Unverified Draft

Decay Ratio Adder Removal

Option I-D/II Exclusion Region Licensing Methodology

Presentation to NRC – Closed Session

October xx, 2005

Agenda

- Purpose
- Background
- Proposal
- Recent Instability Events
- Justification to Remove 0.15 DR Adder
- Demonstration Analysis
- Summary of ODYSY LTR Changes
- Conclusion

Purpose

- Provide justification for removal of 0.15 core decay ratio adder from Options I-D and II exclusion region licensing methodology
- Provide description of proposed changes relative to approved ODYSY LTR

Background

- BWROG Stability Long-Term Solutions (LTS) defined in NEDO-31960
  - Enhanced Option I-A (EIA)
  - Option I-D
  - Option II
  - Option III
- LTS must meet GDC-12
  - Prevent oscillations from occurring, or
  - Detect & suppress oscillations, or
  - Both prevent and detect & suppress

Background

- EIA
  - Prevention solution applicable to all plants
  - Oscillation prevention provided by analytically determined exclusion, restricted regions protected by automatic scram, rod block (respectively)
  - ODYSY approved for region generation and validation in NEDC-32339P Supplement 1
- Option III
  - Detect & suppress solution applicable to all plants
  - Oscillations automatically detected & suppressed by new plant hardware

Background

- Option I-D
  - Prevention and detect & suppress solution
  - Applicable to plants with small cores where only core-wide mode oscillations are possible
  - Existing flow-biased APRM flux scram detects and suppresses core-wide mode oscillations
  - Oscillation prevention provided by analytically determined, administratively controlled exclusion region
  - Buffer region defined outside of exclusion region
  - Stability monitor required

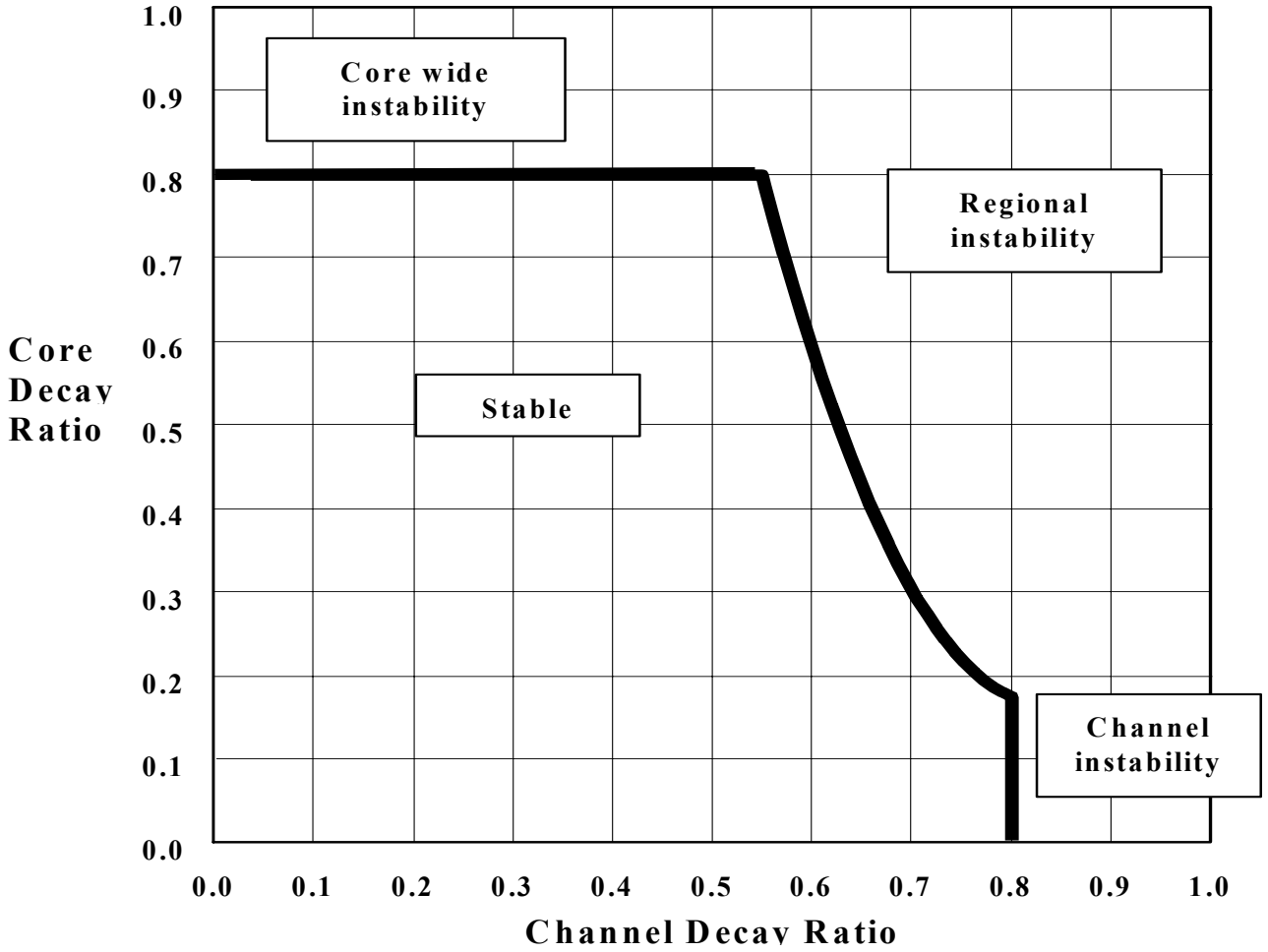
Background

- Option II
  - Prevention and detect & suppress solution
  - Applicable to BWR/2 plants
  - Existing quadrant based flow-biased APRM flux scram detects and suppresses both core-wide and regional mode oscillations
  - Oscillation prevention provided by analytically determined, administratively controlled exclusion region

Background

- Original (FABLE) exclusion region licensing methodology approved in NEDO-31960
- ODYSY exclusion region licensing methodology for Options I-D/II approved in NEDC-32992P
- ODYSY methodology includes 0.15 core decay ratio (DR) adder
  - 0.15 is added to the calculated ODYSY core DR to yield a “procedure” core DR
  - Procedure core DR is compared to 0.80 stability criterion to determine exclusion region boundary
  - 0.15 adder effectively makes stability criterion 0.65

Background – Stability Criteria Map



Background

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- ODYSY LTR did not take credit for methodology improvement to expedite licensing approval
- ODYSY methodology improvements include:
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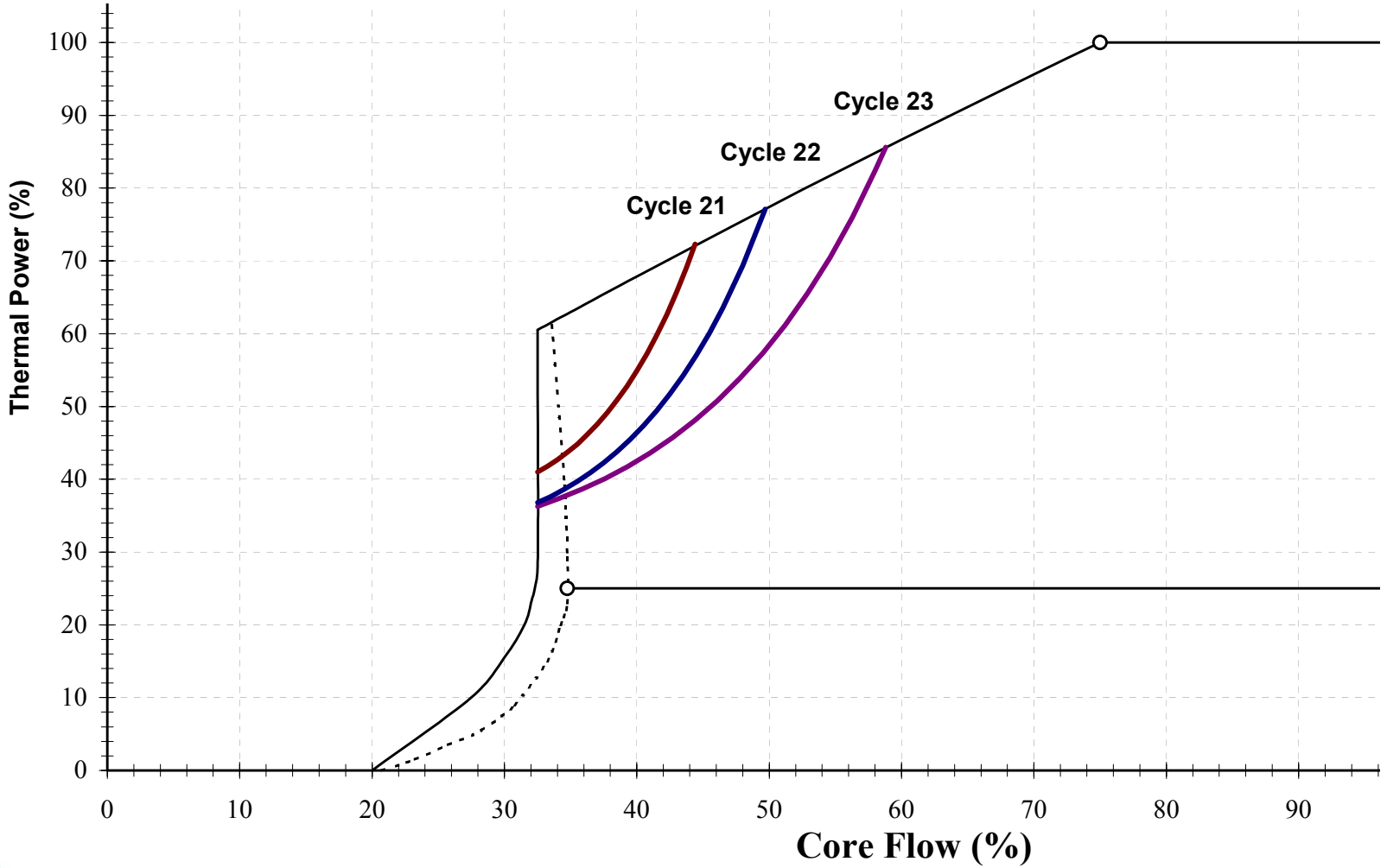
Proposal

- Option I-D/II exclusion regions becoming larger due to high energy core designs
  - Affects plant operation
- 0.15 Adder adds unnecessary conservatism to exclusion region methodology for Option I-D/II
  - Demonstrated by recent instability event analyses and operational experience
- BWROG proposes to remove 0.15 Adder to yield more acceptable regions and avoid unnecessary operational challenge
  - Requires NRC review and approval

Increasing Option I-D Region Size

for representative plant (with 0.15 DR Adder)



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Recent Instability Events

Exclusion regions calculated for two plants with recent instability events without 0.15 DR Adder

- Nine Mile Point 2 – July 24, 2003
  - Recirc pumps downshift and FCV runback
  - Flow reduction: 94% to 28%, power: 100% to 35%
  - FW temperature equilibration raised power to 45%
- Perry – December 23, 2004
  - Recirc pumps downshift
  - Flow reduction: 99% to 33%, power: 100% to 44%
  - FW temperature equilibration raised power to 55%

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Recent Instability Events

- Calculated exclusion regions without 0.15 DR Adder provide significant margin to power/flow conditions where instability events occurred
- Note: oscillations were slowly growing and readily detected and suppressed

Justification to Remove 0.15 DR Adder

- For Options I-D and II, SLMCPR protection provided by flow-biased APRM flux trip
  - Detect and suppress solution element provides direct SLMCPR protection
  - Conservative plant-specific analysis performed each cycle to demonstrate margin to SLMCPR (described in NEDO-32465)

Justification to Remove 0.15 DR Adder

- Exclusion Region provides additional measure of protection (i.e., defense-in-depth)
  - Prevention solution element provides additional, indirect SLMCPR protection
  - Standard approved ODYSY uncertainty (20%) applied to evaluation is appropriate and sufficient
  - Events near boundary not anticipated, not significant and unlikely to approach SLMCPR
  - Region generated based on limiting analysis conditions (Haling depletion, longest cycle exposure analyzed, limiting cycle exposure used)
  - Different (larger) exclusion region generated for reduced feedwater temperature operation

Justification to Remove 0.15 DR Adder

- Exclusion Region conservatism demonstrated by comparison to actual events
- Buffer Region further reduces likelihood of instability for Option I-D plants
- Stability monitor required and operating at all Option I-D plants for additional protection
- Flow-biased APRM flux trip has been lowered for both Option II plants and several Option I-D plants to offer timely scram in case THI oscillations develop

Justification to Remove 0.15 DR Adder

- ODYSY is best-estimate stability code
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  - Significant theoretical improvement over FABLE
  - Appropriate to generate exclusion region

0.15 DR Adder excessively conservative for Option I-D/II exclusion region application

Proposed ODYSY Procedure

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Proposed ODYSY Procedure

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Proposed ODYSY Procedure

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Demonstration Analysis

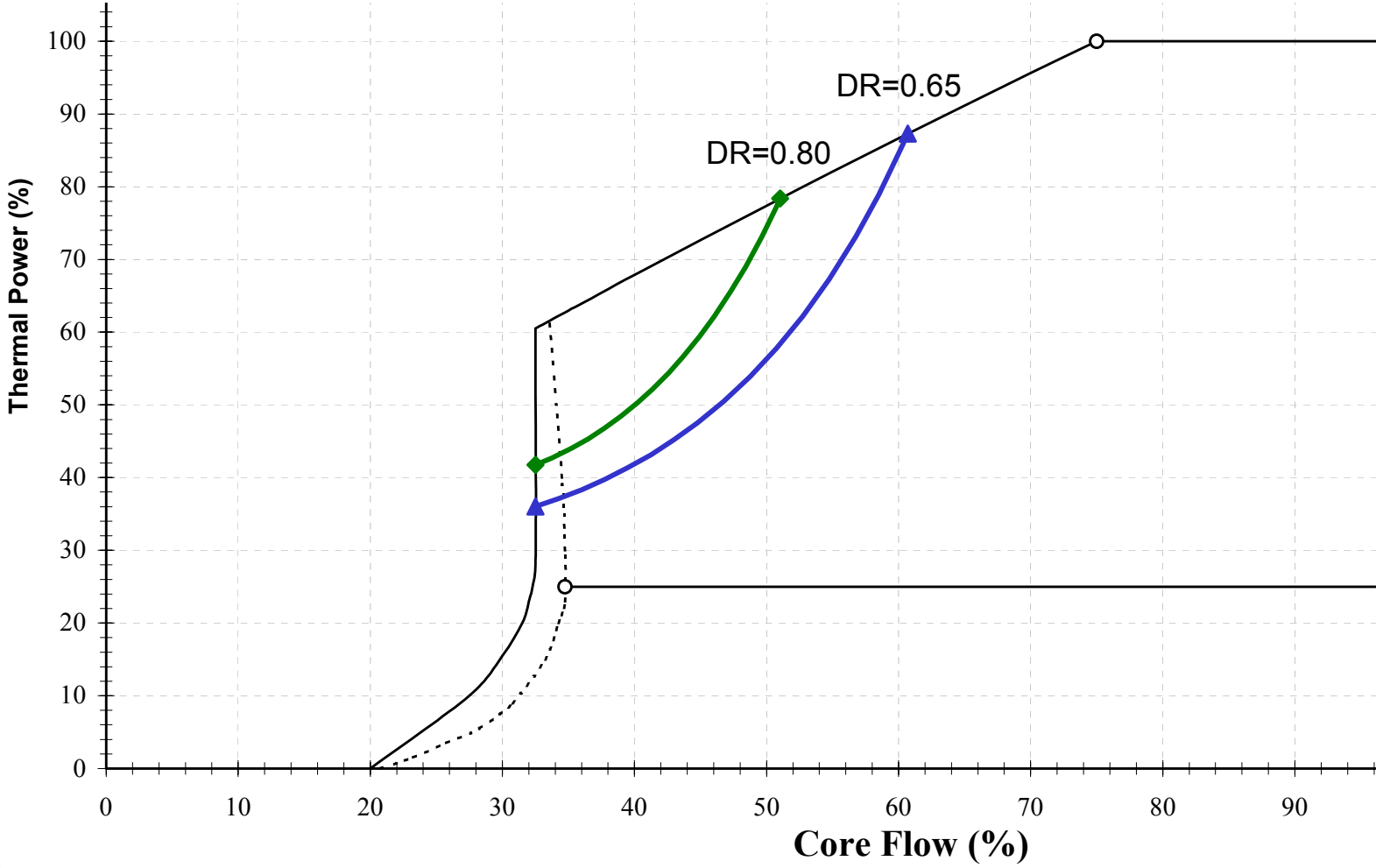
- Exclusion regions generated for two new plants and three plants from original ODYSY LTR
  - New: Plant 1, Plant 2
  - Original: Plant 3, Plant 4, Plant 5
- Regions generated with and without DR adder
  - Core DR criterion: 0.80, 0.65
- Regions generated for reduced feedwater temperature for Plant 1
  - Nominal, -30F, -60F

Demonstration Analysis

Plant	BWR Type	Core Size	Core Loading by Fuel Type	Cycle Length (MWd/ST)	Inlet Orifice Diameter (in)	% Original Licensed Power
1	4	548	10x10 – 100%	12,930	2.22	100.0
2	3	580	10x10 – 81% 9x9 – 19%	13,150	2.21	106.1
3	4	560	10x10 – 34% 9x9 – 64% 8x8 – 2%	13,868	2.09	104.1
4	4	368	8x8 – 100%	10,775	2.09	104.1
5	4	368	9x9 – 30% 8x8 – 70%	10,425	2.22	100.0

Plant 1 Demonstration

Exclusion regions with and without 0.15 DR Adder



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Plant 1 Demonstration

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Plant 1 Demonstration

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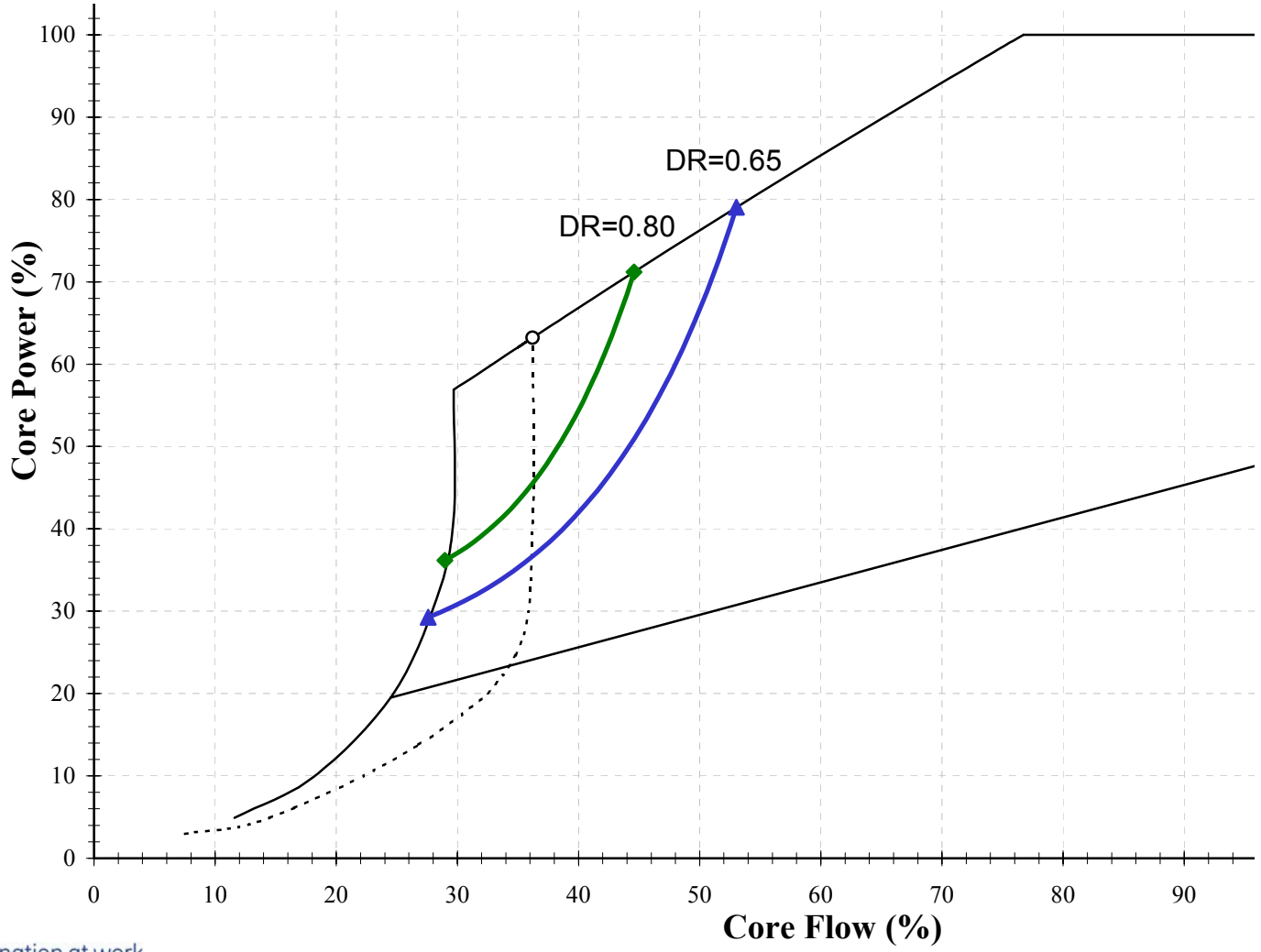
Plant 2 Demonstration

Exclusion regions with and without 0.15 DR Adder



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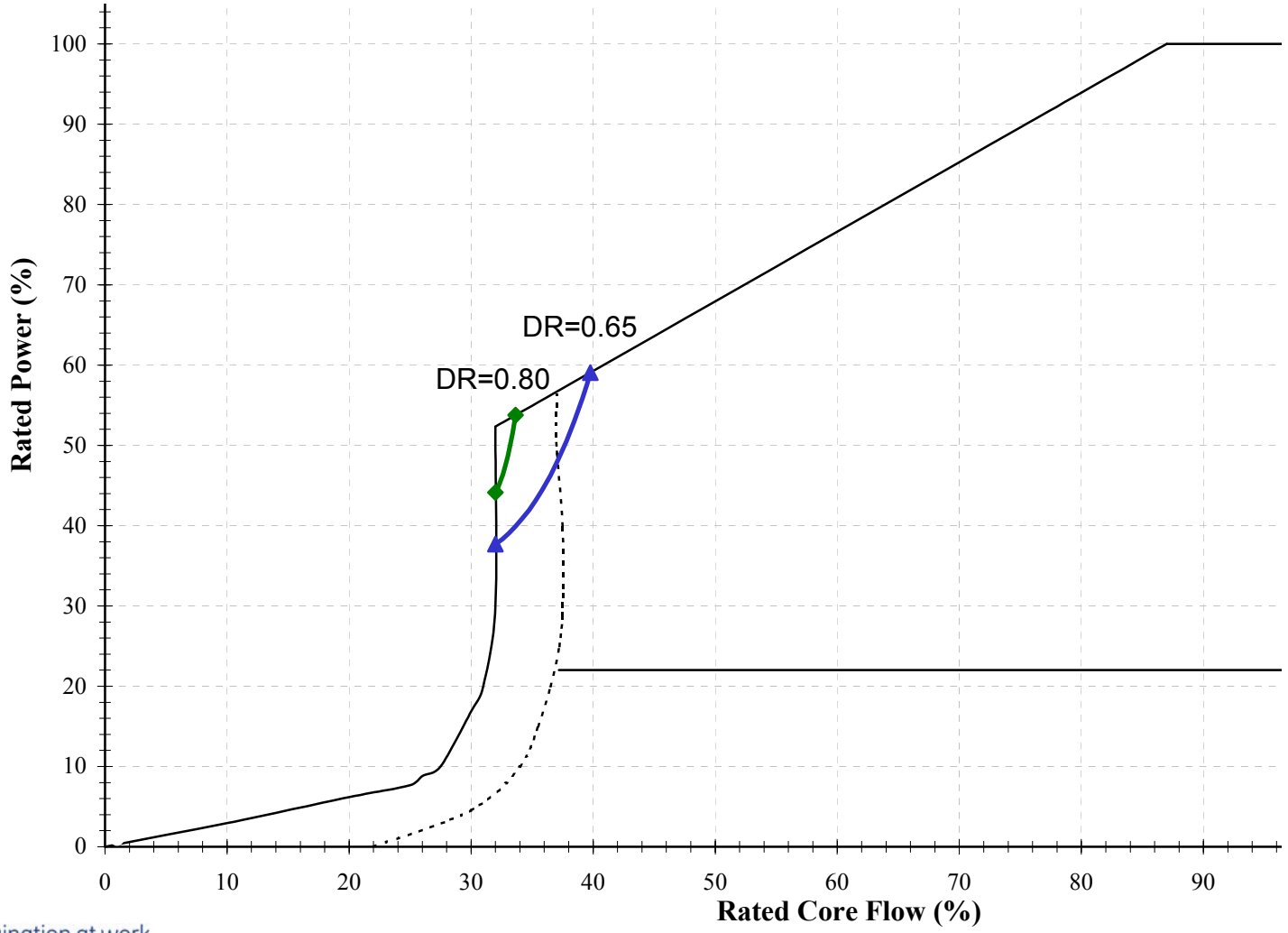
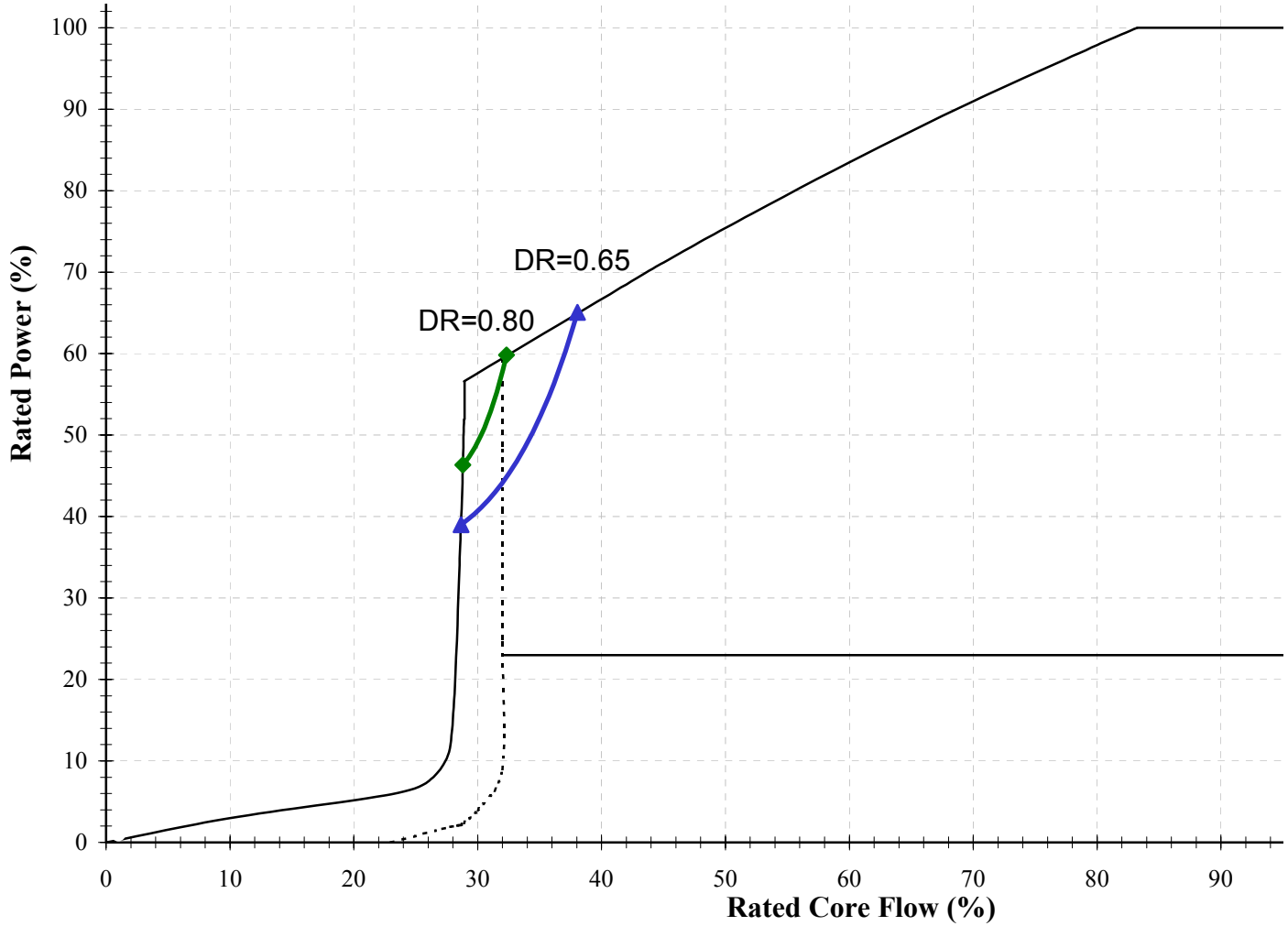
Plant 3 Demonstration

Exclusion regions with and without 0.15 DR Adder



Plant 4 Demonstration

Exclusion regions with and without 0.15 DR Adder



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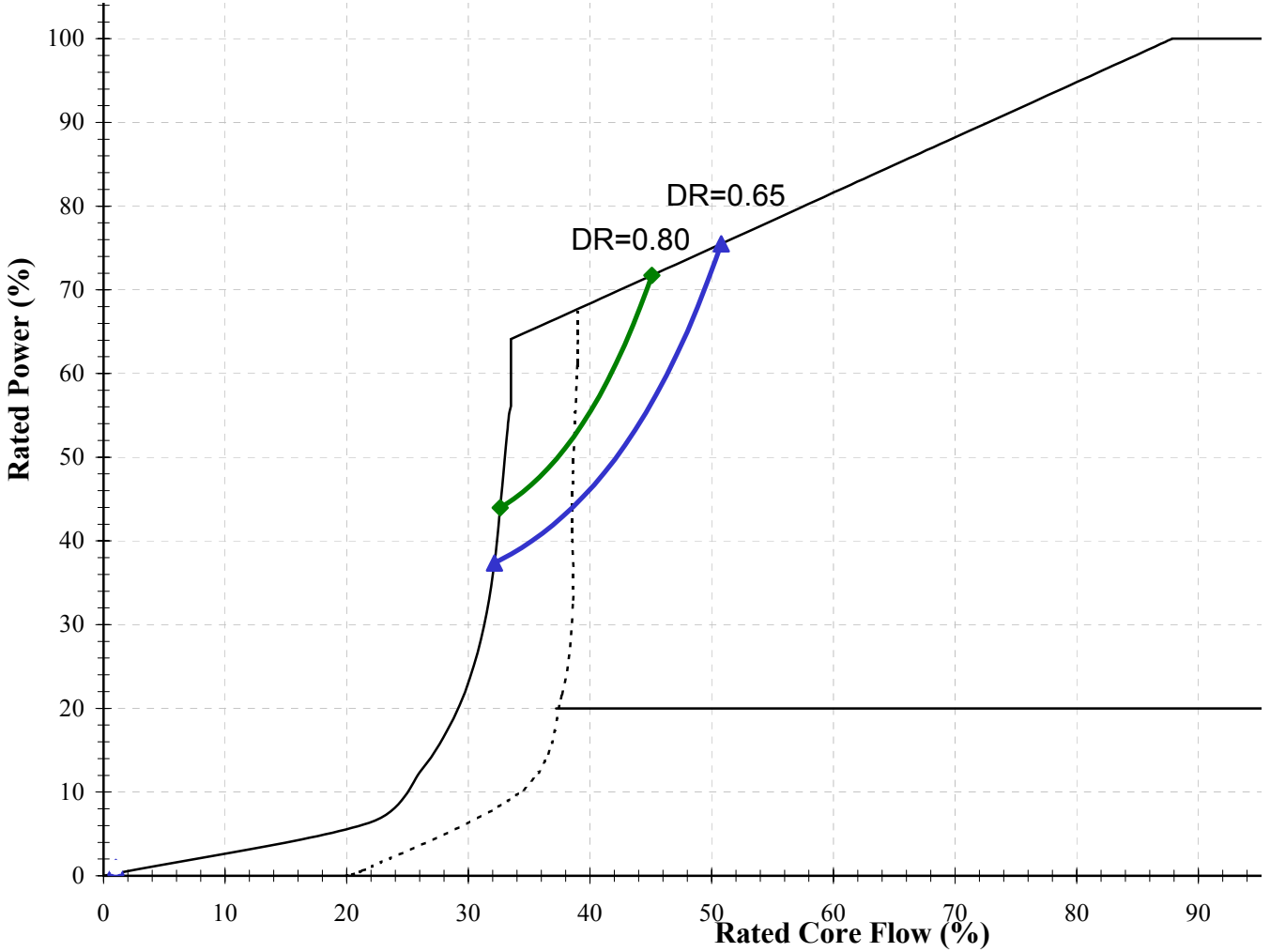
Plant 5 Demonstration

Exclusion regions with and without 0.15 DR Adder



Demonstration Analysis Conclusions

- Analysis performed for plants of different size, varying exclusion region sizes, 8x8 – 10x10 fuel
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Summary of ODYSY LTR Changes

- Removal of 0.15 Core DR Adder
- Removal of comparison to FABLE
  - Outdated and unnecessary to include
- Explicit treatment of feedwater temperature
  - Separate region generated for reduced FW temp
- Addition of recent instability event analysis
- Addition of two new plants (with new fuel/core designs) to demonstration analysis
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Conclusions

- 0.15 Core DR Adder introduces unnecessary conservatism that may affect operations and should be removed from Option I-D/II exclusion region methodology
- New, standalone ODYSY LTR (NEDC-33213P) will be submitted for NRC review
  - Basis no longer includes comparison to FABLE
  - Title will reflect ODYSY application for Option I-D/II

NRC Feedback

- Questions?
- Comments?