



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

January 10, 2017

Mr. Robert S. Bement  
Executive Vice President Nuclear/  
Chief Nuclear Officer  
Mail Station 7602  
Arizona Public Service Company  
P.O. Box 52034  
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3 -  
REGULATORY AUDIT REPORT FOR THE NOVEMBER 2-3, 2016, AUDIT AT  
THE WESTINGHOUSE FACILITY IN ROCKVILLE, MARYLAND, FOR THE  
LICENSE AMENDMENT AND EXEMPTION REQUESTS ASSOCIATED WITH  
NEXT GENERATION FUEL (CAC NOS. MF8076 TO MF8081)

Dear Mr. Bement:

By letter dated July 1, 2016 (Agencywide Documents Access and Management System Accession No. ML16188A336), Arizona Public Service Company (APS, the licensee) submitted a license amendment request (LAR) for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3, requesting an approval to revise the Technical Specifications to support the implementation of next generation fuel (NGF). In addition to the LAR and in accordance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.12, the licensee is requesting an exemption from certain requirements of 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems [ECCS] for light-water nuclear power reactors," and 10 CFR 50, Appendix K, "ECCS Evaluation Models," to allow the use of Optimized ZIRLO™ as a fuel rod cladding material. In summary, the proposed change will allow for the implementation of NGF including the use of Optimized ZIRLO™ fuel rod cladding material. The NGF assemblies contain advanced features to enhance fuel reliability, thermal performance, and fuel cycle economics.

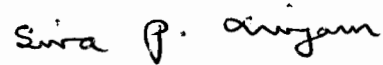
The U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at the Westinghouse facility in Rockville, Maryland, on November 2-3, 2016, in order to gain a better understanding of the licensee's LAR and Exemption for PVNGS, Units 1, 2, and 3. Enclosure 1 to this letter describes the results of the NRC staff's audit. At the beginning of the audit, the licensee presented the slides that are included as Enclosure 2 to this letter.

R. Bement

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If you have any questions, please contact me at 301-415-1564 or via e-mail at [Siva.Lingam@nrc.gov](mailto:Siva.Lingam@nrc.gov).

Sincerely,



Siva P. Lingam, Project Manager  
Plant Licensing Branch IV  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-528, STN 50-529,  
and STN 50-530

Enclosures:

1. Audit Report
2. APS Presentation Slides

cc w/encls: Distribution via Listserv

# **ENCLOSURE 1**

REGULATORY AUDIT REPORT

NOVEMBER 2-3, 2016, AUDIT PERFORMED AT  
WESTINGHOUSE FACILITY IN ROCKVILLE, MARYLAND

ARIZONA PUBLIC SERVICE COMPANY

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3

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



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

REGULATORY AUDIT REPORT PERFORMED AT  
WESTINGHOUSE FACILITY ON NOVEMBER 2-3, 2016  
IN SUPPORT OF THE NEXT GENERATION FUEL  
LICENSE AMENDMENT AND EXEMPTION  
ARIZONA PUBLIC SERVICE COMPANY  
PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3  
DOCKET NOS. STN 50-528, STN 50-529, AND STN 50-530

1.0 BACKGROUND

By letter dated July 1, 2016 (Agencywide Documents Access and Management System Accession No. ML16188A336), Arizona Public Service Company (APS, the licensee) submitted a license amendment request (LAR) for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3, requesting an approval to revise the Technical Specifications to support the implementation of next generation fuel (NGF). In addition to the LAR and in accordance with the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.12, the licensee is requesting an exemption from certain requirements of 10 CFR 50.46, "acceptance criteria for emergency core cooling systems [ECCS] for light-water nuclear power reactors," and 10 CFR 50, Appendix K, "ECCS Evaluation Models," to allow the use of Optimized ZIRLO™ as a fuel rod cladding material. In summary, the proposed change will allow for the implementation of NGF including the use of Optimized ZIRLO™ fuel rod cladding material. The NGF assemblies contain advanced features to enhance fuel reliability, thermal performance, and fuel cycle economics.

The U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at the Westinghouse Electric Company's (WEC's) facility in Rockville, Maryland, on November 2-3, 2016, in order to gain a better understanding of the licensee's NGF LAR and Exemption for PVNGS, Units 1, 2, and 3.

2.0 SCOPE AND PURPOSE

The audit was held on November 2-3, 2016, at WEC's office in Rockville, Maryland, and was conducted in accordance with the audit plan provided to the licensee. The purpose of the audit was to help the NRC staff better understand the documentation and analysis results through interaction with APS's technical experts and to help focus the staff's RAIs on those questions

where docketed information is needed to complete the review. Specifically, the NRC staff discussed the following topics with APS and WEC staff:

- Application of Analysis Methodologies:
  - Adherence to limitations and conditions
  - Selection of critical heat flux (CHF) correlations for specific applications
- Fuel Assembly Structural:
  - Seismic and loss-of-coolant accident (LOCA) testing and analyses
  - Regulatory requirements and safe shutdown earthquake concerns
- Chapter 15 Analyses:
  - Analysis inputs, methods, and results
  - Bounded and unaffected determinations for events
  - Transition core effects
  - Statistical methodology for the fuel assembly misload event
  - Fuel failure analyses and departure from nucleate boiling (DNB) propagation
- LOCA and Long-Term Cooling (LTC) Analyses:
  - Thermal conductivity degradation (TCD)
  - Boric Acid precipitation analysis with the WEC computer code, SKBOR

### 3.0 AUDIT TEAM

The following NRC staff members participated in the audit:

- Siva P. Lingam – Project Manager
- Daniel Beacon – Lead technical reviewer
- John Lehning – Technical reviewer (LOCA and LTC support)
- Mathew Panicker – Technical reviewer (TCD)
- Joshua Kaizer – Technical reviewer (Thermal hydraulics and statistics support)
- Diana Woodyatt – Technical reviewer

The following APS personnel supported the audit:

- Michael Dilorenzo
- Matthew Cox
- Lun-Chih Hwang
- Robert Hicks
- Brian Blackmore
- Charles Karlson (by phone)
- Phillip Hoffspiegel (by phone)
- Shawn Gill (by phone)

- Richard Wenzel (by phone)
- Christopher Cowdin (by phone)
- Tai Shin (by phone)
- David Medek (by phone)

The following APS consultants also supported the audit:

- Douglas Atkins (WEC)
- Brett Kellerman (WEC)
- Sukhwans Singh (WEC)
- Hans Van de Berg (WEC)
- Darrin Smith (WEC)
- Steve Grill (WEC)
- Brett Kellerman (WEC)
- Max O'Cain (WEC)
- Vick Nazareth (Anatech)
- Eric Eggleston (WEC) (by phone)
- Michael Martin (WEC) (by phone)
- Dave Rumschlag (WEC) (by phone)
- Jill Sinegar (WEC) (by phone)
- Paul Joffre (WEC) (by phone)
- Robert Harris (WEC) (by phone)
- Naugab (Ed) Lee (WEC) (by phone)
- Mike Volodzko (WEC) (by phone)
- Elena Del Sesto (WEC) (by phone)

#### 4.0 AUDIT REPORT

At the beginning of the audit, APS provided a presentation that gave a brief overview of the submittal (Enclosure 2). The NRC staff then proceeded to ask APS a number of questions about the analyses performed, the methodologies used, and the results obtained. APS and WEC staff provided responses and discussion regarding the questions. A running list of open items was kept as the audit progressed to ensure that questions not immediately answerable would be returned to and adequately addressed later in the audit.

Some of the topics discussed over the 2 days include: CHF correlation application and DNB analyses, Lead Fuel Assembly performance and testing, performance comparisons between the current WEC Value Added Fuel (referred to as STD) and the new NGF fuel, structural response and interface criteria of the NGF fuel, control element assembly (CEA) drop time analyses, fuel rod mechanical analyses and TCD treatment, Chapter 15 event analyses and results, LOCA analysis methods and results, and the effects of transition cores containing both NGF and STD and how these effects were addressed in the analyses. Additionally, a concurrent breakout session to discuss the details of the setpoints methodology was held in a side office. Joshua Kaizer, of the NRC staff, participated in the breakout session. No related topics for further discussion were outstanding following the breakout session.

During the audit, it was determined that further time would be needed to examine materials related to the statistical fuel assembly misload methodology and the use of SKBOR in the boric acid precipitation analysis. Therefore, documentation was provided for viewing during and following the conclusion of the audit. This documentation included (1) a technical report describing SKBOR code, (2) a boric acid precipitation calculation for Palo Verde, and (3) a statistical analysis of a fuel assembly misload event for Palo Verde. These documents were briefly examined during the audit, and subsequently examined further by John Lehning and Joshua Kaizer, of the NRC staff, on November 15, 2016, at the WEC offices in Rockville, Maryland.

Additionally, two major topics were identified during the audit that necessitated further discussion between the NRC and the licensee. The first topic regarded the requirements for restarting the reactor(s) following a seismic event with ground motions greater than the operating basis earthquake (OBE). The second topic regarded the adequacy and justification of the use of a temperature penalty applied to the radial fall-off (RFO) curve in order to account for the lack of explicit TCD treatment in FATES-3B. These topics were both discussed further in a phone call after the in-person portion of the audit on November 17, 2016. Additional further discussion, outside the scope of this audit, is expected regarding these topics and potentially those examined on November 15, 2016, as well.

At the time the audit was concluded, the following items were considered open items by the NRC staff:

- Justification for the TCD penalty to the RFO curve;
- Restart requirements following an OBE event;
- Further details regarding the use of SKBOR for the boric acid precipitation analysis;
- Further details regarding the use of a statistical fuel assembly misload methodology;
- Justification that more limiting results would not occur in a LOCA analysis, which assumes that offsite power is available;
- Justification for the determination that certain Chapter 15 events are bounded;
- Fuel assembly forced vibration testing apparatus description;
- Justification for containment analysis conclusions; and
- Transition core effects on CEA drop times.

Pending additional review, the NRC will formally issue requests for additional information (RAIs) addressing any remaining unresolved issues. The development of the RAIs will take into account the findings from this audit as well as other issues identified during the review.

## 5.0 CONCLUSION

Through the audit, the NRC staff obtained an enhanced understanding of the licensee's submittal and the details of the included safety analyses and their results. There was open communication throughout the audit, and this helped the NRC staff to communicate concerns about the submittal and have them answered by APS and WEC. The NRC staff is currently in the process of developing RAIs for the review and notes that the majority of the questions were discussed and answered by the licensee during the audit. Because of the audit discussions, the number of potential RAIs has been significantly reduced and the scope of the remaining questions has been focused directly on the topic of concern.

Principal Contributors: D. Beacon, NRR/SNPB  
J. Lehning, NRR/SNPB

Date: January 10, 2017.



## **ENCLOSURE 2**

APS PRESENTATION SLIDES

NOVEMBER 2-3, 2016, AUDIT PERFORMED AT  
WESTINGHOUSE FACILITY IN ROCKVILLE, MARYLAND

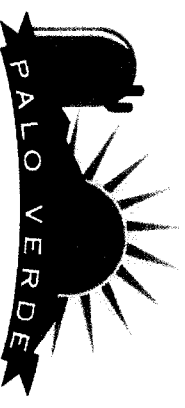
ARIZONA PUBLIC SERVICE COMPANY

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2, AND 3

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

**NRC Audit of Palo Verde Units 1, 2,  
and 3 Next Generation Fuel License  
Amendment Request**

**November 2-3, 2016**



# Agenda

- Introduction
- LAR Overview
- Analysis Methods
- Fuel Assembly Structural
- Chapter 15 Analysis
- LOCA & LTC Analysis
- Summary



# Introduction

- This submittal revises the licensing basis to implement Next Generation Fuel<sup>(1)</sup> at Palo Verde (NL16188A332)
  - Permanent cladding exemption request per 50.12
  - Revises TS 4.2.1 and TS 5.6.5b IAW 50.90
  - Adds a license condition addressing IN 2012-09
- Two public meetings held with the NRC
- Lead Use Assembly test program in Unit 3
- Transitioning to NGF ensures security of supply, improved fuel cycle economics, and increase in DNB margin
- Consistent with precedents for other Combustion Engineering (CE) digital protection plants [ML080840015, (3/26/2008) & ML080880014, (4/15/2008)]

1) Next Generation Fuel design, is CE\_16x16\_NGF and is referred to as CE16NGF through the presentation



# License Amendment Request Submittal Package Contents

- Enclosure
  - Cover letter, Requested Technical Specification changes, License Condition, Regulatory Analysis, Environmental Evaluation, Exemption requests
- Attachment 1 - License Condition Mark-Up
- Attachment 2 – Technical Specification Page Mark-Ups
- Attachment 3 – Clean Technical Specification Pages
- Attachment 4 – Technical Specification Basis Mark-Ups For Information Only
- Attachment 5 – Assessment of Topical Report Limitations and Conditions
- Attachment 6 – Proprietary Affidavit
- Attachment 7 – Non-Proprietary Technical Analysis
- Attachment 8 – Proprietary Technical Analysis



# NRC Staff Audit Areas

- Application of Analysis Methodologies
- Fuel Assembly Structural
- Chapter 15 Analyses
- LOCA and LTC Analyses



# Application of Analysis Methodologies

- Limitations and Conditions and CHF correlations for specific applications
  - Lun-Chih [Larry] Hwang, APS
  - Sukhwans Singh, Westinghouse
  - Vick Nazareth, Anatech
- Setpoints and MSCU related methods
  - Steven Grill, Westinghouse
  - Robert Hicks, APS

NOTE: Other APS and Westinghouse support staff will be available by phone.



# Fuel Assembly Structural

- Seismic/LOCA testing and analyses
  - Eugene Montgomery, APS (remote)
  - Mike Martin, Westinghouse (remote)
  - Eric Eggleston, Westinghouse (remote)



# Chapter 15 Analyses

- Analysis inputs, methods, and results
- Bounded/unaffected determinations for events
- Transition core effects
- Fuel failure analyses and DNB propagation
- For all topics:
  - Robert Hicks, APS
  - Hans Van De Berg, Westinghouse

NOTE: Other APS and Westinghouse support staff will be available by phone.



# LOCA and LTC Analyses

- Treatment of thermal conductivity degradation
- Impact of radial fall-off curve implementation
- Review of sensitivity analysis cases and burnup dependent analyses (described in Att 8, Pg 67) not presented in submittal
- Impact of assumption concerning unavailability of offsite power for LBLOCA case
- Transition mixed-core analysis results
- Understanding how conditions are set for hot rod
- Burnup / initial stored energy assumptions for LBLOCA and SBLOCA
- Long-term cooling / boric acid precipitation
- Reference description for SKBOR code (described in Att 8, section 8.4.5)

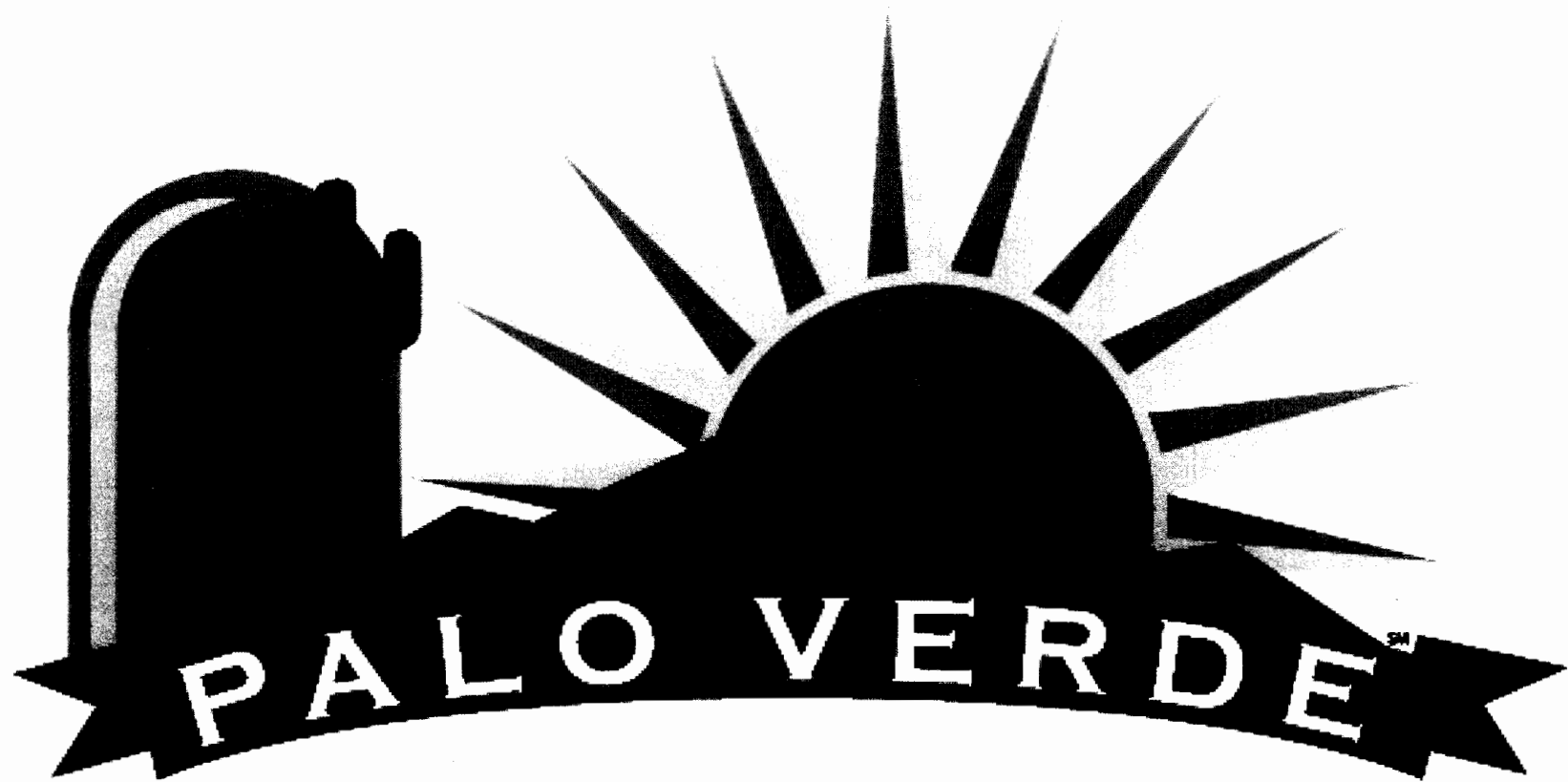


# LOCA and LTC

- Robert Hicks, APS
- David Medek, APS (remote)
- Douglas Atkins, Westinghouse
- Brett Kellerman, Westinghouse
- David Rumschlag, Westinghouse (remote)

NOTE: Other APS and Westinghouse support staff will be available by phone.





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If you have any questions, please contact me at 301-415-1564 or via e-mail at [Siva.Lingam@nrc.gov](mailto:Siva.Lingam@nrc.gov).

Sincerely,

*/RA/*

Siva P. Lingam, Project Manager  
Plant Licensing Branch IV  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

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JLehning, NRR  
MPanicker, NRR

**ADAMS Accession No.: ML17003A076**

\*Audit Summary by memo

OFFICE	NRR/DORL/LPL4/PM	NRR/DORL/LPL4/LA	NRR/DSS/SNPB/BC
NAME	SLingam	PBlechman	RLukes*
DATE	1/10/17	1/9/17	12/16/16
OFFICE	NRR/DORL/LPL4/BC	NRR/DORL/LPL4/PM	
NAME	RPascarelli	SLingam	
DATE	1/10/17	1/10/17	

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