Crystal River 3 Cycle 14 Mark-B-HTP Design

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NGG Nuclear Generation Group

Progress Energy

Attendees

- Progress Energy
  - Sherry Bernhoft
    Superintendent, Systems Engineering
  - Sid Powell
    Supervisor, Licensing and Regulatory Programs
  - Michael Donovan
    Supervisor, Reactor Systems
  - Leo Martin
    Supervisor, PWR Fuel Engineering
- Framatome-ANP
  - Jerry Holm
    Manager, Product Licensing
  - Richard Harne
    Team Leader, Thermal Hydraulic Technology

Purpose

- Present need for Mark-B-HTP (High Thermal Performance) Design
- Describe Design
- Identify NRC Support Necessary
- Communicate Requested Schedule

Background/History

- Leaking Fuel at CR3
  - CR3 has experienced recurring fuel failures each cycle throughout its 25 year operating history
  - Actions to date have not been adequate to address long-standing fuel performance problems
- Root Cause Investigation Performed
  - Inadequate stabilization of the fuel rod by the grid to prevent fuel rod vibration
- Corrective Action to Prevent Reoccurrence
  - Implement HTP spacer design at earliest opportunity

Background/History (Continued)

- Timeline
  - Mark-B10 to Mark-B12 transition planned (early Summer 2002) for Cycle 14 implementation (Fall 2003)
    - Mark-B12 utilized at Davis Besse and TMI-1
  - Chief Nuclear Officer challenge to address CR3 failures (Summer 2002)
  - Aggressive schedule set for Mark-B-HTP introduction for Cycle 14
    - Plan developed (late Summer 2002)
    - Parts being fabricated
    - Flow testing (Spring 2003)
  - Additional NRC reviews are required

Mark-B-HTP Design Description

- Mark-B-HTP is based on Mark-B12 with:
  - Seven zircaloy HTP grids
    - 8 full length line contacts versus 6 stops (2 soft + 4 hard)
    - Slanted flow channels improve mixing
  - One inconel HMP (High Mechanical Performance) grid
    - At bottom of assembly
    - Straight flow channels
  - A FUELGUARD lower end fitting
    - Reduced flow turbulence
    - No "line of sight" design prevents debris entry
    - Debris resistance comparable to fine mesh TRAPPER

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Fuel Design Comparison

Parameter	Mark-B10 (Cycle 13)	Mark-B-HTP (Cycle 14)
Cladding, end cap, guide tube and instrument tube material	All Zirc-4	M5 cladding and guide tubes Zirc-4 end caps and instrument tubes
Plenum Volume (in^3)	[redacted]	[redacted]
Clad ID	0.377"	0.380"
Pellet OD	0.3700"	0.3735"
Cladding Thickness	0.0265"	0.0250"
Pellet Density %Theo	95	96
Active Fuel Length	140.7"	143.0"
Bundle U Weight (KgU)	466	490

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Fuel Design Comparison (Continued)

Parameter	Mark-B10 (Cycle 13)	Mark-B-HTP (Cycle 14)
Bottom grid	Inconel	HMP (Inconel HTP)
Intermediate grids (6)	Mark-BZ Zircaloy	HTP Zircaloy
Top grid	Inconel	HTP Zircaloy
Fuel assembly structure	Floating grids	Welded grids
Debris resistance	Long lower end plug	FUELGUARD

HTP / HMP
Industry Experience

- HTP grid experience
  - Over 3,483 HTP assemblies; zero grid fretting failures
    - H. B. Robinson: 8 cycles 15x15 HTP (409 assemblies)
    - Shearon Harris: 6 cycles 17x17 HTP (353 assemblies)
  - Used in KWU 16x16 and 18x18, CE 14x14 and 15x15, W 17x17 and 15x15 fuel designs
  - Peak Exposure Achieved: 56 GWd/MTU
- HMP (or Inconel HTP) grid experience
  - Used in 503 assemblies; zero grid fretting failures
  - Used in CE 14x14 (276 assemblies), CE 15x15 (171 assemblies), W 17x17 leads (24 assemblies), and KWU 16X16 and 18X18 leads (32 assemblies)

FUELGUARD
Industry Experience

- FUELGUARD experience
  - 3,409 PWR and 1,818 BWR assemblies
    - H. B. Robinson: 6 cycles FUELGUARD (313 assemblies)
    - Shearon Harris: 6 cycles FUELGUARD (353 assemblies)
    - Brunswick: 4 leads in second cycle
  - Zero PWR debris failures (industry wide)
  - 2 BWR debris failures (industry wide)
    - Debris entry from top of bundle suspected
  - Peak Exposure Achieved: 56 GWd/MTU

NRC Reviews Required

- Change to Technical Specification 4.2.1, "Fuel Assemblies," and M5 Exemption Request
  - Schedule
    - Submit LAR 276 October 25, 2002 (LAR 276 also contains changes to T.S. 4.2.2, "Control Rods," unrelated to Mark-B12 implementation)
    - Request Approval August 2003
- Technical Specification changes required to implement Mark-B-HTP
  - SL 2.1.1.2 - LYNXT based HTP DNB correlation limit
  - Figure 2.1.1-1 RCS DNB safety limit (potential)
  - Schedule
    - Submit December 2002
    - Update (if required) May 2003
    - Request Approval August 2003

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NRC Reviews Required (Continued)

- Revision to EMF-92-153, "HTP: Departure From Nucleate Boiling Correlation For High Thermal Performance Fuel"
  - Incorporate results of LYNXT evaluation of HTP CHF database
  - Schedule
    - Submit December 2002
    - Request Approval August 2003

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NRC Reviews Required (Continued)

- Revision to BAW-10179, "Safety Criteria and Methodology for Acceptable Cycle Reload Analyses"
  - Reference revised EMF-92-153
  - Reference BAW-10164, R4, "RELAP5/MOD2-B&W, An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analyses"
    - Approved 04/02 for use in BWNT LOCA EM (BAW-10192)
  - Schedule
    - Submit December 2002
    - Request Approval August 2003

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Summary

- Mark-B-HTP design addresses root cause of fuel failures
- Design features have proven in-reactor experience
- Implementation requires NRC review and approval of several minor revisions to LTRs and Technical Specifications
- Schedule provides adequate time for required reviews

Backups

15x15 Fuel Design Comparison
H. B. Robinson / Crystal River -3

Parameter	Robinson	Crystal River-3
Fuel Rod Diameter, in	0.424	0.430
Fuel Rod Pitch, in	0.563	0.568
Grid Envelope, in	8.436 (HTP)	8.536
Axial Grid Span, in (typical)	20.55	21.09

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Technical Specification 4.2.1 Change and M5 Exemption Request

- Changes to Technical Specification 4.2.1, "Fuel Assemblies"
  - Adopt NUREG-1430, Rev. 2, "Standard Technical Specifications – Babcock and Wilcox Plants" wording
  - Add M5 cladding material
- Exemption Request to allow use of M5 Cladding
  - 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems of light-water nuclear power reactors"
  - 10 CFR 50.44, "Standards for combustible gas control system in light-water-cooled power reactors"
  - 10 CFR 50, Appendix K, "ECCS Evaluation Models"

Changes to BAW-10179 (additional detail)

- Reference LYNXT based HTP correlation topical report
- Reference BAW-10164, R4; RELAP5/MOD2-B&W; Approved 04/02 for use in LOCA EM
- Clarify that BAW-10192 (BWNT LOCA EM topical report) will be used with BAW-10164 R4
- Clarify that the LOCA EM will use the appropriate DNB correlation for the HTP spacer as required by the Approved EM (Notification as required by 10CFR 50.46)
- Incorporate previously approved changes