Fuel Operational Trends in Duke Power Reactors

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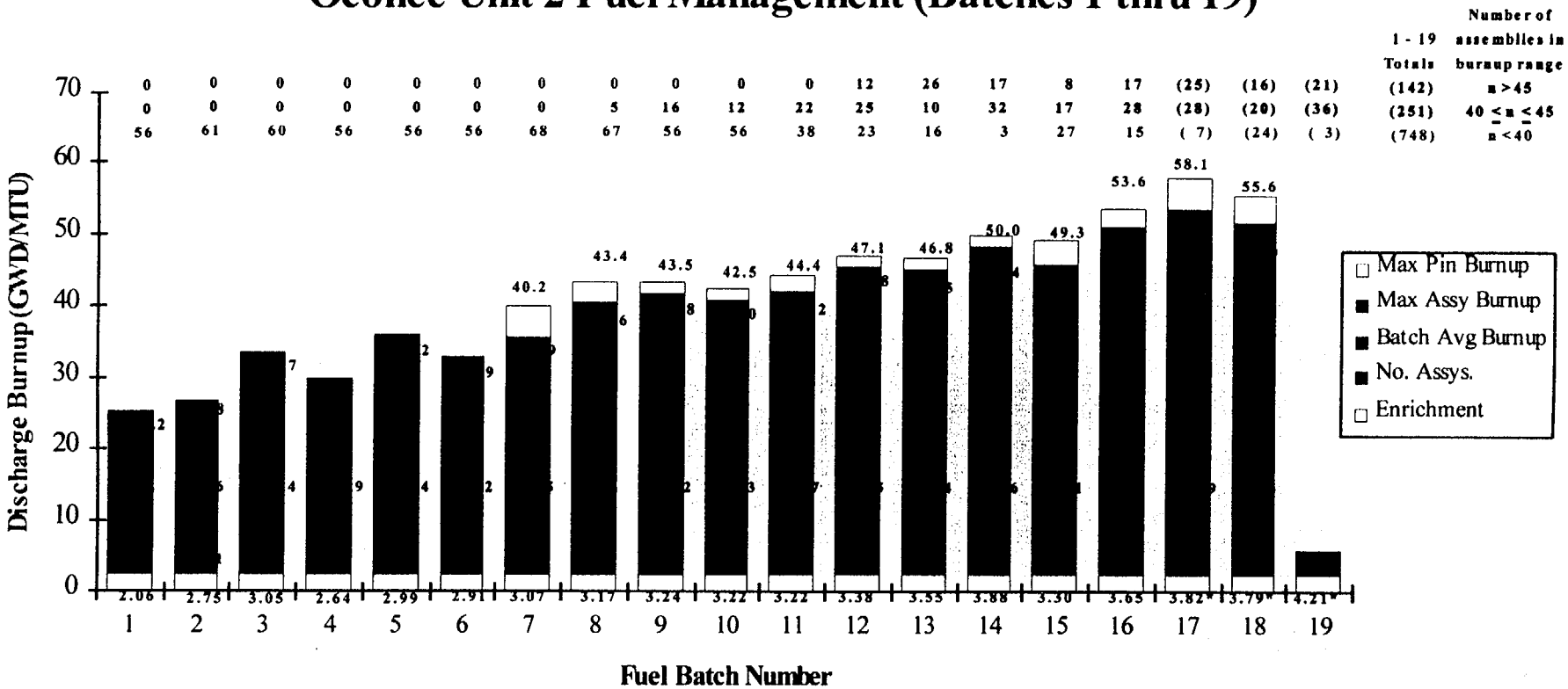
Design/Operational Summary

	Reactor Design	Fuel Design *	F/R Cladding *	FA Structure *	Max. Residence (EFPDs)	Peak Pin B/U GWD/MTU
Catawba 1	W 4-Loop 3411 MWth	FCF 17X17 .374 St'd Mk-BW	St'd Zr-4	Zr-4 GTs & MGs, SS Egs,	1500 (3 cycles)	~57
Catawba 2	W 4-Loop 3411 MWth	W 17X17 .374 St'd Robust	Zirlo	Zirlo GTs & MGs, SS EGs	1500 (3 cycles)	~57
McGuire 1 & 2	W 4-Loop 3411 MWth	W 17X17 .374 St'd Robust	St'd Zr-4	Zr-4 GTs & MGs, SS EGs	1500 (3 cycles)	~57
Oconee 1, 2, &3	B&W 2-Loop 2568 MW	FCF 15X15 .430 St'd	St'd Zr-4	Zr-4 GTs & MGs, SS EGs	2000 (4 cycles)	~55

* Implementing advanced cladding at upcoming RFO for remaining 6 reactors.

Oconee Unit 2 Fuel Management (Batches 1 thru 19)



Typical Mechanical Reload Analysis Scope (Using Approved Vendor Methods)

- Fuel Rod Internal Pressure
  - > system pressure, but
  - no diametral gap increase during Steady-State operation
- Cladding Stress
  - Condition I and II operation
  - ASME Code as Guide
- Cladding Fatigue
  - ASME Code as Guide
  - Cumulative Usage Factor < 1.0
- Cladding Strain
  - Total uniform hoop transient strain < 1%
  - Total Steady-State plastic hoop < 1%

Analysis Scope - Cont'd:

- Fuel Rod Oxidation and Hydriding
  - Limit on metal-to-oxide surface temperature
  - Limit on total hydrogen concentration
  - Limit on span average corrosion thickness
- Fuel Temperature
  - No centerline melt for Conditions I and II
- Cladding Flattening (Creep Collapse)
  - Limits gap size and distribution within fuel column
  - No collapse of free standing plenum region(s)
- Structural & Dimensional
  - FA growth
  - F/R shoulder gap
  - Straightness/Incomplete Rod Insertion

PIE Activities

	F/R Oxide	FA Growth	FA Bow	F/R Growth	Water Channel	GT Distortion	Grid Oxide	Grid Growth	GT Oxide
O2EOC16	✓	✓	✓	✓	✓				
O2EOC17	✓	✓	✓	✓	✓	✓			
O2EOC18	P	P	P	P	P	P	P	P	
O2EOC19	P								
M2EOC10	✓	✓	✓	✓		✓			
C2EOC9	✓	✓	✓	✓		✓	✓	✓	✓

P – Planned inspections

✓ - Completed Inspections

Operational and Design Trends

- Performance as expected with stable/improving reliability
- Projected discharge burnups ~ flat over near term
- Cladding corrosion, RIP, and AOA concerns most limiting
  - Zr-4 approaching corrosion limits - onset of spallation evident from poolside PIE (all Duke reactors w/ Zr-4)
  - Peaking in 4-Loop plants held down by AOA concerns
- Currently implementing design changes for operating margin and robustness
  - W RFA with Zirlo in 4-loop plants
  - FCF Optimized FA (.416) with advanced cladding (M5) in 2 -loop plants
- RCS chemistry changes under evaluation
  - Address AOA for Catawba and McGuire
  - Further reduce dose fields