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PNP 2018-023

April 30, 2018

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

SUBJECT: Response to Second Request for Additional Information – Alternative to the Reexamination Frequency for a Relevant Condition Foreign Material Lodged in the Reactor Pressure Vessel (EPID L-2017-LLR-0142)

Palisades Nuclear Plant
Docket 50-255
Renewed Facility Operating License No. DPR-20

References:

1. Entergy Nuclear Operations, Inc. letter to NRC, PNP 2017-068, *Proposed Alternative – Relief Request Number RR 5-6, Alternative to the Reexamination Frequency for a Relevant Condition – Foreign Material in Reactor Vessel,* dated December 1, 2017 (ADAMS Package Accession Number ML17335A013)

2. NRC e-mail to Entergy Nuclear Operations, Inc., *Palisades Nuclear Plant - Request for additional information regarding proposed alternative for relevant condition (EPID L-2017-LLR-0142)*, dated February 28, 2018 (ADAMS Accession Number ML18059A820)

3. Entergy Nuclear Operations, Inc. letter to NRC, PNP 2018-014, *Response to Request for Additional Information – Alternative to the Reexamination Frequency for a Relevant Condition Foreign Material Lodged in the Reactor Pressure Vessel (EPID L-2017-LLR-0142),* dated March 27, 2018 (ADAMS Package Accession Number ML18086A097)

4. NRC e-mail to Entergy Nuclear Operations, Inc., *Palisades Nuclear Plant - Request for additional information regarding proposed alternative for relevant condition (EPID L-2017-LLR-0142)*, dated April 11, 2018 (ADAMS Accession Number ML18101A113)

Dear Sir or Madam:

Entergy Nuclear Operations, Inc. (ENO) submitted Reference 1 to the Nuclear Regulatory Commission (NRC) requesting authorization for the Palisades Nuclear Plant of proposed alternative, relief request number RR 5-6, *Alternative to the Reexamination Frequency for Relevant Condition – Foreign Material in Reactor Vessel.* ENO received an electronic request for additional information (RAI) from the NRC in Reference 2. In Reference 3, ENO submitted a

response to the request for additional information. ENO received a second electronic RAI from the NRC in Reference 4.

Attached is the ENO response to the second RAI.

This letter contains no new or revised commitments.

Sincerely,

for

JAH/jpm

Attachment 1: Response to Second Request for Additional Information – Alternative to the Reexamination Frequency for a Relevant Condition Foreign Material Lodged in the Reactor Pressure Vessel

cc: Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
Resident Inspector, Palisades, USNRC

Response to Second Request for Additional Information – Alternative to the Reexamination Frequency for a Relevant Condition Foreign Material Lodged in the Reactor Pressure Vessel

A second request for additional information regarding the Entergy Nuclear Operations, Inc. (ENO) proposed alternative at the Palisades Nuclear Plant (PNP) to the reexamination frequency for a relevant condition, concerning foreign material lodged in the reactor pressure vessel, was received from the U.S. Nuclear Regulatory Commission (NRC) by electronic mail on April 11, 2018. The request for additional information (RAI) stated:

By letter dated December 1, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17335A013), as supplemented by letter dated March 27, 2018 (ADAMS Accession No. ML17335A013), Entergy Nuclear Operations, Inc., submitted Request No. RR 5-6 for Palisades Nuclear Plant (PNP) to the U.S. Nuclear Regulatory Commission (NRC) for review and approval, pursuant to the requirements of Title 10 of the Code of Federal Regulations (10 CFR), Section 50.55a(z)(2). The licensee's application (also referred to as RR 5-6) requested that the NRC authorize its proposed alternative to the successive inspection requirement of Paragraph IWB-2420(b) of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection [ISI] of Nuclear Power Plant Components," (also referred to as the Code), for a "relevant condition" – a piece of primary coolant pump (PCP) impeller that is lodged in the interior of the reactor pressure vessel. The proposed alternative is applicable for the remainder of fifth 10-year ISI interval at PNP, which commenced on December 13, 2015 and ends on December 12, 2025. In accordance with 10 CFR 50.55a(z)(2), the licensee submitted its proposed alternative based on its determination that compliance with the specified Code requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff has determined that additional information is required in order to complete its review of this proposed alternative. The staff's request for additional information (RAI) is provided below.

<u>Regulatory and Technical Basis for Follow-Up RAI-2a</u>

Pursuant to 10 CFR 50.55a(g)(4), inservice inspection of ASME Code Class 1, 2, and 3 components shall meet the requirements set forth in the ASME Code, Section XI, including the analytical evaluation requirement of Code Paragraph IWB-3142.4 for acceptance of relevant conditions found by visual examination. The licensee's analytical basis for its proposed alternative relies on the results of its 2014 operability evaluation for meeting the analytical evaluation requirement of Code Paragraph IWB-3142.4. For acceptance of conditions by analytical evaluation, IWB-3142.4 also requires that reexaminations of such conditions be performed during successive inspection periods in accordance with IWB-2420 to determine whether any changes to the conditions have occurred that would require further corrective action. The staff must review certain information from the 2014 analytical evaluation in order to determine whether this condition will remain acceptable for continued service for the duration of this proposed alternative (through December 2025).

Response to Second Request for Additional Information –
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Foreign Material Lodged in the Reactor Pressure Vessel

NRC Request Follow-Up RAI-2a.i

In your response to RAI 2a, dated March 27, 2018, regarding the fracture analysis for the PCP impeller piece, you described the fatigue crack growth rate analysis performed. For the limiting case of an assumed fragment thickness of 1 inch, you stated that the crack growth rate is very low (less than $5x10^{-4}$ inches per loading cycle) and essentially arrests at a depth of approximately 0.75 inches (75% through wall).

i. From the information provided, it is not clear to the staff why the crack arrests at 75% through wall. Please include the basis for assuming that the fracture of this piece can be modeled as a beam loaded by a fixed displacement, considering that your December 1, 2017, application reports a fluid force of 350 pounds acting on the piece. Alternatively, please provide another method to demonstrate that the piece would be unlikely to fracture.

ENO Response Follow-Up RAI-2a.i

i. The ENO basis for assuming that the fracture of this piece can be modeled as a beam with fixed displacement is supported by the following:

   1. The loading used in the analysis conservatively assumed the maximum possible force to bend the component to the maximum displaced shape. There is no mechanism known to produce this level of force. The loading scenario assumed is more appropriately referred to as a force loading on a three-point bending specimen with a displacement limit because the finite size of the gap between the vessel and the flow skirt limits the amount the component can bend, and thus provides an upper bound on applied force that leads to bending. A force higher than the upper bound value is reacted out by contact between the segment and the adjacent components, and does not contribute to larger bending stress. It is noted that the maximum force developed within the limit of this displacement is approximately 4,000 lbf, which is much larger than the steady state lift force of 350 lbf due to fluid flow on this component. As the postulated crack grows past 75% of wall thickness, the maximum force that contributes to bending is reduced to approximately 600 lbf, which is still significantly larger than the maximum lift force.

   2. The analysis does not show the postulated flaw arresting because the ΔK_I values are above the growth threshold for stainless steel by inspection. However, by inspection, the postulated crack growth rate starts to diminish significantly for postulated cracks larger than 75% through-wall. Though arrest is not predicted, the number of cycles (i.e., the number of instances of fluctuation between no-flow and flow conditions due to primary coolant pump (PCP) actuation) necessary to grow the postulated crack past 75% of wall thickness is on the order of thousands of cycles. This is conservative relative to the actual number of PCP actuations, which is estimated to be no more than

one hundred cycles from the time that the relevant condition was identified to the end of the current inservice inspection interval (December 12, 2025).

3. Subparagraphs 1 and 2 above provide justification because there is no known mechanism that can provide such large loads for the number of cycles required for greater than 75% through-wall postulated crack growth.

4. An additional analysis using a bounding 400 lbf was performed. This analysis showed that close to four million cycles would be necessary to grow the postulated crack past 75% through-wall. The fluid force is considered a steady state flow load, and can only cycle as often as the PCPs are actuated.

NRC Request Follow-Up RAI-2a.ii

In your response to RAI 2a, dated March 27, 2018, regarding the fracture analysis for the PCP impeller piece, you described the fatigue crack growth rate analysis performed. For the limiting case of an assumed fragment thickness of 1 inch, you stated that the crack growth rate is very low (less than $5x10^{-4}$ inches per loading cycle) and essentially arrests at a depth of approximately 0.75 inches (75% through wall).

ii. In addition, please address how you considered the margin against fracture; or if the crack arrests in the piece, please address whether the margin against fracture would become unbounded.

ENO Response Follow-Up RAI-2a.ii

ii. The maximum bending stress discussed in response to RAI-2a.i subparagraph 1 above is the maximum load state for this component assuming a conservative 0.1-inch gap between the flow skirt and the reactor vessel and the size of the wedged impeller piece relative to this gap. For the assumed gap size, there is no larger bending stress that can exist in the component, and the forces developed by the assumption on maximum displaced shape are significantly larger than previously calculated fluid forces acting on the wedged impeller piece.

To summarize, the calculation of the postulated crack growth used a conservative assumption regarding the maximum possible applied load and deflection, and the additional analysis demonstrates that significant (i.e., thousands of) cycles of this load would be required to grow a postulated crack through the segment. It is reasonable to conclude that the combination of conservative loading and large number of cycles is not attainable, thus preventing appreciable postulated crack growth.