[7590-01-P]

NUCLEAR REGULATORY COMMISSION

[Docket No. 50-244; NRC-20YY-XXXX]

Entergy Nuclear Operations, Inc.; Palisades Nuclear Plant

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed director's decision under 10 CFR 2.206; issuance.

SUMMARY: The U.S. Nuclear Regulatory Commission (NRC) is issuing a proposed director's decision with regard to a petition dated March 5, 2014, as supplemented on April 8, May 21, and September 3, 2014, filed by Mr. Michael Mulligan (the petitioner), requesting that the NRC take action with regard to Entergy Nuclear Operations, Inc. (ENO or the licensee) at Palisades Nuclear Plant (PNP). The petitioner's requests and the proposed director's decision are included in the SUPPLEMENTARY INFORMATION section of this document.

DATES: [INSERT DATE OF PUBLICATION IN THE *FEDERAL REGISTER*].

ADDRESSES: Please refer to Docket ID NRC-20YY-XXXX when contacting the NRC about the availability of information regarding this document. You may obtain publicly-available information related to this document using any of the following methods:

- **Federal Rulemaking Web Site:** Go to http://www.regulations.gov and search for Docket ID NRC-20YY-XXXX. Address questions about NRC dockets to Carol Gallagher;

telephone: 301-287-3422; e-mail: Carol.Gallagher@nrc.gov. For technical questions, contact the individual listed in the FOR FURTHER INFORMATION CONTACT section of this document.

- **NRC's Agencywide Documents Access and Management System (ADAMS):** You may obtain publicly-available documents online in the ADAMS Public Documents collection at http://www.nrc.gov/reading-rm/adams.html. To begin the search, select "ADAMS Public Documents" and then select "Begin Web-based ADAMS Search." For problems with ADAMS, please contact the NRC's Public Document Room (PDR) reference staff at 1-800-397-4209, 301-415-4737, or by e-mail to pdr.resource@nrc.gov. The ADAMS accession number for each document referenced in this document (if that document is available in ADAMS) is provided the first time that a document is referenced.
- **NRC's PDR:** You may examine and purchase copies of public documents at the NRC's PDR, Room O1-F21, One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852.

FOR FURTHER INFORMATION CONTACT: Jennivine Rankin, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington DC 20555-0001; telephone: 301-415-1530, e-mail: Jennivine.Rankin@nrc.gov.

SUPPLEMENTARY INFORMATION:

I. Introduction.

By letter dated March 5, 2014 (ADAMS Accession No. ML14071A006), as supplemented on April 8, May 21, and September 3, 2014 (ADAMS Accession Nos. ML14143A212,

ML14142A101, and ML14259A135, respectively), Mr. Michael Mulligan submitted a petition under § 2.206 of Title 10 of the Code of Federal Regulations (10 CFR), "Requests for Action under this Subpart," to Mr. Mark Satorius, Executive Director for Operations, of the NRC. The petitioner requested a number of actions to be taken by the NRC and ENO for equipment failures at PNP. As the basis for the request, the petitioner stated that there have been various recent plant events and equipment failures at PNP, such as primary coolant pump (PCP) impeller pieces breaking off and lodging in the reactor vessel (RV), leakage from the safety injection refueling water tank, and flaws in the control rod drive mechanisms.

By e-mail dated March 19, 2014 (ADAMS Accession No. ML14083A680), the NRC informed the petitioner that his request for immediate action to prevent a PNP restart because of a piece of PCP impeller that was lodged between the RV and the flow skirt was denied.

The petitioner addressed the petition review board (PRB) by teleconference on April 8, 2014, and on September 3, 2014, to clarify the basis for the petition. The transcripts of these meetings were treated as supplements to the petition and are available in ADAMS as previously noted in this section.

On September 25, 2014, the NRC issued an acknowledgement letter to the petitioner accepting the petition for review, in part, as recommended by the PRB (ADAMS Accession No. ML14237A726). The letter informed the petitioner that five requests, listed in Section II below, met the criteria for review in accordance with Management Directive (MD) 8.11, "Review Process for 10 CFR 2.206 Petitions" (see http://www.internal.nrc.gov/ADM/DAS/cag/Management_Directives/md8.11.pdf). The letter also stated that the petitioner's remaining requests did not meet the criteria for review, either because they were not requests for enforcement-related action or because they concern now resolved issues that have already been the subject of NRC staff review and evaluation.

Enclosure 1 to the acknowledgement letter explains the NRC staff's basis for why those requests were not accepted into the 2.206 process.

II. Discussion.

This section includes both the petitioner's requests for enforcement-related actions and the NRC's decisions.

Request 1: Request for PNP to open every PCP for inspection and clear up all flaws.

NRC decision: As summarized in the PNP Integrated Inspection Report dated May 7, 2014 (ADAMS Accession No. ML14127A543), the issue of broken impeller pieces has been the subject of continued regulatory oversight. The report details the chronology of significant PCP events at PNP dating back to 1983. In addition, the report indicates that PCP-B is the only pump in service with a refurbished impeller, which is more susceptible to fatigue related failures than the remaining three pumps that have been replaced with newly manufactured impellers. The NRC recognizes that PCP-B continues to remain in service with potential impeller cracks, however, as stated in the inspection report dated May 7, 2014, the NRC did not identify any immediate safety concerns which would pose a danger to public health and safety, or the environment. The staff reached this conclusion by performing an independent evaluation of the licensee's operability determination during the October 2011 vibration incident and during the 2014 refueling outage where a lodged piece of impeller was found between the reactor vessel and flow skirt. During these evaluations, the NRC staff considered PNP's operating experience with broken impeller pieces and evaluated the impact the pieces have on the current transient and accident analyses as described in Chapter 14, "Safety Analysis" of the PNP Final Safety

Analysis Report (FSAR) (ADAMS Accession No. ML14357A602). A summary of the NRC staff's previous evaluations are described further below.

As stated in the NRC's acknowledgement letter dated September 25, 2014, the NRC staff performed an in depth review of the licensee's analysis of the interactions of PCP impeller pieces within the PCP. These analysis considered impeding flow, impacting other vanes, impeding pump coastdown, and causing pressure boundary damage. The PCPs have two design basis safety functions: 1) the pumps provide reactor core cooling during coastdown in the event of a loss of electric power to all four PCPs, and 2) the pump casing is part of the primary coolant system (PCS) pressure boundary. To evaluate the impacts of the PCP pieces, the NRC staff independently reviewed the licensee's operability evaluation during the October 2011 vibration incident and during the 2014 refueling outage. In the reviews the NRC determined that the pump casing, impeller, and therefore, any impeller fragments, are constructed of ductile materials. Should impact occur between an impeller fragment and either the pump casing or the impeller, the result would be ductile deformation and not brittle fracture. Ductile deformation is not expected to cause the generation of a significant number of additional fragments or leakage through the pressure boundary as might occur in the case of brittle fracture. Based on the observed size of impeller fragments, clearances between the impeller and the pump case, the ductile nature of the materials involved and the inertia of the impeller, jamming of the impeller by a fragment is considered to be highly unlikely. Impeller fragments may deform the impeller and/or the casing slightly but would ultimately move out of the PCP. Consequently, there would be little effect on pump coastdown even if a piece broke off following a loss of electric power. In addition, the NRC staff examined the worst case scenario: a failed PCP impeller that reduces the effectiveness of coastdown flow provided by the flywheel. While

this failure is believed to be highly unlikely, it is bounded by the analysis provided in Section 14.7.2, “Reactor Coolant Pump Rotor Seizure,” of the PNP FSAR.

During the operability reviews in 2011 and 2014, the NRC staff also reviewed the impacts of PCP impeller pieces on the PCS pressure boundary. Loss of the pressure boundary due to potential impact was determined not to be a significant concern due to the pressure boundary thickness in comparison to the ductile piece dimensions and the small likelihood that significant impacts would occur. The NRC staff also examined the worst case scenario: a failure of the impeller which could cause a break in the pump and a leak of the reactor coolant system. This failure of the pressure boundary is believed to be highly unlikely and may not be credible; however, it is bounded by the analysis provided in Section 14.17.1, “Large Break LOCA [Loss-of-Coolant Accident],” of the PNP FSAR. The NRC staff also examined the effects of PCP impeller pieces passing through the PCS cold leg, including potentially impacting a resistance temperature detector (RTD) and causing pressure boundary damage. The NRC staff concluded that damage to the RTD resulting from an impeller piece contacting the RTD is not a significant safety concern. Dynamic flow analyses predicted that broken pieces from the pump would not contact the RTD. However, in the unlikely event that contact should occur, any interactions with RTD thermocouples would also be bounded by the large break LOCA analysis or Section 14.17.2, “Small Break LOCA,” of the PNP FSAR. Based on these evaluations, the NRC staff concluded that any consequence of a PCP impeller failure on the safety functions of the PCP is bounded by the current design basis safety analyses.

Besides evaluating impacts on the PCP, the NRC staff also considered the potential impacts of a failed impeller on fuel. Impeller pieces are likely to remain stuck at the flow skirt or at the bottom of the RV, as evidenced by the discovery of previous pieces. This is because flow conditions were insufficient to elevate the pieces that reached the bottom of the RV, and

therefore those pieces would be expected to sit at the flow skirt or on the bottom of the RV. Because all of the instrumentation and control blades enter through the top of the reactor vessel, there are no components in the bottom of the RV for these larger impeller pieces to interact with and therefore, they do not pose a safety risk. While any piece which would become lodged at the flow skirt or the lower core support plate would cause a local flow disturbance, that disturbance would have long decayed away due to mixing and crossflow by the time the flow reaches the active fuel region of the core.

During evaluation of the licensee's operability determination regarding the wedged piece of impeller, the NRC staff did recognize that very small pieces of the impeller could make it through the flow skirt and may interact with the fuel. However, interaction between small metal pieces and the fuel is possible in any reactor under any conditions. While fuel failures do exist in the nuclear industry, these failures result from entirely different interactions with entirely different mechanisms. Fuel failures caused by small metal fragments, other than wires, have not been observed. Therefore, the likelihood of small impeller pieces causing fuel failure is very small. In addition, a clad failure caused by these small fragments would be similar to fretting induced failures seen at operating reactors. If such a failure were to occur, this failure would be detectable through increased activity levels in the PCS. Radiation monitoring would detect this increase in PCS activity levels, and provide the licensee time to take actions that minimize the impact of the fuel failure. If the failure progresses, the reactor would be shut down in accordance with the licensee's Technical Specification 3.4.16, "PCS Specific Activity" (ADAMS Accession No. ML052720263).

In the petitioner's supplement to the petition dated May 21, 2014, the petitioner postulated that impeller failure could result in erosion of the PCS piping. In considering this potential degradation mechanism, it is important to recognize that erosion is a mechanical wear

process that generally occurs in two phase flows and results in loss of material from the pipe due to repeated impact of impinging particles. It is also important to recognize that a few impacts from relatively large pieces of debris which may result in damage to piping is not erosion and has been addressed above. In the present case, the flow in the PCS is designed to be a single liquid phase (i.e., second phase particles such as those which could be generated by an impeller failure are not present). Past operating history indicates that flow through the PCS in the absence of contaminating particles, such as those which could be generated from an impeller, does not result in erosion. However, the velocity of the flow in the PCS is such that, in the presence of second phase particles, the potential for erosion could exist. During evaluation of the 2011 vibration event, the NRC staff has evaluated this potential and concludes that the probability that erosion will occur as a result of impeller failure is extremely low because: 1) the number of particles generated in the appropriate size range to cause erosion would be very small, 2) those particles generated would quickly settle out of the flow stream in low velocity areas, and 3) the particles generated would have hardness values similar to the piping material in which the erosion is postulated resulting in minimal material removal per impact. In combination, these observations indicate that in the event of an impeller failure, few particles of the appropriate size would be generated, few impacts between the particles and the subject piping would occur, and minimal material removal would occur as a result of each impact. Based on the very limited potential for erosion which could exist as a result of an impeller failure, the NRC staff concludes that PCP impeller pieces causing erosion of the PCS piping walls is not a significant safety concern.

In conclusion, the NRC staff recognizes that PCP-B remains in operation with a refurbished impeller that is more susceptible to fatigue related failures. The NRC staff has conducted independent analyses of potential scenarios where impeller pieces have broken off

and concludes that any consequence would be within the design basis of PNP. The NRC staff also concludes that based on the considerations above, there is reasonable assurance that the health and safety of the public will not be endangered by operation of the PNP. Based on the NRC's analysis and the safety significance of potential impeller pieces, NRC concludes the petitioner's request to order PNP to open every PCP for inspection and clear up all flaws is unwarranted. Therefore, the NRC denies the petitioner's request.

Request 2: Request for PNP to replace the PCPs with others designed for their intended duty.

NRC decision: On August 8, 2012, Region III documented a finding of very low safety significance and an associated non-cited violation for the failure of the licensee to operate the PCPs in accordance with their design operating criteria (ADAMS Accession No. ML12221A340). The licensee concluded that the cause of the failures is fatigue-related effects from the operation of the pumps in conditions beyond the maximum flow rates and below the minimum net positive suction head (NPSH) recommendations as described in the PNP FSAR and other design documentation. Cyclic pressure pulses and stresses are created under these reduced pressure conditions that act on the leading edges of the impellers, which can ultimately lead to vane cracking and the release of impeller fragments. The licensee noted, based on metallurgical examination of fragments, previous pump inspection findings, and the mechanism by which the cracks propagate, that weld-refurbished impellers were particularly susceptible to degrading to a point where a piece could be released. At normal operating temperature and pressure, there is adequate NPSH on all PCPs, so these additional stresses are not present. These conditions are present when operating only one or two PCPs during reduced temperatures and pressures (typically during startup and shut down activities). As a result, the

licensee has instituted a monitoring plan, considered the preferred sequence for starting/stopping PCPs during startups and shut downs, and has corrective actions to explore further procedure changes regarding operation of the PCPs and the resultant impact on other aspects of plant operation.

Currently, the licensee has replaced three of the four PCP impellers with newly manufactured impellers. The licensee has implemented compensatory actions to minimize operating the PCPs under low-head and high-flow conditions and has established steps to consider sequencing the PCPs in a manner that prevents excessive fatigue. The NRC staff notes that impellers repaired by welding may be, but not necessarily are, more prone to failure. The NRC staff has reviewed the licensee's implemented corrective actions to date and concludes they are appropriate in the interim while the licensee is working towards a long term solution. The NRC staff will continue the review of the licensee's corrective actions going forward to determine whether the licensee plans to eliminate the known susceptibility of impeller pieces breaking off and to correct the non-cited violation described in the August 8, 2012, inspection report. In addition, as detailed in the NRC staff's decision to Request 1 above, the NRC staff concludes that there is no significant safety concern which would pose a danger to public health and safety, or the environment. Therefore, the NRC denies the petitioner's request to order PNP to replace the PCPs with others designed for their intended duty.

Request 3: Request an Office of the Inspector General (OIG) inspection on why different NRC regions have different analysis criteria for similar PCP events.

NRC decision: The petitioner's request has been forwarded onto the OIG. The NRC staff monitors similar instances of PCP failures through the Operating Experience Program administered by the Office of Nuclear Reactor Regulation, Division of Inspection and

Regional Support, which collects, evaluates, and communicates operating experience, and applies lessons learned. The NRC staff notes there have been plants in other NRC regions where broken parts originated from the PCPs. For example, Salem Nuclear Generating Station, Unit 2 (Salem), recently encountered bolt failures due to stress corrosion cracking that resulted in bolt heads traveling to the lower core support plate. The issues experienced at PNP involved the PCP impellers, which is different than the bolting issues experienced at Salem; therefore, the NRC staff analysis was specific to the phenomenon of PCP impeller pieces. Subsequent to the events of Salem, the NRC staff considered bolting issues at PNP and determined that PNP does not have a similar bolt configuration which would necessitate the application of similar analysis criteria.

Request 4: Request a $10 million fine over these events.

NRC decision: Section 2.3.4, "Civil Penalties," of the NRC's Enforcement Policy (ADAMS Accession No. ML13228A199) describes the NRC's policy of imposing graduated civil penalties taking into account the gravity of the violation as the primary consideration and the ability to pay as a secondary consideration. Civil penalties are considered for all severity level I, II, and III violations. The non-cited violation for the failure of the licensee to operate the PCPs in accordance with their design operating criteria documented in the PNP Integrated Inspection Report dated August 8, 2012, does not meet the threshold for civil penalties under the NRC's Enforcement Policy. In addition, the NRC staff has reviewed the petition and did not find any information that would warrant issuance of additional violations related to PCPs. Therefore, the NRC denies the petitioner's request to impose a $10 million fine on the licensee.

Request 5: Request for PNP to return to yellow or red status and for the NRC to intensify its monitoring of PNP.

NRC decision: The Reactor Oversight Process (ROP) Action Matrix reflects performance issues at the plant. Additional information regarding the ROP Action Matrix can be found at http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/actionmatrix_summary.html. The ROP integrates the NRC's inspection, assessment, and enforcement programs. The fundamental building blocks that form the framework for the regulatory oversight process are seven cornerstones of safety: initiating events, mitigating systems, barrier integrity, emergency preparedness, occupational radiation safety, public radiation safety, and security. These cornerstones have been grouped into three strategic areas: reactor safety, radiation safety, and safeguards. This framework is based on the principle that the agency's mission of assuring public health and safety is met when the agency has reasonable assurance that licensees are meeting the objectives of the seven cornerstones of safety. The reactor inspection program is an integral part, along with performance indicators (PIs), assessment, and enforcement, of the ROP. Acceptable performance in the cornerstones, as measured by the PIs and the risk-informed baseline inspection program, is indicative of overall licensee performance that provides for adequate protection of public health and safety.

The NRC determined the performance at PNP during the most recent quarter was within the Licensee Response Column of the NRC's ROP Action Matrix because all inspection findings had very low (i.e., green) safety significance, and all PIs indicated that the licensee's performance was within the nominal, expected range (i.e., green). Additional information regarding PNP's plant assessments and inspection findings can be found at http://www.nrc.gov/NRR/OVERSIGHT/ASSESS/PALI/pali_chart.html. The NRC inspectors will continue to monitor the licensee's corrective actions to date and going forward to determine

whether the licensee plans to eliminate the known susceptibility of impeller pieces breaking off. Any additional findings will be documented in future inspection reports and will contribute to the plant assessment under the ROP.

The NRC staff has reviewed the inspection efforts to date, and does not find that additional inspections beyond what has already been scheduled are necessary. As discussed in the NRC response to Request 1, the NRC staff concludes that there is reasonable assurance that the health and safety of the public will not be endangered by operation of PNP. For these reasons, the staff does not find that the PCP impeller issues necessitate moving PNP into a higher ROP Action Matrix Column requiring additional regulatory oversight. Therefore, the NRC denies the request to intensify monitoring at PNP.

III. Conclusion.

In conclusion, the NRC found no basis for taking additional enforcement action against the licensee based on the petitioner's concerns. The NRC staff did not find that the continued operation of PNP would adversely affect the health and safety of the public. Therefore, the NRC is denying the petitioner's requested enforcement related actions against PNP. No further action is required.

Consistent with 10 CFR 2.206(c), the NRC staff will file a copy of this Director's Decision with the Secretary of the Commission for the Commission to review. As provided for in 10 CFR 2.206(c)(1), the Director's Decision will constitute the Commission's final action within 25 days of the date of the decision unless the Commission, on its own motion, chooses to review the decision within that time.

Dated at Rockville, Maryland, this day of March 2015.

For the Nuclear Regulatory Commission.

William M. Dean, Director,
Office of Nuclear Reactor Regulation.