Browns Ferry Nuclear Plant

Extended Power Uprate License Amendment Request Containment Accident Pressure Credit Elimination

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BFN EPU – Agenda

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Overview and Schedule	G. Doyle
Containment Accident Pressure (CAP) Credit Elimination	D. Green/P. Donahue
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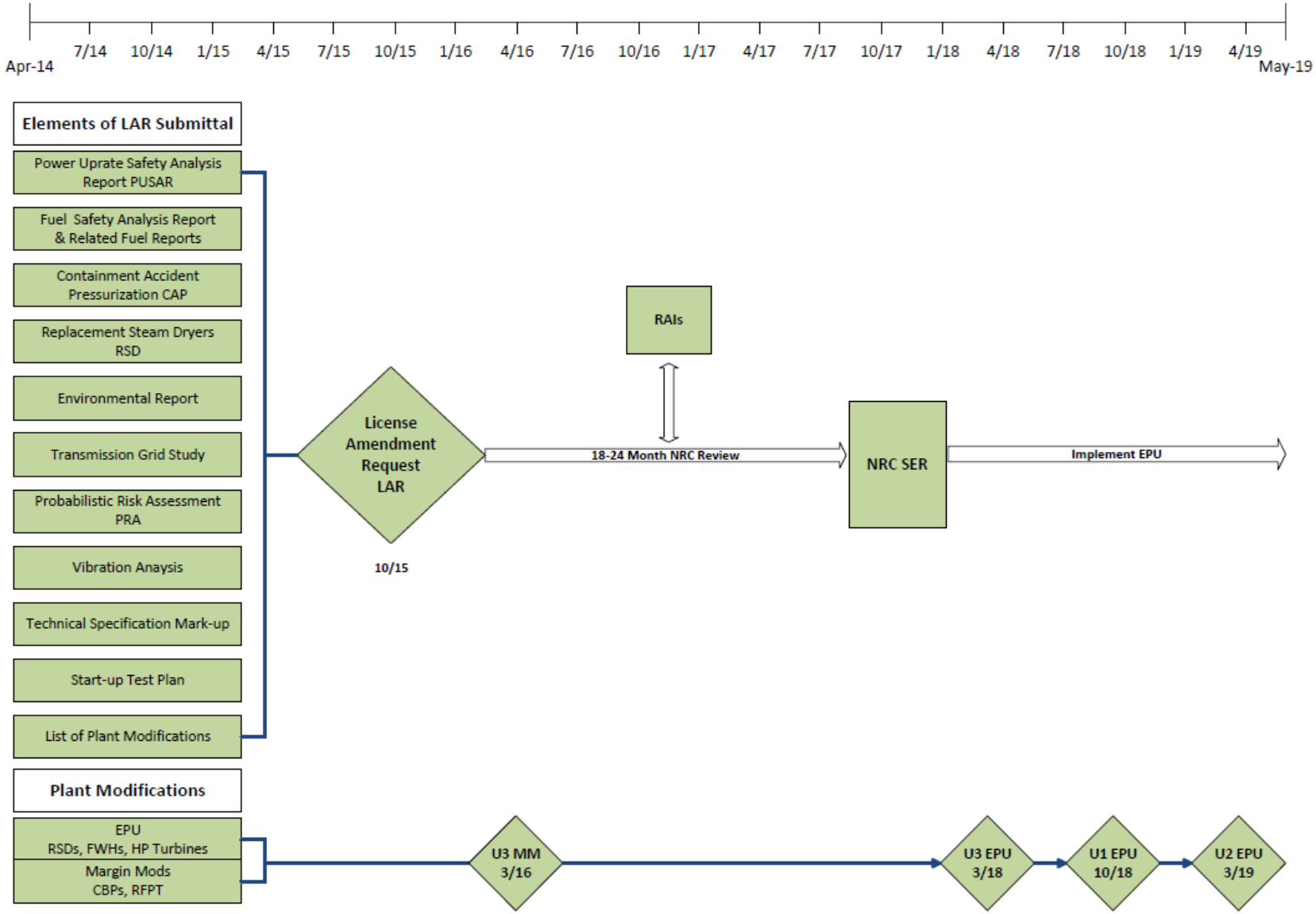
BFN EPU – Overview and Schedule

- New consolidated Browns Ferry Extended Power Uprate (EPU) License Amendment Request (LAR) submittal
  - Supersedes previous Brown Ferry EPU submittals
    - Addresses current Browns Ferry conditions and licensing basis (e.g., AREVA ATRIUM 10XM fuel type)
  - Uses the format of RS-001, Review Standard for Extended Power Uprates
  - Addresses previous applicable NRC Requests for Additional Information (RAIs)
  - Applies improved submittal verification process to ensure completeness and accuracy

BFN EPU – Overview and Schedule



BFN EPU – Overview and Schedule

- We are here to present and discuss our position for addressing Emergency Core Cooling System (ECCS) pump Net Positive Suction Head (NPSH) analyses and CAP credit elimination issues in order to preclude impact to the Browns Ferry EPU LAR review
  - EPU NPSH analyses developed consistent with existing guidance
    - Includes consideration of the guidance provided in SECY-11-0014, Use of Containment Accident Pressure in Analyzing Emergency Core Cooling System and Containment Heat Removal System Pump Performance in Postulated Accidents
    - Previous Browns Ferry EPU LARs (now withdrawn) included CAP credit
      - CAP will not be credited in the new EPU LAR

BFN EPU – CAP Credit Elimination

Background

June 2004	TVA submits EPU LARs for BFN Units 2/3 and Unit 1
February 2007	ACRS first raises concerns with BFN crediting Containment Accident Pressure (CAP)
August 2007 - August 2009	TVA responds to 89 NRC Requests for Additional Information regarding crediting CAP
September 2009	NRC letter to TVA indicates additional time is needed to develop additional guidance to address EPU issues with CAP
December 2010	During meeting with NRC, TVA discusses actions taken to address CAP issue at BFN • Analysis performed using NRC draft guidance to identify and evaluate strategies to address CAP for all events
May 2011	NRC letter to TVA indicates that CAP review criteria (SECY-11-0014) was available and that NRC was prepared to resume review of EPU LARs
September 2011	During meeting with NRC, TVA discussed plans to eliminate credit for CAP in the EPU LAR • NRC recommended that licensees preparing to apply draft guidance should communicate with NRC prior to preparing written documentation so that the most current position on the guidance can be incorporated
November 2012	TVA letter to NRC provides status of EPU LARs • Includes status of revision to EPU CAP analysis to incorporate criteria in SECY-11-0014 • Indicates that prior to submittal of results of the CAP analysis, TVA will request meeting with NRC to discuss the plans for evaluation of CAP
February 2013	TVA letter to NRC states plan to revise CAP analysis, complete replacement steam dryer analysis, and revise the BFN EPU LARs, as necessary
February 2014	Due to lack of activity associated with BFN EPU LARs, NRC closes BFN EPU LAR TAC numbers
June 2014	During drop-in visit with NRC, TVA introduced new EPU Project Team and discussed strategy with BFN Project Manager, EPU PM and Branch Chief • Stated new consolidated LAR would include resolution of CAP issues in accordance with SECY-11-0014
September 2014	TVA letter to NRC withdrew previous EPU LARs • Stated new consolidated EPU LAR would be submitted in October 2015 and would include revised CAP analysis that incorporates current NRC review criteria • Stated upon completion of the revised EPU CAP analysis, TVA will propose meeting with NRC to discuss analysis and results

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Regulatory Alignment

- Current Licensing Basis
  - Browns Ferry currently credits CAP
  - Regulatory Guide 1.82, Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident

- For EPU, analyses follow
  - Constant Pressure Power Uprate (CPPU) Licensing Topical Report (NEDC-33004P, Constant Pressure Power Uprate) guidance
  - RS-001 (Section 2.6.5) guidance
  - NRC draft guidance on CAP per SECY-11-0014
  - NRC communication that 21% uncertainty margin is acceptable in lieu of a plant specific uncertainty evaluation
    - Reference Turkey Point EPU – Containment and Ventilation Branch (SCVB) Request for Additional Information – Round 1.2 (Part 2), SCVB-1.2.4 (ML11119A002)

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Methodology

- In accordance with Regulatory Guide 1.82
  - Used NRC approved codes
    - SHEX
    - ODYN/STEMP for Anticipated Transients Without Scram (ATWS) analysis

Event Type (per SECY-11-0014)	Event Description	Pumps Credited in Limiting Analysis			
		RHR	CS	HPCI	RCIC
Design Basis Accident (DBA)-Loss-of-Coolant Accident (LOCA)	Short-term (first 10 minutes)	Yes	Yes	No	No
	Long-term (beyond 10 minutes)	Yes	Yes	No	No
Special Events	Fire Event	Yes	No	No	No
	ATWS	Yes	No	Yes	Yes
	Station Blackout (SBO)	Yes	No	Yes	Yes

- Event-specific Net Positive Suction Head Available (NPSHa) time history developed for each credited pump
- NPSHa compared to Net Positive Suction Head Required (NPSHr) for each credited pump

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Key Changes/Modifications

Events	Key Changes/Modifications
DBA-LOCA Short-Term (0 - 10 minutes)	➢ Included ECCS pump suction ring header and Residual Heat Removal (RHR) piping volumes ➢ NPSHr 3% curves (RHR and CS) + 21% uncertainty ➢ ECCS pump flow rates are from safety analysis (ECCS performance - fuel)
DBA-LOCA Long-Term (beyond 10 minutes)	➢ More accurate RHR HX fouling ➢ NPSHr 3% curves (RHR and CS) + 21% uncertainty
SBO	➢ More accurate RHR HX fouling ➢ NPSHr 3% curves (RHR)
ATWS (Peak Suppression Pool Temperature)	➢ Increase Standby Liquid Control (SLC) System Boron Enrichment ➢ More accurate RHR HX fouling ➢ NPSHr 3% curves (RHR)
Fire Event	➢ Nominal RHR HX fouling ➢ Nominal initial suppression pool volume (level) ➢ NPSHr 3% curves (RHR)

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Key Assumptions

- DBA-LOCA
  - Vendor supplied NPSHr (3%) curves
  - 21% uncertainty included in NPSH margin per SECY-11-0014
  - Conservative Technical Specification (TS) inputs
    - TS maximum initial suppression pool temperature
    - TS maximum Residual Heat Removal Service Water (RHRSW) (river water) temperature
    - TS minimum initial suppression pool volume (level)
  - Modified design RHR Heat Exchanger (HX) Heat Removal Capability

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Key Assumptions (continued)

- Non-LOCA events
  - Vendor supplied NPSHr (3%) curves
  - 0% uncertainty included in NPSH margin per SECY-11-0014
  - ATWS and SBO
    - Conservative TS inputs
      - TS maximum initial suppression pool temperature
      - TS maximum RHRSW (river water) temperature
      - TS minimum initial suppression pool volume (level)
    - Modified design RHR HX Heat Removal Capability
  - Fire Event
    - Conservative TS inputs
      - TS maximum initial suppression pool temperature
      - TS maximum RHRSW (river water) temperature
    - Nominal initial suppression pool volume (torus level)
      - per SECY-11-0014
    - Nominal RHR HX heat removal capability (HX K value)
      - per SECY-11-0014

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RHR HX Fouling

- RHR HX K value used in containment analyses
  - Current Licensed Thermal Power (CLTP) analysis basis: 223 Btu/sec/°F
  - EPU analysis basis: 265 Btu/sec/°F
- Corresponding RHR HX Fouling Resistance
  - Original Design: 0.002801 hr-ft^2-°F/Btu
  - EPU Design: 0.001521 hr-ft^2-°F/Btu (preliminary)
- Different events may have heat exchanger flow rates different from the base case
  - Where that occurs, the EPU modified design fouling resistance is maintained constant and an event specific K value is calculated
  - A common (EPU design) material condition is thereby the basis for the RHR HX K value used in each event
  - The only event using a nominal RHR HX K value (as allowed by SECY-11-0014) is the Fire Event
  - All other events were conservatively analyzed using a K value based on the EPU design fouling resistance

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RHR HX Fouling (continued)

- Lower RHR HX fouling resistance capability maintained by the Generic Letter 89-13 Program
- Performance tests performed on four RHR HXs support using the lower fouling resistance
  - RHR HXs were selected for testing based on longest time between cleaning and worst case macro fouling observations
- Industry operating experience
  - Similar plant RHR HX configuration and design incorporated lower fouling factors to support elimination of crediting CAP

BFN EPU – CAP Credit Elimination

Preliminary Results

Event / Pump	RHR HX K value	PPT (°F)	NPSHa (ft)	$NPSHr_{eff}$ (ft)[1]	Margin (ft)
DBA-LOCA Short-Term / RHR	N/A	152.0	27.4	24.2	3.2
DBA-LOCA Short-Term / CS			28.3	24.2	4.1
DBA-LOCA Long-Term / RHR	265	178.9	29.0	20.6	8.4
DBA-LOCA Long-Term / CS			26.4	24.2	2.2
SBO / RHR	265	203.7	18.3	17.0	1.3
ATWS / RHR	277	173.3	29.6	17.0	12.6
Fire Event / RHR	307	208.2	16.04	16.0	0.04
SBO, ATWS / High Pressure Coolant Injection (HPCI)	N/A[2]	N/A[2]	63.0	18.8	44.2
SBO, ATWS / Reactor Core Isolation Cooling (RCIC)	N/A[2]	N/A[2]	75.1	22.7	52.4

Notes:

1. $NPSHr_{effective\ (eff)}$ values consistent with SECY-11-0014 draft guidance ($NPSHr_{eff}$ = NPSHr 3% + uncertainties), includes 21% uncertainty adder for DBA-LOCA Cases and 0% adder for Special Events (per SECY-11-0014)
2. Suction for HPCI and RCIC pumps from Condensate Storage Tank

BFN EPU – Acronyms

- ATWS – Anticipated Transient Without Scram
- BTU – British Thermal Unit
- CAP – Containment Accident Pressure
- CLTP – Current Licensed Thermal Power
- CPPU – Constant Pressure Power Uprate
- CS – Core Spray
- DBA – Design Basis Accident
- ECCS – Emergency Core Cooling System
- eff – effective
- EPU – Extended Power Uprate
- F – Farenheit
- ft – feet
- gpm – gallons per minute
- HCTL – Heat Capacity Temperature Limit
- HPCI – High Pressure Coolant Injection
- hr – hour
- HX – Heat Exchanger
- LAR – License Amendment Request
- LOCA – Loss-of-Coolant Accident
- LPCI – Low Pressure Coolant Injection
- LTR – Licensing Topical Report
- N/A – Not applicable
- NFPA – National Fire Protection Association
- NPSH – Net Positive Suction Head
- NPSHa – Net Positive Suction Head Available
- NPSHr – Net Positive Suction Head Required
- PPT – Peak Suppression Pool Temperature
- RCIC – Reactor Core Isolation Cooling
- RDLB – Recirculation Discharge Line Break
- RHR – Residual Heat Removal
- RHRSW – Residual Heat Removal Service Water
- RSLB – Recirculation Suction Line Break
- SCVB – Containment and Ventilation Branch
- sec – second
- SLC – Standby Liquid Control
- TS – Technical Specifications

BFN EPU – Questions/Comments