedwater. In the figure below, the Safeguards Piping Fill system is connected to the 24” reactor feedwater system with 1” piping highlighted in brown. Failure of this piping would

[1] Electric Power Research Institute (EPRI), 3002015999, “Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components,” November 2019.

not prevent the plant from shutting down with normal makeup. Thus, it is reasonable that this class of piping be excluded from being HSS due to the nominal impact on the plant.



C. *Identify any passive SSCs categorized by the existing approved method that have changed by applying the alternate method.*

Response

There are two sources of differences between the EPRI methodology and the approved methodology. SSCs found on BER segments now become HSS while Class 1 Exempt piping and tubing becomes Low Safety Significance (LSS). Table 01-1 describes the SSCs that became HSS from the new methodology and those that become LSS. The table is broken down by affected system, P&ID, and sheet number. A set of drawings is available to view the affected SSCs.

The EPRI process does not put into question any of the standard accepted assumptions used in the internal events or flooding Probabilistic Risk Assessment (PRA). For example, the availability of floor drains, berms, and other flood mitigation measures are already considered in the flooding analysis and do not change when considering pressure boundary categorization. With regard to high energy line breaks, system degradation, impingement, and pipe whip effects are already part of the full power internal events modeling of steam and feedline break initiators. With respect to potential increased loading demands resulting from severed piping or pipe whip, the seismic design requirements bound loading and dynamic requirements of piping supports.

Table 1 Limerick System and Impact of Alternate Pressure Boundary Categorization						
System	Drawing	Sheet	Class 1 Exempt	Description (Now LSS)	BER	Description (Now HSS)
Nuclear Boiler	41	1	Y	Safeguard Keep Full 1 ½" and 1" supply to RFW, vessel instrumentation	Y	HV-1F032A, HV-1F032B, HV-109A, HV-109B
		2	Y	2" main steam flow instrumentation	Y	Steam pressure instrument PP-138A
		4	Y	Safeguard Keep Full 1 ½" and 1" supply to RFW, vessel instrumentation	Y	HV-2F032A, HV-2F032B, HV-209A, HV-209B
		5	Y	2" main steam flow instrumentation	Y	Steam pressure instrument PP-238A
Nuclear Boiler Vessel	42	1	Y	1" vessel level and pressure instrumentation	-	N/A
		3	Y	1" vessel level and pressure instrumentation	-	N/A
Reactor Recirc Pump	43	1	Y	Recirc pump flow ¾" and 1" instrumentation	-	N/A
		2	Y	Recirc pump flow 1" instrumentation	-	N/A
		3	Y	Recirc pump flow ¾" and 1" instrumentation	-	N/A
		4	Y	Recirc pump flow 1" instrumentation	-	N/A
Reactor Water Cleanup	44	1	Y	¾" test connections	Y	Isolation valve HV 1F040
		2	-	N/A	-	N/A
		3	Y	¾" test connections	Y	Isolation valve HV 2F040
		4	-	N'A	-	N/A
Standby Liquid Control	48	1	Y	1" drain and 3/4" test lines.	-	N/A
		2	Y	1" drain and 3/4" test lines.	-	N/A
Reactor Core Isolation Cooling	49	1	Y	1" flow instrument lines, test connections and drains	Y	No affected SSCs
		2	Y	1" flow instrument lines, test connections and drains	Y	No affected SSCs

Table 1 Limerick System and Impact of Alternate Pressure Boundary Categorization

System	Drawing	Sheet	Class 1 Exempt	Description (Now LSS)	BER	Description (Now HSS)
Residual Heat Removal	51	1	Y	1" test connections, MOV bypass line, relief line, and instrument lines	-	N/A
		2	-	N/A	-	N/A
		3	Y	1" test connections, MOV bypass line, and instrument lines	-	N/A
		4	-	N/A	-	N/A
		5	Y	1" test connections, MOV bypass line, relief line, and instrument lines	-	N/A
		6	-	N/A	-	N/A
		7	Y	1" test connections and instrument lines	-	N/A
		8	-	N/A	-	N/A
Core Spray	52	1	Y	1" test connections, drain, and instrument lines	-	N/A
		2	-	N/A	-	N/A
		2A	-	N/A	-	N/A
		3	Y	1" test connections, drain, and instrument lines	-	N/A
High Pressure Coolant Injection	55	1	Y	¾" test connection, valve bypass, and 1" instrument line	Y	8" check valve 1058 connection to feedwater
		2	Y	¾" test connection, valve bypass, and 1" instrument line	Y	No affected SSCs (differs from Unit 1)

Table 2 shows the percent change of HSS components from the current approved passive categorization method to the Alternative Passive treatment for the systems listed below. However, the Nuclear Boiler (NB, System 41) was not categorized and the HSS data represents all components in containment that would have been HSS if categorized. The difference in the methods shows the reduction of HSS components from the removal of Class 1 Exempt components and the addition of BER components.

Table 2 Percent Change in HSS Components from Alternate Pressure Boundary Categorization

System	System Number	Total components HSS	Total components after applying Alt Pass. Treatment	Percent Change	Notes
NB	41	38	48	26%	10 components added due to criteria 4.
RWCU	44	79	19	-76%	2 components added due to criteria 4.
SLCS	48	22	10	-55%	
RCIC	49	47	8	-83%	
RHR	51	204	50	-75%	
CS	52	56	20	-64%	
HPCI	55	50	13	-74%	1 component added due to criteria 4.
RHRSW	12	18	18	0%	
ESW	11	16	16	0%	
	Totals	530	202	-62%	

D. *Provide the number and percentage of SSCs determined to be HSS based on Criteria 1 through 10 and, separately, Criteria 11 through 14 provided in Section 4.2 of EPRI 3002015999.*

Response

All (100%) of the HSS SSCs were determined to be such from the prescribed HSS criteria 1 through 10. There are no SSCs that meet the 11 through 14 criteria.

E. *Provide details of any follow-up EPRI documentation related to the alternate pressure boundary categorization method. Include in this discussion if the Limerick, and any other plant, pilot results have been reviewed by EPRI to assess impact on the categorization results.*

Response

While it is true that EPRI 3002015999 states that a second report was anticipated to be available 2020, the intent of this report was to reflect lessons learned from NRC review of the lead plant submittal. This is similar to what was done for the seismic alternative effort (e.g., EPRI reports 3002012988, 3002017583 and 300202 2453). As such, once NRC review of the Limerick LAR is completed, it is anticipated that a subsequent report will be published.

F. *If additional relevant EPRI documents have been published (e.g., the second report identified in EPRI 3002015999), then provide them on the docket for NRC staff review of its applicability to this LAR.*

Response

Please see response to RAI 01-E, above.

RAI-02 – Prerequisite No. 1, PRA Technical Adequacy Internal Flooding Model

Paragraph (b)(2)(ii) of 10 CFR 50.69 requires a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown (including the plant-specific PRA, margins-type approaches, or other systematic evaluation techniques used to evaluate severe accident vulnerabilities) are adequate for the categorization of SSCs. Paragraph 50.69(b)(2)(iv) requires a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The SoC on Paragraph 50.69(b)(2)(iv) of the rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Section 3.1.3 of Enclosure 1 of the LAR states that the EPRI 3002015999 methodology is proposed as an alternate to the NRC-accepted ANO-2 R&R-004[2] method for SSC categorization. Section 4.1 of the EPRI document specifies prerequisites or requirements that must be met prior to implementing the methodology, including the requirement of a robust internal events and internal flooding PRA (IFPRA). Section 3.1.3 of Enclosure 1 of the LAR states, for Prerequisite No. 1, that Limerick has a risk-informed in-service inspection (RI-ISI) program that is sufficient for use in categorization based on the 'gap' assessment provided in Section 4.1 of the EPRI report (6 clarifications) and the analysis provided in EPRI 102146712. The NRC staff notes the analysis of EPRI 1021467 was performed against the 2008 American Society of Mechanical Engineers/American Nuclear Society (ASME/ANS) Probabilistic Risk Assessment (PRA) Standard. It is unclear to the NRC staff which PRA model (i.e., the 2009 ASME/ANS PRA Standard13 peer-reviewed IFPRA model (in accordance with NRC Regulatory Guide (RG) 1.200) or the RI-ISI application model) will be utilized in the Limerick alternate passive categorization process.

[2] Markley, Michael, U.S. Nuclear Regulatory Commission, letter to Vice President, Operation, Arkansas Nuclear One, Entergy Operations, Inc., "Arkansas Nuclear One, Unit 2 – Approval of Request for Alternative AN0-2 R&R-004, Revision 1, Request to Use Risk-Informed Safety Classification and Treatment for Repair/Replacement Activities in Class 2 & 3 Moderate and High Energy Systems," dated April 22, 2009 (ADAMS Accession No. ML090930246).

A. *Clarify which Limerick PRA model (i.e., RG 1.200 or RI-ISI) will be utilized in the alternate passive categorization process. Include in this discussion whether this requirement is applicable to the full power internal events (FPIE) model.*

Response

Both the RI-ISI program and the Limerick 50.69 categorization program use the same probabilistic risk assessment model of record which includes the peer-reviewed internal flooding PRA model. That model is called the LG117A (LG217A for Unit 2) which was approved in July 2018. This model is periodically updated according to Constellation procedures. Open peer review findings for internal events and flooding for this model revision are addressed in ML21070A412.

B. *Provide a summary of changes, if any, performed in the FPIE and IFPRA to support the alternate passive categorization method.*

Response

There were no changes made to the PRA model of record (or IFPRA) to support the alternate pressure boundary categorization method.

C. *Section 4 of Nuclear Energy Institute (NEI) 00-04, "10 CFR 50.69, SSC Categorization Guideline," states the classification of SSCs with a pressure retaining function should be performed using the ASME Code Case N-660 or, as stated in RG 1.201, "Guidelines for Categorizing Structures, Systems, and Components in Nuclear Power Plants According to Their Safety Significance," alternatives that have received specific NRC approval for the 10 CFR 50.69 categorization program. Section I-3 of the Case N-660 states that indirect effects shall be assessed, and Section I-3.1.3(a)(4) provides high safety significant (HSS) criteria related to indirect effects. Sections I-3.0.1, I-3.1.1, and I-3.2.2 of the ANO-2-R&R-004, Revision 1 alternative pressure categorization state that indirect effects, which include spatial interactions such as pipe whip, jet spray, and loss-of-inventory effects (e.g., draining), be assessed in determining the SSC's categorization. During the NRC's audit, the licensee mentioned that indirect effects are addressed in the plants' safety analyses. The NRC staff notes that the FPIE and IFPRA analysis usually may not explicitly incorporate indirect effects. For example, supporting requirement IFSN-A6, as updated by NRC endorsement in RG 1.200, at Capability Category II allows for qualitative assessment of flood induced mechanisms:*

> *…for the SSCs identified in IFSN-A5, IDENTIFY the susceptibility of each SSC in a flood area to flood-induced failure mechanisms. INCLUDE failure for submergence and spray in the identification process. ASSES qualitatively the impact of flood-induced mechanisms that are not formally addressed (e.g., using the mechanisms listed under Capability Category III of this requirement), by using conservative assumptions.*

Further, the proposed EPRI methodology does not mention indirect effects.

Discuss how comprehensive the FPIE and IFPRA analysis is to model indirect effects (e.g., pipe whip, jet impingement, spray, inventory losses, etc.), and justify why it is adequate to support the 10 CFR 50.69 categorization process.

Response

In the Limerick FPIE and IFPRA, water spraying or splashing on unprotected equipment, except for passive components, is assumed to fail the component unless its design precludes such failure. This satisfies the requirements of the American Society of Mechanical Engineers (ASME) and American Nuclear Society (ANS) PRA Standard RA-Sa-2009 for internal flooding IFSN-A5 and -A6 at the level of Capability Category II.

Section 3.2.3 of EPRI 1019194 states that a sphere of influence of 10 feet for liquid flood sources and 20 feet for high energy flood sources (e.g., feedwater piping) is assumed for equipment damage due to spray effects. For the purposes of gathering data during plant walkdowns, conservative engineering judgment that included a sphere of influence of 30 feet for lateral sources was used for crediting spray sources in the vicinity of susceptible equipment so as to account for uncertainty in the estimation of pipe lengths, redirection of sprays due to obstructions, higher system pressures, etc.

Water spray is considered to be a failure mode of electrical equipment such as switchgear and Motor Control Centers (MCC). The criteria used in the screening of the flood sources are as follows:

- All water sources are assumed capable of causing electrical equipment failure from leaks or ruptures if they are located within 30 ft of the electrical equipment and the electrical equipment is unprotected from the water source.
- The pipe failure rates are characterized as the sum of leaks and ruptures. In some select cases, the geometry of the spray pattern (e.g., direction) is important and this geometry was considered when accounting for spray sources.
- The susceptible (i.e., unprotected) electrical equipment are assumed to fail with a 1.0 failure probability if sprayed.

Internal Flooding operator actions are modeled in the PRA model where appropriate. See Appendix F of the Internal Flooding Notebook for details and Appendix B of the Human Risk Analysis (HRA) Notebook for details. These flooding Human Error Probabilities (HEPs) were developed using detailed HRA methods and followed a similar process as that used to create the non-flood HEPs (e.g., similar quantitative process, procedure review, etc.). The flooding HEPs were documented in the EPRI HRA Calculator.

Drain capacity is evaluated for some flooding scenarios. Appendix E of the Internal Flooding Notebook provides details.

Protection against the dynamic effects (i.e., pipe whip or jet impingement) associated with a pipe rupture is evaluated as part of the specific system design process. This design process evaluation reduces the likelihood of these dynamic effects as well as resulting environmental concerns such as increased temperature, pressure, humidity, and radiation levels. Key mitigative plant equipment is specifically designed for these potential environmental conditions. This is particularly true of piping and equipment found in the BER, also known as High-Energy Line Break (HELB), and equipment found in containment. Therefore, the flood analysis does not re-evaluate these various water damage mechanisms other than component submergence and spray as discussed above. However, the FPIE model does model and incorporate the direct and indirect effects of 1) breaks outside containment, and 2) interfacing system LOCAs (ISLOCAs).

Constellation calculations have shown that for moderate energy water systems, it is reasonable to conclude that pipe whip is not a significant damage mechanism for plant components.

Inventory loss as a result of a pipe break is a key consideration when modeling flooding. Inventory loss, pipe emptying, resultant pump cavitation, flow diversion, and impacts on other systems due to the inventory loss are all considered when developing scenarios in the flooding model. Given these considerations, Constellation has determined that, between the comprehensive internal flooding model, conservative assumptions on direct and indirect flooding effects, and the EPRI guidance for determining HSS segments and components, the proposed process adequately supports the 10 CFR 50.69 pressure boundary categorization process.

D. *Discuss what pipe rupture frequency methodology is employed in the Limerick IFPRA, and justify why it is believed to be adequate to support the alternate passive categorization.*

Response

The Internal Flooding assessment for Limerick follows the EPRI Guidelines as described in EPRI 1019194 “Guidelines for Performance of Internal Flooding Probabilistic Risk Assessment” as Constellation considers this to meet Capability Category II of the ASME PRA Standard. This methodology made use of industry data that was organized and evaluated to arrive at failure rates and frequencies based on the type of system, diameter, and length of pipe [EPRI 3002000079, Rev. 3 “Pipe Rupture Frequencies for Internal Flooding PRAs”]. Since this source of flooding rupture frequencies is the industry standard and is required to meet the highest levels of the Capability Category of the ASME/ANS PRA standard, this data source should be sufficient for the categorization of pressure boundary components in both the approved and EPRI alternate approach.

E. *During the audit, the licensee stated that the Limerick IFPRA uses the EPRI Topical Report (TR) 3002000079, “Pipe Rupture Frequencies for Internal Flooding PRAs,” Revision 3, for the pipe break frequencies. Provide an overview of the EPRI TR-3002000079 report and discuss its basis.*

Discuss both rupture frequencies and assumed break sizes.

Justify why it is adequate to support the 10 CFR 50.69 categorization process.

Response

EPRI TR-3002000079 updates the 2010 EPRI report (1021086) on piping system failure rates for use in PRAs, specifically, internal plant flooding and HELBs. The data is based on extensive U.S. Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) nuclear experience with pipe leakage including data from 1970 through 2009. The latest version represents the third revision to this pipe failure rate report. The failure rate estimates are intended to satisfy requirements of the ASME and ANS PRA Standard RA-Sa-2009. The estimates also support an EPRI PRA Scope and Quality project to provide guidelines on internal flooding analysis and are intended for use in conjunction with separate EPRI guidelines for performing an internal flooding PRA (1019194). Thus, Constellation considers this to be adequate to support 10 CFR 50.69.

This report develops failure rates for various failure modes, including wall thinning, pinhole leaks, larger leaks, and major structural failures. The estimated failure rates include a total failure rate in cases where pipe repair or replacement has been performed. These failure rates and a separate estimate of conditional flood mode probabilities were used to estimate failure rates for sprays, localized flooding, and major flooding for different pipe sizes and selected components. Results are provided in the form of cumulative failure frequency versus equivalent break size, allowing for a more refined analysis of piping system failure modes. The failure rates were estimated per linear foot of pipe and per reactor operating year, with the assumption that each pipe failure is a precursor to a more severe failure mode that could result in a flood. Correction factors are provided, based on generic industry experience, to support strategies for reliability and integrity management, such as leak surveillance and in-service inspection programs. Other information is included to offer guidance for flooding PRAs and the modeling of HELBs. Some plant-level information is included to support estimates of the frequency of maintenance-induced flooding.

Additional results in this report include plant-level flood frequencies from various causes, including pressure boundary failures, spurious fire protection system actuations, design deficiencies, and maintenance-induced floods. The following Table highlights the range of frequencies developed and the service data used in its development. Due to the comprehensiveness of this report and the U.S. plant-specific data it is based upon, Constellation believes it provides adequate piping failure data for internal flooding modeling to support the 10 CFR 50.69 passive categorization process.

Scope of Piping Systems and Service Data Included in This Report[1]

System[2]	Reactor Type Cases	Type Cases	Pipe Class Cases	Nominal Pipe Size (in.) Cases	Service Period (Reactor Years)
Service water	BWR, PWR	River, lake, sea	ASME Class 3, ***non-safety***	2, 4, 10, 24	1/1/70 to 3/31/09 (3,307)
Fire protection	All	with and without WH protection	Non-safety	4, 6, 24	1/1/70 to 3/31/09 (996)
SIR outside containment	All	N/A	ASME Class 3	4, 10, 24	1/1/70 to 3/31/10 (5,166)
CCW and CST	All	N/A	Non-safety	24	1/1/70 to 3/31/10 (5,278)

System[2]	Reactor Type Cases	Type Cases	Pipe Class Cases	Nominal Pipe Size (in.) Cases	Service Period (Reactor Years)
FWC outside containment	BWR	N/A	Non-safety	10, 24	1/1/88 to 3/31/09 (1,296)
	PWR	N/A	Non-safety	10, 24	1/1/88 to 12/31/08 (2,059)
HP steam outside containment	BWR	N/A	Non-safety	10, 24	1/1/88 to 3/31/09 (1,296)
	PWR	N/A	Non-safety	10, 24	1/1/88 to 12/31/08 (2,059)
LP steam	BWR	N/A	Non-safety	10, 24	1/1/88 to 3/31/09 (1,296)
	PWR	N/A	Non-safety	10, 24	1/1/88 to 12/31/08 (2,059)
EXT steam	BWR	N/A	Non-safety	10, 24	1/1/88 to 3/31/09 (1,296)
	PWR	N/A	Non-safety	10, 24	1/1/88 to 12/31/08 (2,059)
Circulating water	All	Piping	Non-safety	>24	1/1/70 to 3/31/10 (3,375)
		Expansion joints	Non-safety		1/1/70 to 12/31/04 (2,899)
Plant Level Floods	***All***	***All***	***All***	***All***	***1/1/70 to 12/31/11 (3,554)***

RAI-03 – Prerequisite No. 2 – Integrity Management

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy

10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Section 3.1.3 of Enclosure 1 of the LAR states that the EPRI 3002015999 methodology is proposed as an alternate to the NRC-accepted ANO-2 R&R-004 method for SSC categorization. Section 4.1 of the EPRI document specifies prerequisites or requirements that must be met prior to implementing the methodology, including the requirement to have robust programs that address localized corrosion, flow-accelerated corrosion, and erosion.

Section 3.1.3 of Enclosure 1 of the LAR states that for Prerequisite No. 2, Limerick programs follow the guidance of all the references listed in the EPRI document. The NRC staff notes that there are other degradation methods (e.g., mechanical wear, fretting, fatigue, and stress corrosion cracking) that can impact the integrity of passive SSCs.

A. *Provide justification that other passive component degradation mechanisms should not be addressed with regards to the component's integrity.*

Response

Approval to use 10CFR50.69 does not absolve a Licensee from meeting other commitments related to pressure boundary integrity. For example, NEI-03-08 (Guidelines for The Management of Materials Issues), Material Reliability Program (MRP), Boiling Water Reactor Vessel and Internals Project (BWRVIP), License Renewal / Subsequent License Renewal (LR/SLR).

Further, during the development of the risk-informed inservice inspection methodologies (RI-ISI) a number of reviews of various degradation mechanisms potentially operative in safety related and non-safety related systems were conducted. As a result of these efforts (References 1-7 below), it was determined that, for systems typically outside the scope of an ISI program, the requirements identified via Prerequisite No. 2 were the appropriate means of assuring pressure boundary integrity

Systems/subsystems typically included within a RI-ISI program (e.g., NRC approved code case N-716-1) that are also within the scope of the pre-determined set of HSS systems/ subsystems contained with the enhanced methodology would continue to be treated within the confines of the RI-ISI program.

Finally, 10CFR50.69(d)(2) requires that the Licensee conduct periodic inspection and testing activities to determine that RISC–3 SSCs will remain capable of performing their safety-related functions under design basis conditions. For significant conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined, and corrective action is taken to preclude repetition.

As such, application of the enhanced methodology in the context of 10CFR50.69 will provide a robust mechanism for assuring pressure boundary integrity.

Note: to add clarification, the planned update to the EPRI report will include in Section 4.1 an example of the intent of this prerequisite (see Attachment 2 EPRI markup).

1. Revised Risk-Informed Inservice Inspection Evaluation Procedure, EPRI, Palo Alto, CA: 1999. TR-112657 Rev. B-A.
2. Nondestructive Evaluation: N761 Revision 1 Pilot Study Results and Lessons Learned. EPRI, Palo Alto, CA: 2014. 3002003029.
3. Application of the EPRI Risk-Informed Inservice Inspection Evaluation Procedure: A BWR Pilot Study (Volumes 1 & 2), EPRI, Palo Alto, CA: 1997. TR-107530.
4. Application of EPRI Risk-Informed Inservice Inspection Guidelines to CE Plants (Volumes 1 & 2), EPRI, Palo Alto, CA: 1997. TR-107531.
5. WCAP-14572, "Westinghouse Owners Group Application of Risk-Based Methods to Piping Inservice Inspection Topical Report," Revision 1-NP-A, dated February 1999.
6. EC-JRC/OECD-NEA Benchmark Study on Risk Informed In Service Inspection Methodologies" [RISMET Benchmark Study - Host plant Ringhals, PWR], Report #NEA/CSNI/R(2010)13
7. Using the EPRI Risk-informed ISI methodology on Piping System in Forsmark 3, Research 2010:42

B. *Alternatively, to Part (A), provide justification that the exclusion of these degradation mechanisms does not impact the passive categorization process.*

Response

Please see response RAI 03-A, above.

RAI-04 – Prerequisite No. 3, Protective Measures for Internal Flooding

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Section 3.1.3 of Enclosure 1 of the LAR states for Prerequisite No. 1, that internal flooding protective measures, such as floor drains and sumps, will be considered low safety significant (LSS) (emphasis added) unless other evaluations determine the failure of these measures invalidate the LSS determination.

The NRC staff notes Section 4.1 of EPRI 3002015999, regarding internal flood protective measures (Prerequisite No. 3), states these measures shall not be categorized as LSS *(emphasis added) unless they are evaluated and shown to not invalidate the HSS determinations provided in Section 4.2, "Predetermined HSS Passive SSCs." It is unclear to the NRC staff how the Limerick approach is in alignment with the proposed EPRI alternate method.*

A. *Provide clarification how internal flooding protective measure SSCs will be categorized in the Limerick 10 CFR 50.69 categorization process. Include in this discussion how the Limerick approach is in alignment with the proposed EPRI alternate methodology.*

   Response

   It was Constellation's intention in writing Section 3.1.3 of Enclosure 1 of the LAR to more clearly state our adherence to the EPRI wording regarding the categorization of internal flooding protective measures (Prerequisite No. 3), not to alter it. Regarding internal flooding protective measures, Constellation has not and will not categorize such measures as LSS unless they are evaluated and shown to not invalidate the HSS determinations provided in EPRI Section 4.2, "Predetermined HSS Passive SSCs."

   Note: to add clarification, the planned update to the EPRI report will include in Section 4.1 an example of the intent of this prerequisite (see Attachment 2 EPRI Markup).

B. *If the Limerick process is not in alignment with the EPRI guidance, then provide justification that the Limerick approach does not impact categorization.*

   Response

   See response to- RAI-04.A above. Limerick is in alignment with the guidance set forth in EPRI 3002015999 regarding internal flooding protective measures.

<u>RAI-05 – Pre-determined HSS SSCs Criteria</u>

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Section 3.1.3 of Enclosure 1 of the LAR states that the EPRI 3002015999 methodology is proposed as an alternate to the NRC-accepted ANO-2 R&R-004 method for passive SSC categorization. Section 4.2 of the EPRI document provides criteria for identifying predetermined HSS SSCs.

A. *Part (a) of the Criterion No. 1 specifies that the Class 1 portions of the reactor coolant pressure boundary can be categorized as LSS when the component failure allows the reactor to be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system. It is unclear to the NRC staff what the Limerick definition/criteria for an orderly shutdown and cooldown (e.g., hot or cold shutdown) to be used in determining the applicability of Part (a).*

   Provide details on what constitutes an acceptable shutdown and cooldown in an orderly manner for the alternate pressure boundary method. Include in this discussion the long-term requirement of the reactor coolant makeup system to achieve safe shutdown conditions.

   Response

   Criterion 1 of the enhanced methodology is derived from 10CFR50.55a(c)(1) and 10CFR50.55a(c)(2). How a Licensee meets this criterion may be specific to the licensing basis for the individual plant. For the purpose of determining which systems and components are required to shut down the reactor and maintain it in a safe shutdown condition at Limerick, a unit is considered in safe shutdown with: (1) the reactivity of the reactor kept to a margin below criticality, consistent with technical specifications; (2) the core decay heat removed at a controlled rate, sufficient to prevent core or reactor coolant system thermal design limits from being exceeded; (3) radioactive material releases controlled to keep the doses within prescribed limits; and (4) operation within design limits of structures, systems, and components necessary to maintain these conditions. [Note: Updated Final Safety Analysis Report (UFSAR) 3.2.1]

   Note: to add clarification, the planned update to the EPRI report will include additional detail explaining how this piping can be classified as Class 1 exempt at some sites while being classified as non-Class 1 at other sites, depending upon the site-specific licensing basis (see attached EPRI markup).

B. *Table 4-1 of EPRI 3002015999 appears to provide the basis for the list of predetermined HSS SSCs. The basis criteria appear to include consistency with the current (ANO-2) passive categorization process and industry insights from the RI-ISI program. Item Nos. 8 through 10 appear to rely on engineering judgement and experience. It is unclear to the NRC staff if the proposed alternate method is sufficiently comprehensive to identify all the necessary HSS SSCs given the apparent reliance on insights, judgements, and experience.*

   Provide justification that the EPRI determination of predetermined HSS SSCs is comprehensive and adequate to identify all SSCs that should be HSS.

   Response

   As mentioned in the RAI, insights, judgments and experience from application of the existing methodology as RI-ISI applications, RI-repair / replacement applications and 50.69 applications were used to support development of the predetermined set of HSS SSCs. This BWR and PWR experience includes application of the technology to a large number of Class 1, Class 2 and Class 3 systems, including non-safety related SSCs in a number of these systems. Additionally, knowledge from these applications informed the understanding on how and why pressure boundary failures can impact defense-in-depth (e.g., loss of inventory versus spatial effects).

The portion of the methodology contained in Section 4.2 of 300201599 is essentially a two-step process. First, the plant is reviewed against criteria 1 through10 to assign SSCs to HSS based upon the criteria contained in criteria 1 through 10. The second step is to determine, on a plant-specific basis, if there are additional SSCs that need to be added to the HSS scope. That is, all pressure boundary components (safety related and non-safety related) are reviewed against the criteria contained in criteria 11, 12 and 13. Any pressure boundary components (safety related or non-safety related) that exceed criteria contained in criteria 11, 12 or 13 are added to the HSS scope.

As such, criteria 1 through 13, taken in total, assure that all SSCs (safety related and non-safety related) have been assessed as to their risk significance. Criteria 1 through 13 assure a robust list of HSS SSCs are identified and that only SSCs with a very small impact on plant risk are categorized as LSS.

C. *Criterion No. 9 implies those passive heat exchangers whose failure does not allow reactor coolant to bypass primary containment can be categorized as LSS. It is unclear to the NRC staff if this criterion applies to all Limerick plant modes of operation.*

   i. *Provide clarification on the Limerick plant modes that will be included in the passive categorization process.*

   Response

   Yes, Criterion 9 was applied to all modes of plant operation at Limerick from at-power to shutdown operations.

   Note: to add clarification, the planned update to the EPRI report will include additional text with regards to at-power and during shutdown (Please see Attachment 2 EPRI Markup).

   ii. *If not all Limerick plant modes are included in the passive categorization process, then provide justification that the exclusion of those Limerick plant modes does not adversely impact the categorization process.*

   Response

   Please see response to RAI-05.C.i., above

D. *Criterion Nos. 11, 12, and 13 provide several risk threshold values to determine when a passive SSC can be designated LSS. These three criteria refer to piping segments in determining the risk impact of piping failures. It appears the calculation of initiating event frequency (IEF) when estimating the risk contribution of piping components will be determined based on pipe segments. However, the methodology does not explain how* *piping segments[3] will be defined when estimating its risk contribution. Consequently, the staff is unclear if the risk calculation will include the entire length of a passive system, those passive segments not screened as HSS (e.g., 'candidate' LSS) based on the first ten criteria of the alternate method, or a smaller segment. In addition, with regards to Criterion Nos. 12 and 13, no justification is provided supporting the risk threshold values delineated in Figures 4-1 and 4-2. Hence, the NRC staff is unclear of the basis in choosing the risk threshold values for Criterion Nos. 12 and 13 and why they are appropriate for categorization of pressure-boundary SSCs. Lastly, it appears that the risk calculations only utilize the internal flooding PRA model.*

The staff notes that other pressure boundary failure events, such as loss of coolant accidents (LOCAs), steam generator tube ruptures, main steam line breaks, and main feedwater line breaks are addressed in the internal events PRA model. It is unclear to the NRC staff how the internal flooding PRA model can address 'candidate' LSS SSCs associated with internal event pressure boundary failures. Therefore:

i. Provide details of what constitutes a piping segment to be evaluated for Criterion Nos. 11, 12, and 13. If the definition differs from the NEI 00-04 endorsed definition, then include in this discussion a justification that the determination of piping segments does not adversely impact the categorization process.

Response

For purposes of applying criterion Nos. 11, 12 and 13, the definition of a pipe segment is not a function of whether it was categorized as HSS or LSS per criterion Nos. 1 through 10. As such, the impact on risk (CDF/LERF) of pressure boundary failures either through the use of the IEPRA or the IFPRA is conducted irrespective of the criteria contained in the enhanced methodology. That is, even if a piping segment, or a portion of a pipe segment, is HSS per one of the first ten criteria of the enhanced methodology, the impact on risk due to its postulated failure is determined consistent with industry guidance (e.g., PRA standard, EPRI 1019194).

While ASME Code Case N-660 is referenced in NEI 00-04, it should be noted that all 10CFR50.69 submittals approved to date reference the ANO2-R&R-004 methodology (RI-RRA) for categorizing pressure boundary components. The technical basis for the ANO RI-RRA methodology is EPRI TR-112657, Rev B-A which is also codified in ASME Code Case N-578 and Appendix R, Supplement 2. A streamlined version is contained in NRC endorsed ASME Code Case N-716.

While slightly different in wording, each of these approaches as to "piping segments" have the same purpose. That is, to group pressure retaining items (e.g., welds, valve bodies, pipe runs, etc.) by common consequence.

In its simplest application, if postulated failure of the entire system (direct and

[3] American Society of Mechanical Engineers (ASME) Code Case N-660, "Risk-Informed Safety Classification for Use in Risk-Informed Repair/Replacement Activities, Section XI, Division 1," July 2002, defines a piping segment for categorization purposes.

indirect effects) had the same consequence (e.g., causes an initiating event X), then only a single segment would need to be defined. However, from a practical perspective this is typically not the case and the system would be divided into segments as the postulated consequence of failure changes. This "segmentation" can be caused by a multitude of impacts such as different trains within the system (e.g., train A versus train B), piping located in different parts of the plant (e.g., flood area C versus flood area D), piping in the same train and same plant area but a portion is upstream of an isolation valve and the other portion is downstream of an isolation valve.

Note: to add clarification, the planned update to the EPRI report will include additional detail discussing the above (see Attachment 2 EPRI Markup).

ii. Provide details of how the IEF will be determined for the passive SSCs being evaluated in either Criterion Nos. 11, 12, or 13. If the analysis includes the entire length of a passive system, then include in this discussion only those portions screened as LSS by Criterion Nos. 1 through 10 of the alternate categorization method, or a smaller segment.

Response

As discussed in i. above, the impact on risk (CDF/LERF) of pressure boundary failures either through the use of the IEPRA or the IFPRA is conducted irrespective of the criteria contained in the enhanced methodology. For example, a segment modeled in the IFPRA would not be reduced in size because a portion of the segment was determined to be HSS per one of the first ten criteria in the enhanced methodology.

As discussed below in iv., for the pilot of the EPRI 3002015999 methodology all initiating events were considered as potential candidates, if appropriate, to represent the pressure boundary failure of a segment. The effort was not limited to just internal flooding initiating events. Initiating events beyond just flooding were considered when addressing criteria 11, 12, and 13. All LOCAs, interfacing system LOCAs, steam breaks, ruptures, and leaks, for example, were considered when reviewing the PRA results to determine if any modeled pressure boundary segment met any of the three criteria.

Similarly, to the current approved process for categorizing pressure retaining SSCs, the periodic feedback and reevaluation process will also apply to the EPRI enhanced process. The feedback and reevaluation process can also be triggered by a model update since the EPRI process is an application of the PRA internal events and flooding models.

iii. Regarding Criterion Nos. 12 and 13, explain the basis for the risk threshold values of the proposed alternate pressure boundary categorization method. Include in this discussion justification that these threshold values do not adversely impact the categorization process.

Response

Application of criteria 11, 12 and 13 identifies plant-specific pressure boundary components that are not assigned to the generic HSS category but that may be risk-significant at a particular plant. Criterion 11 of the enhanced methodology requires that any piping or component whose contribution to CDF (LERF) greater than 1E-6/year (1E-7/year) be assigned to the HSS category. As discussed in the Grand Gulf and DC Cook Safety Evaluation Reports for their ASME Code Case N-716 relief requests (Reference [4], Reference [5]), these guideline values (1E-6 / 1E-7) are suitably small and consistent with the decision guidelines for acceptable changes in CDF and LERF found in NRC endorsed EPRI TR-112657, Rev B-A. Criterion 11 was added as a defense-in-depth measure to provide a method of ensuring that any plant-specific locations that are important to safety are identified. Criterion 11 is only used to add HSS segments and not, for example, to remove system parts generically assigned to the HSS in criterion 1 through 10.

To further the goal of defense-in-depth beyond that previously found acceptable, criterion 12 and 13 were developed and added to the enhanced methodology to conservatively increase the confidence that somewhat important pressure boundary components would not be missed on a plant-specific basis. By incorporating CCDP/CLERP (conditional core damage probability / conditional large early release probability) metrics these measures also provide additional balance between prevention and mitigative. That is, components cannot be assigned to the LSS population based solely on low failure likelihood, unless that likelihood is remote. That is, less than 1E-08 CDF and less than 1E-09 LERF. Similar to criterion 11, criteria 12 and 13 were added to provide additional means of ensuring that any plant-specific locations that are important to safety are identified. Criteria 12 and 13 are used to add HSS segments and not, for example, to remove system parts generically assigned to the HSS in criteria 1 through 10. Finally, 10CFR50.69(d)(2) requires that Licensees ensure, with reasonable confidence, that RISC–3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life.

Criteria 11, 12 and 13 provide confidence that the goal of identifying the more risk-significant locations is met while permitting the use of generic HSS system parts identification to simplify and standardize the evaluation. Satisfying the guidelines in criteria 11, 12 and 13 requires confidence that the PRA (internal event PRA, flooding PRA) is capable of identifying the significant contributors to risk that are not included in the generic results. RG 1.200 states that meeting the attributes of an NRC-endorsed industry PRA standard may be used to demonstrate that a PRA is adequate to support a risk-informed application. RG 1.200 further states that an acceptable approach that can be used to ensure technical adequacy would trigger a peer review of the PRA.

Appendix A of this Attachment is Table 09-1 which provides examples of industry experience of pressure boundary components that exceeded the 1E-6 / 1E-7 metrics (although Limerick does not have any such examples). It provides examples of safety improvements that have been brought about by implementation of criterion 11 on other risk-informed applications. It is expected that use of criteria 12 and 13 together with criterion 11 will provide additional safety improvements.

Note: to add clarification, the planned update to the EPRI report will include additional detail in new Chapter 5.3, discussing the above (see Attachment 2 EPRI Markup).

iv. *Provide clarification on what PRA hazard models are used to determine pressure boundary failure initiators associated with the three risk value criteria.*

1. *If the internal flooding PRA model is only used, then provide details and justification how the risk values of pressure boundary initiators not included in the internal flooding PRA will be calculated.*

Response

Criteria 11, 12 and 13 require that all pressure boundary failures be considered whether they were evaluated in the internal events PRA (e.g., LOCA, LOCA outside containment, ISLOCA, steam line breaks, feed line breaks) or evaluated in the internal flood PRA (e.g., lower energy Class 2 and 3 or non-safety related systems). Note that Limerick has a combined internal events and flooding PRA.

Note: to add clarification, the planned update to the EPRI report will include additional detail in Criteria 11, 12 and 13, discussing the above (see Attachment 2 EPRI Markup).

2. *Alternatively to Part (1), provide justification that excluding the internal events PRA from the alternate method does not adversely impact the categorization process.*

Response

Please see response to RAI-05.D.iv.1, above.

v. *During the audit, the licensee provided a list of internal flood scenarios that describe the flood type (i.e., spray, flood, or major flood), the flood area, and the system sources (e.g., fire protection and service water). The NRC staff understands that the internal flood PRA analysis allows this breakdown if there is a difference in plant impact, such as different SSCs impacted or operator action timing. However, the passive categorization process, as described in NEI 00-04, assesses the entire impact of a passive SSC. This process, for example, would include the aggregate spray, flood, and major flood impacts. It is unclear to the NRC staff how Criterion Nos. 11, 12, and 13, which appear to evaluate scenario specific risk, adequately evaluate the total risk associated with an SSC. Therefore:*

Either justify that 'splitting' the impacts of a single passive SSC into multiple scenarios and evaluating on a single scenario basis adequately assesses the cumulative risk impact of that SSC for Criterion Nos. 11, 12, and 13; or explain how the licensee will ensure the alternate proposed method assesses the cumulative impact of a passive SSC.

Response

Constellation will follow the EPRI methodology as well as the intent of NEI 00-04 and assess the entire impact of a segment cumulatively against the EPRI criteria for all the segment effects including spray, moderate flood, large flood, etc. as is modeled in the FPIE or FPRA.

In order to clarify the above the following will be added to the updated EPRI report:

"For criteria 11, 12 and 13, care should be taken in reviewing the PRA results so that total contribution to CDF and LERF are compared to the risk metrics. For example, separate scenarios of spray, moderate flood and large flood based on different plant impacts should be combined so that the cumulative impact of the SSC is compared to each risk metric (i.e., CDF, LERF, CCDP, CLERP)."

E. *Criterion No. 14 provides three considerations related to restraints or supports. The first consideration, 14.a, states that supports (for example, component support, hanger, or snubber) may remain uncategorized until a need is identified. Section 3.1.3 of Enclosure 1 to the LAR states that the improved methodology represents a more efficient process since it is performed for all piping segments in the plant and not the system-by-system approach of the currently approved approaches. It is unclear to the NRC staff how the first consideration is in alignment with the 'entire plant' analysis approach specified in the alternate method and what constitutes an identified 'need' (for example, whether the associated supports of a passive non-safety related SSC categorized as HSS by the alternate method would be required to be categorized).*

   i. *Provide the criteria to determine when categorization of supports is required.*

Response

The topic of categorizing supports (for example, component support, hanger, or snubber) was discussed during the February 2020 NRC inspection of 10 CFR 50.69 implementation at Limerick. During the inspection, it was discussed that the existing rule allows the Licensees to define the system boundaries and then all components within that system boundary would need to be included in that system's categorization. It was also discussed that the ANO2-R&R-004 methodology, can be applied to *"Class 2 and 3 pressure retaining items or their associated supports"*. As such, component supports, hangers, or snubbers need not be included within a system categorization. Additionally, the example system categorization provided by ANO2 to NRC during RAIs for the relief request included pressure boundary components only. That is, component supports, hangers, or snubbers were not included within the system boundary categorization.

Consistent with this approach, the enhanced methodology does not require component supports, hangers, or snubbers be categorized as part of categorizing the pressure boundary function. The exception to this is when the enhanced methodology identifies non-safety related pressure boundary components as high safety significant. In this case, once the categorization is approved by the IDP panel, 50.69(d) requires that the licensee ensure that RISC–2 SSCs perform their functions consistent with the categorization process assumptions by evaluating treatment being applied to these SSCs to ensure that it supports the key assumptions in the categorization process that relate to their assumed performance. As part of addressing the treatment of RISC-2 SSCs, the assigned critical attributes will be reviewed. Thus, this review should include an assessment of the supports once RISC-2 SSCs are identified and critical attributes are considered.

Note: to add clarification, the planned update to the EPRI report will include additional detail at the end of Chapter 4, discussing the above. (see Attachment 2 EPRI Markup).

ii. *Provide justification that the exclusion of support categorization does not adversely impact plant safety.*

Response

Please see response to RAI-05.E.i, above.

[F]. Table 3-1 of the EPRI report lists a number of alternatives considered for alternate passive component categorization and identifies limitations and challenges associated of each of the considered alternatives. Some identified limitations include the need to address standby system pressure boundary failures and spatial effects.

Describe whether and how the self-identified limitations are addressed by the proposed alternate passive categorization methodology. If not addressed, then justify why they have no impact on the 10 CFR 50.69 categorization.

Response

EPRI Table 5-3 has been revised to address these questions.

Table 05-3 Industry Examples of Exceeding 1E-6 CDF or 1E-7 LERF and Modifications

Plant No.	Issue	Action
1	Interfacing system LOCA exceeded metrics	More refined / realistic analyses
2	Interfacing system LOCA exceeded metrics	More refined / realistic analyses
3	Failure of a fire protection line in the Auxiliary Building which was postulated to flood the Electrical Switchgear Cable Enclosure, Battery Room and Battery Charger	Plant hardware modification (piping removed from area)
	Failures of the circulating water system in the Condenser Pit (CDF contribution of 3.75E-06).	Operating Procedure update to better define human error probabilities (HEPs)
4	Failure of a fire protection line in the Auxiliary Building which was postulated to flood the Electrical Switchgear Cable Enclosure, Battery Room and Battery Charger	Plant hardware modification (piping removed from area)
	Failures of the circulating water system in the Condenser Pit (CDF contribution of 3.75E-06).	Operating Procedure update to better define HEPs
5	Fire protection piping in auxiliary building	Supplementary visual inspection of the associated fire protection piping is required every quarter and 6 UT (thickness) exams per interval.
6	Fire protection piping in auxiliary building	Supplementary visual inspection of the associated fire protection piping is required every quarter and 6 UT (thickness) exams per interval.

Table 05-3 Industry Examples of Exceeding 1E-6 CDF or 1E-7 LERF and Modifications		
Plant No.	**Issue**	**Action**
7	Plant service water exceeded LERF criterion	More refined / realistic analyses
8	Service Water piping in the 480V switchgear room	Five new inspections added looking for wall loss
9	Class 3 nuclear service water in auxiliary feedwater pump room impacting mechanical / electrical equipment	New NDE selected
10	Class 3 nuclear service water in auxiliary feedwater pump room impacting mechanical / electrical equipment	New NDE selected
11	Flooding caused by fire protection piping in the East DC switchgear room	3 of 10 mechanical connections selected for inspection
12	Service Water in Cable Spreading Room – loss of electrical equipment	New NDE selected

Table 05-3 Industry Examples of Exceeding 1E-6 CDF or 1E-7 LERF and Modifications

Plant No.	Issue	Action
13	Service Water in Cable Spreading Room – loss of electrical equipment	New NDE selected
14	Service Water in Auxiliary building exceeded metrics	Updated analysis to allow credit for operator action in response to the postulated flood scenario
	Service Water in Control Building exceeded metrics	Updated analysis to allow credit for operator action in response to the postulated flood scenario
15	Failure of fire protection in the control building (3 separate locations) can cause loss of ESWG Rooms and CSR	Hardware (i.e., flow limiting orifice) and procedure modification
16	This remaining scenario involves a flood originating in the turbine building zone designated TGB. The area is located at elevation 46 feet, essentially plant grade.	More refined / realistic analyses
17	High Pressure Firewater in Auxiliary building exceeded metrics	New NDE and/or removal of piping

Table 05-3 Industry Examples of Exceeding 1E-6 CDF or 1E-7 LERF and Modifications		
Plant No.	**Issue**	**Action**
	Raw Cooling Water in Auxiliary Building exceeded metrics	New NDE and/or removal of piping
18	Failure of expansion bellows can cause loss of ESWG Rooms	Hardware and NDE being investigated

<u>RAI-06 – Pressure Boundary Defense-In-Depth</u>

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Section 2.2 of Enclosure 1 to the LAR states that the licensee will either use the ANO-2 passive categorization method for Class 2 and 3 SSCs or will use the alternate method described in EPRI 3002015999. Section 3.1.2 of the same enclosure states that certain pressure boundary failure events will not be addressed by the alternate defense-in-depth method described in Pressurized Water Reactor Owners Group (PWROG)-20015-NP[4] but, rather, will be assessed by the pressure boundary categorization process (e.g., either by the ANO-2 method or by the EPRI 3002015999 method).

Section 3.3.3 of the enclosure to the NRC safety evaluation of the ANO-2 alternate pressure boundary categorization process states licensee personnel will verify that assigning each segment to the LSS category is not contrary to maintaining defense-in-depth. While EPRI 3002015999 states that the alternate pressure boundary method addresses defense-in-depth, insufficient information is provided in either the EPRI report or the LAR that explains how defense-in-depth is maintained for pressure boundary components classified as LSS.

The EPRI 3002015999 alternate pressure boundary method does not completely address defense-in-depth for all HSS considerations (e.g., passive candidate LSS SSCs). Therefore:

A. Provide justification for how each pressure boundary component that is categorized LSS is evaluated maintaining the defense-in-depth philosophy.

Response

Piping systems in a nuclear power plant contribute to defense-in-depth in two important ways. The first is that the reactor coolant pressure boundary (RCPB) provides one of the sets of barriers in the barrier defense-in-depth arrangement. This barrier protects the release pathway from the reactor core to containment release pathways, and part of it is responsible for protecting against potential containment bypass pathways. This enhanced methodology requires that the applicable Class 1 portion of the RCPB be

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[4] PWROG-20015-NP, "Alternate 10 CFR 50.69 Defense-in-Depth Categorization Process," PA-RMSC-1769, Revision 0, March 2021.

categorized as HSS. Per this enhanced methodology there are no pressure boundary components categorized as LSS that could be considered part of the RCPB (criterion 1).

The second way pressure boundary components can contribute to defense-in-depth is in its role in the protection of the core through providing critical safety functions that require piping system integrity. This was considered in developing the enhanced methodology. The enhanced methodology requires that pressure boundary failures that would fail a critical safety function be categorized as HSS. These include those failures that would impact key inventory sources (criteria 6 and 7), generic lessons learned and plant-specific insights into contributors to core damage or containment performance, including consideration of common cause and balance between prevention and mitigation (criteria 3, 4, 6, 9, 11, 12 and 13), failure of the ultimate heat sink (criterion 5) and components that can have intersystem impact (for example, heat exchangers (criteria 9 and 10), suppression pool and containment sump connections to containment (criterion 6). As such, there are no pressure boundary components categorized as LSS that would challenge these critical safety functions (please see criteria 1 through 13). Essentially, pressure boundary failures that fail a basic safety function could not meet criteria 11 through 13 for LSS, which includes consideration of common cause.

In addition, consistent with the 10CFR50.69 rule, the enhanced methodology does not alter the design basis of the plant. As such, the level of redundancy, independence, and diversity of key safety features, including fission product barriers, remains unchanged. Further, 10CFR50.69(d)(2) requires that Licensees ensure, with reasonable confidence, that RISC–3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life assuring that defense-in-depth is not compromised.

B. *If the passive SSCs categorized as LSS are not evaluated for defense-in-depth, then provide justification that the exclusion of these SSCs from defense-in-depth consideration does not adversely impact the categorization process.*

Response

Please see response to RAI 06-A, above.

C. *The NRC-accepted the ANO-2 R&R-004 method for SSC categorization describes a two-stage categorization process. In the first stage, PRA analyses (or a series of tables which are equivalent to PRA analyses) are used to identify HSS SSCs. In the second stage, licensee personnel re-evaluate the remaining potentially LSS segments. For each segment, qualitative considerations are addressed through a series of conditions or questions. The responses to these questions support the systematic determination on whether SSCs that are not assigned HSS by the quantitative PRA results should, nevertheless, be assigned HSS based on qualitative considerations. In contrast, the proposed alternate method does not appear to address any qualitative considerations. Therefore:*

   i. *Provide justification that the exclusion of the ANO-2 R&R-004 qualitative criteria does not adversely impact the 10 CFR 50.69 categorization process.*

Response

The genesis for these qualitative considerations is NRC letter to South Texas Project dated July 19, 2000 (Reference [6]. In particular, Section 2.2.2 (Use of Risk Insights for SSCs Not Modeled in PRA) of Enclosure 1 of the letter. As discussed in the letter, these considerations are used to addressed components that are not modeled in the PRA.

These additional considerations provide the IDP a mechanism for assessing the safety significance of these not modeled SSCs.

In contrast, the enhanced methodology contained in 3002015999, requires that all SSCs (safety-related and non-safety-related) be subject to the criteria of items 11, 12 and 13. That is, all modeled SSCs are evaluated from a PRA perspective to determine their impact on core damage and large early release, unless it can be shown that their failure will not impact any important (PRA modeled) equipment. For example, non-safety related equipment located in a plant area that does not contain safety related equipment or does not contain equipment whose failure would cause a plant trip.

Thus, these additional considerations to address non-modeled components are not needed for this enhanced methodology. Further, the enhanced methodology contains additional requirements, above and beyond the quantitative PRA results, to assure all important equipment is identified and categorized as high safety significant (HSS) irrespective of their contribution to core damage frequency and large early release frequency and render the suggested additional qualitative considerations as unnecessary. For example, Criterion 1 addresses the reactor coolant pressure boundary, Criterion 2 addresses the shutdown cooling function, Criteria 3 and 4 address high energy piping penetrating the containment, Criterion 5 addresses the ultimate heat sink, Criteria 6 and 7 address core cooling, inventory control and secondary heat removal and Criteria 8, 9 and 10 provide generic insights that are used to capture plant-specific insights.

As such, the 13 criteria taken together assure that HSS is assigned to SSCs that:

- would fail a basic safety function including:
    - reactivity control (e.g., ATWS as modeled in the peer reviewed PRA, see criteria 1, 11, 12, and 13),
    - core cooling (see criteria 5, 6, and 7 and criteria 11, 12, and 13),
    - heat sink (see criteria 3, 4, 5, 9 and 10 and criteria 11, 12, and 13), and
    - RCS inventory (see criteria 1, 2, 4, 6, 8, and 9 and criteria 11, 12, and 13)
- would prevent the plant from reaching and maintaining safe shutdown conditions (e.g., as modeled in the peer reviewed PRA, see criteria 11, 12, and 13)
- are the sole means of successful operator performance and containment integrity or that impact offsite releases (e.g., zero defense-in-depth, see criteria 4, 5, 6, 7, 8, 9 10, 11, 12, and 13)

Further, as there is no change to the design or design basis of the plant in implementing the enhanced methodology, the defense-in-depth philosophy is maintained in that:

- the existing balance among prevention of core damage, prevention of containment failure or bypass, and mitigation of an offsite release is not changed and therefore maintained,
- as the peer reviewed PRA reflects the as built / as operated plant, there is no over-reliance on programmatic activities and operator actions to compensate for weaknesses in the plant design, system redundancy, independence, and diversity,
- common cause failures are taken into account in the use of the peer reviewed PRA supporting the risk analysis categorization, and
- as the plant design and design basis has not changed, the independence of fission-product barriers has also not changed.

Finally, sufficient margins are maintained as the existing safety analysis and acceptance criteria in the plant licensing basis are not changed.

It is also noted that this enhanced methodology is limited to the pressure boundary function (i.e., passive components). All other components including active components with a pressure boundary function will need to be assessed via the rest of the NEI 00-04 process, or approved alternative (e.g., seismic Tier 1, Tier 2). As such, Section 9.2 is still applicable and the IDP will determine whether these functions/SSCs are not implicitly depended upon to maintain safe shutdown capability, prevention of core damage, and maintenance of containment integrity. In making this assessment, the IDP considers the impact of loss of the function/SSC against the remaining capability to perform the basic safety functions (reactivity control, core cooling, heat sink, and RCS inventory).

ii. *Describe how those SSCs not explicitly modeled in the PRA are to be categorized.*

Response

Please see response to item RAI 06-C.i, above.

D. *During the audit, the licensee stated that if a pressure boundary SSC can fail a critical safety function, then it will be designated HSS. However, the staff notes that containment bypass scenarios (e.g., interfacing system LOCAs (ISLOCAs)) can result in the failure of the containment safety function. Table I-4 of the ANO-2 alternate pressure boundary process (also Code Case N-660) identifies containment bypass events based on failure type and number, resulting in High or Medium. ASME Code Case N-716-1 does not appear to take into consideration passive failures that lead directly to containment bypass. Section 6.2 of NEI 00-04 states that containment bypass events, such as ISLOCAs for boiling water reactors, are important challenges to large early release frequency (LERF) risk, and that the licensee should automatically designate an SSC as candidate HSS if it can initiate an ISLOCA.*

Provide justification why specific guidance on containment bypass events, such as ISLOCAs, is not necessary for the alternate passive categorization.

Response

While it is acknowledged that additional guidance would be helpful, the following is also provided. Containment bypass events are assessed, consistent with the existing methodology, as part of the two-step enhanced methodology. First, criteria 1, 4 and 9 will identify some SSCs as HSS due to containment bypass concerns. Criterion 1 requires that the reactor coolant pressure boundary be categorized as HSS which includes a subset of ISLOCA events (e.g., BWR main feedwater and main steam lines outside containment), regardless of their contribution to CDF and LERF. Criterion 4 requires that SSCs within the break exclusion region be categorized as HSS, regardless of their contribution to CDF and LERF. Criterion 9 requires that applicable heat exchangers whose failure could allow reactor coolant to bypass containment be categorized as HSS regardless of their contribution to CDF and LERF.

The second step in the enhanced methodology, with respect to containment bypass events, is to assess the SSCs against criteria 11 and 13. SSCs that exceed the metrics of criteria 11 or 13 are categorized as HSS. A new Table 5-1 is being added to the update of EPRI 3002015999. As can be seen in the first two entries of new Table 5-3 (see Appendix A of this Attachment), ISLOCA events have been identified in the industry as part of the assessment against criterion 11. It is therefore expected that additional SSCs will be identified as plants review their SSCs against criterion 13.

To provide additional clarity on this topic, Sections 4.1 and 4.2 will be updated per the revision in Attachment 2 EPRI Markups.

E. *Provide justification that passive SSCs whose failures could result in containment bypass should not be classified as candidate HSS.*

Response

Please see response to item RAI 06-D, above.

<u>*RAI-07 – Sources of Uncertainty*</u>

Sections 50.69(c)(1)(i) and 50.69(c)(1)(ii) of 10 CFR require that a licensee's PRA be of sufficient quality and level of detail to support the SSC categorization process, and that all aspects of the integrated, systematic process used to characterize SSC importance must reasonably reflect the current plant configuration and operating practices, and applicable plant and industry operational experience.

The guidance in Section 5 of NEI 00-04, as endorsed by RG 1.201, Revision 1, stipulates identification of any applicable sensitivity studies to be used during the categorization process *that are associated with the licensee's choice of specific models and assumptions, as discussed in RG 1.174.*[5]

The staff notes that the guidance in NEI 00-04 stipulates identification of any applicable sensitivity studies to be used during the categorization process that are associated with the licensee's choice of specific PRA models and assumptions, to address uncertainty. The sensitivity studies are performed to ensure that assumptions and sources of uncertainty (e.g., human error, common cause failure, and maintenance probabilities) do not mask the importance of SSCs.

The approved ANO-2 methodology for categorization on passive pressure-retaining components is a consequence-based method and assumes a large pressure boundary failure. In contrast, the alternative EPRI approach proposes to use the internal flooding PRA model with built-in initiating event frequencies, assumed pipe break sizes, screening of flooding sources and flooding scenarios, credit for drains, doors, and human actions. The PRA assumptions and sources of uncertainty could have an impact on the categorization results from the proposed alternative passive categorization method. The EPRI report does not discuss any consideration of PRA uncertainty. Therefore:

A. *Discuss and justify how the proposed passive methodology considers PRA assumptions and sources of uncertainty and how is it consistent with the guidance of NUREG-1855.*[6]

Response

The EPRI report is being updated to reflect additional PRA Technical Adequacy guidance (see Attachment 2 EPRI Markups reflecting update to Prerequisite #1) which requires that the peer reviewed PRA used for 50.69 categorization be assessed with respect to PRA assumptions and sources of uncertainty. The base PRA's (IE and IF) objective is to determine plant risk (i.e., quantifying of risk metrics CDF and LERF). As criteria 11, 12, and 13 of the enhanced methodology use these same metrics to identify plant specific HSS SSCs, additional assessments of PRA assumptions and source of uncertainty is not needed. That is, the conclusions drawn during the base PRA (IE and IF) review of PRA assumptions and sources of uncertainty as contained in the 10CFR50.69 LAR are also valid for meeting criteria 11, 12, and 13.

Prerequisite 2 (Integrity management) and Prerequisite 3 (Protective measures for IF events) further reduce the impacts of PRA assumptions and sources of uncertainty beyond the conclusions of the peer review as Prerequisite 2 assures reliable pressure boundary integrity for the applicable systems/components and Prerequisite 3 requires that credit taken in the IF PRA (e.g., doors, drains) are not reduced or invalidated.

Finally, criteria 1 through 10 assure that important SSCs are categorized as HSS irrespective of the base PRA conclusions as to internal events and internal flooding contribution to CDF and LERF.

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[5] U.S. Nuclear Regulatory Commission, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Regulatory Guide 1.174, Revision 3, January 2018 (ADAMS Accession No. ML17317A256).

[6] https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1855/index.html

B. *Provide a list of identified sources of uncertainty related to the proposed method. Include in this discussion how the Limerick categorization program will address these items.*

Response

Please see response to RAI 07-A., above.

<u>RAI-08 –ISLOCA Flooding Considerations</u>

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC describing the risk sensitivity study and other evaluations and the basis for their acceptability while appropriately representing the potential increase in risk from implementation of the requirements in the rule.

ISLOCA events do not seem to be typically incorporated in the internal flood analysis but could have an additional internal flood impact besides impacting water inventory and bypassing containment, as captured in the FPIE PRA. During the audit, the licensee demonstrated being below the risk thresholds of the proposed method by splitting the internal events ISLOCA sequence initiators on a system basis. Therefore:

A. *Discuss how the Limerick FPIE model incorporates the internal flood aspect for the ISLOCA scenarios.*

Response

There are various ISLOCA pathways modeled in the Limerick FPIE PRA as discussed in response D below. The Vessel Injection node of the ISLOCA event tree models a functional fault tree that credits only those systems unaffected by the postulated ISLOCA pathway and its spatial effects. As an example, the A and C LPCI trains share an ECCS room and therefore the model is set up such that both of these LPCI trains are unavailable to provide injection in response to an ISLOCA scenario in this room.

The ISLOCA Vessel Injection node also evaluates the ability for long-term injection from an external source (i.e., RHRSW crosstie) to replace the inventory that is lost outside of containment. RHRSW injection through RHR requires that the RHRSW pumps, cross-tie valves, and injection valves along with respective power supplies not be subject to a harsh environment due to the discharge of water/steam from the RPV into the Reactor Enclosure.

The Event Tree Notebook (LG-PRA-002 Section 19) evaluates the ISLOCA pathways and their impact on the RHRSW to RHR crosstie components given the equipment location. This analysis determines that the RHRSW pumps, crosstie valves, necessary

LPCI injection valves, and supporting power supplies would not be subject to a harsh steam environment during most ISLOCA scenarios such that long term injection from RHRSW through RHR would be viable. However, the exceptions are ISLOCA scenarios originating in the CS 'B' room in Unit 1 and CS 'A' room in Unit 2. An ISLOCA in the Unit 1 CS 'B' area would potentially result in a steam release affecting the MCC that supports the Unit 1 crosstie valves. Similarly, an ISLOCA in the Unit 2 CS 'A' area would potentially result in a steam release affecting the MCC that supports the Unit 2 crosstie valves.

The ISLOCA vessel injection fault tree is structured such that the RHRSW to RHR crosstie is failed given the ISLOCA scenario occurs in CS Loop 'B' within the Unit 1 PRA model. Similarly, the Unit 2 PRA model is structured so that the RHRSW to RHR crosstie is failed given the ISLOCA scenario occurs in CS Loop 'A'.

B. *If not modeled, then provide justification that the exclusion of the internal flood impact of ISLOCA events does not adversely impact the 10 CFR 50.69 categorization.*

Response

Please see response to RAI 08-A

C. *Alternatively, to Part (B), propose a mechanism to ensure that the internal flood impact associated with ISLOCAs are incorporated into the Limerick FPIE model prior to using the alternate EPRI pressure boundary categorization method.*

Response

Please see response to RAI 08-A

D. *Provide justification for performing risk impact determination by splitting the ISLOCA scenario on a system basis. Justify why the approach does not impact the10 CFR 50.69 categorization.*

Response

ISLOCA initiating event %VLP represents the sum of all the ISLOCA frequencies stemming from the following systems and sections of piping (penetration):

- Core spray loop A discharge line (X-16A)
- Core spray loop B discharge line (X-16B)
- Residual heat removal, low-pressure core injection A (X-45A)
- Residual heat removal, low-pressure core injection B (X-45B)
- Residual heat removal, low-pressure core injection C (X-45C)
- Residual heat removal, low-pressure core injection D (X-45D)
- Residual heat removal, shutdown cooling discharge loop A (X-13A)
- Residual heat removal, shutdown cooling discharge loop B (X-13B)

- Residual heat removal, shutdown cooling suction (X-12)

Since this initiating event is comprised of nine different segments of piping, for the purposes of applying the EPRI enhanced pressure boundary categorization, the initiating event was divided into separate segments. Initiating event %VLP exceeds Criterion 13, which is >1.0E-9 for the product of LERF * CLERP; the result for %VLP is 1.25E-9. However, since the initiator is comprised of nine different segments, none of the segments by themselves would exceed this threshold. A new version of the FPIE model is being completed at this time which will separate %VLP into nine different initiating events.

RAIs on Defense-in-Depth

RAI-09 – PRA Technical Adequacy Prerequisites

Section 50.69(b)(2)(ii) of 10 CFR requires, in part, that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs.

Step 1.b of PWROG-20015-NP states the following:

> *Findings related to the following ASME/ANS RA-Sa-2009 PRA Standard […] technical areas must be closed or dispositioned as not impacting the categorization process:*
>
> *1) Accident sequence analysis*
> *2) Success criteria*
> *3) Initiating event frequencies*
> *4) Truncation*
> *5) Common cause groupings*

A. *The ASME/ANS 2009 PRA standard has other areas related to FPIE PRA, such as: system analysis, data analysis, human reliability analysis and large early release. Explain why the other technical elements in the PRA standard are not considered a prerequisite for the applying the proposed alternate defense-in-depth approach.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

As identified in PWROG-20015-NP, Revision 3 (Reference [7]), all technical elements of the ASME/ANS RA-Sa-2009 PRA Standard (Reference [8]) mentioned in RG 1.200 are prerequisites for a 10 CFR 50.69 license amendment. For Limerick, RG 1.200 Revision 2 (Reference [9]) is used. Findings related to technical areas must be closed or dispositioned as not impacting the categorization process. The intention of the original discussion on the ASME/ANS RA-Sa-2009 PRA Standard in the previous revision of the PWROG-20015-NP report was to inform the reader on the areas that are likely to have the most impact on the alternate defense-in-depth process. An update was made to PWROG-20015-NP to clarify this and avoid misinterpretation. Step 1.b in Section 2.2.2 is modified in PWROG-20015-NP, Revision 3 to address this.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 1.b:

1. PRA Technical Adequacy Pre-Requisites: The alternate core damage defense-in-depth process requires that the full power internal events (FPIE) Core Damage Frequency (CDF) PRA model meets the following requirements:

[…]

b. Findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The review of the FPIE PRA model is completed in accordance with Regulatory Guide 1.200[2] in the 10 CFR 50.69 license amendment as a pre-requisite for approval to implement 10 CFR 50.69.

[2] Reference 4* or Reference 5*, depending on revision used in the 10 CFR 50.69 license amendment. Note that if a future revision of Regulatory Guide 1.200 is referenced in the 10 CFR 50.69 license amendment, it may be considered for use by the licensee in the alternate defense-in-depth process.

B. *With regards to items 1 and 2, explain whether all supporting requirements under Accident Sequence and Success Criteria technical elements of the ASME/ANS-2009 PRA standard are considered a prerequisite. If not, then explain why they were not considered.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

All supporting requirements under Accident Sequence and Success Criteria technical elements identified in the ASME/ANS RA-Sa-2009 PRA Standard (Reference [8]) are considered prerequisites. Findings related to technical areas must be closed or dispositioned as not impacting the categorization process. The modification to Step 1.b in the PWROG-20015-NP, Revision 3 report (Reference [7]) in the response to RAI-09.A clarifies this.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 1.b:

1. PRA Technical Adequacy Pre-Requisites: The alternate core damage defense-in-depth process requires that the full power internal events (FPIE) Core Damage Frequency (CDF) PRA model meets the following requirements:

[…]

b. Findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The review of the FPIE PRA model is completed in accordance with Regulatory Guide 1.200[2] in the 10 CFR 50.69 license amendment as a pre-requisite for approval to implement 10 CFR 50.69.

[2] Reference 4* or Reference 5*, depending on revision used in the 10 CFR 50.69 license amendment. Note that if a future revision of Regulatory Guide 1.200 is referenced in the 10 CFR 50.69 license amendment, it may be considered for use by the licensee in the alternate defense-in-depth process.

C. *With regards to item 3, "initiating event frequencies," explain whether all supporting requirements under the initiating events technical element of the PRA standard are considered a prerequisite.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

All supporting requirements under Initiating Events technical elements identified in the ASME/ANS RA-Sa-2009 PRA Standard (Reference [8]) are considered prerequisites. Findings related to technical areas must be closed or dispositioned as not impacting the categorization process. The modification to Step 1.b in the PWROG-20015-NP, Revision 3 report (Reference [7]) in the response to RAI-09.A clarifies this.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 1.b:

1. PRA Technical Adequacy Pre-Requisites: The alternate core damage defense-in-depth process requires that the full power internal events (FPIE) Core Damage Frequency (CDF) PRA model meets the following requirements:

[…]

b. Findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The review of the FPIE PRA model is completed in accordance with Regulatory Guide 1.200[2] in the 10 CFR 50.69 license amendment as a pre-requisite for approval to implement 10 CFR 50.69.

[2] Reference 4* or Reference 5*, depending on revision used in the 10 CFR 50.69 license amendment. Note that if a future revision of Regulatory Guide 1.200 is referenced in the 10 CFR 50.69 license amendment, it may be considered for use by the licensee in the alternate defense-in-depth process.

D. *Discuss whether and how future changes to the PRA standard will be taken into account.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

Sites have been approved to implement 10 CFR 50.69 through a license amendment that references a revision of Regulatory Guide 1.200. For Limerick, RG 1.200 Revision 2 is used (Reference [9]). The PRA Standard identified in the Regulatory Guide 1.200 revision for the approval to implement 10 CFR 50.69 is the one used, in this scenario Revision 2. For Limerick, ASME/ANS RA-Sa-2009 PRA Standard (Reference [8]) is used. The modification to Step 1.b in the PWROG-20015-NP, Revision 3 report discussed in the response to RAI-09.A adds clarity to this process; specifically it addresses which Regulatory Guide 1.200 revision to use (i.e., the one identified in 10 CFR 50.69 license amendment).

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 1.b:

1. PRA Technical Adequacy Pre-Requisites: The alternate core damage defense-in-depth process requires that the full power internal events (FPIE) Core Damage Frequency (CDF) PRA model meets the following requirements:

[…]

b. Findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The review of the FPIE PRA model is completed in accordance with Regulatory Guide 1.200[2] in the 10 CFR 50.69 license amendment as a pre-requisite for approval to implement 10 CFR 50.69.

[2] Reference 4* or Reference 5*, depending on revision used in the 10 CFR 50.69 license amendment. Note that if a future revision of Regulatory Guide 1.200 is referenced in the 10 CFR 50.69 license amendment, it may be considered for use by the licensee in the alternate defense-in-depth process.

E. *If any relevant changes have been made to the PWROG-20015 guidance, then provide them on the docket for NRC staff review of its applicability to this LAR.*

Response

The PWROG-20015-NP, Revision 3 report (Reference [7]) has been provided in Attachment 3.

<u>RAI-10 – Core Damage Defense in Depth Cutset Filtering</u>

Section 50.69(b)(2)(ii) of 10 CFR requires, in part, that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs.

A. *Step 7.a of PWROG-20015-NP states the following with regards to cutsets filtering: "Filter to only cutsets that have an initiating event and a single basic event representing a failure of an SSC, including an independent failure, a common cause failure, or a human failure event (HFE) which leads to core damage. Ensure cutsets that include flags, split fractions, and other house or special events with an initiating event and a single basic event are not discarded."*

   Explain how the HFEs are taken into account and whether a recovery action could preclude a cutset from being screened in. If so, then explain how that conforms with RG 1.174, Revision 3 defense-in-depth guidance of not overly relying on human actions.

   Response

   **Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

   As discussed further in the response to RAI-10.A.ii, screening criteria have been modified from the previous revision of the PWROG report to require an additional basic event for cutsets with higher initiating event frequencies. In PWROG-20015-NP, Revision 3 (Reference [7]), an HFE basic event (including recovery actions) can lead to "screening out" of a specific scenario in the case that a single initiating event, the HFE basic event, and another basic event (or two basic events if the initiating event frequency is at least 1E-03/yr) are within a cutset and are above the quantitative initiating event frequency screening limit of at least 1E-04/yr. The basis for why HFEs which represent failures in operator actions and recovery actions do not need to be separately screened is provided in Section 2.2.3.3 of PWROG-20015-NP, Revision 3:

   Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

   > HFEs that are identified in a "screened in" cutset will have the SSCs associated with the operator action identified as candidate HSS in the alternate core damage defense-in-depth assessment. Not taking credit for operator actions and recovery actions (via identification of HFEs in the cutset) prevents identification of realistic defense-in-depth pathways within the plant. HFEs associated with an operator action or recovery action represent a level of defense that is identified for that specific cutset and therefore can be used in the cutset qualitative screening for the alternate defense-in-depth process. NEI 00-04, Section 6.1 (Reference 2*) takes credit for operator actions since, as shown in Figure 6-1, an additional 2 redundant systems, not just automatic, are taken into account for the 1E-01/yr row, and all other rows. The 1E-01/yr row in Figure 6-1 is comparable to the alternate core damage defense-in-depth analysis for two basic event criteria for initiating event frequencies that are greater than 1E-03/yr as explained in more detail in Section 2.2.6. For initiating event frequencies at least 1E-04/yr but less than 1E-03/yr, examination of the cutset requires only two basic events to

"screen out" of the alternate core damage defense-in-depth categorization. This is comparable to the one redundant automatic system in NEI 00-04, Figure 6-1 as described in further detail in Section 2.2.6. The alternate process examines all redundancy, rather than solely automatic, since overreliance on operator actions is prevented via the considerations in NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 and Review Defense-in-Depth Implications #2. These considerations allow for evaluation of operator actions with respect to the overall defense-in-depth in the plant and prevent overreliance on specific operator actions. For initiating events that are below the 1E-04/yr threshold, the alternate defense-in-depth process continues to examine the NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 and Review Defense-in-Depth Implications #2 to verify operator actions are not over-relied upon.

Recovery actions represent a type of operator action and an effective means of support. It is important to note that operator actions have supporting SSCs modeled as well. Therefore, defense-in-depth of the system itself will also be examined if the operator action is successful. As stated in Section 2.2.3.3 of PWROG-20015-NP, Revision 3:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

Modeled operator actions are required to have SSC(s) that support performing the action modeled as per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) which is endorsed in Regulatory Guide 1.200 (Reference 4* or Reference 5*, depending on the revision used in the 10 CFR 50.69 license amendment). Therefore, SSCs that support these operator actions can be "screened in" within separate cutsets that have operator actions success in the alternate defense-in-depth assessment.

For example, a failure of an operator to identify the recovery response is not the only failure addressed with the accident sequence that would be evaluated for supporting that recovery. The failure of SSCs used in support of that recovery action can also lead to the same failure result as the recovery action failure. These failures of the SSCs would be identified within other cutsets that are associated with the accident sequence.

There are other analyses beyond just the alternate core damage defense-in-depth assessment that are evaluated to determine if there is overreliance on operator actions. The entire 10 CFR 50.69 categorization effort is examined together, rather than just a specific portion, to comprehensively evaluate categorization. As stated in Section 2.2.3.3 of PWROG-20015-NP, Revision 3:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

Even if the SSCs associated with an operator action or recovery action are candidate LSS in the alternate defense-in-depth assessment, this does not mean the SSCs will be LSS once system categorization is complete. Evaluation of operator actions have other considerations in the categorization process which further evaluates if the SSCs associated with operator actions are candidate LSS:

- The IDP continues to examine the sole means considerations identified in NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5. This examination evaluates whether safety-related candidate LSS functions/SSCs are relied upon for operator actions as the sole means for specific scenarios (e.g., mitigation of an accident or transient). This prevents the situation where reliance on SSCs and operator actions for the sole means of a specific scenario are categorized as LSS for safety-related SSCs. With the implementation of the alternate defense-in-depth process, the engineering team also evaluates the Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

  - "4. The active function/SSC is not called out or relied upon in the plant Emergency/Abnormal Operating Procedures or similar guidance as the sole means for the successful performance of operator actions required to mitigate an accident or transient. This also applies to instrumentation and other equipment associated with the required actions."
  - "5. The active function/SSC is not called out or relied upon in the plant Emergency/Abnormal Operating Procedures or similar guidance as the sole means of achieving actions for assuring long term containment integrity, monitoring of post-accident conditions, or offsite emergency planning activities. This also applies to instrumentation and other equipment associated with the required actions."

- The IDP examines in NEI 00-04, Section 9.2.2 with the Review Defense-in-Depth Implications #2 if there is over-reliance on operator actions for safety-related candidate LSS functions/SSCs. With the implementation of the alternate defense-in-depth process, the engineering team also evaluates the Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.
  - "2. There is no over-reliance on programmatic activities and operator actions to compensate for weaknesses in the plant design."
- If an operator action or recovery action is a significant contributor to CDF or LERF, the FV and RAW associated with the HFE would be identified in the PRA quantitative evaluation in NEI 00-04, Section 5 and the corresponding SSCs associated with that operator action would be candidate HSS.

Discussion on compliance with Regulatory Guide 1.174, Revision 3 (Reference [10]) is met and described further in Section 2.2.3.3 and #6 of Section 2.2.7 of PWROG-20015-NP, Revision 3:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

One of the seven criteria in Regulatory Guide 1.174, Section 2.1.1.2 (Reference 6*) is "preserve sufficient defense against human errors." As mentioned in Regulatory Guide 1.174, "these defenses generally involve the use of procedures, training, and human engineering; however, other considerations (e.g., communication protocols) might also be important." SSCs that would be identified as RISC-3 that have alternative treatments applied would still be required to maintain reasonable confidence of performing their safety-related functions which prevents overreliance on human actions. As stated in Statement of Considerations of 10 CFR 50.69, Section V.3.1, Section 50.69(b)(1) Removal of RISC-3 and RISC-4 SSCs From the Scope of Treatment Requirements (Reference 7*):

> "The special treatment requirements for RISC-3 SSCs are replaced with the high-level, performance-based requirements in § 50.69(d)(2) that require the licensee to provide reasonable confidence that RISC–3 SSCs will continue to be capable of performing their safety-related functions under design basis conditions."

10 CFR 50.69(d)(2) (Reference 7*) is shown below:

> (2) RISC-3 SSCs. The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life. The treatment of RISC-3 SSCs must be consistent with the categorization process. Inspection and testing, and corrective action shall be provided for RISC-3 SSCs.
>
> > (i) Inspection and testing. Periodic inspection and testing activities must be conducted to determine that RISC-3 SSCs will remain capable of performing their safety-related functions under design basis conditions; and
> >
> > (ii) Corrective action. Conditions that would prevent a RISC-3 SSC from performing its safety-related functions under design basis conditions must be corrected in a timely manner. For significant conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined and corrective action taken to preclude repetition.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7, #6:

6. **"Preserve sufficient defense against human errors."**

   a. Preserved. Human error is preserved since the alternate defense-in-depth process does not create new human actions nor does it significantly increase the probability of existing human errors.

   It is important to note that the robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7*): "Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59." This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*) which states "Section 50.69 is structured to maintain the design basis functional requirements of the plant." Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7*): "§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions." Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*):

> "Section 50.69 is **structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained**. Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.**"

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7*):

> "The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

b. "Create new human actions that are important to preserving any of the layers of defense for which a high reliability cannot be demonstrated." Preserved. The proposed modifications with the alternate defense-in-depth process does not create new human errors that might adversely impact one or more layers of defense. The plant design remains the same and would therefore not create any new human actions. Alternative treatments are required to maintain reasonable confidence in supporting their safety-related functions and are not anticipated to create new human actions that are important to preserving layers of defense. Performance monitoring of alternative treatments prevent the overreliance on operator actions.

c. "Significantly increase the probability of existing human errors by significantly affecting performance shaping factors, including mental and physical demands and level of training." Preserved. The alternate defense-in-depth process includes human actions in identifying core damage defense-in-depth. SSCs with alternative treatments are required to maintain reasonable confidence of performing their safety-related functions. Periodic reviews and performance monitoring would evaluate whether these human actions or the SSCs that the human actions support have degradation and a corrective action would be taken to eliminate the degradation. For example, if a support system that requires operator actions is having a degradation, an evaluation of the degradation would be assessed that would identify if the SSCs should be reclassified. Due to the reasonable confidence of RISC-3 SSCs, plant operations are not modified in methods that increase human errors or overreliance on human actions. The alternate defense in-depth categorization process does not modify the currently established process for alternative treatments in 10 CFR 50.69 (Reference 7*) so implementation of the alternate defense-in-depth categorization process does not affect reasonable confidence of alternative treatments. Additionally, NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 evaluates the sole means of operator actions for specific scenarios (e.g., mitigation of an accident or transient), and NEI 00-04, Section 9.2.2., #2 examines over-reliance on operator actions which provide for an additional protection with regards to evaluation of operator actions.

Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist.

No system design modifications are made by implementing the alternate defense-in-depth categorization process or the 10 CFR 50.69 process as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), "Section 50.69 is structured to maintain the design basis functional requirements of the plant." This prevents any human actions from occurring due to a modification in the system design.

i. *Provide a review of Limerick PRA cutsets that meet the HSS thresholds for core damage defense in depth.*

Response

The steps outlined in PWROG-20015-NP Revision 3 were followed when evaluating the Limerick core damage cutsets. This process includes two sets of criteria to determine if a cutset meets the HSS threshold for core damage defense-in-depth. The first set of criteria is that the cutset contains an initiating event with a frequency greater than or equal to 1E-04, but less than 1E-03, and a single basic event representing component unreliability or unavailability. The second set of criteria is that a cutset contains an initiating event greater than or equal to 1E-03 and contains, at most, two basic events that represent component unreliability or unavailability.

During the cutset review for Limerick Unit 1 (it is expected that Limerick Unit 2 results would be similar), a number of components were identified as candidate HSS but the associated systems were not evaluated as part of the pilot process.

An example of a cutset that meets the HSS criteria but did not contain components that were part of the pilot process can be seen below.

Cut Value	BE Value	BE	Description
4.36E-11	6.71E-01	%TT	FREQUENCY OF TURBINE TRIP TRANSIENTS
	2.10E-06	CM	MECHANICAL PORTION OF THE RPS FAILS
	3.09E-05	SEV04XCPI	EXPLOSIVE VALVE XV-48-1F004* COMMON CAUSE FAIL

As can be seen in the Table above, the turbine trip initiator frequency is greater than 1E-03 and there are two basic events that represent component failures which meets the HSS criteria for Core Damage DID. The first event represents the mechanical portion of the reactor protection system, which has not been categorized at Limerick. The second event represents the common cause failure of the standby liquid control system explosive valves. These systems were not part of the pilot evaluation, but the functions associated to the failures represented by these basic events would be candidate HSS in the defense-in-depth categorization process.

A second example of a cutset that meets the HSS criteria but did not contain components that were part of the pilot process can be seen below.

Cut Value	BE Value	BE	Description
2.07E-11	1.78E-02	%LOOP-GRID	GRID CENTERED LOOP INITIATING EVENT
	1.00E-05	JPHSPLDXI0	SPRAY POND WATER LEVEL INSUFFICIENT
	5.12E-01	NOOSP2E-GRID	FAILURE TO RCVR OSP IN 2.5HRS/NO RCVRY IN 0.5HRS -GRID RELATED
	8.99E-01	NOOSPE-GRID	FAILURE TO RCVR OFFSITE PWR EARLY(30 MIN) -GRID RELATED
	2.53E-04	ZTUHRXCWI	COMMON CAUSE FAIL OF HPCI/RCIC PUMPS, TURBINES, OR VALVES

The grid centered Loss of offsite power initiating event frequency is greater than 1E-03 thus requiring at least 3 additional levels of defense-in-depth to screen as LSS. As this cutset does not have 3 levels of defense-in-depth, it screens in as HSS. The JPHSPLDXI0 basic event is an example of a phenomenological event that does not represent a component failure, but it does lead to the failure of low-pressure injection due to the loss of cooling to the ESW system and room cooling for LP ECCS. Per the guidance of PWROG-20015-NP, Revision 3-B, this event does not represent a component failure and is not considered a level of defense in depth for this cutset. Additionally, the NOOSP2E-GRID and NOOSPE-GRID events represent basic events for recovery of offsite power and per the guidance of PWROG-20015-NP, Revision 3-B, these events do not represent a component failure and is not considered a level of defense-in-depth for this cutset. The remaining event, ZTUHRXCWI, represents the failure of HPCI and RCIC injection due to common cause and the associated functions failed as a result of this basic events are identified as HSS from the alternate defense-in-depth categorization process.

The cutset review identified other components as candidate HSS where the systems were evaluated as part of the pilot. Examples of these cutsets are provided in the following tables.

Cut Value	BE Value	BE	Description
4.31E-11	7.06E-02	%TCV	LOSS OF CONDENSER VACUUM

Cut Value	BE Value	BE	Description
	5.69E-03	DPM02DTM	RHR PUMP 1DP202 IN MAINTENANCE
	1.07E-07	EBC123CWI	CCF OF DIV 1, DIV 2, AND DIV 3 CHARGERS

This cutset identifies the D RHR pump and the DIV 1, DIV 2 and DIV 3 battery chargers as candidate HSS. The loss of condenser vacuum initiating event frequency is greater that 1E-03 thus requiring at least 3 additional levels of defense-in-depth to screen as LSS. As this cutset does not have 3 levels of defense-in-depth, it screens in as HSS. The common cause failure of the battery chargers would drive the battery chargers to HSS however this system was not part of the pilot study. The DPM02DTM basic event represents the unavailability of the D RHR pump due to maintenance. This basic event drives the PRA Suppression Pool cooling function to HSS.

Cut Value	BE Value	BE	Description
5.66E-10	7.06E-02	%TCV	LOSS OF CONDENSER VACUUM
	5.00E-02	BPHCFXDXI	CONTAINMENT FAILURE LEADS TO FAILURE OF CRD/COND INJECTION
	6.19E-06	DMV48XCNI	MOV HV51-1F048 RHR HX BYP VLV COMMON CAUSE FAIL TO CLOSE
	1.00E+00	VHUVTHDXI	(2.59E-2) OPERATOR FAILS TO INIT VENT GIVEN RHRSW FAILS (NON-LOCA)
	2.59E-02	VHUVTHDXI_IND	OPERATOR FAILS TO INIT VENT GIVEN RHRSW FAILS (NON-LOCA)

This cutset identifies the RHR heat exchanger bypass valves as HSS. The loss of condenser vacuum initiating event frequency is greater that 1E-03 thus requiring at least 3 additional levels of defense-in-depth to screen as LSS. As this cutset does not have 3 levels of defense-in-depth, it screens in as HSS. The BPHCFXDXI is a phenomenological event that represents a 5% probability that a containment failure will lead to the failure of CRD or Condensate injection and per the guidance of PWROG-20015-NP, Revision 3-B, does not represent a component failure and therefore is not considered a level of defense in depth for this cutset. The VHUVTHDXI and VHUVTHDXI_IND represent the failure of the operator action to initiate venting. These two events represent the same failure, the "_IND" version of the event is the version that applies the probability of failure and is applied during the HRA dependency aspect of the quantification process. The non "_IND" version of the event is used during the quantification process but is eventually set to 1.0 and is used to browse the cutsets in the fault tree. This leaves the common cause failure of the RHR heat exchanger bypass valves. These valves are identified as HSS and drive the suppression pool cooling and shutdown cooling functions of RHR to HSS due to core damage defense-in-depth.

Cut Value	BE Value	BE	Description
1.38E-11	1.00E+00	%TCFACTOR	INITIATING EVENT FOR LOSS OF TECW
	9.20E-05	APS06XCMI	PRESSURE SWITCH 106A/B COMMON CAUSE MISCALIB.
	1.63E-03	TPM03XCRIIEY	COMMON CAUSE FAILURE OF TECW PUMPS FAIL TO RUN
	9.20E-5	ZTTSLDCMI	STEAM LEAK DETECTION COMMON CAUSE MISCALIB.

The loss of TECW initiating event frequency is greater that 1E-03 thus requiring at least 3 additional levels of defense-in-depth to screen as LSS. As this cutset does not have 3 levels of defense-in-depth, it screens in as HSS. The remaining basic events in this cutset represents failure of the PCIG system due to miscalibrations of the 106A/B pressure switches and the miscalibration of the steam leak detection system. The associated functions failed as a result of these basic events are identified as HSS from the alternate defense-in-depth categorization process.

ii. *Further discuss the criteria used for filtering the cutsets. Justify why the proposed method cutset filtering is adequate to assess all defense-in-depth aspects in determining significance.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

The process for filtering cutsets has been modified as shown in Section 2.2.2 in PWROG-20015-NP, Revision 3 (Reference [7]). Below identifies each of the steps within the process outlined in Section 2.2.2 of PWROG-20015-NP, Revision 3 with explanation of each of the steps.

As described in the introductory statement in PWROG-20015-NP, Section 2.2.2, the alternate defense-in-depth process does not assign a Risk-informed Safety Class (RISC) for SSCs until the entire system categorization has been reviewed by the IDP. RISC is only assigned once the system categorization is completed and approved by the IDP.

Introductory Statement in PWROG-20015-NP, Revision 3, Section 2.2.2:

> The following alternate defense-in-depth categorization process can be completed in lieu of NEI 00-04, Section 6.1 (Reference 2*). The alternate core damage defense-in-depth process initial screening is completed in a single plant level analysis for all SSCs with results incorporated into the system categorization. The NEI 00-04, Section 6.2 containment defense-in-depth is unchanged in the alternate defense-in-depth categorization process. Consistent with the NEI 00-04, Section 6.1 core damage defense-in-depth process, the alternate defense-in-depth process is used to identify whether SSCs that are identified as candidate LSS from other analyses in the 10 CFR 50.69 categorization process remain candidate LSS after the defense-in-depth assessment. Even if the alternate defense-in-depth process has an SSC identified as candidate LSS, the remainder of the system categorization steps need to be completed and the Integrated Decision-making Panel (IDP) has to review and approve the system categorization prior to an SSC being assigned as LSS and assigned a RISC. This alternate process is defined in several steps for the analysis:

The first step in the alternate categorization process is with regards to the PRA technical adequacy pre-requisites. It identifies the FPIE PRA model should be used for the alternate defense-in-depth evaluations and that findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference [8]) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The ASME/ANS RA-Sa-2009 PRA Standard allows for a consistent approach in PRA modeling and the peer review process provides for an independent review of the FPIE PRA model. This provides assurances of the level of detail of the FPIE CDF PRA model and this, along with other examinations of the FPIE CDF PRA model in Step 7.b.4, Step 7.5.b, Step 7.b.6, and Step 9, identifies the FPIE CDF PRA model is sufficient to implement alternate defense-in-depth. Further discussion on the sufficiency of using the FPIE CDF PRA model for alternate defense-in-depth is described in RAI-11.H.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 1:

> 1. PRA Technical Adequacy Pre-Requisites: The alternate core damage defense-in-depth process requires that the full power internal events (FPIE) Core Damage Frequency (CDF) PRA model meets the following requirements:

a. The FPIE CDF PRA model used for the alternate defense-in-depth evaluations is acceptable for implementing 10 CFR 50.69.

b. Findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The review of the FPIE PRA model is completed in accordance with Regulatory Guide 1.200[2] in the 10 CFR 50.69 license amendment as a pre-requisite for approval to implement 10 CFR 50.69.

[2] Reference 4 or Reference 5, depending on revision used in the 10 CFR 50.69 license amendment. Note that if a future revision of Regulatory Guide 1.200 is referenced in the 10 CFR 50.69 license amendment, it may be considered for use by the licensee in the alternate defense-in-depth process.

Step 2 allows for previously approved system categorizations to have the alternate defense-in-depth approach implemented.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 2:

2. The alternate defense-in-depth categorization process can be implemented for any system that was previously categorized or systems that will be categorized.

Step 3 does not require that any system that has been previously categorized be re-categorized to the alternate defense-in-depth process. This is to avoid unnecessary re-categorization of already completed systems. The alternate defense-in-depth process is an alternate process to core damage defense-in-depth. NEI 00-04, Section 6.1 is not invalidated by this process and therefore can still be used.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 3:

3. Any system that has been previously categorized is not required to be re-categorized with the alternate defense-in-depth categorization process.

Step 4 of the process provides for the previously approved defense-in-depth process (i.e., NEI 00-04, Section 6.1) to continue to be used. The alternate defense-in-depth process is an alternate process to core damage defense-in-depth. NEI 00-04, Section 6.1 is not invalidated by this process and therefore can still be used.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 4:

4. A plant can implement both the alternate defense-in-depth categorization process and the process identified in the current plant license condition for 10 CFR 50.69. It is determined by the plant whether a system uses the alternate defense-in-depth categorization process.

Step 5 of the process reaffirms the consistency with the NEI 00-04 process with IDP review and approval of system categorizations prior to assignment of RISC or implementation of alternative treatments.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 5:

5. No assignments of RISC (or implementation of alternative treatments) are completed until a system is individually categorized since SSCs are candidate HSS / candidate Low Safety Significant (LSS) until the system categorization is reviewed and approved by the IDP.

Step 6 identifies a high-level flowchart of the process and how it interacts with the remainder of the categorization. The alternate core damage defense-in-depth analysis is shown in yellow.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 6:

6. Candidate HSS SSCs from the alternate core damage defense-in-depth process are identified using the FPIE CDF PRA model in a plant-level analysis. This plant-level analysis provides the input to the system-level defense-in-depth categorization. Refer to Figure 2-1 for a high-level flowchart of the 10 CFR 50.69 categorization process modified by the alternate defense-in-depth categorization process (shown in yellow). Note that the NEI 00-04, Section 6.2 containment defense-in-depth process remains the same.

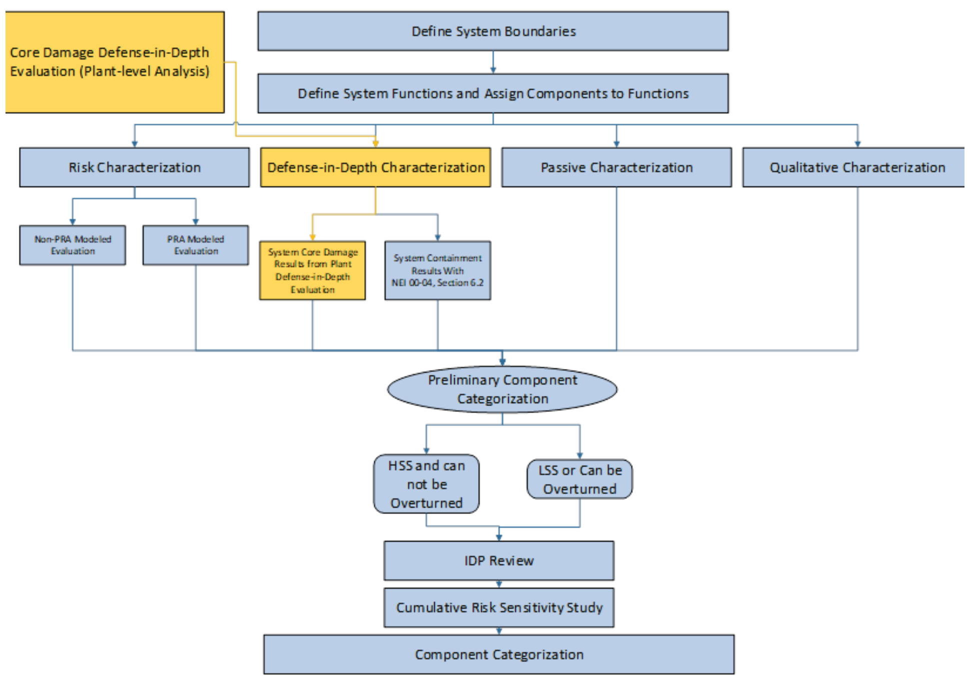

Figure 2-1: High-Level Flowchart of the 10 CFR 50.69 Categorization Process Modified by the Alternate Defense-in-Depth Categorization Process (shown in yellow)

Step 7 identifies the alternate core damage defense-in-depth categorization process completed at the plant level. The plant level analysis is completed to evaluate the CDF FPIE PRA modeling through screening mechanisms. A system level analysis is also completed and is shown in Step 8. The CDF FPIE PRA model is used since it models core damage scenarios.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7:

> **7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

Step 7.a identifies the qualitative screening process.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a:

> **7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.
>
> > a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

The basis for Step 7.a qualitative screening to a maximum of two basic events is shown in PWROG-20015-NP, Section 2.2.6. The two basic events are the maximum that would lead to a “screened in” cutset which is dependent on the quantitative screening discussed in Step 7.b:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> The intent of the alternate defense-in-depth process is to identify SSCs that would be candidate HSS from a cutset with an initiating event and a certain number of basic events, defined in the criteria described in Section 2.2.2, which leads to core damage. NEI 00-04, Section 6.1 (Reference 2*) states that design basis initiating events below the 1E-03/yr threshold must have at least one redundant automatic system present (besides the function/SSC being evaluated). With the more realistic identification of success paths via examination of cutsets from the FPIE CDF PRA model, but with an SSC-level examination, the initiating event frequency lower limit threshold has been decreased by a factor of 10 to 1E-04/yr for the alternate core damage defense-in-depth assessment to avoid “screening out” SSCs that could impact core damage defense-in-depth. If a cutset with an initiating event frequency of at least 1E-04/yr for CDF does not have defense-in-depth based on the criteria defined in Section 2.2.2, the SSCs associated with the initiating event and basic event(s) will be candidate HSS for the alternate core damage defense-in-depth assessment.

Step 7.a.1 identifies the specific type of basic events that are used for screening. This is used to identify defense-in-depth within the cutset.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.1:

> **7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.
>
> > a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).
> >
> > > 1) A basic event counted towards the basic event limit includes an independent failure, a common cause failure (CCF), or a human failure event (HFE) which leads to core damage.

The use of independent failure basic events provides for analysis of defense-in-depth for SSCs within the cutset. Additionally, HFE basic events identify levels of defense-in-depth since operator actions identify realistic defense-in-depth within the plant as discussed in the response to RAI-10.A. CCF basic events provide for defense-in-depth as they are a combination of multiple SSC failures within a single basic event as discussed in Section 2.2.6 of PWROG-20015-NP, Revision 3.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> It is important to realize that, as described in more detail in Section 2.2.3.4, cutsets with CCF basic events that consists of two (2) or three (3) SSC failures would not be automatically “screened out.” Therefore, if there is a lower number of like-SSCs failures (i.e., less than four (4) like-SSCs would have to fail to lead to the accident progression defined in the cutset), that cutset would not be automatically “screened out” from the alternate defense-in-depth assessment. This prevents SSCs in redundant trains from being classified as candidate LSS unless there is significant redundancy or other defense-in-depth is available. Since intra-system CCF is a requirement for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*), “screened in” cutsets with CCF basic events can assign SSCs candidate HSS that are within different trains of equipment.

Step 7.a.2 identifies the specific type of basic events that are not used for screening. This is to identify actual defense-in-depth within the cutset.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.2:

> **7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

[…]

2) Ensure the following basic events are not counted towards the basic event limit in evaluating whether the cutset is qualitatively "screened out": flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with joint human error probabilities (JHEPs) (only if associated independent HFEs are in the cutset), repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events. Examples of the qualitative screening are shown in Section 2.2.3.5.1.

The reasoning for Step 7.a.2 is so that SSCs are not double-counted or basic events that do not correlate with an SSC failure or operation of an SSC are not evaluated as levels of defense-in-depth. The following excerpts discuss this in additional detail.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.5:

Flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with JHEPs (only if associated independent HFEs are in the cutset), repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events are not counted towards the basic event limit. These events being "screened out" of the process prevents them from artificially increasing the amount of defense-in-depth within a cutset and allows for proper identification of defense-in-depth within the plant. Therefore, basic events that are associated with SSC failures or support activation of the SSC are only identified for credit in the alternate defense-in-depth process. For example, a split fraction associated with a phenomenological event does not "screen out" a cutset and is not counted towards the qualitative screening criteria since a split fraction does not represent an SSC failure or independent human action failure. Phenomenological events not causing a cutset to be "screened out" prevents a phenomenological event from being counted towards the defense-in-depth of a system. Another example, which is described in further detail in Section 2.2.3.3, is that repair basic events are not counted towards defense-in-depth to avoid double-counting of the SSC in the defense-in-depth assessment since both the SSC failure and the repair action failure would have to occur for the cutset to be shown.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

Repairing an SSC is generally modeled within the unavailability of a basic event of the SSC failure, which is therefore not identified as a separate basic event in the alternate defense-in-depth assessment. An example of the repair action modeled within unavailability of a basic event is an unavailability calculation based on the SSC failure rate and mean time to repair. Per supporting requirement SY-A24, and DA-C15 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) which is endorsed in Regulatory Guide 1.200 (Reference 4* or Reference 5*, depending on the revision used in the 10 CFR 50.69 license amendment), the probability of repair must be justified through an adequate analysis or examination of data (plant-specific or applicable industry experience). If the repair basic event is separate from the independent basic event of the SSC failure and not modeled within unavailability of the independent basic event of the SSC failure, then the repair basic event would be not counted for defense-in-depth in the qualitative screening as is described in Step 7.a.2) in Section 2.2.2. For example, if a safety injection (SI) pump is out of service and there is a separate basic event for repair of the SI pump, the separate basic event for repair of the SI pump is not counted towards the level of defense-in-depth. This is to avoid double-counting of the SSC in the defense-in-depth assessment since both the SSC failure and the repair action failure would have to occur for the cutset to be shown.

Step 7.a.3 identifies that pressure boundary failure initiating events and pressure boundary failure basic events are not addressed in the alternate core damage defense-in-depth assessment except for ones that impact FPIE CDF PRA model through non-flooding scenarios.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.3:

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

[…]

3) Pressure boundary failure initiating events and pressure boundary failure basic events are not addressed by the alternate core damage defense-in-depth categorization process (e.g., pipe ruptures leading to internal flooding scenarios). Pressure boundary failures are addressed in the pressure boundary categorization analysis. The

exceptions to this are pressure boundary initiating events and pressure boundary basic events that impact the FPIE CDF PRA model through non-flooding scenarios, which are included in the alternate core damage defense-in-depth categorization process.

The basis for Step 7.a.3 on why pressure boundary failure initiating events and pressure boundary failure basic events are not addressed in the alternate core damage defense-in-depth assessment except for ones that impact FPIE CDF PRA model through non-flooding scenarios is provided in the following excerpt.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.5:

> The processes identified in NEI 00-04 (Reference 2*) are for functions that are not pressure boundary (previously known as passive) functions of SSCs. As stated in NEI 00-04 Section 4:
>
> > "The classification of SSCs having only a pressure retaining function (also referred to as passive components), or the passive function of active components, should be performed using the ASME Code Case N-660 [Reference 12*], "Risk-Informed Safety Classification for Use in Risk-Informed Repair/Replacement Activities", or subsequent versions approved by ASME, in lieu of this guidance." (removed reference notation within quote and modified to reference within the bracket)
>
> The pressure boundary categorization has had alternate approaches developed since the creation of NEI 00-04 and Regulatory Guide 1.201, Revision 1 (Reference 11*). These alternate approaches are still designed to meet the pressure boundary categorization portion of the analysis that has examination of internal flooding scenarios.
>
> The alternate defense-in-depth process does not supplement or replace the pressure boundary categorization efforts. Since NEI 00-04 states that the pressure boundary scenarios are not evaluated in the NEI 00-04 process and Regulatory Guide 1.201, Revision 1 (Reference 11*) endorses this guidance with respect to its relation for NEI 00-04, Section 6.1, there is no impact on the pressure boundary categorization process with implementation of the alternate defense-in-depth process.
>
> NEI 00-04, Section 6.1 core damage defense-in-depth does have identification of several aspects related to pressure boundary failure specifically involving design basis events identified and the initiating event frequency associated with them in the example figure NEI 00-04, Figure 6-1. Therefore, examination of pressure boundary initiating events and pressure boundary basic events are not excluded from the alternate defense-in-depth categorization if they impact the FPIE CDF PRA model through non-flooding scenarios as identified in the process outlined in Step 7.a.2) in Section 2.2.2. This allows for consistency with the NEI 00-04, Section 4 quotation above with regards to evaluation of the non-pressure boundary functions of an SSC via the NEI 00-04 process.

Step 7.a.4 screens cutsets with a CCF basic event of four or more SSCs failing from the alternate defense-in-depth assessment due to the significant redundancy provided. The response in RAI-10.E.ii provides justification for screening of these cutsets.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.4:

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

[…]

4) Cutsets with CCF basic events that include a combination of four (4) or more SSCs failing within the same common cause component group can be "screened out" of the filtered cutsets based on the significant redundancy of performing the function.

Step 7.b.1, Step 7.b.2, and Step 7.b.3 identifies different quantitative initiating event frequency threshold levels for the alternate defense-in-depth assessment.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.b.1, Step 7.b.2, Step 7.b.3:

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

[…]

b. Cutset Quantitative Screening

1) Cutsets with initiating events with frequencies that are less than 1E-04/yr are not included in the alternate core damage defense-in-depth categorization process and can be "screened out" of the filtered cutsets.

2) Cutsets with initiating events with frequencies at least 1E-04/yr and less than 1E-03/yr are only "screened in" for the alternate core damage defense-in-depth categorization if there is a maximum of a single basic event from the cutset qualitative screening.

3) Cutsets with initiating events with frequencies that are at least 1E-03/yr are only “screened in” for the alternate core damage defense-in-depth categorization if there is a maximum of two basic events from the cutset qualitative screening.

The basis for this quantitative screening criteria identified in Step 7.b.1, Step 7.b.2, and Step 7.b.3 is provided below.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

The intent of the alternate defense-in-depth process is to identify SSCs that would be candidate HSS from a cutset with an initiating event and a certain number of basic events, defined in the criteria described in Section 2.2.2, which leads to core damage. NEI 00-04, Section 6.1 (Reference 2*) states that design basis initiating events below the 1E-03/yr threshold must have at least one redundant automatic system present (besides the function/SSC being evaluated). With the more realistic identification of success paths via examination of cutsets from the FPIE CDF PRA model, but with an SSC-level examination, the initiating event frequency lower limit threshold has been decreased by a factor of 10 to 1E-04/yr for the alternate core damage defense-in-depth assessment to avoid “screening out” SSCs that could impact core damage defense-in-depth. If a cutset with an initiating event frequency of at least 1E-04/yr for CDF does not have defense-in-depth based on the criteria defined in Section 2.2.2, the SSCs associated with the initiating event and basic event(s) will be candidate HSS for the alternate core damage defense-in-depth assessment.

This cutset examination requires that SSCs with minimal or no defense-in-depth for cutsets within the screening threshold as identified in Section 2.2.2 be “screened in” as candidate HSS for the alternate defense-in-depth since the SSCs identified in cutsets with few basic events represent a limited number of SSC failures that would have to occur to result in core damage. Additionally, there is a secondary threshold that requires an additional level of defense-in-depth for cutsets with higher initiating event frequencies. The additional requirement of more than two basic events being necessary for the SSCs to be candidate LSS at an initiating event frequency threshold of 1E-03/yr for CDF is to allow for an additional level of defense-in-depth to be present for higher frequency initiating events to follow a similar process to Figure 6-1 in NEI 00-04, Section 6.1 of increasing the level of defense-in-depth for higher frequency initiating events. This provides a bounding analysis as shown in the example below.

It is important to realize that, as described in more detail in Section 2.2.3.4, cutsets with CCF basic events that consists of two (2) or three (3) SSC failures would not be automatically “screened out.” Therefore, if there is a lower number of like-SSCs failures (i.e., less than four (4) like-SSCs would have to fail to lead to the accident progression defined in the cutset), that cutset would not be automatically "screened out" from the alternate defense-in-depth assessment. This prevents SSCs in redundant trains from being classified as candidate LSS unless there is significant redundancy or other defense-in-depth is available. Since intra-system CCF is a requirement for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*), "screened in" cutsets with CCF basic events can assign SSCs candidate HSS that are within different trains of equipment.

Examples of how defense-in-depth is approached in the alternate defense-in-depth categorization process are identified below:

- **Greater than 1E-03/yr initiating event frequency:** NEI 00-04, Figure 6-1 requires three or greater diverse trains or two redundant systems (other than the function required for the function/SSC being examined) to remain candidate LSS for defense-in-depth for initiating event frequencies greater than 1E-01/yr. This is the bounding scenario for other initiating event frequency values in NEI 00-04, Figure 6-1. In this scenario, this would fall into the alternate defense-in-depth cutset review of two basic events (initiating event frequency greater than 1E-03/yr for alternate core damage defense-in-depth). Failure pathways for an accident scenario are identified during the cutset review and basic events within a cutset can contain CCF of SSCs as intra-system CCF is required to be taken into account for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). For example, if only two systems supported prevention of the accident scenario for an initiating event greater than 1E-03/yr, a cutset can appear with a basic event associated with CCF of like-SSCs for the trains within System 1 that leads to a failure of System 1 and a basic event associated with CCF of like-SSCs for the trains within System 2 that leads to a failure of System 2. In this scenario, the SSCs associated with these basic events would be identified as candidate HSS due to the limited redundancy available. This matches with only two systems being overall available and is consistent with how NEI 00-04, Figure 6-1 would evaluate this scenario for initiating event frequencies greater than 1E-01/yr. In a modified example where the cutset would instead consist of three basic events (e.g., three CCF basic events of three different systems), this specific cutset would be "screened out" and associated SSCs would be candidate LSS for this cutset in the core damage defense-in-depth analysis (SSCs may still end up as candidate HSS from other cutsets or other analyses). This is the same level of redundancy present within NEI 00-04, Figure 6-1 where there is a requirement of at least 2 redundant systems (or 3 diverse trains) excluding the function / SSC that is being considered. Additionally, since the SSC that are identified as candidate HSS in the core damage defense-in-depth assessment identify associated functions of the SSC as candidate HSS based on the process identified in NEI 00-04, Section 7.1, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information). If the SSC requires multiple failures within a system that are not related via CCF in the cutsets, that can be identified as redundancy within the system itself which the new alternate defense-in-depth approach takes credit for. Additionally, Section 2.2.3.4 describes scenarios where there is significant level of redundancy for CCF (4 or more failures) and why it is appropriate to “screen out” those cutsets. As stated in Section 2.2.3.3, HFE (including operator actions and recovery actions) also have SSC failures that support performing the operator actions and/or recovery actions modeled per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*).

• **Greater than 1E-04/yr, less than 1E-03/yr initiating event frequency:** The single basic event cutset criteria initiating event frequency range is comparable to the initiating event frequencies below 1E-03/yr in Figure 6-1 of NEI 00-04. The alternate core damage defense-in-depth process moves this threshold down by a factor of 10. In the alternate core damage defense-in-depth approach, there has to be one additional defense-in-depth layer to be “screened out” of the single basic event criteria. Figure 6-1 in NEI 00-04 requires at least one redundant automatic system to function in addition to the function/SSC being examined to provide for defense-in-depth. This cutset review would identify any cutsets with a basic event of any SSCs failing (or CCF of SSCs) that would lead to CDF. For a cutset to be “screened out,” two basic events would have to be present. This would require either two systems to be present for this defense-in-depth or there would have to be multiple SSC failures within a system that are not related via CCF in the cutsets to lead to a system failure. If any cutset that includes a CCF basic event is “screened in”, then the associated functions of the candidate HSS SSCs associated with the CCF basic event would be identified as candidate HSS. Therefore, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information) which avoids the SSCs that support the associated function from being candidate LSS in the alternate defense-in-depth assessment. A CCF basic event of a combination greater than four (4) SSCs can be “screened out” due to significant intra-system redundancy as discussed in Section 2.2.3.4. Whether the system is automatic does not factor into a realistic evaluation of defense-in-depth since non-automatic systems also provide functional support of safety-related events and represent realistic defense-in-depth and success paths in a plant.

• **Less than 1E-04/yr initiating event frequency:** Initiating events below 1E-04/yr for CDF cutsets have been "screened out" because of their low likelihood of occurrence. SSCs below that initiating event frequency threshold that have a significant impact to CDF will be evaluated in the FPIE CDF PRA model quantitative determinations (i.e., FV, RAW screening) in NEI 00-04, Section 5 and other analyses described later in this section. Additionally, protection systems must meet single failure criteria as described in 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) for design basis scenarios as shown below based on plant design requirements. In these design basis scenarios with a low initiating event frequency, a single SSC failure in a protection system would not lead to core damage due to a redundant system or a redundant train being available. Based on the low level of occurrence for these design basis initiating events, this provides for defense-in-depth and is based on the overall plant design that remains unchanged by 10 CFR 50.69. As stated in Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), "Section 50.69 is structured to maintain the design basis functional requirements of the plant."

- o 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) : "Criterion 21—Protection system reliability and testability. The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) **no single failure results in loss of the protection function** and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred." (emphasis added in bold)

In the scenario a cutset is "screened out" for the alternate core damage defense-in-depth assessment, then there is defense-in-depth within the plant for the SSCs being examined based on the cutset results in a manner that is similar with the defense-in-depth concept within the NEI 00-04, Section 6.1 process.

Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were "screened out" for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

Step 7.b.4, Step 7.b.5, and Step 7.b.6 (and its sub-steps) have examination of the initiating event frequencies and how initiating events frequencies are examined for applicability in the alternate defense-in-depth process.
PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.b.4, Step 7.b.5, Step 7.b.6 (and its sub-steps):

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

[…]

b. Cutset Quantitative Screening

[…]

4) For initiating events that were "screened out" of the FPIE CDF PRA model, evaluate whether the initiating events would have had a frequency less than 1E-04/yr (quantitative threshold for the alternate core damage defense-in-depth). If this is the case, the initiating event does not impact the alternate core damage defense-in-depth screening as it would already be "screened out" since the initiating event frequency is below 1E-04/yr. If this is not the case and the "screened out" initiating event frequency is greater than or equal to 1E-04/yr, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the FPIE CDF PRA model results should be evaluated with the

originally “screened out” initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

5) For initiating events that were split into multiple initiating events in the FPIE CDF PRA model, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the combined initiating event consisting of a combination of the split initiating events. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

6) The periodic review process identified in NEI 00-04, Section 12 is unchanged but additional clarification is provided for the alternate defense-in-depth process in regards to the bullet on “a review of the impact of the updated risk information on the categorization process results”:

a) During a periodic review, if an initiating event is removed in an update to the FPIE CDF PRA model after using the alternate defense-in-depth categorization, evaluate whether the removed initiating event frequency is less than 1E-04/yr (quantitative threshold for the alternate core damage defense-in-depth). If this is the case, the initiating event does not impact the alternate core damage defense-in-depth screening as it would already be “screened out” since the initiating event frequency is below 1E-04/yr. If this is not the case and the removed initiating event frequency is greater than or equal to 1E-04/yr, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the FPIE CDF PRA model results should be evaluated with the removed initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

b) During a periodic review, if an initiating event is split into multiple initiating events in an update to the FPIE CDF PRA model after completing the alternate defense-in-depth categorization, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the initially combined initiating event. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

Basis for the initiating event frequency evaluation shown in Step 7.b.4, Step 7.b.5, and Step 7.b.6 (and its sub-steps) is shown below.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.7:

When first using the alternate defense-in-depth process, the initiating events are evaluated to determine if any initiating event “screened out” of the FPIE CDF PRA model would be above the initiating event frequency range of quantitative screening, or if initiating events which were split would be within a higher initiating event frequency range, if combined, for the quantitative evaluation of initiating events in the alternate defense-in-depth. Therefore, any initiating events originally “screened out” or split within the FPIE CDF PRA are assessed on their impact on the alternate defense-in-depth process or, alternatively, evaluated within the alternate defense-in-depth assessment.

The initiating events within a PRA model may change after the initial assessments for the alternate defense-in-depth categorization. In the rare event that an initiating event is removed or split, the process evaluates if the removed initiating event was below the initiating event frequency range for quantitative screening or if the split initiating events are moved to a different initiating event frequency range for the quantitative evaluation in the alternate defense-in-depth process. Although this rarely occurs, this process allows for a PRA update affecting the removal or splitting of initiating events to be examined compared to the PRA model version originally used for alternate defense-in-depth screening. This task is completed during the normal periodic review in NEI 00-04, Section 12 (Reference 2*).

These assessments are completed by the engineering team that develops a response to these bases and the bases should be approved by the IDP prior to use of the alternate defense-in-depth method in a system categorization.

Step 7.c (and its sub-step) identifies from the remaining cutsets the SSCs associated with the events. This is completed to properly identify which SSCs are candidate HSS for the alternate core damage defense-in-depth assessment.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.c (and its sub-step):

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

[…]

c. From the remaining filtered “screened in” cutsets, identify the SSCs in the plant that are modeled by these initiating events and basic events.

1) Review HFEs and recovery actions to ensure specific SSC failure modes (e.g., MOV fails to close) are correlated to the HFEs and recovery actions. If they are not, correlate the HFE / recovery action to an SSC(s).

Step 7.d identifies that the SSCs from the plant level assessment that are candidate HSS will be used in the alternate core damage defense-in-depth assessment as candidate HSS at the system level assessment.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.d:

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

[…]

d. The SSCs in the plant identified from the filtered “screened in” cutsets are considered candidate HSS for the alternate core damage defense-in-depth assessment in the system level analysis.

Step 8 and Step 8.a reinforces that the system level assessment of categorization replaces the NEI 00-04, Section 6.1 core damage defense-in-depth assessment and the SSCs identified in the plant-level assessment that are in the system are candidate HSS for the alternate core damage defense-in-depth assessment.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 8 and Step 8.a:

8. Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis: This analysis replaces the considerations in NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

a. SSCs that are candidate HSS from the plant-level analysis that are within the system are identified as candidate HSS for the system level analysis.

Step 8.b reinforces the NEI 00-04, Section 7.1 process with regards to associated functions being assigned candidate HSS continues to be used.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 8.b:

8. Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis: This analysis replaces the considerations in NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

[…]

b. For SSCs that are candidate HSS, the associated functions are driven to candidate HSS following the process in NEI 00-04, Section 7.1.

The basis of SSCs from the core damage defense-in-depth assessment assigning associated functions as candidate HSS is provided below.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.1:

NEI 00-04, Section 7.1 (Reference 2*), states:

"If any SSC is safety significant, from either the PRA-based component safety significance assessment (Section 5) or the defense-in-depth assessment (Section 6), then the associated system function is preliminarily safety significant."

When an SSC is candidate HSS from the FPIE PRA, the Integral PRA, the core damage defense-in-depth, and/or the containment defense-in-depth assessments, the functions driving the candidate HSS determination are identified as "associated functions." All SSCs mapped to an "associated function" are preliminary candidate HSS as described in NEI 00-04, Section 7.1 due to the "associated function" being candidate HSS. Therefore, SSCs (e.g., SSCs not modeled in the PRA or SSCs otherwise identified as candidate LSS) can be candidate HSS from the alternate defense-in-depth assessment if the SSC supports a function that was identified as an associated function in NEI 00-04, Section 7.1. The detailed categorization process described in NEI 00-04, Section 10.2 provides the approach for "performing additional engineering and system analyses to identify specific component level or piece part functions and importance for the safety-significant SSCs" in order to justify and categorize an SSC as candidate LSS. NEI 00-04, Section 7.1 and NEI 00-04, Section 10.2 remain unchanged from the current NEI 00-04 process.

Step 8.c discusses that SSCs and functions outside of the scope of the FPIE CDF PRA do not need to be evaluated for core damage defense-in-depth.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 8.c:

8. Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis: This analysis replaces the considerations in NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

[…]

c. Consistent with the existing NEI 00-04 defense-in-depth process, SSCs and functions outside the scope of the FPIE CDF PRA do not need to be evaluated for core damage defense-in-depth since the level of defense-in-depth is based on the success criteria in the FPIE CDF PRA.

Step 8.c is consistent with the NEI 00-04, Section 6.1 process. As described in the basis below, non-modeled SSCs are not evaluated in the alternate defense-in-depth process since the alternate defense-in-depth examines the level of defense-in-depth available, based on the success criteria used in the PRA.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.8:

NEI 00-04, Section 6.1 (Reference 2*) states the following:

"This figure depicts the internally initiated design basis events considered in the licensee's safety analysis report (i.e., the events that were used to identify an SSC as safety-related) **and considers the level of defense-in-depth available, based on the success criteria used in the PRA.**" (emphasis added in bold)

The NEI 00-04, Section 6.1 process identifies the level of defense-in-depth based on the success criteria in the PRA. The alternate core damage defense-in-depth method continues to examine the success criteria used in the PRA but with a direct examination by a cutset review. A cutset review is used to identify the number of SSC failures that would have to occur to lead to core damage. From the examination of these cutsets, the level of defense for specific initiating event accident scenarios can be determined. CDF PRA models that meet the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) must identify realistic core damage occurrences within the PRA model and identify safety-related functions within the plant. The FPIE CDF PRA model quantitative values (except for initiating event frequency and truncation) are not used for the alternate defense-in-depth process which is consistent with the NEI 00-04, Section 6.1 method on not relying on quantitative insights of the PRA model. Instead of relying on quantitative insights, the alternate defense-in-depth method uses the model structure via cutsets. The model structure has the benefit of having been peer reviewed through the PRA peer review process which provides a rigorous, industry review of the model compared to a system-by-system analysis that is currently completed in the NEI 00-04, Section 6.1 defense-in-depth process.

The ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) takes into account system responses in high level requirements (e.g., HLR-AS-A, HLR-SY-A) along with supporting requirements; SSCs that are not modeled within the FPIE CDF PRA are identified as having a negligible impact on the CDF of the plant and are therefore “screened out” of modeling. PRA models are rigorously peer reviewed to determine acceptability of the PRA model for application at a plant. The peer review process is an essential part to verify that the completeness of the PRA model and assumptions within the PRA model are acceptable. Additionally, the engineering team and the IDP will review acceptability of the PRA model for use in the alternate defense-in-depth assessment for the systems categorized as identified in Section 2.2.2, Step 9.

SSCs that are not modeled in the FPIE CDF PRA model remain addressed in the overall 10 CFR 50.69 process outlined in NEI 00-04. SSCs not modeled in the FPIE CDF PRA can be candidate HSS from the results of the alternate defense-in-depth assessment due to the associated functions that are candidate HSS from alternate defense-in-depth. As described in Section 2.2.3.1, if a non-modeled SSC supports an associated function which is identified as candidate HSS based on an SSC(s) that is identified as candidate HSS in the alternate defense-in-depth assessment, those non-modeled SSCs would be identified as candidate HSS based on the associated function being candidate HSS. NEI 00-04, Section 10.2 continues to remain applicable for downgrading to candidate LSS if criteria are met. Additionally, NEI 00-04, Section 9.2.2 has the seven Review of Risk Information qualitative considerations along with a Review Defense-in-Depth Implications for safety-related candidate LSS functions/SSCs. For example, #1 in the Review of Risk Information examines if a failure of function/SSC causes an initiating event that was originally “screened out” of the PRA based on anticipated low frequency of occurrence. Therefore, additional qualitative considerations have to be evaluated prior to identifying an SSC as candidate LSS even if it is not modeled within the FPIE CDF PRA model.

Step 8.d identifies that the remaining SSCs that are not candidate HSS for the alternate core damage defense-in-depth process will be candidate LSS for the alternate defense-in-depth process. This does not necessarily mean that the SSC will be LSS since there are other categorization elements that need to be completed.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 8.d:

8. Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis: This analysis replaces the considerations in

NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

[…]

d. All other SSCs that are not identified as candidate HSS in the alternate core damage defense-in-depth analysis are considered candidate LSS for the alternate core damage defense-in-depth categorization process.

Step 8.e identifies that the engineering team provides evaluation of the NEI 00-04, Section 9.2.2 Review of Risk Information and Review Defense-in-Depth Implications prior to IDP review. This is to verify that the engineering team examines these considerations prior to the IDP review.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 8.e:

8. Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis: This analysis replaces the considerations in NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

[…]

e. The engineering team is now required to evaluate the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications prior to IDP review. These evaluations will be reviewed and confirmed by the IDP. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

Step 8.e basis is provided below:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.9:

• The IDP continues evaluations identified in NEI 00-04, Section 9 which includes the Review of Risk Information seven considerations and the Review of Defense-in-Depth Implications five considerations. Now, the engineering team evaluates the NEI 00-04, Section 9.2.2 Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations. Additionally, since the IDP reviews these considerations, along with sections of the categorization, they provide additional insights within these considerations on the impact the categorization has on the system. This provides both the knowledge and expertise of the engineering team and the IDP with regards to the NEI 00-04, Section 9.2.2, Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations.

Step 9 (and its sub-steps) identify the IDP review and approval, along with the engineering teams initial examinations completed, that examine the FPIE CDF PRA to determine that the system modeling and assumptions do not impact the identification of core damage defense-in-depth via the alternate core damage defense-in-depth method.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 9 (and its sub-steps):

9. In addition to the IDP review and approval of the initiating event frequencies identified in Step 7.b.4), Step 7.b.5), and Step 7.b.6) (and sub-steps), the IDP should review the alternate defense-in-depth assessment consistent with NEI 00-04, Section 9: "IDP Review and Approval," while evaluating the system categorization, including the Review of Risk Information and Review Defense-in-Depth Implication considerations identified in NEI 00-04, Section 9.2.2. Additionally, the IDP should examine the following considerations for each system prior to system categorization approval. These considerations are initially examined by the engineering team during the system categorization with an initial evaluation provided to the IDP prior to IDP review and approval. If confirmation of these two criteria are not met, the NEI 00-04, Section 6.1 process should be used for the system categorization. It should be confirmed that:

a. The system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth via the alternate core damage defense-in-depth method.

b. The assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth via the alternate core damage defense-in-depth method.

Step 10 identifies that the containment defense-in-depth categorization process continues to use NEI 00-04, Section 6.2.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 10:

10. Containment Defense-in-Depth Categorization Process: Containment defense-in-depth continues to be evaluated using the NEI 00-04, Section 6.2 guidance.

B. *PRA models have additional approximations, such as capacity factors, phenomenological events, and split fractions, built into the model. The ASME/ANS-2009 PRA Standard, regarding Supporting Requirement for Accident Sequence Analysis Index No. B3 (SR AS-B3), states that phenomenological conditions that impact the success of the system or function to be included in the models. The failure of an SSC* *directly attributed to an event (e.g., seismic or flooding) are failed by the initiating event basic event. During the audit, the licensee stated that certain elements (i.e., phenomenological events which may be related to the failure of SSCs) are ignored as basic events in the cutset screening. The treatment of these events is unclear to the NRC staff and may be inconsistent. Provide the basis for the proposed alternate method not crediting phenomenological failures as SSCs in the cutset review.*

Response

Not taking credit for phenomenological failures within the cutset review prevents reliance on defense-in-depth for basic events that do not correspond to SSC failures or support/prevent activation of the SSC in the accident sequence:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.5 (emphasis added in bold):

> Flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with JHEPs (only if associated independent HFEs are in the cutset), repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events are not counted towards the basic event limit. **These events being "screened out" of the process prevents them from artificially increasing the amount of defense-in-depth within a cutset and allows for proper identification of defense-in-depth within the plant. Therefore, basic events that are associated with SSC failures or support activation of the SSC are only identified for credit in the alternate defense-in-depth process. For example, a split fraction associated with a phenomenological event does not "screen out" a cutset and is not counted towards the qualitative screening criteria since a split fraction does not represent an SSC failure or independent human action failure. Phenomenological events not causing a cutset to be "screened out" prevents a phenomenological event from being counted towards the defense-in-depth of a system.** Another example, which is described in further detail in Section 2.2.3.3, is that repair basic events are not counted towards defense-in-depth to avoid double-counting of the SSC in the defense-in-depth assessment since both the SSC failure and the repair action failure would have to occur for the cutset to be shown.

C. *The considerations for maintaining defense-in-depth in RG 1.174 include preventing overreliance on programmatic activities (Consideration No. 2) and preserving sufficient defense against human errors (Consideration No. 6). The proposed method would only identify HSS categorization cutsets that went to core damage because of a failure of single operator action. Secondly, credit for repair or recovery in the PRA model would result in LSS categorization for SSCs that are in cutsets with repair and recovery actions. Therefore:*

i. *Explain the type of recovery and repair actions credited in the Limerick PRA.*

Response

ASME/ANS PRA Standard (RA-Sa-2009) SR HR-H1(CC II) is met. The Limerick PRA credits manual operator actions that recover functional failures including automatic initiation failures or failed MCR manipulations (due to a loss of power, for example). These actions are defined in plant operation procedures to which operators are trained, including the Emergency Operating Procedures and the Off-normal Procedures. Examples of credited recovery actions include ZHULPIDXI, FAILURE TO MANUALLY INITIATE LP ECCS (TRANSIENT) and EHULOPDXI, FAILURE TO START EDG FROM MCR AFTER AUTO INITIATION FAILS.

The Limerick PRA model does not take any credit for repair. The Data Notebook provides historical information on repair estimates for some systems. While these repair basic events are included in the PRA model logic, they are set to TRUE in the flag files and are therefore compressed out during the quantification process.

ii. *Explain and justify how the credit for recovery and repair actions in the PRA impacts the cutset screening (filtering) criteria for defense-in-depth and how it is consistent with the RG 1.174 defense-in-depth considerations.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

Section 2.2.3.3 in PWROG-20015-NP, Revision 3 (Reference [7]) discusses credit for operator actions and recovery actions, along with including operator actions that involve repair actions. RAI-10.A addresses the aspects of operator actions and recovery actions discussion and crediting of these actions. Further discussion with regards to repair actions is shown in the excerpt below. Repair actions are credited if they do not impact the cutset review, for example if the repair action itself is calculated as part of the unavailability of the basic event. In the scenario a separate basic event is identified for a repair action, that specific basic event is not counted towards the level of defense-in-depth in the cutset.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

> Repairing an SSC is generally modeled within the unavailability of a basic event of the SSC failure, which is therefore not identified as a separate basic event in the alternate defense-in-depth assessment. An example of the repair action modeled within unavailability of a basic event is an unavailability calculation based on the SSC failure rate and mean time to

repair. Per supporting requirement SY-A24, and DA-C15 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) which is endorsed in Regulatory Guide 1.200 (Reference 4* or Reference 5*, depending on the revision used in the 10 CFR 50.69 license amendment), the probability of repair must be justified through an adequate analysis or examination of data (plant-specific or applicable industry experience). If the repair basic event is separate from the independent basic event of the SSC failure and not modeled within unavailability of the independent basic event of the SSC failure, then the repair basic event would be not counted for defense-in-depth in the qualitative screening as is described in Step 7.a.2) in Section 2.2.2. For example, if a safety injection (SI) pump is out of service and there is a separate basic event for repair of the SI pump, the separate basic event for repair of the SI pump is not counted towards the level of defense-in-depth. This is to avoid double-counting of the SSC in the defense-in-depth assessment since both the SSC failure and the repair action failure would have to occur for the cutset to be shown.

Based on the discussion with repair actions above, a modification has been made to alternate defense-in-depth process in PWROG-20015-NP, Revision 3, Section 2.2.2 to prevent double counting of repair actions as shown in the bolded section below.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.2 (emphasis added in bold):

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

[…]

2) **Ensure the following basic events are not counted towards the basic event limit** in evaluating whether the cutset is qualitatively “screened out”: flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with joint human error probabilities (JHEPs) (only if associated independent HFEs are in the cutset), **repair basic events that are separate from the independent basic event of the SSC failure**, and other house or special events. Examples of the qualitative screening are shown in Section 2.2.3.5.1.

Regulatory Guide 1.174 (Reference [10]) considerations for all operator actions are addressed in the excerpt provided below. Since the process has been modified to avoid double counting of SSCs with regards to repair actions, repair actions identified as individual basic events are no longer counted as a level of defense-in-depth in the process and do not impact the alternate defense-in-depth assessment.

Discussion on compliance with Regulatory Guide 1.174, Revision 3 (Reference [10]) is met and described further in Section 2.2.3.3 and #6 of Section 2.2.7 of PWROG-20015-NP, Revision 3:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

One of the seven criteria in Regulatory Guide 1.174, Section 2.1.1.2 (Reference 6*) is "preserve sufficient defense against human errors." As mentioned in Regulatory Guide 1.174, "these defenses generally involve the use of procedures, training, and human engineering; however, other considerations (e.g., communication protocols) might also be important." SSCs that would be identified as RISC-3 that have alternative treatments applied would still be required to maintain reasonable confidence of performing their safety-related functions which prevents overreliance on human actions. As stated in Statement of Considerations of 10 CFR 50.69, Section V.3.1, Section 50.69(b)(1) Removal of RISC-3 and RISC-4 SSCs From the Scope of Treatment Requirements (Reference 7*):

> "The special treatment requirements for RISC-3 SSCs are replaced with the high-level, performance-based requirements in § 50.69(d)(2) that require the licensee to provide reasonable confidence that RISC–3 SSCs will continue to be capable of performing their safety-related functions under design basis conditions."

10 CFR 50.69(d)(2) (Reference 7*) is shown below:

> (2) RISC-3 SSCs. The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life. The treatment of RISC-3 SSCs must be consistent with the categorization process. Inspection and testing, and corrective action shall be provided for RISC-3 SSCs.
>
> > (i) Inspection and testing. Periodic inspection and testing activities must be conducted to determine that RISC-3 SSCs will remain capable of performing their safety-related functions under design basis conditions; and
> >
> > (ii) Corrective action. Conditions that would prevent a RISC-3 SSC from performing its safety-related functions under design basis conditions must be corrected in a timely manner. For significant

conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined and corrective action taken to preclude repetition.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7, #6:

6. **"Preserve sufficient defense against human errors."**

a. **Preserved.** Human error is preserved since the alternate defense-in-depth process does not create new human actions nor does it significantly increase the probability of existing human errors.

It is important to note that the robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7*): "Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59." This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*) which states "Section 50.69 is structured to maintain the design basis functional requirements of the plant." Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7*): "§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions." Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*):

> "Section 50.69 **is structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained. **Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small**."

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7*):

> "The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

b. "Create new human actions that are important to preserving any of the layers of defense for which a high reliability cannot be demonstrated." Preserved. The proposed modifications with the alternate defense-in-depth process does not create new human errors that might adversely impact one or more layers of defense. The plant design remains the same and would therefore not create any new human actions. Alternative treatments are required to maintain reasonable confidence in supporting their safety-related functions and are not anticipated to create new human actions that are important to preserving layers of defense. Performance monitoring of alternative treatments prevent the overreliance on operator actions.

c. "Significantly increase the probability of existing human errors by significantly affecting performance shaping factors, including mental and physical demands and level of training." Preserved. The alternate defense-in-depth process includes human actions in identifying core damage defense-in-depth. SSCs with alternative treatments are required to maintain reasonable confidence of performing their safety-related functions. Periodic reviews and performance monitoring would evaluate whether these human actions or the SSCs that the human actions support have degradation and a corrective action would be taken to eliminate the degradation. For example, if a support system that requires operator actions is having a degradation, an evaluation of the degradation would be assessed that would identify if the SSCs should be reclassified. Due to the reasonable confidence of RISC-3 SSCs, plant operations are not modified in methods that increase human errors or overreliance on human actions. The alternate defense in-depth categorization process does not modify the currently established process for alternative treatments in 10 CFR 50.69 (Reference 7*) so implementation of the alternate defense-in-depth categorization process does not affect reasonable confidence of alternative treatments. Additionally, NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 evaluates the sole means of operator actions for specific scenarios (e.g., mitigation of an accident or transient), and NEI 00-04, Section 9.2.2., #2 examines over-reliance on operator actions which provide for an additional protection with regards to evaluation of operator actions.

Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist.

No system design modifications are made by implementing the alternate defense-in-depth categorization process or the 10 CFR 50.69 process as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), “Section 50.69 is structured to maintain the design basis functional requirements of the plant.” This prevents any human actions from occurring due to a modification in the system design.

iii. Explain how the Limerick PRA models joint human error probabilities (JHEPs).

Response

ASME/ANS PRA Standard (RA-Sa-2009) SR HR-G7 is met; joint human error probabilities (JHEPs) were modified or added to the model. The Limerick PRA used the EPRI HRA Calculator dependency module to evaluate the considerations identified in SR HR-G7. SR QU-C1 is also met. Finally, an artificial JHEP floor value was applied, even if the given independent actions were considered to have zero dependence, to avoid underestimating the joint human error probability.

The HRAC dependency module produces recovery file rules that apply the operator action combination events to the applicable cutsets while also retaining the BEIDs for the operator actions that make up the combinations (with the independent action events set to 1.0). This approach allows the independent actions that occur within combinations to remain available for viewing, filtering, or sorting the cutsets as well as browsing the fault tree.

The quantitative portion of the 50.69 categorization process (not in the defense-in-depth assessment) performs sensitivities with HEPs and JHEPs at their 5th and 95th percentile values. The basic event importance measures for these sensitivities are evaluated during the categorization process to account for the uncertainty of the HEP and JHEP values

iv. *Explain and justify how the JHEP modeling impacts the cutset screening (filtering) criteria for defense-in-depth and how it is consistent with the RG 1.174 defense-in-depth considerations.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

Section 2.2.3.3.1 in PWROG-20015-NP, Revision 3 (Reference [7]) discusses joint human error probabilities and how they are taken into account in the PRA model:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3.1:

> JHEPs are identified to address the dependency between HFEs. Quantitative analyses are not examined in the alternate defense-in-depth assessment except for initiating event frequency and truncation. In the scenario that the quantitative impacts of a JHEP are significant to CDF and LERF, this would be identified via the importance measures in NEI 00-04, Section 5 (Reference 2*) which is outside the scope of the alternate defense-in-depth assessment. Therefore, the only impact of the JHEPs with respect to the alternate defense-in-depth assessment is JHEP basic event identification within a cutset.
>
> A FPIE CDF PRA model does identify JHEP consistent with HR-D5, HR-G7, and QU-C1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). If a JHEP is represented by an additional basic event within the cutset to identify the dependency, this basic event does not count towards the criteria for the cutset qualitative screening since it is does not represent an actual level of defense (i.e., the associated independent HFEs present would be taken into account for the defense already in the cutsets). Not having this JHEP count towards the qualitative cutset screening in these scenarios prevents double counting of defense-in-depth identified via HFEs. If a JHEP and the individualized HFEs are combined into a single basic event, the basic event is treated under the same methods as the other HFE basic events; in this scenario the HFEs shared within a single basic event would limit redundancy identified for those HFEs in the cutset screening. This consolidated basic event is more likely to “screen in” a cutset since multiple HFEs are consolidated into a single basic event. If a justification for diversity between actions within the JHEP can be demonstrated, a basis should be provided and the HFEs can be counted as multiple actions.

The application of overall HFEs is explained in more detail in Section 2.2.3.3 which discusses the consistency with Regulatory Guide 1.174, #6 (Reference 6*).

The alternate defense-in-depth process in PWROG-20015-NP, Revision 3, Section 2.2.2 (Reference [7]) prevents double counting of human actions based on JHEPs if independent HFEs are within the cutset as shown in the bolded section below.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.2 (emphasis added in bold):

7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

[…]

2) **Ensure the following basic events are not counted towards the basic event limit** in evaluating whether the cutset is qualitatively "screened out": flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, **events associated with joint human error probabilities (JHEPs) (only if associated independent HFEs are in the cutset),** repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events. Examples of the qualitative screening are shown in Section 2.2.3.5.1.

Since JHEPs are not treated in any different matter than regular HFEs if they are counted, the application of overall HFEs and the consistency with Regulatory Guide 1.174 applies.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.3:

One of the seven criteria in Regulatory Guide 1.174, Section 2.1.1.2 (Reference 6*) is "preserve sufficient defense against human errors." As mentioned in Regulatory Guide 1.174, "these defenses generally involve the use of procedures, training, and human engineering; however, other considerations (e.g., communication protocols) might also be important." SSCs that would be identified as RISC-3 that have alternative treatments applied would still be required to maintain reasonable confidence of performing their safety-related functions which prevents overreliance on human actions. As stated in Statement of Considerations of 10 CFR 50.69, Section V.3.1, Section 50.69(b)(1) Removal of RISC-3 and RISC-4 SSCs From the Scope of Treatment Requirements (Reference 7*):

> “The special treatment requirements for RISC-3 SSCs are replaced with the high-level, performance-based requirements in § 50.69(d)(2) that require the licensee to provide reasonable confidence that RISC–3 SSCs will continue to be capable of performing their safety-related functions under design basis conditions.”

10 CFR 50.69(d)(2) (Reference 7*) is shown below:

> (2) RISC-3 SSCs. The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life. The treatment of RISC-3 SSCs must be consistent with the categorization process. Inspection and testing, and corrective action shall be provided for RISC-3 SSCs.
>
> > (i) Inspection and testing. Periodic inspection and testing activities must be conducted to determine that RISC-3 SSCs will remain capable of performing their safety-related functions under design basis conditions; and
> >
> > (ii) Corrective action. Conditions that would prevent a RISC-3 SSC from performing its safety-related functions under design basis conditions must be corrected in a timely manner. For significant conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined, and corrective action taken to preclude repetition.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7, #6:

6. “Preserve sufficient defense against human errors.”

a. Preserved. Human error is preserved since the alternate defense-in-depth process does not create new human actions nor does it significantly increase the probability of existing human errors.

It is important to note that the robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7*): “Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.” This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*) which states "Section 50.69 is structured to maintain the design basis functional requirements of the plant." Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7*): "§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions." Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*):

> "Section 50.69 is **structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained**. Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small**." (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7*):

> "The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are

maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

b. "Create new human actions that are important to preserving any of the layers of defense for which a high reliability cannot be demonstrated." Preserved. The proposed modifications with the alternate defense-in-depth process does not create new human errors that might adversely impact one or more layers of defense. The plant design remains the same and would therefore not create any new human actions. Alternative treatments are required to maintain reasonable confidence in supporting their safety-related functions and are not anticipated to create new human actions that are important to preserving layers of defense. Performance monitoring of alternative treatments prevent the overreliance on operator actions.

c. "Significantly increase the probability of existing human errors by significantly affecting performance shaping factors, including mental and physical demands and level of training." Preserved. The alternate defense-in-depth process includes human actions in identifying core damage defense-in-depth. SSCs with alternative treatments are required to maintain reasonable confidence of performing their safety-related functions. Periodic reviews and performance monitoring would evaluate whether these human actions or the SSCs that the human actions support have degradation and a corrective action would be taken to eliminate the degradation. For example, if a support system that requires operator actions is having a degradation, an evaluation of the degradation would be assessed that would identify if the SSCs should be reclassified. Due to the reasonable confidence of RISC-3 SSCs, plant operations are not modified in methods that increase human errors or overreliance on human actions. The alternate defense in-depth categorization process does not modify the currently established process for alternative treatments in 10 CFR 50.69 (Reference 7*) so implementation of the alternate defense-in-depth categorization process does not affect reasonable confidence of alternative treatments. Additionally, NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 evaluates the sole means of operator actions for specific scenarios (e.g., mitigation of an accident or transient), and NEI 00-04, Section 9.2.2., #2 examines over-reliance on operator actions which provide for an additional protection with regards to evaluation of operator actions.

Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist.

No system design modifications are made by implementing the alternate defense-in-depth categorization process or the 10 CFR 50.69 process as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), "Section 50.69 is structured to maintain the design basis functional requirements of the plant." This prevents any human actions from occurring due to a modification in the system design.

D. *Based on audit discussions, the NRC staff understands that the proposed alternate categorization process categorizes SSCs as HSS only when there is no backup to the SSC failure (e.g., an initiator with only one SSC failure that leads to core damage is considered a single point failure). The licensee clarified during the audit that this method performs its analysis at the SSC level and not the functional level. Section 6.1 of NEI 00-04 performs the defense-in-depth analysis at the functional level in order to identify all the SSCs that support that function (i.e., safety-critical functions) and what events can cause their simultaneous failure. For example, a loss of alternating or direct current bus initiator or a loss of service water cooling initiator can leave one train available for the injection function and a separate train available for the cooling function and would result in HSS categorization for both trains.*

Provide justification for events that leave only one SSC available for the required functions to avoid core damage are not designated as HSS.

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

Modifications were made to the PWROG-20015-NP, Revision 3 (Reference [7]) to require additional basic events within a cutset for higher initiating event frequencies (>1E-03/yr initiating event frequency within the CDF FPIE PRA model). This process is similar to the NEI 00-04, Section 6.1 (Reference [11]) process as further discussed in Section 2.2.6 in PWROG-20015-NP, Revision 3 which provides details of the level of defense-in-depth and the justification for the screening criteria.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

The intent of the alternate defense-in-depth process is to identify SSCs that would be candidate HSS from a cutset with an initiating event and a certain number of basic events, defined in the criteria described in Section 2.2.2, which leads to core damage. NEI 00-04, Section 6.1 (Reference 2*) states that design basis initiating events below the 1E-03/yr threshold must have at least one redundant automatic system present (besides the function/SSC being evaluated). With the more realistic identification of success paths via examination of cutsets from the FPIE CDF PRA model, but with an SSC-level examination, the initiating event frequency lower limit threshold has been decreased by a factor of 10 to 1E-04/yr for the alternate core damage defense-in-depth assessment to avoid "screening out" SSCs that could impact core damage defense-in-depth. If a cutset with an initiating event frequency of at least 1E-04/yr for CDF does not have defense-in-depth based on the criteria defined in Section 2.2.2, the SSCs associated with the initiating event and basic event(s) will be candidate HSS for the alternate core damage defense-in-depth assessment.

This cutset examination requires that SSCs with minimal or no defense-in-depth for cutsets within the screening threshold as identified in Section 2.2.2 be "screened in" as candidate HSS for the alternate defense-in-depth since the SSCs identified in cutsets with few basic events represent a limited number of SSC failures that would have to occur to result in core damage. Additionally, there is a secondary threshold that requires an additional level of defense-in-depth for cutsets with higher initiating event frequencies. The additional requirement of more than two basic events being necessary for the SSCs to be candidate LSS at an initiating event frequency threshold of 1E-03/yr for CDF is to allow for an additional level of defense-in-depth to be present for higher frequency initiating events to follow a similar process to Figure 6-1 in NEI 00-04, Section 6.1 of increasing the level of defense-in-depth for higher frequency initiating events. This provides a bounding analysis as shown in the example below.

It is important to realize that, as described in more detail in Section 2.2.3.4, cutsets with CCF basic events that consists of two (2) or three (3) SSC failures would not be automatically "screened out." Therefore, if there is a lower number of like-SSCs failures (i.e., less than four (4) like-SSCs would have to fail to lead to the accident progression defined in the cutset), that cutset would not be automatically "screened out" from the alternate defense-in-depth assessment. This prevents SSCs in redundant trains from being classified as candidate LSS unless there is significant redundancy or other defense-in-depth is available. Since intra-system CCF is a requirement for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*), "screened in" cutsets with CCF basic events can assign SSCs candidate HSS that are within different trains of equipment.

Specifically, the following examples in Section 2.2.6 in PWROG-20015-NP, Revision 3 describe how the level of defense-in-depth is identified.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

Examples of how defense-in-depth is approached in the alternate defense-in-depth categorization process are identified below:

- **Greater than 1E-03/yr initiating event frequency:** NEI 00-04, Figure 6-1 requires three or greater diverse trains or two redundant systems (other than the function required for the function/SSC being examined) to remain candidate LSS for defense-in-depth for initiating event frequencies greater than 1E-01/yr. This is the bounding scenario for other initiating event frequency values in NEI 00-04, Figure 6-1. In this scenario, this would fall into the alternate defense-in-depth cutset review of two basic events (initiating event frequency greater than 1E-03/yr for alternate core damage defense-in-depth). Failure pathways for an accident scenario are identified during the cutset review and basic events within a cutset can contain CCF of SSCs as intra-system CCF is required to be taken into account for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). For example, if only two systems supported prevention of the accident scenario for an initiating event greater than 1E-03/yr, a cutset can appear with a basic event associated with CCF of like-SSCs for the trains within System 1 that leads to a failure of System 1 and a basic event associated with CCF of like-SSCs for the trains within System 2 that leads to a failure of System 2. In this scenario, the SSCs associated with these basic events would be identified as candidate HSS due to the limited redundancy available. This matches with only two systems being overall available and is consistent with how NEI 00-04, Figure 6-1 would evaluate this scenario for initiating event frequencies greater than 1E-01/yr. In a modified example where the cutset would instead consist of three basic events (e.g., three CCF basic events of three different systems), this specific cutset would be “screened out” and associated SSCs would be candidate LSS for this cutset in the core damage defense-in-depth analysis (SSCs may still end up as candidate HSS from other cutsets or other analyses). This is the same level of redundancy present within NEI 00-04, Figure 6-1 where there is a requirement of at least 2 redundant systems (or 3 diverse trains) excluding the function / SSC that is being considered. Additionally, since the SSC that are identified as candidate HSS in the core damage defense-in-depth assessment identify associated functions of the SSC as candidate HSS based on the process identified in NEI 00-04, Section 7.1, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information). If the SSC requires multiple failures within a system that are not related via CCF in the cutsets, that can be identified as redundancy within the system itself which the new alternate defense-in-depth approach takes credit for. Additionally, Section 2.2.3.4 describes scenarios where there is significant level of redundancy for CCF (4 or more failures) and why it is appropriate to “screen out” those cutsets. As stated in Section 2.2.3.3, HFE (including operator actions and recovery actions) also have SSC failures that support performing the operator actions and/or recovery actions modeled per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*).

• **Greater than 1E-04/yr, less than 1E-03/yr initiating event frequency:** The single basic event cutset criteria initiating event frequency range is comparable to the initiating event frequencies below 1E-03/yr in Figure 6-1 of NEI 00-04. The alternate core damage defense-in-depth process moves this threshold down by a factor of 10. In the alternate core damage defense-in-depth approach, there has to be one additional defense-in-depth layer to be “screened out” of the single basic event criteria. Figure 6-1 in NEI 00-04 requires at least one redundant automatic system to function in addition to the function/SSC being examined to provide for defense-in-depth. This cutset review would identify any cutsets with a basic event of any SSCs failing (or CCF of SSCs) that would lead to CDF. For a cutset to be “screened out,” two basic events would have to be present. This would require either two systems to be present for this defense-in-depth or there would have to be multiple SSC failures within a system that are not related via CCF in the cutsets to lead to a system failure. If any cutset that includes a CCF basic event is “screened in”, then the associated functions of the candidate HSS SSCs associated with the CCF basic event would be identified as candidate HSS. Therefore, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information) which avoids the SSCs that support the associated function from being candidate LSS in the alternate defense-in-depth assessment. A CCF basic event of a combination greater than four (4) SSCs can be “screened out” due to significant intra-system redundancy as discussed in Section 2.2.3.4. Whether the system is automatic does not factor into a realistic evaluation of defense-in-depth since non-automatic systems also provide functional support of safety-related events and represent realistic defense-in-depth and success paths in a plant.

• **Less than 1E-04/yr initiating event frequency:** Initiating events below 1E-04/yr for CDF cutsets have been “screened out” because of their low likelihood of occurrence. SSCs below that initiating event frequency threshold that have a significant impact to CDF will be evaluated in the FPIE CDF PRA model quantitative determinations (i.e., FV, RAW screening) in NEI 00-04, Section 5 and other analyses described later in this section. Additionally, protection systems must meet single failure criteria as described in 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) for design basis scenarios as shown below based on plant design requirements. In these design basis scenarios with a low initiating event frequency, a single SSC failure in a protection system would not lead to core damage due to a redundant system or a redundant train being available. Based on the low level of occurrence for these design basis initiating events, this provides for defense-in-depth and is based on the overall plant design that remains unchanged by 10 CFR 50.69. As stated in Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), “Section 50.69 is structured to maintain the design basis functional requirements of the plant.”

- o 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) : “Criterion 21—Protection system reliability and testability. The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) **no single failure results in loss of the protection function** and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred." (emphasis added in bold)

In the scenario a cutset is "screened out" for the alternate core damage defense-in-depth assessment, then there is defense-in-depth within the plant for the SSCs being examined based on the cutset results in a manner that is similar with the defense-in-depth concept within the NEI 00-04, Section 6.1 process.

As stated in Section 2.2.6 in PWROG-20015-NP, Revision 3 (Reference [7]) there are additional evaluations that are completed for 10 CFR 50.69 beyond the alternate core damage defense-in-depth.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were "screened out" for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

E. *Step 7.a.2 of PWROG-20015-NP states, with regards to common cause failures (CCFs), "Common cause failure groups that are greater than or equal to four can be screened out of the filtered cutsets." During the regulatory audit, the licensee explained that a CCF of 4 or more components is screened out of the filtered cutsets, but a failure of 2 or 3 components out of a group of 4 or more is maintained in the filtered cutsets for* *defense-in-depth. The rationale provided during the audit was that a CCF of 3 components or less is included in the filtered cutsets to maintain consistency with the guidance in the NEI 00-04 defense-in-depth matrix, which required 3 trains or less as a function of the frequency of the initiating event. The NRC staff notes that the defense-in-depth matrix appears to be at the system train level, which assumes 100 percent train capacity for mitigation, while CCF groups may not map directly to system trains. Therefore:*

i. *Provide a list of SSCs modeled in the Limerick PRA that have four or more SSCs in their common cause grouping.*

Response

The following are those SSCs included in the Limerick PRA model with CCF group sizes of four or more:

- AC Buses (4kV)
- ADS / SRVs
- APRMs
- ARI Solenoids
- Batteries and Battery Chargers
- Circ Water Pumps and Valves
- Core Spray Pumps
- EDGs and Auto Initiation Relays
- EDG Room Fans
- ESW Pumps and Valves
- Nitrogen Bottles
- RHR Pumps and Valves
- RHRSW Pumps
- RRCS Analog Trip Modules
- RPS Relays, Switches, Trip Units
- RPT Breakers
- Suppression Pool Suction Strainers
- Spray Pond Valves, Spray Pond Pump House HVAC Dampers and Fans

ii. *Provide justification for excluding from the filtered cutsets those containing basic events that represent CCFs of 4 or more components.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses*.

The process was clarified in PWROG-20015-NP, Revision 3, Section 2.2.2 (Reference [7]) under Step 7.a.4, to "screen out" only CCF basic events that include a failure of four or more SSCs. For example, common cause failure of 2 out of 4 or 3 out of 4 would not be automatically "screened out" of the cutset review (but 4 out of 4 would be "screened out").

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.4:

> **7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.
>
> a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).
>
> […]
>
> 4) Cutsets with CCF basic events that include a combination of four (4) or more SSCs failing within the same common cause component group can be "screened out" of the filtered cutsets based on the significant redundancy of performing the function.

Additionally, PWROG-20015-NP, Revision 3, Section 2.2.3.4 (Reference [7]) provides a basis for why the exclusion of CCF basic events with a combination of four (4) or more SSCs failing within the same common cause component group is appropriate with avoidance of overreliance on like-SSCs since the smaller combination CCF basic events would not be automatically "screened out" and therefore sufficient intra-system redundancy would have to exist prior to CCF basic events being screened out based on the number of failures within the CCF basic event.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.4:

> Exclusion of cutsets with CCF basic events that include a combination of four (4) or more SSCs failing within the same common cause component group (CCCG) is due to the level of redundancy within the system itself which is currently not taken into account in the NEI 00-04, Section 6.1 (Reference 2*) core damage defense-in-depth process. Not taking into account any defense-in-depth for redundancy for like-SSCs prevents realistic identification of defense-in-depth within plants and is overly conservative. Under the current NEI 00-04, Section 6.1 process, a plant with two trains of like-SSCs compared to four trains of like-SSCs would

be treated in the same manner with respect to core damage defense-in-depth even though there are two additional trains of redundancy. The Detailed SSC Categorization in NEI 00-04, Section 10.2 does allow for redundancy to be taken into account if “A failure for the SSC would not prevent a safety-significant function from being fulfilled.” Although this can be evaluated in NEI 00-04, Section 10.2, the alternate process that takes credit for significant redundancy in the function allows for consistent application of CCF in the alternate core damage defense-in-depth assessment. The alternate categorization process allows for plants to take credit for additional redundancy within their design.

The alternate defense-in-depth process ensures CCFs with SSC combinations less than four (4) are candidate HSS if they are within a cutset “screened in” for the alternate defense-in-depth assessment. Therefore, if a cutset “screened in” is identified with a basic event of a CCF of two (2) or three (3) like-SSCs, the SSCs associated with that CCF basic event are candidate HSS for the alternate defense-in-depth process.

Prevention of overreliance on like-SSCs is addressed by the CCF basic events of combinations of two (2) or three (3) SSCs failing from being automatically “screened out” of the cutset qualitative screening in the alternate defense-in-depth process. If there is a CCF basic event of a combination of four (4) or more SSCs, the process “screens out” the cutset due to the level of defense in depth of the like-SSCs. Additionally, four (4) SSCs failing due to common cause is generally a rare event when compared to a common cause event of a smaller combination. This “screening out” only impacts the SSC HSS/LSS determination if the SSCs associated with the CCF aren’t already identified within the smaller sets of common cause for that CCCG in “screened in” cutsets for alternate defense-in-depth. For example, if a CCF event for a combination two (2) out of four (4) SSCs with the same CCCG was included in a cutset that is “screened in” and if the other corresponding cutsets for the other combinations of two (2) out of four (4) CCF basic events are also “screened in”, then all those SSCs associated in the four (4) out of four (4) CCF basic event would be candidate HSS regardless of the cutset with the four (4) out of four (4) CCF basic event being automatically “screened out.” Therefore, redundant trains with like-SSCs within the CCCG would not automatically “screen out” for alternate defense-in-depth unless there is sufficient redundancy in the number of SSC failures (i.e., a combination of four (4) or more SSCs failing) that would have to occur to lead to CDF or LERF.

Additionally, other aspects of the 10 CFR 50.69 categorization and implementation also provide for protections against CCF:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.4:

If a CCF basic event, including a combination of four (4) or more SSCs failing, impacts CDF or LERF of the model significantly, then this is evaluated in the FV and RAW quantitative screening in NEI 00-04, Section 5. Additionally, NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications #4 evaluates with respect to common cause failure and other qualitative evaluations in NEI 00-04, Section 9.2.2, Review of Risk Information and NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications also examine considerations with respect to situations in the plant in general (which may include impacts of CCF). Finally, an SSC being assigned LSS and provided a RISC requires that alternative treatments for an SSC continue to have reasonable confidence the SSC is performing their safety-related functions. This is further evaluated via immediate evaluations and periodic reviews identified in NEI 00-04, Section 12 which identifies degradation in RISC-3 and RISC-4 SSCs:

> "If significant changes to the plant risk profile are identified, or if it is identified that a RISC-3 or RISC-4 SSC can (or actually did) prevent a safety significant function from being satisfied, an immediate evaluation and review should be performed prior to the normally scheduled periodic review. Otherwise, the assessment of potential equipment performance changes and new technical information should be performed during the normally scheduled periodic review cycle."

F. *Step 7.b of PWROG-20015-NP states, with regard to cutset quantitative screening, "Cutsets with initiating events with frequencies that are less than 1E-04 per year are not included in the alternate core damage defense-in-depth categorization process and can be screened out of the filtered cutsets." During the audit, the licensee provided a list of several internal flood initiators associated with the same system, such as the battery room area, which were split based on their flooding type (e.g., spray, flood, major flood). It is unclear how the proposed method assesses the defense-in-depth impact of a specific SSC if the combined IEF of their associated scenarios for a specific hazard (e.g., internal flooding and fire) is above the 1E-04 per year threshold.*

   i. *Discuss whether and how uncertainty in initiating event frequency is taken into account in the alternate defense-in-depth categorization.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

The PWROG-20015-NP, Revision 3, Section 2.2.3.6 (Reference [7]) discusses how uncertainty in initiating event frequency is taken into account. The identification of the initiating event frequency values are consistent with the approach currently completed in NEI 00-04, Section 6.1 (Reference [11]) which uses the PRA model to identify the initiating event frequency.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.6:

The initiating event frequency mean is used for determination of the alternate defense-in-depth categorization consistent with NEI 00-04, Section 6.1 (Reference 2*) process which also uses the FPIE CDF PRA model to identify the initiating event frequency value. The distribution of the frequency is not used within the analysis. The initiating event frequency has been reduced by a factor of 10 from the lowest level threshold in the NEI 00-04, Section 6.1 process (1E-04/yr instead of 1E-03/yr) to account for uncertainty in the initiating event frequency. Calculation of initiating event frequency is consistent with IE-C1 of the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) supporting requirements.

ii. *Discuss how it is assured that initiating events would not be split into multiple initiating events of lower frequencies.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

The PWROG-20015-NP, Revision 3 (Reference [7]) has added clarification to the process on proper identification and evaluation of split initiating events in Section 2.2.2 under Step 7.b.5, and Step 7.b.6.b.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.b.5, Step 7.b.6.b:
7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis: The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

[…]

b. Cutset Quantitative Screening

[…]

5) For initiating events that were split into multiple initiating events in the FPIE CDF PRA model, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the combined initiating event consisting of a combination of the split initiating events. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and

approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

6) The periodic review process identified in NEI 00-04, Section 12 is unchanged but additional clarification is provided for the alternate defense-in-depth process in regards to the bullet on “a review of the impact of the updated risk information on the categorization process results”:

[…]

b) During a periodic review, if an initiating event is split into multiple initiating events in an update to the FPIE CDF PRA model after completing the alternate defense-in-depth categorization, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the initially combined initiating event. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

The basis for these steps is shown below.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.7:

When first using the alternate defense-in-depth process, the initiating events are evaluated to determine if any initiating event “screened out” of the FPIE CDF PRA model would be above the initiating event frequency range of quantitative screening, or if initiating events which were split would be within a higher initiating event frequency range, if combined, for the quantitative evaluation of initiating events in the alternate defense-in-depth. Therefore, any initiating events originally “screened out” or split within the FPIE CDF PRA are assessed on their impact on the alternate defense-in-depth process or, alternatively, evaluated within the alternate defense-in-depth assessment.

The initiating events within a PRA model may change after the initial assessments for the alternate defense-in-depth categorization. In the rare event that an initiating event is removed or split, the process evaluates if the removed initiating event was below the initiating event frequency range for quantitative screening or if the split initiating events are moved to a different initiating event frequency range for the quantitative evaluation in the alternate defense-in-depth process. Although this rarely occurs, this process allows for a PRA update affecting the removal or splitting of initiating events to be examined compared to the PRA model version originally used for alternate defense-in-depth screening. This task is completed during the normal periodic review in NEI 00-04, Section 12 (Reference 2*).

These assessments are completed by the engineering team that develops a response to these bases and the bases should be approved by the IDP prior to use of the alternate defense-in-depth method in a system categorization.

iii. *List all initiating events in the Limerick PRA that have an initiating event frequency less than 1E-4 per year.*

Response

The following are those Limerick FPIE PRA model initiating events with a value of less than 1E-04/year.

Initiating Events	Frequency	Description
%A-STEAM	1.74E-05	FREQUENCY OF LARGE LOCA EVENTS – ABOVE TAF
%A-WATER	4.35E-06	FREQUENCY OF LARGE LOCA EVENTS – BELOW TAF
%RPV	1.00E-08	FREQUENCY OF RPV RUPTURE
%S1-STEAM	5.76E-05	FREQUENCY OF MEDIUM LOCA – ABOVE TAF
%S1-WATER	3.29E-05	FREQUENCY OF MEDIUM LOCA – BELOW TAF
%VHP	1.00E-08	HIGH PRESSURE LINE BREAK INITIATING EVENT FREQUENCY
%VLP	2.64E-08	LOW PRESSURE LINE BREAK INITIATING EVENT FREQUENCY

The following are those Limerick Internal Flooding initiating events with a value of less than 1E-04/year.

Initiating Events	Frequency	Description
%FL-CE-FL02-FLD	2.04E-05	Fire Area 2: Control Enclosure, 13kV Switchgear Room, Flood
%FL-CE-FL02-MAJ	3.77E-06	Fire Area 2: Control Enclosure, 13kV Switchgear Room, Major Flood

Initiating Events	Frequency	Description
%FL-CE-FL03-FLD1-A	6.78E-06	Fire Area 7: Control Enclosure, 4kV Switchgear corridor, flood
%FL-CE-FL03-FLD2-A	5.71E-06	Fire Area 8,9,10,11: Control Enclosure, Battery Room, Spray, flood
%FL-CE-FL03-FLD2-B	6.74E-05	Fire Area 8,9,10,11: Control Enclosure, Battery Room, Spray, FPS flood
%FL-CE-FL03-FLD3-A	5.71E-06	Fire Area 7,8,9,10: SWGR and battery rooms
%FL-CE-FL03-FLD3-B	6.74E-05	Fire Area 7,8,9,10: SWGR and battery rooms, flood, FPS
%FL-CE-FL03-FLD4-A	6.78E-06	Fire Area 7: Control Enclosure, 4kV Switchgear corridor, flood - long term
%FL-CE-FL03-SPR3	5.37E-06	Fire Area 7,8: Control Enclosure, 4kV Switchgear corridor, Spray
%FL-CE-FL03-SPR4	8.95E-06	Fire Area 10: Control Enclosure, Battery Room, Spray
%FL-CE-FL04-FLD-A	2.14E-06	Fire Area 21,22,23: Control Enclosure, Unit 2 static inverter room, flood
%FL-CE-FL04-MAJ-A	3.97E-07	Fire Area 21,22,23: Control Enclosure, Unit 2 static inverter room, major flood
%FL-CE-FL04-MAJ-B	6.76E-05	Fire Area 21,22,23: Control Enclosure, Unit 2 static inverter room, FPS major flood
%FL-CE-FL06-FLD	3.57E-06	Fire Area 25,26: Control Enclosure, Auxiliary Equipment room, flood
%FL-CE-FL06-MAJ	6.62E-07	Fire Area 25,26: Control Enclosure, Auxiliary Equipment room, major flood
%FL-CE-FL06-SPR	1.79E-05	Fire Area 25,26: Control Enclosure, Auxiliary Equipment room, spray

Initiating Events	Frequency	Description
%FL-DG-FL01-FLD-1A	7.68E-06	Fire Area 124,79A: Diesel Gen. Enclosure, Diesel Gen. Cell, flood
%FL-DG-FL01-FLD-1C	3.17E-05	Fire Area 124,79A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW flood
%FL-DG-FL01-FLD-2A	5.00E-06	Fire Area 80A: Diesel Gen. Enclosure, Diesel Gen. Cell, flood
%FL-DG-FL01-FLD-2C	3.17E-05	Fire Area 80A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW flood
%FL-DG-FL01-FLD-3A	5.00E-06	Fire Area 81A: Diesel Gen. Enclosure, Diesel Gen. Cell, flood
%FL-DG-FL01-FLD-3C	3.17E-05	Fire Area 81A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW flood
%FL-DG-FL01-FLD-4A	5.00E-06	Fire Area 82A: Diesel Gen. Enclosure, Diesel Gen. Cell, flood
%FL-DG-FL01-FLD-4C	3.17E-05	Fire Area 82A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW flood
%FL-DG-FL01-MAJ-1A	1.42E-06	Fire Area 124,79A: Diesel Gen. Enclosure, Diesel Gen. Cell, major flood
%FL-DG-FL01-MAJ-1B	7.58E-05	Fire Area 124,79A: Diesel Gen. Enclosure, Diesel Gen. Cell, FPS major flood
%FL-DG-FL01-MAJ-1C	5.05E-06	Fire Area 124,79A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW major flood
%FL-DG-FL01-MAJ-2A	9.26E-07	Fire Area 80A: Diesel Gen. Enclosure, Diesel Gen. Cell, major flood
%FL-DG-FL01-MAJ-2B	7.58E-05	Fire Area 80A: Diesel Gen. Enclosure, Diesel Gen. Cell, FPS major flood
%FL-DG-FL01-	5.05E-06	Fire Area 80A: Diesel Gen.

Initiating Events	Frequency	Description
MAJ-2C		Enclosure, Diesel Gen. Cell, ESW major flood
%FL-DG-FL01-MAJ-3A	9.26E-07	Fire Area 81A: Diesel Gen. Enclosure, Diesel Gen. Cell, major flood
%FL-DG-FL01-MAJ-3B	7.58E-05	Fire Area 81A: Diesel Gen. Enclosure, Diesel Gen. Cell, FPS major flood
%FL-DG-FL01-MAJ-3C	5.05E-06	Fire Area 81A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW major flood
%FL-DG-FL01-MAJ-4A	9.26E-07	Fire Area 82A: Diesel Gen. Enclosure, Diesel Gen. Cell, major flood
%FL-DG-FL01-MAJ-4B	7.58E-05	Fire Area 82A: Diesel Gen. Enclosure, Diesel Gen. Cell, FPS major flood
%FL-DG-FL01-MAJ-4C	5.05E-06	Fire Area 82A: Diesel Gen. Enclosure, Diesel Gen. Cell, ESW major flood
%FL-RB-FL01-FLD-A	2.02E-06	Fire Area 32: Reactor Building, RHR HX & Pump Room, flood
%FL-RB-FL01-MAJ-A	4.51E-07	Fire Area 32: Reactor Building, RHR HX & Pump Room, major flood
%FL-RB-FL01-MAJ-B	2.51E-05	Fire Area 32: Reactor Building, RHR HX & Pump Room, ESW major flood
%FL-RB-FL02-FLD-A	5.59E-06	Fire Area 31: Reactor Building, RHR HX & Pump Room, flood
%FL-RB-FL02-MAJ-A	1.11E-06	Fire Area 31: Reactor Building, RHR HX & Pump Room, major flood
%FL-RB-FL02-MAJ-B	2.51E-05	Fire Area 31: Reactor Building, RHR HX & Pump Room, ESW major flood
%FL-RB-FL03-FLD-A	6.16E-07	Fire Area 35: Reactor Building, Unit 1 Core spray Pump Room, flood
%FL-RB-FL03-FLD-B	4.30E-05	Fire Area 35: Reactor Building, Unit 1 Core spray Pump Room, ESW flood

Initiating Events	Frequency	Description
%FL-RB-FL03-MAJ-A	1.25E-07	Fire Area 35: Reactor Building, Unit 1 Core spray Pump Room, major flood
%FL-RB-FL04-FLD-A	1.70E-06	Fire Area 38: Reactor Building, Unit 1 Core spray Pump Room, flood
%FL-RB-FL04-FLD-B	4.30E-05	Fire Area 38: Reactor Building, Unit 1 Core spray Pump Room, ESW flood
%FL-RB-FL04-MAJ-A	3.28E-07	Fire Area 38: Reactor Building, Unit 1 Core spray Pump Room, major flood
%FL-RB-FL05-FLD-A	9.34E-07	Fire Area 36: Reactor Building, Unit 1 Core spray Pump Room, flood
%FL-RB-FL05-FLD-B	7.98E-05	Fire Area 36: Reactor Building, Unit 1 Core spray Pump Room, ESW flood
%FL-RB-FL05-MAJ-A	1.77E-07	Fire Area 36: Reactor Building, Unit 1 Core spray Pump Room, major flood
%FL-RB-FL05-MAJ-B	1.36E-05	Fire Area 36: Reactor Building, Unit 1 Core spray Pump Room, ESW major flood
%FL-RB-FL06-FLD-A	1.16E-06	Fire Area 37: Reactor Building, Unit 1 Core spray Pump Room, flood
%FL-RB-FL06-FLD-B	3.23E-05	Fire Area 37: Reactor Building, Unit 1 Core spray Pump Room, ESW flood
%FL-RB-FL06-MAJ-A	2.22E-07	Fire Area 37: Reactor Building, Unit 1 Core spray Pump Room, major flood
%FL-RB-FL07-FLD-A	7.10E-07	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, flood
%FL-RB-FL07-FLD-B	3.71E-07	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, CST flood
%FL-RB-FL07-FLD-C	2.70E-05	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, FPS flood
%FL-RB-FL07-FLD-D	3.99E-05	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, ESW flood
%FL-RB-FL07-MAJ-A	1.43E-07	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, major flood
%FL-RB-FL07-MAJ-B	6.09E-08	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, CST major flood

Initiating Events	Frequency	Description
%FL-RB-FL07-MAJ-C	8.92E-06	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, FPS major flood
%FL-RB-FL07-MAJ-D	6.78E-06	Fire Area 34: Reactor Building, Unit 1 HPCI Pump Room, ESW major flood
%FL-RB-FL08-FLD-A	5.03E-06	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, flood
%FL-RB-FL08-FLD-B	2.30E-06	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, CST flood
%FL-RB-FL08-FLD-C	6.74E-05	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, FPS flood
%FL-RB-FL08-FLD-D	1.61E-05	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, ESW flood
%FL-RB-FL08-MAJ-A	1.03E-06	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, major flood
%FL-RB-FL08-MAJ-B	4.23E-07	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, CST major flood
%FL-RB-FL08-MAJ-C	2.23E-05	Fire Area 33: Reactor Building, Unit 1 RCIC Pump Room, FPS major flood
%FL-RB-FL08A-FLD-A	7.92E-05	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, flood
%FL-RB-FL08A-FLD-B	7.95E-08	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, CST flood
%FL-RB-FL08A-FLD-C	4.48E-05	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, FPS flood
%FL-RB-FL08A-MAJ-A	3.43E-05	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, major flood
%FL-RB-FL08A-MAJ-B	1.31E-08	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, CST major flood
%FL-RB-FL08A-MAJ-C	2.17E-05	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, FPS major flood
%FL-RB-FL08A-MAJ-D	3.80E-05	Fire Area 41: Reactor Building, Unit 1 RECW Equipment, SW major flood
%FL-RB-FL08B-FLD-A	2.46E-06	Fire Area 42: Reactor Building, Unit 1 RECW Equipment & SSA Area, flood

Initiating Events	Frequency	Description
%FL-RB-FL08B-FLD-C	7.92E-05	Fire Area 42: Reactor Building, Unit 1 RECW Equipment & SSA Area, ESW flood
%FL-RB-FL08B-MAJ-A	4.49E-07	Fire Area 42: Reactor Building, Unit 1 RECW Equipment & SSA Area, major flood
%FL-RB-FL08B-MAJ-B	5.73E-05	Fire Area 42: Reactor Building, Unit 1 RECW Equipment & SSA Area, FPS major flood
%FL-RB-FL08B-MAJ-C	1.26E-05	Fire Area 42: Reactor Building, Unit 1 RECW Equipment & SSA Area, ESW major flood
%FL-RB-FL09-FLD-A	1.02E-06	Fire Area 44E&W: Reactor Building, Unit 1 Safeguard System Access Area, flood
%FL-RB-FL09-FLD-C	5.37E-05	Fire Area 44E&W: Reactor Building, Unit 1 Safeguard System Access Area, SW flood
%FL-RB-FL09-FLD-D	2.02E-07	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, RHR LP A flood
%FL-RB-FL09-FLD-E	2.02E-07	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, RHR LP B flood
%FL-RB-FL09-FLD-F	2.84E-07	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, CS LP A flood
%FL-RB-FL09-FLD-G	2.84E-07	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, CS LP A flood
%FL-RB-FL09-MAJ-A	2.39E-07	Fire Area 44E&W: Reactor Building, Unit 1 Safeguard System Access Area, major flood
%FL-RB-FL09-MAJ-B	4.60E-05	Fire Area 44E&W: Reactor Bldng, Unit 1 Safeguard System Access Area, FPS major-no drains

Initiating Events	**Frequency**	**Description**
%FL-RB-FL09-MAJ-D	4.51E-08	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, RHR LP A major flood
%FL-RB-FL09-MAJ-E	4.51E-08	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, RHR LP B major flood
%FL-RB-FL09-MAJ-F	6.43E-08	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, CS LP A major flood
%FL-RB-FL09-MAJ-G	6.43E-08	Fire Area 44E&W: Rctr Bldng, Unit 1 Safeguard System Access Area, CS LP A major flood
%FL-RB-FL09-MAJ1-C	2.52E-06	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (2001-3000)
%FL-RB-FL09-MAJ1D- C	2.52E-06	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (2001-3000)-drains
%FL-RB-FL09-MAJ2-C	1.41E-06	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (3001-4000)
%FL-RB-FL09-MAJ2D- C	1.41E-06	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (3001-4000)-drains
%FL-RB-FL09-MAJ3-C	9.71E-07	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (4001-5000)
%FL-RB-FL09-MAJ3D- C	9.71E-07	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (4001-5000)-drains
%FL-RB-FL09-MAJ4-C	7.24E-07	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (5001-6000)
%FL-RB-FL09-MAJ4D- C	7.24E-07	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (5001-6000)-drains

Initiating Events	Frequency	Description
%FL-RB-FL09-MAJ5-C	1.11E-06	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (6001-8206)
%FL-RB-FL09-MAJ5D- C	1.11E-06	Fire Area 44E&W: RB, Unit 1 Safeguard System Access Area, SW (6001-8206)-drains
%FL-RB-FL09-MAJD-B	4.60E-05	Fire Area 44E&W: Reactor Bldng, Unit 1 Safeguard System Access Area, FPS major-drains
%FL-RB-FL09-SPR1	1.43E-05	Fire Area 44E&W: Reactor Building, Unit 1 Safeguard System Access Area, spray 1
%FL-RB-FL10-FLD-A	7.14E-06	Fire Area 45E&W: Reactor Bldng, Unit 1 CRD Hydraulic Equipment Area, CST flood
%FL-RB-FL10-FLD-B	1.59E-07	Fire Area 45E&W: Reactor Bldng, Unit 1 CRD Hydraulic Equipment Area, FPS flood
%FL-RB-FL10-MAJ-A	1.32E-06	Fire Area 45E&W: Reactor Bldng, Unit 1 CRD Hydraulic Equipment Area, CST major flood
%FL-RB-FL10-MAJ-B	2.61E-08	Fire Area 45E&W: Reactor Bldng, Unit 1 CRD Hydraulic Equipment Area, FPS major flood
%FL-RB-FL10-MAJ-C	7.52E-05	Fire Area 45E&W: Reactor Building, Unit 1 CRD Hydraulic Equipment Area, SW major flood
%FL-RB-FL10-MAJ-D	4.92E-05	Fire Area 45E&W: Reactor Building, Unit 1 CRD Hydraulic Equipment Area, NSW major flood
%FL-RB-FL11-FLD	1.76E-06	Fire Area 46: Reactor Building, Unit 1 Main Steam Tunnel, flood
%FL-RB-FL11-MAJ	3.42E-06	Fire Area 46: Reactor Building, Unit 1 Main Steam Tunnel, major flood

Initiating Events	Frequency	Description
%FL-RB-FL11-SPR	1.52E-05	Fire Area 46: Reactor Building, Unit 1 Main Steam Tunnel, spray
%FL-RB-FL12-FLD-A	1.07E-05	Fire Area 47E&W: React Bldg, Unit 1 Isolation Valve Compartment Area, flood
%FL-RB-FL12-FLD-B	4.24E-07	Fire Area 47E&W: React Bldg, Unit 1 Isolation Valve Compartment Area, CST flood
%FL-RB-FL12-MAJ-A	1.98E-06	Fire Area 47E&W: React Bldg, Unit 1 Isolation Valve Compartment Area, major flood
%FL-RB-FL12-MAJ-B	6.96E-08	Fire Area 47E&W: React Bldg, Unit 1 Isolation Valve Compartment Area, CST major flood
%FL-RB-FL12-MAJ-C	5.29E-05	Fire Area 47E&W: React Bldg, Unit 1 Isolation Valve Compartment Area, FPS major flood
%FL-RB-FL13-FLD-A	4.78E-05	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt Upr Fan, Exh Fil Rms, flood
%FL-RB-FL13-FLD-B	5.30E-07	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt & Exh Filter Rms, CST flood
%FL-RB-FL13-FLD-D	2.69E-05	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt & Exh Filter Rms, SW flood
%FL-RB-FL13-MAJ-A	1.26E-05	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt Upr Fan, Exh Fil Rms, major flood
%FL-RB-FL13-MAJ-B	8.70E-08	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt & Exh Filter Rms, CST major flood

Initiating Events	Frequency	Description
%FL-RB-FL13-MAJ-C	6.07E-05	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt & Exh Filter Rms, FPS major flood
%FL-RB-FL13-MAJ-D	7.59E-06	Fire Area 48E&W,50: React Bldg, Unit 1 RWCU Cmprtmnt & Exh Filter Rms, SW major flood
%FL-RB-FL13-SPR1	6.65E-06	Fire Area 48W: Reactor Building, Unit 1 RWCU Holding Pump Compartments, spray 1
%FL-RB-FL14-FLD-A	5.71E-06	Fire Area 78: Reactor Building, Refueling Area, FPS flood
%FL-RB-FL14-FLD-B	1.52E-05	Fire Area 78: Reactor Building, Refueling Area, SW flood
%FL-RB-FL14-MAJ-A	1.06E-06	Fire Area 78: Reactor Building, Refueling Area, FPS major flood
%FL-RB-FL14-MAJ-B	7.38E-06	Fire Area 78: Reactor Building, Refueling Area, SW major flood
%FL-SP-FL01-MAJ	1.65E-05	Fire Area 122: Spray Pond Pump House, Spray Pond Pump Str West, major flood
%FL-TE-FL04-SPR1	1.43E-05	Fire Area 94: Turbine Enclosure, spray 1
%FL-TE-FL04-SPR3	1.52E-05	Fire Area 94: Turbine Enclosure, spray 3
%FL-TE-FL04-SPR4	7.62E-06	Fire Area 94: Turbine Enclosure, spray 4
%FL-TE-FL05-SPR1	5.37E-07	Fire Area 95: Turbine Enclosure, spray 1
%FL-TE-FL05-SPR2	3.99E-05	Fire Area 95: Turbine Enclosure, spray 2
%FL-TE-FL07-MAJ	7.18E-05	Fire Area 99: Turbine Enclosure, major flood

iv. *Discuss how the proposed method considers the cumulative defense-in-depth impact of a specific SSC when its associated individual scenario IEFs are below the 1E-04 per year threshold.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

The level of defense-in-depth basis is described in Section 2.2.6 in PWROG-20015-NP, Revision 3 (Reference [7]) and provides a basis for those initiating event frequencies below the 1E-04/yr threshold.

PWROG-20015-NP, Revision 3, Section 2.2.6:

- **Less than 1E-04/yr initiating event frequency:** Initiating events below 1E-04/yr for CDF cutsets have been "screened out" because of their low likelihood of occurrence. SSCs below that initiating event frequency threshold that have a significant impact to CDF will be evaluated in the FPIE CDF PRA model quantitative determinations (i.e., FV, RAW screening) in NEI 00-04, Section 5 and other analyses described later in this section. Additionally, protection systems must meet single failure criteria as described in 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) for design basis scenarios as shown below based on plant design requirements. In these design basis scenarios with a low initiating event frequency, a single SSC failure in a protection system would not lead to core damage due to a redundant system or a redundant train being available. Based on the low level of occurrence for these design basis initiating events, this provides for defense-in-depth and is based on the overall plant design that remains unchanged by 10 CFR 50.69. As stated in Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), "Section 50.69 is structured to maintain the design basis functional requirements of the plant."
    - o 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) : "Criterion 21—Protection system reliability and testability. The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) **no single failure results in loss of the protection function** and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred."

Additionally, as stated in Section 2.2.6 in PWROG-20015-NP, Revision 3 there are additional evaluations that are completed for 10 CFR 50.69 beyond the alternate core damage defense-in-depth.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were “screened out” for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

G. *Step 7.f of PWROG-20015-NP states, “Consistent with the existing NEI 00-04 defense-in-depth process, SSCs and functions outside the scope of the PRA do not need to be evaluated for core damage defense-in-depth since the level of defense-in-depth is based on the success criteria in the PRA.”*

   i. *Per NEI 00-04, defense-in-depth is to be applied to all SSCs, not only those modeled in the PRA. Therefore, please justify the statements in Step 7.f.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

PWROG-20015-NP, Revision 3, Section 2.2.3.8 (Reference [7]) discusses how NEI 00-04, Section 6.1 does not examine SSCs outside of the PRA:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.8:

> NEI 00-04, Section 6.1 (Reference 2*) states the following:

> > "This figure depicts the internally initiated design basis events considered in the licensee's safety analysis report (i.e., the events that were used to identify an SSC as safety-related) **and considers the level of defense-in-depth available, based on the success criteria used in the PRA.**"
>
> The NEI 00-04, Section 6.1 process identifies the level of defense-in-depth based on the success criteria in the PRA. The alternate core damage defense-in-depth method continues to examine the success criteria used in the PRA but with a direct examination by a cutset review.

Even if an SSC is not within a PRA model, that does not necessarily mean that the SSC is not evaluated with respect to defense-in-depth. As stated in PWROG-20015-NP, Revision 3, Section 2.2.3.8:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.8:

> SSCs that are not modeled in the FPIE CDF PRA model remain addressed in the overall 10 CFR 50.69 process outlined in NEI 00-04. SSCs not modeled in the FPIE CDF PRA can be candidate HSS from the results of the alternate defense-in-depth assessment due to the associated functions that are candidate HSS from alternate defense-in-depth. As described in Section 2.2.3.1, if a non-modeled SSC supports an associated function which is identified as candidate HSS based on an SSC(s) that is identified as candidate HSS in the alternate defense-in-depth assessment, those non-modeled SSCs would be identified as candidate HSS based on the associated function being candidate HSS. NEI 00-04, Section 10.2 continues to remain applicable for downgrading to candidate LSS if criteria are met. Additionally, NEI 00-04, Section 9.2.2 has the seven Review of Risk Information qualitative considerations along with a Review Defense-in-Depth Implications for safety-related candidate LSS functions/SSCs. For example, #1 in the Review of Risk Information examines if a failure of function/SSC causes an initiating event that was originally "screened out" of the PRA based on anticipated low frequency of occurrence. Therefore, additional qualitative considerations have to be evaluated prior to identifying an SSC as candidate LSS even if it is not modeled within the FPIE CDF PRA model.

PWROG-20015-NP, Revision 3, Section 2.2.3.1 discussed associated functions. A description on associated functions is shown in the following excerpt:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.1:

> NEI 00-04, Section 7.1 (Reference 2*), states:
>
> > "If any SSC is safety significant, from either the PRA-based component safety significance assessment (Section 5) or the defense-in-depth assessment (Section 6), then the associated system function is preliminarily safety significant."
>
> When an SSC is candidate HSS from the FPIE PRA, the Integral PRA, the core damage defense-in-depth, and/or the containment defense-in-

depth assessments, the functions driving the candidate HSS determination are identified as “associated functions.” All SSCs mapped to an “associated function” are preliminary candidate HSS as described in NEI 00-04, Section 7.1 due to the “associated function” being candidate HSS. Therefore, SSCs (e.g., SSCs not modeled in the PRA or SSCs otherwise identified as candidate LSS) can be candidate HSS from the alternate defense-in-depth assessment if the SSC supports a function that was identified as an associated function in NEI 00-04, Section 7.1. The detailed categorization process described in NEI 00-04, Section 10.2 provides the approach for “performing additional engineering and system analyses to identify specific component level or piece part functions and importance for the safety-significant SSCs” in order to justify and categorize an SSC as candidate LSS. NEI 00-04, Section 7.1 and NEI 00-04, Section 10.2 remain unchanged from the current NEI 00-04 process.

ii. *For Limerick’s categorization performed using NEI 00-04 guidance, discuss whether there were any SSCs not modeled in the PRA but marked HSS by the NEI 00-04 defense-in-depth approach. If so, then describe them.*

Response

Of the systems reviewed for the LAR, only the RHR System (051), Core Spray System (052), Control Enclosure HVAC and Chilled Water Systems (078/090), and Diesel System (020/081/092A) had non-modeled SSCs categorized as HSS by the NEI 00-04 Core Damage DID assessment. The review was performed by comparing the Appendix 1: PRA Components to Basic Event Mapping to the Categorization Results (Appendix 12 or 13 depending on the document).

The non-modeled SSCs that were HSS from the NEI 00-04 Core Damage DID assessment in System 051 were associated with functions that supported other previously categorized systems. The support functions took the significance of the functions they supported in the supported systems. They were not explicitly reviewed in the categorization document. The SSCs consisted of safety- related fuses and panels. The alternate method did not change the results.

In System 052, the SSCs consisted of various safety-related relays associated with the power supplies to the trip units and the diesel generator and ECCS system initiation logic during a LOCA.

In System 078/090, the SSCs consisted of safety-related Back Pressure Steam Isolation Dampers and their associated control switches. The categorization effort requires the identification of HSS SSCs. In practice, this means that any SSC that is not definitively HSS, must be demonstrated to be LSS without doubt. If an SSC cannot be demonstrated to be LSS, no alternative treatment may be applied to it. The restriction of alternative treatment may be accomplished by designating the SSC as HSS.

In System 020/081/092A, the SSCs consisted of various DG SSCs related to lube oil, fuel oil, and cooling that are not explicitly modeled. The majority of which were Safety-related with a small number being non-safety lube and cooling motors. However, the functional association of the categorization effort made them HSS from PRA as well.

H. *As a potential sensitivity study, explain the impact on the results of the categorization if the screening criterion was increased to two or three elements (i.e., basic events) for both core damage and containment defense-in-depth cases.*

Response

A pilot study of the Alternate Defense-in-Depth Approach was performed in accordance with the initial version of PWROG-20015-NP on ten previously categorized Limerick Generating Station systems. The systems, number of components, functions, and whether the system is modeled in the PRA are summarized below in Table 3.

Table 3: Limerick Pilot Study Systems

System	Functions (QTY)	PRA Modeled (Y/N)
001 – Main Steam (MS)	15	Y
012 – Residual Heat Removal Service Water (RHRSW)	17	Y
025 – Steam Leak Detection (SLD)	7	Y
026 – Radiation Monitors (RMS)	34	Y
051 – Residual Heat Removal (RHR)	26	Y
052 – Core Spray (CS)	20	Y
059 – Primary Containment Instrument Gas (PCIG)	18	Y
076 – Reactor Enclosure HVAC (REHVAC)	25	Y
078/090 – Control Enclosure HVAC (CEHVAC)	27	N
092A – Emergency Diesel Generators (EDG)	13	Y

The systems selected represent both front line and support systems which adequately exercised the pilot process. The screening criteria from PWROG-20015-NP Revision 0 identified basic events meeting the HSS criteria for two systems. The two systems were RHR and PCIG; each system had two functions considered to be HSS as part of the alternate defense-in-depth approach. Table 4 shows the identified systems and their respective HSS functions.

Table 4: Summary of HSS Functions from the Alternate Defense-in-Depth (DID) Approach (Revision 0)		
System	**Function**	**Function Description**
RHR	51A-01	LPCI Mode – Provide low pressure coolant injection to the RPV.
	51B-01	Suppression Pool Cooling Mode - Provide cooling to remove heat from the suppression pool.
PCIG	059-01B	Distribute air from the PCIG compressors or gas from the nitrogen bottles to the ADS MSRVs.
	059-03	Nitrogen bottles, Outside Connection to Nitrogen Bottle, and Diesel Air Start Receiver Cross tie to ADS and the A, C, and N non-ADS MSRVs.

In response to NRC questions from its January 2022 audit, the screening criterion was changed to account for different initiating event frequencies. Cutsets with initiating events with frequencies at least 1E-04/yr and less than 1E-03/yr were only “screened in” for the alternate core damage defense-in-depth categorization if there was at most one basic event from the cutset qualitative screening. Cutsets with initiating events having frequencies that were greater than 1E-03/yr were only “screened in” for the alternate core damage defense-in-depth categorization if there were at most two basic events from the cutset qualitative screening.

The sensitivity study performed in response to this RAI was evaluated comparing two different sets of screening criteria for core damage defense-in-depth. This study was performed using the Unit 1 PRA IE Core damage model. The first screening criteria used “screened in” cutsets with an initiating event greater than 1E-04/yr and at most 2 basic events from the cutset qualitative screening. The screening criteria in the second evaluation “screened in” cutsets with an initiating event greater than 1E-04/yr and at most 3 basic events from the cutset qualitative screening.

Both sensitivity case study evaluations reviewed a subset of the full power initiating events included in the Limerick PRA. However, the subset of initiating events selected provide an adequate representation of the different initiating event frequencies and site consequences included in the PRA model in order to exercise the process. The initiating events evaluated as a part of these sensitivity studies can be seen in Table 5 below.

Table 5: Initiating Events Evaluated in Sensitivity Study for RAI 10.H		
Initiating Event	**Freq**	**Description**
%TT	6.71E-01	FREQUENCY OF TURBINE TRIP TRANSIENTS
%TF	4.88E-02	LOSS OF FEEDWATER
%LOOP-GRID	1.78E-02	GRID CENTERED LOOP INITIATING EVENT
%S2-STEAM	2.04E-04	FREQUENCY OF SMALL LOCA - ABOVE TAF

%S2-WATER	1.65E-04	FREQUENCY OF SMALL LOCA - BELOW TAF

The two sensitivity sets of screening criteria was applied to the original ten pilot systems identified in Table 3. The screening identified component basic events meeting the HSS criteria for six systems. These systems were RHR, PCIG, SLD, REHVAC, EDG and RHRSW. All components mapped to any of the HSS functions whether modeled or not would be identified as HSS from the Core Damage Defense in Depth analysis. Table 6 provides the functions that were identified as HSS from the results of the sensitivity study.

Table 6: RAI 10.H Sensitivity Results						
System	**Function**	**PWROG-20015-NP Rev 0 HSS**	**PWROG-20015-NP Rev 3 HSS**	**2 Element HSS**	**3 Element HSS**	**Description**
RHR	51A-01	Yes	Yes	Yes	Yes	LPCI Mode – Provide low pressure coolant injection to the RPV
	51B-01	Yes	Yes	Yes	Yes	Suppression Pool Cooling Mode - Provide cooling to remove heat from the suppression pool.
	51B-03	No	Yes	Yes	Yes	Shutdown Cooling / ADHR Mode - Remove decay heat and sensible heat from the primary system so that the reactor can be shut down for a refueling and servicing operation.
PCIG	059-01B	Yes	Yes	Yes	Yes	Distribute air from 059-01A to the ADS MSRVs
	059-03	Yes	Yes	Yes	Yes	Long term gas supply for ADS/Main Steam Relief Valves and diesel starting air supply to ADS/MSRV valves.
SLD	025-SC_LD_HPCI	No	Yes	Yes	Yes	Secondary Containment Leak Detection - Alarm and Isolation Initiation associated with the HPCI System
	025-SC_LD_RCIC	No	Yes	Yes	Yes	Secondary Containment Leak Detection - Alarm and Isolation Initiation associated with the RCIC System
REHVAC	076A-01/02.1	No	Yes	Yes	Yes	Provide cooling to the RHR pump compartments during DBA conditions. Cooling is initiated manually, when the RHR pumps start or upon a rise in compartment temperature above the auto/standby start setpoint.
EDG	092A-01/02	No	No	No	Yes	Provide a Reliable Source of 4 kV power for Class 1E Loads - Engine and Generator Controls.

Table 6: RAI 10.H Sensitivity Results						
System	**Function**	**PWROG-20015-NP Rev 0 HSS**	**PWROG-20015-NP Rev 3 HSS**	**2 Element HSS**	**3 Element HSS**	**Description**
RHRSW	12-01/02/03/07/08	No	Yes	Yes	Yes	Provide a reliable source of cooling water to the RHR heat exchangers for all operating modes of the RHR system including heat removal under accident conditions. This includes operation in spray mode or in spray bypass mode.

When applying the criteria that includes at most 3 cutset elements, the only additional system with a newly identified HSS function was the EDG system. However, this function was already identified as HSS from other aspects of the categorization process when the system was initially categorized, so there would be no change to categorization of components in this function due to the Alternate Core Damage Defense in Depth analysis.

Comparing the results of these sensitivity studies to the results obtained by applying the guidance described in PWROG-20015-NP Revision 3, the only function that was identified as HSS was for the EDG system. This function was already HSS from the other additional process steps of 50.69 categorization. Therefore, the results of the sensitivity study do not show any additional functions from the pilot systems as HSS when compared to the initial PWROG-20015-NP guidance. It is expected that this conclusion would be consistent when applied to other initiating events that were not evaluated as part of this sensitivity study.

A sensitivity study was not performed for Containment Defense in Depth as the alternate methodology guidance for this process step has been removed from PWROG-20015-NP Revision 3.

RAI-11 – Defense-in-Depth First Order Core Damage Cutset Approach

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) of 10 CFR requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the rule.

Sections 2.1.1.2 and 2.1.2.3 of RG 1.174 provide seven considerations of proposed licensing changes regarding defense-in-depth. The first consideration, "Preserve a reasonable balance among the layers of defense," states the licensing change should not significantly reduce the effectiveness of a layer of defense. The fifth consideration, "Maintain multiple fission product barriers," states the change should not significantly reduce the effectiveness of these barriers.

Section 3.1.2, "Alternate Defense-in-Depth Categorization Process," of the LAR states that cutsets having an initiating event and a single basic event representing either an SSC, CCF, or HFE are to be evaluated for defense-in-depth categorization. It continues by stating that this process meets defense-in-depth guidance Is discussed in PWROG-20015-NP. Section 2.2.5 of the PWROG guidance states that a reasonable balance among the layers of defense is achieved in this method in that there is a reasonable confidence that SSCs will remain capable of performing their safety-related functions.

Regarding fission product barriers, the guidance implies that the method maintains reasonable confidence that the barriers will perform their safety-related functions. The defense-in-depth approach is to ensure that there are multiple layers (e.g., alternate success paths) of mitigation in responding to an event and that the failure of one layer is usually represented by a single basic event. To provide a reasonable balance assessment, a licensee should evaluate all the layers in context of responding to an event, such as redundancy and diversity (no common cause failures across the layers of defense). The single basic event approach (first order cutset) would either identify single point failures that represent a lack of defense-in-depth or common cause failure of several components that represent a lack of diversity. The layered approach of defense-in-depth would be represented by cutsets with two or more basic events.

It is unclear to the NRC staff the basis for why this approach is adequate for defense-in-depth categorizations. Table 4 of the LAR supplement dated May 5, 2021, regarding functions identified as HSS by the alternate method, lists the low-pressure core injection (LPCI) mode and suppression pool cooling mode of the residual heat removal system and providing air or gas to the automatic depression system (ADS) relief valves or other steam relief valves. These are backup functions to the other functions (e.g., feedwater, reactor core isolation cooling (RCIC), and high-pressure injection (HPCI)) that would normally require failure first. Therefore, the associated accident sequences for these functions would be represented in two or more *ordered cutsets. It is unclear to the staff how these functions were determined to be HSS by the first order method of the alternate approach.*

Therefore, the NRC staff requests the following:

A. Clarify if the intent of the alternate defense-in-depth method is to assign 'candidate' HSS to SSCs that provide only one layer of defense to an event (e.g., no defense-in-depth exists).

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

The PWROG-20015-NP, Revision 3 report (Reference [7]) has been modified so higher initiating event frequencies require additional level of defense-in-depth compared to lower initiating event frequencies. The below excerpts explain the alternate defense-in-depth process in more detail with identification of appropriate layers of defense and its comparisons to the NEI 00-04, Section 6.1 (Reference [11]) process.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

The intent of the alternate defense-in-depth process is to identify SSCs that would be candidate HSS from a cutset with an initiating event and a certain number of basic events, defined in the criteria described in Section 2.2.2, which leads to core damage. NEI 00-04, Section 6.1 (Reference 2*) states that design basis initiating events below the 1E-03/yr threshold must have at least one redundant automatic system present (besides the function/SSC being evaluated). With the more realistic identification of success paths via examination of cutsets from the FPIE CDF PRA model, but with an SSC-level examination, the initiating event frequency lower limit threshold has been decreased by a factor of 10 to 1E-04/yr for the alternate core damage defense-in-depth assessment to avoid "screening out" SSCs that could impact core damage defense-in-depth. If a cutset with an initiating event frequency of at least 1E-04/yr for CDF does not have defense-in-depth based on the criteria defined in Section 2.2.2, the SSCs associated with the initiating event and basic event(s) will be candidate HSS for the alternate core damage defense-in-depth assessment.

This cutset examination requires that SSCs with minimal or no defense-in-depth for cutsets within the screening threshold as identified in Section 2.2.2 be "screened in" as candidate HSS for the alternate defense-in-depth since the SSCs identified in cutsets with few basic events represent a limited number of SSC failures that would have to occur to result in core damage. Additionally, there is a secondary threshold that requires an additional level of defense-in-depth for cutsets with higher initiating event frequencies. The additional requirement of more than two basic events being necessary for the SSCs to be candidate LSS at an initiating event frequency threshold of 1E-03/yr for CDF is to allow for an additional level of defense-in-depth to be present for higher frequency initiating events to follow a similar process to Figure 6-1 in NEI 00-04, Section 6.1 of increasing the level of defense-in-depth for higher frequency initiating events. This provides a bounding analysis as shown in the example below.

It is important to realize that, as described in more detail in Section 2.2.3.4, cutsets with CCF basic events that consists of two (2) or three (3) SSC failures would not be automatically "screened out." Therefore, if there is a lower number of like-SSCs failures (i.e., less than four (4) like-SSCs would have to fail to lead to the accident progression defined in the cutset), that cutset would not be automatically "screened out" from the alternate defense-in-depth assessment. This prevents SSCs in redundant trains from being classified as candidate LSS unless there is significant redundancy or other defense-in-depth is available. Since intra-system CCF is a requirement for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*), "screened in" cutsets with CCF basic events can assign SSCs candidate HSS that are within different trains of equipment.

Specifically, the following examples in Section 2.2.6 in PWROG-20015-NP, Revision 3 describes how the level of defense-in-depth is identified.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

Examples of how defense-in-depth is approached in the alternate defense-in-depth categorization process are identified below:

- **Greater than 1E-03/yr initiating event frequency:** NEI 00-04, Figure 6-1 requires three or greater diverse trains or two redundant systems (other than the function required for the function/SSC being examined) to remain candidate LSS for defense-in-depth for initiating event frequencies greater than 1E-01/yr. This is the bounding scenario for other initiating event frequency values in NEI 00-04, Figure 6-1. In this scenario, this would fall into the alternate defense-in-depth cutset review of two basic events (initiating event frequency greater than 1E-03/yr for alternate core damage defense-in-depth). Failure pathways for an accident scenario are identified during the cutset review and basic events within a cutset can contain CCF of SSCs as intra-system CCF is required to be taken into account for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). For example, if only two systems supported prevention of the accident scenario for an initiating event greater than 1E-03/yr, a cutset can appear with a basic event associated with CCF of like-SSCs for the trains within System 1 that leads to a failure of System 1 and a basic event associated with CCF of like-SSCs for the trains within System 2 that leads to a failure of System 2. In this scenario, the SSCs associated with these basic events would be identified as candidate HSS due to the limited redundancy available. This matches with only two systems being overall available and is consistent with how NEI 00-04, Figure 6-1 would evaluate this scenario for initiating event frequencies greater than 1E-01/yr. In a modified example where the cutset would instead consist of three basic events (e.g., three CCF basic events of three different systems), this specific cutset would be “screened out” and associated SSCs would be candidate LSS for this cutset in the core damage defense-in-depth analysis (SSCs may still end up as candidate HSS from other cutsets or other analyses). This is the same level of redundancy present within NEI 00-04, Figure 6-1 where there is a requirement of at least 2 redundant systems (or 3 diverse trains) excluding the function / SSC that is being considered. Additionally, since the SSC that are identified as candidate HSS in the core damage defense-in-depth assessment identify associated functions of the SSC as candidate HSS based on the process identified in NEI 00-04, Section 7.1, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information). If the SSC requires multiple failures within a system that are not related via CCF in the cutsets, that can be identified as redundancy within the system itself which the new alternate defense-in-depth approach takes credit for. Additionally, Section 2.2.3.4 describes scenarios where there is significant level of redundancy for CCF (4 or more failures) and why it is appropriate to “screen out” those cutsets. As stated in Section 2.2.3.3, HFE (including operator actions and recovery actions) also have SSC failures that support performing the operator actions and/or recovery actions modeled per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*).

• **Greater than 1E-04/yr, less than 1E-03/yr initiating event frequency:** The single basic event cutset criteria initiating event frequency range is comparable to the initiating event frequencies below 1E-03/yr in Figure 6-1 of NEI 00-04. The alternate core damage defense-in-depth process moves this threshold down by a factor of 10. In the alternate core damage defense-in-depth approach, there has to be one additional defense-in-depth layer to be “screened out” of the single basic event criteria. Figure 6-1 in NEI 00-04 requires at least one redundant automatic system to function in addition to the function/SSC being examined to provide for defense-in-depth. This cutset review would identify any cutsets with a basic event of any SSCs failing (or CCF of SSCs) that would lead to CDF. For a cutset to be “screened out,” two basic events would have to be present. This would require either two systems to be present for this defense-in-depth or there would have to be multiple SSC failures within a system that are not related via CCF in the cutsets to lead to a system failure. If any cutset that includes a CCF basic event is “screened in”, then the associated functions of the candidate HSS SSCs associated with the CCF basic event would be identified as candidate HSS. Therefore, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information) which avoids the SSCs that support the associated function from being candidate LSS in the alternate defense-in-depth assessment. A CCF basic event of a combination greater than four (4) SSCs can be “screened out” due to significant intra-system redundancy as discussed in Section 2.2.3.4.

Whether the system is automatic does not factor into a realistic evaluation of defense-in-depth since non-automatic systems also provide functional support of safety-related events and represent realistic defense-in-depth and success paths in a plant.

- **Less than 1E-04/yr initiating event frequency:** Initiating events below 1E-04/yr for CDF cutsets have been "screened out" because of their low likelihood of occurrence. SSCs below that initiating event frequency threshold that have a significant impact to CDF will be evaluated in the FPIE CDF PRA model quantitative determinations (i.e., FV, RAW screening) in NEI 00-04, Section 5 and other analyses described later in this section. Additionally, protection systems must meet single failure criteria as described in 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) for design basis scenarios as shown below based on plant design requirements. In these design basis scenarios with a low initiating event frequency, a single SSC failure in a protection system would not lead to core damage due to a redundant system or a redundant train being available. Based on the low level of occurrence for these design basis initiating events, this provides for defense-in-depth and is based on the overall plant design that remains unchanged by 10 CFR 50.69. As stated in Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), "Section 50.69 is structured to maintain the design basis functional requirements of the plant."
  - o 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) : "Criterion 21—Protection system reliability and testability. The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) **no single failure results in loss of the protection function** and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred." (emphasis added in bold)

In the scenario a cutset is "screened out" for the alternate core damage defense-in-depth assessment, then there is defense-in-depth within the plant for the SSCs being examined based on the cutset results in a manner that is similar with the defense-in-depth concept within the NEI 00-04, Section 6.1 process.

As stated in Section 2.2.6 in PWROG-20015-NP, Revision 3 there are additional evaluations that are completed for 10 CFR 50.69 beyond the alternate core damage defense-in-depth.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were "screened out" for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

B. *RG 1.174, Revision 3, states that risk-informed implementation changes are permitted for small increases in risk when the maintenance of sufficient defense in depth is reasonably assured. Item 3 of Section 2.2.5 of PWROG-20015-NP, Revision 1, states that regarding compliance with RG 1.174, system redundancy, independence, and diversity are preserved since no system design modifications are made by the proposed alternate method. The NRC staff notes that RG 1.174 states that the preservation is in the context of the expected frequency and consequences of challenges to the system.*

The PWROG method appears to consider the frequency of challenges; however, it does not appear to consider the reliability of systems responding to those challenges. During the audit, the licensee stated that the proposed use of first order cutsets (i.e., those with a single SSC failure) is consistent with the safety analysis' single failure criterion (i.e., core damage or large early releases can be avoided for design events and one SSC failure).

Sections 6.2.1.1.3.3 (regarding containment accident response analysis) and 6.3.1.1.2 (regarding core damage) of the Limerick updated final safety analysis report (UFSAR) appear to demonstrate the need for multiple layers of SSCs in responding to design accidents. For example, Case A analysis in Section 6.2.1.1.3.3.1.6 (regarding long-term accident responses) assumes the availability of HPCI, core spray, and all LPCI pumps. With regards to emergency core cooling system scenarios, Part d of Section 6.3.1.1.2 has combinations of LPCI, core spray, ADS, and HPCI with some systems having a multiple loop requirement.

As shown in Figure 6-1 of NEI 00-04, not all layers of defense-in-depth should be categorized as HSS. However, it is unclear to the NRC staff why only SSCs that provide one layer of defense-in-depth are categorized as HSS, especially when there is no apparent reliability consideration in the proposed alternate method (e.g., SSCs with high *failure rates such as the shared function of the safety-related HPCI train and non-safety RCIC train). Therefore:*

i. *Provide justification on how the first order cutset meets the RG 1.174 requirement to identify essential SSCs that preserve the required level of defense-in-depth based on challenges to the responding systems.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

The alternate defense-in-depth process has been modified to identify a maximum of two basic events with an initiating event in the qualitative screening for an initiating event frequency above 1E-03/yr for the FPIE CDF PRA model. Cutsets with initiating events with frequencies at least 1E-04/yr and less than 1E-03/yr are "screened in" for the alternate core damage defense-in-depth categorization if there is a maximum of a single basic event from the cutset qualitative screening. This process follows a similar method of screening as in NEI 00-04, Section 6.1 (Reference [11]) which is described in RAI-10.D. PWROG-20015-NP, Revision 3 (Reference [7]) Section 2.2.7 provides a detailed discussion on Regulatory Guide 1.174 (Reference [10]) and its applicability. Refer to the PWROG-20015-NP, Revision 3 report for the entire text of Section 2.2.7.

It is important to note that the alternate defense-in-depth process is one portion of the overall 50.69 categorization effort. The other portions of the 50.69 categorization continue to be evaluated. The alternate defense-in-depth process completes NEI 00-04, Section 6.1 in an alternate process but the remainder of the 10 CFR 50.69 process has been maintained. Additionally, qualitative considerations are now required to be examined by the engineering team. For example, NEI 00-04, Section 9.2.2 continues to be evaluated by the IDP but now is also required to be initially examined by the engineering team completing the categorization to provide for additional insights in defense-in-depth during the evaluation to provide for qualitative examinations by the engineering team to support the alternate defense-in-depth process. The alternate defense-in-depth process basis and comparison to the NEI 00-04, Section 6.1 process is described in further detail in RAI-10.D. As stated in the PWROG-20015-NP, Revision 3 report, there are no design changes from implementation of 10 CFR 50.69 or alternate defense-in-depth process. Alternative treatments and periodic reviews along with performance monitoring also continue to be used in the alternate defense-in-depth process.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7:

> It is important to note that the robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7*): "Changes that affect any non-treatment

aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59." This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*) which states "Section 50.69 is structured to maintain the design basis functional requirements of the plant." Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7*): "§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions." Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*):

> "Section 50.69 is **structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained**. Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.**" (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7*):

> "The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

ii. *Provide justification how the first order cutset criterion takes into consideration the reliability of systems in determining the number of layers of defense-in-depth in responding to plant challenges. Include in this discussion how the proposed approach is consistent with the Limerick UFSAR in identifying the required number of layers of defense-in-depth for design events.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

It is important to recognize that the alternate core damage defense-in-depth assessment does not just evaluate scenarios within the Limerick updated final safety analysis report (UFSAR) (Reference [12]) and instead uses the PRA model structure. As stated in PWROG-20015-NP, Revision 3, Section 2.2.3.2 (Reference [7]:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.3.2:

> The use of the FPIE CDF PRA model structure allows for a more realistic approach in identification of defense-in-depth within a plant compared to a system-by-system analysis that is currently completed in the NEI 00-04, Section 6.1 core damage defense-in-depth process.

Modifications have also been made to the process with a detailed basis of the modified process provided in the response to RAI-10.D. This was done in order to provide for an additional level of defense-in-depth for higher frequency initiating events. The alternate defense-in-depth process identifies SSCs with minimal or no defense-in-depth to identify them as candidate HSS. As stated in PWROG-20015-NP, Revision 3, Section 2.2.6:

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> This cutset examination requires that SSCs with minimal or no defense-in-depth for cutsets within the screening threshold as identified in Section 2.2.2 be “screened in” as candidate HSS for the alternate defense-in-depth since the SSCs identified in cutsets with few basic events represent a limited number of SSC failures that would have to occur to result in core damage. Additionally, there is a secondary threshold that requires an additional level of defense-in-depth for cutsets with higher initiating event frequencies. The additional requirement of more than two basic events being necessary for the SSCs to be candidate LSS at an initiating event

> frequency threshold of 1E-03/yr for CDF is to allow for an additional level of defense-in-depth to be present for higher frequency initiating events to follow a similar process to Figure 6-1 in NEI 00-04, Section 6.1 of increasing the level of defense-in-depth for higher frequency initiating events. This provides a bounding analysis as shown in the example below.

With regards to reliability of systems in determining the number of layers for defense-in-depth, the defense-in-depth process is not the only evaluation for categorization and does not examine unavailability or reliability of systems which is instead captured in the quantitative assessments as stated in PWROG-20015-NP, Revision 3, Section 2.2.6. NEI 00-04, Section 6.1 (Reference [11]) also does not examine the unavailability or reliability of a system within the process and instead uses the level of defense-in-depth in a qualitative approach except for screening to levels of defense-in-depth based on initiating event frequency which the alternate defense-in-depth process also does.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were "screened out" for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

The background information in RAI-11.B mentions that Section 6.2.1.1.3.3 and Section 6.3.1.1.2 in the Limerick UFSAR identifies the need for multiple layers of SSCs to respond to design basis accidents. The single failure design criterion is present within the examples provided where any single failure would not result in a failure to mitigate the design basis accident. The alternate defense-in-depth process does not modify the plant design and therefore does not impact the level of defense-in-depth available. No system design modifications are made by implementing the alternate defense-in-depth categorization process or the 10 CFR 50.69 process as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference [13]), "Section

50.69 is structured to maintain the design basis functional requirements of the plant". Additionally, SSCs with alternative treatments are required to maintain reasonable confidence to support their safety-related functions as stated in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule, "Treatment requirements for the SSCs are applied as necessary to maintain functionality and reliability and are a function of the category into which the SSC is categorized." NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule, "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Therefore, since the system design is remaining the same and alternative treatments are required to provide reasonable confidence that the SSC performs their safety-related functions, the defense-in-depth of SSCs remains present within the plant.

As identified in the background to RAI-11.B, Part d of the UFSAR Section 6.3.1.1.2 has combinations of LPCI, CS, ADS, and HPCI with some systems having a multiple loop requirement. The successful operation of the ECCS even with a single active component failure is identified in Part d, Part e, and Part f of the UFSAR, Section 6.3.1.1.2:

> "d. If there is a break in a pipe that is not a part of the ECCS, **no single active component failure in the ECCS**, including all common and support components, **prevents automatic initiation and successful operation of less than one of the following combinations of ECCS equipment:** […]"
>
> "e. If there is a break in a pipe that is a part of the ECCS, **no single active component failure in the ECCS**, including all common and support components, **prevents automatic initiation and successful operation of less than one of the following combinations of ECCS equipment**:
>
> 1. Three LPCI loops and ADS
> 2. Two LPCI loops, one CS loop, and the ADS and HPCI
>
> These are the minimum ECCS combinations which result after assuming any failure (from d. above), and assuming that the ECCS line break disables the affected loop/system."
>
> "f. Long-term (later than10 minutes after initiation signal) cooling requirements call for the removal of decay heat via the RHRSW system. In addition to the break which initiated the loss-of-coolant event, **the system can sustain one failure, either active or passive**, and have at least one low pressure ECCS pump (LPCI or CS) operating for makeup, one RHR pump with a heat exchanger, and 100% RHRSW flow to the heat exchanger operating for heat removal."

As stated in Part f in Section 6.3.1.1.2 of the Limerick UFSAR, long-term cooling requirements can have the system sustain one failure of either active or passive in addition to the break which initiated the LOCA event.

An example of a CDF cutset with a MLOCA initiating event along with a failure within the ECCS:

BE Value	BE	Description
%S1-WATER	**3.29E-05**	**FREQUENCY OF MEDIUM LOCA - BELOW TAF**
1-CL-3B	*1.00E+00*	*CLASS 3B*
1-SEQ-S1-021	*1.00E+00*	*SEQUENCE S1-021*
AHUWS1DXI	*1.00E+00*	*(2.35E-2) OPERATORS FAIL TO INITIATE EMERGENCY DEPRESSURIZATION (MEDIUM LOCA, WATER)*
AHUWS1DXI_IND	**2.35E-02**	**OPERATORS FAIL TO INITIATE EMERGENCY DEPRESSURIZATION (MEDIUM LOCA, WATER)**
ZTUHRXCWI	**2.53E-04**	**COMMON CAUSE FAIL OF HPCI/RCIC**
ZZAVFACTOR	*9.57E-01*	*PLANT AVAILABILITY FACTOR*

In the above cutset, as seen in the italicized:

- 1-CL-3B, 1-SEQ-S1-021, and ZZAVFACTOR are either 1.0 tags or general availability factor events and would be not counted towards the basic event limit as identified in PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.2.
- AHUWS1DXI is a 1.0 tag event when incorporating JHEPs via the recovery file and would be not counted towards the basic event limit as identified in PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.2.

This cutset would end up being “screened out” based on the initiating event frequency for MLOCA. It is important to recognize that the NEI 00-04, Section 6.1 method would have “screened out” MLOCA events with 1 redundant automatic system.

Other cutsets are also examine for this system. For example:

BE Value	BE	Description
%TT	**6.71E-01**	**FREQUENCY OF TURBINE TRIP TRANSIENTS**
1-CL-1A	*1.00E+00*	*CLASS 1A*
1-SEQ-TT-038	*1.00E+00*	*SEQUENCE TT-038*
APPALLHFI	**1.20E-07**	**PCIG PIPE RUPTURES AND ACCUMULATOR RUPTURES**
ZTUHRXCWI	**2.53E-04**	**COMMON CAUSE FAIL OF HPCI/RCIC**
ZZAVFACTOR	*9.57E-01*	*PLANT AVAILABILITY FACTOR*

In the above cutset, as seen in the italicized:

- 1-CL-1A and 1-SEQ-TT-038, ZZAVFACTOR are either 1.0 tags or general availability factor events and would be not counted towards the basic event limit as identified in PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.a.2.

With the initiating event frequency being 6.71E-01/yr and there only being two basic events that would be "screened in" in the cutset qualitative screening, the SSCs associated with this initiating event and basic events will be identified as candidate HSS for the alternate core damage defense-in-depth assessment.

The above example shows that basic events that are within cutsets with lower frequency initiating events that are "screened out" can also be present within higher frequency initiating events and still be "screened in" within the alternate defense-in-depth assessment. In this scenario the SSCs linked to ZTUHRXCWI which generally represents the 2 of 2 CCF failure between similar HPCI and RCIC components (either pumps or valves), would be identified as candidate HSS and the associated functions would be identified as candidate HSS from NEI 00-04, Section 7.1. Additionally, the APPALLHFI basic event would be identified as HSS as this event fails the function of PCIG system providing gas to operate the necessary valve for depressurization.

In other scenarios, even if an SSC is not "screened in" within the alternate defense-in-depth assessment, there are other analyses (e.g., quantitative assessment in NEI 00-04, Section 5 and Review of Risk Information and Review Defense-in-Depth Implications in NEI 00-04, Section 9.2.2) that would also evaluate the impacts of these SSCs. For example, the HPCI and RCIC injection functions are candidate HSS from the PRA Quantitative 50.69 assessment category.

iii. *Explain how the reliability of each layer of defense-in-depth is taken into consideration by the proposed method. Include in this discussion justification why an SSC is not categorized as HSS when it has only one backup to avoid core damage is an SSC with significant unavailability and reliability.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses*.

It is important to note that the alternate defense-in-depth process is one portion of the overall 50.69 categorization effort. The other portions of the 50.69 categorization continue to be evaluated. With regards to unavailability and unreliability of SSC in determining the number of layers for defense-in-depth, the defense-in-depth process is not the only evaluation for categorization and does not examine unavailability or unreliability of systems which is instead captured in the quantitative assessments in NEI 00-04, Section 5 (Reference [11]). NEI 00-04, Section 6.1 also does not examine the unavailability or unreliability of a system within the process and instead uses the level of defense-in-depth in a qualitative approach except for screening to levels of defense-in-depth based on initiating event frequency which the alternate defense-in-depth process also does.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were "screened out" for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

In the situation where an SSC has a high unreliability or unavailability, it would be evaluated in NEI 00-04, Section 5 quantitative assessments that examine the quantitative impacts of the FPIE CDF PRA model via importance measures. The following excerpt in the PWROG-20015-NP report (Reference [7]) identifies the alternate defense-in-depth process does not modify the plant design, does not modify the implementation of alternative treatments with reasonable confidence, and continues to have periodic monitoring.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7:

> It is important to note that the robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7*): "Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59." This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*) which states "Section 50.69 is structured to maintain the design basis functional requirements of the plant." Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable

confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7*): "§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions." Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*):

> "Section 50.69 is **structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained**. Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.**" (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7*):

> "The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

Further justification on the overall alternate defense-in-depth screening is provided in Section 2.2.6 of the PWROG-20015-NP, Revision 3 report.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

Examples of how defense-in-depth is approached in the alternate defense-in-depth categorization process are identified below:

- **Greater than 1E-03/yr initiating event frequency:** NEI 00-04, Figure 6-1 requires three or greater diverse trains or two redundant systems (other than the function required for the function/SSC being examined) to remain candidate LSS for defense-in-depth for initiating event frequencies greater than 1E-01/yr. This is the bounding scenario for other initiating event frequency values in NEI 00-04, Figure 6-1. In this scenario, this would fall into the alternate defense-in-depth cutset review of two basic events (initiating event frequency greater than 1E-03/yr for alternate core damage defense-in-depth). Failure pathways for an accident scenario are identified during the cutset review and basic events within a cutset can contain CCF of SSCs as intra-system CCF is required to be taken into account for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). For example, if only two systems supported prevention of the accident scenario for an initiating event greater than 1E-03/yr, a cutset can appear with a basic event associated with CCF of like-SSCs for the trains within System 1 that leads to a failure of System 1 and a basic event associated with CCF of like-SSCs for the trains within System 2 that leads to a failure of System 2. In this scenario, the SSCs associated with these basic events would be identified as candidate HSS due to the limited redundancy available. This matches with only two systems being overall available and is consistent with how NEI 00-04, Figure 6-1 would evaluate this scenario for initiating event frequencies greater than 1E-01/yr. In a modified example where the cutset would instead consist of three basic events (e.g., three CCF basic events of three different systems), this specific cutset would be “screened out” and associated SSCs would be candidate LSS for this cutset in the core damage defense-in-depth analysis (SSCs may still end up as candidate HSS from other cutsets or other analyses). This is the same level of redundancy present within NEI 00-04, Figure 6-1 where there is a requirement of at least 2 redundant systems (or 3 diverse trains) excluding the function / SSC that is being considered. Additionally, since the SSC that are identified as candidate HSS in the core damage defense-in-depth assessment identify associated functions of the SSC as candidate HSS based on the process identified in NEI 00-04, Section 7.1, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information). If the

SSC requires multiple failures within a system that are not related via CCF in the cutsets, that can be identified as redundancy within the system itself which the new alternate defense-in-depth approach takes credit for. Additionally, Section 2.2.3.4 describes scenarios where there is significant level of redundancy for CCF (4 or more failures) and why it is appropriate to “screen out” those cutsets. As stated in Section 2.2.3.3, HFE (including operator actions and recovery actions) also have SSC failures that support performing the operator actions and/or recovery actions modeled per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*).

• **Greater than 1E-04/yr, less than 1E-03/yr initiating event frequency:** The single basic event cutset criteria initiating event frequency range is comparable to the initiating event frequencies below 1E-03/yr in Figure 6-1 of NEI 00-04. The alternate core damage defense-in-depth process moves this threshold down by a factor of 10. In the alternate core damage defense-in-depth approach, there has to be one additional defense-in-depth layer to be “screened out” of the single basic event criteria. Figure 6-1 in NEI 00-04 requires at least one redundant automatic system to function in addition to the function/SSC being examined to provide for defense-in-depth. This cutset review would identify any cutsets with a basic event of any SSCs failing (or CCF of SSCs) that would lead to CDF. For a cutset to be “screened out,” two basic events would have to be present. This would require either two systems to be present for this defense-in-depth or there would have to be multiple SSC failures within a system that are not related via CCF in the cutsets to lead to a system failure. If any cutset that includes a CCF basic event is “screened in”, then the associated functions of the candidate HSS SSCs associated with the CCF basic event would be identified as candidate HSS. Therefore, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information) which avoids the SSCs that support the associated function from being candidate LSS in the alternate defense-in-depth assessment. A CCF basic event of a combination greater than four (4) SSCs can be “screened out” due to significant intra-system redundancy as discussed in Section 2.2.3.4. Whether the system is automatic does not factor into a realistic evaluation of defense-in-depth since non-automatic systems also provide functional support of safety-related events and represent realistic defense-in-depth and success paths in a plant.

• **Less than 1E-04/yr initiating event frequency:** Initiating events below 1E-04/yr for CDF cutsets have been “screened out” because of their low likelihood of occurrence. SSCs below that initiating event frequency threshold that have a significant impact to CDF will be evaluated in the FPIE CDF PRA model quantitative determinations (i.e., FV, RAW screening) in NEI 00-04, Section 5 and other analyses described later in this section. Additionally, protection systems must meet single failure criteria as described in 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) for design basis scenarios as shown below based on plant design requirements. In these design basis scenarios with a low initiating event frequency, a single SSC failure in a protection system would not lead to core damage due to a redundant system or a redundant train being available. Based on the low level of occurrence for these design basis initiating events, this provides for defense-in-depth and is based on the overall plant design that remains unchanged by 10 CFR 50.69. As stated in Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*), "Section 50.69 is structured to maintain the design basis functional requirements of the plant."

- o 10 CFR 50, Appendix A, Criterion 21 (Reference 8*) : "Criterion 21—Protection system reliability and testability. The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) **no single failure results in loss of the protection function** and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred." (emphasis added in bold)

In the scenario a cutset is "screened out" for the alternate core damage defense-in-depth assessment, then there is defense-in-depth within the plant for the SSCs being examined based on the cutset results in a manner that is similar with the defense-in-depth concept within the NEI 00-04, Section 6.1 process.

C. *The NRC staff notes the licensee's demonstration of the alternate defense-in-depth method presented during the audit identified approximately 34 cutsets in what appeared to be in the 1E-11 per year core damage frequency range. A typical PRA analysis quantitatively results in thousands of cutsets in the 1E-11 range, which are usually not in the top 100 high frequency contributors to core damage frequency range and, therefore, not risk-significant. It is unclear to the NRC staff how the proposed method uses risk significant cutsets when identifying HSS SSCs. Provide justification how the proposed method incorporates risk-significant cutsets in its categorization process. Include in this* *discussion why there are no apparent specified consideration of the most risk significant cutsets (i.e., 1E-06 to 1E-07 per year) in the proposed method.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

It is important to note that the alternate defense-in-depth process is one portion of the overall 50.69 categorization effort. The other portions of the 50.69 categorization continue to be evaluated. Evaluation of risk significance of cutsets are addressed in the quantitative evaluations in NEI 00-04, Section 5 (Reference [11]) via the importance measure evaluation; as stated in PWROG-20015-NP, Revision 3, Section 2.2.6 (Reference [7]). NEI 00-04, Section 6.1 also does not examine risk significance of a system within its process and instead uses the level of defense-in-depth in a qualitative approach except for screening to levels of defense-in-depth based on initiating event frequency which the alternate defense-in-depth process also does. As stated in the excerpt below, NEI 00-04, Section 5 evaluates the risk significance of cutsets.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were “screened out” for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00 04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

D. *Defense-in-depth consideration Item 3 of RG 1.174 states that diversity is accomplished by having equipment that performs the same function rely on different attributes, such as different principles of operation, different physical variables, different conditions of operation. It further states that diversity is required when high availability and reliability of a function is required so that a single design feature does not fail that function. Section 2.2.5 of PWROG-20015-NP states that the diversity requirement is not impacted since there are no plant modifications resulting from the categorization.*

i. *Provide details of how the proposed method identifies and assesses the defense-in-depth diversity requirement for risk-significant scenarios.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

It is important to note that the alternate defense-in-depth process is one portion of the overall 50.69 categorization effort. The other portions of the 50.69 categorization continue to be evaluated. Evaluation of risk significance of cutsets is addressed in the quantitative evaluations in NEI 00-04, Section 5 via the importance measure evaluation; as stated in PWROG-20015-NP, Revision 3, Section 2.2.6. NEI 00-04, Section 6.1 also does not examine risk significance of a system within the its process and instead uses the level of defense-in-depth in a qualitative approach except for screening to levels of defense-in-depth based on initiating event frequency which the alternate defense-in-depth process also does. As stated in the excerpt below, NEI 00-04, Section 5 evaluates the risk significance of cutsets.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.6:

> Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were “screened out” for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00-04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

Additionally, It is important to realize that no system design modifications are made by implementing the alternate defense-in-depth categorization process or the 10 CFR 50.69 process as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference [13]), “Section 50.69 is structured to maintain the design basis functional requirements of the plant". Additionally, SSCs with alternative treatments are required to maintain reasonable confidence so support is maintained for their safety functions as stated in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference [13]), "Treatment requirements for the SSCs are applied as necessary to maintain functionality and reliability and are a function of the category into which the SSC is categorized." Therefore, since the system design is remaining the same and alternative treatments are required to provide reasonable confidence that the SSC performs their safety related functions, the diversity of SSCs requirement remains present.

ii. *Provide justification that this method meets the RG 1.174 consideration of preserving system redundancy, independence, and diversity commensurate with the expected frequency and consequences of challenges to the system, including consideration of uncertainty.*

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

#3 in Section 2.2.7 in PWROG-20015-NP, Revision 3 (Reference [7]) discusses preservation of diversity with respect to Regulatory Guide 1.174 (Reference [10]).

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7, #3:

3. "Preserve system redundancy, independence, and diversity commensurate with the expected frequency and consequences of challenges to the system, including consideration of uncertainty."

a. **Preserved.** System redundancy, independence, and diversity are preserved in the alternate defense-in-depth categorization process.

The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7*): "Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59." This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*) which states "Section 50.69 is structured to maintain the design basis functional requirements of the plant." Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7*): "§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions." Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7*):

> "Section 50.69 is **structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained. **Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.**" (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7*):

> "The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

One of the reasons alternative treatments are required to maintain reasonable confidence to perform their safety related functions is so RISC-3 SSCs continue to provide system reliability for safety-related functions. Therefore, these alternative treatments allow for preservation of system redundancy, independence, and diversity since the SSCs are required to continue to support their safety-related functions and have reasonable confidence to do so. Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements." Periodic reviews and performance monitoring would identify any increase in frequency or decrease in availability or reliability. The plant design continues to remain unchanged based on 10 CFR 50.69 and alternate core damage defense-in-depth which prevents changes to the design that could impact system redundancy, independence, and diversity of SSCs.

Additionally, the alternate defense-in-depth process is one portion of the overall 10 CFR 50.69 assessment. The alternate defense-in-depth process only modifies the core damage defense-in-depth portion of NEI 00-04, Section 6.1, which does not change the alternative treatment requirements, periodic reviews requirements, performance monitoring requirements, or the plant design. Importance measures, which examine risk significance of an SSC, continue to be used to identify SSCs as candidate HSS / candidate LSS in NEI 00-04, Section 5. The only quantitative impacts used in the alternate core damage defense-in-depth categorization are initiating event frequency and truncation.

Uncertainty in the FPIE CDF PRA models for the use of the alternate defense-in-depth assessment are addressed by the evaluation of three measures. Parameter uncertainty is addressed by limited use of the quantitative values (initiating event frequency and truncation limits) in the alternate defense-in-depth assessment. The alternate defense-in-depth assessment uses the initiating event frequency values for quantitative screening similar to how NEI 00-04, Section 6.1 core damage defense-in-depth uses the initiating event frequencies found in the FPIE CDF PRA to evaluate core damage defense-in-depth. To reduce occurrence of uncertainty affecting the evaluation of defense-in-depth, the initiating event frequencies lower threshold has been reduced by a factor of 10 compared to the limit identified in NEI 00-04, Section 6.1. Truncation is consistent with the established truncation limits that meets supporting requirement QU-B3 in ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). If the FPIE CDF PRA results are regenerated, the truncation limit should be consistent with the baseline CDF truncation limit. If a higher truncation limit is required to be applied due to limitations, justification should be provided to demonstrate that an adequate sample size of cutsets is available to support this application. Modeling uncertainty is taken into account by the peer review process of the model along with following the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). As stated in Regulatory Guide 1.174, Revision 3 (Reference 6*), "In many cases, the appropriateness of the models adopted is not questioned, and these models have become, de facto, the consensus models to use. NUREG-1855 [Reference 10*] defines a consensus model as one that has a publicly available published basis and has been peer reviewed and widely adopted by an appropriate stakeholder group. In addition, widely accepted PRA practices may be regarded as consensus models" (in-text citation added in brackets). The peer review importance in identifying PRA completeness and technical adequacy is further discussed in the Statement of Considerations of 10 CFR 50.69, III.2.0, Methodology for Categorization (Reference 7*) "The peer review focuses on the PRA's completeness and technical adequacy for determining the importance of particular SSCs, including consideration of the scope, level of detail, and technical quality of the PRA model, the assumptions made in the development of the results, and the uncertainties that impact the analysis. This provides confidence that for IDP decisions that use PRA information, the results of the categorization process provide a valid representation of the risk importance of SSCs." The final criteria, completeness uncertainty, is taken into account by the implementation of alternative treatments; as stated in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), "Treatment requirements for the SSCs are applied as necessary to maintain functionality and reliability and are a function of the category into which the SSC is categorized." Additionally, as stated in 10 CFR 50.69(d)(2) (Reference 7*):"The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life." Alternative treatments are required to maintain reasonable confidence of SSC performance in order to prevent degradation of SSC performance.

Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7*), “Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.” In addition to the alternate defense-in-depth process, it is important to realize that there are also other evaluations that address uncertainties in the PRA model. NEI 00-04, Section 5 examine the quantitative impacts from sensitivity studies of PRA models used. Additionally, NEI 00-04, Section 8 has a risk sensitivity analysis applied to LSS SSCs.

E. *Table 4 of the LAR supplement dated May 5, 2021, provides the functions identified as HSS by the alternate method, including the low-pressure core injection mode and suppression pool cooling mode of the residual heat removal system and providing air or gas to the automatic depression system relief valves or other steam relief valves. These functions appear to be backup or support functions to other primary functions (e.g., feedwater, reactor core isolation cooling, and high-pressure injection). Therefore, it appears the associated accident sequences for these functions would be represented in cutsets with two or more basic events. It is unclear to the NRC staff how these functions were determined to be HSS by the first order method of the alternate approach.*

   Explain and justify how the functions provided in Table 4 of the supplement dated May 5, 2021, were determined by the alternate method using first order cutsets.

   Response

   The cutsets identified during the alternate core damage defense-in-depth review are discussed in the response to RAI 10.A.i.

F. *Tables 3 and 5 of LAR supplement dated May 5, 2021, provide 11 functions that were categorized as LSS by the proposed alternate defense-in-depth, which were previously identified as HSS based on the NEI 00-04, Chapter 6, “Defense-in-depth Assessment.” Three of the functions appear to have changed to LSS because of the alternate core damage defense-in-depth methodology. These include one function for each of the following systems: core spray, reactor enclosure heating, ventilation, and air conditioning, and control enclosure heating, ventilation, and air conditioning. The LAR supplement states that sufficient redundancy and diversity exists. For each of these three functions, provide a summary of the available redundancy and diversity. Discuss the categorization results based on NEI 00-04. Explain whether the listed diversity is credited in the Limerick design basis.*

   Response

   Core Spray - Provide Diesel Generator and ECCS system initiation logic during a LOCA. The mapping for this function includes the Core Spray relays and switches required for operation of ECCS logic and initiation of the diesel generator start. The categorization results using the NEI 00-04 method were based on a perceived lack of value relative to the categorization effort required to determine the function, whose scope was broad, to be LSS. A conservative decision was made to designate the function as HSS. The new method, which relies on the built in PRA logic, is capable of showing that the function is LSS with respect to the scope of the Core Damage Defense-in-Depth assessment. The Limerick PRA includes basic events representing the failure of the Core Spray logic but they did not show up in any cutsets above truncation and therefore are considered LSS.

Core Spray - Supply power to the ECCS trip units, steam leak monitors, and downstream instrumentation. The mapping for this function includes the power supplies and in- line relays in the Core Spray system that provide power to the ECCS trip units as well as other instrumentation. The categorization results using the NEI 00-04 method were based on a perceived lack of value relative to the categorization effort required to determine the function, whose scope was broad, to be HSS. A conservative decision was made to designate the function as HSS. The new method, which relies on the built in PRA logic, is capable of showing that the function is LSS with respect to the scope of the Core Damage Defense-in-Depth assessment. The Limerick PRA includes basic events representing the failure of the Core Spray logic but they did not show up in any cutsets above truncation and therefore is considered LSS.

Reactor Enclosure HVAC - Supply power to the ECCS trip units, steam leak monitors, and downstream instrumentation. This is a non-modeled function and therefore is not able to be driven to HSS by the alternate defense in depth categorization process. However, this function will still be categorized in the qualitative and IDP categorization elements of the process which may identify this function as HSS. This function isolates areas within the RE when line break signals are actuated. The dampers are located throughout the RE. The categorization results using the NEI 00-04 method were based on a perceived lack of value relative to the categorization effort required to determine the function, whose scope was broad, to be HSS. A conservative decision was made to designate the function as HSS.

Control Enclosure HVAC - Steam Flooding Dampers - Isolate on a sensed high differential pressure, or manual isolation signal. This is a non-modeled function and therefore is not able to be driven to HSS by the alternate defense in depth categorization process. However, this function will still be categorized in the qualitative and IDP categorization elements of the process which may identify this function as HSS. The mapping for this function includes all Steam Flooding Dampers that have isolation signals associated with manual release and high differential pressure as well as supporting equipment and initiation logic. They are located throughout the Control Enclosure. The categorization results using the NEI 00-04 method were based on a perceived lack of value relative to the categorization effort required to determine the function, whose scope was broad, to be HSS. A conservative decision was made to designate the function as HSS.

G. *RG 1.174, Revision 3, Section C.2.1.1.3, “Evaluating the Impact of the Proposed Licensing Basis Change on Defense in Depth,” states that to address the unknown and unforeseen failure mechanisms or phenomena, the licensee’s evaluation of this defense-in-depth consideration should also address insights based on traditional* *engineering approaches. Results and insights of the risk assessment might be used to support the conclusion; however, the results and insights of the risk assessment should not be the only basis for justifying that this defense-in-depth consideration is met. The licensee should consider the impact of the proposed licensing basis change on each of the layers of defense.*

Explain how the proposed defense-in-depth methodology addresses this aspect of RG 1.174, Revision 3.

Response

See response below.

As an alternative, propose a mechanism outside of reliance on the IDP, to include traditional engineering approaches to account for defense-in-depth outside of PRA.

Response

***Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

Modifications have been made to the PWROG-20015-NP process (Reference [7]). As shown in PWROG-20015-NP, Revision 2.2.2, Step 7.b.4, Step 7.b.5, Step 7.b.6 (and its sub-steps), Step 8.e, Step 9 have been added to address evaluations to verify the acceptability of the PRA for the alternate defense-in-depth assessment and to further complete evaluations with qualitative considerations. Step 7.b.4, Step 7.5.b, Step 7.b.6, and Step 9 are identified to examine whether that the FPIE CDF PRA model is sufficient for alternate defense-in-depth for the system(s) being categorized. Additionally, Step 8.e has been introduced that requires the engineering team to evaluate the NEI 00-04, Section 9.2.2 (Reference [11]), Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications prior to IDP review to allow for examination of the considerations with engineers directly involved in the categorization of the system.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 7.b.4, Step 7.b.5, Step 7.b.6 (and its sub-steps):

> **7. Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.
>
> […]
>
> b. Cutset Quantitative Screening
>
> […]
>
> 4) For initiating events that were “screened out” of the FPIE CDF PRA model, evaluate whether the initiating events would have had a frequency less than 1E-04/yr (quantitative threshold for the

alternate core damage defense-in-depth). If this is the case, the initiating event does not impact the alternate core damage defense-in-depth screening as it would already be “screened out” since the initiating event frequency is below 1E-04/yr. If this is not the case and the “screened out” initiating event frequency is greater than or equal to 1E-04/yr, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the FPIE CDF PRA model results should be evaluated with the originally “screened out” initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

5) For initiating events that were split into multiple initiating events in the FPIE CDF PRA model, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the combined initiating event consisting of a combination of the split initiating events. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

6) The periodic review process identified in NEI 00-04, Section 12 is unchanged but additional clarification is provided for the alternate defense-in-depth process in regards to the bullet on “a review of the impact of the updated risk information on the categorization process results”:

a) During a periodic review, if an initiating event is removed in an update to the FPIE CDF PRA model after using the alternate defense-in-depth categorization, evaluate whether the removed initiating event frequency is less than 1E-04/yr (quantitative threshold for the alternate core damage defense-in-depth). If this is the case, the initiating event does not impact the alternate core damage defense-in-depth screening as it would already be “screened out” since the initiating event frequency is below 1E-04/yr. If this is not the case and the removed initiating event frequency is greater than or equal to 1E-04/yr, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the FPIE CDF PRA model results should be evaluated with the removed initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

b) During a periodic review, if an initiating event is split into multiple initiating events in an update to the FPIE CDF PRA model after completing the alternate defense-in-depth categorization, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the initially combined initiating event. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 8.e:

8. Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis: This analysis replaces the considerations in NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

[…]

e. The engineering team is now required to evaluate the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications prior to IDP review. These evaluations will be reviewed and confirmed by the IDP. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

PWROG-20015-NP, Revision 3, Section 2.2.2, Step 9 (and its sub-steps):

9. In addition to the IDP review and approval of the initiating event frequencies identified in Step 7.b.4), Step 7.b.5), and Step 7.b.6) (and sub-steps), the IDP should review the alternate defense-in-depth assessment consistent with NEI 00-04, Section 9: "IDP Review and Approval," while evaluating the system categorization, including the Review of Risk Information and Review Defense-in-Depth Implication considerations identified in NEI 00-04, Section 9.2.2. Additionally, the IDP should examine the following considerations for each system prior to system categorization approval. These considerations are initially examined by the engineering team during the system categorization with an initial evaluation provided to the IDP prior to IDP review and approval. If

confirmation of these two criteria are not met, the NEI 00-04, Section 6.1 process should be used for the system categorization. It should be confirmed that:

a. The system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth via the alternate core damage defense-in-depth method.

b. The assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth via the alternate core damage defense-in-depth method.

Beyond the modifications made to the process, #1f in Section 2.2.7 in PWROG-20015-NP, Revision 3 discusses the basis on addressing this criterion in Regulatory Guide 1.174 (Reference [10]):

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.7, #1f:

1. "Preserve a reasonable balance among the layers of defense"

[…]

f. Regulatory Guide 1.174, Revision 3, Section 2.1.1.3 (Reference 6*) states:

> "to address the unknown and unforeseen failure mechanisms or phenomena, the licensee's evaluation of this defense-in-depth consideration should also address insights based on traditional engineering approaches. Results and insights of the risk assessment might be used to support the conclusion; however, the results and insights of the risk assessment should not be the only basis for justifying that this defense-in-depth consideration is met. The licensee should consider the impact of the proposed licensing basis change on each of the layers of defense."

The alternate defense-in-depth categorization uses the FPIE CDF PRA cutsets to identify the level of defense-in-depth available. The alternate defense-in-depth categorization does not use the quantitative results of the FPIE CDF PRA model (excluding initiating event frequency and truncation). Use of the FPIE CDF PRA model structure allows for the alternate defense-in-depth process to examine detailed accident scenarios that have been modeled and peer reviewed consistent with the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). In fact, traditional engineering approaches are used to identify the accident sequences as well as system modeling, and CCF within the FPIE CDF PRA model. The FPIE CDF PRA model has been developed using systematic approaches; for example, to identify initiating events as shown in IE-A1, identify appropriate system analysis information as shown in SY-A2, identifying appropriate accident sequences in AS-A1, justification for CCCG in SY-B3 of the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*). Additionally, since unknown or unforeseen failure mechanisms can be present, other analyses in 10 CFR 50.69 provide additional examination of defense-in-depth so the alternate defense-in-depth process which uses the FPIE CDF PRA model structure are not the only basis for meeting this consideration:

(1) NEI 00-04, Section 9.2.2 examination of the Review of Risk Information seven qualitative considerations and the Review Defense-in-Depth Implications five qualitative considerations.
(2) Section 2.2.2, Step 9 (and sub steps) considerations on if the system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth and whether assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth.
(3) The examination of initiating event within the PRA model as described in the process outlined in Section 2.2.2, Step 7.b.4), Step 7.b.5), and Step 7.b.6) (and sub steps).
(4) The pressure boundary analysis defense-in-depth is completed within its own analysis.

H. *RG 1.174 Defense-in-Depth Consideration Item No. 1, "reasonable balance among the layers of defense," states that the context of layers of defense is to prevent any events from progressing to core damage. Section 6.1 of NEI 00-04, regarding core damage defense-in-depth, states that internally initiated design basis events considered in the licensee's safety analysis report are to assess their appropriate defense-in-depth requirements for categorization. The NRC staff notes that Section 8.3.2.1.1.2 of the Limerick UFSAR identifies other design basis event fires (e.g., safe shutdown and station blackout). Section 7.1.2.7.11 of the UFSAR states that electrical train system separation is based on credible events, such as pipe ruptures and fires, and Section 7.3.2.1.2.2.3 addresses the fire protection system and its design basis.*

Section 2.2.2 of PWROG-20015-NP states that only the FPIE PRA model is used for the proposed alternate method. It is unclear to the NRC staff why this method excludes other hazard PRA models (e.g., internal flooding, fire) when they represent events that lead to core damage.

Provide justification that the exclusion of other hazard PRA models from the alternate defense-in-depth method is consistent with the RG 1.174 defense-in-depth consideration of addressing any event that leads to core damage and the NEI 00-04 requirement for internally initiated design related events.

Response

**Reference numbering within quotations from the PWROG-20015-NP, Revision 3 report use the numerical list identified within the PWROG-20015-NP report, Section 3, References section and not the reference list outlined in the RAI responses.*

This is consistent with the current process present in the NEI 00-04, Section 6.1 (Reference [11]) defense-in-depth process. As seen in NEI 00-04, Section 6.1, only FPIE initiating events are present in NEI 00-04, Figure 6-1. This is further reinforced with the requirement that the defense-in-depth in NEI 00-04, Section 6.1 should use the success criteria of the PRA model and that only an FPIE PRA model with internal flooding is required for 10 CFR 50.69. Additionally, NEI 00-04, Section 6.1 states internally initiated design basis events should be the ones considered. The internal flooding model evaluates pressure boundary failures that would be evaluated in the pressure boundary assessment outside of the NEI 00-04, Section 6.1 process. Additionally, it is important to realize that other hazards are still examined within the NEI 00-04 process and the overall categorization process is required to be completed, including IDP review, prior to RISC determination and alternative treatments being applied. NEI 00-04, Section 5 contains evaluations of other hazards and therefore other hazards are not ignored in the 10 CFR 50.69 categorization process to stay consistent with RG 1.174 (Reference [10]). The following excerpt provides additional information including the previous interpretation of core damage defense-in-depth and internal events in the Limerick license condition.

Excerpt from PWROG-20015-NP, Revision 3, Section 2.2.8:

10 CFR 50.69 only requires a FPIE with internal flooding PRA model to implement 10 CFR 50.69. An FPIE PRA model (without internal flooding) that meets the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3*) identifies pressure boundary initiating events and pressure boundary basic events that have impacts that are not associated with internal flooding. As discussed in Section 2.2.5, the pressure boundary aspects that relate to internal flooding are evaluated in another assessment outside of NEI 00 04, Section 6.1 defense-in-depth “active” categorization process.

Additionally, NEI 00-04, Section 6.1 states:

> “This figure **[Figure 6-1 in NEI 00-04]** depicts the **internally initiated design basis events considered in the licensee's safety analysis report (i.e., the events that were used to identify an SSC as safety-related)** and considers the level of defense-in-depth available, based on the success criteria used in the PRA.” (emphasis added in bold, figure identification added in bolded brackets)

These internally initiated design basis events considered in the licensee’s safety analysis report corresponds to the Safety Analysis Chapter of the Final Safety Analysis Report which are captured in the FPIE PRA model. This is consistent with previous interpretations of the NEI 00-04, Section 6.1 approach. For example, in Enclosure 3, Section 3.6 of ML18165A162, “Limerick Generating Station, Units 1 and 2 – Issuance of Amendment Nos. 230 and 193 to Adopt Title 10 of the Code of Federal Regulations Section 50.69, “Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors” (CAC Nos. MF9873 and MF9874; EPID L-2017-LLA-0275)” (Reference 9*) the following is stated:

> “NEI 00-04, Section 6.0, provides guidance on assessment of DID. Figure 6-1 in NEI 00 04 provides guidance to assess design-basis DID based on the likelihood of the design-basis **internal event initiating event** and the number of redundant and diverse trains nominally available to mitigate the initiating event.” (emphasis added in bold)

The alternate defense-in-depth process follows the concept of examination of internal event initiating events that are used to identify core damage defense-in-depth in NEI 00-04, Section 6.1 based on previous interpretation of the process as identified above. The pressure boundary analysis is separately evaluated as discussed in Section 2.2.5 of this report which examines internal flooding scenarios. Therefore, the FPIE CDF PRA model, which includes pressure boundary failure initiating events and pressure boundary failure basic events that impact the FPIE CDF PRA model through non-flooding scenarios is acceptable for use in the alternate core damage defense-in-depth process.

It is also important to realize that NEI 00-04 includes other examinations risk information and defense-in-depth reviews. For example, PRA importance measures and screenings in NEI 00-04, Section 5, and the Review of Risk Information and Review Defense-in-Depth Implications in NEI 00-04, Section 9.2.2 continue to be evaluated, and the pressure boundary analysis is completed outside of the NEI 00-04, Section 6.1 guidance. The NEI 00-04, Section 5 evaluations specifically addresses other hazards within the plant. With these other evaluations present for examination of other hazards and the basis that NEI 00-04, Section 6.1 examines only internal event initiating events, this provides consistency with the previous NEI 00-04, Section 6.1 process.

RAI-12 – Defense-in-Depth First Order Large Early Release Cutset Approach and Screening

Section 50.69(b)(2)(ii) of 10 CFR requires that a LAR include a description of the measures taken to assure that the quality and level of detail of the systematic processes that evaluate the plant for internal and external events during normal operation, low power, and shutdown are adequate for the categorization of SSCs. Section 50.69(b)(2)(iv) requires that a LAR include a description of, and basis for acceptability of, the evaluations to be conducted to satisfy 10 CFR 50.69(c)(1)(iv). The SoC on 10 CFR 50.69(b)(2)(iv) of the Final Rule states that the licensee is required to include information about the evaluations they intend to conduct to provide reasonable confidence that the potential increase in risk would be small. The SoC further clarifies that a licensee must provide sufficient information to the NRC, describing the risk sensitivity study and other evaluations and the basis for their acceptability as appropriately representing the potential increase in risk from implementation of the requirements in the Rule.

Sections 2.1.1.2 and 2.1.2.3 of RG 1.174 provide seven considerations of proposed licensing changes regarding defense-in-depth. The first consideration, “Preserve a reasonable balance among the layers of defense,” states the licensing change should not significantly reduce the effectiveness of a layer of defense. The fifth consideration, “Maintain multiple fission product barriers,” states the change should not significantly reduce the effectiveness of these barriers.

Section 3.1.2 of Enclosure 1 to the LAR states that the process used for core damage defense-in-depth is the same as the one used for containment defense-in-depth with the exception that the FPIE LERF PRA model will be used as discussed in PWROG-20015-NP, and each system categorized continues using the guidance in NEI 00-04, Section 6.2, “Long-Term Containment Integrity.” Section 2.2.5 of the PWROG guidance states that a reasonable balance among the layers of defense is achieved in this method because there is a reasonable confidence that SSCs will remain capable of performing their safety-related functions.

Regarding fission product barriers, the method is stated to maintain reasonable confidence that the barriers will perform their safety-related functions.

A. *Step 8.b.1 of the PWROG guidance states to only filter cutsets with a single basic event (e.g., SSC failure, CCF, or HFE) that leads to containment failure. The NRC staff notes that core damage cutsets that lead to a plant damage state proceeding to a large early release event usually contains more than one failure: typically, at least one failure leading to core damage and one failure related to loss of containment. It is unclear to the NRC staff if the containment defense-in-depth approach applies the filtering process to the core damage cutset failures or to the containment-related failures. During the audit, the licensee clarified that only basic events representing failures that resulted in both core damage and large early release would be screened for HSS consideration. The Limerick pilot of the proposed alternate method did not identify any SSCs as HSS for the containment defense in depth. Provide justification that the proposed method for defense-in-depth is in accordance with the seven defense-in-depth considerations of RG 1.174, with particular emphasis on items 1 (i.e., preserve reasonable balance among the layers of defense) and 5 (i.e., maintain multiple fission product barriers).*

   Response

   The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

B. *The single basic event approach (first order cutset) will either identify single point failures that represent a lack of defense-in-depth or common cause failure of several components that represent a lack of diversity. The layered approach of defense-in-depth would be represented by cutsets with two or more basic events. It is unclear to the NRC staff the basis of why this approach is adequate for defense-in-depth categorizations.*

   i. *Clarify if the intent of the alternate defense-in-depth method is to assign 'candidate' HSS to SSCs that provide only one layer of defense to an event (e.g., no defense-in-depth exists).*

      Response

      The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

ii. *Regarding SSCs that have only one back-up function that is not diverse, explain and justify why the SSC should not be categorized as HSS. Include in this discussion how this explanation is in accordance with the seven defense-in-depth considerations of RG 1.174.*

Response

The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

iii. *With regards to the answer to Parts i and ii above, provide justification that this approach does not adversely impact the categorization process.*

Response

The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

C. *Step 8.b.2.a of the PWROG guidance states that cutsets with IEFs less than 1E-04 per year may be screened from the alternate defense-in-depth approach. Section 6.2 of NEI 00-04 provides guidance for considering containment bypass events, such as ISLOCAs, in determining passive SSC categorization. Containment bypass events usually have an IEF < 1E-04/year, yet they are significant contributors to LERF risk since they bypass the containment. Therefore:*

i. *Describe how the alternate containment defense-in-depth approach assesses containment bypass events. Include in this discussion the treatment of cutsets that do not contain a containment-related SSC failure that was not part of the core damage cutset.*

Response

The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

ii. *Provide justification that the screening of a containment bypass events associated with an IEF < 1E-04/year is consistent with the seven defense-in-depth RG 1.174 considerations. Include in this discussion how the third layer of defense for public health and safety is bypassed.*

Response

The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

D. *The guidance on containment defense-in-depth in Chapter 6 of NEI 00-04 contains the following questions to decide whether SSCs are to be HSS that address containment isolation:*

- *Does the SSC support containment isolation for containment penetrations that are:*
  - *directly connected to containment atmosphere, and*
  - *> 2 inches in diameter, and*
  - *not locked closed or only locally operated?*

- *Does the SSC support containment isolation for containment penetrations that are:*
  - *part of the reactor coolant system pressure boundary, and*
  - *> 3/8 inches in diameter, and*
  - *not locked closed or only locally operated?*

Describe how the containment penetrations are modeled in the Limerick PRA. Describe whether and, if yes, how the above considerations on containment isolation defense-in-depth from NEI 00-04 are addressed by the new proposed alternate defense-in-depth.

Response

The request for the NRC to approve the alternate containment defense-in-depth approach has been rescinded. Though Constellation considers the proposed Containment Defense in Depth an acceptable alternative approach to the approved process, Limerick, in coordination with the PWROG elected to withdraw this portion of the submittal. Limerick and the PWROG determined that efficiency gains to the overall categorization process will be best substantiated after the Limerick LAR is approved. Therefore, this RAI response no longer applies. Limerick will continue to use its currently approved NEI 00-04 Section 6.2 categorization methodology for Containment Defense in Depth.

References

[1] Exelon Generation Company, LLC letter to the U.S. Nuclear Regulatory Commission, Limerick Generating Station, Units 1 and 2, "Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Tier 1 Categorization Process [...]," dated March 11, 2021 (ADAMS Accession No. ML21070A412).

[2] Exelon Generation Company, LLC letter to the U.S. Nuclear Regulatory Commission, Limerick Generating Station, Units 1 and 2, "Supplement - Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Tier 1 Categorization Process [...]," dated May 5, 2021 (ADAMS Accession No. ML21125A215).

[3] Email from A. Klett (U.S. Nuclear Regulatory Commission) to G. Stewart (Constellation Energy Generation, LLC), "NRC Request for Additional Information - Limerick License Amendment Request (L-2021-LLA-0042)," dated May 13, 2022 (ADAMS Accession No. ML22136A003).

[4] USNRC letter from Thomas G Hiltz, Chief, Plant Licensing Branch IV, Division of Operating Reactor Licensing Office of Nuclear Reactor Regulation to Mr. Brian S. Ford, Senior Manager, Nuclear Safety & Licensing, Entergy Operations, Inc.,, "GRAND GULF NUCLEAR STATION UNIT 1 - REQUEST FOR ALTERNATIVE GG-ISl-002 - IMPLEMENT RISK-INFORMED INSERVICE INSPECTION PROGRAM BASED ON AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE, CODE CASE N-716, (TAC NO. MD3044)," dated September 21, 2007..

[5] USNRC letter from Travis L. Tate, Acting Branch Chief, Plant Licensing Branch 3-1, Division of Operating Reactor Licensing, Office of Nuclear Reactor Regulation to Mr. Mano K. Nazar Senior Vice President and Chief Nuclear Officer, Indiana Michigan Power, "DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2 - RISK-INFORMED SAFETY-BASED INSERVICE INSPECTION PROGRAM FOR CLASS 1 AND 2 PIPING WELDS (TAC NOS. MD3137 AND MD3138)," dated September 28, 2007.

[6] USNRC letter from John A. Zwolinski, Director, Division of Licensing Project Management Office of Nuclear Reactor Regulation to Mr. William T. Cottle President and Chief Executive Officer STP Nuclear Operating Company South Texas Project, "SOUTH

TEXAS PROJECT, UNITS 1 AND 2 - DRAFT REVIEW GUIDELINES ON RISK-INFORMED EXEMPTIONS FROM SPECIAL TREATMENT REQUIREMENTS (TAC NOS. MA6057/MA6058)," dated July 19, 2000. .

[7] Pressurized Water Reactors Owners Group, PWROG-20015-NP, Revision 3, "Alternate 10 CFR 50.69 Defense-in-Depth Categorization Process," dated June 2022.

[8] The American Society of Mechanical Engineers, American Nuclear Society, ASME/ANS RA-Sa-2009, "Standard for Level l/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications Addendum A to RA-S-2008," dated February 2009.

[9] U.S. Nuclear Regulatory Commission, Regulatory Guide 1.200, Revision 2, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," March 2009.

[10] U.S. Nuclear Regulatory Commission, Regulatory Guide 1.174, Revision 3, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," dated January 2018.

[11] Nuclear Energy Institute, NEI 00-04, Revision 0, "10 CFR 50.69 SSC Categorization Guideline," dated July 2005.

[12] Limerick Generating Station, Units 1&2, Updated Final Safety Analysis Report, Revision 20, dated September 20, 2020.

[13] 10 CFR 50.69, Final Rule, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors," dated November 22, 2004..

Attachment 1

Response to Request for Additional Information
License Amendment Request

Limerick Generating Station, Units 1 and 2
Docket Nos. 50-352 and 50-353

Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Categorization Process in Accordance with the Requirements of 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors"

Appendix A

Revised Proposed FOL Appendix C License Condition Markups

APPENDIX C

ADDITIONAL CONDITIONS
OPERATING LICENSE NO. NPF-39

Constellation Energy Generation, LLC shall comply with the following conditions on the schedule noted below:

Amendment No.	Additional Conditions
230, 255, [XXX]	Constellation Energy Generation, LLC is approved to implement 10 CFR 50.69 using the processes for categorization of Risk-Informed Safety Class (RISC)-1, RISC-2, RISC-3, and RISC-4 structures, systems, and components (SSCs) using: Probabilistic Risk Assessment (PRA) models to evaluate risk associated with internal events, including internal flooding, and internal fire; the shutdown safety assessment process to assess shutdown risk; the Arkansas Nuclear One, Unit 2 (ANO-2) passive categorization method to assess passive component risk for Class 2 and Class 3 SSCs and their associated supports; and the results of non-PRA evaluations that are based on the IPEEE Screening Assessment for External Hazards, i.e., seismic margin analysis (SMA) to evaluate seismic risk, and a screening of other external hazards updated using the external hazard screening significance process identified in ASME/ANS PRA Standard RA-Sa-2009; as specified in Unit 1 License Amendment No. 230 dated July 31, 2018. ~~Constellation Energy Generation, LLC will complete the implementation items listed in Attachment 2 of Exelon letter to NRC dated April 23, 2018 prior to implementation of 10 CFR 50.69. All issues identified in the attachment will be addressed and any associated changes will be made, focused-scope peer reviews will be performed on changes that are PRA upgrades as defined in the PRA standard (ASME/ANS RA-Sa-2009, as endorsed by RG 1.200, Revision 2), and any findings will be resolved and reflected in the PRA of record prior to implementation of the 10 CFR 50.69 categorization process.~~ Prior NRC approval, under 10 CFR 50.90, is required for a change to the categorization process specified above (e.g., change from a seismic margins approach to a seismic probabilistic risk assessment approach).

Replace with UNIT 1 FOL INSERT

UNIT 1 FOL INSERT

In addition, Constellation Energy Generation, LLC (CEG) is approved to implement 10 CFR 50.69 using any of the following alternative processes for categorization of RISC-1, RISC-2, RISC-3, and RISC-4 SSCs as specified in Unit 1 License Amendment No. [XXX] dated [DATE]:

- the alternative defense-in-depth approach as described in the licensee’s letters dated March 11, 2021, May 5, 2021, and June 30, 2022.
- the alternative pressure boundary categorization approach as described in licensee’s letters dated March 11, 2021, and June 30, 2022.
- the alternative seismic approach as described in the licensee's letters dated December 15, 2021, and February 14, 2022.

APPENDIX C

ADDITIONAL CONDITIONS
OPERATING LICENSE NO. NPF-85

Exelon Generation Company, LLC shall comply with the following conditions on the schedule noted below:

Amendment No.	Additional Conditions
~~193~~ [YYY]	Exelon is approved to implement 10 CFR 50.69 using the processes for categorization of Risk-Informed Safety Class (RISC)-1, RISC-2, RISC-3, and RISC-4 structures, systems, and components (SSCs) using: Probabilistic Risk Assessment (PRA) models to evaluate risk associated with internal events, including internal flooding, and internal fire; the shutdown safety assessment process to assess shutdown risk; the Arkansas Nuclear One, Unit 2 (AN0-2) passive categorization method to assess passive component risk for Class 2 and Class 3 SSCs and their associated supports; and the results of non-PRA evaluations that are based on the IPEEE Screening Assessment for External Hazards, i.e., seismic margin analysis (SMA) to evaluate seismic risk, and a screening of other external hazards updated using the external hazard screening significance process identified in ASME/ANS PRA Standard RA-Sa-2009; as specified in Unit 2 License Amendment No. 193 dated July 31, 2018. ~~Exelon will complete the implementation items listed in Attachment 2 of Exelon letter to NRC dated April 23, 2018 prior to implementation of 10 CFR 50.69. All issues identified in the attachment will be addressed and any associated changes will be made, focused-scope peer reviews will be performed on changes that are PRA upgrades as defined in the PRA standard (ASME/ANS RA-Sa-2009, as endorsed by RG 1.200, Revision 2), and any findings will be resolved and reflected in the PRA of record prior to implementation of the 10 CFR 50.69 categorization process.~~ Prior NRC approval, under 10 CFR 50.90, is required for a change to the categorization process specified above (e.g., change from a seismic margins approach to a seismic probabilistic risk assessment approach).

Replace with UNIT 2 FOL INSERT

UNIT 2 FOL INSERT

In addition, Constellation Energy Generation, LLC (CEG) is approved to implement 10 CFR 50.69 using any of the following alternative processes for categorization of RISC-1, RISC-2, RISC-3, and RISC-4 SSCs as specified in Unit 2 License Amendment No. [XXX] dated [DATE]:

- the alternative defense-in-depth approach as described in the licensee’s letters dated March 11, 2021, May 5, 2021, and June 30, 2022.
- the alternative pressure boundary categorization approach as described in licensee’s letters dated March 11, 2021, and June 30, 2022.
- the alternative seismic approach as described in the licensee's letters dated December 15, 2021, and February 14, 2022.

Attachment 2

Response to Request for Additional Information
License Amendment Request

Limerick Generating Station, Units 1 and 2
Docket Nos. 50-352 and 50-353

Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Categorization Process in Accordance with the Requirements of 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors"

EPRI 3002015999 Markups

ELECTRIC POWER RESEARCH INSTITUTE

Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components

~~3002015999~~

- **Cost-effective**. On a plant-specific basis, the new categorization methodology is applied once, no matter how many systems are selected for full 10 CFR 50.69 categorization and alternative treatment. Additionally, if a licensee were to categorize five systems in Year X and then were to categorize another five systems in Year X+1, the list of HSS systems/subsystems from a pressure boundary perspective would not change. Obviously, this would have a positive impact on the cost of pressure boundary categorization. Additionally, as discussed previously, this would provide stability to the overall categorization scheme.

4.1 Prerequisites

Prior to implementing the categorization process contained in section 4.2, a licensee will need to assure that the following prerequisites have been met. Each requirement is listed below and explained in further detail in succeeding paragraphs.

- Prerequisite 1 – PRA technical adequacy
  - Robust internal events PRA model, including IF
- Prerequisite 2 – Integrity management
  - Robust program that addresses localized corrosion
  - Robust program that addresses FAC
  - Robust program that addresses erosion
- Prerequisite 3 – Protective measures for IF events

Prerequisite 1 – PRA technical adequacy (Pressure Boundary Failures)~~IF~~

As stated previously, the plant needs to have a robust internal events PRA, including IF, that addresses failure of all pressure boundary components (e.g. main steam line breaks, main feedwater line breaks, internal flooding events, interfacing system LOCA, etc.). As this methodology is being used in support of 10CFR50.69 applications, the plant-specific PRA needs to be sufficient to support the License Amendment Request (LAR) approval process, including consideration of PRA assumptions and sources of uncertainty.

Paragraph 50.69(c)(1)(i) of 10 CFR requires, in part, that the PRA must be of sufficient quality and level of detail to support the categorization process, and must be subjected to a peer review process assessed against a standard or set of acceptance criteria that is endorsed by the NRC. Paragraph 50.69(b)(2)(iii) of 10 CFR requires the results of the PRA review process conducted to meet 10 CFR 50.59(c)(1)(i) be submitted as part of the application. This can include full-scope peer review of the internal events and internal flooding PRA against RG 1.200, Revision 2 as well as a gap assessments of earlier peer reviews of the internal events and internal flooding PRA against RG 1.200, Revision 2. An example of the review of a plant-specific PRA that meets these requirements can be found in [X1].

~~A similar requirement was imposed upon the development of RI-ISI programs. To help determine if a plant had a PRA sufficient to develop an RI-ISI program, EPRI report 1021467, *Probabilistic Risk Assessment Technical Adequacy Guidance for Risk-Informed In-Service Inspection Programs,* [12] was developed. This report identifies which portions of the PRA (that is, supporting requirements [SRs]) apply to the development of RI-ISI programs and for those~~

~~portions of the PRA that do apply to (RI-ISI) programs, what level of technical adequacy is needed.~~

~~EPRI report 1021467 has been reviewed to identify whether its technical justification and conclusions are also valid for the categorization of pressure boundary components for 10 CFR 50.69 purposes. That is, is a PRA that meets the requirements of 1021467 sufficient to support the categorization of pressure boundary components for 10 CFR 50.69 purposes?~~

~~As it pertains to 10 CFR 50.69, insights obtained from this review of EPRI report 1021467 include the following:~~

- ~~RI-ISI and 10 CFR 50.69 both require a living program component (for example, 10 CFR 50.69(e) Feedback and Process Adjustment).~~
- ~~EPRI report 1021467 was able to show that inclusion of external hazards (for example, seismic and internal fires) was not required in order to develop an RI-ISI program because their inclusion would not change the conclusions derived from the RI-ISI process. Because of the broad spectrum of programs that can be impacted by 10 CFR 50.69, this conclusion may be overly optimistic for 10 CFR 50.69 categorization purposes. However, as NEI00-4 requires that external hazards be included in the overall categorization process, they do not need to be explicitly addressed as part of this new enhanced methodology for pressure boundary components. (Note: EPRI Report 3002012988, *Alternative Approaches for Addressing Seismic Risk in 10CFR50.69 Risk-Informed Categorization* [13], has been developed as an alternative to NEI00-04 and is under review by NRC for the Calvert Cliffs application [14].~~
- ~~EPRI report 1021467 makes several statements that key assumptions and treatment of uncertainties will not significantly impact the results of the RI-ISI program. As to 10 CFR 50.69 applications, key uncertainties and assumptions are addressed as part of the LAR process, so an explicit consideration for this new methodology is not required. (Note: NEI has developed a 10 CFR 50.69 LAR template that incorporates lessons learned from industry/NRC interactions on this topic.)~~
- ~~Regarding SR IF-B2, report 1021467 noted that RI-ISI only applied to piping. 10 CFR 50.69 can also apply to tanks, gaskets, fitting, and so on. As the requirements for this SR apply to all capability categories, there is no change is needed to support 10 CFR 50.69 applications.~~
- ~~SR IF-C3b deals with inter-area propagation and barriers to inter-area propagation, including penetrations, doors, walls, hatchways, and heating, ventilation, and air conditioning (HVAC) ducts. One of the prerequisites of this enhanced methodology is that these barriers cannot be categorized as RISC-3 without an explicit evaluation of the barriers' impact on the pressure boundary categorization results.~~
- ~~SR IF-D6 deals with the consideration of human-induced floods. 10 CFR 50.69 categorization results (HSS or LSS) will not negatively or positively impact these actions.~~

~~In conclusion, PRA models meeting the guidance of EPRI report 1021467 taken together with the overall 10 CFR 50.69 categorization process (NEI00-04, EPRI report 3002012988 [2, 13]), and the LAR submittal and review process provides required confidence that the plant-specific internal events PRA including IF is robust and capable of identifying any plant-specific outliers that should be defined as HSS.~~

Prerequisite 2 – Integrity management

In the context of developing an enhanced methodology for categorizing pressure boundary components for 10CFR50.69 purposes, it is important to note that approval to implement 10CFR50.69 does not absolve a Licensee from meeting other commitments related to pressure boundary integrity. For example, NEI-03-08 (Guidelines For The Management Of Materials Issues), Material Reliability Program (MRP), Boiling Water Reactor Vessel and Internals Project (BWRVIP), License Renewal / Subsequence License Renewal (SR/SLR).

Further, during the development of the risk-informed inservice inspection methodologies (RI-ISI) a number of reviews of various degradation mechanisms potentially operative in safety related and non-safety related systems was conducted. As a result of these efforts [X1 – X7], it was determined that for systems typically outside the scope of an ISI program the requirements identified below were the appropriate means of assuring pressure boundary integrity

Systems/subsystems typically included with in a RI-ISI program (e.g. NRC approved code case N-716-1) that are also within the scope of the pre-determined set of HSS systems/ subsystems contained with the enhanced methodology would continue to be treated within the confines of the RI-ISI program.

Finally (d)(2) the 10CFR50.69 rule requires that the Licensee conduct periodic inspection and testing activities to determine that RISC–3 SSCs will remain capable of performing their safety-related functions under design basis conditions. For significant conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined and corrective action is taken to preclude repetition.

As such, application of the prerequisites below in the context of 10CFR50.69 will provide a robust mechanism for assuring pressure boundary integrity:

~~The following aspects address key issues associated with the reliability of passive SSCs:~~

- **Robust program that addresses localized corrosion**. The plant shall have a robust program that addresses localized corrosion (for example, pitting and microbiologically influenced corrosion that follows the guidance contained in EPRI reports TR-103403, *Service Water System Corrosion and Deposition Sourcebook* [15]; 3002003190, *Engineering and Design Considerations for Service Water Chemical Addition Systems*; [16]; TR-102063, *Guide for the Examination of Service Water System Piping* [17], 1010059, *Service Water Piping Guideline* [18], and 1016456, *Recommendations for an Effective Program to Control the Degradation of Buried Pipe* [19]. Program health can be determined via self-assessments, benchmarking, or peer review.
- **Robust program that addresses FAC**. The plant shall have a robust program to address FAC that follows the recommendations contained in EPRI report 3002000563 *Recommendations for an Effective Flow-Accelerated Corrosion Program* [20]. This may include the use of standardized health reports such as those developed out of NEI Efficiency Bulletin 16-34, *Streamline Program Health Reporting* [21].
- **Robust program that addresses erosion**. The plant shall have a robust program to address erosion that follows the guidance of EPRI report 3002005530, *Recommendations for an Effective Program Against Erosive Attack* [22]. For a number of licensees, this may be addressed as part of a license renewal commitment. Additionally, some licensees may

include erosion within their FAC program, whereas other licensees may choose to address erosion as a separate program.

Prerequisite 3 – Protective measures for IF events

Protective measures for IF events (that is, floor drains, flood alarm equipment, and barriers) shall not be categorized as LSS unless additional evaluations have been conducted to show that loss of these measures, or a subset of these measures, will not invalidate the HSS determination provided in section 4.2. For example, if a submarine door has been credited in preventing a flood from exiting one flood zone into another flood zone, then that submarine door shall be considered HSS unless an evaluation has been conducted showing that loss of the submarine door will not significantly increase plant risk (i.e. exceed criterion 11, 12 or 13).

4.2 Predetermined HSS Passive SSCs

The following section describes the scope of systems, subsystems, and piping segments that have been predetermined to be HSS. Table 4-1 also identifies the scope of predetermined components together with a listing of additional clarifications and considerations that were used in defining this scope.

HSS components shall include the following:

1. Class 1 portions of the RCPB, with the exception of the following:
   a. In the event of postulated failure of the component during normal reactor operation, the reactor can be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system.
   b. The component is or can be isolated from the reactor coolant system by two valves in series (both closed, both open, or one closed and the other open). Each open valve must be capable of automatic actuation and, assuming the other valve is open, its closure time must be such that, in the event of postulated failure of the component during normal reactor operation, each valve remains operable and the reactor can be shut down and cooled down in an orderly manner, assuming makeup is provided by the reactor coolant makeup system only.

> Note: Depending upon the plant-specific licensing basis, the above may be classified as Class 1, Class 1 exempt, or non-Class 1 (e.g. Class 2). For plants that have classified this piping as Class 1 or Class 1 exempt, consideration should be given to re-classifying this piping as other than Class 1 in order to gain the full benefit of a 10CFR50.69 application. This change would obviously need to follow the applicable commitment change control process (e.g. 10CFR50.59).

2. Applicable portions of the shutdown cooling pressure boundary function. That is, Class 1 and 2 components of systems or portions of systems needed to use the normal shutdown cooling flow path in either of the following ways:
    a. As part of the RCPB from the reactor pressure vessel (RPV) to the second isolation valve (that is, farthest from the RPV) capable of remote closure, or to the containment penetration, whichever encompasses the larger number of welds
    b. As part of other systems or portions of systems from the RPV to the second isolation valve (that is, farthest from the RPV) capable of remote closure or to the containment penetration, whichever encompasses the larger number of welds
3. Class 2 portions of steam generators and Class 2 feedwater system components greater than nominal pipe size (NPS) 4 (DN 100) of pressurized water reactors (PWRs) from the steam generator to the outer containment isolation valve.
4. Components larger than NPS 4 (DN 100) within the break exclusion region (BER) for high-energy piping systems, as applicable.
5. Portions of the ultimate heat sink (UHS) flow path (for example, service water) whose failures will fail both trains (that is, unisolable failure of the UHS function). (Note: even if piping is isolated/independent, structures such as the service water pumphouse [for example, reservoir, bay] would be expected to be HSS.)
6. Tanks/vessels and connected piping and components up to the first isolation valve that support/provide inventory to multiple systems/functions (for example, refueling water storage tank [RWST] and containment sump for PWRs, suppression pool [SP] for boiling water reactors [BWRs]).
7. Condensate storage tank (CST) for auxiliary feedwater (AFW)/emergency feedwater (EFW) in a PWR unless there is a redundant independent reliable source (for example, auto switchover to service water supply to each train of AFW/EFW suction). This includes connected piping greater than 4 in. (101.6 mm) up to the first isolation valve in the AFW/EFW protected volume of the CST.
8. For PWR plants, low-volume, intermediate safety systems that typically consist of two physically independent trains (for example, component cooling water [CCW]) that are, on a plant-specific basis, physically connected. For example, loss of pressure boundary integrity of train A will drain train B as well.
9. Heat exchangers that if they fail (for example, tube or tubesheet failures) could allow reactor coolant to bypass primary containment while the plant is at-power or during shutdown).
10. Other heat exchangers—if not explicitly addressed in 11 through 13 below, other heat exchangers should be evaluated to determine if component failure (for example, tube or tubesheet) may impact multiple systems. If yes, the methodology and criteria of [5, 6] shall be used to determine HSS versus LSS assignment.
11. Any piping or component, (including piping segments or components grouped or subsumed within existing plant initiating event groups, (e.g. main feedwater breaks inside containment, main steam line breaks outside containment, service water flooding events, interfacing system LOCA) whose contributions to CDF is greater than 1E-06/year, or whose contribution to LERF is greater than 1E-07/year, based upon a plant-specific PRA model that

includes pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses).

12. Any piping or component, (including piping segments or components grouped or subsumed within existing plant initiating event groups, (e.g. main feedwater breaks inside containment, main steam line breaks outside containment, service water flooding events, interfacing system LOCA) whose contributions to CDF is greater than 1E-08/year and the product of its CDF contribution times its associated CCDP is greater than 1E-08/year, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses). (See Figure 4-1.)

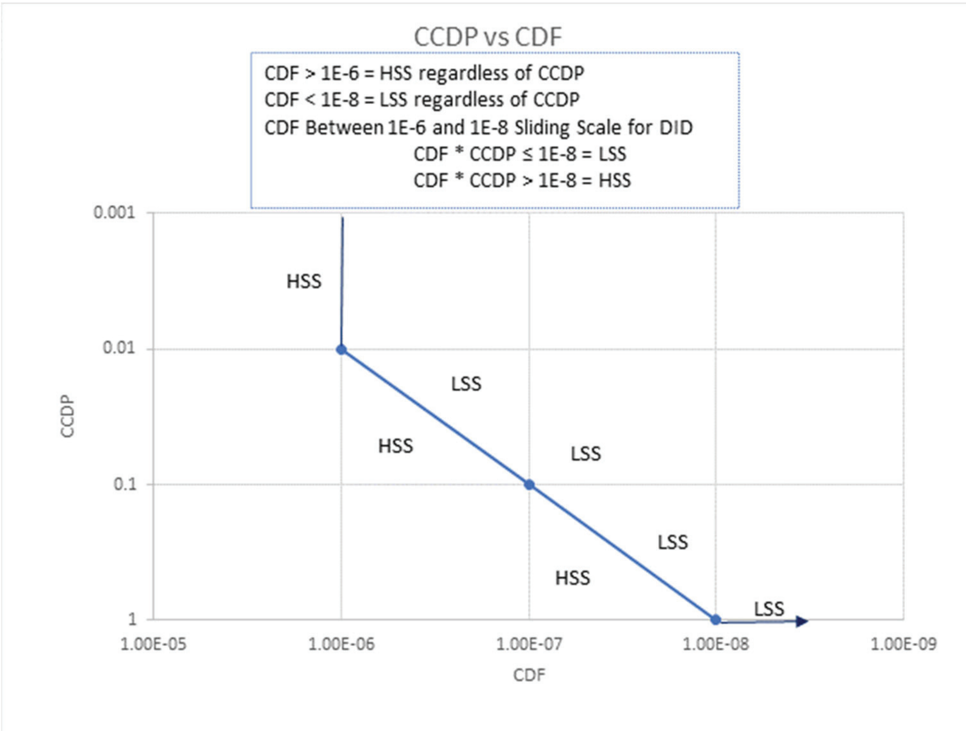

Figure 4-1
CCDP versus CDF threshold

13. Any piping or component, (including piping segments or components grouped or subsumed within existing plant initiating event groups, (e.g. main feedwater breaks inside containment, main steam line breaks outside containment, service water flooding events, interfacing system LOCA) whose contributions to LERF is greater than 1E-09/year and the product of its LERF contribution times its associated CLERP is greater than 1E-09/year, based upon a plant-specific PRA of pressure boundary failures (for example, pipe whip, jet impingement, spray, and inventory losses). (See Figure 4-2.)

For criterion 11, 12 and 13, care should be taken in reviewing the PRA results so that total contribution to CDF and LERF are compared to the risk metrics. For example, separate scenarios of spray, moderate flood and large flood based on different plant impacts should be combined so that the cumulative impact of the SSC is compared to each risk metric (i.e. CDF, LERF, CCDP, CLERP).

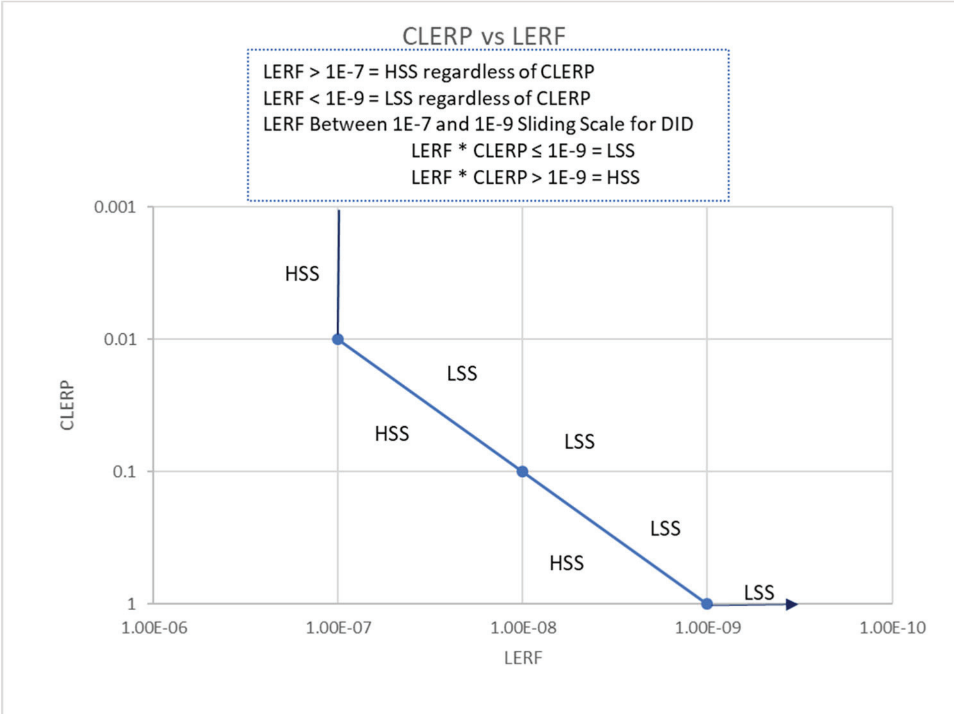

Figure 4-2
CLERP versus LERF threshold

For purposes of applying criterion Nos. 11, 12 and 13, the definition of a pipe segment is not a function of whether it was categorized as HSS or LSS per criterion Nos. 1 through 10. That is, even if a piping segment, or a portion of a pipe segment, is HSS per one of the first ten of the criteria above, the impact on risk due to its postulated failure is determined consistent with industry guidance (e.g., PRA standard, EPRI 1019194).

While ASME Code Case N-660 is referenced in NEI 00-04, it should be noted that all 10CFR50.69 submittals approved to date reference the ANO2-R&R-004 methodology (RI-RRA) for categorizing pressure boundary components. The technical basis for the ANO RI-RRA methodology is EPRI TR-112657, Rev B-A which is also codified in ASME Code Case N-578 and Appendix R, Supplement 2. A streamlined version of which in contained in NRC endorsed ASME Code Case N-716.

While slightly different in wording each of these approaches as to "piping segments" have the same purpose. That is, to group pressure retaining items (e.g., welds, valve bodies, pipe runs, etc.) by common consequence.

In its simplest application, if postulated failure of the entire system (direct and indirect effects) had the same consequence (e.g., causes an initiating event X), then only a single segment would need to be defined. However, from a practical perspective this is typically not the case and the system would be divided into segments as the postulated consequence of failure changes. This "segmentation" can be caused by a multitude of impacts such as different trains within the system (e.g., train A versus train B), piping located in different parts of the plant (e.g. flood area C versus flood area D), piping in the same train and same plant area but a portion is upstream of an isolation valve and the other portion is downstream of an isolation.

14. Piping/component support boundaries. Any of the following options may be used:

    a. Supports (for example, component support, hanger, or snubber) may remain un-categorized until a need has been identified (for example, a significant repair/replacement or modification is required).

    b. A component support, hanger, or snubber shall have the same categorization as the highest ranked piping segment within the piping analytical model in which the support is included.

    c. A combination of restraints or supports such that the LSS piping and associated SSCs attached to the HSS piping are included in scope up to a boundary point that encompasses at least two supports in each of three orthogonal directions [23, 24].

Systems, subsystems, and segments that meet any of the above criteria ~~in the~~ are to be categorized HSS. All other safety-related and non-safety-related systems, subsystems, and components not classified as HSS in accordance with the preceding list shall be categorized LSS.

With respect to categorizing supports (for example, component support, hanger, or snubber) there has been considerable discussion as whether support should be included within a system boundary. The 10CFR50.69 rule allows the Licensees to define the system boundaries and then all components within that system boundary would need to be included in that system's categorization. Currently approved 10CFR50.69 LARs are using the "ANO2-R&R-004" [Z] methodology, which can be applied to "Class 2 and 3 pressure retaining items or their associated supports". As such, component supports, hangers, or snubbers need not be included within a system categorization. Additionally, the example system categorization provided by ANO2 to NRC during RAIs for the relief request included pressure boundary components only. That is, component supports, hangers, or snubbers were not included within the system boundary categorization.

Consistent with this approach, the enhanced methodology does not require component supports, hangers, or snubbers be categorized as part of categorizing the pressure boundary function. The exception to this is when the enhanced methodology identifies non-safety related pressure boundary components as high safety significant. In this case once the categorization is approved by the IDP panel, 50.69(d) requires that the licensee ensure that RISC–2 SSCs perform their functions consistent with the categorization process assumptions by evaluating treatment being applied to these SSCs to ensure that it supports the key assumptions in the categorization process that relate to their assumed performance. Thus, this review should include an assessment of the supports once RISC-2 SSCs are identified.

5.3 Criterions 11, 12 and 13

Application of criteria 11, 12 and 13 identifies plant-specific pressure boundary components that are not assigned to the generic HSS category but that may be risk-significant at a particular plant. Criterion 11 of the enhanced methodology requires that any piping or component whose contribution to CDF (LERF) greater than 1E-6/year (1E-7/year) be assigned to the HSS category. As discussed in the Grand Gulf and DC Cook Safety Evaluation Reports for their ASME Code Case N-716 relief requests [X, Y], these guideline values (1E-6 / 1E-7) are suitably small and consistent with the decision guidelines for acceptable changes in CDF and LERF found in NRC endorsed EPRI TR-112657, Rev B-A. Criterion 11 was added as a defense-in-depth measure to provide a method of ensuring that any plant-specific locations that are important to safety are identified. Criterion 11 is only used to add HSS segments and not, for example, to remove system parts generically assigned to the HSS in criterion 1 through 10.

To further the goal of defense-in-depth beyond that previously found acceptable, criterion 12 and 13 were developed and added to the enhanced methodology to conservatively increase the confidence that somewhat important pressure boundary components would not be missed on a plant-specific basis. By incorporating CCDP/CLERP (conditional core dame probability / conditional large early release probability) metrics these measures also provide additional balance between prevention and mitigative. That is, components cannot be assigned to the LSS population based solely on low failure likelihood, unless that likelihood is remote. That is, less than 1E-08 CDF and less than 1E-09 LERF. Similar to criterion 11, criterions 12 and 13 were added to provide additional means of ensuring that any plant-specific locations that are important to safety are identified. Criterion 12 and 13, are used to add HSS segments and not, for example, to remove system parts generically assigned to the HSS in criterion 1 through 10. Finally, 10CFR50.69(d)(2) requires that Licensees ensure, with reasonable confidence, that RISC–3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life.

Criterion 11, 12 and 13 provides confidence that the goal of identifying the more risk-significant locations is met while permitting the use of generic HSS system parts identification to simplify and standardize the evaluation. Satisfying the guidelines in criterion 11, 12 and 13 requires confidence that the PRA (internal event PRA, internal flooding PRA) is capable of identifying the significant contributors to risk that are not included in the generic results. RG 1.200 states that meeting the attributes of an NRC-endorsed industry PRA standard may be used to demonstrate that a PRA is adequate to support a risk-informed application. RG 1.200 further states that an acceptable approach that can be used to ensure technical adequacy would trigger a peer review of the PRA. As discussed in Prerequisite #1, a robust plant-specific PRA is required to implement this enhanced methodology.

Table 5-3 below provides examples of industry experience of pressure boundary components that exceeded the 1E-6 / 1E-7 metrics. This table provides examples of safety improvements that have been brought about by voluntary implementation of criterion 11 on other risk-informed applications. It is expected that use of criterion 12 and 13 together with criterion 11 will provide additional safety improvements.

Table 5-32
Examples of Implementation of Criterion 11

Plant No.	Issue	Action
1	Interfacing system LOCA exceeded metrics	More refined / realistic analyses
2	Interfacing system LOCA exceeded metrics	More refined / realistic analyses
3	Failure of a fire protection line in the Auxiliary Building which was postulated to flood the Electrical Switchgear Cable Enclosure, Battery Room and Battery Charger	Plant hardware modification (piping removed from area)
	Failures of the circulating water system in the Condenser Pit (CDF contribution of 3.75E-06).	Operating Procedure update to better define human error probabilities (HEPs)
4	Failure of a fire protection line in the Auxiliary Building which was postulated to flood the Electrical Switchgear Cable Enclosure, Battery Room and Battery Charger	Plant hardware modification (piping removed from area)
	Failures of the circulating water system in the Condenser Pit (CDF contribution of 3.75E-06).	Operating Procedure update to better define HEPs
5	Fire protection piping in auxiliary building	Supplementary visual inspection of the associated fire protection piping is required every quarter and 6 UT (thickness) exams per interval.
6	Fire protection piping in auxiliary building	Supplementary visual inspection of the associated fire protection piping is required every quarter and 6 UT (thickness) exams per interval.

Plant No.	Issue	Action
7	Plant service water exceeded LERF criterion	More refined / realistic analyses
8	Service Water piping in the 480V switchgear room	Five new inspections added looking for wall loss
9	Class 3 nuclear service water in auxiliary feedwater pump room impacting mechanical / electrical equipment	New NDE selected
10	Class 3 nuclear service water in auxiliary feedwater pump room impacting mechanical / electrical equipment	New NDE selected
11	Flooding caused by fire protection piping in the East DC switchgear room	3 of 10 mechanical connections selected for inspection
12	Service Water in Cable Spreading Room – loss of electrical equipment	New NDE selected
13	Service Water in Cable Spreading Room – loss of electrical equipment	New NDE selected

Plant No.	Issue	Action
14	Service Water in Auxiliary building exceeded metrics	Updated analysis to allow credit for operator action in response to the postulated flood scenario
	Service Water in Control Building exceeded metrics	Updated analysis to allow credit for operator action in response to the postulated flood scenario
15	Failure of fire protection in the control building (3 separate locations) can cause loss of ESWG Rooms and CSR	Hardware (i.e. flow limiting orifice) and procedure modification
16	This remaining scenario involves a flood originating in the turbine building zone designated TGB. The area is located at elevation 46 feet, essentially plant grade.	More refined / realistic analyses
17	High Pressure Firewater in Auxiliary building exceeded metrics	New NDE and/or removal of piping
	Raw Cooling Water in Auxiliary Building exceeded metrics	New NDE and/or removal of piping
18	Failure of expansion bellows can cause loss of ESWG Rooms	Hardware and NDE being investigated

18. *Service Water Piping Guideline*. EPRI, Palo Alto, CA: 2005. 1010059.
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Attachment 3

Response to Request for Additional Information
License Amendment Request

Limerick Generating Station, Units 1 and 2
Docket Nos. 50-352 and 50-353

Application to Implement an Alternate Defense-in-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Categorization Process in Accordance with the Requirements of 10 CFR 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors"

PWROG-20015-NP Revision 3 with Revision Bars

PRESSURIZED WATER REACTOR OWNERS GROUP

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PWROG-20015-NP
Revision 3

WESTINGHOUSE NON-PROPRIETARY CLASS 3

Alternate 10 CFR 50.69 Defense-in-Depth Categorization Process

Risk Management Committee

PA-RMSC-1769, Revision 2

June 2022

Westinghouse

PWROG-20015-NP
Revision 3

Alternate 10 CFR 50.69 Defense-in-Depth Categorization Process

PA-RMSC-1769, Revision 2

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June 2022

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Record of Revisions

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1	March 2021	Removal of export control disclaimer for NRC public release.
2	January 2022	Updates to process to address NRC comments, improve clarity, and provide additional basis information.
3	June 2022	Updates to process to address NRC comments, improve clarity, and provide additional basis information. Change bars identify modifications between Revision 1 and Revision 3.

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Constellation Generation Co. LLC	Braidwood 1 & 2 (W)	X	
	Byron 1 & 2 (W)	X	
	Calvert Cliffs 1 & 2 (CE)	X	
	Ginna (W)	X	
Dominion Energy	Millstone 2 (CE)	X	
	Millstone 3 (W)	X	
	North Anna 1 & 2 (W)	X	
	Surry 1 & 2 (W)	X	
	V.C. Summer (W)	X	
Duke Energy Carolinas	Catawba 1 & 2 (W)	X	
	McGuire 1 & 2 (W)	X	
	Oconee 1, 2, & 3 (B&W)	X	
Duke Energy Progress	Robinson 2 (W)	X	
	Shearon Harris (W)	X	
Energy Harbor	Beaver Valley 1 & 2 (W)	X	
	Davis-Besse (B&W)	X	
Entergy Palisades	Palisades (CE)		X
Entergy Operations South	Arkansas 1 (B&W)	X	
	Arkansas 2 (CE)	X	
	Waterford 3 (CE)	X	
Evergy	Wolf Creek (W)	X	
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Luminant Power	Comanche Peak 1 & 2 (W)	X	
Pacific Gas & Electric	Diablo Canyon 1 & 2 (W)		X
PSEG – Nuclear	Salem 1 & 2 (W)	X	
So. Texas Project Nuclear Operating Co.	South Texas Project 1 & 2 (W)		X
Southern Nuclear Operating Co.	Farley 1 & 2 (W)	X	
	Vogtle 1 & 2 (W)	X	
	Vogtle 3 & 4 (W)	X	
Tennessee Valley Authority	Sequoyah 1 & 2 (W)	X	
	Watts Bar 1 & 2 (W)	X	
Xcel Energy	Prairie Island 1 & 2 (W)	X	

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	Vandellos 2 (W)	X	
Centrales Nucleares Almaraz-Trillo	Almaraz 1 & 2 (W)	X	
CEZ**	Temelin		X
EDF Energy	Sizewell B (W)	X	
Electrabel	Doel 1, 2 & 4 (W)	X	
	Tihange 1 & 3 (W)	X	
Electricite de France	56 Units	X	
Elektriciteits Produktiemaatschappij Zuid-Nederland	Borssele 1 (Siemens)	X	
Eletronuclear-Eletrobras	Angra 1 (W)	X	
Emirates Nuclear Energy Corporation	Barakah 1 & 2	X	
Hokkaido	Tomari 1, 2 & 3 (MHI)	X	
Japan Atomic Power Company	Tsuruga 2 (MHI)	X	
Kansai Electric Co., LTD	Mihama 3 (W)	X	
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	Hanul 3, 4, 5 & 6 (CE)	X	
Kyushu	Genkai 3 & 4 (MHI)	X	
	Sendai 1 & 2 (MHI)	X	
Nuklearna Electrarna KRSKO	Krsko (W)	X	
Ringhals AB	Ringhals 3 & 4 (W)	X	
Shikoku	Ikata 3 (MHI)	X	
Taiwan Power Co.	Maanshan 1 & 2 (W)	X	

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2 ALTERNATE DEFENSE-IN-DEPTH CATEGORIZATION PROCESS OVERVIEW

Project authorization PA-RMSC-1769, “Alternate 50.69 Categorization Process” (Reference 1) developed an alternate core damage defense-in-depth categorization process to the core damage defense-in-depth process outlined in NEI 00-04, “10 CFR 50.69 SSC Categorization Guideline” (Reference 2), Section 6.1. During the implementation of 10 CFR 50.69 (Reference 7) by various licensees, it was determined that several processes are overly conservative when performing the 10 CFR 50.69 categorization and are resource intensive, without providing a commensurate benefit to the health and safety of the public. For example, when evaluating core damage defense-in-depth, credit cannot be taken for multiple identical, redundant trains. To address this, an alternate approach has been developed for optional use in lieu of the current core damage defense-in-depth categorization process outlined in NEI 00-04, Section 6.1.

A plant can choose to implement this process or use the core damage defense-in-depth categorization process in NEI 00-04, Section 6.1.

2.1 NEI 00-04 PROCESS

The NEI 00-04 (Reference 2) **core damage defense-in-depth** process has been identified as overly conservative and resource intensive as credit cannot be taken for multiple identical, redundant trains. As stated in NEI 00-04, Section 6.1:

> *“For each design basis event, identify the region of Figure 6-1* **[in NEI 00-04]** *in which the plant mitigation capability lies without credit for the function/SSC that has been proposed as low safety-significant, and without credit for any identical, redundant SSCs within the system that are also classified as low safety-significant.”* (figure identification added in bolded brackets)

This causes a conservative interpretation in the examination of core damage defense-in-depth. Instead of merely relying on bottom-line risk estimates, defense-in-depth is invoked as a strategy to ensure public safety. To deny credit for redundant identical SSCs within the same system (e.g., multiple diesel generators in the 4kV system) is to deny existence of defense-in-depth within a system. This report provides an alternate approach to improve the implementation of defense-in-depth which determines the appropriate amount of measures.

The NEI 00-04 **containment defense-in-depth** process continues to be evaluated using the NEI 00-04, Section 6.2 guidance.

2.2 ALTERNATE DEFENSE-IN-DEPTH CATEGORIZATION PROCESS

2.2.1 Background

When NEI 00-04 (Reference 2) was being developed in the early 2000s, PRA models varied from rather simplistic models to moderately complex models. Computer software and hardware capability at the time limited the amount of detail that could be included in PRA models. There also was no industry consensus on a PRA standard to ensure that the model developers used acceptable, consistent methods. Peer reviews of PRA models were being performed with differing guidance. As a result, there were significant limitations and variability to PRA models and questions regarding the completeness and acceptability of the models.

In the last 20 years, the capability of PRA models has increased substantially as has the level of review to determine technical acceptability through the creation of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3), industry wide peer review processes, regulatory guidance on PRA technical adequacy[1], and Regulatory Guide 1.200 (Revision 2 (Reference 4) or Revision 3 (Reference 5), depending on the revision used in the 10 CFR 50.69 license amendment). The PRA standard and peer review processes ensure that in the development of the PRA model the appropriate SSCs are modeled in the correct accident sequences, including common cause considerations. There is updated regulatory guidance for an approach to determine the technical adequacy of probabilistic risk assessment results for risk-informed activities, Regulatory Guide 1.174, Revision 3 (Reference 6). The PRA models for 10 CFR 50.69 are required to meet the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) for all high level requirements including those for initiating events, accident sequences, system analysis, and success criteria. Using insights from the model structure can provide a more efficient way of evaluating defense-in-depth for 10 CFR 50.69.

Sites with approved license amendments to implement 10 CFR 50.69 have had their PRA model(s) evaluated against Regulatory Guide 1.200 (Reference 4 or Reference 5, depending on the revision used in the 10 CFR 50.69 license amendment) and documented in the NRC Staff Safety Evaluation Report (SER) as acceptable for implementation of 10 CFR 50.69.

2.2.2 Alternate Process

The following alternate defense-in-depth categorization process can be completed in lieu of NEI 00-04, Section 6.1 (Reference 2). The alternate core damage defense-in-depth process initial screening is completed in a single plant level analysis for all SSCs with results incorporated into the system categorization. The NEI 00-04, Section 6.2 containment defense-in-depth is unchanged in the alternate defense-in-depth categorization process. Consistent with the NEI 00-04, Section 6.1 core damage defense-in-depth process, the alternate defense-in-depth process is used to identify whether SSCs that are identified as candidate LSS from other analyses in the 10 CFR 50.69 categorization process remain candidate LSS after the defense-in-depth assessment. Even if the alternate defense-in-depth process has an SSC identified as candidate LSS, the remainder of the system categorization steps need to be completed and the Integrated Decision-making Panel (IDP) has to review and approve the

[1] There are no changes to the technical adequacy requirements of the PRA between Revision 2 and Revision 3 of Regulatory Guide 1.200 (Reference 4 or Reference 5, respectively).

system categorization prior to an SSC being assigned as LSS and assigned a RISC. This alternate process is defined in several steps for the analysis:

1. **PRA Technical Adequacy Pre-Requisites:** The alternate core damage defense-in-depth process requires that the full power internal events (FPIE) Core Damage Frequency (CDF) PRA model meets the following requirements:

    a. The FPIE CDF PRA model used for the alternate defense-in-depth evaluations is acceptable for implementing 10 CFR 50.69.

    b. Findings related to the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) technical elements must be closed or dispositioned as not impacting the alternate defense-in-depth categorization process. The review of the FPIE PRA model is completed in accordance with Regulatory Guide 1.200[2] in the 10 CFR 50.69 license amendment as a pre-requisite for approval to implement 10 CFR 50.69.

2. The alternate defense-in-depth categorization process can be implemented for any system that was previously categorized or systems that will be categorized.

3. Any system that has been previously categorized is not required to be re-categorized with the alternate defense-in-depth categorization process.

4. A plant can implement both the alternate defense-in-depth categorization process and the process identified in the current plant license condition for 10 CFR 50.69. It is determined by the plant whether a system uses the alternate defense-in-depth categorization process.

5. No assignments of RISC (or implementation of alternative treatments) are completed until a system is individually categorized since SSCs are candidate HSS / candidate Low Safety Significant (LSS) until the system categorization is reviewed and approved by the IDP.

6. Candidate HSS SSCs from the alternate core damage defense-in-depth process are identified using the FPIE CDF PRA model in a plant-level analysis. This plant-level analysis provides the input to the system-level defense-in-depth categorization. Refer to Figure 2-1 for a high-level flowchart of the 10 CFR 50.69 categorization process modified by the alternate defense-in-depth categorization process (shown in yellow). Note that the NEI 00-04, Section 6.2 containment defense-in-depth process remains the same.

[2] Reference 4 or Reference 5, depending on revision used in the 10 CFR 50.69 license amendment. Note that if a future revision of Regulatory Guide 1.200 is referenced in the 10 CFR 50.69 license amendment, it may be considered for use by the licensee in the alternate defense-in-depth process.

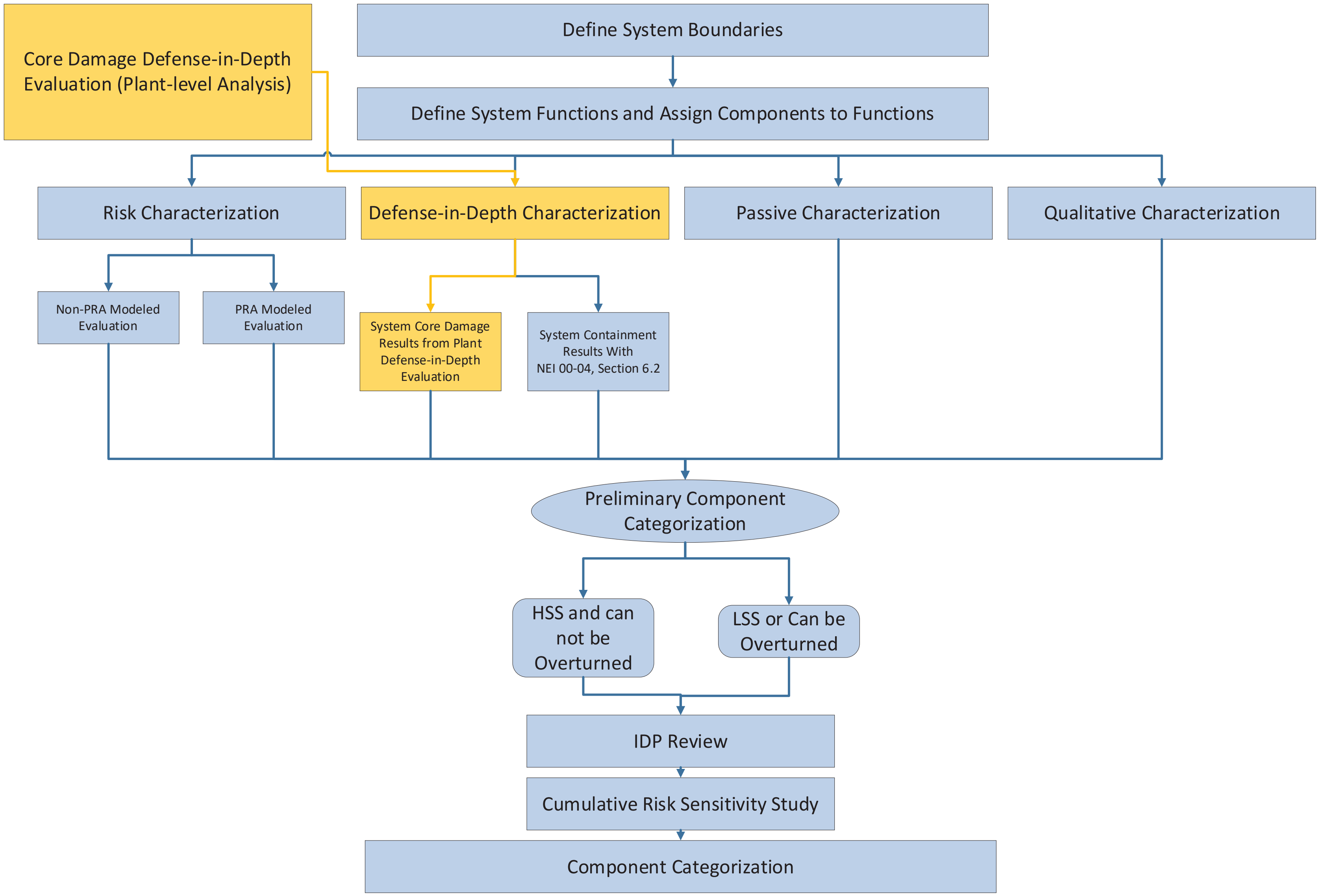

Figure 2-1: High-Level Flowchart of the 10 CFR 50.69 Categorization Process Modified by the Alternate Defense-in-Depth Categorization Process (shown in yellow)

7. **Alternate Core Damage Defense-in-Depth Categorization Process – Plant Level Analysis:** The initial cutset screening is completed at the plant level, not the system level. The results from the FPIE CDF PRA model are used.

   a. Cutset Qualitative Screening: Filter to only cutsets that have an initiating event and a maximum of two basic events representing a failure of an SSC(s).

      1) A basic event counted towards the basic event limit includes an independent failure, a common cause failure (CCF), or a human failure event (HFE) which leads to core damage.

      2) Ensure the following basic events are not counted towards the basic event limit in evaluating whether the cutset is qualitatively "screened out": flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with joint human error probabilities (JHEPs) (only if associated independent HFEs are in the cutset), repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events. Examples of the qualitative screening are shown in Section 2.2.3.5.1.

      3) Pressure boundary failure initiating events and pressure boundary failure basic events are not addressed by the alternate core damage defense-in-depth categorization process (e.g., pipe ruptures leading to internal flooding scenarios). Pressure boundary failures are addressed in the pressure boundary categorization analysis. The exceptions to this are pressure boundary initiating events and pressure boundary basic events that impact the FPIE CDF PRA model through non-flooding scenarios, which are included in the alternate core damage defense-in-depth categorization process.

      4) Cutsets with CCF basic events that include a combination of four (4) or more SSCs failing within the same common cause component group can be "screened out" of the filtered cutsets based on the significant redundancy of performing the function.

   b. Cutset Quantitative Screening

      1) Cutsets with initiating events with frequencies that are less than 1E-04/yr are not included in the alternate core damage defense-in-depth categorization process and can be "screened out" of the filtered cutsets.

      2) Cutsets with initiating events with frequencies at least 1E-04/yr and less than 1E-03/yr are only "screened in" for the alternate core damage

defense-in-depth categorization if there is a maximum of a single basic event from the cutset qualitative screening.

3) Cutsets with initiating events with frequencies that are at least 1E-03/yr are only “screened in” for the alternate core damage defense-in-depth categorization if there is a maximum of two basic events from the cutset qualitative screening.

4) For initiating events that were “screened out” of the FPIE CDF PRA model, evaluate whether the initiating events would have had a frequency less than 1E-04/yr (quantitative threshold for the alternate core damage defense-in-depth). If this is the case, the initiating event does not impact the alternate core damage defense-in-depth screening as it would already be “screened out” since the initiating event frequency is below 1E-04/yr. If this is not the case and the “screened out” initiating event frequency is greater than or equal to 1E-04/yr, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the FPIE CDF PRA model results should be evaluated with the originally “screened out” initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

5) For initiating events that were split into multiple initiating events in the FPIE CDF PRA model, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the combined initiating event consisting of a combination of the split initiating events. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to finalization of a system categorization that uses the alternate defense-in-depth method.

6) The periodic review process identified in NEI 00-04, Section 12 is unchanged but additional clarification is provided for the alternate defense-in-depth process in regards to the bullet on “*a review of the impact of the updated risk information on the categorization process results*”:

    a) During a periodic review, if an initiating event is removed in an update to the FPIE CDF PRA model after using the alternate defense-in-depth categorization, evaluate whether the removed initiating event frequency is less than 1E-04/yr (quantitative threshold for the alternate core damage defense-in-depth). If this is the case, the initiating event does not impact the alternate core damage defense-in-depth screening as it would already be "screened out" since the initiating event frequency is below 1E-04/yr. If this is not the case and the removed initiating event frequency is greater than or equal to 1E-04/yr, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the FPIE CDF PRA model results should be evaluated with the removed initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

b) During a periodic review, if an initiating event is split into multiple initiating events in an update to the FPIE CDF PRA model after completing the alternate defense-in-depth categorization, evaluate the split initiating events did not fall into a lower frequency range for the alternate core damage defense-in-depth quantitative screening than the initially combined initiating event. If the split initiating events fall into a lower frequency range, a basis should be provided on how it does not impact the alternate core damage defense-in-depth categorization or the model results should be evaluated with the combined initiating event included. The engineering team is responsible for developing these bases and the bases are reviewed and approved by the IDP prior to periodic review finalization of a system categorization that uses the alternate defense-in-depth method.

c. From the remaining filtered "screened in" cutsets, identify the SSCs in the plant that are modeled by these initiating events and basic events.

1) Review HFEs and recovery actions to ensure specific SSC failure modes (e.g., MOV fails to close) are correlated to the HFEs and recovery actions. If they are not, correlate the HFE / recovery action to an SSC(s).

d. The SSCs in the plant identified from the filtered "screened in" cutsets are considered candidate HSS for the alternate core damage defense-in-depth assessment in the system level analysis.

8. **Alternate Core Damage Defense-in-Depth Categorization Process – System Level Analysis:** This analysis replaces the considerations in NEI 00-04, Section 6.1. The results of the cutset screening from the plant level analysis alternate core damage defense-in-depth process are used.

a. SSCs that are candidate HSS from the plant-level analysis that are within the system are identified as candidate HSS for the system level analysis.

b. For SSCs that are candidate HSS, the associated functions are driven to candidate HSS following the process in NEI 00-04, Section 7.1.

c. Consistent with the existing NEI 00-04 defense-in-depth process, SSCs and functions outside the scope of the FPIE CDF PRA do not need to be evaluated for core damage defense-in-depth since the level of defense-in-depth is based on the success criteria in the FPIE CDF PRA.

d. All other SSCs that are not identified as candidate HSS in the alternate core damage defense-in-depth analysis are considered candidate LSS for the alternate core damage defense-in-depth categorization process.

e. The engineering team is now required to evaluate the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications prior to IDP review. These evaluations will be reviewed and confirmed by the IDP. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

9. In addition to the IDP review and approval of the initiating event frequencies identified in Step 7.b.4), Step 7.b.5), and Step 7.b.6) (and sub-steps), the IDP should review the alternate defense-in-depth assessment consistent with NEI 00-04, Section 9: "*IDP Review and Approval,*" while evaluating the system categorization, including the Review of Risk Information and Review Defense-in-Depth Implication considerations identified in NEI 00-04, Section 9.2.2. Additionally, the IDP should examine the following considerations for each system prior to system categorization approval. These considerations are initially examined by the engineering team during the system categorization with an initial evaluation provided to the IDP prior to IDP review and approval. If confirmation of these two criteria are not met, the NEI 00-04, Section 6.1 process should be used for the system categorization. It should be confirmed that:

a. The system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth via the alternate core damage defense-in-depth method.

b. The assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth via the alternate core damage defense-in-depth method.

10. **Containment Defense-in-Depth Categorization Process:** Containment defense-in-depth continues to be evaluated using the NEI 00-04, Section 6.2 guidance.

2.2.3 Basis for the Alternate Core Damage Defense-in-Depth Categorization Process

NEI 00-04, Section 6.1 (Reference 2) can be evaluated at the function level or the SSC level by identifying functions required for design basis events for the function/SSC. The PRA (NEI 00-04, Section 5) and containment defense-in-depth (NEI 00-04, Section 6.2) are completed at the SSC level while the Review of Risk Information (NEI 00-04, Section 9.2.2) can be completed at the function or SSC level. The alternate core damage defense-in-depth categorization process evaluates at the SSC level since the analysis now examines the specific failure events leading to core damage. The associated functions of candidate HSS SSCs in the core damage defense-in-depth assessment remain evaluated with identification of associated functions as candidate HSS as outlined in NEI 00-04, Section 7.1.

The alternate core damage defense-in-depth categorization process continues to rely on the PRA success criteria in evaluating defense-in-depth. A high-level comparison between the NEI 00-04, Section 6.1 process and the alternate core damage defense-in-depth categorization process are:

1. The alternate core damage defense-in-depth categorization process evaluation is at the SSC level and is preliminarily evaluated for the entire plant in one analysis with an evaluation completed at the system level prior to assignment of RISC.

2. Consistent with the NEI 00-04 process, assignments of RISC are not complete until a system is individually categorized since the SSCs are candidate HSS / candidate LSS until they are reviewed by the IDP.

3. The alternate core damage defense-in-depth categorization process continues to maintain the associated functions as candidate HSS for candidate HSS SSCs identified in the alternate core damage defense-in-depth process as directed in NEI 00-04, Section 7.1. Refer to Section 2.2.3.1 for additional information.

4. In the alternate core damage defense-in-depth categorization process, NEI 00-04, Figure 6-1 (Defense-in-Depth Matrix example) is replaced with identification of defense-in-depth via cutsets. The discussion on the level of defense-in-depth and its comparison to the NEI 00-04, Section 6.1 process is shown in Section 2.2.6.

5. In the alternate core damage defense-in-depth categorization process, crediting identical, redundant SSCs within the system in certain cutsets is acceptable. Refer to Section 2.2.3.4 for additional information.

6. The alternate core damage defense-in-depth categorization process uses the PRA model structure and insights to enhance the core damage defense-in-depth analysis. Refer to Section 2.2.3.2 for additional information.

7. The alternate core damage defense-in-depth categorization process does not evaluate initiating events with a frequency less than 1E-04/yr while NEI 00-04, Figure 6-1 has the lowest initiating event frequency range less than 1E-03/yr. Refer to Section 2.2.6 for additional information.

8. Consistency of the alternate defense-in-depth process with Regulatory Guide 1.174, Revision 3 (Reference 6) is provided in Section 2.2.7.

2.2.3.1 Associated Functions with respect to NEI 00-04 Section, 7.1 and NEI 00-04, Section 10.2

NEI 00-04, Section 7.1 (Reference 2), states:

> *"If any SSC is safety significant, from either the PRA-based component safety significance assessment (Section 5) or the defense-in-depth assessment (Section 6), then the associated system function is preliminarily safety significant."*

When an SSC is candidate HSS from the FPIE PRA, the Integral PRA, the core damage defense-in-depth, and/or the containment defense-in-depth assessments, the functions driving the candidate HSS determination are identified as "associated functions." All SSCs mapped to an "associated function" are preliminary candidate HSS as described in NEI 00-04, Section 7.1 due to the "associated function" being candidate HSS. Therefore, SSCs (e.g., SSCs not modeled in the PRA or SSCs otherwise identified as candidate LSS) can be candidate HSS from the alternate defense-in-depth assessment if the SSC supports a function that was identified as an associated function in NEI 00-04, Section 7.1. The detailed categorization process described in NEI 00-04, Section 10.2 provides the approach for "*performing additional engineering and system analyses to identify specific component level or piece part functions and importance for the safety-significant SSCs*" in order to justify and categorize an SSC as candidate LSS. NEI 00-04, Section 7.1 and NEI 00-04, Section 10.2 remain unchanged from the current NEI 00-04 process.

2.2.3.2 Use of FPIE CDF PRA Assumptions and Success Criteria

The alternate core damage defense-in-depth categorization process uses the FPIE CDF PRA model assumptions and success criteria by examination of the cutsets. This is similar to the NEI 00-04, Section 6.1 (Reference 2) core damage defense-in-depth process which uses the PRA model success criteria. NEI 00-04, Section 6.1 states:

> "*This figure* **[Figure 6-1 in NEI 00-04]** *depicts the internally initiated design basis events considered in the licensee's safety analysis report (i.e., the events that were used to identify an SSC as safety-related) and considers the level of defense-in-depth available,* ***based on the success criteria used in the PRA****.*" (emphasis added in bold, figure identification added in bolded brackets)

The FPIE CDF PRA model structure has been peer reviewed by industry reviewers consistent with Regulatory Guide 1.200 (Reference 4 or Reference 5, depending on the revision used in the 10 CFR 50.69 license amendment) and the alternate defense-in-depth approach uses the PRA model cutsets without depending on quantitative analysis except for initiating event frequency and truncation. Initiating event frequency determination is based on NEI 00-04, Section 6.1 limits as further described in Section 2.2.6. Truncation is consistent with the established truncation limits that meets supporting requirement QU-B3 in ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). If the FPIE CDF PRA results are regenerated, the truncation limit should be consistent with the baseline CDF truncation limit. If a higher truncation limit is required to be applied due to limitations, justification should be provided to demonstrate that an adequate sample size of cutsets is available to support this application.

The use of the FPIE CDF PRA model structure allows for a more realistic approach in identification of defense-in-depth within a plant compared to a system-by-system analysis that is currently completed in the NEI 00-04, Section 6.1 core damage defense-in-depth process. Not considering the detailed PRA model structure and analyses could prevent the identification of PRA credited SSCs that are not safety-related but are realistically credited to support the prevention of core damage. The alternate approach will improve the quality of the analysis for the core damage defense-in-depth since detailed accident sequences have already been modeled within the FPIE CDF PRA model structure and use of that model structure will provide further clarity to the level of defense-in-depth available.

It is important to realize that the use of the FPIE CDF PRA model in the core damage defense-in-depth analysis is just one aspect for evaluation of core damage:

- Significant CDF risk contributor are an examination of the quantitative impacts identified within the PRA model and are not evaluated in the alternate core damage defense-in-depth process. This is identified in the PRA importance measure steps within NEI 00-04, Section 5. If significant CDF risk contributors are present, the FV and RAW of the SSC would exceed the importance measures threshold and the SSC would be candidate HSS regardless of the defense-in-depth analysis. This is one reason why the alternate defense-in-depth assessment does not base the core damage defense-in-depth on quantitative screenings, with the exclusion of the initiating event frequency and truncation, since a review of the cutsets based only on the model structure can identify scenarios that would lead to core damage but may not be significant CDF risk contributors.

- NEI 00-04, Section 9.2.2, Review of Risk Information and Review Defense-in-Depth Implications considerations also evaluate qualitative considerations in regards to safety-related candidate LSS functions/SSCs being categorized. The IDP examines these considerations and verifies that these considerations have been met. Now, the engineering team evaluates the Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

- The alternate core damage defense-in-depth process has the engineering team and the IDP evaluate whether the FPIE CDF PRA model is adequate for the system being categorized with the alternate core damage defense-in-depth assessment including:
  - Evaluating initiating events “screened out” or split in the FPIE CDF PRA model.
  - Whether system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth via the alternate core damage defense-in-depth method.
  - Assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth via the alternate core damage defense-in-depth method.

Consistent with the existing NEI 00-04, Section 6.1 defense-in-depth process, SSCs and functions outside the scope of the FPIE CDF PRA model do not need to be evaluated for the alternate core damage defense-in-depth categorization process since the level of defense-in-depth is based on the success criteria in the PRA in NEI 00-04, Section 6.1. Additional information on this basis is provided in Section 2.2.3.8.

2.2.3.3 Human Failure Events Impact in the Evaluation of Defense-in-Depth Process

HFEs that are identified in a “screened in” cutset will have the SSCs associated with the operator action identified as candidate HSS in the alternate core damage defense-in-depth assessment. Not taking credit for operator actions and recovery actions (via identification of HFEs in the cutset) prevents identification of realistic defense-in-depth pathways within the plant. HFEs associated with an operator action or recovery action represent a level of defense that is identified for that specific cutset and therefore can be used in the cutset qualitative screening for the alternate defense-in-depth process. NEI 00-04, Section 6.1 (Reference 2) takes credit for operator actions since, as shown in Figure 6-1, an additional 2 redundant systems, not just automatic, are taken into account for the 1E-01/yr row, and all other rows. The 1E-01/yr row in Figure 6-1 is comparable to the alternate core damage defense-in-depth analysis for two basic event criteria for initiating event frequencies that are greater than 1E-03/yr as explained in more detail in Section 2.2.6. For initiating event frequencies at least 1E-04/yr but less than 1E-03/yr, examination of the cutset requires only two basic events to “screen out” of the alternate core damage defense-in-depth categorization. This is comparable to the one redundant automatic system in NEI 00-04, Figure 6-1 as described in further detail in Section 2.2.6. The alternate process examines all redundancy, rather than solely automatic, since overreliance on operator actions is prevented via the considerations in NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 and Review Defense-in-Depth Implications #2. These considerations allow for evaluation of operator actions with respect to the overall defense-in-depth in the plant and prevent overreliance on specific operator actions. For initiating events that are below the 1E-04/yr threshold, the alternate defense-in-depth process continues to examine the NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 and Review Defense-in-Depth Implications #2 to verify operator actions are not over-relied upon.

Modeled operator actions are required to have SSC(s) that support performing the action modeled as per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) which is endorsed in Regulatory Guide 1.200 (Reference 4 or Reference 5, depending on the revision used in the 10 CFR 50.69 license amendment). Therefore, SSCs that support these operator actions can be "screened in" within separate cutsets that have operator actions success in the alternate defense-in-depth assessment.

For example, a failure of an operator to identify the recovery response is not the only failure addressed with the accident sequence that would be evaluated for supporting that recovery. The failure of SSCs used in support of that recovery action can also lead to the same failure result as the recovery action failure. These failures of the SSCs would be identified within other cutsets that are associated with the accident sequence.

Repairing an SSC is generally modeled within the unavailability of a basic event of the SSC failure, which is therefore not identified as a separate basic event in the alternate defense-in-depth assessment. An example of the repair action modeled within unavailability of a basic event is an unavailability calculation based on the SSC failure rate and mean time to repair. Per supporting requirement SY-A24, and DA-C15 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) which is endorsed in Regulatory Guide 1.200 (Reference 4 or Reference 5, depending on the revision used in the 10 CFR 50.69 license amendment), the probability of repair must be justified through an adequate analysis or examination of data (plant-specific or applicable industry experience). If the repair basic event is separate from the independent basic event of the SSC failure and not modeled within unavailability of the independent basic event of the SSC failure, then the repair basic event would be not counted for defense-in-depth in the qualitative screening as is described in Step 7.a.2) in Section 2.2.2. For example, if a safety injection (SI) pump is out of service and there is a separate basic event for repair of the SI pump, the separate basic event for repair of the SI pump is not counted towards the level of defense-in-depth. This is to avoid double-counting of the SSC in the defense-in-depth assessment since both the SSC failure and the repair action failure would have to occur for the cutset to be shown.

Even if the SSCs associated with an operator action or recovery action are candidate LSS in the alternate defense-in-depth assessment, this does not mean the SSCs will be LSS once system categorization is complete. Evaluation of operator actions have other considerations in the categorization process which further evaluates if the SSCs associated with operator actions are candidate LSS:

- The IDP continues to examine the sole means considerations identified in NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5. This examination evaluates whether safety-related candidate LSS functions/SSCs are relied upon for operator actions as the sole means for specific scenarios (e.g., mitigation of an accident or transient). This prevents the situation where reliance on SSCs and operator actions for the sole means of a specific scenario are categorized as LSS for safety-related SSCs. With the implementation of the alternate defense-in-depth process, the engineering team also evaluates the Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

- *"4. The active function/SSC is not called out or relied upon in the plant Emergency/Abnormal Operating Procedures or similar guidance as the sole means for the successful performance of operator actions required to mitigate an accident or transient. This also applies to instrumentation and other equipment associated with the required actions."*

- *"5. The active function/SSC is not called out or relied upon in the plant Emergency/Abnormal Operating Procedures or similar guidance as the sole means of achieving actions for assuring long term containment integrity, monitoring of post-accident conditions, or offsite emergency planning activities. This also applies to instrumentation and other equipment associated with the required actions."*

- The IDP examines in NEI 00-04, Section 9.2.2 with the Review Defense-in-Depth Implications #2 if there is over-reliance on operator actions for safety-related candidate LSS functions/SSCs. With the implementation of the alternate defense-in-depth process, the engineering team also evaluates the Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations.

  - *"2. There is no over-reliance on programmatic activities and operator actions to compensate for weaknesses in the plant design."*

- If an operator action or recovery action is a significant contributor to CDF or LERF, the FV and RAW associated with the HFE would be identified in the PRA quantitative evaluation in NEI 00-04, Section 5 and the corresponding SSCs associated with that operator action would be candidate HSS.

One of the seven criteria in Regulatory Guide 1.174, Section 2.1.1.2 (Reference 6) is "*preserve sufficient defense against human errors*." As mentioned in Regulatory Guide 1.174, "*these defenses generally involve the use of procedures, training, and human engineering; however, other considerations (e.g., communication protocols) might also be important.*" SSCs that would be identified as RISC-3 that have alternative treatments applied would still be required to maintain reasonable confidence of performing their safety-related functions which prevents overreliance on human actions. As stated in Statement of Considerations of 10 CFR 50.69, Section V.3.1, Section 50.69(b)(1) Removal of RISC-3 and RISC-4 SSCs From the Scope of Treatment Requirements (Reference 7):

"The special treatment requirements for RISC-3 SSCs are replaced with the high-level, performance-based requirements in § 50.69(d)(2) that require the licensee to provide reasonable confidence that RISC–3 SSCs will continue to be capable of performing their safety-related functions under design basis conditions."

10 CFR 50.69(d)(2) (Reference 7) is shown below:

(2) RISC-3 SSCs. The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life. The treatment of RISC-3 SSCs must be consistent with the categorization process. Inspection and testing, and corrective action shall be provided for RISC-3 SSCs.

(i) Inspection and testing. Periodic inspection and testing activities must be conducted to determine that RISC-3 SSCs will remain capable of performing their safety-related functions under design basis conditions; and

(ii) Corrective action. Conditions that would prevent a RISC-3 SSC from performing its safety-related functions under design basis conditions must be corrected in a timely manner. For significant conditions adverse to quality, measures must be taken to provide reasonable confidence that the cause of the condition is determined and corrective action taken to preclude repetition.

Further discussion on Regulatory Guide 1.174 is provided in Section 2.2.7, #6.

2.2.3.3.1 Joint Human Error Probabilities

JHEPs are identified to address the dependency between HFEs. Quantitative analyses are not examined in the alternate defense-in-depth assessment except for initiating event frequency and truncation. In the scenario that the quantitative impacts of a JHEP are significant to CDF and LERF, this would be identified via the importance measures in NEI 00-04, Section 5 (Reference 2) which is outside the scope of the alternate defense-in-depth assessment. Therefore, the only impact of the JHEPs with respect to the alternate defense-in-depth assessment is JHEP basic event identification within a cutset.

A FPIE CDF PRA model does identify JHEP consistent with HR-D5, HR-G7, and QU-C1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). If a JHEP is represented by an additional basic event within the cutset to identify the dependency, this basic event does not count towards the criteria for the cutset qualitative screening since it is does not represent an actual level of defense (i.e., the associated independent HFEs present would be taken into account for the defense already in the cutsets). Not having this JHEP count towards the qualitative cutset screening in these scenarios prevents double counting of defense-in-depth identified via HFEs. If a JHEP and the individualized HFEs are combined into a single basic event, the basic event is treated under the same methods as the other HFE basic events; in this scenario the HFEs shared within a single basic event would limit redundancy identified for those

HFEs in the cutset screening. This consolidated basic event is more likely to "screen in" a cutset since multiple HFEs are consolidated into a single basic event. If a justification for diversity between actions within the JHEP can be demonstrated, a basis should be provided and the HFEs can be counted as multiple actions.

The application of overall HFEs is explained in more detail in Section 2.2.3.3 which discusses the consistency with Regulatory Guide 1.174, #6 (Reference 6).

2.2.3.4 Common Cause Failure (CCF)

Exclusion of cutsets with CCF basic events that include a combination of four (4) or more SSCs failing within the same common cause component group (CCCG) is due to the level of redundancy within the system itself which is currently not taken into account in the NEI 00-04, Section 6.1 (Reference 2) core damage defense-in-depth process. Not taking into account any defense-in-depth for redundancy for like-SSCs prevents realistic identification of defense-in-depth within plants and is overly conservative. Under the current NEI 00-04, Section 6.1 process, a plant with two trains of like-SSCs compared to four trains of like-SSCs would be treated in the same manner with respect to core damage defense-in-depth even though there are two additional trains of redundancy. The Detailed SSC Categorization in NEI 00-04, Section 10.2 does allow for redundancy to be taken into account if "*A failure for the SSC would not prevent a safety-significant function from being fulfilled.*" Although this can be evaluated in NEI 00-04, Section 10.2, the alternate process that takes credit for significant redundancy in the function allows for consistent application of CCF in the alternate core damage defense-in-depth assessment. The alternate categorization process allows for plants to take credit for additional redundancy within their design.

The alternate defense-in-depth process ensures CCFs with SSC combinations less than four (4) are candidate HSS if they are within a cutset "screened in" for the alternate defense-in-depth assessment. Therefore, if a cutset "screened in" is identified with a basic event of a CCF of two (2) or three (3) like-SSCs, the SSCs associated with that CCF basic event are candidate HSS for the alternate defense-in-depth process.

Prevention of overreliance on like-SSCs is addressed by the CCF basic events of combinations of two (2) or three (3) SSCs failing from being automatically "screened out" of the cutset qualitative screening in the alternate defense-in-depth process. If there is a CCF basic event of a combination of four (4) or more SSCs, the process "screens out" the cutset due to the level of defense-in-depth of the like-SSCs. Additionally, four (4) SSCs failing due to common cause is generally a rare event when compared to a common cause event of a smaller combination. This "screening out" only impacts the SSC HSS/LSS determination if the SSCs associated with the CCF aren't already identified within the smaller sets of common cause for that CCCG in "screened in" cutsets for alternate defense-in-depth. For example, if a CCF event for a combination two (2) out of four (4) SSCs with the same CCCG was included in a cutset that is "screened in" and if the other corresponding cutsets for the other combinations of two (2) out of four (4) CCF basic events are also "screened in", then all those SSCs associated in the four (4) out of four (4) CCF basic event would be candidate HSS regardless of the cutset with the four (4) out of four (4) CCF basic event being automatically "screened out." Therefore, redundant trains with like-SSCs within the CCCG would not automatically "screen out" for alternate defense-in-depth unless there is sufficient redundancy in the number of SSC failures (i.e., a combination of four (4) or more SSCs failing) that would have to occur to lead to CDF or LERF.

CCCGs are established for SSCs having distinctly different failure modes, designs, and/or manufacturers. Trains of redundant SSCs are located within the same CCCG consistent with SY-B1 and SY-B3 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) unless there is a specific reason why the SSCs are not like-SSCs. If that is the case this would be examined during a peer review to verify the CCCG basis is correct. Use of the FPIE CDF PRA model allows for a detailed evaluation to identify like-SSCs and to classify its potential for common cause failure based on the identification process of CCF in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). This is one of the improvements with using the PRA model structure via the cutsets since it allows for understanding the impacts of individual SSCs and CCFs and to provide insights to better inform realistic defense-in-depth pathways within the plant.

If a CCF basic event, including a combination of four (4) or more SSCs failing, impacts CDF or LERF of the model significantly, then this is evaluated in the FV and RAW quantitative screening in NEI 00-04, Section 5. Additionally, NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications #4 evaluates with respect to common cause failure and other qualitative evaluations in NEI 00-04, Section 9.2.2, Review of Risk Information and NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications also examine considerations with respect to situations in the plant in general (which may include impacts of CCF). Finally, an SSC being assigned LSS and provided a RISC requires that alternative treatments for an SSC continue to have reasonable confidence the SSC is performing their safety-related functions. This is further evaluated via immediate evaluations and periodic reviews identified in NEI 00-04, Section 12 which identifies degradation in RISC-3 and RISC-4 SSCs:

> *"If significant changes to the plant risk profile are identified, or if it is identified that a RISC-3 or RISC-4 SSC can (or actually did) prevent a safety significant function from being satisfied, an immediate evaluation and review should be performed prior to the normally scheduled periodic review. Otherwise, the assessment of potential equipment performance changes and new technical information should be performed during the normally scheduled periodic review cycle."*

Inter-system CCF is not examined in the alternate core damage defense-in-depth process. This is consistent with NEI 00-04, Section 6.1 which provides no examination of inter-system common cause failure:

- The core damage defense-in-depth process used in NEI 00-04, Section 6.1 examines "*the level of defense-in-depth available, based on the success criteria used in the PRA.*" PRA model acceptability for 10 CFR 50.69 implementation includes Capability Category II FPIE PRA models which do not require identification of inter-system common cause failure consistent with the SY-B2 supporting requirement in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3).

- Additionally, NEI 00-04, Section 6.1 states "*For each design basis event, identify the region of Figure 6-1* ***[in NEI 00-04]*** *in which the plant mitigation capability lies without credit for the function/SSC that has been proposed as low safety-significant, and* ***without credit for any identical, redundant SSCs within the system*** *that are also classified as low safety-significant*" (emphasis added in bold, figure identification added in bolded brackets). The examination in NEI 00-04, Section 6.1 only does not allow credit to be taken for identical, redundant SSCs that are within the system. There is no mention of inter-system CCF exclusions in the NEI 00-04, Section 6.1 core damage defense-in-depth process.

Even if inter-system common cause failure is modeled, lower CCF basic events (i.e., 2 or 3 SSCs CCF) would still be able to identify a system failure impact unless there was sufficient CCF redundancy within the system itself (i.e., four (4) or more SSCs are required to fail to lead to a failure of the system).

CCF compliance with Regulatory Guide 1.174, Revision 3 (Reference 6) is identified in Section 2.2.7, #4.

2.2.3.4.1 Example of Common Cause Failure

An example for screening of CCF is shown below. If there is a FPIE CDF PRA cutset with the following:

- A single initiating event within the range of 1E-04/yr and 1E-03/yr
- A CCF basic event that has three (3) out of four (4) emergency diesel generators (EDGs) failing

The SSCs associated with the CCF basic event would be candidate HSS for this cutset since the amount of SSCs within the CCF basic event is only a combination of 3 SSCs (even though the CCCG is four (4)).

If there is a CDF cutset with the following:

- A single initiating event within the range of 1E-04/yr and 1E-03/yr
- A CCF basic event that has four (4) out of four (4) EDG failing

The SSCs associated with the CCF basic event would be candidate LSS for this cutset since the amount of SSCs within the CCF basic event is four (4) and this cutset would be "screened out" of the cutset qualitative screening due to this. Though this does not necessarily mean the SSCs will remain LSS since there are other analyses (e.g. NEI 00-04, Section 5 (Reference 2)) and/or if another cutset with a CCF combination of three (3) of less of the SSCs leads to the SSCs being candidate HSS (e.g., the three (3) out of four (4) EDGs failing in the first example).

2.2.3.5 Other Aspects of Cutset Qualitative Screening

Cutsets can include FLEX equipment since a plant can rely on that as an additional measure of defense-in-depth within the plant and therefore FLEX equipment can be accounted for in the cutset qualitative screening. Although FLEX equipment is not necessarily a permanently installed system, the plant can take credit for FLEX equipment which is consistent with the current NEI 00-04, Section 6.1 process (Reference 2) for the reason that if FLEX equipment is identified in the PRA then it is consistent with the statement of "*considers the level of defense-in-depth available, based on the success criteria used in the PRA.*" FLEX within the PRA has to be modeled and peer reviewed consistent with the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) to be accounted for in the alternate defense-in-depth assessment.

SSCs that fail due to a direct impact of an initiating events will not be identified as candidate HSS for that cutset within the alternate defense-in-depth assessment. Basic events associated with those SSCs failing would not be within the cutset since it isn't a minimal cutset due to the dependency analysis completed in SY-B5 in accordance with the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). This prevents a situation where an initiating event that leads to a direct failure of an SSC has the SSC failure identified as defense-in-depth for that cutset. Since the initiating event leads directly to a failure of that SSC, the SSC performance is not taken into account for defense-in-depth in the cutset qualitative screening. But, if an initiating event is caused by an SSC failure, it would be identified as candidate HSS if the cutset is "screened in" as outlined in Step 7.c in Section 2.2.2.

Flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with JHEPs (only if associated independent HFEs are in the cutset), repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events are not counted towards the basic event limit. These events being "screened out" of the process prevents them from artificially increasing the amount of defense-in-depth within a cutset and allows for proper identification of defense-in-depth within the plant. Therefore, basic events that are associated with SSC failures or support activation of the SSC are only identified for credit in the alternate defense-in-depth process. For example, a split fraction associated with a phenomenological event does not "screen out" a cutset and is not counted towards the qualitative screening criteria since a split fraction does not represent an SSC failure or independent human action failure. Phenomenological events not causing a cutset to be "screened out" prevents a phenomenological event from being counted towards the defense-in-depth of a system. Another example, which is described in further detail in Section 2.2.3.3, is that repair basic events are not counted towards defense-in-depth to avoid double-counting of the SSC in the defense-in-depth assessment since both the SSC failure and the repair action failure would have to occur for the cutset to be shown.

For an examination on why the pressure boundary analysis is not included in the alternate defense-in-depth assessment except for pressure boundary initiating events and pressure boundary basic events that impact the FPIE CDF PRA model through non-flooding scenarios, refer to Section 2.2.5.

2.2.3.5.1 Example of Qualitative Screening

An example for identifying basic events that are not counted towards the basic event limit in the qualitative screening are shown below in an example cutset:

- A single initiating event
- A basic event that leads to an SSC failure
- A CCF basic event that leads to a 2 out of 3 SSC failure
- A split fraction associated with a phenomenological event (e.g., SG tube conditional failure probabilities)

In this scenario, the split fraction associated with a phenomenological event would not count towards the basic event limit in the cutset and the cutset would be "screened in" for the qualitative screening portion. Based on the quantitative analysis and the initiating event frequency, this cutset may be "screened in" or "screened out" based on that result. For example, if this was a FPIE CDF cutset with an initiating event frequency less than 1E-03/yr, then this example cutset would "screen out" since there are two basic events that are "screened in" for the qualitative screening process. But, if the initiating event frequency is at least 1E-03/yr then this cutset would "screen in" since there are only two basic events.

The non-counting of certain basic events occurs for flags, split fractions (including but not limited to initiating event frequency split fractions and basic event split fractions), split fractions associated with phenomenological events (e.g., SG tube conditional failure probabilities), consequential loss events, plant availability factors, events associated with JHEPs (only if associated independent HFEs are in the cutset), repair basic events that are separate from the independent basic event of the SSC failure, and other house or special events.

2.2.3.6 Initiating Events Frequency Uncertainty

The initiating event frequency mean is used for determination of the alternate defense-in-depth categorization consistent with NEI 00-04, Section 6.1 (Reference 2) process which also uses the FPIE CDF PRA model to identify the initiating event frequency value. The distribution of the frequency is not used within the analysis. The initiating event frequency has been reduced by a factor of 10 from the lowest level threshold in the NEI 00-04, Section 6.1 process (1E-04/yr instead of 1E-03/yr) to account for uncertainty in the initiating event frequency. Calculation of initiating event frequency is consistent with IE-C1 of the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) supporting requirements.

2.2.3.7 Initiating Events Removed or Split

When first using the alternate defense-in-depth process, the initiating events are evaluated to determine if any initiating event "screened out" of the FPIE CDF PRA model would be above the initiating event frequency range of quantitative screening, or if initiating events which were split would be within a higher initiating event frequency range, if combined, for the quantitative evaluation of initiating events in the alternate defense-in-depth. Therefore, any initiating events originally "screened out" or split within the FPIE CDF PRA are assessed on their impact on the alternate defense-in-depth process or, alternatively, evaluated within the alternate defense-in-depth assessment.

The initiating events within a PRA model may change after the initial assessments for the alternate defense-in-depth categorization. In the rare event that an initiating event is removed or split, the process evaluates if the removed initiating event was below the initiating event frequency range for quantitative screening or if the split initiating events are moved to a different initiating event frequency range for the quantitative evaluation in the alternate defense-in-depth process. Although this rarely occurs, this process allows for a PRA update affecting the removal or splitting of initiating events to be examined compared to the PRA model version originally used for alternate defense-in-depth screening. This task is completed during the normal periodic review in NEI 00-04, Section 12 (Reference 2).

These assessments are completed by the engineering team that develops a response to these bases and the bases should be approved by the IDP prior to use of the alternate defense-in-depth method in a system categorization.

Evaluation of internal flooding scenarios are examined in the pressure boundary analysis as discussed in Section 2.2.5.

2.2.3.8 Non-modeled SSCs

NEI 00-04, Section 6.1 (Reference 2) states the following:

> "*This figure depicts the internally initiated design basis events considered in the licensee's safety analysis report (i.e., the events that were used to identify an SSC as safety-related)* ***and considers the level of defense-in-depth available, based on the success criteria used in the PRA****.*" (emphasis added in bold)

The NEI 00-04, Section 6.1 process identifies the level of defense-in-depth based on the success criteria in the PRA. The alternate core damage defense-in-depth method continues to examine the success criteria used in the PRA but with a direct examination by a cutset review. A cutset review is used to identify the number of SSC failures that would have to occur to lead to core damage. From the examination of these cutsets, the level of defense for specific initiating event accident scenarios can be determined. CDF PRA models that meet the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) must identify realistic core damage occurrences within the PRA model and identify safety-related functions within the plant. The FPIE CDF PRA model quantitative values (except for initiating event frequency and truncation) are not used for the alternate defense-in-depth process which is consistent with the NEI 00-04, Section 6.1 method on not relying on quantitative insights of the PRA model. Instead of relying on quantitative insights, the alternate defense-in-depth method uses the model structure via cutsets. The model structure has the benefit of having been peer reviewed through the PRA peer review process which provides a rigorous, industry review of the model compared to a system-by-system analysis that is currently completed in the NEI 00-04, Section 6.1 defense-in-depth process.

The ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) takes into account system responses in high level requirements (e.g., HLR-AS-A, HLR-SY-A) along with supporting requirements; SSCs that are not modeled within the FPIE CDF PRA are identified as having a negligible impact on the CDF of the plant and are therefore “screened out” of modeling. PRA models are rigorously peer reviewed to determine acceptability of the PRA model for application at a plant. The peer review process is an essential part to verify that the completeness of the PRA model and assumptions within the PRA model are acceptable. Additionally, the engineering team and the IDP will review acceptability of the PRA model for use in the alternate defense-in-depth assessment for the systems categorized as identified in Section 2.2.2, Step 9.

SSCs that are not modeled in the FPIE CDF PRA model remain addressed in the overall 10 CFR 50.69 process outlined in NEI 00-04. SSCs not modeled in the FPIE CDF PRA can be candidate HSS from the results of the alternate defense-in-depth assessment due to the associated functions that are candidate HSS from alternate defense-in-depth. As described in Section 2.2.3.1, if a non-modeled SSC supports an associated function which is identified as candidate HSS based on an SSC(s) that is identified as candidate HSS in the alternate defense-in-depth assessment, those non-modeled SSCs would be identified as candidate HSS based on the associated function being candidate HSS. NEI 00-04, Section 10.2 continues to remain applicable for downgrading to candidate LSS if criteria are met. Additionally, NEI 00-04, Section 9.2.2 has the seven Review of Risk Information qualitative considerations along with a Review Defense-in-Depth Implications for safety-related candidate LSS functions/SSCs. For example, #1 in the Review of Risk Information examines if a failure of function/SSC causes an initiating event that was originally “screened out” of the PRA based on anticipated low frequency of occurrence. Therefore, additional qualitative considerations have to be evaluated prior to identifying an SSC as candidate LSS even if it is not modeled within the FPIE CDF PRA model.

2.2.4 Basis for the Containment Defense-in-Depth Categorization Process

The containment defense-in-depth categorization process remains the same as in NEI 00-04, Section 6.2 (Reference 2).

2.2.5 Pressure Boundary Analysis

The processes identified in NEI 00-04 (Reference 2) are for functions that are not pressure boundary (previously known as passive) functions of SSCs. As stated in NEI 00-04 Section 4:

> “*The classification of SSCs having only a pressure retaining function (also referred to as passive components), or the passive function of active components, should be performed using the ASME Code Case N-660 [Reference 12], “Risk-Informed Safety Classification for Use in Risk-Informed Repair/Replacement Activities”, or subsequent versions approved by ASME, in lieu of this guidance.*” (removed reference notation within quote and modified to reference within the bracket)

The pressure boundary categorization has had alternate approaches developed since the creation of NEI 00-04 and Regulatory Guide 1.201, Revision 1 (Reference 11). These alternate approaches are still designed to meet the pressure boundary categorization portion of the analysis that has examination of internal flooding scenarios.

The alternate defense-in-depth process does not supplement or replace the pressure boundary categorization efforts. Since NEI 00-04 states that the pressure boundary scenarios are not evaluated in the NEI 00-04 process and Regulatory Guide 1.201, Revision 1 (Reference 11) endorses this guidance with respect to its relation for NEI 00-04, Section 6.1, there is no impact on the pressure boundary categorization process with implementation of the alternate defense-in-depth process.

NEI 00-04, Section 6.1 core damage defense-in-depth does have identification of several aspects related to pressure boundary failure specifically involving design basis events identified and the initiating event frequency associated with them in the example figure NEI 00-04, Figure 6-1. Therefore, examination of pressure boundary initiating events and pressure boundary basic events are not excluded from the alternate defense-in-depth categorization if they impact the FPIE CDF PRA model through non-flooding scenarios as identified in the process outlined in Step 7.a.2) in Section 2.2.2. This allows for consistency with the NEI 00-04, Section 4 quotation above with regards to evaluation of the non-pressure boundary functions of an SSC via the NEI 00-04 process.

2.2.6 Level of Defense-in-Depth Basis

This response discusses the main concept of the process, for additional information how HFE or CCF affects the process refer to Section 2.2.3.3 and Section 2.2.3.4, respectively.

The intent of the alternate defense-in-depth process is to identify SSCs that would be candidate HSS from a cutset with an initiating event and a certain number of basic events, defined in the criteria described in Section 2.2.2, which leads to core damage. NEI 00-04, Section 6.1 (Reference 2) states that design basis initiating events below the 1E-03/yr threshold must have at least one redundant automatic system present (besides the function/SSC being evaluated). With the more realistic identification of success paths via examination of cutsets from the FPIE CDF PRA model, but with an SSC-level examination, the initiating event frequency lower limit threshold has been decreased by a factor of 10 to 1E-04/yr for the alternate core damage defense-in-depth assessment to avoid “screening out” SSCs that could impact core damage defense-in-depth. If a cutset with an initiating event frequency of at least 1E-04/yr for CDF does not have defense-in-depth based on the criteria defined in Section 2.2.2, the SSCs associated with the initiating event and basic event(s) will be candidate HSS for the alternate core damage defense-in-depth assessment.

This cutset examination requires that SSCs with minimal or no defense-in-depth for cutsets within the screening threshold as identified in Section 2.2.2 be “screened in” as candidate HSS for the alternate defense-in-depth since the SSCs identified in cutsets with few basic events represent a limited number of SSC failures that would have to occur to result in core damage. Additionally, there is a secondary threshold that requires an additional level of defense-in-depth for cutsets with higher initiating event frequencies. The additional requirement of more than two basic events being necessary for the SSCs to be candidate LSS at an initiating event frequency threshold of 1E-03/yr for CDF is to allow for an additional level of defense-in-depth to be present for higher frequency initiating events to follow a similar process to Figure 6-1 in NEI 00-04, Section 6.1 of increasing the level of defense-in-depth for higher frequency initiating events. This provides a bounding analysis as shown in the example below.

It is important to realize that, as described in more detail in Section 2.2.3.4, cutsets with CCF basic events that consists of two (2) or three (3) SSC failures would not be automatically "screened out." Therefore, if there is a lower number of like-SSCs failures (i.e., less than four (4) like-SSCs would have to fail to lead to the accident progression defined in the cutset), that cutset would not be automatically "screened out" from the alternate defense-in-depth assessment. This prevents SSCs in redundant trains from being classified as candidate LSS unless there is significant redundancy or other defense-in-depth is available. Since intra-system CCF is a requirement for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3), "screened in" cutsets with CCF basic events can assign SSCs candidate HSS that are within different trains of equipment.

Examples of how defense-in-depth is approached in the alternate defense-in-depth categorization process are identified below:

- **Greater than 1E-03/yr initiating event frequency:** NEI 00-04, Figure 6-1 requires three or greater diverse trains or two redundant systems (other than the function required for the function/SSC being examined) to remain candidate LSS for defense-in-depth for initiating event frequencies greater than 1E-01/yr. This is the bounding scenario for other initiating event frequency values in NEI 00-04, Figure 6-1. In this scenario, this would fall into the alternate defense-in-depth cutset review of two basic events (initiating event frequency greater than 1E-03/yr for alternate core damage defense-in-depth). Failure pathways for an accident scenario are identified during the cutset review and basic events within a cutset can contain CCF of SSCs as intra-system CCF is required to be taken into account for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). For example, if only two systems supported prevention of the accident scenario for an initiating event greater than 1E-03/yr, a cutset can appear with a basic event associated with CCF of like-SSCs for the trains within System 1 that leads to a failure of System 1 and a basic event associated with CCF of like-SSCs for the trains within System 2 that leads to a failure of System 2. In this scenario, the SSCs associated with these basic events would be identified as candidate HSS due to the limited redundancy available. This matches with only two systems being overall available and is consistent with how NEI 00-04, Figure 6-1 would evaluate this scenario for initiating event frequencies greater than 1E-01/yr. In a modified example where the cutset would instead consist of three basic events (e.g., three CCF basic events of three different systems), this specific cutset would be "screened out" and associated SSCs would be candidate LSS for this cutset in the core damage defense-in-depth analysis (SSCs may still end up as candidate HSS from other cutsets or other analyses). This is the same level of redundancy present within NEI 00-04, Figure 6-1 where there is a requirement of at least 2 redundant systems (or 3 diverse trains) excluding the function / SSC that is being considered. Additionally, since the SSC that are identified as candidate HSS in the core damage defense-in-depth assessment identify associated functions of the SSC as candidate HSS based on the process identified in NEI 00-04, Section 7.1, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information). If the SSC requires multiple failures within a system that are not related via CCF in the cutsets, that can be identified as redundancy within the system itself which the new alternate defense-in-depth approach takes credit for. Additionally, Section 2.2.3.4 describes scenarios where there is significant level of redundancy for CCF (4 or more failures) and why it is appropriate to “screen out” those cutsets. As stated in Section 2.2.3.3, HFE (including operator actions and recovery actions) also have SSC failures that support performing the operator actions and/or recovery actions modeled per supporting requirement HR-F2, SY-A9, and SY-B12 of ASME/ANS RA-Sa-2009 PRA Standard (Reference 3).

- **Greater than 1E-04/yr, less than 1E-03/yr initiating event frequency:** The single basic event cutset criteria initiating event frequency range is comparable to the initiating event frequencies below 1E-03/yr in Figure 6-1 of NEI 00-04. The alternate core damage defense-in-depth process moves this threshold down by a factor of 10. In the alternate core damage defense-in-depth approach, there has to be one additional defense-in-depth layer to be “screened out” of the single basic event criteria. Figure 6-1 in NEI 00-04 requires at least one redundant automatic system to function in addition to the function/SSC being examined to provide for defense-in-depth. This cutset review would identify any cutsets with a basic event of any SSCs failing (or CCF of SSCs) that would lead to CDF. For a cutset to be “screened out,” two basic events would have to be present. This would require either two systems to be present for this defense-in-depth or there would have to be multiple SSC failures within a system that are not related via CCF in the cutsets to lead to a system failure. If any cutset that includes a CCF basic event is “screened in”, then the associated functions of the candidate HSS SSCs associated with the CCF basic event would be identified as candidate HSS. Therefore, the other SSCs that support that associated function are identified as preliminary candidate HSS based on the associated function HSS determination (refer to Section 2.2.3.1 for more information) which avoids the SSCs that support the associated function from being candidate LSS in the alternate defense-in-depth assessment. A CCF basic event of a combination greater than four (4) SSCs can be “screened out” due to significant intra-system redundancy as discussed in Section 2.2.3.4. Whether the system is automatic does not factor into a realistic evaluation of defense-in-depth since non-automatic systems also provide functional support of safety-related events and represent realistic defense-in-depth and success paths in a plant.

- **Less than 1E-04/yr initiating event frequency:** Initiating events below 1E-04/yr for CDF cutsets have been “screened out” because of their low likelihood of occurrence.

SSCs below that initiating event frequency threshold that have a significant impact to CDF will be evaluated in the FPIE CDF PRA model quantitative determinations (i.e., FV, RAW screening) in NEI 00-04, Section 5 and other analyses described later in this section. Additionally, protection systems must meet single failure criteria as described in 10 CFR 50, Appendix A, Criterion 21 (Reference 8) for design basis scenarios as shown below based on plant design requirements. In these design basis scenarios with a low initiating event frequency, a single SSC failure in a protection system would not lead to core damage due to a redundant system or a redundant train being available. Based on the low level of occurrence for these design basis initiating events, this provides for defense-in-depth and is based on the overall plant design that remains unchanged by 10 CFR 50.69. As stated in Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7), "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*"

- 10 CFR 50, Appendix A, Criterion 21 (Reference 8): "*Criterion 21—Protection system reliability and testability. The protection system shall be designed for high functional reliability and inservice testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1)* ***no single failure results in loss of the protection function*** *and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred.*" (emphasis added in bold)

In the scenario a cutset is "screened out" for the alternate core damage defense-in-depth assessment, then there is defense-in-depth within the plant for the SSCs being examined based on the cutset results in a manner that is similar with the defense-in-depth concept within the NEI 00-04, Section 6.1 process.

Additionally, the alternate core damage defense-in-depth approach is not the only evaluation for categorization. The alternate core damage defense-in-depth process does not examine the reliability of systems or the unavailability of systems when determining candidate HSS / candidate LSS for SSCs in core damage defense-in-depth since defense-in-depth is not intended to be a quantitative evaluation; therefore the alternate defense-in-depth limits quantitative aspects to the initiating event frequency and truncation. But, if an SSC has a significant impact to CDF or LERF from cutsets that were "screened out" for the alternate core damage defense-in-depth assessment, it should be identified via the importance measures for FV and RAW within the FPIE CDF PRA quantitative assessment in NEI 00-04, Section 5. Additionally, the engineering team completes and the IDP reviews and approves the seven (7) considerations of the NEI 00-04, Section 9.2.2, Review of Risk Information and the five (5) considerations of NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications. The entire 10 CFR 50.69 categorization process is completed to verify that SSCs are properly categorized and these additional categorization steps are not affected by the alternate defense-in-depth process. The entire 10 CFR 50.69 categorization process together identifies the HSS and LSS classification of SSCs.

2.2.7 Considerations for Defense-in-Depth in Regulatory Guide 1.174

The alternate defense-in-depth categorization process is consistent with Section 2.1.1.2 of Regulatory Guide 1.174 (Reference 6). A discussion on each of the considerations is provided below which summarizes the approaches identified in this PWROG report. For all of these bases, it is important to realize that the FPIE CDF PRA model cutsets qualitative results (only initiating event frequency and truncation are examined quantitatively) are used for core damage defense-in-depth but the FPIE CDF PRA model is not the only analysis that is considered in 10 CFR 50.69 categorization. For example, NEI 00-04, Section 9.2.2 (Reference 2) has the Review of Risk Information and Review Defense-in-Depth Implications considerations. In addition, the quantitative results of the FPIE CDF PRA model are examined in Section 5 of NEI 00-04 and other analyses, such as the fire evaluation, are also completed to determine RISC of the SSCs.

1. ***"Preserve a reasonable balance among the layers of defense"***

    a. **Preserved.** The alternate defense-in-depth categorization process preserves reasonable balance as shown in the layers of defense-in-depth in the following sub-sections of this consideration. The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

        "Section 50.69 is ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the*

> *requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.****"* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

b. **"*Robust plant design to survive hazards and minimize challenges that could result in an event occurring.*"** Preserved. The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such* *as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small."*** (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make*

adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

The robustness of the plant design to survive hazards and minimize challenges that could result in an event occurring are not impacted by 10 CFR 50.69 or the alternate categorization process. 10 CFR 50.69 and the alternate categorization process do not change the plant design and therefore the plant design remains the same. Additionally, minimizing the number of challenges are identified by alternative treatments maintaining reasonable confidence of performing safety-related functions and periodic review / performance monitoring of alternative treatments identifying any potential decrease in reliability and applying corrective actions as appropriate. New initiating events are not introduced since the plant design remains the same and alternative treatments are required to provide for reasonable confidence that safety-related functions are supported so no significant increase in the likelihood of initiating events would exist. Plants are required to maintain reasonable confidence that SSCs with alternative treatments remain capable of performing their safety-related functions under design basis conditions as stated in 10 CFR 50.69(d)(2) (Reference 7):*"The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life."*

c. "*Prevention of a severe accident (core damage) if an event occurs.*"
Preserved. The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain

unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is **structured to maintain the design basis functional requirements of the plant**. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained. **Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.**"* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

The plant design remaining unchanged and the alternative treatments providing reasonable confidence that the SSCs continue to support their safety-related functions provides for continued prevention of a severe accident if an event occurs. Periodic reviews and performance monitoring of alternative treatments provides for identification of any degraded performance resulting in alternative treatments. Periodic reviews and performance monitoring provide for a review of alternative treatments to verify they are providing reasonable confidence of supporting their safety-related functions to support the prevention of core damage if an event occurs. The alternate core damage defense-in-depth assessment replacement of NEI 00-04, Section 6.1 does not impact the prevention of core damage if an event occurs and instead provides for an alternative approach to the defense-in-depth analysis. The alternate defense-in-depth process does not change the plant design, does not change the alternative treatments required to provide reasonable confidence, and does not change periodic review or performance monitoring.

The alternate core damage defense-in-depth assessment replacement of NEI 00-04, Section 6.1 does not impact the prevention of core damage if an event occurs and instead provides for an alternative approach to defense-in-depth. CDF cutsets are examined to identify the number of basic events supporting a specific cutset to identify the level of core damage defense-in-depth. The alternate defense-in-depth process does not use the quantitative results except for initiating event frequency (which is also used in NEI 00-04, Section 6.1) and truncation limits for cutsets. This allows for minimal reliance on the quantitative impacts of the PRA results consistent with the NEI 00-04, Section 6.1 method. This cutset examination requires that SSCs with minimal or no defense-in-depth for cutsets within the screening threshold as identified in Section 2.2.2 be “screened in” as candidate HSS for the alternate defense-in-depth since the SSCs identified in cutsets with few basic events represent a limited number of SSC failures that would have to occur to result in core damage. Additionally, there is a secondary threshold that requires an additional level of defense-in-depth for cutsets with higher initiating event frequencies. The additional requirement of more than two basic events being necessary for the SSCs to be candidate LSS at an initiating event frequency threshold of 1E-03/yr for CDF is to allow for an additional level of defense-in-depth to be present for higher frequency initiating events to follow a similar process to Figure 6-1 in NEI 00-04, Section 6.1 of increasing the level of defense-in-depth for higher frequency initiating events. Further discussion on the level of defense-in-depth is provided in Section 2.2.6. CCF is examined in the alternate defense-in-depth assessment which is used to identify non-diverse SSCs within a system from the CCF basic events. The only cutsets that are automatically “screened out” due to CCF redundancy is for CCF basic events that involve four (4) or more SSCs failing within the basic event (this screening is completed to account for redundancy within the system); this defense-in-depth would only be valid if the SSCs associated with the CCF aren't already identified within the smaller sets of common cause for that group of "screened in" cutsets for alternate defense-in-depth. Since intra-system CCF is a requirement for Capability Category II FPIE CDF PRA models consistent with SY-B1 in the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3), "screened in" cutsets with CCF basic events can assign SSCs candidate HSS that are within different trains. Additionally, other analyses in 10 CFR 50.69 provide for examination of defense-in-depth so insights from the cutset review are not the only examination of defense-in-depth within the categorization process:

(1) NEI 00-04, Section 9.2.2 examination of the Review of Risk Information seven qualitative considerations and the Review Defense-in-Depth Implications five qualitative considerations.

(2) Section 2.2.2, Step 9 (and sub-steps) considerations on if the system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth and whether assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth.

(3) The examination of initiating events within the PRA model as described in the process outlined in Section 2.2.2, Step 7.b.4), Step 7.b.5), and Step 7.b.6) (and sub-steps).

(4) The pressure boundary analysis defense-in-depth is completed within its own analysis.

d. **"*Containment of the source term if a severe accident occurs.*"** Preserved. No impact from the alternate defense-in-depth assessment. NEI 00-04, Section 6.2 remains in use and this is not impacted by the alternate core damage defense-in-depth approach.

The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for

Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.****"* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

e. "***Protection of the public from any releases of radioactive material (e.g., through siting in low-population areas and the ability to shelter or evacuate people, if necessary).***" Preserved. No impact from the alternate defense-in-depth assessment with regards to protection of the public from any releases of radioactive materials.

The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable***

> ***confidence that any increases in CDF or LERF will be acceptably small.*"** (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

f. Regulatory Guide 1.174, Revision 3, Section 2.1.1.3 (Reference 6) states:

> *"to address the unknown and unforeseen failure mechanisms or phenomena, the licensee's evaluation of this defense-in-depth consideration should also address insights based on traditional engineering approaches. Results and insights of the risk assessment might be used to support the conclusion; however, the results and insights of the risk assessment should not be the only basis for justifying that this defense-in-depth consideration is met. The licensee should consider the impact of the proposed licensing basis change on each of the layers of defense."*

The alternate defense-in-depth categorization uses the FPIE CDF PRA cutsets to identify the level of defense-in-depth available. The alternate defense-in-depth categorization does not use the quantitative results of the FPIE CDF PRA model (excluding initiating event frequency and truncation). Use of the FPIE CDF PRA model structure allows for the alternate defense-in-depth process to examine detailed accident scenarios that have been modeled and peer reviewed consistent with the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). In fact, traditional engineering approaches are used to identify the accident sequences as well as system modeling, and CCF within the FPIE CDF PRA model. The FPIE CDF PRA model has been developed using systematic approaches; for example, to identify initiating events as shown in IE-A1, identify appropriate system analysis information as shown in SY-A2, identifying appropriate accident sequences in AS-A1, justification for CCCG in SY-B3 of the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). Additionally, since unknown or unforeseen failure mechanisms can be present, other analyses in 10 CFR 50.69 provide additional examination of defense-in-depth so the alternate defense-in-depth process which uses the FPIE CDF PRA model structure are not the only basis for meeting this consideration:

(1) NEI 00-04, Section 9.2.2 examination of the Review of Risk Information seven qualitative considerations and the Review Defense-in-Depth Implications five qualitative considerations.

(2) Section 2.2.2, Step 9 (and sub-steps) considerations on if the system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth and whether assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth.

(3) The examination of initiating event within the PRA model as described in the process outlined in Section 2.2.2, Step 7.b.4), Step 7.b.5), and Step 7.b.6) (and sub-steps).

(4) The pressure boundary analysis defense-in-depth is completed within its own analysis.

2. ***“Preserve adequate capability of design features without an overreliance on programmatic activities as compensatory measures.”***

   a. **Preserved.** The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): “*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*” This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small."*** (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

The plant design is not modified with 10 CFR 50.69 or the alternate core damage defense-in-depth process. The Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Programmatic activities to maintain reasonable confidence are consistent with the currently approved 10 CFR 50.69 process and have not been modified with the alternate defense-in-depth assessment. The IDP is used in 10 CFR 50.69 to provide for an independent review of the system categorization prior to approval. The IDP consists of an expert panel that is knowledgeable about the plant design and provides an independent assessment that the RISC determinations are appropriate.

3. ***"Preserve system redundancy, independence, and diversity commensurate with the expected frequency and consequences of challenges to the system, including consideration of uncertainty."***

   a. **Preserved.** System redundancy, independence, and diversity are preserved in the alternate defense-in-depth categorization process.

   The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their* *design basis functions.*” Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *“Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.****”* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), “*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*” Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *“The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid.”*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

One of the reasons alternative treatments are required to maintain reasonable confidence to perform their safety-related functions is so RISC-3 SSCs continue to provide system reliability for safety-related functions. Therefore, these alternative treatments allow for preservation of system redundancy, independence, and diversity since the SSCs are required to continue to support their safety-related functions and have reasonable confidence to do so. Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Periodic reviews and performance monitoring would identify any increase in frequency or decrease in availability or reliability. The plant design continues to remain unchanged based on 10 CFR 50.69 and alternate core damage defense-in-depth which prevents changes to the design that could impact system redundancy, independence, and diversity of SSCs.

Additionally, the alternate defense-in-depth process is one portion of the overall 10 CFR 50.69 assessment. The alternate defense-in-depth process only modifies the core damage defense-in-depth portion of NEI 00-04, Section 6.1, which does not change the alternative treatment requirements, periodic reviews requirements, performance monitoring requirements, or the plant design. Importance measures, which examine risk significance of an SSC, continue to be used to identify SSCs as candidate HSS / candidate LSS in NEI 00-04, Section 5. The only quantitative impacts used in the alternate core damage defense-in-depth categorization are initiating event frequency and truncation.

Uncertainty in the FPIE CDF PRA models for the use of the alternate defense-in-depth assessment are addressed by the evaluation of three measures. Parameter uncertainty is addressed by limited use of the quantitative values (initiating event frequency and truncation limits) in the alternate defense-in-depth assessment. The alternate defense-in-depth assessment uses the initiating event frequency values for quantitative screening similar to how NEI 00-04, Section 6.1 core damage defense-in-depth uses the initiating event frequencies found in the FPIE CDF PRA to evaluate core damage defense-in-depth. To reduce occurrence of uncertainty affecting the evaluation of defense-in-depth, the initiating event frequencies lower threshold has been reduced by a factor of 10 compared to the limit identified in NEI 00-04, Section 6.1. Truncation is consistent with the established truncation limits that meets supporting requirement QU-B3 in ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). If the FPIE CDF PRA results are regenerated, the truncation limit should be consistent with the baseline CDF truncation limit. If a higher truncation limit is required to be applied due to limitations, justification should be provided to demonstrate that an adequate sample size of cutsets is available to support this application. Modeling uncertainty is taken into account by the peer review process of the model along with following the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3). As stated in Regulatory Guide 1.174, Revision 3 (Reference 6), "*In many cases, the appropriateness of the models adopted is not questioned, and these models have become, de facto, the consensus models to use. NUREG-1855 [Reference 10] defines a consensus model as one that has a publicly available published basis and has been peer reviewed and widely adopted by an appropriate stakeholder group. In addition, widely accepted PRA practices may be regarded as consensus models*" (in-text citation added in brackets). The peer review importance in identifying PRA completeness and technical adequacy is further discussed in the Statement of Considerations of 10 CFR 50.69, III.2.0, Methodology for Categorization (Reference 7) "*The peer review focuses on the PRA's completeness and technical adequacy for determining the importance of particular SSCs, including consideration of the scope, level of detail, and technical quality of the PRA model, the assumptions made in the development of the results, and the uncertainties that impact the analysis. This provides confidence that for IDP decisions that use PRA information, the results of the categorization process provide a valid representation of the risk importance of SSCs.*" The final criteria, completeness uncertainty, is taken into account by the implementation of alternative treatments; as stated in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Treatment requirements for the SSCs are applied as necessary to maintain functionality and reliability and are a function of the category into which the SSC is categorized.*" Additionally, as stated in 10 CFR 50.69(d)(2) (Reference 7):*"The licensee or applicant shall ensure, with reasonable confidence, that RISC-3 SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life."* Alternative treatments are required to maintain reasonable confidence of SSC performance in order to prevent degradation of SSC performance. Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements."* In addition to the alternate defense-in-depth process, it is important to realize that there are also other evaluations that address uncertainties in the PRA model. NEI 00-04, Section 5 examine the quantitative impacts from sensitivity studies of PRA models used. Additionally, NEI 00-04, Section 8 has a risk sensitivity analysis applied to LSS SSCs.

4. ***"Preserve adequate defense against potential CCF."***

   a. **Preserved.** The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

      > *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small."*** (emphasis added in bold)

      NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment* *processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

Alternative treatments require that RISC-3 SSCs maintain reasonable confidence and have periodic monitoring and performance monitoring which provide for defense against degradation of SSCs that could result in CCF. If an adverse trend is detected, corrective actions can be taken as appropriate to eliminate the adverse trend. Additionally, the plant design remains unchanged which continues to preserve the design's defense against CCF. The alternate defense-in-depth process does not modify the alternative treatment requirements for reasonable confidence and periodic reviews / performance monitoring, nor does it modify the plant design.

No new CCF events would be identified from the alternate defense-in-depth assessment since the plant design is not modified. Any increase in the frequency of CCF would be addressed by alternative treatments requiring reasonable confidence that they will continue to perform their safety functions and corrective actions taken to eliminate an adverse trend if one exists. Additionally, due to the alternative treatments requiring reasonable confidence that they will continue to perform their safety-related functions, there is no weakening or defeating of existing defense against CCF in the alternate defense-in-depth process and no additional coupling factors are created by implementation of the alternate defense-in-depth assessment.

The alternate defense-in-depth process evaluates CCF which is used to identify non-diverse SSCs within a system which is represented as a single CCF basic event. The alternate defense-in-depth process evaluation of CCF for appropriate determination of RISC for SSCs allows for an evaluation of adequate defense against potential CCFs for the core damage defense-in-depth assessment. The only cutsets that are automatically "screened out" due to CCF redundancy is for CCF basic events that involve four (4) or more SSCs failing within the basic event (this screening is completed to account for significant redundancy within a system); this defense-in-depth would only be valid if the SSCs associated with the CCF aren't already identified within the smaller sets of common cause for that group in "screened in" cutsets for alternate defense-in-depth. Since the alternate defense-in-depth assessment does not use quantitative impacts (except for initiating event frequency and truncation), the alternate defense-in-depth process provides a qualitative evaluation of CCF screening compared to the PRA model quantitative examination in NEI 00-04, Section 5. Additionally, common cause failure continues to be examined in the NEI 00-04, Section 9.2.2, Review Defense-in-Depth Implications, #4 consideration.

5. ***"Maintain multiple fission product barriers."***

   a. **Preserved.** Multiple fission product barriers are maintained and are not modified by the alternate defense-in-depth categorization process.

      The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

      > *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to***

> ***ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.****"* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

Alternative treatments require that RISC-3 SSCs maintain reasonable confidence and have periodic review and performance monitoring which prevent increases in the frequency of existing challenges to the integrity of barriers or the failure probability of any individual barrier. As stated in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Treatment requirements for the SSCs are applied as necessary to maintain functionality and reliability and are a function of the category into which the SSC is categorized. Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Additionally, as stated in 10 CFR 50.69(d)(2) (Reference 7):*"The licensee or applicant shall ensure, with reasonable confidence, that RISC-3*

SSCs remain capable of performing their safety-related functions under design basis conditions, including seismic conditions and environmental conditions and effects throughout their service life." Core damage defense-in-depth is still examined except in an alternate process with the alternate core damage defense-in-depth methodology. Containment defense-in-depth continues to use NEI 00-04, Section 6.2. The alternate core damage defense-in-depth identifies defense-in-depth in a process that is similar to the NEI 00-04, Section 6.1 method. The alternate defense-in-depth process identifies the level of defense-in-depth within a cutset review to identify appropriate RISC determinations for the level of defense-in-depth. Additionally, other areas of 10 CFR 50.69 like NEI 00-04, Section 9.2.2 Review of Risk Information seven qualitative considerations and the Review Defense-in-Depth Implications five qualitative considerations provide additional examination of core damage defense-in-depth which are now required to be evaluated by the engineering team as well as the IDP. No new or additional failure dependencies among barriers is created by implementation of alternate core damage defense-in-depth since no design changes have occurred.

6. ***"Preserve sufficient defense against human errors."***

   a. **Preserved.** Human error is preserved since the alternate defense-in-depth process does not create new human actions nor does it significantly increase the probability of existing human errors.

      It is important to note that the robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.****"* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

b. ***"Create new human actions that are important to preserving any of the layers of defense for which a high reliability cannot be demonstrated."***
Preserved. The proposed modifications with the alternate defense-in-depth process does not create new human errors that might adversely impact one or more layers of defense. The plant design remains the same and would therefore

not create any new human actions. Alternative treatments are required to maintain reasonable confidence in supporting their safety-related functions and are not anticipated to create new human actions that are important to preserving layers of defense. Performance monitoring of alternative treatments prevent the overreliance on operator actions.

c. ***"Significantly increase the probability of existing human errors by significantly affecting performance shaping factors, including mental and physical demands and level of training."*** Preserved. The alternate defense-in-depth process includes human actions in identifying core damage defense-in-depth. SSCs with alternative treatments are required to maintain reasonable confidence of performing their safety-related functions. Periodic reviews and performance monitoring would evaluate whether these human actions or the SSCs that the human actions support have degradation and a corrective action would be taken to eliminate the degradation. For example, if a support system that requires operator actions is having a degradation, an evaluation of the degradation would be assessed that would identify if the SSCs should be reclassified. Due to the reasonable confidence of RISC-3 SSCs, plant operations are not modified in methods that increase human errors or overreliance on human actions. The alternate defense-in-depth categorization process does not modify the currently established process for alternative treatments in 10 CFR 50.69 (Reference 7) so implementation of the alternate defense-in-depth categorization process does not affect reasonable confidence of alternative treatments. Additionally, NEI 00-04, Section 9.2.2, Review of Risk Information, #4 and #5 evaluates the sole means of operator actions for specific scenarios (e.g., mitigation of an accident or transient), and NEI 00-04, Section 9.2.2., #2 examines over-reliance on operator actions which provide for an additional protection with regards to evaluation of operator actions.

Periodic reviews and performance monitoring that are identified in the NEI 00-04, Section 12 process are unaffected by the alternate defense-in-depth process and continue to identify if adverse trends from alternative treatments exist.

No system design modifications are made by implementing the alternate defense-in-depth categorization process or the 10 CFR 50.69 process as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7), "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* This prevents any human actions from occurring due to a modification in the system design.

7. ***"Continue to meet the intent of the plant's design criteria."***

a. **Preserved.** The robust plant design is maintained and has not changed based on the implementation of 10 CFR 50.69 or the alternate defense-in-depth categorization. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.6.0, Implementation Process Requirements (Reference 7): "*Changes that affect any non-treatment aspects of an SSC (e.g., changes to the SSC design basis functional requirements) are still required to be evaluated in accordance with other regulatory requirements such as § 50.59.*" This is further reinforced in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant.*" Additionally, alternative treatments provide for no significant changes in SSC reliability due to being required to provide reasonable confidence of supporting their safety-related functions. The alternative treatment requirements remain unchanged with the alternate defense-in-depth process. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.7.2, Defense-in-Depth is Maintained (Reference 7): "*§ 50.69 imposes high-level treatment requirements that when effectively implemented, maintain the capability of RISC-3 SSCs to perform their design basis functions.*" Additionally, as stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"Section 50.69 is* ***structured to maintain the design basis functional requirements of the plant****. These requirements (that maintain design basis functional requirements) when considered in conjunction with the requirements to provide reasonable confidence that the potential change in risk is small (as previously discussed), also provide reasonable confidence that safety margins are maintained.* ***Specifically, licensees are required to ensure with reasonable confidence that RISC–3 SSCs remain capable of performing their design basis functions and these SSCs must remain capable of performing their design basis function, e.g., by providing a reliability that is not significantly degraded, to provide reasonable confidence that any increases in CDF or LERF will be acceptably small.****"* (emphasis added in bold)

NEI 00-04, Section 12 requires periodic reviews and performance monitoring of the categorization results to identify adverse trends on SSC performance. This allows for defense-in-depth for the safety-related functions to be maintained since reasonable confidence of performing safety-related functions must be maintained for SSCs through periodic reviews and performance monitoring. This is consistent with the concept identified in the Statement of Considerations of 10 CFR 50.69, Section III, Final Rule (Reference 7), "*Finally, assessment activities are conducted to make adjustments to the categorization and treatment processes as needed so that SSCs continue to meet applicable requirements.*" Performance monitoring of alternative treatments of RISC-3 SSCs is also required per 10 CFR 50.69(e)(3) (Reference 7):

> *"The licensee shall consider data collected in § 50.69(d)(2)(i) for RISC–3 SSCs to determine if there are any adverse changes in performance such that the SSC unreliability values approach or exceed the values used in the evaluations conducted to satisfy § 50.69(c)(1)(iv). The licensee shall make adjustments as necessary to the categorization or treatment processes so that the categorization process and results are maintained valid."*

The periodic review and performance monitoring processes are maintained in the alternate defense-in-depth process; the alternate defense-in-depth process provides a note to review initiating event frequencies in the alternate defense-in-depth during the periodic review process to verify the alternate defense-in-depth process is not impacted by FPIE PRA model changes. PRA model examination is already part of the periodic review process.

The 10 CFR 50.69 and the alternate defense-in-depth categorization process do not impact the plant design. The alternate defense-in-depth categorization process does not modify the currently established process for alternative treatments in 10 CFR 50.69. Alternative treatments are required to provide reasonable confidence that they maintain reasonable confidence to perform their safety-related functions. Periodic reviews and performance monitoring would evaluate whether these human actions or the SSCs that the human actions support have degradation and a corrective action would be taken to eliminate the degradation. As stated in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7) which states "*Section 50.69 is structured to maintain the design basis functional requirements of the plant."* The design criteria is not affected by implementation of alternate defense-in-depth and the plant continues to meet the design criteria.

2.2.8 Use of FPIE CDF PRA Model for Alternate Defense-in-Depth

The alternate defense-in-depth process uses the FPIE CDF PRA model. The base FPIE CDF PRA model is used for the evaluation of alternate core damage defense-in-depth since it provides a realistic interpretation of the accident sequences within the plant. Evaluation based on sensitivity studies are examined within the quantitative evaluation of the PRA model in NEI 00-04, Section 5 (Reference 2). Additional sensitivity studies are also performed in NEI 00-04, Section 8.

10 CFR 50.69 only requires a FPIE with internal flooding PRA model to implement 10 CFR 50.69. An FPIE PRA model (without internal flooding) that meets the ASME/ANS RA-Sa-2009 PRA Standard (Reference 3) identifies pressure boundary initiating events and pressure boundary basic events that have impacts that are not associated with internal flooding. As discussed in Section 2.2.5, the pressure boundary aspects that relate to internal flooding are evaluated in another assessment outside of NEI 00-04, Section 6.1 defense-in-depth "active" categorization process.

Additionally, NEI 00-04, Section 6.1 states:

> "*This figure* **[Figure 6-1 in NEI 00-04]** *depicts the* ***internally initiated design basis events considered in the licensee's safety analysis report (i.e., the events that were used to identify an SSC as safety-related)*** *and considers the level of defense-in-depth available, based on the success criteria used in the PRA.*" (emphasis added in bold, figure identification added in bolded brackets)

These internally initiated design basis events considered in the licensee's safety analysis report corresponds to the Safety Analysis Chapter of the Final Safety Analysis Report which are captured in the FPIE PRA model. This is consistent with previous interpretations of the NEI 00-04, Section 6.1 approach. For example, in Enclosure 3, Section 3.6 of ML18165A162, "*Limerick Generating Station, Units 1 and 2 – Issuance of Amendment Nos. 230 and 193 to Adopt Title 10 of the Code of Federal Regulations Section 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors" (CAC Nos. MF9873 and MF9874; EPID L-2017-LLA-0275)*" (Reference 9) the following is stated:

> *"NEI 00-04, Section 6.0, provides guidance on assessment of DID. Figure 6-1 in NEI 00-04 provides guidance to assess design-basis DID based on the likelihood of the design-basis* ***internal event initiating event*** *and the number of redundant and diverse trains nominally available to mitigate the initiating event."* (emphasis added in bold)

The alternate defense-in-depth process follows the concept of examination of internal event initiating events that are used to identify core damage defense-in-depth in NEI 00-04, Section 6.1 based on previous interpretation of the process as identified above. The pressure boundary analysis is separately evaluated as discussed in Section 2.2.5 of this report which examines internal flooding scenarios. Therefore, the FPIE CDF PRA model, which includes pressure boundary failure initiating events and pressure boundary failure basic events that impact the FPIE CDF PRA model through non-flooding scenarios is acceptable for use in the alternate core damage defense-in-depth process.

It is also important to realize that NEI 00-04 includes other examinations risk information and defense-in-depth reviews. For example, PRA importance measures and screenings in NEI 00-04, Section 5, and the Review of Risk Information and Review Defense-in-Depth Implications in NEI 00-04, Section 9.2.2 continue to be evaluated, and the pressure boundary analysis is completed outside of the NEI 00-04, Section 6.1 guidance. The NEI 00-04, Section 5 evaluations specifically addresses other hazards within the plant. With these other evaluations present for examination of other hazards and the basis that NEI 00-04, Section 6.1 examines only internal event initiating events, this provides consistency with the previous NEI 00-04, Section 6.1 process.

2.2.9 Scope of the Integrated Decision-making Panel

The alternate defense-in-depth process discusses the IDP scope and review since the IDP is a critical part of the 10 CFR 50.69 categorization process. The IDP is the final decision-maker of categorization for functions / SSCs of a system and only after the approval of the categorization by the IDP can alternative treatments for SSCs be implemented. This is described in the Statement of Considerations of 10 CFR 50.69, Section III.2.0, Methodology for Categorization (Reference 7):

> *"The IDP makes the final determination of the safety significance of SSCs using a process that takes all this information into consideration, in a structured, documented manner. The structure provides* consistency *to decisions that may be made over time and the documentation gives both the licensee and the NRC the ability to understand the basis for the categorization decision, should questions arise at a later date."*

The IDP does not solely examine functions during their review. Specifically, the IDP evaluates SSCs with respect to defense-in-depth if a detailed categorization is performed. As stated in NEI 00-04, Section 9.2 (Reference 2):

> "*In this follow-up session, the IDP would be expected to review the basis for the re-categorization and to assess the impact of this recategorization on the risk importance and defense in depth implications using the same criteria as in the original IDP session for candidate low safety-significant SSCs."*

As described in NEI 00-04, Section 9.1, the IDP has training in multiple topic areas, including in the PRA modeling scope and assumptions "*covered to the extent necessary to provide the IDP with a level of knowledge sufficient to evaluate and approve SSC categorizations using both probabilistic and deterministic information.*" The IDP being aware of the assumptions of the PRA allows for them to identify how these assumptions impact the alternate defense-in-depth process and provide a review that the FPIE CDF PRA model is sufficient to use for alternate core damage defense-in-depth. As shown in the alternate defense-in-depth process outlined in Section 2.2.2 the IDP:

- Reviews and approves the bases developed by the engineering team regarding how initiating events "screened out" of the FPIE CDF PRA model do not impact the alternate core damage defense-in-depth categorization or if they should be included in the model results for the alternate core damage defense-in-depth categorization. The IDP also approves any modifications to these during periodic reviews.

- Reviews and approves the bases developed by the engineering team regarding how an initiating event split into multiple initiating events of the FPIE CDF PRA model do not impact the alternate core damage defense-in-depth categorization or if they should be combined in the model results for the alternate core damage defense-in-depth categorization. The IDP also approves any new split initiating events during periodic reviews.

- Reviews and approve the evaluation whether the system modeled within the FPIE CDF PRA is modeled with sufficient detail to identify core damage defense-in-depth via the alternate core damage defense-in-depth method.

- Reviews and approves the evaluation that assumptions identified in the FPIE CDF PRA model do not prevent identification of failure pathways that would impact the identification of core damage defense-in-depth via the alternate core damage defense-in-depth method.

- The IDP continues evaluations identified in NEI 00-04, Section 9 which includes the Review of Risk Information seven considerations and the Review of Defense-in-Depth Implications five considerations. Now, the engineering team evaluates the NEI 00-04, Section 9.2.2 Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations prior to the IDP review and approval in accordance with Step 8.e in Section 2.2.2. The engineering team evaluation allows for examination of these considerations by engineers that were directly involved in the categorization of the system which can provide insights into these considerations. Additionally, since the IDP reviews these considerations, along with sections of the categorization, they provide additional insights within these considerations on the impact the categorization has on the system. This provides both the knowledge and expertise of the engineering team and the IDP with regards to the NEI 00-04, Section 9.2.2, Review of Risk Information considerations and the Review Defense-in-Depth Implications considerations.

Hence, the IDP review of the alternate core damage defense-in-depth process, along with their other reviews, is an integral aspect of the 10 CFR 50.69 categorization acceptability. They provide an independent review of the analysis that has been completed by the engineering team.

3 REFERENCES

1. PA-RMSC-1769, Revision 2, "Alternate 50.69 Categorization Process."

2. NEI 00-04, Revision 0, "10 CFR 50.69 SSC Categorization Guideline," July 2005.

3. ASME/ANS RA-Sa-2009, "Standard for Level I/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," Addendum A to RA-S-2008, The American Society of Mechanical Engineers, New York, NY, American Nuclear Society, La Grange Park, Illinois, dated February 2009.

4. NRC Regulatory Guide 1.200, Revision 2, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," U.S. Nuclear Regulatory Commission, March 2009.

5. NRC Regulatory Guide 1.200, Revision 3, "Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities," U.S. Nuclear Regulatory Commission, December 2020.

6. NRC Regulatory Guide 1.174, Revision 3, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," U.S. Nuclear Regulatory Commission, January 2018.

7. 10 CFR 50.69, Final Rule, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors," November 22, 2004.

8. 10 CFR 50, Appendix A, Criterion 21, Nuclear Regulatory Commission.

9. ML18165A162, "Limerick Generating Station, Units 1 and 2 – Issuance of Amendment Nos. 230 and 193 to Adopt Title 10 of the Code of Federal Regulations Section 50.69, "Risk-Informed Categorization and Treatment of Structures, Systems and Components for Nuclear Power Reactors" (CAC Nos. MF9873 and MF9874; EPID L-2017-LLA-0275)," U.S. Nuclear Regulatory Commission, July 31, 2018.

10. NUREG-1855, Revision 1, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decisionmaking," U.S. Nuclear Regulatory Commission, March 2017.

11. NRC Regulatory Guide 1.201, Revision 1, "Guidelines for Categorizing Structures, Systems, and Components in Nuclear Power Plants According to their Safety Significance," U.S. Nuclear Regulatory Commission, May 2006.

12. ASME Code Case, N-660, "Risk-Informed Safety Classification for Use in Risk-Informed Repair/Replacement Activities," July 2002.

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