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Draft Flood Penetration Seal Performance at Nuclear Power Plants Literature Review (Task 1.1) and Test Methodology (Task 1.2)

Comment On: NRC-2018-0028-0007
Development of an Ex Situ Performance Testing Protocol for Nuclear Power Plant Flood Penetration Seals

Document: NRC-2018-0028-DRAFT-0008
Comment on FR Doc # 2020-16717

Submitter Information

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General Comment

Comments from EPRI on n Draft NUREG-2240, “Development of an Ex Situ Performance Testing Protocol for Nuclear Power Plant Flood Penetration Seals,” Docket ID NRC-2018-0028

Attachments

PT-090120-189 EPRI Comments on Draft NUREG-2240 - Flood Seal Testing

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

September 1, 2020
PT-090120-189

Office of Administration
Mail Stop: TWFN-7-A60M
U.S. Nuclear Regulatory Commission
Division of Risk Analysis
Washington, D.C. 20555-0001
Attn: Program Management, Announcements and Editing Staff

Subject: Comments on Draft NUREG-2240, "Development of an Ex Situ Performance Testing Protocol for Nuclear Power Plant Flood Penetration Seals," Docket ID NRC-2018-0028

Dear Sirs:

Thank you for providing the opportunity to comment on the subject document. Please find the comments from EPRI in Attachment 1. The comments in Attachment 1 contain general and specific recommendations on the subject matter.

If you have questions about any of these comments or would like to discuss resolution, please contact Rob Choromokos at 650-855-8545 or via rchoromokos@epri.com.

Sincerely,

Kelli Voelsing

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Attachment 1 – EPRI Comments on ”Draft NUREG-2240, “Development of an Ex Situ Performance Testing Protocol for Nuclear Power Plant Flood Penetration Seals”

PT-090120-189 - Attachment 1: EPRI comments on draft NUREG-2240
"Development of an Ex Situ Performance Testing Protocol for
Nuclear Power Plant Flood Penetration Seals"

General Comments:

No.	Comment	Recommendation
GC1	In general, this draft NUREG suggests numerous applications (new installations, in-situ, PRA, etc.) for the laboratory testing protocol with limited, if any, guidance. For example, what is the basis for applying laboratory-based seal results to an in-situ plant seal? The NUREG does state that the test protocol is not an NRC-approved test standard, only applicable to a laboratory setting and does not reflect on the performance of a given seal assembly or application. In this regard, the NUREG accomplishes the stated goal of developing a potential test device and protocol. However, this goal appears to fall short of the stated motivation of the program which is to establish a test standard and to assess the effectiveness of a penetration seal installed in a nuclear plant with or without a potential degraded or non-conforming condition. Given the acknowledged, and considerable, differences between a laboratory seal (ex-situ) and the as-installed (in-situ) NPP seals (i.e., age, materials, configurations, etc.), it is not clear that this test protocol for laboratory testing can provide useful information on how in-situ plant seals would perform under flood conditions in actual nuclear plants. There is an implicit assumption in the development of the laboratory testing protocol that the protocol is readily applied to an installed (in-situ) plant seal, which is not supported by the document or state of knowledge in this area.	The report should acknowledge that until additional work is done to address issues associated with flood seals installed, maintained, aged, and inspected under a variety of conditions in the actual plants, that laboratory testing of seals does not yield results that apply directly to the ability of flood seals installed in nuclear plants to perform their function, nor on their fragility under various conditions. For example, Section 3.1 should be revised as the text states that protocol was developed to evaluate seal assemblies that are (or will be) installed in commercial NPPs. There is no methodology presented in this draft NUREG on how to extend the performance results of laboratory testing (ex-situ) to as-installed (in-situ) seals in an NPP.
GC2	Similarly, the protocol is intended to support the needs of various interested parties including the PRA analysts. It also suggests that this protocol and resulting test data may be suited for probabilistic risk assessments (PRAs) without detail on how the use of the	Until additional work is completed to identify the inputs needed for the PRA and ensuring the protocol provides the necessary data, the statements that results obtained using this protocol can support PRA analysis should be minimized, or removed.

No.	Comment	Recommendation
	flooding PRA would inform the test protocol and vice versa. For example, 1. The protocol does not discuss the need to establish fragility curves or uncertainty estimates for flood penetration seals. 2. No discussion is provided regarding test to test variability of the repeat installations of the same seals 3. No discussion is provided on establishing uncertainties related to failure probability given installation techniques, variations in material details for similar types of seals (e.g., LDSEs) 4. No discussion is provided on uncertainty associated with seal degradation, aging and maintenance programs.	
GC3	Regarding the conclusion, it is not clear what was learned regarding how flood penetration seals would perform under flooding conditions since the testing was not necessarily prototypical of an in-situ NPP flood seal. Prototypical considerations include: • Orientation • Penetration Size • Number of penetrating objects • Maximum penetrating object size • Spacing between penetrating objects • Maximum free area • Barrier construction • Penetrating object material • Penetration sleeve or liner • Barrier thickness • Service Temperature	The conclusions of this document should be limited to the development of the test apparatus and protocol in a laboratory environment. There is insufficient information in this NUREG to extrapolate or generalize the performance of penetration seals in any specific application. The document would benefit from a clearer problem statement and how the proposed test protocol furthers the solution. It's not clear whether the testing protocol is intended for future flood seals to be installed in NPPs or to investigate the performance of current in-situ flood seals in NPPs. Both are unique challenges to ensure prototypicality of the laboratory experiment and application of the results. If it is indeed both of these items as the document reads, the protocol does fall short in providing the necessary test requirements to apply the results.

No.	Comment	Recommendation
	• Pipe/cable movements • Clearances • Area / Perimeter Ratio • Seismic movements • Aging effects	

Specific Comments

No.	Section	Comment
SC1	Section 1, Page 1.2	"The overall intent of this draft protocol and subsequent testing (Task 2) was to provide background research and knowledge for NRC staff or industry that could be used to support the evaluation of the flood mitigation performance of penetration seals." Abstract states: "However, data and observations from this testing series primarily served to exercise the test protocol and should not be interpreted as qualifying or disqualifying any specific flood penetration seal or installation design" The two statement seem contradictory in the sense that the test data (background research or knowledge) shown in the report could be used to support the evaluation of the flood mitigation performance of the seal but at the same time the report states that the test data should not be used for qualification/disqualification. The first statement would need to be clarified in terms on what the NRC staff or industry could use from this test report.
SC3	Section 3.1	"Additionally, the basic testing methods and terminology outlined within the test protocol will enable future users to generate test data with a level of confidence that results are potentially replicable and comparable among testing facilities regardless of specific test equipment design."

No.	Section	Comment
		There are a wide spectrum of tests including installation procedures, test-test variability for a spectrum of penetrants and seal sizes that are not addressed by this protocol. Comprehensive test matrix for investigation of the most contributing parameters for the seal dislodgement and leakage is not discussed.
	Section 3.1	It is stated that "The protocol was developed to evaluation the flood mitigation performance of the different types of penetration seal assemblies/materials that are (or will be) installed…" As stated in General Comment 1 (GC1), the results are not applicable without assessing the differences in as-tested and as-installed seal and boundary conditions.
SC4	Section 3.3	Link does not take the reader to "A full listing of all public comments."
SC5	Section 4.1	Test objective is for lab testing only (ex-situ). How is this test method better suited for testing the seal performance than one would expect from OEM vendor tests is not apparent? What attributes differentiate this test method to any typical vendor's test methods is not clearly defined.
SC5	Section 4.1	Some plants test seals in place with pneumatic loads. These are not fully prototypical but can establish some thresholds for dislodgement and leakage. Have there been thoughts regarding comparisons of the air tests to hydrostatic tests?
SC7	Section 4.3.1	Has curing time vs load been tested? Does load capability increase or decrease over the initial several weeks of installation. Is there any guidance or knowledge to be presented on preparing the test specimens?
SC8	Section 4.3.2	It is stated: "Care was taken to ensure that all seals and penetrants represented typical "as-built" configurations found in NPPs." How can we be sure that the foam seals used for the testing are installed and formed the same way the seals in the plant did? Did we inspect during the testing that the foam formed around the penetrants uniformly and concluded that the seal installation was correct? What was the technique used to insure proper formation of the foam seals?
SC9	Section 4.3	The authors state: "Testing to obtain experimentally significant data (for use in flood fragility analysis, PRAs, etc.) would require the installation of materials that are 100% representative of the material found at the NPP for the specific assembly being tested/evaluated Seals." This statement may be oversimplified as seals in a plant use different installation protocols, have more variation in penetration

No.	Section	Comment
		placement and are aged. One data point derived from one lab configuration may not be sufficient for the development of a fragility model.
SC10	Section 4.3	Page 1.2 states: "The overall intent of this draft protocol and subsequent testing (Task 2) was to provide background research and knowledge for NRC staff or industry that could be used to support the evaluation of the flood mitigation performance of penetration seals." Section 4.3 states: "For example, pipe and other penetrant material may not be exactly representative of the "nuclear grade" steel material found at NPPs" Consider clarifying "nuclear-grade steel" as the key difference here is whether the pipe and penetrant materials are representative of the materials including steel found in nuclear power plants, not whether the piping is "nuclear-grade steel." Given the difference in the boundary conditions and materials between the laboratory test seals and prototypical plant seal configuration, what knowledge is gained on plant in-situ performance? Is the knowledge gained really just specific to the test apparatus?
SC11	Test Decks	In showing the pictures of the test decks it would be helpful if each location on the photographs were marked with the appropriate ID so the reader can go back and forth from the test results without always referencing the penetration maps.
SC12	4.10.2	Does the program intend to differentiate partial failure from full dislodgement? Tests 1-4 note failure as seal ejection. Test 5 and 6 note the failure as a nonconforming seal, but the test sequence says seal dislodgement. Are we defining seal dislodgement as either seal ejection or deforms sufficiently to pass large amounts of water? If so, is there a practical criterion for the boundary between a leak and dislodgment. Is there any insight with respect to under which seals would deform vs. eject? Given the lack of visibility due to the topside enclosure, are you getting any insight into the onset of failure? Or where specifically failure occurs?
SC13	4.10.2	Figure 5-13, what is the black material on top of what seems to be a white foam? It is possible that this observation indicates ineffective mixing of the components mixed to form the seal.
SC14	Table 6-1	"However, dynamic pressure testing may be performed to mimic real-life flooding conditions." Please clarify what this intended to represent. We think you mean an increasing static head over time due to flooding (i.e., time history). Dynamic pressure implies a velocity component. Are you suggesting falling water or impingement?

No.	Section	Comment
SC15	Section 6	Section 6 states: "A secondary objective of this test series was to provide NRC staff with experience and knowledge of flood penetration seal behavior under simulated flooding conditions. Each test provided new demonstrations of how flood penetration seals leak, why flood penetrations fail, and when such leakage occurs" If the testing configurations are different from the actual plant configurations, it is not clear how any of the test results could provide relevant indication on when the leakages occur and when the seal would dislodge for a realistic plant configurations and applications.
SC16	Section 7	Section 7 states: "Harvesting of aged penetrations from decommissioned sites could provide insight regarding their material properties and the effects of environmental factors." Given the fact that there are many types and configurations of flood seals existing in the plants, it is unclear what type of general performance information could be derived from the harvesting/fragility effort that would provide robust guidance to the utilities with regards to their particular seals (seal design/ seal age, seal condition…).
SC17	Section 7	Section 7 states: "The completion of this exploratory research project has provided NRC staff with fundamental experience of how flood penetrations seals perform under simulated flooding conditions…" It is important to highlight that the performance of these seals have been assessed through the test boundary conditions that are not representative of the actual plant equipment. The test results, without any additional scaling analyses, would not be representative of the actual seal performance.
SC18	Appendix A	Insure -: ensure
SC19	Appendix A	Appendix A states: "1.2 This protocol is the result of an NRC flooding research program and is developed for potential use by at least two (2) sets of distinct end users and functions 1) Manufacturers and 2) NPPs and Regulators. Specifically, paragraph 1.2.2 states that NPPs and Regulators, "…protocol is developed…to obtain insights on the type of testing that should be performed…" The paragraph is unclear on what is being recommended. Perhaps replace "should" with "could" since this is not a standard and represents an approach.

No.	Section	Comment
SC20	Appendix A	Appendix A states: "1.7 The intent for this test protocol is to develop data to determine the flood mitigation performance of penetration seal assemblies; of all types (materials, configurations, etc.) that are likely used in flood-rated barriers having specific, analyzed flood-resistance performance parameters." Is the intent of the protocol to develop DATA to determine the flood mitigation performance, OR is it to determine PARAMETERS important for the seal performance (leakage, dislodgement pressure)? If it is the data, how can this data be used for any other seal design other than the tested designs and configurations?
SC21	Appendix A	Appendix A states: "1.10 It is not the intent of this test protocol to determine the performance capabilities of a flood seal subsequent to being exposed to a flooding event. It is the responsibility of the user of this test protocol, or the data resulting from testing performed in accordance with this test protocol, to evaluate the condition of any flood seal, including the potential for degradation, whether visible or not, after exposure to an actual flooding event." Where does the protocol provide guidance on how to evaluate the performance of any seal located in its actual location in NPP? The protocol as presented in this document is not designed to evaluate the performance of the already installed seals, it rather provides one potential method to evaluate the performance of a new seal. Again, the performance of the seal to multiple flooding events can be evaluated, the test plan would need to define the performance requirements. Why is this disclaimer made for this specific condition and not all the other end-use application considerations?
SC22	Appendix A	The report notes: to obtain insights on the type of testing that should be performed for getting performance data for flood penetration seal assemblies/materials used in specific configurations, with specific flood exposure parameters, for use in supporting flood probabilistic risk assessments (PRAs)." As presented, it is not clear how this protocol supports the development of seal fragility given comments in the General Comment 2.
SC23	Appendix A	Membrane penetration test into cabinets, etc. are not discussed in the body of the report. Should these be added?
SC24	Appendix A	Section 4.7 & 4.8, Shouldn't the seal be installed in accordance with the manufacturer recommendations. Why is section 4.8 provided since this is an end use application requirement and this draft NUREG is not addressing end use application.

No.	Section	Comment
SC25	Appendix A	Appendix A Section 5.2. Shouldn't the test conditions replicate the end use application? This could be stated here.
SC26	Appendix B	Says protocol not applicable to terminal boxes, but Appendix A seems to indicate that membrane tests involving termination in boxes are included.
SC27	Appendix B	Section B.2, Applicability states that the test protocol is intended to be applicable to any penetration seal that is intended for installation in flood-rate barrier. The scope being a new installation and not an in-situ or existing plant seal. The protocol (and document) would be well served to provide end-user guidance on the technical and quality requirements of the new seal in a plant application (i.e., flood, age, temperature, humidity, radiation, mechanical loads, etc.). This scope of a new installation should be consistent throughout the document.
SC28	Appendix B	Appendix B states that "Aging; the potential impacts on seal assembly due to "aging" effects are not part of this protocol. If this is an issue of concern, the candidate seal assembly should be subjected to any artificial aging methodologies/procedures/techniques separately, prior to testing the assembly for flood resistance." Is there evidence to support the recommendation above that artificial aging would have similar effects/impacts to the actual as-installed aged seal performance?