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10 CFR 50.90
10 CFR 50.69

May 5, 2021

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: 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"

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. Email from V. Sreenivas (U.S. Nuclear Regulatory Commission) to G. Stewart (Exelon Generation Company, LLC), "Limerick Application to Modify 50.69 Categorization to Implement an Alternate Defense-In-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Tier 1 Categorization Process," dated April 20, 2021 (ADAMS Accession No. ML21111A031).

In 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 Tier 1 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.

In Reference 2, the NRC requested that Exelon provide supplemental information by May 7, 2021, to support the acceptance review of the license amendment request. The attachment to this letter provides a restatement of the NRC questions followed by our responses.

Exelon has reviewed the information supporting the No Significant Hazards Consideration and the Environmental Consideration that was previously provided to the NRC in Reference 1. The information in this LAR supplement 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 supplement.

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

If you should have any questions regarding this submittal, please contact Glenn Stewart at 610-765-5529.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 5th day of May 2021.

Respectfully,

D. P. Helker

David P. Helker
Sr. Manager - Licensing and Regulatory Affairs
Exelon Generation Company, LLC

Attachment: License Amendment Request Supplement - Application to Implement Alternate Categorization Processes in Accordance with the Requirements of 10 CFR 50.69.

cc: USNRC Region I, Regional Administrator
USNRC Project Manager, LGS
USNRC Senior Resident Inspector, LGS
Director, Bureau of Radiation Protection - Pennsylvania Department of Environmental Protection

**ATTACHMENT**

**License Amendment Request Supplement**

**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 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"**

In 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 license condition in Appendix C to allow the use of an alternate defense-in-depth (DID) categorization process, an alternate pressure boundary categorization process, and an alternate Seismic Tier 1 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.

In Reference [2], the NRC requested that Exelon provide supplemental information by May 7, 2021 to support the acceptance review of the license amendment request. A restatement of the NRC questions followed by our responses is provided below.

1. <u>Alternate defense-in-depth Categorization Process</u>

Section 50.69 (c)(1)(iii) requires that defense-in-depth be maintained as part of the categorization requirements. Section 6 of NEI 00-04 as endorsed by RG 1.201 provides guidance for assessing defense-in-depth. It includes considerations for core damage and containment defense-in-depth. For core damage, the guidance provides a table generally requesting multiple trains or systems, depending on the frequency of the initiating events, "without credit for any identical, redundant SSCs within the systems that are also classified as low safety-significant." Similar considerations are provided for containment defense-in-depth regarding containment bypass, isolation, early hydrogen burns and long-term integrity. The currently endorsed NEI 00-04 categorization guidance evaluates defense-in-depth independently from the PRA results, thus ensuring that SSCs that otherwise might be considered low safety significant, but are important to defense-in-depth, will be categorized as high safety significant (and will remain subject to special treatment requirements). This process follows the intent of 10 CFR 50.69 and the tenets of integrated decision-making as outlined in RG 1.174 which preserves the required separate evaluation of PRA results from that of deterministic defense-in-depth.

Section 2.1.1.3 of RG 1.174, states how defense-in-depth should not be based exclusively on the PRA:

> "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."

In its LAR, the licensee is proposing to replace the NEI 00-04 defense-in-depth methodology with an alternate defense-in-depth methodology, as documented in PWROG-20015-NP, Revision 1, "Alternate 10 CFR 50.69 Defense-in-Depth Categorization Process" (ADAMS Accession Nos. ML21082A521 and ML21082A522). According to PWROG-20015-NP Section 2.2.3,

> “the alternate core damage [or containment] defense-in-depth categorization process uses the [Full Power Internal Events] FPIE PRA model assumptions and success criteria to allow for defense-in-depth categorization of systems with only the PRA model assumptions and success criteria.”

PWROG-20015-NP Section 2.2.3 further states

> “In the alternate core damage defense-in-depth categorization process, replacement of NEI 00-04 […] with identification of risk significant cutsets is based on the success criteria used in the PRA.”

Section 2.2.5 of PWROG-20015-NP, Revision 1 provides description of how the proposed alternative categorization meets key principle 3 of RG 1.174 of maintaining defense-in-depth. It references back to the language in paragraph 50.69(d)(2) which requires the licensees ensure, with reasonable confidence, that RISC-3 SSCs (those with alternative treatments) remain capable of performing their safety-related functions under design basis conditions. The NRC staff notes that, according to the Statements of Consideration in the Federal Register Notice (FRN) Vol. 69, No. 224, dated November 22, 2004, the rule does not specify alternative treatments for RISC-3 SSCs, because the low safety significance of these SSCs supports allowing licensees to establish treatment without prior NRC review. Further, in the FRN, the NRC notes that for low safety significant (RISC-3) SSCs, the 50.69 rule language provides an acceptable, though reduced, level of confidence that these SSCs will satisfy functional requirements.

The LAR references a pilot categorization that was performed at Limerick on ten systems, and states that “the pilot results were found to be reasonable and consistent”, however the staff finds neither the LAR, nor the PWROG document, provide sufficient supporting evidence to support the staff safety conclusions regarding the acceptability of the alternate defense in depth approach. LAR Section 3.1.2 acknowledges that “the pilot resulted in fewer HSS functions from defense-in-depth and fewer HSS components overall.”

In order to facilitate its review, the NRC staff is requesting further justification on the robustness and adequacy of the proposed alternate defense-in-depth categorization process. Such information could include:

i. Discussion of the Limerick ten system pilot categorization, including discussion of the systems categorized.

**<u>Response</u>**

The "Alternate 10 CFR 50.69 Defense-in-Depth Categorization" and "Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components" approach was applied to 10 systems as noted in Table 1 below. Table 1 shows the system number, the system name, number of components, the number of functions, and whether the system is modeled in the full power internal events (including internal flooding) PRA model. The data in Table 1 includes components for both Limerick units.

(Note: The Enhanced Risk-Informed Categorization Methodology for Pressure Boundary Components is performed on a plant-wide basis).

Although the 10 systems were previously fully categorized using the traditional NEI 00-04 process steps, the pilot only exercised the steps of the alternate defense-in-depth and alternate pressure boundary categorization approach.

| **Table 1**<br>**Limerick Pilot Study Systems for Units 1&2** | | | |
|---|---|---|---|
| **System** | **Components (QTY)** | **Functions (QTY)** | **PRA Modeled (Y/N)** |
| 001 – Main Steam (MS) | 1,648 | 15 | Y |
| 012 – Residual Heat Removal Service Water (RHRSW) | 654 | 17 | Y |
| 025 – Steam Leak Detection (SLD) | 304 | 7 | Y |
| 026 – Radiation Monitors (RMS) | 1,530 | 34 | Y |
| 051 – Residual Heat Removal (RHR) | 3,177 | 26 | Y |
| 052 – Core Spray (CS) | 1,519 | 20 | Y |
| 059 – Primary Containment Instrument Gas (PCIG) | 1,301 | 18 | Y |
| 076 – Reactor Enclosure HVAC (REHVAC) | 5,468 | 25 | Y |
| 078/090 – Control Enclosure HVAC (CEHVAC) | 2,990 | 27 | N |
| 092A – Emergency Diesel Generators (EDG) | 7,271 | 13 | Y |

Table 2 below provides a summary of the pilot results for functions and SSCs evaluated and the functions and SSCs that changed at the conclusion of the pilot.

| **Table 2**<br>**Overall Summary of Pilot Study Results** | |
|---|---|
| **Data Point** | **Result** |
| Total Functions Evaluated | 200 |
| Total SSCs Evaluated | 22834 |

| **Table 2**<br><br>**Overall Summary of Pilot Study Results** | |
|---|---|
| **Data Point** | **Result** |
| Functions Affected by alternate DID | 13 / 7% |
| SSCs Affected by alternate DID | 1595 / 7% |

The responses to questions ii through v collectively provide additional details specific to the 10 pilot systems. The responses to questions vi and vii are more generic to the categorization process as a whole.

ii. Comparison and justification of results of the defense-in-depth categorization of the ten pilot systems between existing NEI 00-04 and PWROG-20015-NP methodologies.

**Response**

Of the 10 systems that were piloted, six systems had functions that were considered high safety significant (HSS) from the traditional NEI Defense-in-Depth approach but were considered low safety significant (LSS) by the Alternate Defense-in-Depth approach. This is an update from the information provided in the original license amendment request (Reference [1]).

Functions that were LSS by the Alternate Defense-in-Depth approach were justified by meeting the LSS criteria in Sections 7 and 8 of PWROG-20015-NP, Revision 1, for core damage and containment defense-in-depth, respectively. For example, in the core damage and containment defense-in-depth assessments, SSCs associated with cutsets with initiating events having frequencies that are less than 1E-04/yr are screened out. Note that these SSCs would still be subject to the other categorization process steps in NEI 00-04 if full categorization were performed. These additional assessments could still result in some SSCs becoming HSS.

The six systems and the respective LSS functions from the alternate approach are shown in Table 3 below.

| **Table 3**<br><br>**Pilot Systems with LSS Functions from Alternate Approach** | | |
|---|---|---|
| **System** | **Defense-in-Depth** | **Function** |
| Core Spray | Core Damage | Provide Diesel Generator and ECCS system initiation logic during a LOCA. |

| Table 3<br>Pilot Systems with LSS Functions from Alternate Approach | | |
|---|---|---|
| **System** | **Defense-in-Depth** | **Function** |
| | Core Damage | Supply power to the ECCS trip units, steam leak monitors, and downstream instrumentation. |
| | Containment | Provide keep fill to Feedwater injection to maintain a water seal during design basis events. |
| | Containment | Mitigate an ISLOCA event. |
| Radiation Monitoring | Containment | Provide a trip signal from the North Stack post- accident wide range monitors to the containment purge valves in the event of a high radiation condition when required by the Tech Specs. |
| Reactor Enclosure HVAC | Core Damage | Provide Reactor Enclosure Venting/Isolation by closing steam flooding dampers to minimize steam flooding in critical areas on a sensed high differential pressure. |
| Control Enclosure HVAC | Core Damage | Steam Flooding Dampers - Isolate on a sensed high differential pressure, or manual isolation signal. |
| Steam Leak Detection | Containment | Secondary Containment Leak Detection - Alarm and Isolation Initiation associated with the Main Steam Line. |
| | Containment | Secondary Containment Leak Detection - Alarm and Isolation Initiation associated with the RWCU System. |
| RHR | Core Damage | Electrical SSCs supporting HSS functions in HPCI, CS, and RCIC systems |
| | Containment | Provide Containment Isolations |

iii. Discussion of the categorization results and justification that support the licensee's conclusion that the pilot results are "reasonable."

**Response**

For SSCs that screened LSS using the alternate defense-in-depth approach, these SSCs were shown to have adequate redundancy and diversity using the approved PRA model. The alternate defense-in-depth approach uses the PRA model structure and insights to enhance the defense-in-depth analyses which shows redundancy and diversity exists. Therefore, the conclusion that they are LSS is reasonable and justified. The opposite is true for SSCs that screened HSS, e.g., PCIG and RHR. These SSCs are relied upon in multiple accident mitigation strategies without adequate redundancy and diversity as discussed in the following paragraphs regarding the PCIG and RHR systems. The conclusions that they are HSS are reasonable and justified given the lack of diversity and redundancy.

In the case of the PCIG system, the functions do not have adequate redundancy due to common and significant components in the junctions of the flow paths. The system also has minimal redundancy in the form of other systems that could achieve, singularly or in conjunction with other systems, similar mitigative results. In the case of PCIG, pipe and accumulator ruptures and pressure switch failures are examples of SSCs whose failures lead to failure of the function to supply gas to the automatic depressurization system (ADS) valves.

In the case of the RHR system, the RHR functions for low pressure coolant injection and suppression pool cooling have minimal redundancy in the form of other systems that could achieve, singularly or in conjunction with other systems, similar mitigative results. The residual heat removal function relies on motor operator valves whose failure to open could lead to the failure of the LPCI mode of RHR requiring all components associated with the function (pumps, valves, control logic, etc.) be categorized as high safety significant. Further, failure to open certain suppression pool cooling (SPC) motor operated valves leads to failure of the SPC mode of RHR also requiring all components associated with the function be categorized as high safety significant.

Therefore, the alternate approach reasonably concludes that significant SSCs are HSS.

iv. Discussion of the number and types of SSCs identified as HSS by the alternate defense-in-depth categorization process at Limerick.

**Response**

Table 4 below summarizes the functions identified as HSS using the Alternate DID Methodology, the associated SSCs, and the significant equipment within the functions.

**Table 4:**
**Pilot HSS Functions and Example SSCs (Units 1 and 2)**

| System | Function<br># SSCs | Function Description | Significant SSCs<br>(Single Unit,<br>Single Train Shown) |
|---|---|---|---|
| RHR | 51A-01<br><br>642 SSCs | LPCI Mode – Provide low pressure coolant injection to the RPV.<br><br>The flow path for this function includes all trains of the RHR pumps taking suction from the suppression pool and pumping the water through to the LPCI injection lines. | 1A1F211 RHR Suppression Pool Strainer<br><br>HV-1F004A RHR Pump Suction PCIV<br><br>1AP202 1A RHR Pump<br><br>1F031A RHR Pump Disch Check Vlv<br><br>HVC-1F048A RHR HTX Shell side Bypass<br><br>HV-1F017A RHR LPCI Inj PCIV<br><br>HV-1F041A LPCI Inj HDR CHK and Bypass PCIV |

**Table 4:**
**Pilot HSS Functions and Example SSCs (Units 1 and 2)**

| System | Function # SSCs | Function Description | Significant SSCs (Single Unit, Single Train Shown) |
|---|---|---|---|
| | 51B-01<br><br>737 SSCs | Suppression Pool Cooling Mode - Provide cooling to remove heat from the suppression pool.<br><br>Mapping for this function includes the normal, emergency, and alternate suppression pool cooling alignments. In the normal and emergency cooling alignments, the pumps taking suction from the suppression pool and pumping water to the RHR heat exchangers. Flow then goes through the outlet valves and back to the suppression pool. The alternate alignment cross-ties the heat exchangers to the train of redundant pumps. | 1A1F211 RHR Suppression Pool Strainer<br><br>HV-1F004A RHR Pump Suction PCIV<br><br>1AP202 1A RHR Pump<br><br>1F031A RHR Pump Disch Check Vlv<br><br>HVC-1F048A RHR HTX Shell side Bypass<br><br>HV-1F024A RHR Full Flow Test Return<br><br>HV-125A RHR Full Flow Test PCIV |
| PCIG | 059-01B<br><br>60 SSCs | Distribute air from the PCIG compressors or gas from the nitrogen bottles to the ADS MSRVs.<br><br>Multiple pathways are provided to the ADS valves from headers that connect multiple sources. This function includes only those components associated with providing gas from the header that is fed by the non-safety related PCIG compressors or from the nitrogen bottles during non-fire scenarios that share the same header. This function includes the components responsible for sensing low header pressure and switching to the Nitrogen Bottles (059-03). | SV-150A N2 Supply to ADS<br><br>HV-151A ADS Instrument Gas PCIV |

**Table 4:**
**Pilot HSS Functions and Example SSCs (Units 1 and 2)**

| **System** | **Function # SSCs** | **Function Description** | **Significant SSCs (Single Unit, Single Train Shown)** |
|---|---|---|---|
| | 059-03<br><br>162 SSCs | 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.<br><br>This function includes the components in the short flow path from the quick-connect to the main header. This function also includes the nitrogen bottles. Includes components in the flow paths through the Drywell A Instrument Gas PCIV valve through the Drywell B Instrument Gas valve to the A, C, and N non-ADS SRVs. Also include the components in the flow path from Long-Term Nitrogen Flow Path PCIVs to the ADS SRVs. This function includes habitable and uninhabitable main control room response scenarios. | To MSRVs<br>1A-S252 PCIG/ADS Nitrogen Bottles<br><br>PCV-152A-1 ADS Backup N2 Supply Pressure Control Vlv<br><br>SV-152A N2 Supply to ADS System<br><br>059-1143 Backup N2 HDR Outboard Leak Test<br><br>059-1098 Pri Cont Inst Gas HDR Outboard<br><br>HV-129B Inst Gas Outboard PCIV<br><br>To ADS Valves<br>1A-S252 PCIG/ADS Nitrogen Bottles<br><br>PCV-152A-1 ADS Backup N2 Supply Pressure Control Vlv<br><br>SV-152A N2 Supply to ADS System<br><br>HV-151A ADS Instrument Gas PCIV |

v. Percentages of SSCs categorized in LSS and HSS category.

**Response**

The number of SSCs identified as HSS by the alternate defense-in-depth approach are shown in Table 5 below and include pumps, valves, and control logic relays. Table 5 also shows a side-by-side comparison of the categorization results using the NEI 00-04 approach and the alternate approach as well as percentage changes to show LSS and HSS categories.

**Table 5**

**Comparison of Categorization Results for U1 & U2 Combined**

| System [1] | NEI 00-04 Qty [2] (HSS/LSS) | Alternate DID Qty [2] (HSS/LSS) | Change in HSS (Qty) | Change in HSS (%) | Functions Resulting in Categorization Changes | Rationale |
|---|---|---|---|---|---|---|
| 001 – Main Steam (MS) | 4/1466 | 4/1466 | 0 | 0% | N/A | N/A – No change. |
| 012 – Residual Heat Removal Service Water (RHRSW) | 158/487 | 158/487 | 0 | 0% | N/A | N/A – No change. |
| 025 – Steam Leak Detection (SLD) | 250/50 | 78/222 | -172 | -69% | Secondary Containment Leak Detection - Alarm and Isolation Initiation associated with the RWCU<br><br>Secondary Containment Leak Detection - Alarm and Isolation Initiation | Both functions were originally HSS in the approved categorization due to the deterministic Containment Isolation Defense-in-Depth assessment because the SSCs were determined to “support containment isolation for containment penetrations that…” meet the NEI 00-04 screening criteria. However, the system, and therefore the functions, contain no Primary Containment Isolation Valves. The functions contain temperature elements that |

**Table 5**

**Comparison of Categorization Results for U1 & U2 Combined**

| System [1] | NEI 00-04 Qty [2] (HSS/LSS) | Alternate DID Qty [2] (HSS/LSS) | Change in HSS (Qty) | Change in HSS (%) | Functions Resulting in Categorization Changes | Rationale |
|---|---|---|---|---|---|---|
| | | | | | associated with MS piping. | act as a means to automatically isolate containment isolation valves that meet the section criteria for screening HSS. Following the alternate assessment criteria this function is not considered to contribute to LERF and therefore LSS. This is reasonable as failure of the functions would not fail the isolation valves nor would it fail other means of detecting steam leaks. |
| 026 – Radiation Monitors (RMS) | 112/1381 | 54/1439 | -58 | -52% | Provide a trip signal from the North Stack post-accident wide range monitors to the containment purge valves in the event of a high radiation condition when required by the Tech Specs. | This function was originally HSS in the approved categorization due to the deterministic Containment Isolation Defense-in-Depth assessment because the SSCs were determined to “support containment isolation for containment penetrations that…” meet the NEI 00-04 screening criteria. However, the system, and therefore the function, contains no Primary Containment Isolation Valves. The North Stack Rad. monitor function sends close signals to normally closed valves, many of which are fail closed valves, that are in other plant systems. Failure of the function would not fail the valves or alternate means to isolate during an event. |

**Table 5**

**Comparison of Categorization Results for U1 & U2 Combined**

| System [1] | NEI 00-04 Qty [2] (HSS/LSS) | Alternate DID Qty [2] (HSS/LSS) | Change in HSS (Qty) | Change in HSS (%) | Functions Resulting in Categorization Changes | Rationale |
|---|---|---|---|---|---|---|
| 051 – Residual Heat Removal (RHR) | 1415/1704 | 1359/1760 | -56 | -4% | Provide Containment Isolations. | The containment isolation function was originally HSS due to the deterministic Containment Isolation Defense-in-Depth assessment because the SSCs were determined to "support containment isolation for containment penetrations that…" meet the NEI 00-04 screening criteria. Under the alternate screening these components are not considered significant LERF contributors and are, therefore, LSS. |
| | | | | | Electrical SSCs supporting HSS functions in HPCI, CS, and RCIC systems. | The support functions are reported as changing but are actually support functions for other Limerick systems and require further review to confirm the change. Support functions take the significance of the functions within the system(s) they support. |
| 052 – Core Spray (CS) | 384/1134 | 110/1408 | -274 | -71% | Provide Diesel Generator and ECCS system initiation logic during a LOCA. | Failure of the automatic initiation logic would not fail the diesel generators or the means to start them manually nor would it fail the ECCS systems. |

**Table 5**

**Comparison of Categorization Results for U1 & U2 Combined**

| System [1] | NEI 00-04 Qty [2] (HSS/LSS) | Alternate DID Qty [2] (HSS/LSS) | Change in HSS (Qty) | Change in HSS (%) | Functions Resulting in Categorization Changes | Rationale |
|---|---|---|---|---|---|---|
| | | | | | Supply power to the ECCS trip units, steam leak monitors, and downstream instrumentation. | This function interfaces with systems that were not categorized as part of this pilot. The results are presented as LSS since it was not explicitly HSS from the alternate DID screening criteria. In order to get a final categorization for this function those supported systems would need to be evaluated. |
| | | | | | Provide keep fill to Feedwater injection to maintain a water seal during design basis events. | This function provides a water seal to prevent potential release following a design basis accident and was considered HSS from the containment defense in depth assessment. Following the alternate guidance this function is not considered to be a major contributor to LERF and is, therefore, LSS. |

**Table 5**

**Comparison of Categorization Results for U1 & U2 Combined**

| System [1] | NEI 00-04 Qty [2] (HSS/LSS) | Alternate DID Qty [2] (HSS/LSS) | Change in HSS (Qty) | Change in HSS (%) | Functions Resulting in Categorization Changes | Rationale |
|---|---|---|---|---|---|---|
| | | | | | SSCs credited for mitigation of an ISLOCA event | The SSCs that support this function were identified as providing ISLOCA mitigation from the PRA notebook. The original analysis took the conservative approach of considering all SSCs credited in the ISLOCA notebook to be HSS. Under the alternate guidance, these components are not considered to be major contributors to LERF and are, therefore, LSS. |
| 059 – Primary Containment Instrument Gas (PCIG) | 160/733 | 160/733 | 0 | 0% | N/A | N/A – No change. |
| 076 – Reactor Enclosure HVAC (REHVAC) | 930/4392 | 218/5104 | -712 | -77% | Provide Reactor Enclosure Venting/Isolation by closing steam flooding dampers to minimize steam flooding in critical areas on a sensed high differential pressure. | The actuation of steam flooding dampers does not prevent or mitigate core damage. The equipment separated from the steam source by the dampers may contribute to core damage but are not, typically, located side-by-side such that the failure of a single set of dampers would fail all mitigating means. The dampers contained in this function are independent of one another. Therefore, failure of one would not fail another. |

**Table 5**

**Comparison of Categorization Results for U1 & U2 Combined**

| System [1] | NEI 00-04 Qty [2] (HSS/LSS) | Alternate DID Qty [2] (HSS/LSS) | Change in HSS (Qty) | Change in HSS (%) | Functions Resulting in Categorization Changes | Rationale |
|---|---|---|---|---|---|---|
| 078/090 – Control Enclosure HVAC (CEHVAC) | 325/2619 | 2/2942 | -323 | -99% | Steam Flooding Dampers - Isolate on a sensed high differential pressure, or manual isolation signal | The actuation of steam flooding dampers does not prevent or mitigate core damage. The equipment separated from the steam source by the dampers may contribute to core damage but are not, typically, located side-by-side such that the failure of a single set of dampers would fail all mitigating means. The dampers contained in this function are independent of one another. Therefore, failure of one would not fail another. |
| 092A – Emergency Diesel Generators (EDG) | 1847/2687 | 1847/2687 | 0 | 0% | N/A | N/A – No change. |

Notes
1. The number of SSCs categorized within a system may differ from total number of SSCs in the system since some SSCs remained uncategorized and did not get a final risk-informed safety class (RISC) designation. This was due to some SSCs supporting other systems such that their impact to the other systems was not fully considered. Specific reasons for remaining uncategorized would be explained in their respective system categorization documents.

2. The results are not truly a one-to-one comparison of final categorization results. The NEI 00-04 column of results presented in Table 5 represent the final categorization results after the completion of all the categorization steps. The results presented in the Alternate DID column represent only the outcome of the alternate defense-in-depth categorization from the categorization pilot. A true comparison of results could only be made once the 10 pilot systems have undergone a second full categorization that incorporates the alternate defense-in-depth approach with the unchanged categorization steps of NEI 00-04.

vi. Further justification how use of the PRA success criteria for defense in depth conclusions can ensure that unforeseen failure mechanisms or phenomena are addressed in the categorization process.

**Response**

The Limerick PRA models represent the current plant design and configuration and current operating practices and have been demonstrated to be technically acceptable for use in 50.69 categorization. The models have undergone extensive peer reviews and have been shown to meet consensus PRA standards and industry PRA programs such that unforeseen failure mechanisms or phenomena are addressed to the extent required by the standards and programs. Furthermore, as stated in the Final Rule Section I.1 published in the Federal Register 69 FR 68008 for 10 CFR 50.69, "The probabilistic approach to defense-in-depth enhances and extends the traditional deterministic approach by allowing consideration of a broader set of potential challenges to safety using the PRA."

In addition:

- Sensitivity analyses will continue to be performed. For example, the "3x sensitivity" simultaneously increases unreliability and unavailability of all modeled LSS equipment by a factor of 3 to detect trends in performance degradation and understand margins to HSS thresholds. The sensitivity studies are explicitly performed to account for these unforeseen failure mechanisms or phenomena and the results of the sensitivity analyses are discussed with the IDP.

- Several other sensitivity studies are performed which exercise key areas of uncertainty in the PRA (e.g., human reliability, common cause failures, and no maintenance plant configuration). If an SSC that had been initially identified as LSS is found to exceed the safety significance thresholds in a sensitivity study, this information is provided to the IDP for consideration, along with an explanation of the results of the sensitivity study.

- Exelon uses a "buffer" factor for PRA categorization results (10% margin to the NEI 00-04 importance measure thresholds). This helps ensure that the categorization results are not sensitive to future PRA changes or small changes in reliability over time.

- Performance monitoring of RISC-3 SSCs, as required by 10 CFR 50.69(e)(3), is established to provide assurance that potential increases in failure rates will be detected and addressed before reaching the rate assumed in the integrated sensitivity study.

- Finally, in addition to the PRA models, other traditional engineering approaches are used throughout all of categorization that enhance defense-in-depth. Examples include the System Engineering Assessments and IDP Assessments.

vii. Justification that the potential increased number of LSS SSCs that would result from the alternate defense-in-depth categorization ensure that plant safety is maintained, including how it is ensured that sufficient safety margins are maintained by the proposed categorization, as required by 50.69(c)(1)(iv).

**Response**

The potential increase in LSS SCCs using the alternate defense-in-depth methodology does not impact plant safety. System categorization does not impact the existing safety analyses and it does not change the existing design basis conditions and requirements of safety related SSCs. The impact that categorization has on the design criteria of SSCs within a system is addressed in Section 9.2.2 of NEI 00-04 where it states:

> "Because the only requirements that are relaxed for LSS SSCs are those related to treatment, existing safety margins for SSCs arising from the design technical and functional requirements would remain. It is also required that there be reasonable confidence that any potential increases in CDF and LERF be small from assumed changes in reliability resulting from the treatment changes permitted by §50.69. As a result, individual SSCs continue to be capable of performing their design basis functions, as well as to perform any beyond design basis functions consistent with the categorization process and results. Therefore, it can be concluded that the sufficient safety margins are preserved. Consequently, no specific assessment of safety margin is required by the IDP."

In addition, implementation of the alternate defense-in-depth approach will be part of the overall categorization steps discussed in NEI 00-04. The impact on plant safety based on a postulated change in reliability of SSCs is assessed with the performance of sensitivity studies. As discussed in Section 1.5 of NEI 00-04:

> "The final step in the process of categorizing SSCs into risk-informed safety classifications involves the evaluation of the risk implications of changes in special treatment. This risk sensitivity study is performed using the available PRAs to evaluate the potential impact on CDF and LERF, based on a postulated change in reliability. In this risk sensitivity study, the unreliability of all modeled low safety-significant SSCs is increased simultaneously by a common multiplier as an indication of the potential trend in CDF and LERF, if there were a degradation in the performance of low safety-significant SSCs. A simultaneous degradation of all SSCs is extremely unlikely for an entire group of components. Utility corrective action programs would see a substantial rise in failure events and corrective actions would be taken long before the entire population experienced such degradation. Individual components may see variations in performance on this order, but it is exceedingly unlikely that the performance of a large group of components would all shift in an unfavorable manner at the same time."

The alternate defense-in-depth categorization process does not change the above conclusions that plant safety and safety margins are maintained.

2. Alternate Seismic Tier 1 Categorization Process

Section 50.69(c)(1) requires that SSCs be categorized using a categorization process that determines if an SSC performs one or more safety significant functions and identifies those functions. In its LAR, the licensee is proposing an alternative to the NEI 00-04 methodology as endorsed by RG 1.201 for consideration of seismic risk in the categorization process. The proposed alternative seismic categorization approach is based on the information in EPRI 3002017583, “Alternative Approaches for Addressing Seismic Risk in 10 CFR 50.69 Risk-Informed Categorization” for Tier 1 – Low Seismic Hazard/High Seismic Margin Sites. Section 2.2.2.1, “Integral Assessment,” of EPRI 3002017583 describes the integral importance measure determination from NEI 00-04 and explains how the importance from each risk contributor to the total risk can result in an HSS determination.

The staff’s review of the appropriateness of the proposed alternative seismic categorization approach (the so-called “Tier 1” approach), for meeting the requirements in 10 CFR 50.69, includes an evaluation of the relative contribution of the plant-specific seismic risk to the overall plant risk. The relative contribution is important due to the use of the integrated importance measures for categorization in the licensee’s approved 10 CFR 50.69 program. The staff identified the most recent docketed seismic CDF and seismic LERF estimates from the licensee’s risk-informed completion times (RICT) LAR and supplements as documented in the staff’s corresponding safety evaluation (ADAMS Accession No. ML20034F637). Based on these estimates, the staff has identified challenges to the use of the proposed alternative seismic approach with respect to Section 2.2.2.1, “Integral Assessment,” in EPRI 3002017583. Specifically, the staff has identified a relatively large contribution of seismic risk to overall plant risk, especially for LERF. This would challenge the determination that seismic risk will not solely result in HSS determination based on integrated importance measures and therefore, challenge the use of the predominantly qualitative consideration of seismic risk in the proposed approach.

The staff is aware that the docketed information on seismic CDF and seismic LERF may be a conservative estimate that was provided to meet the particular needs of the RICT program. The licensee stated in their 50.69 application that for “Tier 1 sites, the seismic risk (CDF/LERF) will be low such that seismic hazard risk is unlikely to influence an HSS decision.” However, this statement is based on the premise that the relative contribution of seismic risk is low when compared with the overall plant risk. Therefore, in order to facilitate its acceptance review, the NRC staff is requesting that the licensee provide supporting information to show that the relative contribution of seismic risk is low when compared with the overall plant risk. This information would provide support for the basis to accept the LAR for a detailed review of the proposed alternative seismic approach in its approved 10 CFR 50.69 program. The NRC staff will evaluate detailed justifications provided by the licensee (e.g., conservatisms in the seismic CDF and seismic LERF estimates) as part of its review of the LAR. If the staff’s review determines that the relative seismic risk contribution cannot be justified to be low compared to the overall plant risk, the staff may not have adequate technical justification to approve the proposed alternative seismic approach for use in the licensee’s approved 10 CFR 50.69 program.

**Response**

The LAR (Section 3.1.4) and EPRI report 3002017583 (Section 2.2.2.1) do not explicitly state that the relative contribution of seismic risk is (or needs to be) low when compared with the overall plant risk.

The following information is provided to support that seismic risk will not solely result in an HSS determination based on integrated importance measures and therefore, will not challenge the use of the qualitative consideration of seismic risk in the proposed approach.

1. Limerick Hazard Meets Tier 1: The Limerick seismic hazard curve meets the low hazard (Tier 1) criteria specified in EPRI 3002017583. As stated in the Limerick LAR, *"at these sites, the GMRS is either very low or within the range of the SSE such that unique seismic categorization insights are not expected."*

2. Limited Unique Seismic Insights: 50.69 categorization is based on the relative ranking (using Fussell-Vesely (F-V) and Risk Achievement Worth (RAW) values and thresholds) of SSCs within each Probabilistic Risk Assessment (PRA) model. The trial studies for high seismic hazard sites used in EPRI 3002017583 showed that HSS SSCs from the Full Power Internal Events (FPIE) PRA and Fire PRA (FPRA) models encompass the HSS SSCs from a Seismic PRA (SPRA) with few exceptions. Therefore, as stated in the Summary and Conclusions section of EPRI 3002017583, "the seismic risk insights provided only limited unique insights into the 50.69 categorization process."

3. Limerick Seismic Risk Low Relative to RG 1.174: The absolute values for seismic risk at Limerick (Seismic CDF (SCDF): 3.7E-06 / yr., Seismic LERF (SLERF): 1.9E-06 / yr.) are low risk relative to NRC RG 1.174 thresholds (CDF: 1E-04 / yr., LERF: 1E-05 / yr.).

4. Limerick 4-Division Plant: The Limerick plant is a robust design with four divisions for each unit, i.e., 4 safety-related divisions of AC power and DC power, 4 emergency diesel generators (EDGs), 4 Residual Heat Removal (RHR) Pumps and 4 Core Spray Pumps. This yields lower FPIE and FPRA CDF and LERF values for Limerick when compared to typical U.S. light water reactors (LWRs).

5. Limerick FPIE PRA and FPRA More Refined: Comparing the CDF/LERF values from mature, peer-reviewed PRA models (for internal events and fire) with an estimate performed for purposes of screening a seismic hazard and/or developing a RICT seismic penalty without consideration of the purpose of the estimate is an inappropriate comparison. The seismic risk estimate is not as refined as the FPIE and FPRA models since it does not credit the robust defense in depth inherent at Limerick nor changes to the plant and plant PRA models since the Individual Plant Evaluation of External Events (IPEEE) (Reference [3]) was performed (1996-2000). This skews the SCDF and SLERF values relative to the FPIE and FPRA CDF and LERF counterparts and results in an estimated SLERF value that is a higher percentage of total LERF versus other Tier 1 plants. For this reason, and also since Limerick has no SPRA model, the statement in the second paragraph of this request that reads "The relative contribution is important due to the use of the integrated importance measures for categorization in the licensee's

approved 10 CFR 50.69 program" is not applicable since Limerick has no seismic F-V values to apply in 50.69 categorization.

6. <u>Conservatisms in RICT LAR SCDF Estimate</u>: The estimated SCDF used in the Limerick RICT LAR is based on most recent available information for the site's seismic hazard curve (Near Term Task Force (NTTF) Recommendation 2.1, Seismic Hazard Screening Submittal, 2014) and plant level fragility value (high confidence of low probability of failure (HCLPF) from the IPEEE (1996-2000)). Both inputs were assessed by NRC in the respective submittals (NTTF, IPEEE).

   The SCDF estimate provided in the Limerick RICT LAR is an approximation; the conservatism in the assessment of seismic risk in the RICT process primarily comes from the application of the estimated RICT SCDF and SLERF penalty values in RICT calculations (i.e., the total SCDF and total SLERF seismic penalties are treated as ΔSCDF and ΔSLERF). The SCDF estimate provided in the Limerick RICT LAR was calculated as a nominal estimate using a typical approximation methodology (i.e., mathematical convolution of the site PGA-based seismic hazard curve with an estimate of the PGA-based plant level seismic fragility where PGA is peak ground acceleration). This convolution estimation approach is a common analysis in approximating an SCDF for use in risk-informed decision making (e.g., it is commonly used in RICT seismic penalty calculations); the NRC used this approach in the GI-199 risk assessment (Reference [4]) in absence of a full-scope SPRA.

   Due to the time schedule of this response and the specialized expertise that would be required, this response does not involve investigation into conservatisms that exist in the probabilistic seismic hazard curve development. However, conservatisms can be identified to exist in the SMA (seismic margin analysis) based plant level seismic fragility used in the SCDF convolution calculation. An SMA is intended to show the inherent margin in SSC seismic capacities beyond the plant design basis earthquake. For the Limerick IPEEE SMA, all the functions of the success path component list (SPCL) were assessed as meeting the 0.3g PGA RLE and thus the Limerick IPEEE SMA-based plant level fragility is stated as being 0.3g PGA HCLPF[1]. The SMA shows the margin up to the SMA review level earthquake (RLE); the margin beyond the RLE is not typically known. A review of the Limerick Severe Accident Risk Assessment (SARA) SPRA (References [5] and [6]) has been performed as part of this response to illustrate the margin beyond the SMA RLE. There is insufficient quantification results documentation to assist in back-calculating a plant level HCLPF from the SCDF results themselves; however, the fragility calculations can be used to assist in illustrating the additional margin beyond the RLE HCLPF. This review is shown in Table 6 as a comparison of the Limerick IPEEE SPCL systems versus SARA SPRA HCLPF information.

   As can be seen from Table 6 below, based on the fragility analyses of the Limerick SARA SPRA a case can be made for a plant level seismic fragility of 0.4g PGA HCLPF.

[1] The value of 0.3g PGA HCLPF is used as the Limerick SMA-based plant level fragility as discussed in Limerick RICT LAR, dated December 13, 2018, ADAMS Accession No. ML18347B366. The value in NRC GI-199 (Reference [4]) does not take into account the Limerick IPEEE RAIs and is thus inappropriate.

If a plant level seismic fragility of 0.4g PGA HCLPF (instead of 0.3g PGA) were used in the RICT seismic penalty SCDF convolution calculation the SCDF result (1.9E-6/yr) would be approximately half of the result documented in the Limerick RICT LAR.

7. Conservatisms in RICT LAR SLERF Estimate: The estimated seismic LERF used in the Limerick RICT LAR is for the purpose of providing an SLERF penalty value in RICT calculations and contains conservatisms in the calculation. The calculation of the Limerick RICT SLERF penalty value is performed by estimating an average seismic conditional Large Early release probability (SCLERP), based on the spectrum of SCDF accident sequence types, and multiplying the convolved SCDF estimate by the average SCLERP estimate. The estimation of the average SCLERP involves: 1) use of seismic accident sequence frequencies and fragility information from a 1983 Limerick SPRA created for the SARA study (References [5] and [6] - assessed in NRC NUREG-3493, ML071650308) to estimate the contribution of SCDF accident sequence types; and 2) sensitivity quantifications of the Limerick 2017 FPIE PRA Model of Record (Reference [7]) to produce seismically-biased conditional Large Early release probability (CLERP) values for each SCDF accident sequence type. A number of conservatisms remain in the Limerick RICT LAR SCLERP development, as outlined below:

- SCLERP assigned to Direct to Core Damage SCDF sequences: The SCLERP of 1.0 assigned in the RICT LAR calculation is conservative. Some of these SCDF direct to core damage contributors would not necessarily be directly LERF (e.g., control enclosure structural fragility alone would be expected to have the same SCLERP as seismic-induced Loss of Offsite Power (LOOP) with early loss of injection, i.e., 1.1E-2). An estimated 0.8 SCLERP would reflect that some portion of these sequences are not directly SLERF.

- SCLERP assigned to Unmitigated Anticipated Transient Without Scram (ATWS) SCDF sequences: These accidents proceed with high reactor power discharge into the suppression pool causing pressurization and dynamic loading and failure of the primary containment in the PRA “Early” time frame. The SCLERP of 1.0 assigned in the RICT LAR calculation is conservative in that this estimate assumes 1) an unscrubbed large release from the primary containment (i.e., assumed large failure in the drywell (DW) and no potential for wetwell (WW) airspace failure location) and 2) no credit for radionuclide filtration in the reactor enclosure. If these obvious scrubbing mechanisms were credited, an SCLERP of 0.25 or lower (e.g., the Limerick FPIE PRA results in an ATWS sequence CLERP of 0.5 with no recoveries and no credit for reactor enclosure filtration) would be applicable to this SCDF sequence type.

- SCLERP assigned to Loss of Containment Heat Removal SCDF sequences: The SCLERP of 5E-2 assigned in the RICT LAR calculation is conservative. This SCLERP estimate is based on the LGS Level 2 PRA modeling and the LGS Emergency Action Level procedure. The LGS Emergency Action Level procedure has directives (including Emergency Director discretion) that are modeled in the PRA with a high probability of declaration of a General Emergency well before primary containment failure and thus outside the "Early" timing criterion. However, the LGS PRA includes a 5% probability that the General Emergency declaration is delayed and thus the release occurs in the PRA "Early" time frame. Use of a 5E-2 probability for the SCLERP is conservative in that this value is based only on the timing component (i.e., “Early”) of LERF and does not account for the location or size of the primary containment failure or release filtration in the reactor enclosure in producing a non-"Large" magnitude release. If these obvious scrubbing mechanisms were credited, an SCLERP of approximately 2.5E-2 (i.e., approximately half of 5E-2) would be applicable to this SCDF sequence type.

If the SCLERP conservatisms discussed above were removed in the RICT seismic penalty SLERF calculation, and the previously described revised SCDF included, the SLERF result (5.6E-7/yr) would be approximately a third of the result documented in the Limerick RICT LAR.

8. <u>Significant Fraction of RICT LAR SLERF Estimate Not Directly Applicable</u>: Although not explicitly addressed and accounted for in the NEI 00-04 construct for SSC categorization, a significant fraction of calculated SLERF would not be directly applicable or useful for SSC categorization purposes. This fraction is comprised of seismic induced severe damage states (e.g., seismic-induced Reactor Pressure Vessel (RPV) support failure, seismic-induced primary containment failure) that are modeled in the SLERF calculation as leading directly to SLERF. Approximately one third of the calculated SLERF described above involves such severe damage states. For the majority of the plant SSCs (i.e., other than SSCs such as primary system and safety structures that are already HSS), this portion of the calculated SLERF is not influenced by whether or not an SSC is categorized as HSS or LSS.

9. <u>Limerick Plant Improvements</u>: A number of plant improvements (physical modifications as well as procedures) have been instituted at Limerick over the years and these are not explicitly captured in the previously discussed RICT LAR SCDF and SLERF estimates. Some of these plant improvements are discussed below:

   - FLEX: FLEX mitigating strategies were developed in response to the Fukushima accident and are implemented in station blackout (SBO) scenarios. Credit for implementing the FLEX pumps, FLEX generators, and the Hardened Containment Vent System has been included in the Limerick FPIE and Fire PRA models, which has reduced the CDF and LERF contributions for SBO scenarios. The FLEX strategies are designed to reduce the risk contribution for SBO scenarios for beyond design basis scenarios (e.g., seismic events).

   - Technical Support Guidance: Several contingency procedures (e.g., B.5.b procedures) developed for responding to catastrophic events (e.g., beyond design basis seismic events).

   - Improvement of Emergency Procedure Guidelines (EPGs) following Boiling Water Reactor Owners Group (BWROG) symptom-based guidance: Severe Accident Management Procedures (SAMPs) based on the current EPGs / Severe Accident Guidelines (SAGs) ensures utilization of the latest strategies from the BWROG to deal with severe accidents.

- 4kV Cross-tie Procedure:  Defines process for cross-tying busses to provide power as needed to any of the 4 kV busses.  This procedure supports flexibility for mitigating and reducing risk for seismic-induced LOOP scenarios with subsequent failure of individual 4 kV busses.

- Fire water to RHR cross-tie:  Allows use of fire water for RPV injection or containment spray given loss of all other injection systems during a LOOP/SBO scenario.

**Table 6**

**LIMERICK IPEEE SMA SPCL AND SARA SPRA HCLPFs**

| Limerick IPEEE SMA SPCL | | | |
|---|---|---|---|
| **Function** | **Preferred Path System(s)** | **Alternate Path System(s)** | **SARA SPRA HCLPF Information** |
| Reactivity Control | Control Rod Drive | Control Rod Drive | HCLPF=0.62g PGA (SLC tank wall buckling). Lowest capacity SLC component failure mode. In NRC Safety Evaluation Report (SER) of IPEEE, NRC mentioned SLC should be considered as the alternate path. |
| | HCUs | HCUs | |
| | Scram Discharge Volume | Scram Discharge Volume | |
| Pressure Control | SRVs | SRVs | HCLPF=0.86g PGA (SRV, loss of function). Lowest capacity failure mode of SRV function. |
| Inventory Control | HPCI | "D" LPCI | HCLPF=1.10g PGA (HPCI Discharge MOV, valve yoke). Lowest capacity HPCI failure mode. |
| | | | HCLPF=1.31g PGA (RHR Pump, rotor deflection). Lowest capacity RHR LPCI function component failure mode. |
| | RCIC | "C" LPCI | HCLPF=1.18g PGA (RCIC Turbine Auxiliaries, structural). Lowest capacity RCIC failure mode. |
| | | | HCLPF=1.31g PGA (RHR Pump, rotor deflection). Lowest capacity RHR LPCI function component failure mode. |

**Table 6**

**LIMERICK IPEEE SMA SPCL AND SARA SPRA HCLPFs**

| Limerick IPEEE SMA SPCL | | | SARA SPRA HCLPF Information |
|---|---|---|---|
| **Function** | **Preferred Path System(s)** | **Alternate Path System(s)** | |
| Heat Removal | RHR SPC "A" | RHR SPC "B" | HCLPF=0.41g PGA (RHR Heat Exchangers, anchor bolts). Lowest capacity RHR SPC component failure mode. |
| | RHR SDC "A" | RHR SDC "B" | HCLPF=0.41g PGA (RHR Heat Exchangers, anchor bolts). Lowest capacity RHR SPC component failure mode. |
| Support Systems | EDG 1 and EDG 3 | EDG 2 and EDG 4 | HCLPF=0.40g PGA (440VAC transformer breaker, loss of function). Lowest capacity Emergency AC component failure mode. |
| | Diesel Encl. Ventilation | Diesel Encl. Ventilation | HCLPF=0.48g PGA (EDG heating and ventilation, structural). |
| | RHRSW A and C | RHRSW B and D | HCLPF=1.12g PGA (RHRSW Pumps, anchor bolts). Lowest capacity RHRSW component failure mode. |
| | ESW A and C | ESW B and D | HCLPF=0.70g PGA (ESW Discharge 20" CVs, fracture). Lowest capacity ESW component failure mode. |
| | SP Level/Temp Instr. | SP Level/Temp Instr. | HCLPF=0.50g PGA. Such equipment generally rugged and no SARA fragility calculations. The 0.50g PGA estimate provided here as a reasonable estimate for the purpose of this comparison. |

**Table 6**

**LIMERICK IPEEE SMA SPCL AND SARA SPRA HCLPFs**

| Limerick IPEEE SMA SPCL | | | |
|---|---|---|---|
| **Function** | **Preferred Path System(s)** | **Alternate Path System(s)** | **SARA SPRA HCLPF Information** |
| | Rx Level/Pressure Instr. | Rx Level/Pressure Instr. | HCLPF=0.50g PGA. Such equipment generally rugged and no SARA fragility calculations. The 0.50g PGA estimate provided here as a reasonable estimate for the purpose of this comparison. |
| | Class 1E DC | Class 1E DC | HCLPF=0.40g PGA (125VDC/250VDC Bus, loss of function). Lowest capacity DC component failure mode (not including recoverable relay chatter). |
| | -- | ADS N2 Bottles | HCLPF=0.50g PGA. The N2 accumulators screened at above 0.3g PGA in the IPEEE and no fragility was provided in the SARA SPRA. A reasonably low estimate of HCLPF=0.5g PGA is provided here as general information. |

## References

[1] Exelon Generation Company, LLC letter to the U.S. Nuclear Regulatory Commission, Limerick Generating Station, Units 1 and 2, "Application to Implement a 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] Email from V. Sreenivas (U.S. Nuclear Regulatory Commission) to G. Stewart (Exelon Generation Company, LLC), "Limerick Application to Modify 50.69 Categorization to Implement an Alternate Defense-In-Depth Categorization Process, an Alternate Pressure Boundary Categorization Process, and an Alternate Seismic Tier 1 Categorization Process," dated April 20, 2021 (ADAMS Accession No. ML21111A031).

[3] Philadelphia Electric Company, Individual Plant Examination External Events (IPEEE), Limerick Generating Station, Units 1 and 2, June 26, 1995.

[4] Generic Issue 199, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants," U.S. NRC IN 2010-18, September 2, 2010.

[5] Limerick Generating Station Severe Accident Risk Assessment, prepared for Philadelphia Electric Company by NUS Corporation, April 1983, [This was assessed by NRC staff in NUREG/CR-3493 (ML071650308)].

[6] Philadelphia Electric Company letter to USNRC, "Limerick Generating Station, Units 1 and 2 Response to Request for Additional Information Regarding Consideration of Severe Accident Mitigation Design Alternatives," June 23, 1989 [includes documentation of 1989 updates to Limerick SARA study].

[7] Limerick Generating Station Full Power Internal Events PRA 2017 Model of Record, LG217A.