

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

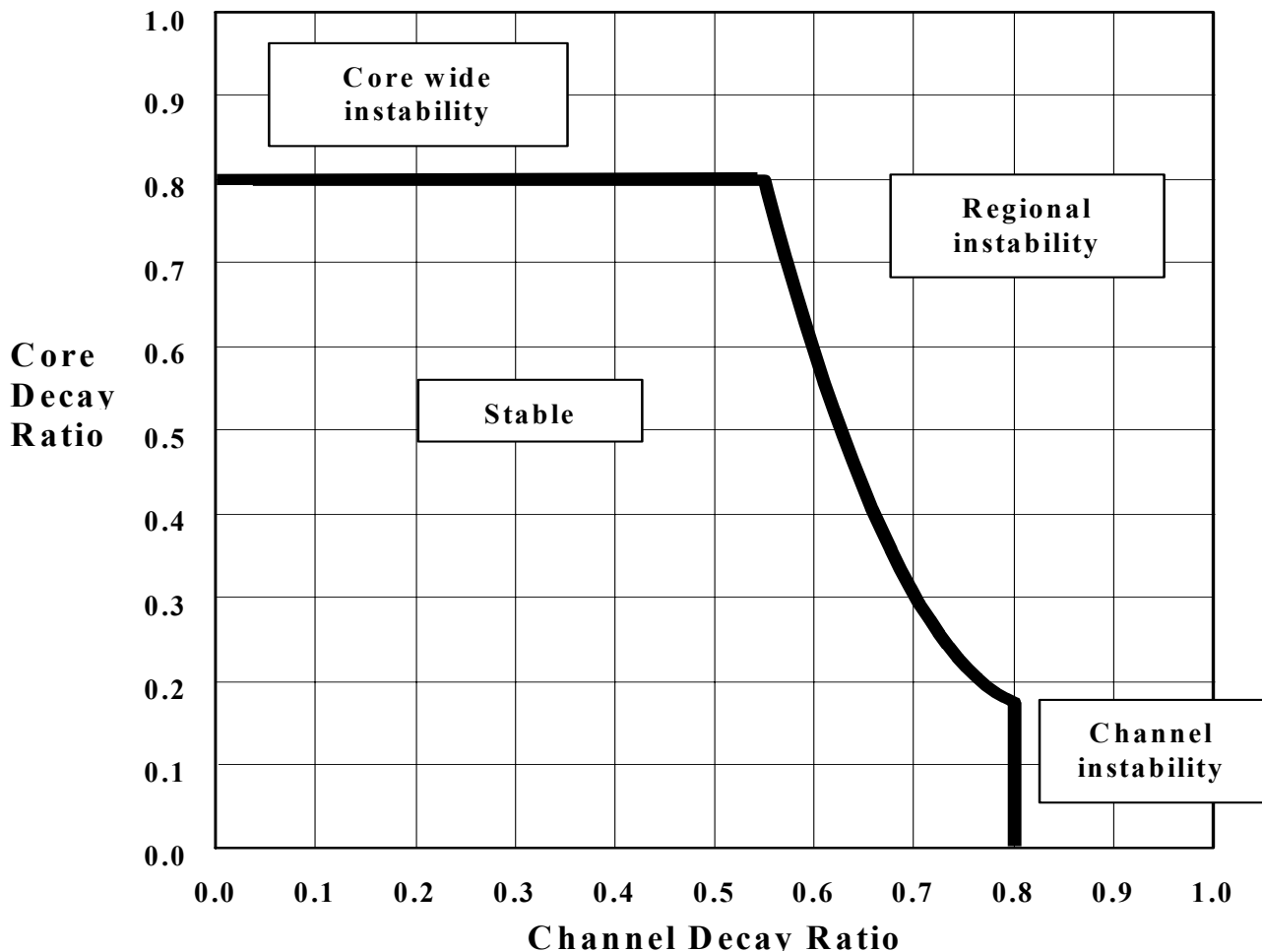
Background

- 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

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

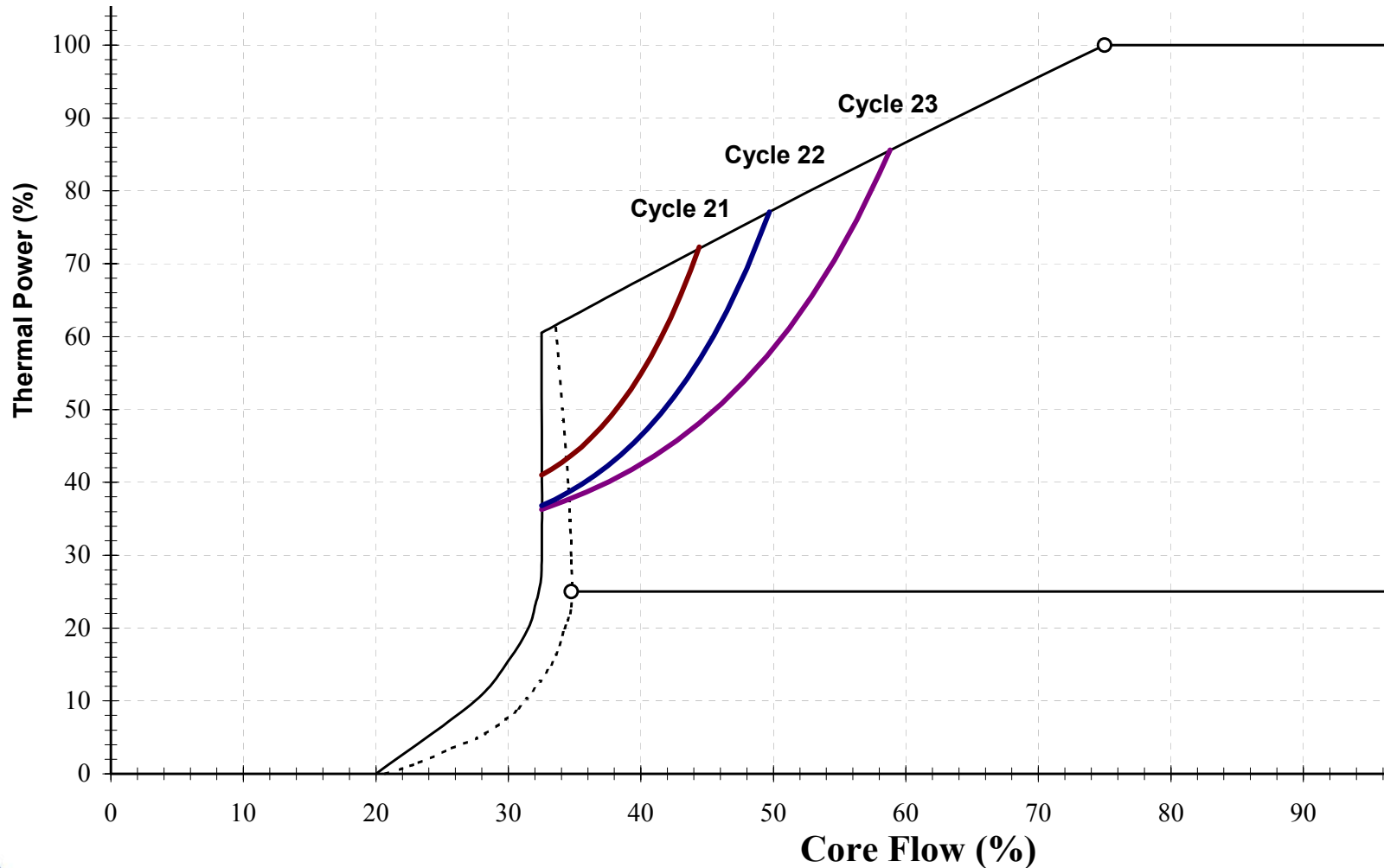
–

]]

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)



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%

[[

]]

[[

]]

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 TH1 oscillations develop

Justification to Remove 0.15 DR Adder

- ODYSY is best-estimate stability code
 - [[

]]
 - 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

1. [[

2.

]]

Proposed ODYSY Procedure

3. [[

4.

5.

6.

]]

Proposed ODYSY Procedure

- [[

]]

Demonstration Analysis

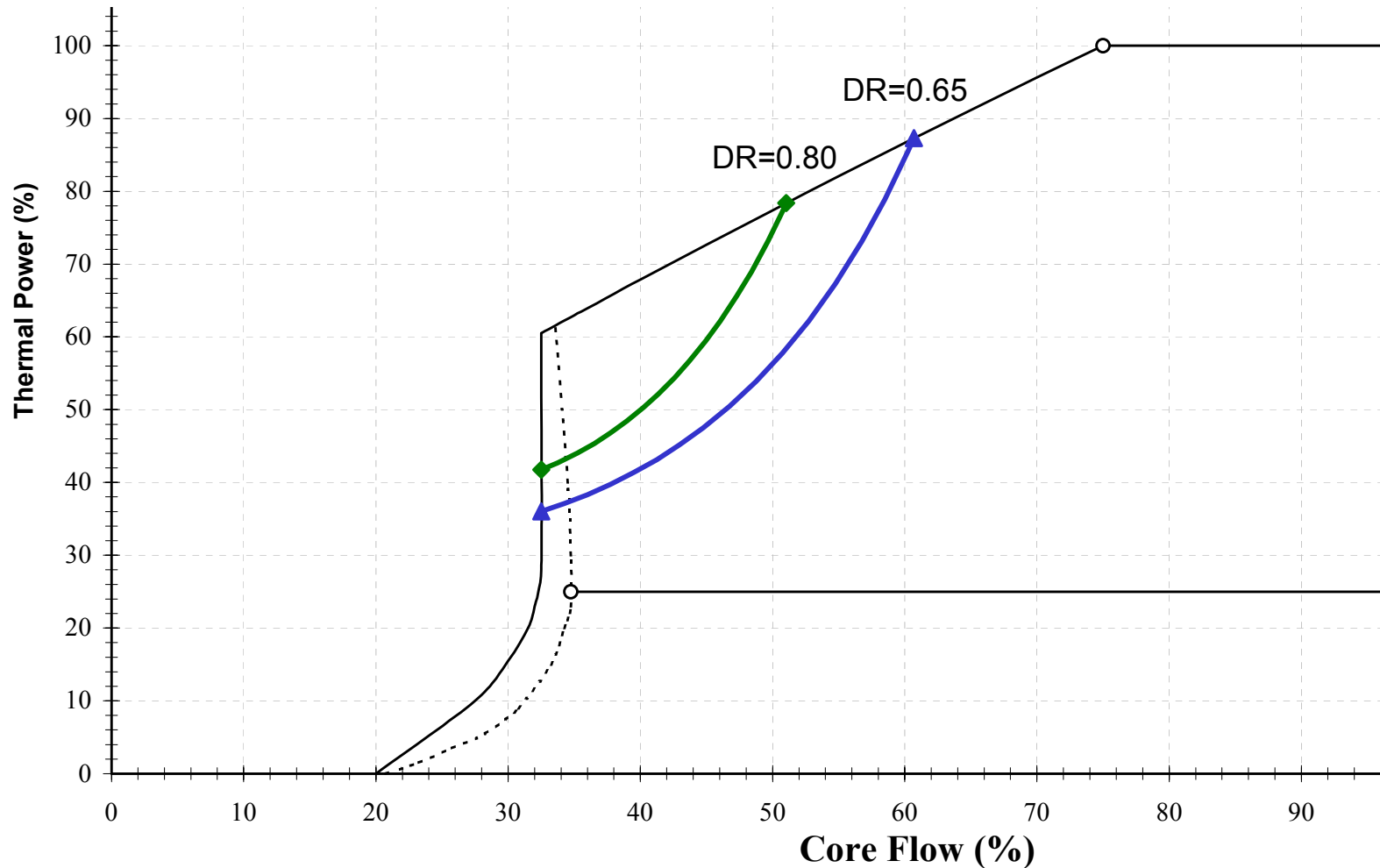
- Exclusion regions generated for two new plants and three plants from original ODYSY LTR
 - New: Plant 1, Plant 2
 - Original: Plant 3, Plant 4, Plant 5
- Regions generated with and without DR adder
 - Core DR criterion: 0.80, 0.65
- Regions generated for reduced feedwater temperature for Plant 1
 -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



Plant 1 Demonstration

[[

]]

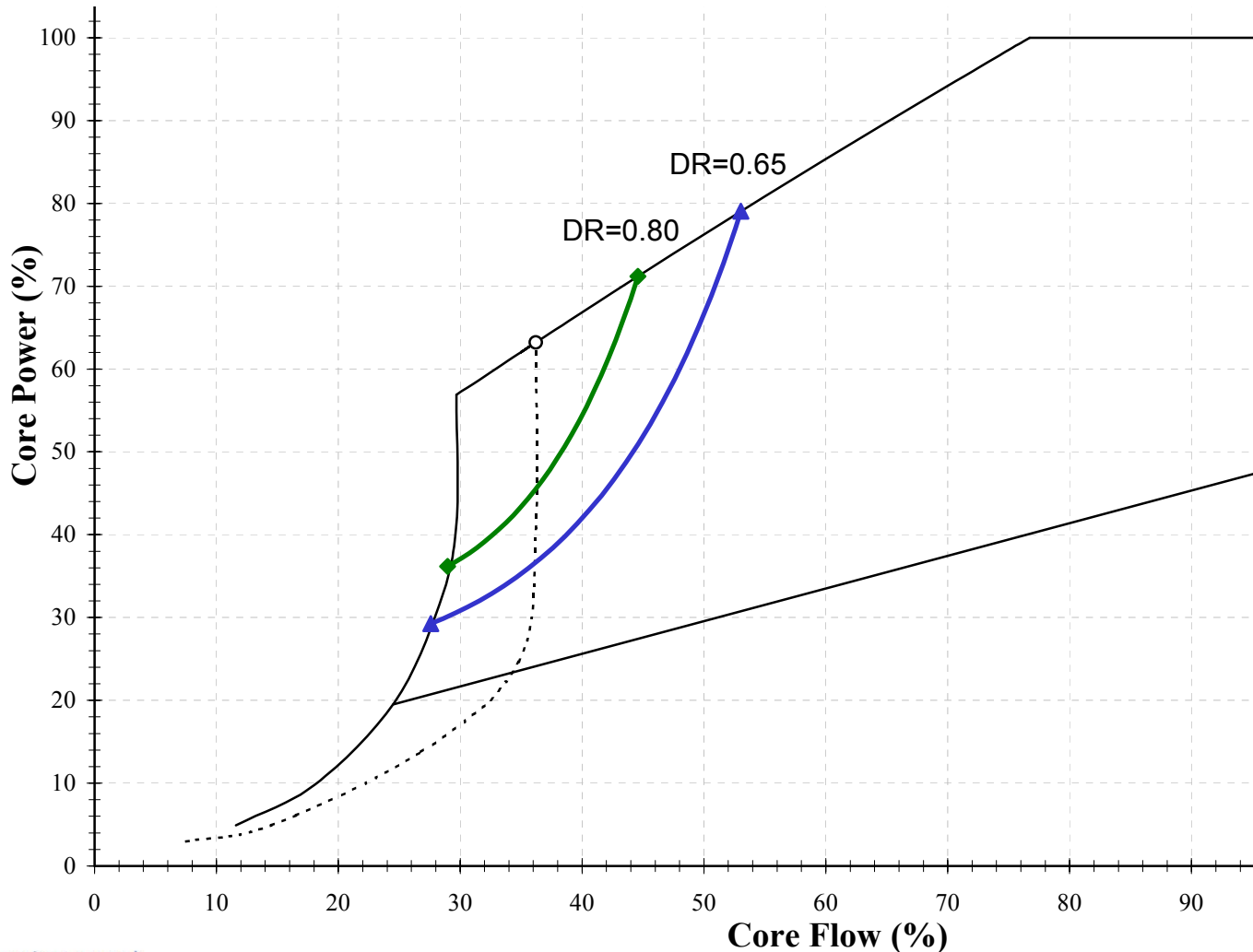
Plant 1 Demonstration

[[

]]

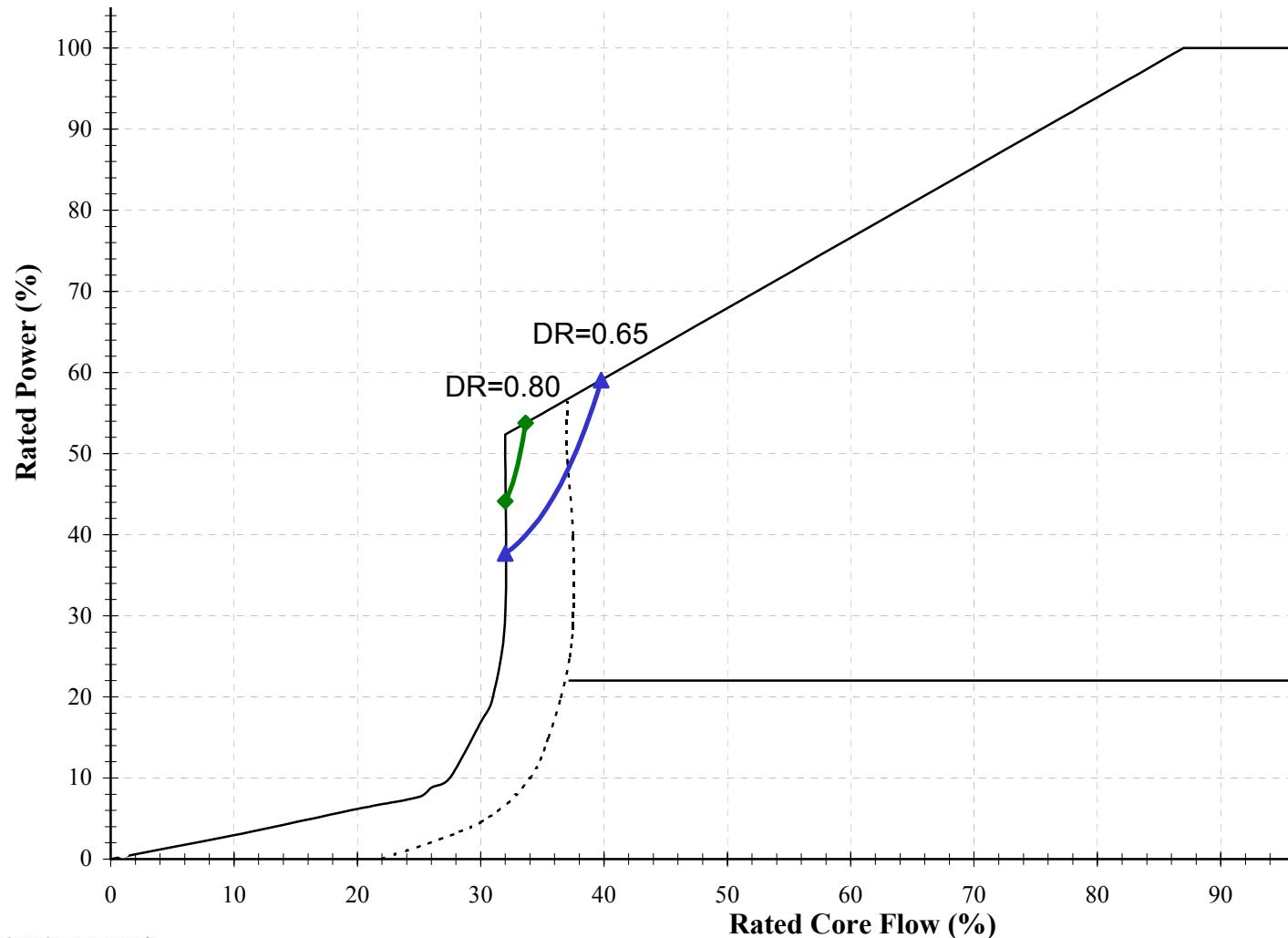
Plant 2 Demonstration

Exclusion regions with and without 0.15 DR Adder



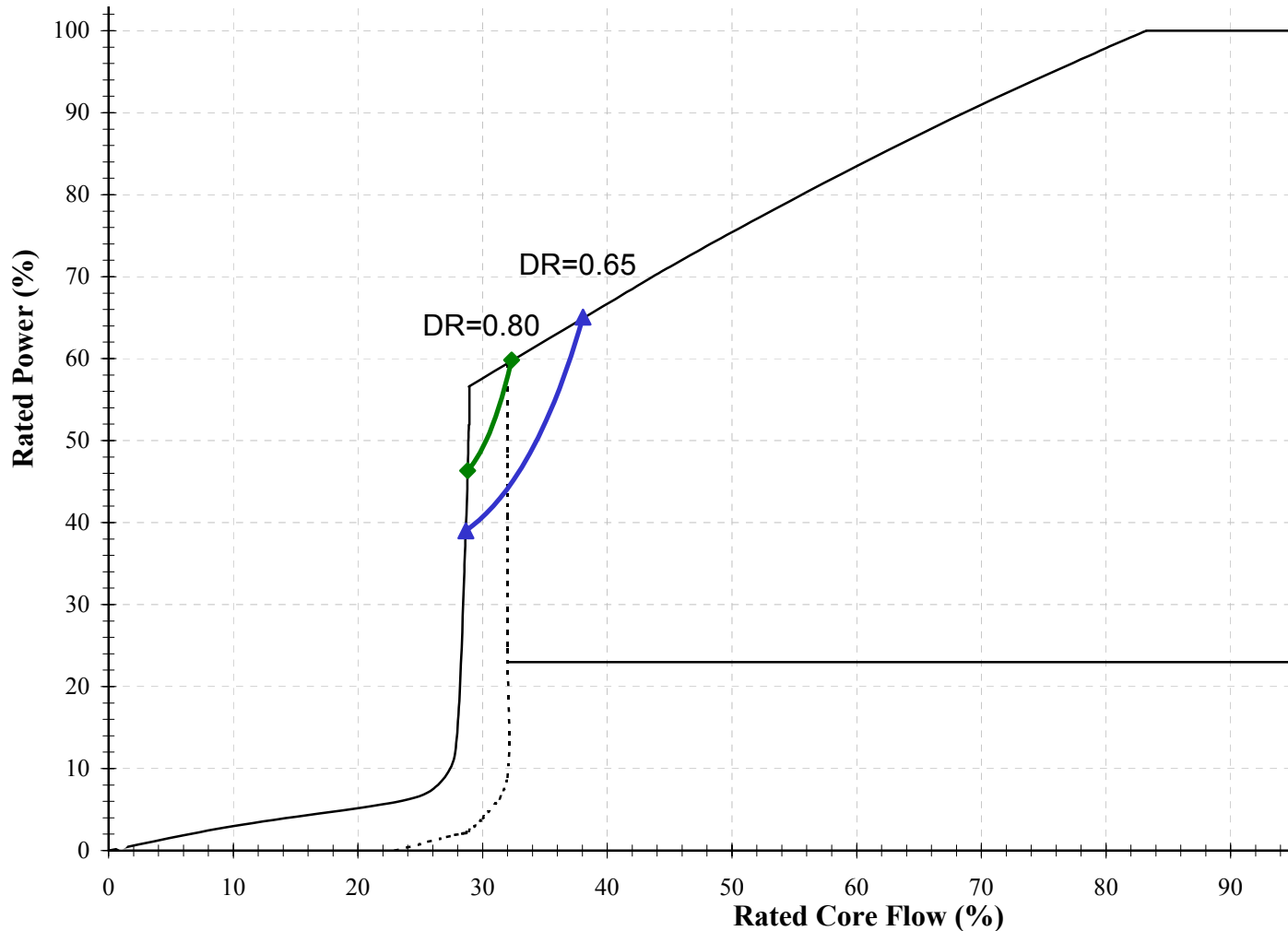
Plant 3 Demonstration

Exclusion regions with and without 0.15 DR Adder



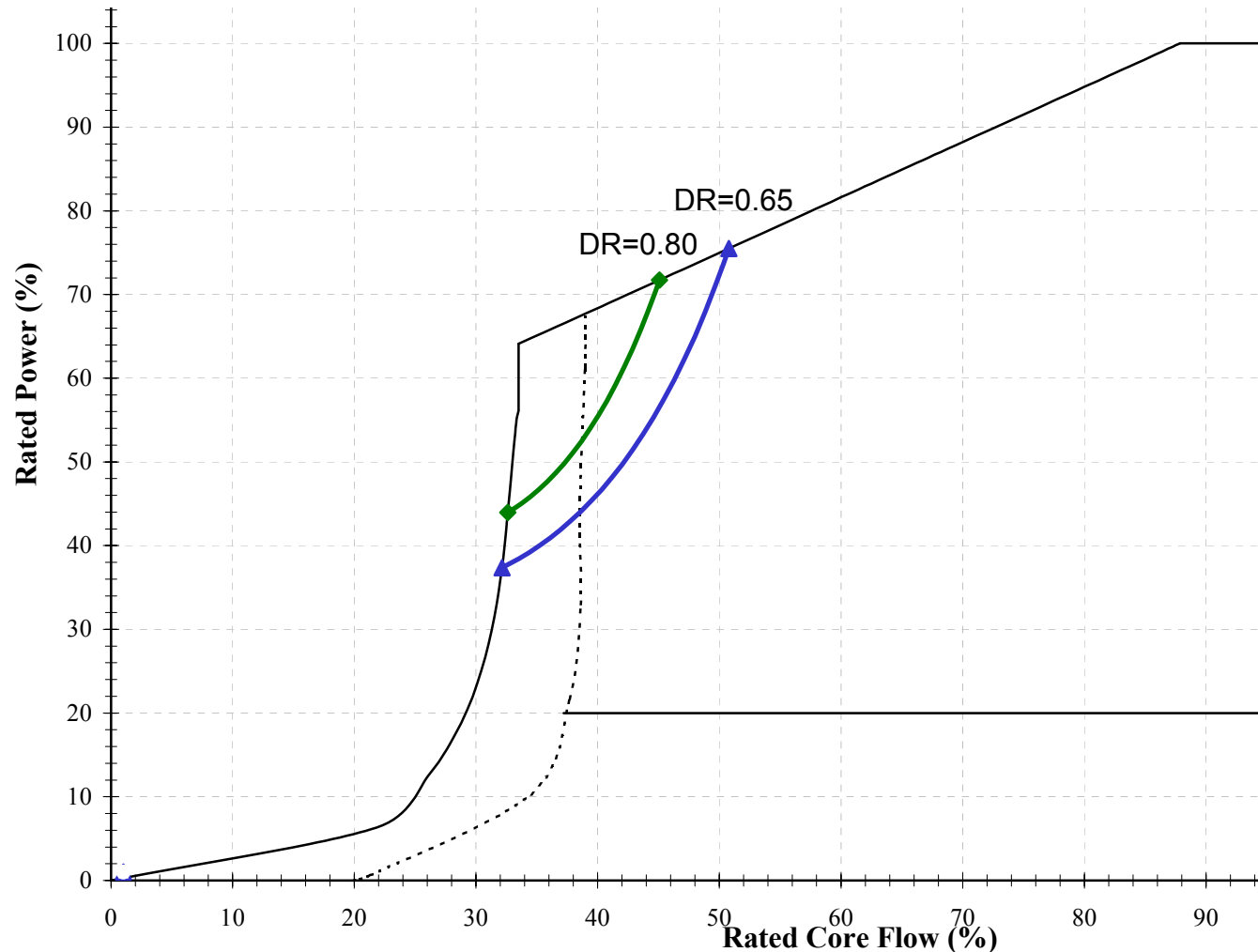
Plant 4 Demonstration

Exclusion regions with and without 0.15 DR Adder



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
- [[

-

]]

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
- [[
]]

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?