



Browns Ferry Nuclear Plant

Maximum Extended Load Line Limit Analysis Plus License Amendment Request

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Browns Ferry Nuclear Plant (BFN) MELLRA+ LAR Agenda

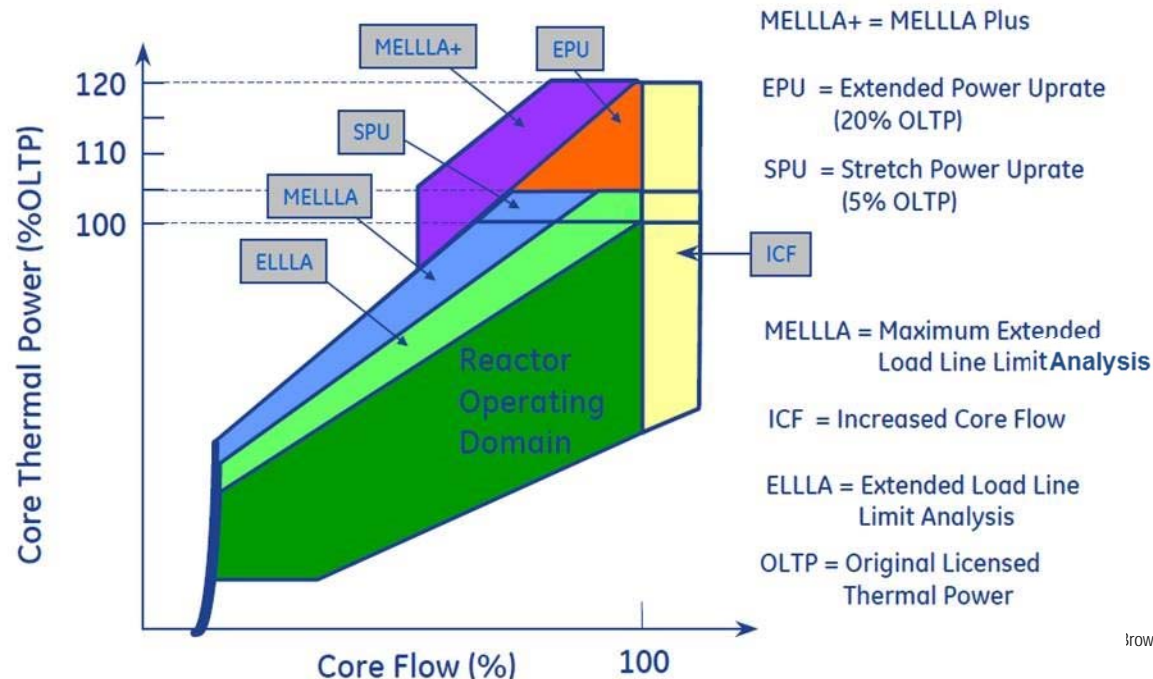
- Introductions P. Donahue
- Background B. Baker
- LAR Overview D. Green
- Electronic Reading Room D. Green
- MELLRA+ Analyses Comparison – BFN to Brunswick M. Dick/G. Storey
 - Tennessee Valley Authority Scope Analyses
 - GEH Scope Analyses
 - AREVA/Framatome Scope Analyses
- Questions/Comments P. Donahue

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Background

- Extended Power Uprate (EPU) power levels restrict flow window
 - Maximum Extended Load Line Limit Analysis (MELLLA) rod line extrapolated to EPU power
 - Licensed flow window reduced: 99% - 105% core flow at rated EPU power
 - Administrative margin would limit operating flow window: 100% - 104% range
- MELLLA Plus (MELLLA+) raises the maximum allowed rod line
 - Licensed flow window: 85% - 105% core flow at rated EPU power

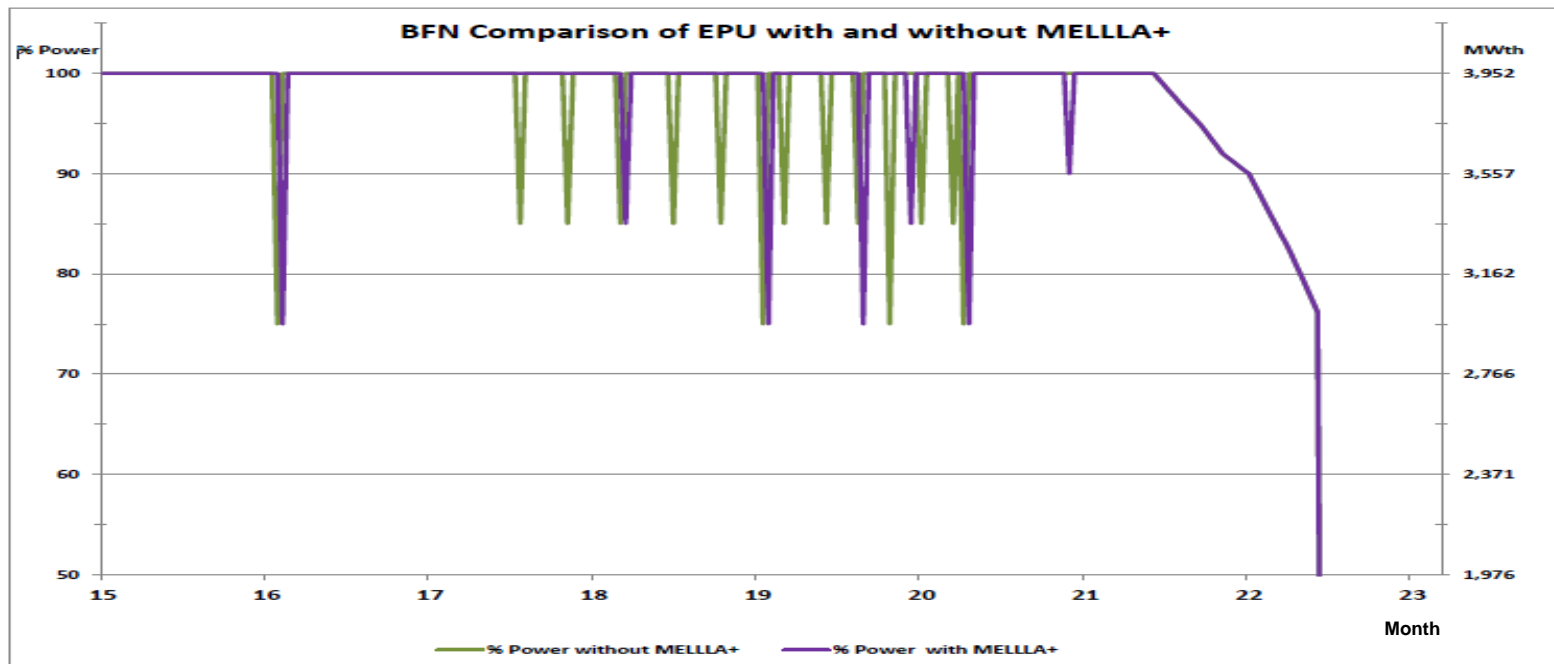
MELLLA+ Boundary



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Background (continued)

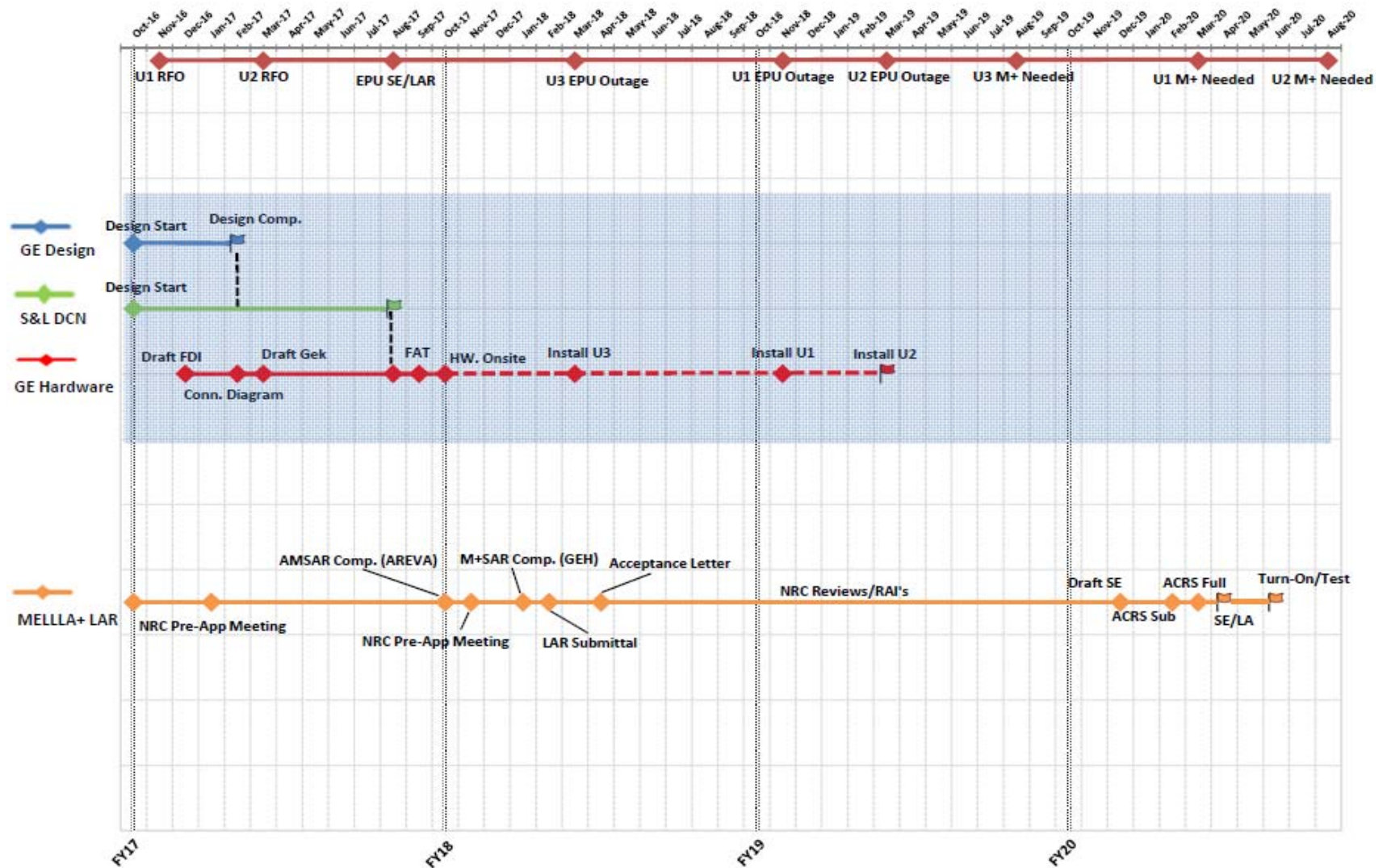
- Expands nominal core flow window at EPU conditions
 - Reduction in number of near end of cycle down-powers
 - Fewer control rod manipulations required to manage reactivity



- Provides improved core instability algorithm - Detect and Suppress Solution – Confirmation Density (DSS-CD)
- Increases station capacity factor during the operating cycle

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Background (continued)



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LAR Overview

- Renewed Facility Operating License and Technical Specifications (TS) Changes
 - New License Condition to prohibit operation at reduced Feedwater (FW) temperature in MELLLA+ operating domain
 - TS 3.3.1.1, Reactor Protection System (RPS) Instrumentation -
 - Actions changed to reflect implementation of DSS-CD stability solution
 - Deleted Surveillance Requirement associated with verifying OPRM is not bypassed due to implementation of DSS-CD stability solution
 - Revised Oscillation Power Range Monitor (OPRM) Upscale Applicability to reflect implementation of DSS-CD stability solution
 - Revised Allowable Value for APRM Flow Biased Simulated Thermal Power – High Function
 - TS 3.4.1, Recirculation Loops Operating - Added Note and Actions to prohibit single loop operation in the MELLLA+ operating domain
 - TS 5.6.5, Core Operating Limits Report (COLR) - Revised to reflect implementation of DSS-CD stability solution
 - TS 5.6.7, OPRM Report - Added to reflect implementation of DSS-CD stability solution

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LAR Overview (continued)

- General Electric - Hitachi (GEH) MELLLA+ Safety Analysis Report (M+SAR)
 - Provides results of safety analyses and evaluations performed that support operation under MELLLA+ conditions
 - Technical evaluations supporting proposed MELLLA+ operation are based on Nuclear Regulatory Commission (NRC)-approved MELLLA+ Licensing Topical Report (NEDC-33006P-A), including associated Limitations and Conditions
 - Addresses Limitations and Conditions of the NRC-approved Interim Methods Licensing Topical Report (NEDC-33173P-A) and NRC-approved DSS-CD Licensing Topical Report (NEDC-33075P-A)
 - For certain fuel analyses, the technical evaluations are provided in the AREVA MELLLA+ Safety Analysis Report (AMSAR) and fuel analysis related reports
 - Addresses the addition of the DSS-CD stability algorithm, including setpoints, diversity, armed region, and backup stability protection
(Includes information to address Brunswick Requests for Additional Information (RAIs) SRXB-RAI-1, -2, and -3)
 - Includes demonstration that Containment Accident Pressure (CAP) credit is not required to ensure adequate Net Positive Suction Head (NPSH) for Emergency Core Cooling System (ECCS) pumps under MELLLA+ conditions
(Included to address Pre-application Meeting feedback and Brunswick RAIs)

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LAR Overview (continued)

- Provides Anticipated Transient Without Scram with Instability (ATWS-I) Analysis
 - GEH explicitly analyzed ATRIUM 10XM fuel for ATWS-I
 - Treatment of uncertainties associated with modeling AREVA fuel follows the conservative approach used for Brunswick
 - Demonstrates that coolable geometry is maintained
(Brunswick LAR includes similar approach)
 - Addresses NRC concerns with Minimum Stable Film Boiling Correlation (T_{\min})
 - ATWS-I results provided using the current T_{\min} correlation in TRACG (i.e., modified Shumway)
 - Sensitivity analysis results using the homogeneous nucleation T_{\min} model are also provided, including an assessment that coolable geometry is maintained
(Included to address Brunswick RAI SRXB-RAI-7)

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LAR Overview (continued)

Note: AREVA nuclear reactor operations was recently renamed Framatome - for the purposes of this presentation, AREVA should be considered synonymous with Framatome

- AMSAR and Fuel Analysis Related Reports
 - Similar to Power Uprate Safety Analysis Report/Fuel Uprate Safety Analysis Report approach of BFN EPU LAR
 - Supplements the M+SAR and summarizes the results of fuel related safety analyses and evaluations performed to support proposed operation under MELLLA+ conditions
(Brunswick LAR includes both GEH and AREVA/Framatome scope evaluations in a single document)
 - Includes Appendices addressing applicable Limitations and Conditions of associated MELLLA+ and Interim Methods Licensing Topical Reports
 - MELLLA+ LAR also includes AREVA/Framatome fuel analysis related reports
 - No new AREVA/Framatome methods required for MELLLA+ analyses and evaluations
 - Reports updated to consider EPU and MELLLA+ conditions
 - AREVA/Framatome fuel analysis related reports similar to recent BFN fuel transition LARs and BFN EPU LAR
 - Transition cycle design report
 - Basis of representative Reload Report analyses
 - EPU transition core re-depleted at MELLLA+ conditions
(Included to address BFN transition cores)
 - Equilibrium cycle ATRIUM 10XM design report
 - Basis of AMSAR fuel related analyses
 - EPU equilibrium core re-depleted at MELLLA+ conditions
(Brunswick LAR includes similar report)

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LAR Overview (continued)

- AREVA/Framatome fuel analysis related reports similar to recent BFN fuel transition LARs and BFN EPU LAR
 - Reload Analysis Report (transition cycle based)
 - Full representative reload evaluation
(Brunswick LAR includes similar report which addresses ATRIUM 10XM fuel, BFN report addresses ATRIUM 10 and ATRIUM 10XM fuel)
(Brunswick report includes reference to disposition of events table, BFN report includes disposition of events table)
 - Fuel rod thermal mechanical report
 - Demonstrates application of RODEX4 to BFN at MELLLA+ conditions
(Included to address potential RAIs – Brunswick RAI SNPB-RAI-1)
 - Fuel thermal hydraulic report
 - Demonstrates continued acceptability of thermal hydraulic performance of ATRIUM 10XM and legacy ATRIUM 10 fuel at MELLLA+ conditions
(Included to address BFN transition cores)
 - Safety Limit Minimum Critical Power Ratio (SLMCPR) Report
 - Performed for representative transition core using SAFLIM3D
(Brunswick addresses this topic in their integrated M+SAR)
 - Methods applicability report
 - Plant specific demonstration of AREVA/Framatome methods applicability at MELLLA+ conditions
 - Update to prior supplements of ANP-2860, Browns Ferry Unit 1 – Summary of Responses to Request for Additional Information, Extension to use ATRIUM 10XM Fuel for Extended Power Uprate
 - Also provides data to support removal of SLMCPR adder required by Limitation and Condition 9.5 of the GEH Methods Licensing Topical Report (NEDC-33173P-A, Applicability of GE Methods to Expanded Operating Domains)
(Brunswick includes similar report, BFN report updated to address Brunswick RAI SRXB-RAI-12 (SLMCPR adder))

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LAR Overview (continued)

- AREVA/Framatome fuel analysis related reports similar to recent BFN fuel transition LARs and BFN EPU LAR (continued)
 - Loss of Coolant Accident (LOCA)
 - New break spectrum analysis at MELLLA+ conditions
 - ATRIUM 10XM fuel based
 - Break spectrum and ATRIUM 10XM fuel Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) reports included in LAR
(Brunswick LAR includes similar report, BFN report provide more results based on past BFN LOCA break spectrum reports provided to NRC)
 - Legacy ATRIUM 10 LOCA approach (same approach as used for EPU)
 - LOCA system response from the MELLLA+ based ATRIUM 10XM analysis will be used to drive ATRIUM 10 hot channel heatup
 - ATRIUM 10XM break spectrum is applicable because the two fuel types are closely matched thermal hydraulically
 - MAPLHGR report for ATRIUM 10 provided
(Included to address BFN transition cores)
 - Treatment of 10 CFR 50.46c Issues
 - Same approach as included in BFN EPU LAR
 - Update 10 CFR 50.46c evaluation presented in ANP-3409, Fuel-Related Emergent Regulatory Issues, for MELLLA+ conditions
(Included consistent with BFN EPU LAR)
 - Treatment of Reactivity Initiated Accidents (RIAs)
 - RIA will be evaluated with NRC-approved methodology
 - 230 Calorie limit will be imposed for fuel fragmentation
 - For BFN EPU LAR, an additional conservative RIA evaluation was presented in ANP-3409, Fuel-Related Emergent Regulatory Issues
 - Similar evaluation performed for MELLLA+ and updated for latest draft criteria
(Included to address potential RIAs – Brunswick RAI SNPB-RAI-2)

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LAR Overview (continued)

- Differences Between BFN Units Potentially Impacting MELLLA+ Analyses
 - During the NRC acceptance review of the Brunswick MELLLA+ LAR, this information was requested
 - Describes differences between BFN units that could impact MELLLA+ analyses and evaluations
 - Includes discussion of how these differences were addressed in the BFN MELLLA+ analyses and evaluations
 - e.g., use of bounding or representative values in analyses or performing separate analyses for different configurations

(Included to address Brunswick MELLLA+ LAR Acceptance Review issue)

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LAR Overview (continued)

- Basis for FW Temperature Reduction Input Parameter Values for BFN MELLLA+ Anticipated Transient Without Scram with Instability (ATWS-I) Analysis
 - During NRC audit of Brunswick MELLLA+ LAR analyses, NRC requested this information from Brunswick
 - Provides detailed basis for FW temperature reduction rate used in analysis
 - BFN plant trip data utilized

(Included to address Brunswick RAI SRXB-RAI-8)
- BFN-specific responses to issues identified in Brunswick RAIs
 - Including a comparison of steady state modeling and benchmarking results of the BFN equilibrium core from the AREVA/Framatome computer code MICROBURN-B2 and the GEH computer code PANAC11
(MELLLA+ LAR Attachments 34 and 35)
(Included to address Brunswick RAI SRXB-RAI-11)
 - Remainder of applicable Brunswick RAIs not already included in other BFN MELLLA+ LAR Attachments
 - SRXB-RAI-4, -5, -6, -7, -9, and -10
 - SNPB-RAI-3, -4, and -7

(MELLLA+ LAR Supplement 1)
(Included to address Brunswick RAIs)

BFN MELLA+ LAR

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 docketed submittals or RAIs
 - Normal NRC process will be used for docketed submittals and RAIs
- URL for reading room portal (same as BFN EPU reading room portal)
 - <https://bfepurr.certrec.com>
- Access to reading room restricted to those NRC personnel granted access
- 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 and reviewer) informing them that information is available for review
 - If, after reviewing the reading room file, NRC determines information from file is needed, TVA will submit the required information on the docket

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MELLLA+ Analyses Comparison – BFN to Brunswick

- Tennessee Valley Authority Scope Analyses

- High Energy Line Break (HELB)

- Standard approach used by GEH for dispositioning Reactor Water Cleanup (RWCU) HELBs under MELLLA+ conditions is to take advantage of the station's existing Final Feedwater Temperature Reduction (FFWTR) and/or Feedwater Heater Out of Service (FWHOOS) HELB analyses
- MELLLA+ core inlet subcooling at statepoint of 77.6% power/ 55% core flow not bounded by EPU power with FFWTR in the MELLLA domain.
- As a result, RWCU HELB analyses needed to reflect EPU under MELLLA+ conditions were performed and results summarized in M+SAR

(Brunswick existing HELB analyses bound MELLLA+ conditions, no new HELB analyses required)

- Containment Accident Pressure Credit

- Containment Accident Pressure (CAP) credit is not required to ensure adequate Net Positive Suction Head (NPSH) for Emergency Core Cooling System (ECCS) pumps under MELLLA+ conditions
- Consistent with Current Licensing Basis established with BFN EPU
- Only ATWS event suppression pool temperature response affected by MELLLA+
 - Large NPSH margin
- Supporting analyses described in M+SAR

(Brunswick LAR maintained Current Licensing Basis, which required credit for CAP)

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MELLLA+ Analyses Comparison – BFN to Brunswick

- GEH Scope Analyses

- AREVA/Framatome provided the following thermal hydraulic data to BFN for transmittal to GEH/GNF
 - Channel seal resistance
 - Core support plate resistance
 - Specific core and bundle-specific thermal-hydraulic results for four radial peaking factors and three axial power shapes at 100/100 and 54.3/37.3 power/flow conditions
 - Core pressure drop and bypass flow fractions for various power/flow and axial profiles

GNF used this data to create the ISCOR basedeck for ATRIUM 10XM used by GEH/GNF for analysis

(Brunswick created the ISCOR basedeck for ATRIUM 10XM and provided it to GEH/GNF for analysis)

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MELLLA+ Analyses Comparison – BFN to Brunswick

- AREVA/Framatome Scope Analyses

- BFN used minimum core flow for LOCA analysis
 - For BFN LOCA analysis, as discussed in the AMSAR, no credit taken for any setdown in thermal limits
 - Minimum core flow of 55% evaluated

(In Brunswick LOCA analysis, LOCA calculations in MELLLA+ region were performed and justified at a “transition” point rather than the minimum core flow of 55%, based on crediting off-rated thermal limits - both approaches comply with Limitation and Condition 12.10.a)

- BFN statistical data for SRVs supported 3% drift value assumption for all valves, with one SRV out-of-service, as bounding
 - BFN, based on statistical work, provided AREVA/Framatome with the 95/95 setpoints for the ATWS evaluation
 - ATWS calculations demonstrated that assuming 3% drift on all valves, with one SRV out-of-service, bounded the data provided by BFN
 - ATWS pressure limits were met

(Brunswick statistical data for SRV did not support 3% drift for all valves; Brunswick provided AREVA/Framatome with a different set of drift values for SRVs, consistent with plant-specific performance)

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MELLLA+ Analyses Comparison – BFN to Brunswick

- AREVA/Framatome Scope Analyses (continued)
 - BFN Representative Reload Safety Analysis Report based on ACE critical power correlation equivalent to ACE Revision 1
 - BFN current licensing basis ACE critical power correlation is ACE Revision 0 plus ANP-3140 (which is the plant-specific correction to ACE Revision 0)
 - ANP-3140 is equivalent to the ACE supplement that resulted in ACE Revision 1

(Brunswick Unit 1 Cycle 19 MELLLA+ Reload Analysis Report was based on critical power correlation ACE Revision 0)

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Acronym List

- AMSAR – AREVA MELLLA+ Safety Analysis Report
- ATWS – Anticipated Transient Without Scram
- ATWS-I – ATWS with Instability
- BFN – Browns Ferry Nuclear Plant
- CAP – Containment Accident Pressure
- COLR – Core Operating Limits Report
- DSS-CD – Detect and Suppress Solution – Confirmation Density
- ECCS – Emergency Core Cooling System
- ELLLA – Extended Load Line Limit Analysis
- EPU – Extended Power Uprate
- FFTWR – Final Feedwater Temperature Reduction
- FWHOOS – Feedwater Heater Out of Service
- FW – Feedwater
- GEH – General Electric - Hitachi
- GNF – Global Nuclear Fuels
- HELB – High Energy Line Break
- ICF – Increased Core Flow
- LAR – License Amendment Request
- LOCA – Loss of Coolant Accident
- MAPLHGR – Maximum Average Planar Linear Heat Generation Rate
- MELLLA – Maximum Extended Load Line Limit Analysis
- MELLLA+ – MELLLA Plus
- M+SAR – MELLLA+ Safety Analysis Report (GEH)
- NPSH – Net Positive Suction Head
- NRC – Nuclear Regulatory Commission
- OLTP – Original Licensed Thermal Power
- OPRM – Oscillation Power Range Monitor
- RAIs – Requests for Additional Information
- RIAs – Reactivity Initiated Accidents
- RPS – Reactor Protection System
- RWCU – Reactor Water Cleanup
- SLMCPR – Safety Limit Minimum Critical Power Ratio
- SPU – Stretch Power Uprate
- SRV – Safety Relief Valve
- T_{min} – Minimum Stable Film Boiling Correlation
- TS – Technical Specifications

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Questions/Comments