10 CFR 50.73

aps

DWIGHT C. MIMS
Senior Vice President, Nuclear
Regulatory & Oversight

Palo Verde
Nuclear Generating Station
P.O. Box 52034
Phoenix, AZ 85072
Mail Station 7605
Tel 623 393 5403

102-06699-DCM/DFH
May 7, 2013

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

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS)**
Units 1, 2, and 3
Docket No. STN 50-528, STN 50-529, and STN 50-530
License No. NPF 41, NPF 51, and NPF 74
Licensee Event Report 2013-001-00

Enclosed please find Licensee Event Report (LER) 50-528/2013-001-00 that has been prepared and submitted pursuant to 10 CFR 50.73. This LER reports an unanalyzed condition due to the spent fuel pool criticality analysis of record not being updated following a power uprate.

In accordance with 10 CFR 50.4, copies of this LER are being forwarded to the Nuclear Regulatory Commission (NRC) Regional Office, NRC Region IV, and the Senior Resident Inspector. If you have questions regarding this submittal, please contact Mark McGhee, Operations Support Manager, Regulatory Affairs, at (623) 393-4972.

Arizona Public Service Company makes no commitments in this letter.

Sincerely,

D.C. Mims

DCM/DFH/hsc

Enclosure

cc:	A.T. Howell III	NRC Region IV Regional Administrator
	J. K. Rankin	NRC NRR Project Manager for PVNGS
	M. A. Brown	NRC Senior Resident Inspector for PVNGS

IE22
NRR

NRC FORM 366 (10-2010)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2013

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Palo Verde Nuclear Generating Station (PVNGS) Unit 1	05000528	1 OF 6

4. TITLE
Unanalyzed Condition Due to Spent Fuel Pool Criticality Analysis of Record Not Updated for Power Uprate

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME: PVNGS Unit 2	DOCKET NUMBER: 05000529
3	8	2013	2013	- 001 -	00	05	07	2013	FACILITY NAME: PVNGS Unit 3	DOCKET NUMBER: 05000530

9. OPERATING MODE: 1 / 1 / 1

10. POWER LEVEL: 100 / 100 / 100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☒ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
Mark McGhee, Operations Support Manager, Regulatory Affairs	623-393-4972

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED		15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)*	☒ NO				

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines*

On March 8, 2013, PVNGS engineering personnel determined that certain impacts to the spent fuel pool (SFP) criticality analysis of record (AOR) had not been considered as part of the project to perform a power uprate to 3990 MW thermal in 2003. The power uprate impacted the reactivity of fuel discharged to the SFP but the SFP criticality AOR was not revised to account for the increased fuel reactivity. Therefore, this condition is being reported as an unanalyzed condition in accordance with 10 CFR 50.73(a)(2)(ii)(B).

The cause was procedures and processes lacked adequate rigor to identify impacts to the SFP criticality AOR. Additionally, the impacts of power uprate relative to the SFP criticality AOR were not well known or understood by personnel involved.

As an interim corrective action, an administrative control was implemented to apply a burnup penalty to low margin fuel assemblies to ensure Technical Specification (TS) reactivity requirements are met under all conditions. Planned corrective actions will revise design change procedures to consider reactivity impacts on the SFP and will revise the SFP criticality AOR using updated methodology and input parameters.

No similar events have been reported to the NRC in the prior three years.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Palo Verde Nuclear Generating Station Unit 1	05000528	2013	-- 001	-- 00	2 OF 6

NARRATIVE

All times are Mountain Standard Time and approximate unless otherwise indicated.

1. REPORTING REQUIREMENT(S):

This Licensee Event Report (LER) is being submitted pursuant to 10 CFR 50.73(a)(2)(ii)(B) as an unanalyzed condition. Specifically, the Palo Verde Nuclear Generating Station (PVNGS) analysis of record (AOR) for Spent Fuel Pool (SFP) criticality was not revised to support a license amendment to allow power uprate to 3990 MW thermal (MWth) in 2003. This condition was reported to the NRC pursuant to 10 CFR 50.72(b)(3)(ii) in event notification 48814 on March 8, 2013.

2. DESCRIPTION OF STRUCTURE(S), SYSTEM(S) AND COMPONENT(S):

The fuel building in each PVNGS unit is a seismic category 1, reinforced concrete structure located adjacent to the containment and auxiliary buildings. The fuel building primarily houses the SFP (EIIS: DB), new fuel storage area, the dry spent fuel storage system loading and transfer equipment, and the SFP cooling heat exchangers and pumps. The SFP is a stainless steel lined, concrete walled pool that is an integral part of the fuel building. The SFP holds approximately 390,000 gallons of borated water and is designed to store up to 1205 new or spent fuel assemblies in storage racks arranged on the bottom of the SFP. Upon receipt, new fuel assemblies are normally stored dry in vertical racks in the fuel building and are then transferred into the SFP prior to core reload during refueling outages. The dry storage racks provide storage capacity for 90 fuel assemblies.

The SFP system is supported by the SFP cooling system (PC) (EIIS: DA) which consists of two independent 100 percent capacity trains each with piping, pump and heat exchanger. Each train is capable of providing adequate heat removal during normal conditions and the pumps and heat exchangers may be operated in parallel or cross-connected to provide additional heat removal capability during periods where SFP heat loads are higher. Additionally, the safety injection system (SI), which is normally used for inventory control and heat removal of the reactor coolant system, may be cross connected to the PC cooling system to cool the SFP. Normally, the PC system is adequate to handle the spent fuel decay heat load and the SI system is isolated from the PC system. The SFP cleanup system (PC) provides for purification of the SFP water inventory to maintain water chemistry within specifications. The PC cleanup system consists of two trains, having redundant piping, strainers, pumps, filters and mixed bed ion exchangers.

The spent fuel storage racks are designed for wet storage of either new or spent fuel in a vertical configuration. The storage racks are stainless steel honeycomb structures with rectangular fuel storage cells. The storage racks provide fuel assembly spacing with a nominal 9.5 inch center-to-center distance between adjacent storage cell locations which includes consideration of rack fabrication tolerances and predicted deflections resulting from

NARRATIVE

a safe shutdown earthquake (SSE). This arrangement is designed to maintain adequate spacing of stored fuel assemblies for control of reactivity.

The SFP criticality analysis supports TS LCO 3.7.15, Fuel Storage Pool Boron Concentration, and LCO 3.7.17, Spent Fuel Assembly Storage, as well as TS Design Features 4.3.1, Fuel Storage Criticality. The SFP is designed to prevent criticality by use of adequate spacing of fuel assemblies, maintenance of minimum soluble boron concentration, and placement restrictions for stored fuel based on fuel assembly initial enrichment, burnup and decay time. The PVNGS SFP design does not require use of neutron absorbing materials for reactivity control. The design requirements related to criticality assure an effective neutron multiplication factor (Keff) of less than or equal to 0.95 for all conditions given a minimum SFP soluble boron concentration of 900 parts per million (ppm). The design also requires that Keff remains less than 1.0 with a SFP soluble boron concentration of 0 ppm. These Keff limits include allowances for biases and uncertainties, including methodology and temperature biases, and enrichment, fuel pellet stack density, steel thickness, storage cell pitch, fuel assembly position and calculational uncertainties.

The soluble boron in the SFP water ensures that there is a sufficient amount of negative reactivity in the SFP at all times. TS LCO 3.7.15 requires SFP soluble boron concentration to be greater than or equal to 2150 ppm when any fuel assembly is stored in the SFP. Normal soluble boron concentrations in the SFPs are maintained between 4000 ppm and 4400 ppm during all modes of operation. Maintenance of SFP boron concentration in excess of the value required by LCO 3.7.15 provides additional reactivity margin and allows the SFP to be used as a source of borated water to restore RCS shutdown margin in an emergency.

PVNGS procedures establish controls for the movement of both new and spent fuel assemblies to ensure the requirements for fuel storage and SFP criticality are met. The specific location where a fuel assembly may be stored in the SFP is governed by LCO 3.7.17, Spent Fuel Assembly Storage. LCO 3.7.17 ensures the combination of initial enrichment, burnup, and decay time of each fuel assembly stored in each of the four regions of the SFP is within the acceptable burnup domain for each region and remains subcritical.

3. INITIAL PLANT CONDITIONS:

On March 8, 2013, PVNGS Units 1, 2, and 3 were in Mode 1 (Power Operation), at 100 percent power and normal operating temperature and pressure. There were no structures, systems, or components inoperable that contributed to the event.

NARRATIVE

4. EVENT DESCRIPTION:

On March 8, 2013, PVNGS engineering personnel determined that certain impacts on the SFP criticality AOR had not been considered as part of the project to perform a power uprate from 3876 MWth to 3990 MWth in 2003. As a result, the input parameters used in the SFP criticality AOR had not been appropriately revised for the power uprate conditions.

The non-conservative impact of the 2003 power uprate change on the SFP criticality calculation results principally from enhanced plutonium production in each fuel assembly which occurs due to higher moderator and fuel temperatures under power uprate conditions. The higher moderator and fuel temperatures bias the neutron energy spectrum more toward fast neutrons which then results in greater uranium 238 resonance absorption and subsequent higher plutonium production. The higher plutonium concentrations in fuel assemblies that have operated under power uprate conditions are not accounted for in the SFP criticality calculations resulting in fuel assemblies being discharged into the SFP that are more reactive than previously predicted.

When informed of the condition, operations personnel performed an immediate operability determination (IOD) which considered both the borated and unborated TS requirements. The IOD concluded that the fuel assembly storage configurations in the SFPs were operable but non-conforming. The IOD conclusion for the borated case was supported by station requirements to maintain SFP boron concentration greater than 4000 ppm. The operability determination for the unborated case was based on engineering judgment that conservatisms within the AOR adequately bound the condition. Operations requested that a prompt operability determination (POD) be developed to establish the reactivity margin for fuel that had been operated under power uprate conditions and now stored in the SFPs.

For the unborated case, the POD, completed on March 22, 2013, concluded that sufficient reactivity margin exists for fuel manufactured at the Columbia Fuel Fabrication Facility (CFFF) to comply with TS requirements. The reactivity margin for non-CFFF manufactured fuel was not sufficient for storage of this fuel in the most limiting SFP locations for the unborated case. In response, administrative controls were established to ensure TS requirements are met for the most limiting storage locations.

The POD established administrative controls to ensure that burnup penalties are applied to placement of non-CFFF manufactured fuel assemblies in order to maintain compliance with TSs.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTAL NUMBER	REVISION NUMBER	
Palo Verde Nuclear Generating Station Unit 1	05000528	2013	-- 001	-- 00	5 OF 6

NARRATIVE

5. ASSESSMENT OF SAFETY CONSEQUENCES:

To assess the safety consequences, an evaluation was performed using the power uprate value of 3990 MWth and the SFP criticality AOR methodology. The evaluation concluded that TS 4.3.1.1.c. would require an increase in minimum SFP boron concentration from 900 ppm to 935 ppm to ensure that Keff of the storage racks remains below 0.95. The SFP boron concentration at PVNGS is required to be maintained greater than 2150 ppm by LCO 3.7.15, Fuel Storage Pool Boron Concentration, and the actual operating concentration is maintained between 4000 ppm and 4400 ppm; therefore, adequate margin was maintained at all times.

Additional evaluations were performed to ensure that fuel stored in the spent fuel storage racks would remain subcritical even if the SFP is assumed to be fully flooded with unborated water as required by TS 4.3.1.1.b. The evaluation determined that, when manufacturing tolerances were considered, fuel storage requirements were met for fuel manufactured at the CFFF due to conservatisms in the AOR. For fuel that was not manufactured at the CFFF, the evaluation determined that the AOR conservatisms were not sufficient to ensure Keff was less than 1.0 in the unborated case for the most limiting SFP storage locations. As a result, burnup penalties were applied to non-CFFF manufactured fuel to establish the needed margin when determining the allowed SFP storage locations in accordance with the requirements of TS LCO 3.7.17.

Reviews of the actual fuel storage configurations for the past three years determined that, with the burnup penalty applied, the TS requirements for the condition with the SFP flooded with unborated water were met. No conditions were identified where the non-CFFF manufactured fuel assemblies were stored in non-allowable locations.

These evaluations also show no credible deboration event that could have diluted the SFP from the TS value of 2150 ppm boron to 900 ppm boron without detection. The slight increase in boron concentration from 900 ppm to 935 ppm required to maintain Keff less than or equal to 0.95 (TS 4.3.1.1.c) is small when compared to the procedurally required SFP boron concentration of 4000 ppm to 4400 ppm.

The condition would not have prevented the fulfillment of a safety function; and, the condition did not result in a safety system functional failure as defined by 10 CFR 50.73 (a)(2)(v). This event did not result in a challenge to the fission product barriers or result in the release of radioactive materials; and the event did not adversely affect the safe operation of the plant or health and safety of the public.

NARRATIVE

6. CAUSE OF THE EVENT:

The cause was procedures and processes lacked adequate rigor to identify impacts to the SFP criticality AOR. Additionally, the impacts of power uprate relative to the SFP criticality AOR were not well known or understood by personnel involved.

7. CORRECTIVE ACTIONS:

As an immediate corrective action, an administrative control was implemented to prevent movement of fuel assemblies in the three PVNGS SFPs. This fuel movement restriction was lifted following completion of analysis that showed that acceptable margin existed with the applied burnup penalties and implementation of administrative controls to establish burnup penalties.

The following interim corrective actions were implemented:

- As a compensatory measure, procedures were revised to establish additional reactivity margin (burnup penalties) for fuel assemblies identified as having lower margins in limiting SFP storage locations.
- The Unit 1, 2 and 3 SFP design documents, which determine the allowable SFP storage locations for each fuel assembly, were revised to implement the burnup penalties required by the revised procedures.

The following corrective actions are planned:

- To sustain compensatory measures to maintain reactivity margin for fuel assemblies discharged into the SFP in the future, procedures will be revised to establish manufacturing tolerances for new fuel assemblies.
- Revise design change procedures and documentation to consider reactivity impacts on the SFP.
- Revise the SFP criticality AOR using updated methodology and input parameters and submit a license amendment request.

If information is subsequently developed that would significantly affect a reader's understanding or perception of this event, a supplement to this LER will be submitted.

8. PREVIOUS SIMILAR EVENTS:

No similar events have been reported to the NRC in the prior three years.