Browns Ferry Nuclear Plant

Extended Power Uprate License Amendment Request
NRC Public Meeting

Gerry Doyle
Director EPU
November 10, 2015

BFN EPU – Agenda

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• Analysis Code MICROBURN-B2	G Storey
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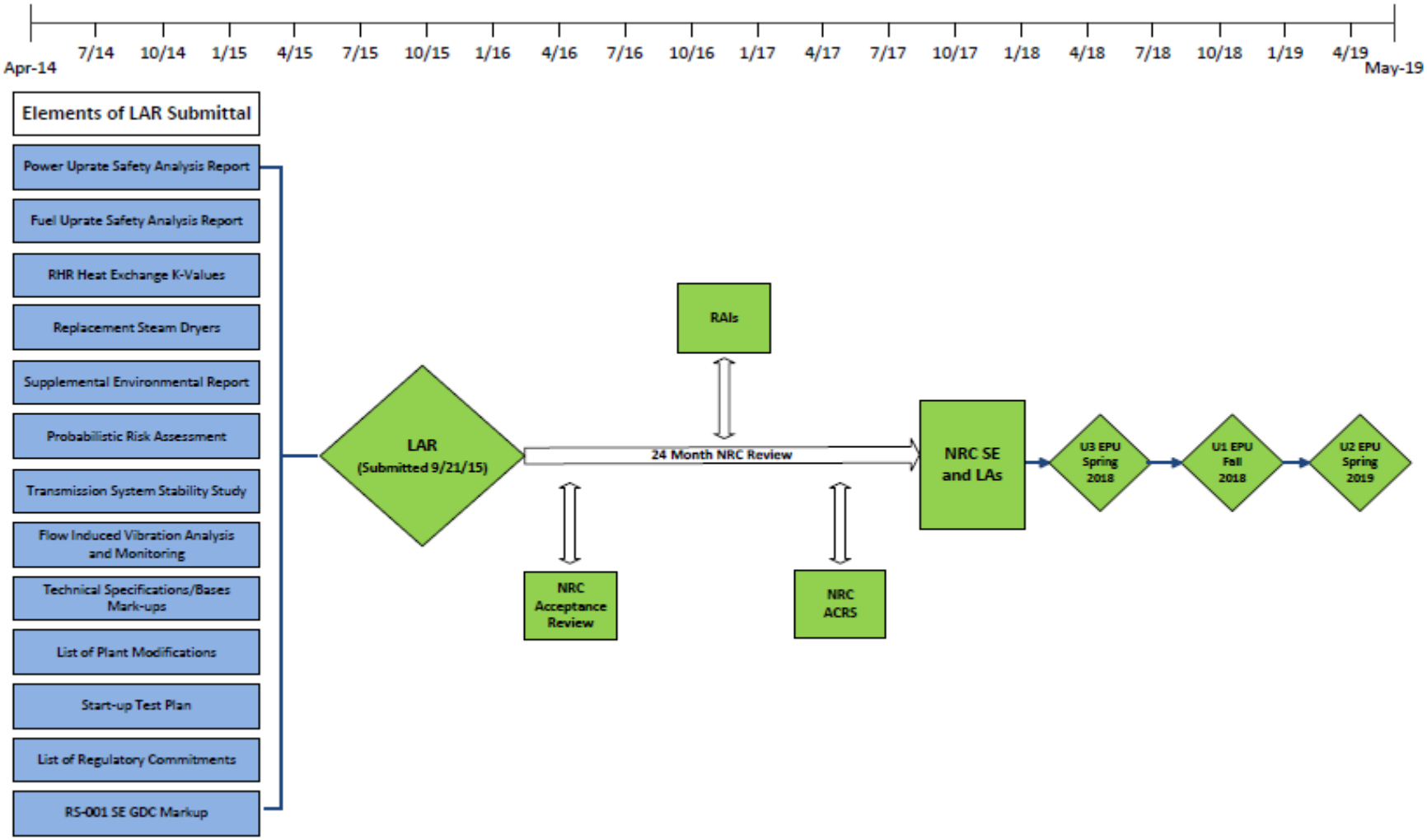
BFN EPU – Introductions

- Gerry Doyle – Director, Extended Power Uprate (EPU)
- Pete Donahue – EPU Engineering Manager
- Dan Green – EPU Licensing Manager
- Jeff Kimberlin – EPU Operations Support Manager
- Ed Schrull – Fleet Licensing Manager
- Greg Storey – Fleet BWR Fuels Engineering Manager

BFN EPU – Overview



BFN EPU – Submittal Format and Content/Approach

- New Consolidated License Amendment Request (LAR) Submittal
  - Supersedes all previous Browns Ferry Nuclear Plant (BFN) Extended Power Uprate (EPU) submittals
    - Previous submittals withdrawn
    - Addresses current BFN conditions
  - Format of RS-001, *Review Standard for Extended Power Uprates*
  - Applied Lessons Learned
    - Previous applicable NRC Requests for Additional Information addressed in new submittal
  - Includes replacement of Steam Dryers
  - Includes resolution of Containment Accident Pressure issue
    - In accordance with SECY 11-0014, *Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents*, guidance
  - Applied improved submittal Verification and Validation process
    - To ensure completeness and accuracy

BFN EPU – Submittal Format and Content/Approach (continued)

- Applied Institute of Nuclear Power Operations (INPO) Operating Experience (OE)
  - Significant Event Report (SER) 5-02, *Lessons Learned from Power Uprates*
  - INPO 09-005, *Power Uprate Implementation Strategies – A Leadership Perspective*
  - INPO Event Report (IER) 14-20*, Integrated Risk – Healthy Technical Conscience*
- Applied results of Benchmarking
  - Benchmarking of recent Boiling Water Reactor (BWR) Licensees with EPU LARs
    - Monticello, Grand Gulf, Peach Bottom
- Applied BWR Owners' Group (BWROG) Lessons Learned
  - BWROG-TP-043, *BWR Owners' Group EPU Committee – Extended Power Uprate (EPU) Lessons Learned and Recommendations*

BFN EPU – Disposition of Pre-application Meetings Feedback

NRC Pre-application Meeting – Fuel Aspects 10/14/14	
Feedback	**Disposition**
For reactor vessel fluence, ensure there is a clear demonstration of the applicability of Power Uprate Safety Analysis Report (PUSAR) conclusions by comparing reactor vessel fluence resulting from GE14 fuel to reactor vessel fluence resulting from ATRIUM 10XM fuel.	Addressed in section 2.1.2, "Pressure-Temperature Limits and Upper-Shelf Energy" of BFN EPU LAR Attachment 8 – Fuel Uprate Safety Analysis Report (FUSAR) (pages 5 through 7).
For events (e.g., overpower events, positive reactivity insertion events, loss of feedwater heating) described in the Disposition of Event summary in the representative ATRIUM 10XM Reload Report, ensure the Disposition of Event summary clearly describes the impact of EPU on the event and the associated critical thinking or analyses performed.	Addressed in BFN EPU LAR Attachment 20 – ANP-3404P, Browns Ferry Unit 3 Cycle 19 Representative Reload Analysis at Extended Power Uprate (Proprietary). BFN EPU LAR Attachment 20, Table 2.1, "Disposition of Events Summary for EPU and Areva Fuel at Browns Ferry" located on page 2-3 addresses this item.
With respect to the LOCA approach to legacy ATRIUM 10, ensure a detailed explanation regarding the Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) limit analysis and how fuel burn-up conditions are reflected in the analysis are provided in the LAR.	Addressed in BFN EPU LAR Attachment 12 – ANP-3378P, Browns Ferry Units 1, 2, and 3 LOCA-ECCS Analysis MAPLHGR Limits for ATRIUM 10XM Fuel (EPU) (Proprietary) and BFN EPU LAR Attachment 14 - ANP-3384P, Browns Ferry Units 1, 2, and 3 LOCA-ECCS Analysis MAPLHGR Limits for ATRIUM-10 Fuel (EPU) (Proprietary). Entire report.
Provide NRC with a listing and description of any additional fuel related power ascension tests that would be required for EPU.	Addressed in section 2.12.1, "Approach to EPU Power Level and Test Plan" of BFN EPU LAR Attachment 8 – FUSAR (page 162). Also addressed in Table 46-1, Note 3 of BFN EPU LAR Attachment 46 – Startup Test Plan (page Att 46-62).
Evaluate need for a pre-application meeting regarding Startup Testing.	The Startup Test pre-application meeting took place on 4/7/15.
Regarding the approach to the treatment of 10CFR50.46c issues, work with Farideh Saba (NRC) to arrange a follow-up meeting such that Paul Clifford and Chris Jackson would be in attendance.	The 10CFR50.46c pre-application meeting took place on 1/15/15.

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Fuel Aspects 10/14/14 (continued)	
Feedback	**Disposition**
For the follow-up meeting regarding the approach to the treatment of 10CFR50.46c issues, develop a detailed listing of activities and associated timeline necessary to demonstrate full compliance with the current proposed rule. Also, develop a detailed description of the approach proposed to taken in the BFN EPU submittal.	The 10CFR50.46c pre-application meeting slides included a detailed listing of activities and associated timeline necessary to demonstrate full compliance with the current proposed rule 10CFR50.46c.
With respect to reactivity initiated accidents, the NRC indicated that the revised Standard Review Plan (SRP) guidance might be issued in 2015. Work with Farideh Saba to determine the current schedule for issuance of the revised SRP guidance from Paul Clifford.	The 10CFR50.46c pre-application meeting slides included slides on Reactivity Initiated Accident Issues.

NRC Pre-application Meeting – Approach to Treatment of Hydrogen Embrittlement Issues 01/15/15	
Feedback	**Disposition**
Implement approach to 10 CFR 50.46c presented to NRC and include in BFN EPU LAR.	ANP-3409P, "Fuel-Related Emergent Regulatory Issues," Rev. 2 addresses the approach implemented to address 10 CFR 50.46c. This report was included in the BFN EPU LAR as Attachment 37.
With respect to reactivity initiated accident acceptance criteria, i.e., Control Rod Drop Accident (CRDA) acceptance criteria, consider addressing fuel melt criteria in the BFN EPU LAR.	Fuel melt criteria are addressed in Section 3.2 (Core Coolability) of ANP-3409P, Rev. 2 (BFN EPU LAR Attachment 37).
With respect to reactivity initiated accident acceptance criteria, i.e., CRDA acceptance criteria, consider addressing pellet-to-cladding mechanical interaction (PCMI) failure threshold in the BFN EPU LAR. Since PCMI failure threshold acceptance criteria impacts the number of fuel rods that would be postulated to fail in a CRDA, a margin discussion relative to resulting dose consequence changes for the CRDA could be provided.	PCMI Cladding Failure is addressed in section 3.3.2 of ANP-3409P, Rev. 2 (BFN EPU LAR Attachment 37). Section 3.3.4 of the report addresses Dose Consequence.

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Startup Test Plan 04/07/15	
Feedback	**Disposition**
Evaluate the need to perform more Traversing Incore Probe (TIP) traces during EPU startup, include determining what other Boiling Water Reactors (BWRs) have done during EPU Startups.	The BFN EPU LAR Attachment 46 – Startup Test Plan addresses this item in Note 3 of Table 46-1. The test at 3458 MWt may be considered the additional test. Note 3 discusses what other BWRs have done for the Core Power Distribution Test.
Expand the justification for not performing Update Final Safety Analysis Report (UFSAR) Initial Startup Test No. 21 (Flux Response to Rods) to more completely describe the intent of the original test and then ensure the justification adequately addresses how the intent is satisfied by other means and/or why the test is no longer required.	Startup Test No. 21 (Flux Response to Rods) is included in Table 46-1 of BFN EPU LAR Attachment 46 – Startup Test Plan.
Evaluate whether feedwater control system scram recovery feature settings need to be adjusted to account for EPU conditions.	This is addressed in the last paragraph on page 46-29 BFN EPU LAR Attachment 46 – Startup Test Plan.
Set up new pre-application meeting regarding the EPU Vibration Monitoring Plan with Farideh Saba.	Vibration Monitoring Plan Pre-application Meeting held on 6/9/15.
Review Recirculation Pump Trip operating experience, included in the Startup Test Plan justification for not performing the Recirculation Pump Trip test, and determine if any of these events were initiated at a high rod line. If they did not occur at a high rod line, NRC is concerned that the event would not be limiting/challenging and therefore the justification may not be sufficient.	BFN EPU LAR Attachment 46 – Startup Test Plan updated to include recirculation pump trip events that were initiated at a high rod line.

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Replacement Steam Dryers 04/22/15	
Feedback	**Disposition**
Enhance the discussion and justification for the acceptability of the stress results for the seismic blocks in the Steam Dryer Analysis Report (SDAR).	In the BFN EPU LAR, the seismic block stress analysis results are included in the SDAR (Attachment 40). Based on changes in the design (use of upgraded materials), the seismic block stress results have been shown to be within Code Allowables. These results are reflected in the BFN EPU LAR submitted to the NRC on 09/21/15.
Ensure the plan for monitoring recirculation pump vibration is covered in the EPU Vibration Monitoring Plan Pre-application Meeting presentation.	The EPU Pre-application meeting on Flow Induced Vibration (FIV) Monitoring Program took place on 6/9/15. Page 5 of the FIV Monitoring EPU Pre-application meeting presentation indicates that, "Vibration studies associated with Steam Dryer replacement, including effects of Reactor Recirculation Pump vane passing frequencies will be addressed as part of Steam Dryer vibration monitoring."

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Containment Accident Pressure Credit Elimination 05/12/15	
Feedback	**Disposition**
With respect to the use of ODYN/STEMP for the Anticipated Transient Without Scram (ATWS) analysis, describe in the EPU LAR the previous NRC approval for BFN Unit 1 of ODYN/STEMP and justify applying this code to BFN Units 2 and 3.	Note 5 of Table 1-1 of the BFN EPU LAR Attachment 6 – PUSAR indicates that STEMP has been accepted in the NRC review of NEDC-32868P, "GE14 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR)."
With respect to the Design Basis Accident - Loss of Coolant Accident (Short Term), provide description/justification in the EPU LAR regarding the acceptability of using ECCS pump flow rates from the safety analysis instead of runout flow.	Addressed in sections 2.6.5.1, "Pool Temperature Response" and 2.6.5.2, "ECCS Net Positive Suction Head" of the BFN EPU LAR Attachment 6 – PUSAR.
In the EPU LAR, address what would be the impact of higher relative humidity and lower relative humidity on suppression pool temperatures or demonstrate that we used conservative relative humidity values.	Addressed in note 6 of Table 2.6-2a of BFN EPU LAR Attachment 6 – PUSAR (pages 2-325 and 2-326).
In the EPU LAR, describe the basis/justification for changing from a Residual Heat Removal (RHR) Heat Exchanger (HX) k value of 223 to 265, including Browns Ferry specific experience (e.g., performance testing) and industry experience. Also address future RHR HX performance testing, e.g., consistent with the NFPA 805 transition LAR commitment.	Addressed in BFN EPU LAR Attachment 39 – Heat Exchanger K Values Utilized in EPU Containment Analyses. See sections 1.0 and 2.3 (pages Att 39-1 and Att 39-7).
In the EPU LAR, provide a basis for the parameter values selected for the Containment Accident Pressure (CAP) credit elimination analyses. In addition, identify and justify any less conservative values used in the EPU analyses as compared to the current licensing basis analyses.	Addressed in section 2.6.5.2, "ECCS Net Positive Suction Head" of BFN EPU LAR Attachment 6 – PUSAR. PUSAR Tables 2.3-8a (SBO), 2.8-1 (ATWS), 2.5-1 (NFPA), 2.6-2a, 2.6-2b, and 2.6-6 are also applicable to this item.
In the EPU LAR, for the $NPSHr_{eff}$ values used in the Design Basis Accident - Loss of Coolant Accident analyses, describe if these values were consistent with the values presented in the UFSAR and if the NPSH3% values were provided by the pump vendors.	Addressed in section 2.6.5.2, "ECCS Net Positive Suction Head" of BFN EPU LAR Attachment 6 – PUSAR (pages 2-306 and 2-307).

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Containment Accident Pressure Credit Elimination 05/12/15 (continued)	
Feedback	**Disposition**
In the EPU LAR, for the $NPSHr_{eff}$ values used in the Station Blackout, Anticipated Transient Without Scram and the Fire Event analyses, describe why there is a difference between these values.	Addressed in Table 2.6-4, "ECCS Pump EPU NPSH Summary" of BFN EPU LAR Attachment 6 – PUSAR. Table 2.6-4 is on page 2-331 of the PUSAR.
In the EPU LAR, for the RHR HX k value used in the Fire Event analysis, describe if the nominal k value of 307 still has margin to the values determined/supported by RHR HX performance testing (e.g., justify its use).	Addressed in BFN EPU LAR Attachment 39 – Heat Exchanger K Values Utilized in EPU Containment Analyses. See sections 1.0 and 2.3 (pages Att 39-5 and Att 39-6).
In the EPU LAR, provide the input parameters used for the analyses (OPL-4A) to allow the NRC to run their own confirmatory analyses.	Addressed in Table 2.6-6, "Input Comparisons Between CLTP and EPU for Limiting Long Term SP Temperature Analysis" of BFN EPU LAR Attachment 6 – PUSAR. Table 2.6-6 is on pages 2-339 through 2-347 of the PUSAR.
In the EPU LAR, provide justification for the use of the 21% uncertainty adder in the BFN analyses.	Addressed in section 2.6.5.2, "ECCS Net Positive Suction Head" of BFN EPU LAR Attachment 6 – PUSAR (page 2-307).
In the EPU LAR, for the Fire Event, document the additional margin obtained using nominal RHR Service Water temperature in the EPU LAR. Also, document the margin associated with using the defense-in-depth Emergency High Pressure Makeup pump in the EPU LAR.	Addressed under the "Fire Event ECCS NPSH" heading in section 2.6.5.2, "ECCS Net Positive Suction Head" of BFN EPU LAR Attachment 6 – PUSAR (page 2-315).
In the EPU LAR, for the Emergency High Pressure Makeup Pump, describe any preventive maintenance (PM) and surveillances that are to be performed on this pump or provide justification for not requiring PMs or surveillances.	The Emergency High Pressure Makeup Pump (EHPMP) is discussed under the "Fire Event ECCS NPSH" heading in section 2.6.5.2, "ECCS Net Positive Suction Head" of BFN EPU LAR Attachment 6 – PUSAR (page 2-315). The postulated use of the EHPMP is considered in a sensitivity case analysis for comparison purposes only. The EHPMP is not credited in the BFN EPU LAR. The preventive maintenance and surveillances associated with the EHPMP are items which will be addressed during the detailed design process for the pump.

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Probabilistic Risk Assessment (PRA) 05/21/15	
Feedback	**Disposition**
Ensure results of internal events focused peer review and fire events focused peer review are incorporated into the PRA LAR attachment prior to submittal to NRC.	In the BFN EPU LAR (dated 09/21/15), the results of the recent internal events focused peer review and the fire events focused peer review have been incorporated into the PRA LAR attachment (Attachment 44).
Ensure PRA results in LAR are presented in terms of mean Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) values in order to allow comparison to Regulatory Guide 1.174 acceptance guidelines.	Section 5.6 of BFN EPU LAR Attachment 44, Probabilistic Risk Assessment, provides the total risks associated with EPU. The aggregated risks are shown relative to the acceptance guidelines given in Regulatory Guide 1.174.

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Flow Induced Vibration Monitoring 06/09/15	
Feedback	**Disposition**
Tim Lupold (NRC) asked if we had modeled the Main Steam System before the Acoustic Vibration Suppressors (AVSs) were installed? He also asked if we had taken data before and after the installation of the AVSs. If we had taken data, he indicated the NRC would be interested in knowing how the results compared to the model. Action - Ensure issue described above is addressed in the SDAR	In the BFN EPU LAR (dated 09/21/15), information regarding the AVSs and their impact of the main steam system acoustic load analysis has been included in the SDAR Section 4.1.4.2 (Attachment 40).
Michael Breach (NRC) asked if we were doing anything with the jet pumps relative to anti-vibration modifications? We responded that EPU results in insignificant jet pump flow increase and therefore jet pump vibration would not be expected to increase. We indicated that jet pump clamps had been installed on all three units. Action - Check the PUSAR section on jet pumps to ensure it addresses the installation of the jet pump anti-vibration modifications.	BFN EPU LAR Attachment 6 – PUSAR Section 2.2.3.1.2, "Structural Evaluation of Other RPV Internals" indicates that jet pump sensing lines on all three units were installed with clamps to address existing vibrational concerns. The Jet Pump Sensing Lines discussion is on page 2-79.
Tim Lupold (NRC) asked, with respect to the Operating Experience (OE) slide, what did we learn from our review of OE. Pete Donahue responded that OE allowed us to help determine the appropriate breadth and scope of the program, including locations and components to monitor. Action - Ensure discussion of how OE was used in the development of the Vibration Monitoring Program is included in the EPU LAR.	Section 1.0 of BFN EPU LAR Attachment 45 – Flow Induced Vibration Analysis and Monitoring Program discusses operating experience. Section 2.0 of Attachment 45 discusses how the test program will incorporate the guidance and OE discussed in Section 1.0. Section 2.0 also indicates that modifications to small bore branch piping to reduce susceptibility to header-induced vibrations have been made as a result of BFN operating experience.
Tim Lupold (NRC) asked about the types of vibration monitoring instruments that would be used (e.g., accelerometers or displacement measuring devices). Action - Ensure that the EPU LAR discusses the types of vibration monitoring instruments to be used and where they will be located.	Section 2.0 (page Att 45-3) of BFN EPU LAR Attachment 45 – Flow Induced Vibration Analysis and Monitoring Program indicates that, "Piping inside containment and inaccessible piping outside containment will be monitored using vibration sensors (accelerometers or displacement transducers) installed at selected locations on the piping and attached components."

BFN EPU – Disposition of Pre-application Meetings Feedback (continued)

NRC Pre-application Meeting – Flow Induced Vibration Monitoring 06/09/15 (continued)	
Feedback	**Disposition**
Michael Breach (NRC) asked if we had considered Single Loop Operation (SLO) flow in the vibration monitoring program. Pete Donahue indicated that SLO flow had been considered in the Replacement Steam Dryer analysis and would be included in our evaluation of Information Notice (IN) 2015-04. Action - Follow-up on site response/actions associated with IN 2015-04 to ensure flow at SLO conditions is addressed/included.	This issue is being tracked in the BFN Corrective Action Program (CR # 1072732).
Tim Lupold (NRC) asked if we had previous vibration data for the other two units. We indicated that we only had data for Unit 1. Tim Lupold then asked if the unit's design were the same such that the data from Unit 1 could be applied to Units 2 and 3. Pete Donahue indicated that the units were nearly identical. Action - Ensure the issue described above is addressed in the EPU LAR.	Section 3.0 (page Att 45-4) of BFN EPU LAR Attachment 45 – Flow Induced Vibration Analysis and Monitoring Program indicates that, "The Unit 1 baseline vibration monitoring results are used to demonstrate that projected vibrations are anticipated to be acceptable. This conclusion is applicable to the other units based on the general similarity of the three units."
Michael Breach (NRC) asked if we had issues with Core Spray nozzles in the past. We indicated that we would look into this issue. Action - Ensure the issue described above is addressed in the EPU LAR.	The Core Spray Nozzle is addressed on page 2-73, Section 2.2.2.3, "Reactor Vessel" of the BFN EPU LAR Attachment 6 – PUSAR. The Core Spray Nozzle is identified as a component modified since original construction.
Tim Lupold (NRC) asked if we would have Level 1 and Level 2 acceptance criteria associated with vibration during EPU startup testing/monitoring. We indicated that we would. Action - Ensure that the EPU LAR Attachment for Vibration Monitoring addresses the issue described above.	Section 4.4 (page Att 45-16) of BFN EPU LAR Attachment 45 – Flow Induced Vibration Analysis and Monitoring Program indicates that, "Level 1 and Level 2 criteria are established to aid in evaluation of the data and decision making during power ascension."
Tim Lupold (NRC) asked, for the recirculation system, if we were looking at including vibration data from the program to modify the existing ISI program. We indicated that this would be done as part of the IN 2015-04 response. We also indicated that we were thinking about bump tests as part of the IN 2015-04 response. Action - Follow-up on site response/actions associated with IN 2015-04 to ensure this information gets incorporated into the response.	This issue is being tracked in the BFN Corrective Action Program (CR # 1072732).

BFN EPU – Electronic Reading Room

- Facilitates NRC review
  - Allows file sharing (e.g., calculations) with NRC reviewers
  - Files may be opened and viewed by NRC reviewers, but copying, printing or downloading files is precluded
  - Will not be used for Requests for Additional Information (RAIs)
    - Normal NRC process will be used for RAIs
- URL for reading room portal
  - https://bfepurr.certrec.com
- Access to reading room restricted to those NRC personnel granted access
  - BFN reading room administrator grants specific NRC personnel access to the reading room
    - Need NRC reviewer names and email addresses to assign user names and passwords
- Process
  - NRC requests information to review (e.g., calculation)
  - Information is obtained and file uploaded by BFN reading room administrator
  - After file is uploaded, an email is generated to NRC (Project Manager or reviewer, as determined by NRC), informing them that information is available for review
  - If, after reviewing the reading room file, NRC determines information from file is needed, the Tennessee Valley Authority will submit the required information on the docket

BFN EPU – Electronic Reading Room (continued)

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BFN EPU – Electronic Reading Room (continued)

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Audit Files (4)							
Calculations (6)							
Drawings (5)							
Others (1)							
Procedures (4)							
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BFN EPU – Electronic Reading Room (continued)

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	Record/Document Name	File	Revision Number	Description	Date Added	Requestor Name	Request Date	Status	Comments/Notes
Audit Files (4)									
- Containment Accident Pressure Credit Elimination Audit (1)									
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- Fuels Analyses Audit (1)									
	Sample Files	Sample File 5(1).pdf (81KB)			10/5/2015 1:06 PM CST		10/5/2015	Pending	
- Other Audits (1)									
	Sample Other	Sample File 3(2).pdf (81KB)			10/6/2015 10:08 AM CST		10/6/2015		
- Replacement Steam Dryer Audit (1)									
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Calculations (6)									
Drawings (5)									
Others (1)									
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BFN EPU – Electronic Reading Room (continued)

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Calculations (6)									
- Containment (1)									
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- Dose (1)									
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- Fuel Related (1)									
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- Other Calculations (1)									
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- PRA (1)									
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- Setpoint (1)									
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Drawings (5)									
Others (1)									
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	Record/Document Name	File	Revision Number	Description	Date Added	Requestor Name	Request Date	Status	Comments/Notes
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Calculations (6)									
Drawings (5)									
- ECCS (1)									
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- Electrical (1)									
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- Mechanical (1)									
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- Other Drawings (1)									
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- Systems (1)									
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Procedures (4)									
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	Record/Document Name	File	Revision Number	Description	Date Added	Requestor Name	Request Date	Status	Comments/Notes
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Calculations (6)									
Drawings (5)									
Others (1)									
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Procedures (4)									
References (1)									

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BFN EPU – Electronic Reading Room (continued)

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Record/Document Name	File	Revision Number	Description	Date Added	Requestor Name	Request Date	Status	Comments/Notes
Audit Files (4)								
Calculations (6)								
Drawings (5)								
Others (1)								
Procedures (4)								
- Maintenance (1)								
Sample 2	Sample File 1.pdf (81KB)	001		9/21/2015 2:14 PM CST	Michelle Thomas	9/24/2015	Pending	
- Operations (1)								
Sample File	Sample File 1(1).pdf (81KB)			10/5/2015 1:05 PM CST		10/5/2015	Open	
- Other Procedures (1)								
Sample Other Procedures	Sample File 3(5).pdf (81KB)			10/6/2015 10:11 AM CST		10/6/2015		
- Surveillance (1)								
Sample Surveillance	Sample File 4(5).pdf (81KB)			10/6/2015 10:12 AM CST		10/6/2015		
References (1)								

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BFN EPU – Electronic Reading Room (continued)

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	Record/Document Name	File	Revision Number	Description	Date Added	Requestor Name	Request Date	Status	Comments/Notes
Audit Files (4)									
Calculations (6)									
Drawings (5)									
Others (1)									
Procedures (4)									
References (1)									
	Reference Sample	Sample File 4(1).pdf (81KB)			10/6/2015 10:08 AM CST		10/6/2015		

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BFN EPU – Proposed Audit Schedule

- Regulatory audits allow NRC to more efficiently conduct its review or gain insights on a licensee's programs or processes
- Regulatory audits are conducted with the intent for the NRC to gain understanding, to verify information, and/or to identify information that will require docketing to support the basis of the licensing or regulatory decision
  - Proposed audit schedule to facilitate NRC review of EPU LAR
    - Replacement Steam Dryer Design and Analyses
      - February 8 – 12, 2016
    - Containment Accident Pressure Credit Elimination Analyses
      - March 14 – 18, 2016
    - Fuels Analyses
      - March 21 – 25, 2016
    - Other Audits, as needed

BFN EPU – Acceptance Review Issues

- Replacement Steam Dryers
  - Analysis Methodology
    - BFN Replacement Steam Dryer (RSD) acoustic load definition was developed using the GEH Plant Based Load Evaluation Methods
    - For BFN, one acoustic load definition was developed that bounds the loading for all three BFN units
    - The RSD for the initial unit at EPU conditions will have on-dryer instrumentation such that actual RSD loading can be compared to predicted loads
  - Acoustic Vibration Suppressors (AVSs)
    - AVSs were designed and installed on all three BFN units to reduce the depth of the standpipe cavity and eliminate an excessive resonance source
    - Main Steam Line (MSL) strain gauge data, taken after the installation of the AVSs, shows that the acoustic resonance associated with the standpipes has been eliminated
    - Stress analyses for the BFN RSDs used MSL acoustic data for each BFN unit taken with the AVSs installed

BFN EPU – Acceptance Review Issues

- Replacement Steam Dryers (continued)
  - Acoustic Side Branches (ASBs)
    - BFN does not currently experience any significant resonances associated with the Safety Relief Valve (SRV) standpipes requiring ASB installation at BFN
      - However, based on analyses, it is predicted that SRV resonance could occur at the increased steam flow velocities for EPU
    - SRV resonance at BFN EPU conditions is addressed in the BFN SDAR (NEDC-33824P, EPU LAR Attachment 40)
    - In addition, monitoring of main steam system piping vibration and SRV vibration at EPU conditions will be performed in accordance with the Flow Induced Vibration Analysis and Monitoring Program (EPU LAR Attachment 45)

BFN EPU – Acceptance Review Issues

- Containment Accident Pressure Credit Elimination
  - Residual Heat Removal Heat Exchanger Thermal Performance Testing

Unit 1	1A	1B	1C	1D
Fouling Resistance (hr-ft^2-F/Btu) or Date of Test	12/02/2015	03/02/2016	12/02/2015	03/02/2016
Unit 2	**2A**	**2B**	**2C**	**2D**
Fouling Resistance (hr-ft^2-F/Btu) or Date of Test	0.001107	01/06/2016	0.000820	01/06/2016
Unit 3	**3A**	**3B**	**3C**	**3D**
Fouling Resistance (hr-ft^2-F/Btu) or Date of Test	0.000516	0.000519*	0.000674	0.000595*

  - EPU Design Fouling Resistance is 0.001521
  - EPU Nominal Fouling Resistance (Fire Event) is 0.001097

* Preliminary results

BFN EPU – Acceptance Review Issues

- Spent Fuel Pool Criticality Analysis
  - Fuel Uprate Safety Analysis Report (FUSAR) (EPU LAR Attachment 8) section 2.8.6.2 addresses spent fuel storage
    - Summarizes results of the criticality safety analyses (CSA) of record
    - AREVA fuel types that will reside in EPU cores evaluated
  - BFN CSA reports comply with the requirements of DSS-ISG-2010-01, *Staff Guidance Regarding the Nuclear Safety Analysis for Spent Fuel Pools*
  - CSAs included sensitivity studies for parameters potentially affected by EPU
    - Power density sensitivity
      - ± 50% variation in power density for a fixed void fraction
      - Higher power density resulted in lower in rack k-infinity (k_∞)
    - Void history sensitivity
      - Range of void histories between 0% and 90% studied
      - Limiting void history used in the CSA
      - High void history not limiting (typically 0% void history limiting)
    - Control history sensitivity
      - Uncontrolled history produces the limiting result
      - No EPU impacts

BFN EPU – Acceptance Review Issues

- Spent Fuel Pool Criticality Analysis (continued)
  - Fuel temperature sensitivity
    - ± 100°F variation in fuel temperature
    - In rack k_∞ shown to be insensitive to operating fuel temperature
  - Power shape sensitivity
    - No impact from EPU
    - Lattices evaluated at the limiting exposure and void history combination
  - Pool temperature sensitivity
    - Higher decay heat from EPU operation could raise pool temperature
    - Evaluation showed minimum pool temperature limiting
- Conclusions
  - Parameters potentially affected by EPU operation studied
  - CSA reports of record are applicable and conservative for EPU

BFN EPU – Acceptance Review Issues

- Spent Fuel Pool Criticality Analysis (continued)
  - Additional controls to prevent criticality during fuel movement
    - Reactor Engineering creates Fuel Assembly Transfer Form (FATF), based on CSA
    - Fuel moves are verified and tracked to be in accordance with FATF by the following
      - Performer
      - Concurrent Verifier
      - A Senior Reactor Operator on the refuel bridge
      - A Reactor Engineer on the refuel floor
      - Separate individual at a remote location using installed camera on refueling bridge
      - A Licensed Operator in the Control Room
    - FATF requirements are input into the Bridge and Trolley Tracking System (BATTS) prior to fuel movement
      - BATTS provides alternate indication/alarm when performing fuel movements in the reactor core or spent fuel pool

BFN EPU – Acceptance Review Issues

- Analysis Code MICROBURN-B2
  - AREVA identified an issue with the MICROBURN-B2 analysis
    - Related to convergence of the thermal hydraulic solution at low core flows
    - Affects the version of the code used to support the BFN EPU LAR
  - Nature of the issue
    - Calculation of the bypass flow at low core flow conditions can oscillate between two values without reaching convergence (maximum iterations reached)
      - Presence of voiding in the upper bypass creates the convergence difficulties
    - Code will continue to run with the unconverged hydraulic solution
    - Results in the axial power shape not being correct in MICROBURN-B2
    - Problem observed for core flows < 40% of rated
  - Extent of condition
    - Investigations show the thermal hydraulic stability analysis is affected
      - Incorrect axial power shape affects stability results
    - Flow dependent Critical Power Ratio (CPR) and Linear Heat Generation Rate limits include cases below 40% core flow
      - Evaluations show these two analyses are not affected for EPU LAR
    - All other analyses in the EPU LAR that involve MICROBURN-B2 are performed at core flows of 50% and higher
    - FUSAR and Unit 3 Cycle 19 EPU Representative Reload Report affected

BFN EPU – Acceptance Review Issues

- Analysis Code MICROBURN-B2 (continued)
  - Effect on FUSAR (ANP-3403P) (EPU LAR Attachment 8)
    - Generic Delta Critical Power Ratio (CPR) over Initial Minimum CPR (MCPR) Versus Oscillation Magnitude (DIVOM) line presented in Figure 2.8-3 will still be bounding
      - Calculated points below the line will change slightly
    - Small changes to decay ratio values in Tables 2.8-2 and 2.8-3
      - Backup Stability Protection region boundaries remain the same
    - Operating limit CPR values presented in Table 2.8-1 will decrease slightly
      - Values in current FUSAR report are conservative
      - Stability will continue to not set the overall CPR operating limit when the analysis is rerun
  - Effect on Unit 3 Cycle 19 EPU Representative Reload Report (ANP-3404P) (EPU LAR Attachment 20)
    - Operating limit CPR values presented in Table 4.3 decrease slightly
      - Values in current revision of the report are conservative
      - Stability will continue to not set the overall CPR operating limit when the analysis is rerun
  - Corrective actions to prevent recurrence
    - Improved convergence scheme in MICROBURN-B2 for low flow cases
    - Message will be written to error file if the condition should occur

BFN EPU – Acceptance Review Issues

- Analysis Code MICROBURN-B2 (continued)
  - AREVA identified a second issue during investigation of the MICROBURN-B2 flow convergence problem
    - Related to application of the void quality correlation at low core flows
  - Nature of the issue
    - Void quality correlation used in the EPU LAR work has a low mass flux cutoff
    - Cutoff is used to preclude non-physical results for calculations where very high quality conditions may occur (Anticipated Transient Without Scram with Core Instability)
    - Cutoff may not be appropriate for calculations with low to moderate quality conditions
  - Extent of condition
    - Similar to the flow convergence issue, stability analysis may be affected
      - Difference in results is on the order of normal cycle to cycle variation in results
    - Other events at low flow shown not to be affected by this issue
    - FUSAR and Unit 3 Cycle 19 EPU Representative Reload Report affected
  - Corrective actions to prevent recurrence
    - Issue still in discovery
    - Corrective actions will be defined when discovery has been completed

BFN EPU – Acceptance Review Issues

- Analysis Code MICROBURN-B2 (continued)
  - Browns Ferry EPU LAR Supplement
    - Interim Report, addressing both issues, expected to be submitted by November 9, 2015
      - Supports continuing EPU LAR acceptance reviews
    - Revised FUSAR and Unit 3 Cycle 19 EPU Representative Reload Report, addressing both issues, expected to be submitted by December 15, 2015

BFN EPU – Acronym List

- ACRS – Advisory Committee on Reactor Safeguards
- ASBs – Acoustic Side Branches
- ATWS – Anticipated Transient Without Scram
- AVSs – Acoustic Vibration Suppressors
- BATTS – Bridge and Trolley Tracking System
- BFN – Browns Ferry Nuclear Plant
- Btu – British Thermal Unit
- BWR – Boiling Water Reactor
- BWROG – BWR Owners' Group
- CAP – Containment Accident Pressure
- CDF – Core Damage Frequency
- CPR – Critical Power Ratio
- CRDA – Control Rod Drop Accident
- CSA – Criticality Safety Analysis
- DIVOM – Delta CPR over Initial MCPR Versus Oscillation Magnitude
- ECCS – Emergency Core Cooling System
- EHPMP – Emergency High Pressure Makeup Pump
- EPU – Extended Power Uprate
- F – Farenheit
- FATF – Fuel Assembly Transfer Form
- ft^2 – square feet
- FUSAR – Fuel Uprate Safety Analysis Report
- FIV – Flow Induced Vibration
- GDC – General Design Criteria
- hr – hour
- HX – Heat Exchanger
- Hz – Hertz
- IER – INPO Event Report
- IN – Information Notice
- INPO – Institute of Nuclear Power Operations
- LA – License Amendment
- LAR – License Amendment Request
- LERF – Large Early Release Frequency
- MAPLHGR – Maximum Average Planar Linear Heat Generation Rate
- MCPR – Minimum Critical Power Ratio
- MSL – Main Steam Line
- MWt – Megawatt Thermal
- NPSH – Net Positive Suction Head
- NRC – Nuclear Regulatory Commission
- OE – Operating Experience
- PCMI – Pellet-to-Cladding Mechanical Interaction
- PM – Preventive Maintenance
- PRA – Probabilistic Risk Assessment
- PUSAR – Power Uprate Safety Analysis Report
- RAI – Request for Additional Information
- RHR – Residual Heat Removal
- RSD – Replacement Steam Dryer
- SDAR – Steam Dryer Analysis Report
- SE – Safety Evaluation
- SER – Significant Event Report
- SLO – Single Loop Operation
- SRP – Standard Review Plan
- SRV – Safety Relief Valve
- TIP – Traversing Incore Probe
- UFSAR – Updated Safety Analysis Report

BFN EPU – Questions/Comments