Prairie Island Nuclear Generating Plant

Spent Fuel Pool Criticality Technical Specification Changes

Round 2 Request for Additional Information

Public Meeting
Rockville, MD
March 9, 2017

Introductions

- **Xcel Energy**
  - Tom Conboy, PINGP Director Site Operations
  - Mark Brossart, PINGP Reactor Engineering Supervisor
  - Marty Murphy, Director Nuclear Licensing Reg Affairs
  - Sean Martin, Nuclear Analysis and Design (NAD)
  - Darius Ahrar, NAD Supervisor
  - Glenn Adams, Project Licensing
- **Westinghouse**
  - Mike Wenner
  - Andrew Blanco
  - Doug Sipes

Project Principles

- Maintain adequate nuclear safety margins
- Maintain existing SFP capacity (minimize empty cells)
- Focus on safety (avoid unnecessary fuel moves)
- Minimize complexity of fuel selection procedures (human factors)

Meeting Objectives

- Understand regulatory and technical basis for RAIs
- Understand the conservatism in the recent criticality analysis and the impact on safety and operations
- Request the NRC reconsider the need for these RAIs

- Alternate approach to addressing the RAIs if warranted
- A schedule for resolution

Background

PINGP SFP Criticality Licensing History

- Long history of conservative analysis
  - 1997 – Credit for pool boron per generic WCAP 14416
  - 2006 – Credited gadolinium in fresh fuel. Plant specific analysis addressing “Kopp letter”.
  - 2013 - Corrected errors in 2006 analysis. Met DSS-ISG-2010-01.
  - 2015 LAR – Analyzed IFBA. Increased pool boron from 1800 ppm to 2500 ppm.

Background

IFBA SFP Criticality LAR

- Reason: IFBA must be modeled (not a net poison like gadolinium)
- Analysis Method: Supplement to 2013 NRC-approved analysis (WCAP-17400-P)
- Scope of changes:
  - Include IFBA in depletion models, no credit for gadolinium
  - Revised the burnup curves for TS
  - Increased SFP soluble boron requirement in TS

Background

IFBA SFP Criticality LAR Licensing Merits

- Analysis comports with:
  - Current PINGP licensing basis
  - Interim Staff Guidance
- Analysis extended to include established precedent
  - Conservative application of misloading accident
  - Bias for fission product nuclides (NUREG/CR-7109)
- Results meet the conservative margins of the 50.68

Background

IFBA SFP Criticality LAR Progress

11-17-15	**LAR submitted**
1-7-16	**LAR accepted**
4-12-16	**Round 1 RAIs**
5-23-16	**Round 1 RAI Reply**
10-31-16	**Round 2 RAIs (eccentricity and grid growth bias)**
1-16-17	**Westinghouse provided analysis results (for Rd 2 RAI)**
2-16-17	**Letter deferring response until public meeting**

RAI-6

***Draft guidance document, NEI 12-16*, "Guidance for Performing Criticality Analyses of Fuel Storage at Light-Water Reactor Power Plants," is in the process of being finalized. However, the NRC technical staff has reached agreement with NEI on many aspects of the document without exception. One of these aspects is in regards to accounting for the reactivity effect of [[proprietary]]. The NRC staff did not identify that this accounting practice was not implemented during its initial review of WCAP-17400-P, Supplement 1, Revision 1, "Prairie Island Units 1 and 2 Spent Fuel Pool Criticality Safety Analysis: Supplemental Analysis for the Storage of IFBA Bearing Fuel," and consequently it was not identified in the corresponding requests for additional information issued on April 12, 2016.**

In order for the NRC staff to complete its review of WCAP-17400-P, Supplement 1, Revision 1, *please correct the accounting* of the [[proprietary]] to align with the *current NRC and industry understanding of this phenomena* to ensure that the 10 CFR 50.68(b)(4) requirements are met. The NRC staff believes this correction is particularly necessary in this case because of the *large reactivity effect* specific to Prairie Island spent fuel pool storage conditions.

RAI-7

A concern was recently brought to the attention of the NRC staff **regarding the potential for fuel assembly spacer grid growth during irradiation and its impact on spent fuel pool criticality safety analyses. This concern has also been identified and *is being addressed as part of NEI 12-16 guidance development*.**

The fuel assembly grids have been shown to expand over the course of their utilization in the reactor (see Figure 4 of Ref. 1). *How does this affect the Prairie Island spent fuel pool criticality safety analysis* in WCAP-17400-P, Supplement 1, Revision 1 and the ability to meet 10 CFR 50.68(b)(4) requirements? The NRC staff has performed studies showing that the effect of uniform pitch changes of 0.5% and 1% under spent fuel pool storage conditions can result in reactivity effects of approximately 500 pcm and 1000 pcm, respectively.

Concerns with RAI

NRC RAI-6, Eccentric Fuel Positioning as a bias

- LAR: Treated as uncertainty (consistent licensing basis and NRC approved analysis)
- RAI requires eccentric positioning as a bias, based on:
  - NEI agreement on draft guidance NEI 12-16
  - Large reactivity effect on PINGP
- No basis established that adverse eccentricity was probable
- No statistical basis for treating the adverse eccentricity as a bias
- Little precedent and no approved topical methodology for modeling eccentricity as a bias

Concerns with RAI

NRC RAI-7, Spacer Grid Growth

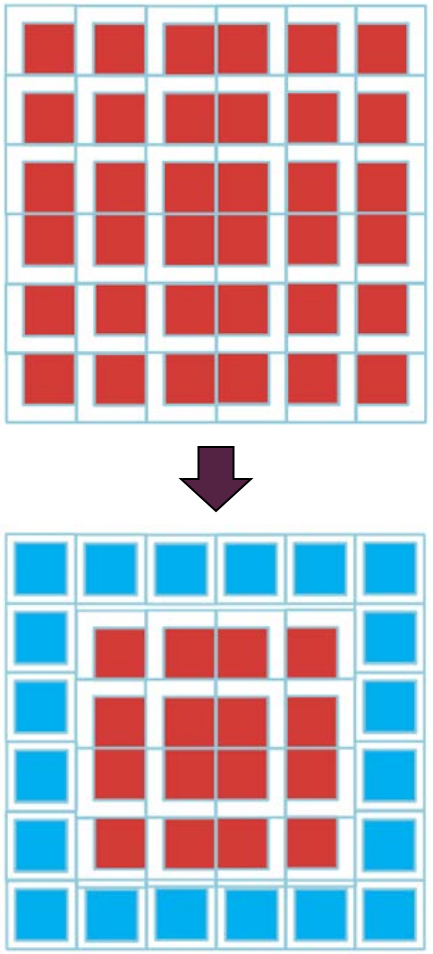
- LAR: Considered pin pitch tolerance, not grid growth
- ISG: No consideration of grid growth
- RAI requests consideration of grid growth, based on:
  - General concern that grids expand during irradiation
  - Issue identified in NEI 12-16 guidance development
  - NRC Staff study of uniform pitch changes cause 1000 pcm increase

RAI Reply – Preliminary Approach

Bounding Model for RAI Reply

- Eccentricity modeled with some decoupling ($\Delta k\downarrow$)
- Eccentric effect applied as a bias
- Grid growth data taken from Westinghouse field data
- Selected bounding growth rate

RAI-6 Preliminary Approach



Model of Eccentricity Changed

- Analysis of Record, LAR assumed 6x6 reflected

Analysis for Round 2 RAI Reply

- Assumes 4x4 (16) assemblies are adversely eccentric
  - Very improbable statistically (later)
- When reflected, two concentric rows decouple the eccentric array
- When reflected at boundary, the model represents >>16 eccentric bundles in SFP

RAI-7 Preliminary Approach

Grid Growth Data

- Measured growth data from longitudinally stamped ZIRLO® grids
- 122 different measurements of growth at varying burnups
- Growth is scaled to 14x14 fuel grid size

Conservatisms

- Excluded single data point, not median
- Assumed uniform pin pitch growth
- Assumed all grids grow at max growth rate
  - Ignores axial variation in burnup
  - Ignores Inconel top grid at location which drives reactivity most

RAI-7 Preliminary Approach

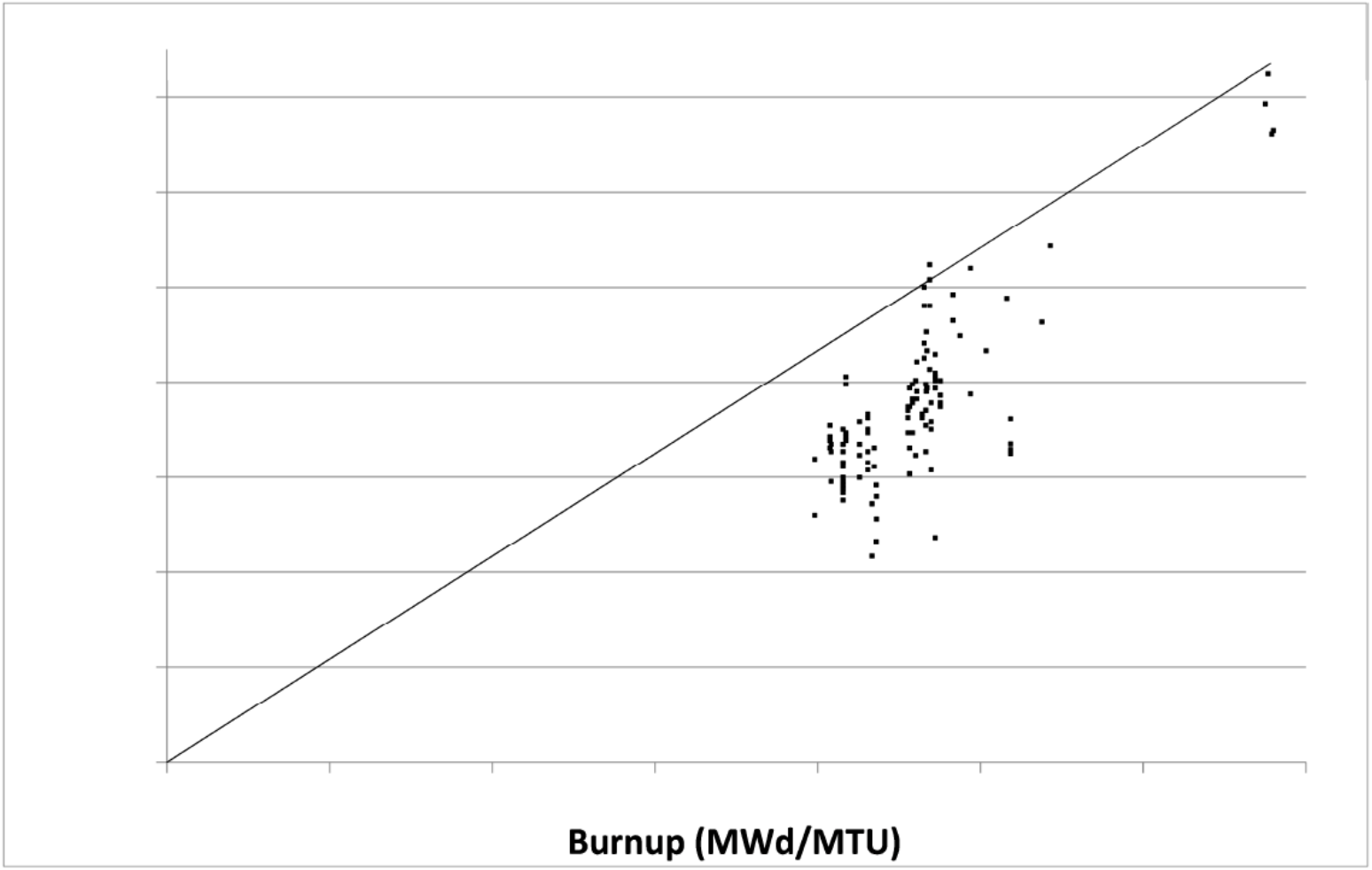
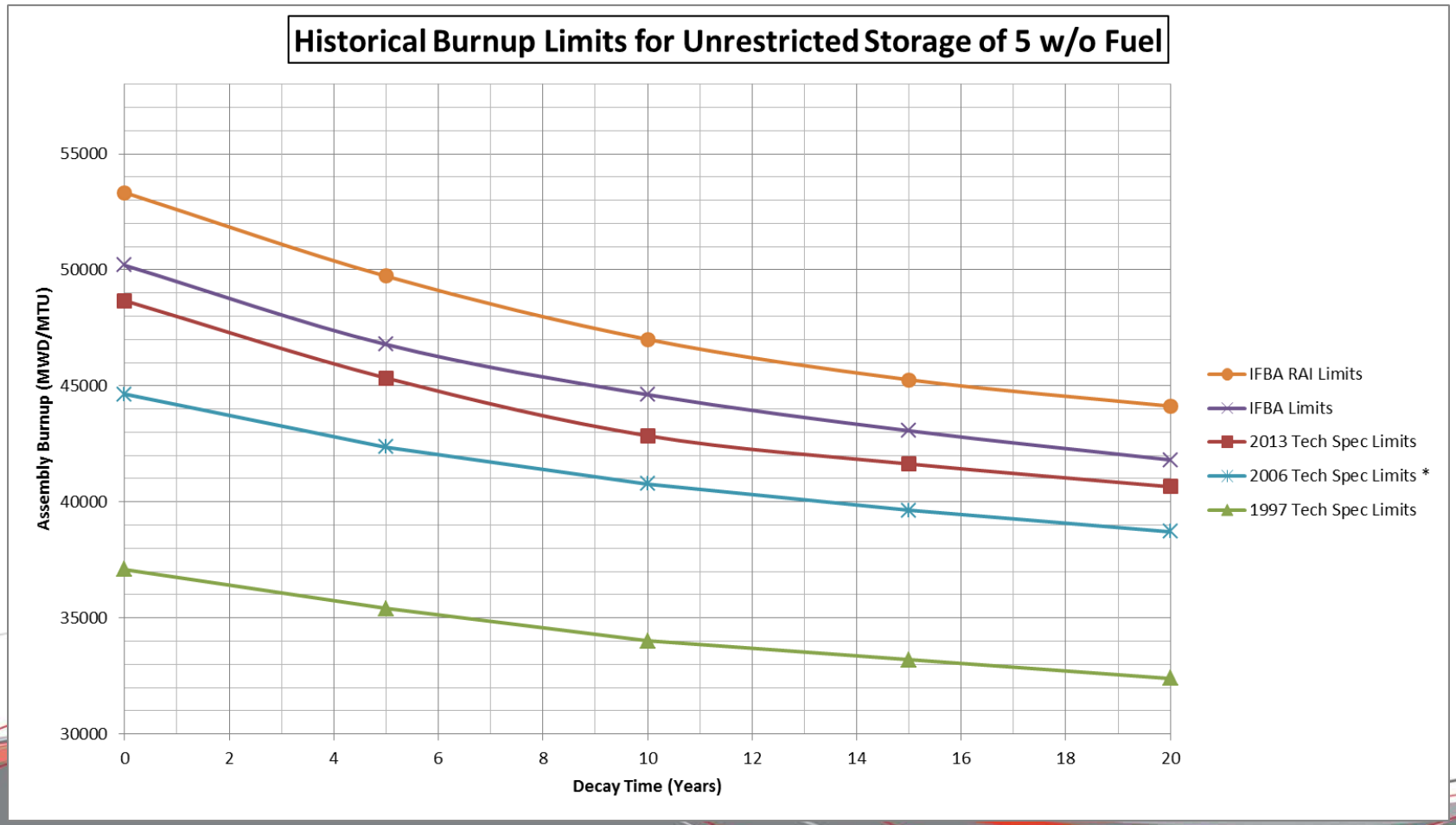


Figure 7-4: Grid Growth Database Data for Longitudinally Stamped ZIRLO® Grids

RAI Preliminary Approach – Plant Impacts

- Category 6 (unrestricted storage) requirements increase up to 4 GWD/MTU
  - Compared to 1997, unrestricted storage approaching an additional cycle of exposure
- Increased inventory of Category 4 and Category 5
  - Category 5 arrays require control rods
  - Category 4 arrays require empty cells

RAI Preliminary Approach – Plant Impacts

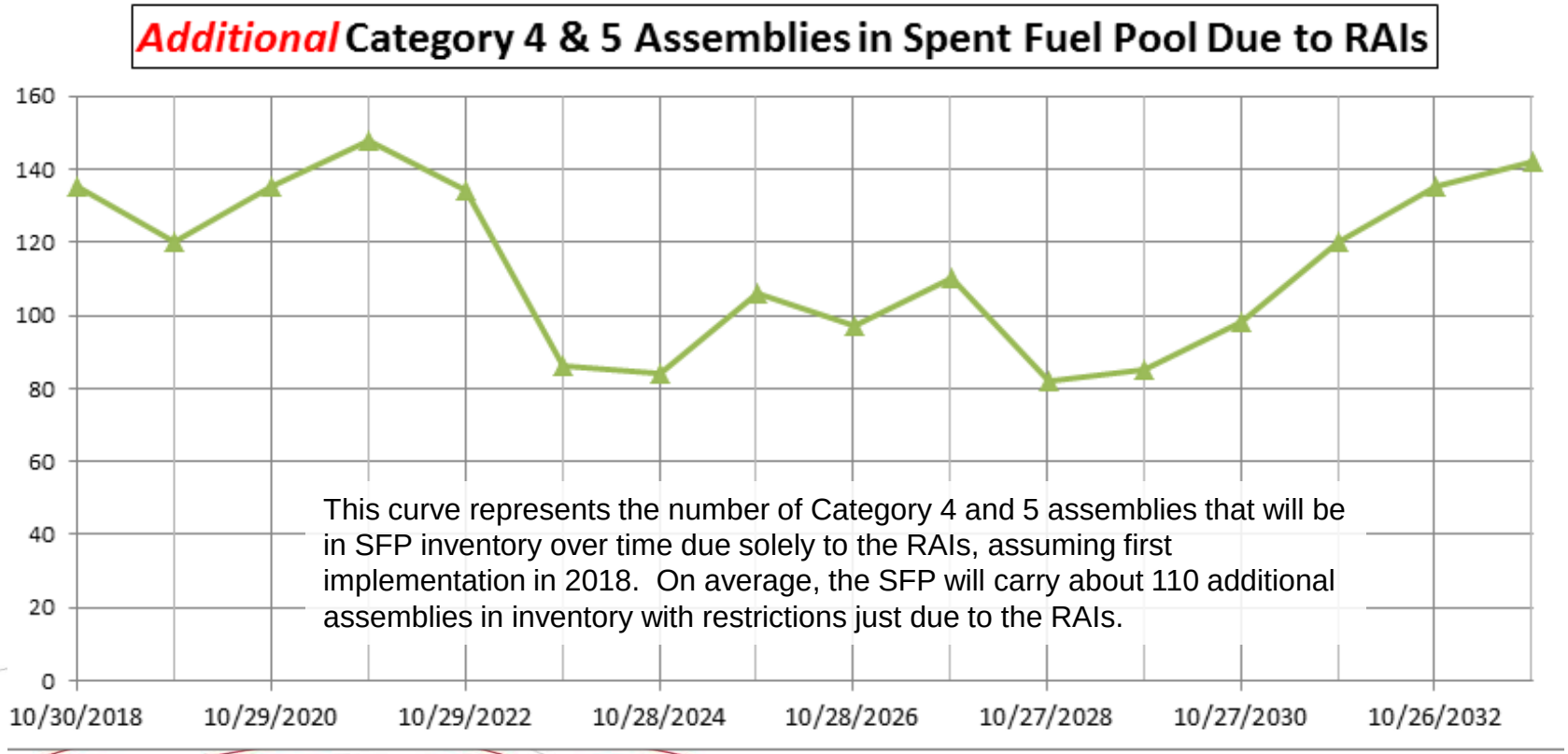


RAI Preliminary Approach – Plant Impacts

Plant impacts are non-trivial

- > 100 additional fuel moves for initial implementation
- Incrementally more fuel moves each refueling for higher inventory of Category 5 and 4 assemblies
- Possible acceleration of cask loading campaigns

RAI Preliminary Approach – Plant Impacts



RAI Preliminary Approach – Conclusion

- Request the NRC reconsider the need for these RAIs
  - Submitted analysis (LAR) comports with NRC Interim Staff Guidance and current PINGP licensing basis
  - Results meet the conservative margins of 10 CFR 50.68
  - Requested treatment not consistent with PINGP licensing basis
  - NRC has not endorsed NEI 12-16
  - Analytical treatment results in unnecessary fuel moves

RAI Response – Alternate Approach

- **If RAI is not withdrawn:**
  - Alternate analytical approach is necessary
  - NRC engagement and assurance for next round of analysis

RAI-6 Alternate Approach

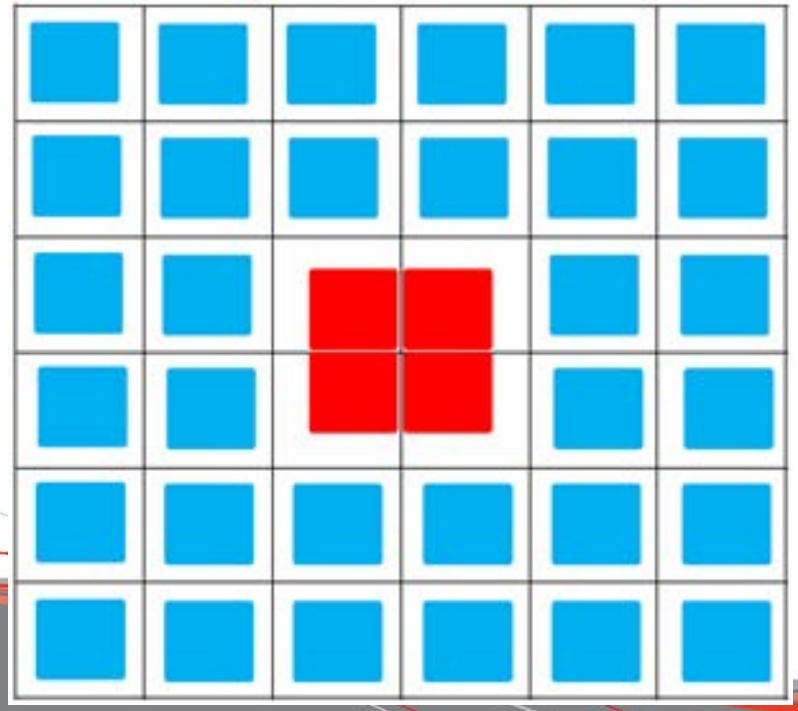
- Eccentricity traditionally handled as uncertainty
- PINGP fuel placement within a cell is a random, analog condition
  - Two-dimensional freedom
  - No forces to bias fuel in any particular direction
  - Imprecision of fuel placement equipment
  - Imprecision of fuel placement process
  - Success criterion: anywhere within storage cell

RAI-6 Alternate Approach

- Probability approaches to a conservative eccentricity model:
  1. 2x2 array with 9 possible positions of equal likelihood. Probability of AEL is ~ 1:6,561
  2. Assume conservative probability of occurrence (e.g., 1E-5) then calculate partially-eccentric position for a 2x2 or 3x3 array (assuming uniform probability distribution for assembly within a cell)

RAI-6 Alternate Approach

- If adverse eccentricity must be modeled
  - Model reflect only the credible AELs



RAI-7 Alternate Approach

- **Grid growth not previously considered**
- **No topical treatment of data**
- **In recognition of the stated conservatisms:**
  - Use the median growth value, and
  - Credit non-uniform growth distribution

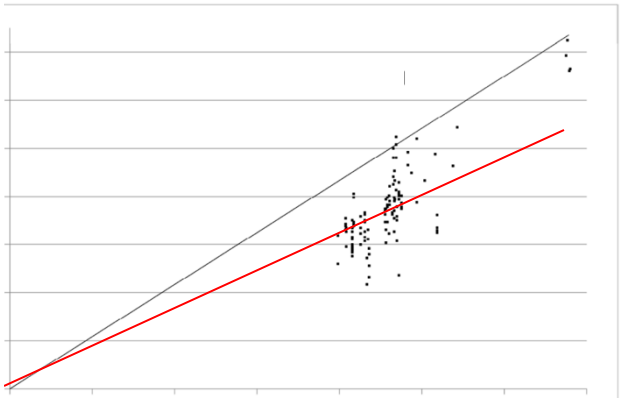


Figure 7-4: Grid Growth Database Data for Longitudinally Stamped ZIRLO™ Grids

RAI Reply (Reduce B/U Uncertainty)

- **Reduce <u>Depletion Uncertainty</u>**
  - Apply new depletion benchmarks
  - Reduce uncertainty from 5% to ~ 3%
  - Supported by EPRI Reports
    - 680 flux maps from 44 PWR cycles
  - Supported by NEI 12-16

Conclusion

- **Perceived increase in analytical margin does not offset the risks of fuel moves**
- **Alternate approach is more appropriate than bounding treatment of RAIs**
- **Technical engagement on next round of analysis**
  - Review statistics on eccentricity, grid growth
  - Alternate studies
  - Align on criticality models and methods
  - Increase confidence next analysis acceptable

Proposed Plan for Resolution

Date	Milestone
APR 2017	Preliminary models and methods
MAY 2017	Engagement with NRC ▪ Regulatory basis for RAIs ▪ Alternate approach to analysis
MAY 2017	Acceptable models and methods established
SEP 2017	LAR supplement w/ revised models/methods
NOV 2017	Requested amendment date

Overall Conclusion

- **NRC reconsider RAIs**
- **NRC engagement for alternate approach to RAIs**

Questions