Brunswick Units 1 and 2 MELLLA+ Implementation

Pre-Application Meeting

January 08, 2013

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Brunswick Units 1 and 2 MELLLA+ Implementation

- Duke Participants
  - John Siphers
  - Roger Thomas
  - Jeff Boaz
  - Bill Murray
  - Charles Stroupe (Presenter)

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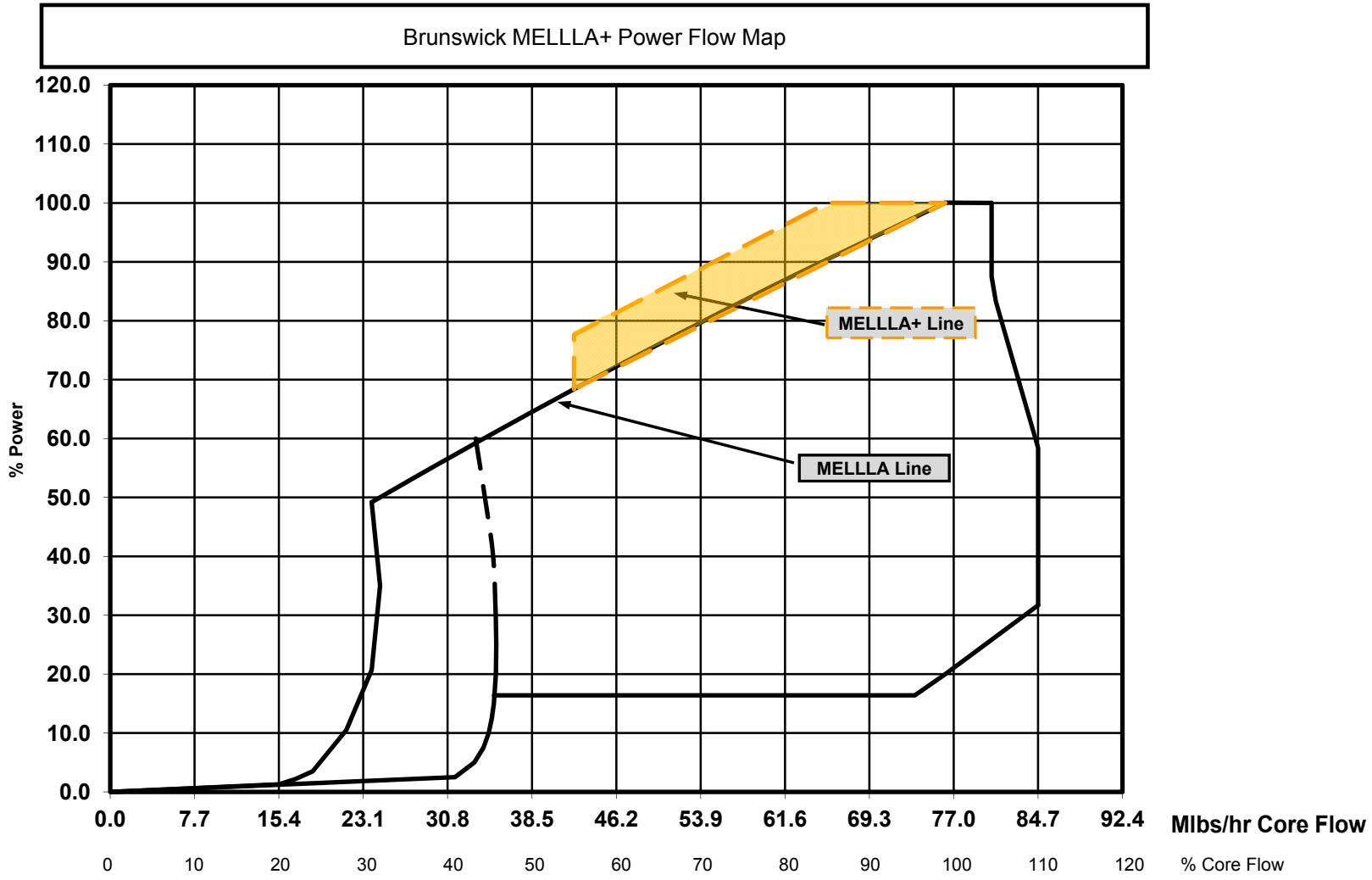
Agenda

- Introduction and Objectives
- MELLLA+ benefits for Brunswick (BSEP)
- Approach to fuel and plant licensing analysis strategy
- Approach to thermal hydraulic stability solution
- Approach to ATWS analysis
- Other MELLLA+ impacts
- Schedule
- Questions and answers

Objectives

- Identify benefits of MELLLA+ for Brunswick (BSEP)
- Looking for feedback on specific aspects of MELLLA+ implementation that are unique to BSEP
  - Use of two vendors and mixed vendor methodology
  - Use of AREVA's approved Enhanced Option III (EO-III) methodology for stability
  - Sample problem for LAR will be mixed core (A10XM & A10)
  - No change to existing Containment Accident Pressure (CAP) credit
  - No impact on Annulus Pressurization (AP) Loads
  - Project schedule

Introduction and Objectives
MELLLA+ overview



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MELLLA+ benefits for BSEP

- MELLLA+ will increase the full-power flow window
  - Current MELLLA flow window is 5.5%; MELLLA+ will extend the flow window to 19.5%
  - MELLLA+ reduces the number of down powers and rod improvements required to manage reactivity
- Operation at MELLLA+ conditions requires ~70% fewer power maneuvers to facilitate rod improvements than at MELLLA minimizing required rod improvements
- MELLLA+ provides the opportunity to increase the Standby Liquid Control (SLC) system capability by increasing the B-10 enrichment

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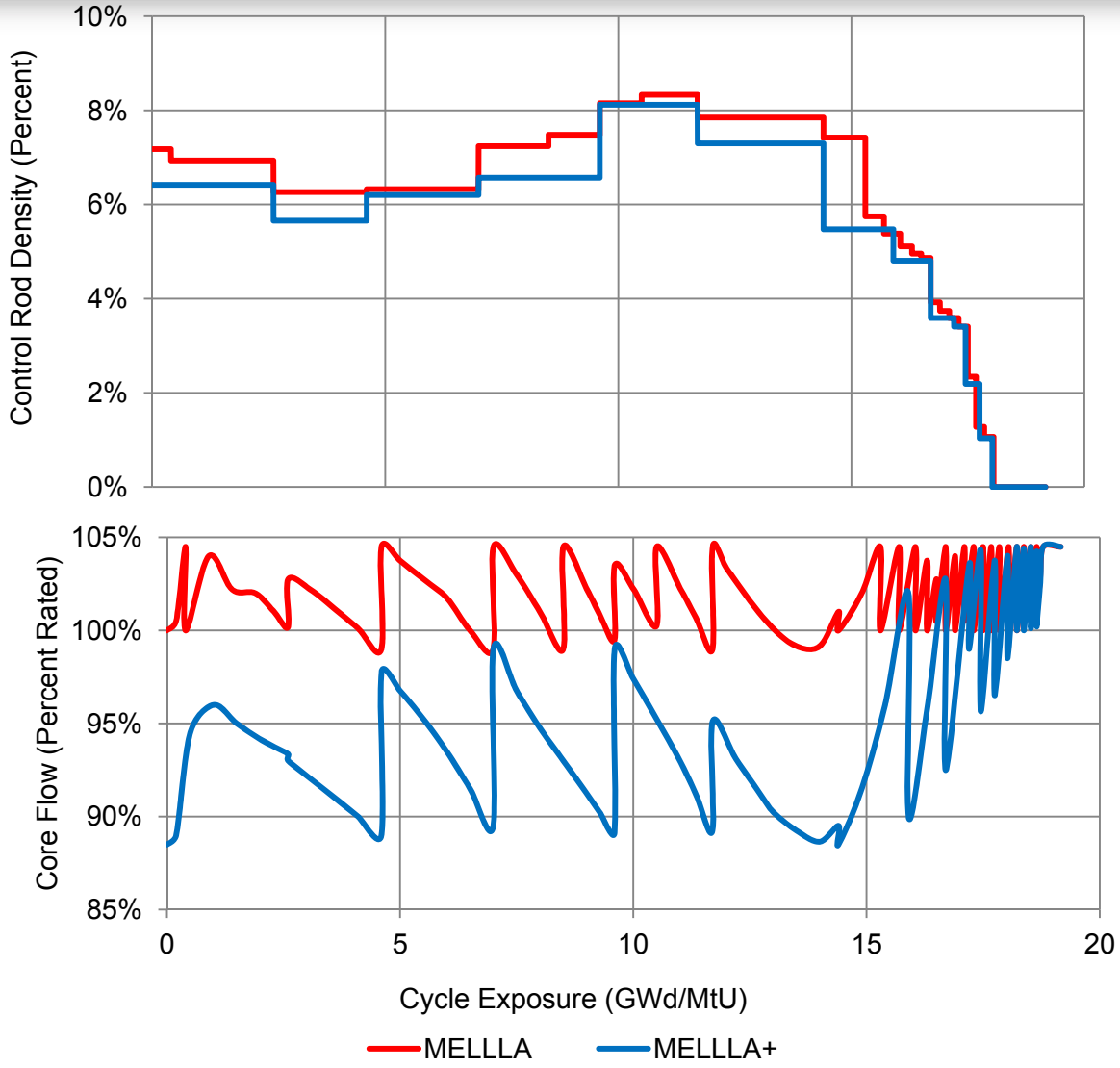
MELLLA+ benefits for BSEP



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MELLLA+ benefits for BSEP

- Core performance margins maintained
- MELLLA+ will have minimal impact on core parameters
  - No loss of thermal limit margins (MFLCPR, MAPRAT, LHGR)

	MELLLA	MELLLA+
Core max radial peak	1.38 average 1.46 max	1.39 average 1.47 max
Core average void	49.1% average 51.8% max	47.7% average 52.9% max
Core max exit void	84.9% average 87% max	87.5% average 90% max
Average inlet subcooling	20.9 Btu/lb	24.2 Btu/lb

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Fuel and plant licensing analysis strategy

- GEH generic M+ LTR process (NEDC-33006P-A) with GEH methodologies and analysis will address:
  - Non-fuel impacts
  - Long term ATWS and ATWS instability explicitly modeling A10XM fuel
- AREVA methodologies and analyses will address:
  - Fuel, core design, COLR fuel limits
  - ATWS overpressure (COTRANSA2)
  - Methods applicability to MELLLA+ (Report submitted as part of LAR)
- Duke Energy will address:
  - Integration of GEH and AREVA analyses
  - APRM and Enhanced Option III setpoints and implementation
  - Risk evaluation, procedure updates, operator training
  - Plant changes to mitigate ATWS (SLC B-10 enrichment increase)
  - Stability scram activation
  - Application of existing plant specific EPU analysis

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Fuel and plant licensing analysis strategy

- MELLLA+ LAR to be based on current A10XM fuel type
  - GEH will analyze long term ATWS and ATWS-I by explicitly modeling an A10XM equilibrium core designed by AREVA
- MELLLA+ LAR sample problem and cycle application
  - B1C19 reload analysis report sample problem to be used in LAR; core comprised of 1 batch of A10XM with remainder A10
  - B1C21 reload analysis report cycle specific application; first Unit 1 MELLLA+ cycle with full core A10XM
  - B2C22 reload analysis report cycle specific application; first Unit 2 MELLLA+ cycle (implement mid-cycle with full core A10XM)
- The LAR will have proprietary information from both vendors appropriately marked to protect each vendors proprietary information

Fuel and plant licensing analysis strategy
Preliminary Technical Specification changes

- TLO APRM flow biased STP scram line
  - Scram margin: expansion for M+ region; reduction for EO-III stability solution
  - Corresponding changes in flow biased rod block
  - Existing AL-AV-NTSP set-point margins maintained
  - Protect EO-III Channel Instability Exclusion Region (CIER) region
- Define MELLLA+ region, add EO-III to COLR methods
- New equipment OOS actions
  - FWHOOS, SLO and OPRM inoperable not allowed in MELLLA+
  - Exit MELLLA+ region within 12 hours for inoperable condition
- OPRM inoperable
  - Implement manual BSP regions in COLR (no change)
  - Exit MELLLA+ region within 12 hours; OPRM OOS or reduced FWT (new)
  - Automatic scram stability protection above BSP scram region (new protection)
- SLC B-10 enrichment increase

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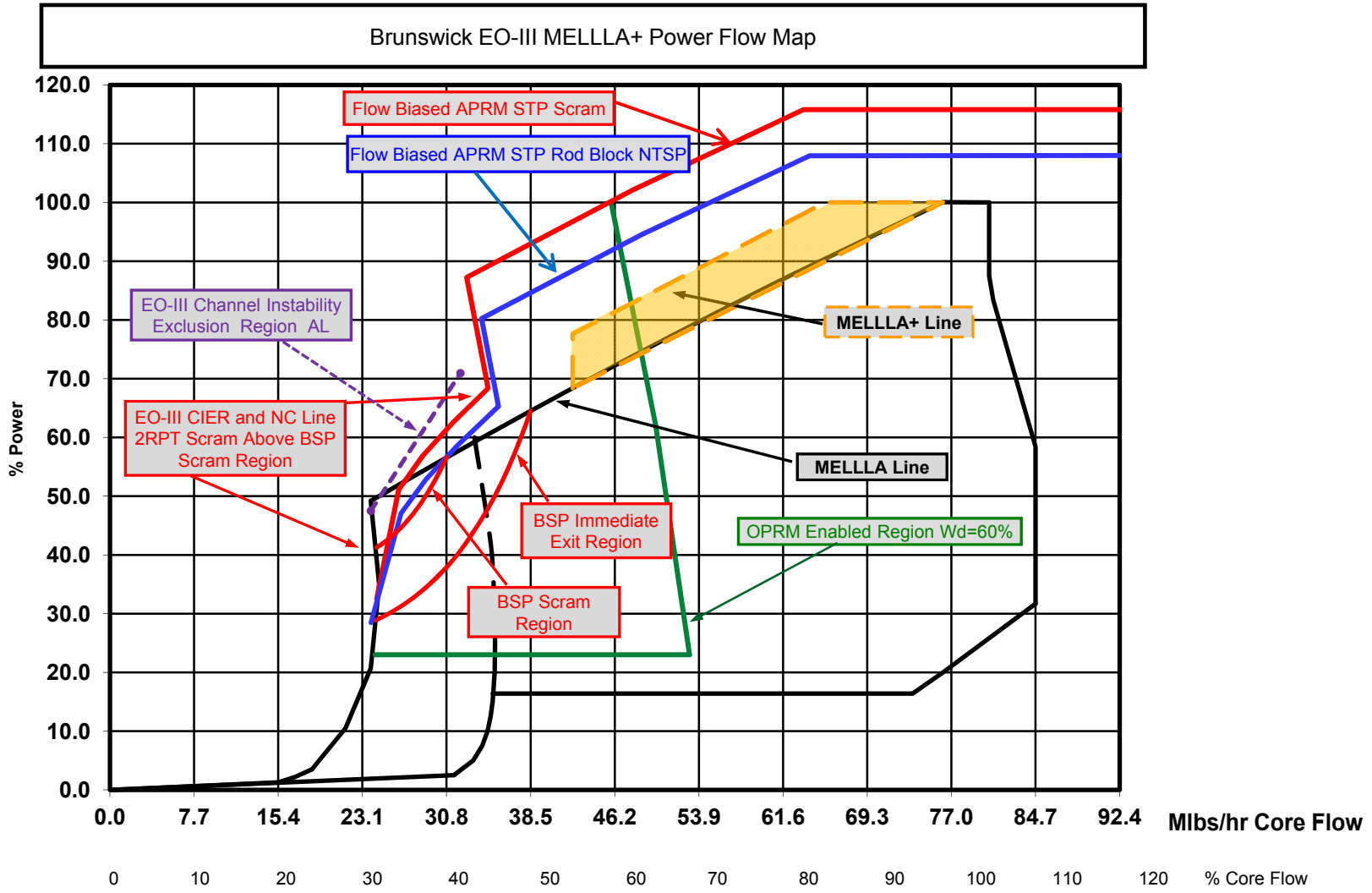
Thermal hydraulic stability solution

- Implement approved AREVA Enhanced Option III (EO-III)
- EO-III Algorithm same as Option III with additional channel instability protection
- EO-III has a Channel Exclusion SPT AL Line that will be protected via:
  - Setdown of flow biased APRM SCRAM NTSP
  - Setdown of flow biased APRM Rod Block NTSP
- Provides an automatic scram to protect the CIER after a 2RPT trip from MELLLA+ conditions
- Implemented via existing BSEP PRNM hardware

Thermal hydraulic stability solution
Power flow map



ATWS analysis and mitigation
Long term response

- BSEP EPU increased SLC B-10 enrichment to 47 atom percent
  - TS require two pumps in service, but
  - Single pump meets ATWS rule boron injection rate requirement
- Long term ATWS MELLLA+ margin improvement will be demonstrated with A10XM specific ODYN analyses
  - MELLLA+ rod line intercepts NC line post 2RPT ~20% higher in power
  - SLC B-10 enrichment increase to 92 atom percent (~2x increase)
  - SLC enrichment should offset MELLLA+ heat load increase
- No anticipated loss of margin with MELLLA+

ATWS analysis and mitigation
Post depressurization

- NEDC-33006P-A Generic MELLLA+ LTR and SER: Best estimate TRACG or equivalent analysis of post depressurization ATWS required if HSBW not injected before shutdown/HCTL is reached
- BSEP has potential to inject HSBW before shutdown/HCTL
  - Increase SLC B-10 enrichment (47 to 92 atom percent)
- TRACG analysis will be performed if needed explicitly modeling A10XM fuel

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ATWS analysis and mitigation
Overpressure and instability

- ATWS instability
  - GEH will explicitly analyze the A10XM fuel for ATWS-I
- ATWS overpressure mitigation
  - Existing AREVA methodology will provide analysis of record
  - SRVOOS is supported for MELLLA+ (no change)
  - Analysis will apply 95/95 SRV upper setpoint tolerance
    - Different than the TS requirement
    - Based on plant performance
- No deviation from MELLLA+ LTR

MELLLA+ Impact
Containment Accident Pressure (CAP)

- Brunswick MELLLA+LAR will not request any new or additional CAP credit relative to the current approved EPU licensing basis as described in SECY-11-0014
- Brunswick MELLLA+ implementation will have no adverse impact on CAP margin
  - No impact on LOCA CAP (NEDC-33006P-A NRC SER Section 4.2.6)
    - BNP takes no CAP credit for short term LOCA with some credit for long term LOCA
  - No impact on Appendix R CAP (NEDC-33006P-A NRC SER Section 4.2.6)
  - No impact on SBO CAP (NEDC-33006P-A NRC SER Section 4.2.6)
  - Expected improved ATWS CAP margin due to SLC B-10 enrichment upgrade
- New results will be compared to existing to show bounded
- No requirement that additional uncertainty be applied to ECCS NPSH calculations i.e,. 21% uncertainty in SECY-11-0014 will not be used

MELLLA+ Impact
Annulus Pressurization (AP) Loads Impact

- BSEP has a Mark I containment
- Current Licensing Basis:
  - BSEP analyzed two breaks: feedwater and recirc suction line
  - Recirc guards were installed to mitigate limiting recirc suction line break
- MELLLA+ does not impact AP loads
- Existing licensing basis will be maintained

Project schedule

- MELLLA+ LAR submittal (both Units) — Summer 2014
  - B1C19 sample problem with A10XM
- B1C21 cycle specific application results to NRC — Fall 2015
  - First planned MELLLA+ cycle
- MELLLA+ requested approval (both Units) — Spring 2016
- MELLLA+ implementation
  - BNP1 – During B1C21 refueling outage — Spring 2016
  - BNP2 – Online implementation during B2C22 — Summer 2016

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Objectives

- Looking for feedback for unique BSEP specific aspects of MELLLA+ implementation
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- Plan on sharing results of ongoing analyses during an interim update (Summer 2013)

BSEP Units 1 and 2 MELLLA+ Implementation

Questions?

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Selected Acronyms

AL – Analytical Limit

AP – Annulus Pressurization

APRM – Average Power Range Monitor

ATWS – Anticipated Transient Without Scram

AV – Allowed Value

BSP – Backup Stability Protection

CAP – Containment Accident Pressure

CIER – Channel Instability Exclusion Region

ECCS – Emergency Core Cooling System

EO-III – Enhanced Option III

EPU – Extended Power Uprate

FWHOOS – Feedwater Heater Out Of Service

FWT – Feedwater Temperature

HCTL – Heat Capacity Temperature Limit

HSBW – Hot Shutdown Boron Weight

MELLLA – Maximum Extended Load Line Limit Analysis

NC – Natural Circulation

NPSH – Net Positive Suction Head

NTSP – Nominal Trip Setpoint

PRNM – Power Range Neutron Monitor

SBO – Station Black Out

SLC – Standby Liquid Control

SLO – Single Loop Operation

SPT – Stability Protection Trip

STP – Simulated Thermal Power

TLO – Two Loop Operation

2RPT – Two Recirculation Pump Trip