March 28, 2017

MEMORANDUM TO: Robert J. Pascarelli, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Robert G. Lukes, Chief ***/RA/***
Nuclear Performance and Code Review Branch
Division of Safety Systems
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION SUPPORTING THE U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF "PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 – TRANSITION TO CE 16X16 NGF AND REVISED TECHNICAL SPECIFICATIONS 5.6.5 AND 4.2.1" (CAC NOS. MF8076, MF8077, MF8078, MF8079, MF8080, AND MF8081)

By application dated July 1, 2016, Arizona Public Service (APS) requested changes to the Technical Specifications (TS) for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3. The proposed changes revise TS 4.2.1, "Reactor Core, Fuel Assemblies" and 5.6.5.b, "Core Operating Limits Report (COLR)" and will allow the use of Combustion Engineering (CE) 16x16 Next Generation Fuel clad with the Optimized ZIRLO™ material in PVNGS, Units 1, 2, and 3. To support the fuel transition, APS also requested an exemption from certain requirements of Title 10 of the *Code of Federal Regulation* (10 CFR) 50.46 and 10 CFR 50 Appendix K to allow the use of Optimized ZIRLO™ as a cladding material in PVNGS.

The U.S. Nuclear Regulatory Commission staff has reviewed the above-mentioned submittal, has conducted two regulatory audits, and has determined that additional information is required to complete the review. Requests for Additional Information are attached.

Docket No.: 50-528
50-529
50-530

Enclosure:
As stated

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301-415-2820

Pascarelli, R.

REQUEST FOR ADDITIONAL INFORMATION SUPPORTING THE U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF "PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 – TRANSITION TO CE 16X16 NGF AND REVISED TECHNICAL SPECIFICATIONS 5.6.5 AND 4.2.1" (CAC NOS. MF8076, MF8077, MF8078, MF8079, MF8080, AND MF8081) Dated: March 28, 2017

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ADAMS Accession No.: ML17082A446 NRR-106

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DATE	03/23/2017	03/23/2017	03/23/2017	03/28/2017

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REQUEST FOR ADDITIONAL INFORMATION SUPPORTING THE U.S. NUCLEAR REGULATORY COMMISSION REVIEW OF "PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 – TRANSITION TO CE 16X16 NGF AND REVISED TECHNICAL SPECIFICATIONS 5.6.5 AND 4.2.1"

DOCKET NOS.: 50-528, 50-529, AND 50-530

RAI 1. CENPD-178-P-A Methodology

The CENPD-178-P-A methodology referenced in the submittal specifies that a hydraulic shaker attaches to the bottom of the assembly during the forced vibration fuel assembly testing. The testing facility contains an apparatus that uses an electro-mechanical shaker that attaches to the center of the assembly. Please clarify which shaker is used and justify its use as part of the methodology.

RAI 2. Transition Core Control Element Assembly Drop Times

Provide justification that the full core Next Generation Fuel (NGF) and full core Value Added Fuel (referred to as STD) control element assembly (CEA) drop time analyses bound the CEA drop times expected for transition cores containing both NGF and STD fuel assemblies.

RAI 3. Bounded and Non-Impacted Chapter 15 Events

In Section 7 of Attachment 8, Non-Loss-of-Coolant-Accident (LOCA) Safety Analysis, Table 7-1 lists the impact of the use of NGF on Chapter 15 Non-LOCA events.

a. Transition to NGF fuel is determined to have "no impact" on a number of Chapter 15 events, listed below. For these events, explain the process for determining that the inputs are unchanged and justify why they are unchanged. If any of the input has changed, justify that the event is not impacted.

    - Startup of an Inactive Reactor Coolant Pump
    - Inadvertent Deboration
    - Inadvertent Operation of the Emergency Core Cooling System (ECCS)
    - Steam Generator Tube Rupture

b. A number of Chapter 15 events, listed below, are determined to be "bounded" without specific justification. Justify that these events are bounded. Identify the bounding assumptions and justify that they are appropriate. If the bounded event has been

quantitatively analyzed, provide the margin between the new NGF analysis and the bounding analysis. For comparison, also provide the analogous margin associated with the current "bounded" STD analysis of record (AOR) for these events.

- Decrease in Feedwater (FW) Temperature
- Increase in Main FW Flow
- Loss of External Load
- Turbine Trip
- Main Steam Isolation Valve Closure
- Loss of Non-emergency AC Power to the Station Auxiliaries
- Loss of Normal FW Flow
- Chemical and Volume Control System Malfunction – Pressurizer Level Control System Malfunction with Loss of AC Power (LOP)

RAI 4. Evaluated Chapter 15 Events

a. Justify that the CENTS evaluations, completed as part of the Chapter 15 AORs, remain applicable for the transient system response, and do not require re-analysis to support the transition to NGF.

b. Attachment 7/8, Section 7.1.3: Demonstrate that the "system model changes" due to NGF are bounded by the AOR for the Increase in Main Steam Flow (IMSF), Inadvertent Opening of a Steam Generator Atmospheric Dump Valve (IOSGADV), and IOSGADV with LOP events. Demonstrate that the AOR flow coastdown remains conservative, identify what system model changes are necessary because of NGF, and justify why they are small. Demonstrate that these small changes result in an insignificant impact to the overall transient system.

c. Attachment 7/8, Section 7.1.3: Demonstrate that the current analysis for calculated fuel failure (i.e. AOR DNBR vs. NGF DNBR) bounds the IMSF+LOP and IOSGADV+LOP events.

d. Attachment 7/8, Section 7.3.4: Identify the fuel specific failure analysis methodology and describe the fuel failure analysis that was completed. Compare it with the fuel failure AOR and explain the relevance of less than 4 seconds of overall time in DNB.

RAI 5. Additional Description of SKBOR

Palo Verde has proposed to use the SKBOR code to determine the time available prior to precipitation of boric acid following a postulated LOCA affecting one of the reactor coolant system cold legs. The use of SKBOR represents a change to the original methodology for analyzing long-term core cooling that is described in topical report CENPD-254-P-A. A detailed

description of the SKBOR methodology was not included in the license amendment request. Therefore, please submit documentation concerning the following:

a. A technical description of the SKBOR code.

b. A description of the post-processing steps (e.g., using NSAPLOT) to determine additional parameters such as the void distribution, loop differential pressure, and hot leg entrainment criteria.

c. A description of how the boric acid concentration of the sump fluid is determined.

RAI 6. Thermal Conductivity Degradation and Radial Fall-Off Curve Penalty

Palo Verde has proposed imposing a radial fall-off curve to offset the lack of explicit consideration of thermal conductivity degradation (TCD) in the fuel performance models in the FATES3B and STRIKIN-II codes.

a. Provide technical justification that the proposed allowance for TCD is adequate for the full set of analyzed events within Palo Verde's licensing basis (e.g., by comparing the results calculated by FATES3B and STRIKIN-II against those of a fuel performance code that explicitly models thermal conductivity degradation and has been reviewed by the U.S. Nuclear Regulatory Commission (NRC) staff).

b. Provide confirmation that the actual radial fall-off curves implemented to ensure compliance with the TCD allowance will be included in the applicable Core Operating Limits Report submittals for Palo Verde.

RAI 7. Appendix K LOCA LOOP Considerations

Palo Verde has assumed that the limiting results for evaluating the large-break LOCA event would occur when offsite power is unavailable. The availability of offsite power would result in earlier emergency core cooling system (ECCS) pump start times than considered in the license amendment request submittal. While it is possible that earlier ECCS pump start times may tend to refill the downcomer more rapidly (thereby promoting an earlier reflooding of the reactor core), it is also possible that the downcomer may continue to be refilled largely by the safety injection tanks, even if earlier ECCS pump start times are implemented. In the latter case, the earlier spilling of ECCS coolant into containment would tend to produce a more severe containment pressure reduction, and hence offer increased resistance to reflooding the core. The net impact of these countervailing tendencies on the results of the large-break LOCA analysis is not obvious; in particular, the NRC staff notes the counterintuitive observation that, according to the current, conservative Appendix K evaluation methodology, large-break LOCA scenarios with full availability of the ECCS are calculated to be more limiting than cases with a single failure that would reduce ECCS flow. Therefore, provide the results of an additional analysis of the large-break LOCA event with offsite power available and realistic pump start

times to confirm whether the results are bounded by the analysis presented in the license amendment request submittal.

RAI 8. Statistical Treatment of the Inadvertent Fuel Misloading Event

Palo Verde has proposed to implement a statistical methodology for treating the event described in Section 15.4.7 of its Updated Final Safety Analysis Report (UFSAR), "Inadvertent Loading of a Fuel Assembly into the Improper Position." The proposed methodology has not been previously reviewed and approved by the NRC staff and was not sufficiently described in the license amendment request.

a. Either provide an adequate description and justification for the proposed approach or confirm that Palo Verde will continue to use current licensing-basis methods to analyze this event.

b. If fuel failure is predicted for the UFSAR Section 15.4.7 event "Inadvertent Loading of a Fuel Assembly into the Improper Position," confirm that the consequences of the event are bounded by those of other analyzed events within the applicable event category, and hence, are a small fraction of Title 10 of the Code of Federal Regulations 100 limits. Further clarify the failure mode of the affected fuel rods and explain whether the failure mechanism could propagate to neighboring rods.

RAI 9. Containment Analyses

a. In Section 9.1 of Attachment 8, Mass and Energy Release Analysis for Postulated LOCAs , it is stated that an evaluation of the impact of NGF on the LOCA Mass and Energy (M&E) AORs was performed. Additionally, a comparison of fuel parameters and operating conditions was performed. Please describe how the containment LOCA M&E release was determined for the NGF analyses. To confirm that the AOR LOCA M&E short term (FSAR Table 6.2.1-4 and 6.2.1-5) and long term (from the end of post reflood) releases remain bounding, provide quantitative results comparing to the AOR M&E releases for the following:

    i. Short-term M&E release during blowdown. Also, confirm that the AOR containment pressure response for peak pressure determination and containment temperature response for equipment environmental qualification remain bounding.

    ii. Long-term M&E release for the sump temperature response. Also, confirm that the AOR sump temperature profile for the ECCS pumps net positive suction head analysis remain bounding.

b. In Section 9.2 of Attachment 8, M&E Release Analysis for Postulated Secondary System Pipe Ruptures Inside Containment, it is stated that the AOR FW temperature bounds the

NGF temperature. What is the FW temperature used for AOR and the NGF analysis? Explain how the AOR temperature produces bounding results.

c. In Section 9.2 of Attachment 8, it is stated that the M&E source energy based on NGF operating conditions will remain bounded by the AOR MSLB source energy. Justify quantitatively that the parameters that determine the AOR MSLB containment M&E source energy bound those that determine the M&E source energy with NGF.