

**Attachment 4 contains PROPRIETARY information
To be withheld under 10 CFR 2.390**

**10 CFR 50.90
10 CFR 50.12**



102-07869-MLL/MDD
March 1, 2019

MARIA L. LACAL
Senior Vice President, Nuclear
Regulatory & Oversight

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

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station Units 1, 2, and 3
Docket Nos. STN 50-528, 50-529, and 50-530
Renewed Operating License Nos. NPF-41, NPF-51, NPF-74
Audit Presentation Slides Regarding License Amendment Request and
Exemption Request to Support the Implementation of Framatome
CE16HTP™ Fuel**

By letter dated July 6, 2018 [Agencywide Documents Access and Management System (ADAMS) Accession No. ML18187A417], as supplemented by letter dated October 18, 2018 (ADAMS Accession No. ML18296A466), Arizona Public Service Company (APS) requested changes to the Technical Specifications, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.90, to support the implementation of Framatome Advanced Combustion Engineering (CE16HTP™) fuel design with M5® as a fuel rod cladding material and gadolinia as a burnable absorber for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2, and 3. In addition to this license amendment request (LAR), APS is requesting an exemption, pursuant to 10 CFR 50.12, 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 Part 50, Appendix K, *ECCS Evaluation Models*, to allow the use of Framatome M5® alloy as a fuel cladding material.

This amendment will adapt the approved PVNGS reload analysis methodology to address both Westinghouse and Framatome fuel, including the implementation of selected Framatome methodologies, parameters, and correlations. The ability to use either Westinghouse or Framatome fuel will ensure security of the PVNGS fuel supply by providing for multiple fuel vendors with reliable fuel designs and geographically diverse manufacturing facilities.

By letter dated January 15, 2019 (ADAMS Accession No. ML19011A108), the NRC staff published an audit plan to facilitate the NRC staff review of the LAR. The audit was held in Rockville, Maryland, on January 22 and 23, 2019. This letter transmits the presentation slides that were provided on January 22, 2019, during the audit.

The letter includes four attachments. Attachment 1 is an affidavit signed by APS that sets forth the basis on which the proprietary information in Attachment 4 may be withheld from

**Attachment 4 transmitted herewith contains PROPRIETARY information.
When separated from Attachment 4, this transmittal is decontrolled.**

A member of the STARS Alliance LLC

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102-07869-MLL/MDD

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U. S. Nuclear Regulatory Commission

Audit Presentation Slides Regarding License Amendment Request and Exemption Request to Support the Implementation of Framatome CE16HTP™ Fuel

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public disclosure by the Commission and addresses with specificity the considerations listed in 10 CFR 2.390(b)(4). Correspondence with respect to the proprietary aspects of Attachment 4 regarding APS information or the supporting APS affidavit should be addressed to Mr. Bruce Rash, APS Vice President, Nuclear Engineering.

Attachment 2 is an affidavit signed by Framatome that set forth the basis on which the proprietary information in Attachment 4 may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in 10 CFR 2.390(b)(4). Correspondence with respect to the proprietary aspects of Attachment 4 regarding Framatome information or the supporting Framatome affidavit should be addressed to Mr. Philip A. Opsal, Framatome Manager, Product Licensing.

Attachment 3 is a non-proprietary version of the audit presentation slides, which reflects the redaction of proprietary information. Attachment 4 is the proprietary version of the audit presentation slides.

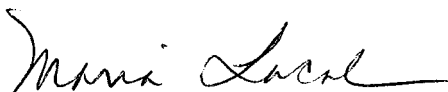
No new commitments are being made in this submittal. By copy of this letter, this information is being forwarded to the Arizona Department of Health Services in accordance with 10 CFR 50.91(b)(1).

Should you have any questions concerning the content of this letter, please contact Matthew S. Cox, Licensing Section Leader, Nuclear Regulatory Affairs, at (623) 393-5753.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: March 1, 2019
(Date)

Sincerely,



MLL/MDD/CJS/mg

Attachment 1 - Arizona Public Service Company (APS) Affidavit

Attachment 2 - Framatome Affidavit

Attachment 3 - Non-Proprietary Audit Presentation Slides

Attachment 4 - Proprietary Audit Presentation Slides

cc: S. A. Morris NRC Region IV Regional Administrator
S. P. Lingam NRC NRR Project Manager for PVNGS
C. A. Peabody NRC Senior Resident Inspector for PVNGS
B. Goretzki Arizona Department of Health Services (ADHS)

Attachment 1

Arizona Public Service Company (APS) Affidavit

**Submitted in Accordance with 10 CFR 2.390
to Consider Attachment 4 as a Proprietary Document**

A F F I D A V I T

STATE OF ARIZONA)
) ss.
CITY OF PHOENIX)

1. My name is Bruce Rash. I am employed by Arizona Public Service Company ("APS"). My present capacity is Vice President, Nuclear Engineering, for the Palo Verde Nuclear Generating Station ("PVNGS"), and in that capacity I am authorized to execute this Affidavit.

2. APS is the operating agent for PVNGS. I am familiar with the policies established by APS to determine whether certain APS information is proprietary and confidential, and to ensure the proper application of these policies.

3. I am familiar with APS information in the following document: Attachment 4 to APS Correspondence 102-07869, "Audit Presentation Slides Regarding License Amendment Request and Exemption Request to Support the Implementation of Framatome CE16HTP™ Fuel," referred to herein as "Document." Information contained in this Document has been classified by APS as proprietary in accordance with the policies established by APS for the control and protection of proprietary and confidential information.

4. The information contained in this Document is proprietary and confidential in nature and of the type customarily held in confidence by Framatome (formerly Areva, Inc.), Westinghouse, and APS, and not made available to the public. Based on my experience in the nuclear industry, I am aware that other companies also regard the type of information contained in the Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding proprietary information from public

disclosure is made in accordance with 10 CFR 2.390. The information qualifies for withholding from public disclosure under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. APS applied the following criteria to determine that the information contained in the Document should be classified as proprietary and confidential:

- (a) APS has a non-disclosure agreement with Westinghouse Electric Company LLC ("Westinghouse"), Framatome, and Structural Integrity Associates, Inc. (SI), under which Westinghouse and Framatome have provided to APS certain proprietary and confidential information contained in the Document.
- (b) The information reveals details of Westinghouse's, APS's, and/or Framatome's research and development plans and programs, or the results of these plans and programs.
- (c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive commercial advantage for Westinghouse, APS, and/or Framatome.
- (d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive commercial advantage for Westinghouse, APS, and/or Framatome on product optimization or marketability.
- (e) The unauthorized use of the information by one of Westinghouse's, APS's, and/or Framatome's competitors would permit the offending party to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.
- (f) The information contained in the Document is vital to a competitive commercial advantage held by Westinghouse, APS, and/or Framatome, would be helpful to

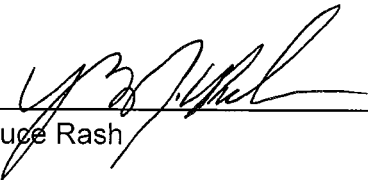
their competitors, and would likely cause substantial harm to the competitive position of Westinghouse, APS, and/or Framatome.

(g) It reveals aspects of past, present, or future Westinghouse, Framatome, or APS funded development plans and programs of potential commercial value.

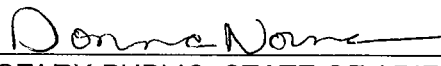
7. In accordance with APS's policies governing the protection and control of proprietary and confidential information, the information contained in this Document has been made available, on a limited basis, to others outside APS only as required and under suitable agreement providing for nondisclosure and limited use of the information.

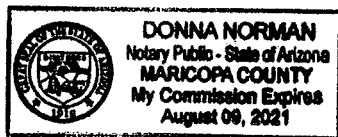
8. APS's policies require that proprietary and confidential information be kept in a secured file or area and distributed on a need-to-know basis. The information contained in the Document has been kept in accordance with these policies.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief, and if called as a witness I would competently testify thereto. I declare under penalty of perjury under the laws of the State of Arizona that the above is true and correct.


Bruce Rash

SUBSCRIBED before me this 28TH
day of February, 2019.


NOTARY PUBLIC, STATE OF ARIZONA
MY COMMISSION EXPIRES: August 9, 2021
Reg. #:



Attachment 2

Framatome Affidavit

**Submitted in Accordance with 10 CFR 2.390
to Consider Attachment 4 as a Proprietary Document**

AFFIDAVIT

COMMONWEALTH OF VIRGINIA)
) ss.
CITY OF LYNCHBURG)

1. My name is Philip A. Opsal. I am Manager, Product Licensing, for Framatome Inc., (formally known as AREVA Inc.), and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome Inc., to determine whether certain Framatome Inc. information is proprietary. I am familiar with the policies established by Framatome Inc. to ensure the proper application of these criteria.

3. I am familiar with the Framatome Inc. (formally AREVA Inc.) information contained in the following presentation slides which supported an NRC audit of Palo Verde (herein referred to as Documents):

- a) Thermal-Hydraulics (T-H) – Core Pressure Drop Profile
- b) Non-LOCA Analyses – Gas Gap Conductance and Peak Fuel Centerline Temperature.

4. These Documents contain information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome Inc. and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in these Documents as proprietary and confidential.

5. These Documents have been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in these Documents be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure

is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by Framatome Inc. to determine whether information should be classified as proprietary:

- (a) The information reveals details of Framatome Inc.'s research and development plans and programs or their results.
- (b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.
- (c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome Inc.
- (d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome Inc. in product optimization or marketability.
- (e) The information is vital to a competitive advantage held by Framatome Inc., would be helpful to competitors to Framatome Inc., and would likely cause substantial harm to the competitive position of Framatome Inc.

The information in these Documents is considered proprietary for the reasons set forth in paragraphs 6(b), 6(c), 6(d) and 6(e) above.

7. In accordance with Framatome Inc.'s policies governing the protection and control of information, proprietary information contained in these Documents has been made available, on a limited basis, to others outside Framatome Inc. only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome Inc.'s policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Paige A. O'Neil

SUBSCRIBED before me this 22
day of February, 2018.9 ^{HHE}

Heidi Hamilton Elder

Heidi Hamilton Elder
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 12/31/2022
Reg. # 7777873



Attachment 3

Non-Proprietary Audit Presentation Slides



NRC Audit Entrance
Framatome CE16HTP Fuel License Amendment
Palo Verde Units 1, 2, and 3 – **NON-PROPRIETARY**

January 22, 2019

Attendees

- Palo Verde
 - Tom Weber – Nuclear Regulatory Affairs Director
 - Mike Dilorenzo – Nuclear Regulatory Affairs Department Leader
 - Tom Remick – Nuclear Fuel Analysis Department Leader
 - Ryan Lane - Operations Shift Manager
 - Matthew Cox – Regulatory Affairs Section Leader
 - Chuck Karlson – Reload Analysis Section Leader
 - Dave Ricks – Transient Analysis Section Leader



Attendees

- Palo Verde

- Dave Medek – Consulting Engineer, Transient Analysis (LOCA, Ch. 15, Methodology Control)
- Robert Hicks – Sr. Engineer, Transient Analysis (LOCA, Ch. 15)
- Shawn Gill – Sr. Engineer, Reload Analysis (T-H, Setpoints)
- Calvin Meddings – Sr. Engineer, Reload Analysis (Setpoints)
- Jenying Wu – Sr. Engineer, Nuclear Analysis (Physics)
- Luke McIntyre – Engineer II, Dry Cask (Mechanical Design)
- Chris Cowdin – Engineer II, Reload Analysis (T-H)
- Hans Van de Berg – Consultant (T-H, Ch. 15, Setpoints)
- Mark Drucker – Consultant (T-H, Setpoints, Fuel Performance)



Attendees

- Framatome
 - Greg Kessler (Project Manager)
 - Nathan Hottle (Reg. Affairs)
 - Brett Matthews (Seismic)
 - Lisa Gerken (LOCA)
 - Ryan Swanson (T-H)
 - Miao Sun (Fuel Performance/COPERNIC)
 - Chris Allison (Fuel Performance/COPERNIC)



Discussion Topics

- Attendees
- Opening Remarks
- Framatome Fuel Project
- Reload Design Process
- Fuel Assembly Mechanical Design
- Thermal-Hydraulics (T-H)
- T-H Code Modification Process
- Mixed Cores
- LOCA Analyses
- Non-LOCA Analyses
- Setpoints



Opening Remarks

- Framatome CE16HTP Fuel Licensing
 - Pre-Submittal Meeting
 - License Amendment Request
 - Teleconferences
 - Acceptance Review Questions
- First Regulatory Audit
 - Breakout Sessions
- Next Steps
 - Requests for Additional Information (RAIs)
 - Second Regulatory Audit



Framatome Fuel Project

- APS is planning on using Framatome CE16HTP fuel in the spring 2020 refueling of Unit 2
 - 100 CE16HTP fuel assemblies to be loaded
 - Essentially the same design as lead test assemblies
 - Fuel manufacturing underway
- NRC approval is required for the APS reload methodology changes needed to address Framatome fuel



Framatome Fuel Project

- Overall Goals

- Increase security of supply
 - Reliable fuel designs
 - Multiple fuel vendors
 - Geographically diverse manufacturing
 - Commercial considerations
- Implement an improved fuel design
- Maintain existing methods to the extent practical
- Utilize NRC-approved methods to the extent practical
- Use general approach the NRC has seen before (SONGS, ML11215A090)
- Build off Next Generation Fuel (NGF) approval (ML17319A103 / ML17319A107)



Framatome Fuel Project

- Reload Methods Addressed in the Submittal
 - Update NRC-approved APS reload methods to address Framatome fuel
 - Use of NRC-approved Framatome mechanical design and LOCA methods
 - Use of NRC-approved Framatome COPERNIC methods for fuel behavior analysis (thermal conductivity degradation)
 - Use of NRC-approved Framatome BHTP critical heat flux (CHF) correlation
 - Use of NRC-approved VIPRE-01 as an alternative to VIPRE-W
 - 10 CFR 50.12 permanent cladding exemption request



Framatome Fuel Project

- **APS**
 - Palo Verde reload methodology licensed by NRC June 14, 1993
 - Experienced staff, have done ~50 in-house reloads
- **Structural Integrity / GD Barri**
 - Analytical and licensing support
- **Framatome**
 - CE HTP fuel in use at most CE plants (all 14x14 plants, one 15x15 plant, one 16x16 plant)
- **Zachry Nuclear Engineering**
 - VIPRE-01 subject matter expert (code maintenance and development)
- **Westinghouse**
 - Compatibility evaluations



Reload Design Process

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Reload Design Process

- Technical Specification (TS) 2.1.1.2
 - Peak fuel centerline temperature safety limit
- TS 4.2.1
 - Design features (fuel assemblies)
- TS 5.6.5.b
 - Core Operating Limits Report (COLR) analytical methods
- 10 CFR 50.12 Permanent Cladding Exemption
- TS Bases
- Non-COLR Methods



Fuel Assembly Mechanical Design

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Fuel Assembly Mechanical Design

- Essentially the same design as lead test assemblies
- Mechanical Compatibility
 - Fuel assemblies
 - Upper tie plates
 - Lower tie plates
 - Guide tubes
 - Instrument tubes



Fuel Assembly Mechanical Design

- Normal Operation & Anticipated Operational Occurrences
 - Acceptance criteria per Standard Review Plan 4.2, *Fuel System Design*, (stress and strain limits, creep collapse, fuel rod hydriding, fatigue, etc.)
- Faulted Condition
 - Structural response to externally applied forces (earthquakes and pipe breaks)
 - Framatome topical report ANP-10337P-A
 - Lateral and vertical analyses
 - Co-resident CE16STD and CE16NGF considered
 - End-of-life grid crush



Thermal-Hydraulics (T-H)

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Thermal-Hydraulics (T-H)

- Thermal-Hydraulic Compatibility
 - Core Pressure Drop Profile

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Thermal-Hydraulics (T-H)

- Thermal-Hydraulic Compatibility
 - RCS loop flow
 - Total bypass flow
 - Crossflow velocity
 - Control rod drop time
 - Fuel rod bow
 - Guide tube heating



Thermal-Hydraulics (T-H)

- BHTP Critical Heat Flux Correlation
 - DNBR SAFDL = 1.27
 - VIPRE model selections
 - Statistical combination of uncertainties – system parameter uncertainties, BHTP correlation uncertainty, and VIPRE-based DNBR sensitivity
 - Benchmark to experimental data
 - Comparison to NRC-approved Framatome LYNXT application
 - NRC Information Notice 2014-01, *Fuel Safety Limit Calculation Inputs Were Inconsistent with NRC-Approved Correlation Limit Values*
 - DNBR Probability Distribution Function
 - Probability of fuel damage as a function of DNBR
 - Used in downstream analyses



Thermal-Hydraulics (T-H)

- VIPRE Codes
 - COLR Methodology TS
 - Current – VIPRE-W (Westinghouse)
 - To be added – VIPRE-01 (Electric Power Research Institute)
 - Proposed Treatment of Codes
 - Separate entities in SQA program (different vendors)
 - Interchangeable for licensing applications (numerical results)

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T-H Code Modification Process

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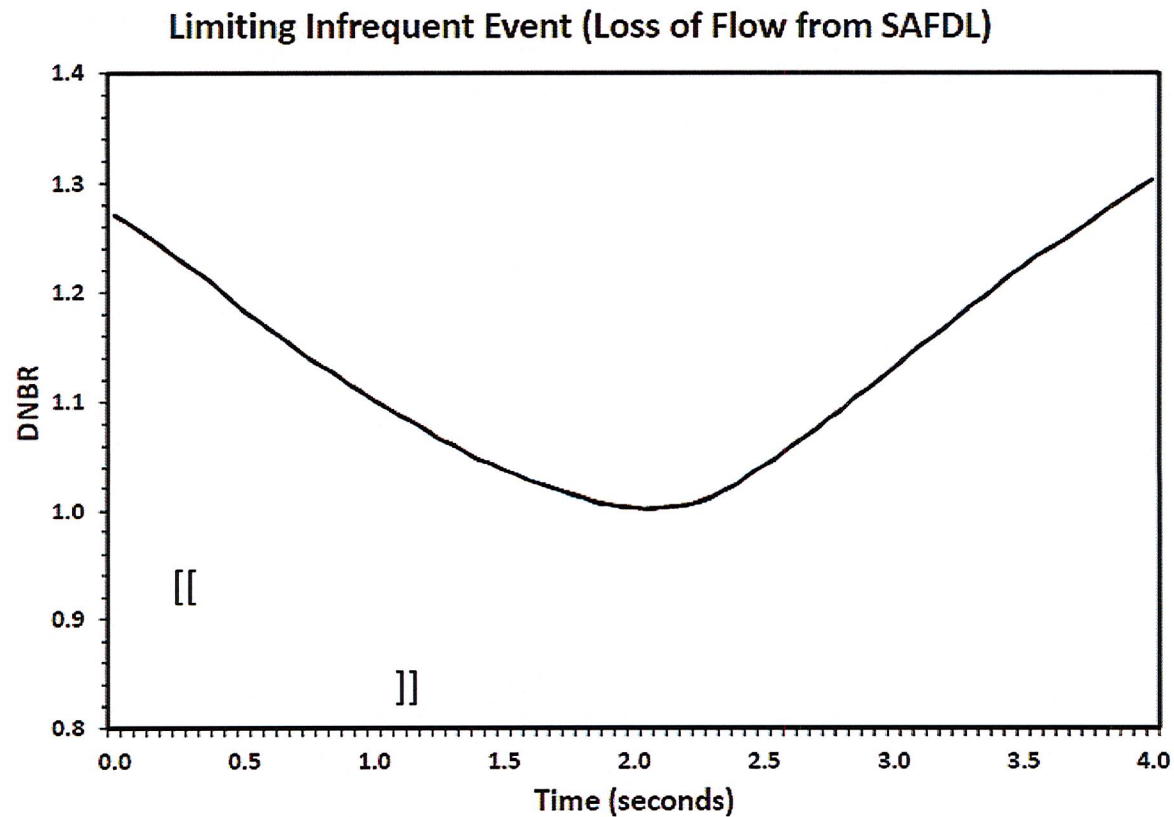
T-H Code Modification Process

- Existing Change Processes Cannot be Fully Used
 - Generic Letter 83-11, Supplement 1, *Licensee Qualification for Performing Safety Analyses*
 - 10 CFR 50.59, *Changes, Tests, and Experiments*
- 10 CFR 50.90, *Application for Amendment of License, Construction Permit, or Early Site Permit*
- Proposed Change Process for T-H Codes
 - Based on concepts of generic letter and 10 CFR 50.59
 - Applicable only to NRC-approved codes and CHF correlations already in Palo Verde TS 5.6.5 (COLR Methodology)



T-H Code Modification Process

- SQA Program Implementation Example 1



T-H Code Modification Process

- SQA Program Implementation Example 2
 - CEA Ejection (BHTP)

Power Level	Pre-Ejected Radial Peaking Factor	Post-Ejected Radial Peaking Factor	VIPRE-W mDNBR	VIPRE-01 mDNBR
20%	1.1	2.4	1.341	1.341
20%	1.1	2.6	1.131	1.131
20%	1.5	2.3	1.330	1.330
20%	1.5	2.5	1.142	1.142
50%	1.3	2.6	1.360	1.360
50%	1.3	2.8	1.198	1.198
50%	1.5	2.5	1.370	1.370
50%	1.5	2.7	1.207	1.207



T-H Code Modification Process

- SQA Program Implementation Example 2
 - CEA Ejection (BHTP)

Power Level	Pre-Ejected Radial Peaking Factor	Post-Ejected Radial Peaking Factor	VIPRE-W mDNBR	VIPRE-01 mDNBR
65% COLSS In Service	1.1	2.5	1.406	1.407
65% COLSS In Service	1.1	2.7	1.224	1.224
65% COLSS In Service	1.5	2.4	1.308	1.308
65% COLSS In Service	1.5	2.6	1.136	1.136
65% COLSS Out of Service	1.1	1.9	1.540	1.540
65% COLSS Out of Service	1.1	2.1	1.286	1.286
65% COLSS Out of Service	1.5	1.8	1.370	1.370
65% COLSS Out of Service	1.5	2.0	1.139	1.139



T-H Code Modification Process

- SQA Program Implementation Example 3
 - CETOP-D / BHTP (preliminary results)
 - Time of minimum DNBR for the limiting infrequent event (loss of flow from SAFDL)
 - CE16STD (CETOP-D / CE-1) = 2.1 seconds
 - CE16HTP (CETOP-D / BHTP) = 2.0 seconds
 - CE16HTP [[]] = 2.05 seconds



T-H Code Modification Process

- *Sui Generis* Safety Evaluation
 - Code and CHF correlation must already be in TS 5.6.5
 - Limit to Palo Verde, similar to safety evaluation for NRC approval of CENTS code application for CEA ejection at Palo Verde [ML012880473]
 - Adoption by others would require prior NRC review and approval
 - Specify limitations and constraints
 - Specify scope and content for future NRC notifications



Mixed Cores

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Mixed Cores

- Mechanical Compatibility
- Thermal-Hydraulic Compatibility
- Thermal Margin Assessment
 - Inlet flow distribution
 - Detailed full core model with each quarter-assembly
 - Demonstration calculation includes all 3 fuel types
 - Different spacer grid loss coefficients

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- No generic mixed core penalty required



LOCA Analyses

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LOCA Analyses

- 10 CFR 50.46 Analysis Results

	UFSAR (pre-CE16NGF)	CE16STD / CE16NGF	CE16HTP
Large Break LOCA			
Evaluation Model	Appendix K	Appendix K	Realistic
PCT	2106 °F	2129.6 °F	1752 °F
MLO	11.9 %	15.78 %	2.37 %
CWO	0.781 %	0.813 %	0.020 %

Small Break LOCA

Evaluation Model	Appendix K	Appendix K	Appendix K
PCT	1618 °F	1678 °F	1620 °F
MLO	1.28 %	4.5 %	2.96 %
CWO	0.2 %	0.33 %	0.006 %

PCT – peak cladding temperature

MLO – maximum local oxidation

CWO – core-wide oxidation

CE16HTP small break LOCA – new time limit on existing operator action



LOCA Analyses

- Long-Term Core Cooling
 - Analysis for Next Generation Fuel license amendment remains bounding
- 10 CFR 50.46 Reporting
- Containment Analyses
 - Current mass/energy release analyses remain bounding for CE16HTP



Non-LOCA Analyses

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Non-LOCA Analyses

- Control Element Assembly (CEA) Ejection
 - Example of Framatome methodology adoption for part of analysis
 - COPERNIC fuel performance code
 - Thermal conductivity degradation (NRC IN 2009-23)
 - Corrosion model

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- Apply NRC interim acceptance criteria of Standard Review Plan 4.2, *Fuel System Design*



Non-LOCA Analyses

- Hot Zero Power (HZP) CEA Withdrawal
 - Example of COPENIC implications for input parameters
 - Transient linear heat rate > 21 kW/ft
 - Evaluate deposited energy and fuel centerline melt
 - Gas gap conductance
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 - Peak fuel centerline temperature
 - UFSAR – 2600 °F
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Non-LOCA Analyses

- 21 kW/ft Linear Heat Rate Limit
 - Legacy TS
 - TS 2.1.1.2, *Peak Linear Heat Rate* (Safety Limit)
 - TS 2.2.1, *Reactor Trip Setpoints* (Limiting Safety System Setting)
 - Current TS
 - TS 2.1.1.2, *Peak Fuel Centerline Temperature* – Amendment 145, December 2002 [ML023040463]
 - TS Table 3.3.1-1, *Reactor Protective System Instrumentation*
 - CEN-372-P-A, *Fuel Rod Maximum Allowable Gas Pressure*, May 1990

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Non-LOCA Analyses

- Limiting Infrequent Event (Loss of Flow from SAFDL)

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- CE16HTP Input Parameters with Other Codes
 - CENTS example – tuning factors for core differential pressure drop, RCS flow rate, flow coastdown
 - HERMITE example – cladding thermal conductivity, cladding specific heat



Non-LOCA Analyses

- Main Steam Line Break

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Setpoints

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Setpoints

- CEN-356(V)-P-A (Rev. 1-P-A) Methodology
 - Exclusive to digital COLSS/CPCS plants
 - Core Operating Limits Supervisory System (COLSS)
 - Core Protection Calculator System (CPCS)
 - Critical heat flux correlation
 - CETOP with CE-1 CHF correlation installed in Palo Verde COLSS/CPCS
 - Same axial-independent correlation applied to CE16STD design
 - Modified statistical combination of uncertainties (MSCU) process for determination of setpoints
 - Uncertainty factors are conservative to at least a 95% probability and 95% confidence level
 - System parameter uncertainties (engineering hot channel factors, CHF correlation, etc.)
 - State parameter uncertainties (measured state parameters, COLSS and CPCS algorithms, etc.)



Setpoints

- WCAP-16500-P-A (Supp. 1, Rev. 1) Methodology
 - Augments CEN-356(V)-P-A methodology
 - Critical heat flux correlation
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 - Methodology changes address biases introduced by different CHF correlations
 - Axial-dependent COLSS/CPCS constants serve as heat flux penalties for on-line DNBR calculations
 - DNB power operating limit (POL) error correlation with temperature / pressure / flow



Setpoints

- Mixed Core with Framatome Fuel

- Thermal-hydraulic analyses

- Model the actual mixed core
- Identify the potentially limiting fuel types

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- COLSS/CPC setpoint overall uncertainty analysis

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Questions?

