APS

A subsidiary of Pinnacle West Capital Corporation

Palo Verde Nuclear
Generating Station

John H. Hesser
Vice President
Nuclear Engineering

Tel: 623-393-5553
Fax: 623-393-6077

Mail Station 7605
PO Box 52034
Phoenix, Arizona 85072-2034

102-06191-JHH/RKR
May 12, 2010

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

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 3
Docket No. STN 50-530
Response to Request for Additional Information Regarding the Request for Temporary Exemption from the Provisions of 10 CFR 50.46 and 10 CFR 50, Appendix K for Lead Fuel Assemblies

By letter no. 102-06089, dated November 02, 2009, Arizona Public Service Company (APS) submitted a request for a temporary exemption from the requirements of 10 CFR 50.46 “Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,” and 10 CFR 50, Appendix K, “ECCS Evaluation Models,” in order to use Lead Fuel Assemblies (LFAs) in PVNGS Unit 3, Cycles 16, 17, and 18. By e-mail dated February 24, 2010, the Nuclear Regulatory Commission (NRC) staff requested additional information to support their review of the exemption request. The request for additional information was clarified in an April 1, 2010, phone call between the APS and NRC staffs. The enclosure contains the APS response to the request for additional information.

No commitments are being made to the NRC by this letter. Should you need further information regarding this submittal, please contact Russell A. Stroud, Licensing Section Leader, at (623) 393-5111.

Sincerely,

[signature]

DCM/RAS/RKR/gat

A001
NRR

Enclosure: APS Response to NRC Request for Additional Information

cc:	E. E. Collins Jr.	NRC Region IV Regional Administrator
	J. R. Hall	NRC NRR Project Manager
	L. K. Gibson	NRC NRR Project Manager
	R. I. Treadway	NRC Senior Resident Inspector for PVNGS

ENCLOSURE

APS Response to NRC Request for Additional Information

NRC Request 1

Specify clearly and explicitly the type of current (resident) fuel in PVNGS Unit 3 core. Also specify the topical report (TR) related to this fuel. If there has been any modification of the fuel assembly from the specifications described in the TR, provide the new information.

Response:

The PVNGS Unit 3 reactor incorporates a Combustion Engineering (CE) 16x16 standard (CE16STD) fuel assembly design with five guide tubes. Each guide tube displaces four fuel rod positions. Therefore, by design, a 16x16 fuel assembly would have 236 fuel rods per assembly that could be clad with Zircaloy or ZIRLO™. This standard fuel assembly design is described in the PVNGS Updated Final Safety Analysis Report (UFSAR), Section 4.1. The majority of the PVNGS Unit 3 Cycle 16 resident fuel assemblies incorporate the Inconel 625 Top Grid with a few (< 10) reinserted assemblies with a Zircaloy-4 Top Grid.

There is no single topical report that provides the licensing basis for evaluating the CE 16x16 standard fuel assembly design. The standard fuel assembly licensing methodologies are described throughout the PVNGS UFSAR with the appropriate NRC approved topical reports referenced. The licensing approach used for the CE fuel design was to make evolutionary changes to the basic fuel design described (and approved) in the UFSAR. These evolutionary changes were addressed under the 10 CFR 50.59 process.

In WCAP-16500-P-A (Reference 1), the NRC reviewed and approved the CE 16X16 next generation fuel (CE16NGF) design. The work performed to develop the PVNGS Lead Fuel Assemblies (LFAs) for implementation into PVNGS Unit 3 is based on the CE16NGF fuel design contained in WCAP-16500-P-A. WCAP-16500-P-A references the standard fuel topical reports and provides the basis for the new design.

NRC Request 2

Specify clearly and explicitly the details of the Lead Fuel Assemblies (LFAs) PVNGS has requested to be inserted in to the PVNGS Unit 3 core during the Fall 2010 refueling outage.

Response:

The goals of the PVNGS LFA program are:

- Improve fuel performance to eliminate crud failures and oxide spallation occurring at high duty operation.
- Improve fuel reliability by increasing grid to rod fretting margin.

The design features a full complement of innovative components defined below to improve fuel reliability, fuel cycle economics, fuel duty, higher burnup capability and thermal performance for PVNGS.

- Advanced mid grids with "I" spring rod supports and side supported mixing vanes at selected elevations.
- Replace CE top Inconel grid with Westinghouse style top Inconel grid.
- Use of Stress Relief Annealed (SRA) ZIRLO™ material for guide tubes and Optimized ZIRLO™ material for cladding and grid straps.
- The addition of 2 Intermediate Flow Mixing (IFM) Grids.
- The Westinghouse advanced 0.374" outside diameter (OD) rod.
- ZrB_2 integrated burnable absorber.
- Anti-rotation joint between guide thimbles and the top nozzle.
- Continued use of Guardian™ grid with solid lower end cap.
- Thimble screw redesigned to eliminate the welding of a locking disk.
- Bottom nozzle revised to add crimp pockets for receiving the thimble screw.
- Adapter threaded and tack welded to the bottom nozzle to guide/restrain the center Instrument tube.

The work performed to develop the PVNGS LFAs for implementation into PVNGS Unit 3 is based extensively on the CE16NGF fuel design recently developed and operating in full batch at Waterford 3 and Arkansas Nuclear One Unit 2. The details of the PVNGS LFAs for implementation into PVNGS Unit 3 are based on the CE16NGF fuel design contained in WCAP-16500-P-A (Reference 1).

NRC Request 3

Please provide details such as type of assembly (generic names), types of grids for each assembly (Top grid, mid grids (vaned or not), whether there are any IFM grids, bottom grids), material of grids, fuel rod dimensions (specifically fuel rod diameter) for both the LFAs and co-resident fuel in PVNGS Unit 3 core. A table similar to Table 2-1 of WCAP-16500-P-A comparing/contrasting the above details for the LFAs and the co-resident fuel would enable the staff to fully understand the make-up of the core for a complete review of the application.

Response:

The work performed to develop the PVNGS LFAs for implementation into PVNGS Unit 3 is based on the CE16NGF design recently developed and operating in Waterford 3 and Arkansas One Unit 2. WCAP-16500-P-A (Reference 1) provides the basis for the CE16NGF design and was reviewed and approved by the NRC.

The PVNGS LFA is consistent with the Plant D design defined in Figure 1-1 of WCAP-16500-P-A (Page 8 of 95, Reference 1).

The Plant D design documented in the response to RAI No. 2 of Reference 2 is applicable to PVNGS.

The Plant D column of Table 2-1 (Page 6 of 20) in the response to RAI No. 2 of Reference 2 is applicable to PVNGS. Table 1 provides more specific details.

A dimensional and material comparison between the PVNGS standard design (PVSTD) and PVNGS LFA design (PVLFA) is shown in Table 2.

Table 1 Differences for Plant B (CE16NGF) and Plant D (PVNGS LFA = PVLFA)			
COMPONENT	**PLANT B (CE16NGF)**	**PLANT D (PVLFA)**	**COMMENTS (For PVLFA)**
Fuel Rod			
Fuel Rod Design and Dimensional Configuration	Reference	Same	
Grids			
Inconel Top Grid	Reference	Same	
Mid Grids	Reference	Same	
IFM Grids	Reference	Same	
Guardian Grid	Reference	Same	
Guide Thimbles			
Outer Guide Thimbles	Reference	Same	
Center Instrumentation Thimble	Reference	Different	PVNGS design Center Instrumentation Thimble: 1) is bulged to the Inconel Top Grid only; 2) is guided/restrained by an adapter at the bottom. PVNGS In-Core Instrumentation centering dimples are retained.
Top Nozzle			
Outer Guide Posts	Reference	Similar	PVNGS design Outer Guide Posts are slightly shorter and have CE16NGF threads.
Center Guide Post	Reference	Different	PVNGS design Center Guide Post is modified to accommodate the Core Exit thermocouple.
Holddown Plate	Reference	Different	PVNGS design Holddown Plate has slightly deeper counter-bores for the outer Holddown Springs.
Flow Plate	Reference	Similar	CE16NGF design Flow Plate with slight modification to accommodate PVNGS design Center Guide Post.
Holddown Springs	Reference	Different	PVNGS design Holddown Springs are slightly shorter.

Table 1 (continued) Differences for Plant B (CE16NGF) and Plant D (PVNGS LFA = PVLFA)			
COMPONENT	**PLANT B (CE16NGF)**	**PLANT D (PVLFA)**	**COMMENTS (For PVLFA)**
Bottom Nozzle			
Bottom Nozzle	Reference	Different	PVNGS design Bottom Nozzle with slight modifications that include: 1) addition of raised bosses on the underside of the plate to house the CE16NGF design Thimble Screw crimp pockets; 2) a new adapter to guide/restrain the center Instrumentation Thimble that replaces the old restraint feature.
Adapter	N/A	New	PVNGS design Adapter to guide/restrain the center Instrumentation Thimble.
Thimble Screws	Reference	Same	
Threaded Joint Connections	Reference	Same	
Skeleton - Thimble Bulge Tooling	Reference	Same	

Table 2 Comparison of PVNGS LFA Design and the PVNGS Standard Design		
	PVLFA	**PVSTD**
FUEL ASSEMBLY		
Rod array in assembly	16x16	Same
Rods per assembly	236	Same
Fuel assembly pitch, inches	Table 3-1 of WCAP-16500	Same
Fuel rod pitch, inches	0.506	Same
Overall assembly height, inches	Taller by 0.143 inches	Reference Design*
GUIDE THIMBLE/INSTRUMENT TUBES		
Number of guide thimble tubes (GT)	4	Same
GT Material	ZIRLO™	Zircaloy-4
GT O.D. above dashpot, inches	Table 2-1 of WCAP-16500	Same
GT I.D. above dashpot, inches	Table 2-1 of WCAP-16500	Same
Number of instrument tubes	1	Same
Instrument tube material	ZIRLO™	Zircaloy-4
Instrument tube O.D., inches	Table 2-1 of WCAP-16500	Same
Instrument tube I.D., inches	Table 2-1 of WCAP-16500	Same
GRIDS		
Total number of grids	13	11
Number of Inconel top/bottom grids	2 (1 Each)	Same
Top grid material type	Inconel 718	Inconel 625
Top grid inner strap height, inches	Taller by 0.014 inches	Table 2-1 of WCAP-16500
Bottom grid material type	Inconel 625	Same
Bottom grid inner strap height, inches	Table 2-1 of WCAP-16500	Same
Number of mid grids	9 (6 vaned, 3 unvaned)	9 (unvaned)
Mid grid material type	Optimized ZIRLO™	Zircaloy-4
Unvaned mid grid strap height, inches	Table 2-1 of WCAP-16500	Table 2-1 of WCAP-16500
Vaned mid grid strap height, inches	Table 2-1 of WCAP-16500	N/A

Table 2 (continued) Comparison of PVNGS LFA Design and the PVNGS Standard Design		
	PVLFA	**PVSTD**
Number of IFM grids	2	N/A
IFM grid material type	Optimized ZIRLO™	N/A
IFM grid inner strap height, inches	Table 2-1 of WCAP-16500	N/A
TOP NOZZLE (TN)		
TN material type	Cast 304 SS & 304 SS (Posts)	Same
TN envelope (Flow Plate), inches	Table 2-1 of WCAP-16500	Same
OUTER GUIDE POST		
Guide post material type	304 SS	Same
Guide post O.D, inches	Same	Reference Design*
FUEL ASSEMBLY HOLDDOWN SPRING		
Material type	Inconel 750	Same
Free length, inches	Shorter by 0.299 inches	Reference Design*
Wire diameter, inches	Same	Reference Design*
Total number of turns	Same	Reference Design*
Max. solid height, inches	Same	Reference Design*
BOTTOM NOZZLE (BN)		
BN material type	Low Cobalt 304 SS	Cast 304 SS
BN envelope, inches	Table 2-1 of WCAP-16500	Same
FUEL ROD		
Cladding O.D., inches	0.374	0.382
Fuel rod length, inches	Table 2-1 of WCAP-16500	Table 2-1 of WCAP-16500
Pellet diameter, inches	0.3225	0.3255
Active pellet stack length, inches	150.0	Same
Cladding material type	Optimized ZIRLO™	ZIRLO™

**Reference Design refers to proprietary information for current PVNGS fuel design*

NRC Request 4

Specify what fraction of the total number of fuel rods of the LFAs will be clad in Optimized ZIRLO™.

Response:

The PVNGS Unit 3 Cycle 16 reactor core shall contain eight LFAs with each fuel assembly containing 100% (i.e., all 236 fuel rods per assembly) of the fuel rods clad with Optimized ZIRLO™.

NRC Request 5

Provide the details regarding the critical heat flux (CHF) correlations recommended by the fuel vendor(s) for the LFAs and the resident fuel in PVNGS Unit 3 core for the proposed upcoming cycle.

Response:

The LFAs will be introduced in PVNGS Unit 3 Cycle 16 core. PVNGS Unit 3 Cycle 16 will be a mixed core containing the current CE16STD fuel assemblies and eight LFAs. While, the CE16STD fuel bundle design contains no mixing vane mid grids and no Intermediate Flow Mixing (IFM) grids, the PVNGS LFA bundle design includes six mixing vane mid grids with two IFMs in addition to three non-mixing vane mid grids at the lower portion of the bundle. The mixing vane grids and IFMs have been shown to improve DNBR margin due to turbulent mixing.

A mixed core Departure from Nucleate Boiling (DNB) analysis was performed to verify that the LFAs are not leading the core at the proposed locations using NRC approved WSSV-T (Reference 3) and ABB-NV (Reference 4) CHF correlations. The WSSV-T CHF correlation was applied in the mixing vane and IFM grid spans and ABB-NV CHF correlation was applied in the non-mixing vane grid spans. Calculations of heat flux for LFAs in a mixed core environment were compared to heat fluxes of a core with uniform CE16STD fuel over a wide range of operating conditions. The results of these comparisons show that the LFAs have 6% available power margin for the limiting combination of pressure, temperature, and flow conditions without taking advantage of the 5% power reduction credit available for the LFAs due to their non-limiting location in the PVNGS Unit 3 Cycle 16 core design.

Thus, since there is adequate heat flux margin available to support LFAs at the proposed locations of the core, it is conservative to treat the LFAs as CE16STD fuel with the CE16STD CE-1 CHF correlation (References 5 and 6). The use of the CE-1 CHF correlation with our current CE16STD fuel is consistent with the PVNGS Reload Methodology.

NRC Request from February 24, 2010 E-Mail:

Separate from the attached RAIs, the staff noted that TS 4.2.1, "Fuel Assemblies," does not contain an explicit provision to allow the use of advanced zirconium alloy in assembly structural materials other than cladding, such as spacer grids. Thus, if Optimized ZIRLO™ is used in non-cladding components of the LFAs, a license amendment to revise TS 4.2.1 may also be needed.

Response:

The intention of technical specification (TS) 4.2.1 is to allow the placement of a limited number of LFAs that have not completed representative testing into the PVNGS Cores in non-limiting core regions. The TS authorizes the use of cladding material other than Zircaloy or ZIRLO with an approved exemption.

Optimized ZIRLO™ material will be used for the fuel rod cladding. Optimized ZIRLO™ will also be used for mid grids, IFM grids, and grid straps. The use of Optimized ZIRLO™ material for structural materials other than cladding is consistent with the current CE16NGF Waterford and Arkansas fuel batches.

The PVNGS request for a Temporary Exemption from the provisions of 10CFR 50.46 and 10CFR 50 Appendix K is specifically to allow the use of Optimized ZIRLO™ alloy as the fuel rod cladding material at PVNGS. PVNGS will evaluate all other differences (physics, thermal hydraulics, mechanical design, and safety analysis) associated with the LFAs as a change to the Plant in accordance with 10 CFR 50.59. The 10 CFR 50.59 review is expected to conclude that a license amendment request is not required.

References:

- Reference 1: WCAP-16500-P-A, "CE 16x16 Next Generation Fuel Core Reference Report," August 2007.
- Reference 2: Westinghouse Letter to the NRC, "Response to NRC's Request for Additional Information By the Office Nuclear Reactor Regulation Topical Report WCAP-16500-P, CE 16x16 Next Generation Fuel Core Reference Report (TAC No. MD0560, Proprietary/Nonproprietary),"LTR-NRC-06-66, November 29, 2006.
- Reference 3: WCAP-16523-P-A, "Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes," August 2007.
- Reference 4: CEN-387-P-A, "ABB Critical Heat Flux Correlations for PWR Fuel," May 2000.

- Reference 5: CENPD-162-P-A, "Critical Heat Flux Correlation for C-E Fuel Assemblies with Standard Spacer Grids, Part 1, Uniform Axial Power Distribution," September 1976.

- Reference 6: CENPD-207-P-A, "Critical Heat Flux Correlation for C-E Fuel Assemblies with Standard Spacer Grids, Part 2, Non-Uniform Axial Power Distribution," December 1984.