APS

Palo Verde Nuclear
Generating Station

David Mauldin
Vice President
Nuclear Engineering
and Support

TEL (623) 393-5553
FAX (623) 393-6077

Mail Station 7605
P.O. Box 52034
Phoenix, AZ 85072-2034

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ATTN: Document Control Desk
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Reference: 1) Letter 102-04540-CDM/SAB/JAP, dated March 2, 2001, "Lead Fuel Assembly – Exemption Request Extension," from D. Mauldin, APS to USNRC

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 3
Docket No. STN 50-530
Additional Information for Lead Fuel Assembly -
Exemption Request Extension

In Reference 1, Arizona Public Service Company (APS) requested an exemption from the requirements of 10 CFR 50.44, 10 CFR 50.46 and 10 CFR 50, Appendix K, for PVNGS Unit 3. This exemption will allow continued testing of a Lead Fuel Assembly (LFA) containing fuel rods fabricated with an advanced zirconium based cladding material.

On July 19, 2001 and August 16, 2001, the NRC staff and PVNGS conducted telephone calls concerning the Reference 1 submittal. Some questions were asked concerning the duty of the lead fuel assembly and other items. PVNGS is providing responses to these questions in the accompanying enclosure.

No commitments are being made to the NRC by this letter.

Should you have any questions, please contact Thomas N. Weber at (623) 393- 5764.

Sincerely, Carl Stephenson
For
David Mauldin

CDM/TNW/JAP/kg

Enclosure
cc: E. W. Merschoff
L. R. Wharton
J. H. Moorman

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ENCLOSURE

Additional Information for

Lead Fuel Assembly – Exemption Request Extension

NRC Question #1:
How many rods are predicted to have burnups above 60 Mwd/kgU? For what part of the cycle?

APS response:
Background:
The reactor is modeled in quarter core rotational symmetry. Since the Lead Fuel Assembly (LFA) is in the center, only one node or a quarter of the assembly is modeled. The node chosen for modeling is the node with the largest burnup. This is conservative since it causes the center assembly to have the largest burnup/fluence and the lower power in the center assembly results in the balance of assemblies producing more power. The physics design model is created from two end points to bound the possible cycle lengths from the previous cycle. For the question above, the answer is provided based on the shortest end point of Cycle 9, which causes the greatest burnup in the LFA. The values are best estimate.

The first pin in the LFA as modeled above to achieve 60 Mwd/kgU occurs at 225 Effective Full Power Days (EFPD). By the end of cycle (EOC), ~545 EFPD, all pins exceed 60 Mwd/kgU.

NRC Question #2:
What is the predicted corrosion levels for the Alloy A rods? Is it predicted by a separate correlation?

APS response:
The fuel rod corrosion evaluation is currently ongoing and is not yet complete. This evaluation is using the Westinghouse/Combustion Engineering (W/CE) corrosion model benchmarked to the Alloy A oxide data and using the specific power history for the LFA. The results from this work will be used to set the oxide thickness acceptance criterion of the LFA for continued irradiation for the EOC-9 poolside inspection.

However, in order to provide an estimate of the expected corrosion behavior of the LFA at the end of cycle 10, the trend curve from the Alloy A oxide data in Palo Verde Unit 3 is used. This data consists of the measurements from the four cycles of operation of the Batch F lead test rods (LTRs) and the first two cycles of operation of the LFA. This data is presented in Figure 2.1 of Enclosure 2 in the Arizona Public Service Company (APS) exemption request to the NRC (102-04540-CDM/SAB/JAP, dated March 2, 2001) and shows the LFA following the same trend as the LTRs. An exponential regression curve through the data in Figure 2.1 gives a projected best estimate oxide thickness of 64 microns and an upper 3 sigma limit of 80 microns at a cycle 10 maximum end-of-life burnup of 72 MWd/kgU.

NRC Question #3:
Enclosure 4, Page 2, last paragraph under 4 [Letter 102-04540-CDM/SAB/JAP, dated March 2, 2001, "Lead Fuel Assembly – Exemption Request Extension," from D. Mauldin, APS to USNRC]. Please define "unsatisfactory performance."

APS response:
The term "unsatisfactory performance" in this paragraph is defined as observed attributes or conditions that (1) are unexpected and (2) have the potential of jeopardizing the rods' or assemblies' ability to meet design requirements at the end of cycle 10. Thresholds for "unsatisfactory performance" will be established as specific criteria for comparison to results from nondestructive measurements and visual observations that will be performed during the Unit 3 EOC-9 refueling outage. These thresholds will be determined prior to the upcoming inspections that will be conducted in Unit 3's refueling outage (October 2001). Those inspections will assess the corrosion and dimensional changes that have occurred as a result of three cycles of operation in Palo Verde Unit 3. Measurement values that are outside of the expected range for that specific attribute or observations that are judged to be symptomatic of an unusual condition will be indicative of unsatisfactory performance.

NRC Question #4:
Enclosure 4, Page 3, last paragraph under 6 [Letter 102-04540-CDM/SAB/JAP, dated March 2, 2001, "Lead Fuel Assembly – Exemption Request Extension," from D. Mauldin, APS to USNRC]. Please clarify.

APS response:
The rod drop test procedure is 77ST-9RX01. If testing is performed using the software method (normal method), all Control Element Assemblies (CEAs) are tested. Normal drop time testing therefore includes the center CEA, which is above the LFA.

APS normally uses the software method and would only use the manual method if unusual conditions existed. For example, either of the following conditions would require a manual test:

- A retest for CEA's that failed the software test or
- If only one channel of the Reed Switch Position Transmitters (RSPTs) were available. Although each CEA has two RSPTs, loading the rod drop test software into a Control Element Assembly Calculator (CEAC) causes that CEAC to be inoperable. If one channel were already inoperable, the normal method can not be conducted.

The manual test directly impacts the refueling outage length as each CEA is individually dropped. Therefore, the part length CEAs (PLCEAs) are not included in the manual test since they are not credited in the safety analysis. The manual test does not include the center CEA over the LFA since it is a PLCEA and is not credited in the safety analysis.

The first use of the software method was in Unit 3 in November 1995. PVNGS experienced problems with RSPT indications on one CEAC and had to revert to the manual method. The first successful use of the software method occurred in the following refueling outage in Unit 2 in May 1996. Since May 1996, PVNGS has used the manual method only once. The manual method was used as a re-test for only one CEA (CEA #20) in Unit 2 (May 1999).

NRC Question #5:
Discuss the design evaluation of the LFA. Use of approved codes? Is the LFA modeled separately? What are the limiting parameters?

APS response:
Evaluations of the performance of the LFA are currently underway in the areas of fuel performance, mechanical design, transient analysis, and fuel rod corrosion. Standard W/CE codes are being used for the evaluations and are based on the power history of the LFA. The limiting conditions, at this time, are in the mechanical design area. There are specific requirements for stress, strain, and fatigue. The most limiting is for the requirement not to exceed 1% total strain during a transient above a burnup of 52 MWd/kgU. Initial indications are that all the limits will be met.

NRC Question #6:
How is the LFA handled for safety assessment? Are all design limits met for the LFA? What is the limiting transient and effect of the LFA?

APS response:

How is the LFA handled for safety assessment?

The impact of re-installing the Alloy-A Lead Fuel Assembly (LFA) in Unit 3, Cycle 10 on all of the Design Basis Events (DBEs) discussed in Chapter 15 of the PVNGS Updated Final Safety Analysis Report (UFSAR) was examined. Most of these DBEs are analyzed using either the CENTS or CESEC simulation codes, both of which use point-kinetics to model the reactor core. Point-kinetics models evaluate the entire reactor core as a discrete energy source, and are not sensitive to the design of any one fuel assembly. Consequently, most of the UFSAR Chapter 15 DBEs are not impacted by installation of the LFA.

Several UFSAR Chapter 15 DBEs are analyzed without a point-kinetics simulation code. These include several decreased reactor coolant flow events and the CEA Ejection event. The following decreased reactor coolant flow events are analyzed using the 1-D HERMITE simulation code: 1) Total Loss of Forced Reactor Coolant Flow, 2) Excess Load with a Loss of Off-Site Power, and 3) Reactor Coolant Pump (RCP) Seized Rotor / Sheared Shaft event. 1-D HERMITE uses one-dimensional space-time neutronics to simulate the entire core. While this modeling method is potentially impacted by one fuel assembly within a reactor core, the analysis method for decreased reactor coolant flow events includes the use of the "power clipping" option in 1-D HERMITE. This option limits the power rise in the core's hot assembly to no faster than the power rise in the core's average assembly. Because of this limit, the 1-D HERMITE results are dominated by the design of the core's average fuel assembly. Since the LFA is a unique assembly within the core, it cannot be the average assembly. Hence, the installation of the LFA does not impact the decreased reactor coolant flow events analyzed using 1-D HERMITE.

This leaves the CEA Ejection event, which is analyzed using the non-LOCA version of the STRIKIN-II analysis code. The STRIKIN-II code models both a hot and an average fuel assembly for the core, which, when considered together, can individually model the remaining assemblies in the core. Because both the hot and the average assemblies impact the results of a CEA Ejection in this manner, the CEA Ejection analysis results can be impacted by any single fuel assembly in the core. Hence, the CEA Ejection required detailed analysis to support installation of the LFA.

Are all design limits met for the LFA?

As determined in the above discussion, for all DBEs other than the CEA Ejection event, the installation of the LFA has no impact on analysis results. Since the Unit 3, Cycle 10 reload analysis demonstrates that all relevant design criteria for these DBEs have been met, it can be concluded that the design limits for the LFA have been met for these DBEs as well.

For the CEA Ejection event, analysis supporting the installation of the LFA was split into two parts. One part being above 20% power and the other part being at or below 20% power.

Above 20% power, the CEA Power Dependent Insertion Limit (PDIL) only permits insertion of CEA Regulating Groups 4 and 5. The CEAs included in these two regulating groups are located in the outer half of the core. Hence, the ejected CEA is located in a fuel assembly that is well away from the LFA (which is located in the very center of the core). Additionally, the power peak associated with such a CEA ejection is located in a fuel assembly adjacent to the ejected CEA. Consequently, any fuel failure associated with a CEA ejection above 20% power occurs in fuel assemblies close to the ejected CEA and not the LFA. Hence, for the CEA Ejection above 20% power analysis, the installation of the LFA has no impact on the Unit 3, Cycle 10 reload analysis results. The peak reactor coolant system (RCS) pressure and radiological dose criteria for the CEA Ejection event above 20% power for the LFA is satisfied by the Unit 3, Cycle 10 reload analysis CEA Ejection results.

At or below 20% power, the CEA PDIL permits insertion of CEA Regulating Group 3. This regulating group controls CEAs that are located in fuel assemblies that are immediately adjacent to the LFA (the center fuel assembly). Because of this, it was possible that the subsequent power peak would occur in the LFA. Accordingly, a detailed STRIKIN-II analysis was run to demonstrate the impact of an ejected Regulating Group 3 CEA on the LFA. This analysis demonstrated that the peak RCS pressure and fuel failure results for a 20% (or less) power CEA ejection that includes the LFA remain bounded by those reported for the CEA Ejection Analysis of Record case. Because the fuel failure result is bounded by the Analysis of Record case, the radiological consequences a CEA Ejection at or below 20% power case are also bounded by the radiological consequences of the CEA Ejection Analysis of Record case.

What is the limiting transient and effect of the LFA?

As discussed above, the limiting DBE for installation of the LFA is the CEA Ejection event at or below 20% power. Detailed analysis of this case, including the LFA, demonstrates that the results remain bounded by the CEA Ejection Analysis of Record case. Accordingly, the impact of this CEA Ejection event is no more adverse for the LFA than the impact on the center fuel assembly reported in the CEA Analysis of Record.

Additional Information:

APS has developed an alternate core design in the event that the LFA will not be re-installed. Reasons for not re-installing the LFA include unacceptable poolside inspection results or unacceptable results from the necessary analyses and evaluations in such areas as fuel performance, mechanical design, corrosion, and accidents. The alternate design replaces the LFA with an assembly of comparable reactivity that has standard OPTIN clad and will not exceed 60 MWd/kgU. This design has been evaluated and determined to have power distribution variances from the LFA design comparable to normal as-built tolerances. Both core designs are fully assessed in the reload safety analyses.