Brunswick Units 1 and 2 MELLA+ Implementation

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Eric Geyer

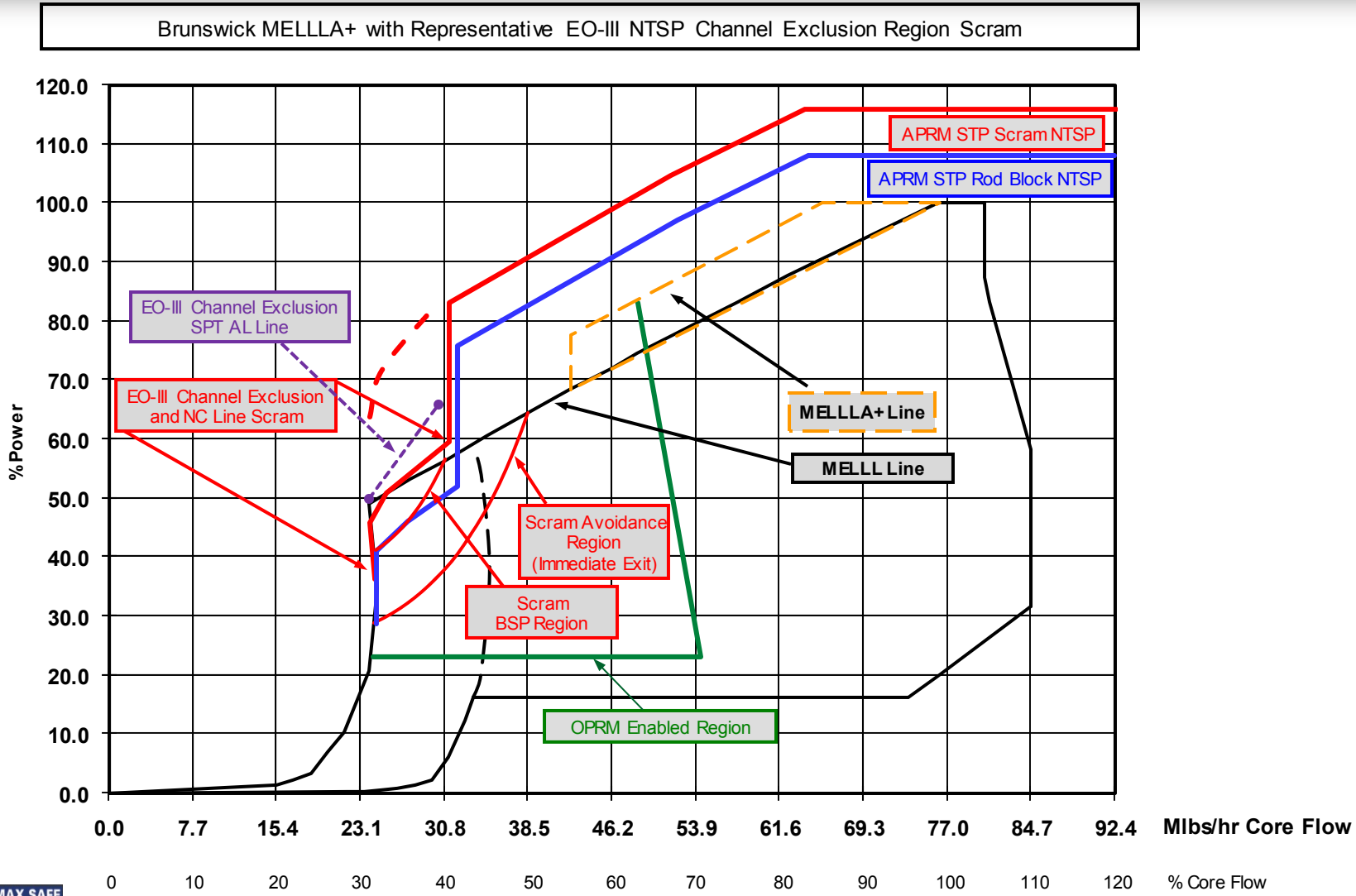
Bill Murray

John Siphers

Agenda

- Introduction and objectives
- MELLLA+ benefits for Brunswick (BSEP)
- Fuel and plant licensing analysis strategy
- Thermal hydraulic stability solution
- ATWS analysis and mitigation
- Fuel design
- Schedule
- Questions and answers

Introduction and objectives
MELLLA+ overview



Introduction and objectives
BSEP MELLLA+ licensing progress to date

- Nov 2002: BSEP MELLLA+ LAR submitted
- Significant NRC review completed; BSEP RAI responses:
  - May 2003 — Moisture carryover FAC
  - Jun 2003, Oct 2003 — Vessel fluence
  - Jul 2003 — SLO APRM STP scram
  - Sep 2003 — ATWS response
  - Nov 2003 — Human factors, operator training
  - Apr 2004, Mar 2005 — Irradiated stress corrosion cracking
- Aug 2005: MELLLA+ LAR withdrawn
  - Intent to resubmit at later date “as soon as practical”
  - Pending resolution of concerns with supporting generic LTRs

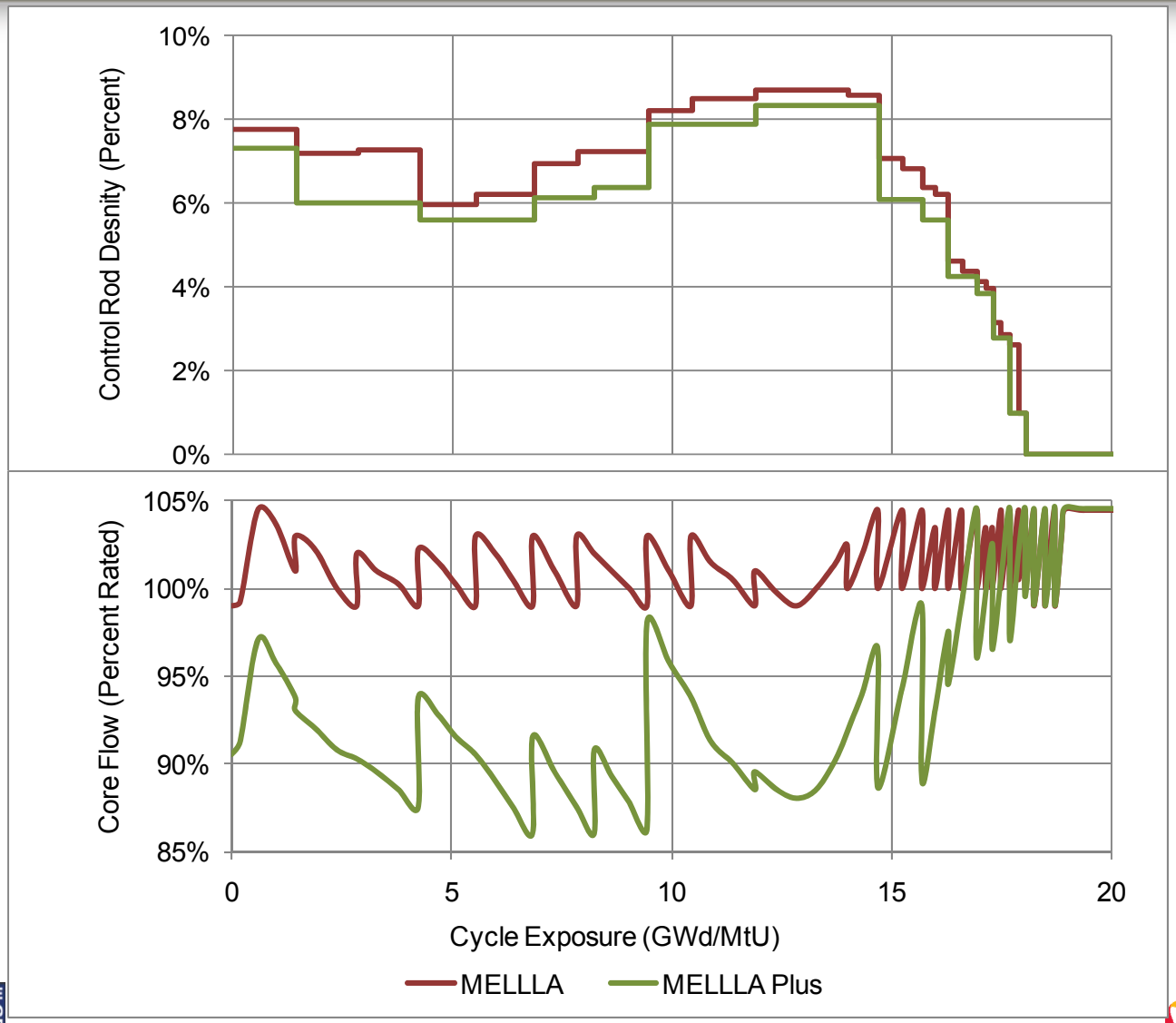
Introduction and objectives
Progress toward LAR readiness

- BSEP fuel supplier change approved
  - Jul 2007: ANP-2638 AREVA EPU methods applicability
  - Mar 2008: BSEP ATRIUM-10 reload
- Supporting generic LTRs approved
  - Sep 2007: NEDC-33006 GEH generic MELLLA+ for GE14
  - Jan 2008: NEDC-33173 GEH methods for GE14
  - May 2008: ANP-10262 AREVA EO-III Stability
- Objectives
  - Provide complete, efficient LAR that leverages past work
  - Reduce challenges to reactivity management and fuel integrity
  - Maintain and improve safety margins
  - Improve reactivity management

MELLLA+ benefits for BSEP

- Reactivity can be controlled with flow or control rods
  - MELLLA+ expands flow window from 5.5% to 19.5%
  - MELLLA requires ~75% more rod movement than MELLLA+
- Control rod movement challenges:
  - Reactivity management (2007 INPO Area For Improvement)
  - Fuel integrity (2008 INPO Recommendation)
- MELLLA+ improves reactivity management and fuel integrity
- Cost savings do not support MELLLA+ implementation
  - Analyses do not support significant fuel utilization improvement
  - Reduced pump power provides only small generation increase

MELLLA+ benefits for BSEP



MAX SAFE NGG GEN 2009

Progress Energy

MELLLA+ benefits for BSEP

Parameter	MELLLA Cycle Avg / Cycle Limiting	MELLLA+ Cycle Avg / Cycle Limiting
Core flow	101.5% / 99.0%	93.1% / 86.0%
Core max radial peak	1.35 / 1.46	1.33 / 1.38
CPR margin	11.9% / 6.8%	8.9% / 5.3%
Core avg void	46.4% / 50.4%	47.9% / 52.2%
Core max exit void	84.3% / 87.7%	85.4% / 87.9%
LHGR margin	19.3% / 10.1%	17.9% / 11.1%
MAPRAT margin	23.7% / 13.4%	22.9% / 16.7%
Inlet subcooling	21.6 Btu/lb / NA	23.9 Btu/lb / NA

- Radial peaking and excess CPR margin exchanged for reduced flow
- Core performance margins maintained

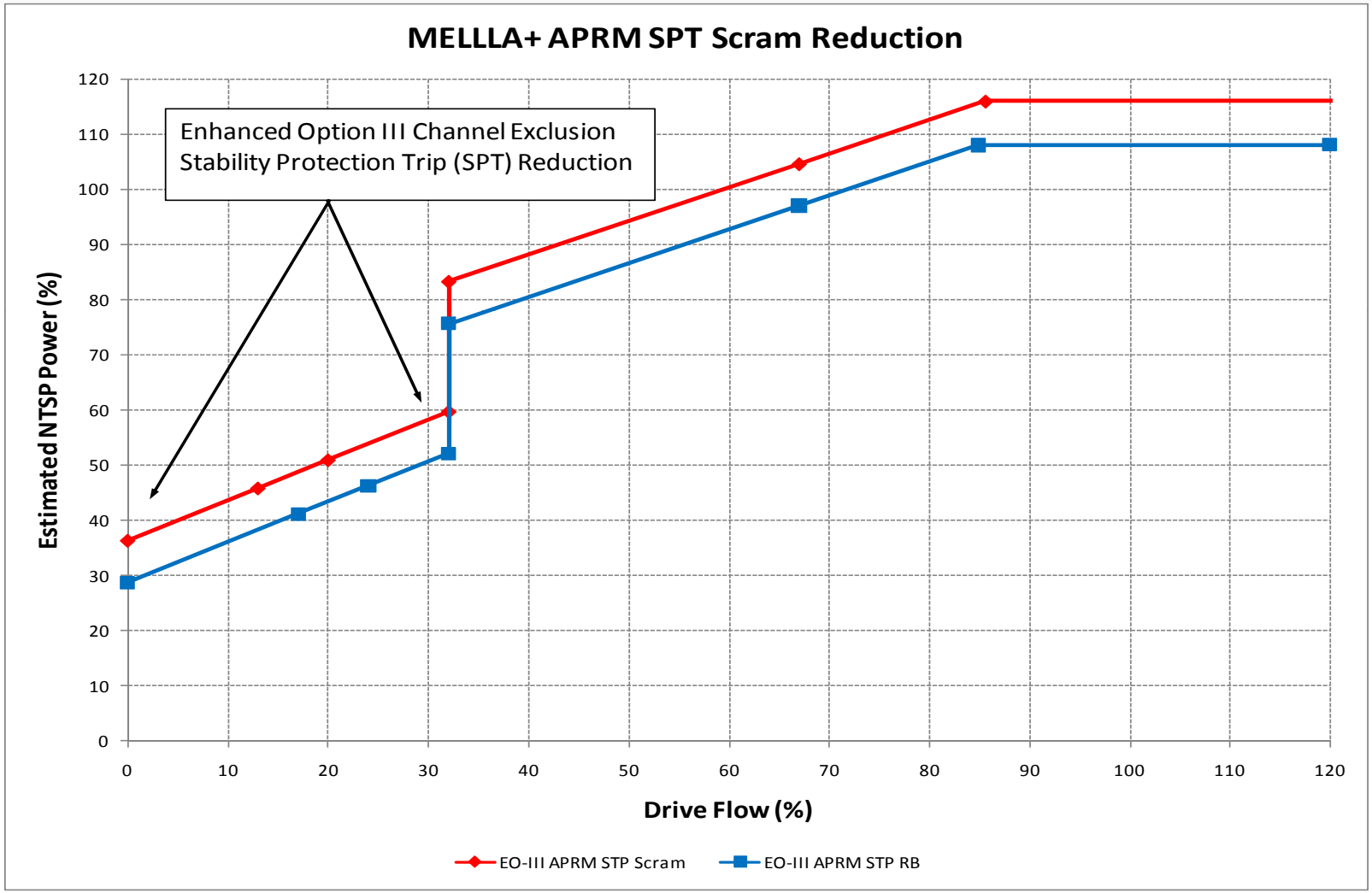
Fuel and plant licensing analysis strategy

- Generic GEH M+ LTR process (NEDC-33006PA) will address:
  - Non-fuel impacts
  - Long term ATWS and ATWS instability for GE14 fuel
- AREVA methodologies and analyses will address:
  - Fuel, core design, COLR fuel limits
  - ATWS overpressure
  - GE14 ATWS analysis applicability to AREVA fuel
  - Methods applicability to MELLLA+
- Progress Energy will address:
  - Integration of GEH and AREVA analyses
  - APRM and Enhanced Option III set points
  - Risk evaluation, EPG/SAGs, operator training
  - Plant modifications to mitigate ATWS
  - Stability scram activation

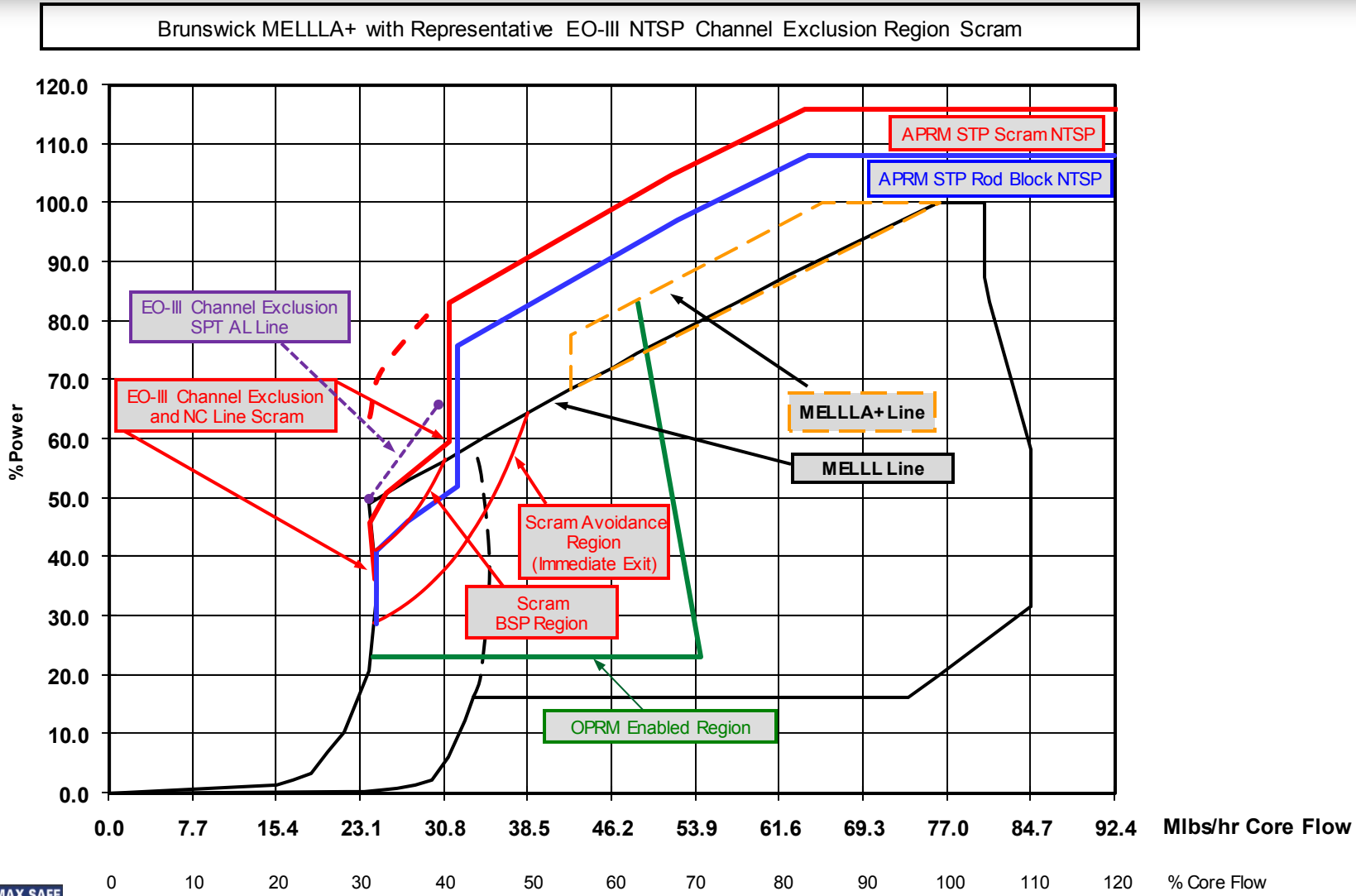
Fuel and plant licensing analysis strategy
Preliminary Technical Specification changes

- TLO APRM flow biased STP scram line (3.3.1.1.2b)
  - 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
- Define MELLLA+ region , add EO-III to COLR methods (5.6.5)
- New equipment OOS LCO actions (various TS's)
  - SRVOOS (if required), SLO and OPRM inoperable
  - Exit MELLLA+ region within 12 hours for disallowed condition
- OPRM inoperable
  - Implement manual BSP regions in COLR (no change)
  - Exit MELLLA+ region within 12 hours; OPRM OOS or reduced FWT (new)
  - APRM scram natural circ line protection above BSP scram region (new protection)
- 1 SLCS pump OOS
  - Exit MELLLA+ region within 12 hours (new)
  - Shutdown in 7 days (no change)

Thermal hydraulic stability solution
Enhanced Option III TLO APRM Scram



Thermal hydraulic stability solution
Power flow map



ATWS analysis and mitigation
Long term response

- BSEP EPU increased SLCS B10 enrichment to 47 w/o
  - ATWS rule compliance basis remains two pumps, but
  - Single pump meets ATWS rule boron injection rate requirement
  - EPU risk assessment and current PSA model credit pump redundancy
- Long term ATWS MELLLA+ margin improvement will be demonstrated with GE14 ODYN analyses
  - MELLLA+ rod line intercepts NC line post 2RPT ~20% higher in power
  - Faster B10 injection reduces heat load (HSBW injected faster)
  - BSEP can increase SLCS B10 enrichment by up to a factor of 2
  - Potential to offset MELLLA+ heat load increase clearly sufficient
- No loss of margin with MELLLA+; no increase in risk with single SLCS pump
- AREVA fuel applicability to be dispositioned similar to BSEP AREVA fuel transition

ATWS analysis and mitigation
Post depressurization

- NEDC-33006P Generic M+ LTR and SER: Best estimate TRACG or equivalent analysis of post depressurization ATWS required if HSBW not injected before HCTL reached
- BSEP has potential to inject HSBW before HCTL
  - Increase SLCS B10 enrichment (x2)
  - Credit both SLCS pumps (x2)
  - New TS LCO action to exit MELLLA+ if 1 SLCS pump OOS
  - Applicability of GE14 analysis to AREVA fuel will be dispositioned
- Substantial physical safety improvement
  - Simplifies analysis
  - Simplifies NRC review
  - NRC feedback critical

ATWS analysis and mitigation
Overpressure and instability

- ATWS instability
  - Same approach as long term; demonstrate change in margin for GE14 core with increased B10 injection rate
  - B10 injection rate increase expected to provide some mitigation even with shorter event timing than long term containment heating
  - Applicability to AREVA fuel to be addressed by disposition
  - NRC feedback critical
- ATWS overpressure mitigation
  - MG set replacement with adjustable speed drive improves 2RPT coastdown rate
  - SRVOOS support for MELLLA+ to be evaluated
  - Cycle specific AREVA overpressure analysis

Fuel design
ATRIUM-10XM (A10XM)

- MELLLA+ LAR to be based on A10XM if timing and reviews support
- A10XM requires adding two COLR methodologies to TS
  - ACE CPR correlation and RODEX4 fuel rod TM methodology
  - LAR will demonstrate SER compliance
  - Generically approved; no sample problem
- A10XM LAR separate from MELLLA+
  - Separate submittal preceding MELLLA+
  - A10XM approval (both Units) preceding MELLLA+ approval
- MELLLA+ LAR sample problem and cycle application
  - B2C20 reload analysis report sample problem; first Unit 2 A10XM reload
  - B1C19 reload analysis report cycle specific application; first Unit1 A10XM reload and MELLLA+

Fuel design
ATRIUM-10XM fuel cycle operation

Parameter	MELLLA+ A10 Cycle Avg / Cycle Limiting	MELLLA+ A10XM Cycle Avg / Cycle Limiting
Core flow	93.1% / 86.0%	91.4% / 85.7%
Core max radial peak	1.33 / 1.38	1.39 / 1.47
CPR margin	8.9% / 5.3%	14.8% / 5.0%
Core avg void	47.9% / 52.2%	47.7% / 52.9%
Core max exit void	85.4% / 87.9%	87.5% / 90.0%
LHGR margin	17.9% / 11.1%	13.7% / 7.3%
MAPRAT margin	22.9% / 16.7%	22.9% / 16.4%
Inlet subcooling	23.9 Btu/lb / NA	24.2 Btu/lb / NA

- Improved CPR margin supports radial peaking increase and reduced flow
- Core performance margins maintained

Schedule

- A10XM LAR; ACE and RODEX (both Units) Spring 2010
- MELLLA+ LAR submittal (both Units) Fall 2010
  - B2C20 sample problem with A10XM
- ATRIUM-10XM approval (both Units) Spring 2011
- First ATRIUM-10XM reload (B2C20) Spring 2011
- B1C19 cycle specific application Fall 2011
  - First MELLLA+ cycle with A10XM
- MELLLA+ approval (both Units) Spring 2012

- NRC feedback critical

Summary

- Reduce challenges to reactivity management
- Reduce challenges to fuel integrity
- Maintain and improve safety margins
- Efficient LAR approach
  - Leverage past work
  - Address fuel design

BSEP Units 1 and 2 MELLLA+ Implementation

Questions?