

**Dominion Millstone Unit 3  
Spent Fuel Pool Criticality  
RAI 26-30 Response Plan**

February 17, 2010

# MP3 RAI 26-30 Response Plan

- RAI 26

- **Issue: Margin needed to cover power history effects**
  - NUREG/CR-6665 estimated history effect magnitude  $\sim 0.002 \Delta K$
  - Soluble boron used for simulated fuel depletion was cited as a source of margin in RAI 5 response, boron margin information requested
- **Response plan – Power history effect margin**
  - Review NUREG/CR-6665 recommendation
    - Deplete at constant power and add margin for history effects
    - ORNL/TM-12973 says to apply margin as “uncertainty in  $k_{eff}$ ”
  - Conservatively apply as a constant  $0.002 \Delta K$  bias in burnup requirement curves using burnup relationship discussed in RAI 27(b) response
    - No bias needed for fresh fuel with no burnup history
    - Penalty will be applied as part of RAI 30 response

# MP3 RAI 26-30 Response Plan

- RAI 26
  - **Response plan – Provide soluble boron margin**
    - Analysis used constant 1000 ppm for simulated depletions
    - Provide cycle average boron for all completed cycles and current cycle
      - Expect 50-100 ppm margin for SPU cycles based on recent cycles and currently operating SPU cycle
  - **Response plan – Clarify RAI 5 soluble boron margin response**
    - 1000 ppm is projected to bound SPU cycles
    - Cycle 6 (pre-SPU) had greater than 1000 ppm cycle average boron
      - Outlier 21 month cycle
    - All Cycle 6 fuel was depleted in at least one other cycle
      - Maximum 2 cycle average boron is 1008 ppm
      - Very small reactivity impact
    - Multiple sources of compensating margin are available (credit as-operated moderator temperature)

# MP3 RAI 26-30 Response Plan

- RAI 27(a)
  - **Issue: Provide code validation or justify not performing a criticality code validation for calculating RAI 21 penalties**
    - PARAGON / SCALE 5.1 used to develop RAI 21 burnup penalties
    - PHOENIX / SCALE 4.4 used for original WCAP 16721 burnup calculations
  - **Response plan – SCALE 5.1**
    - Provide code validation information for SCALE 5.1
    - Provide a comparison of SCALE 5.1 and SCALE 4.4 uncertainty and bias
    - Bias difference between SCALE 5.1 and SCALE 4.4 cancels out for reactivity difference calculations
  - **Response plan – PARAGON**
    - PARAGON and PHOENIX are used to calculate isotopic content of depleted fuel determined at reactor operating conditions, not for  $K_{\text{eff}}$  in the SFP
    - PARAGON SER permits use for the same purposes as PHOENIX
    - Bias between PARAGON and PHOENIX cancels out for reactivity difference calculations

# MP3 RAI 26-30 Response Plan

- RAI 27(b)
  - **Issue:** Explain the basis for Table 21-6 ( $\Delta K / \Delta Bu$  ratios)
  - **Response plan**
    - Values in Table 21-6 are superseded by RAI 30 response
    - Basis for the ratios is  $(K_2 - K_1) / (Bu_2 - Bu_1)$  using values from WCAP Tables 4-9 and 4-10 over a burnup change of 10 GWD/MTU
- RAI 27(c)
  - **Issue:** Provide depletion parameters used in RAI 21 response
  - **Response plan**
    - Provide a list of depletion parameters used
      - Moderator temperature
      - Soluble boron
      - Core power
      - Fuel characteristics
    - RAI 21 parameters are bounded by RAI 30 (higher moderator temperature)

# MP3 RAI 26-30 Response Plan

- RAI 27(d)
  - **Issue: Response to RAI 21 for No Blanket fuel takes credit for margin that earlier responses already took credit for as conservatisms**
    - Explain impact on earlier responses
    - Explain how bias and uncertainty are affected by use of as-built fuel characteristics and depletion conditions
  - **Response plan**
    - RAI 21 response crediting as-built conditions was only for Region 2 for already depleted No Blanket fuel
    - Dominion will store all No Blanket fuel in Region 1 or Region 3
      - Restriction footnote will be added to TS Figure 3.9-3 (Region 2)
    - Region 1 justification:
      - RAI 21 issue was justification of axial burnup shapes
      - Region 1 burnup requirements are very low
      - Uniform axial shape is conservative for low burnup
    - Region 3 justification
      - All No Blanket fuel was used in pre-uprate cycles
      - Existing TS Figure 3.9-4 is basis for this fuel

# MP3 RAI 26-30 Response Plan

- RAI 27(e)
  - Issue: Provide RAI 21 title change to TS Figure 3.9-4
  - Response plan
    - RAI 21 response was referring to changes made to TS Figure 3.9-4 that were already provided in the original submittal
    - No change needed to TS Figure 3.9-4 as submitted in Dominion letter Serial Number 07-0450

# MP3 RAI 26-30 Response Plan

- RAI 28

- **Issue: Conflicting DNC and NUREG/CR-6760 conclusions about the effect of IFBA must be resolved**

- DNC submittal indicates it is conservative to ignore IFBA
- NUREG/CR-6760 indicates it is non-conservative to ignore IFBA

- **Response plan**

- Recalculate IFBA effect
  - Use maximum previous or proposed IFBA loading, 120 inch IFBA
  - Use RAI 21 shapes and models, RAI 30 temperatures
  - Determine burnup penalty versus assembly burnup
  - Include in burnup penalty described in RAI 30
  - Add burnup penalty to TS curves for Region 2 and Region 3
    - Burnup requirement is too low for a penalty in Region 1

# MP3 RAI 26-30 Response Plan

- RAI 29
  - **Issue: Has MP3 used any flux suppression devices?**
    - RAI 5 response stated that MP3 fuel management does not use fixed burnable absorbers
  - **Response plan – flux suppression devices**
    - MP3 has not used any flux suppression devices in any cycle
  - **Response plan – Clarify RAI 5 fixed burnable absorber response**
    - MP3 fuel management has no current or planned use of fixed burnable absorbers
      - Batches B, C, and D (pre-SPU Cycles 1 and 2) had fixed absorbers in No Blanket fuel
    - Clarification - Region 1:
      - Existing TS Figure 3.9-1 bounds SPU analysis and is basis for pre-SPU fuel
      - Burnup requirement is very low in Region 1
      - Absorber history is not significant at very low burnup
    - Clarification - Region 2:
      - RAI 27(d) response does not permit storage of No Blanket fuel in Region 2
    - Clarification - Region 3:
      - Existing TS Figure 3.9-4 is basis for pre-SPU fuel

# MP3 RAI 26-30 Response Plan

- RAI 30
  - **Issue: Provide the core average moderator exit temperature (nominal flow) and maximum assembly moderator exit temperature (minimum flow)**
    - It appears that a nominal rather than a conservative value was used
  - **Response plan**
    - Provide nominal core average moderator exit temperature (620.4 F vs 628 F analyzed)
    - Provide bounding maximum assembly moderator exit temperature versus burnup based on recent cycle fuel management and minimum TS flow
      - Calculate moderator exit temperature penalty using RAI 21 models and burnup profiles
      - Sum all relevant penalties
        - Bounding exit moderator temperature penalty
        - RAI 21 axial node and burnup shape penalty
        - RAI 28 IFBA history penalty
        - RAI 26 power history penalty
        - Increase administrative margin from 0.1%  $\Delta K$  to 0.5%  $\Delta K$
      - Convert penalty to burnup using best estimate  $\Delta K / \Delta Bu$  (WCAP Tables 4-9 and 4-10)
    - Summarize RAI analysis conservatisms