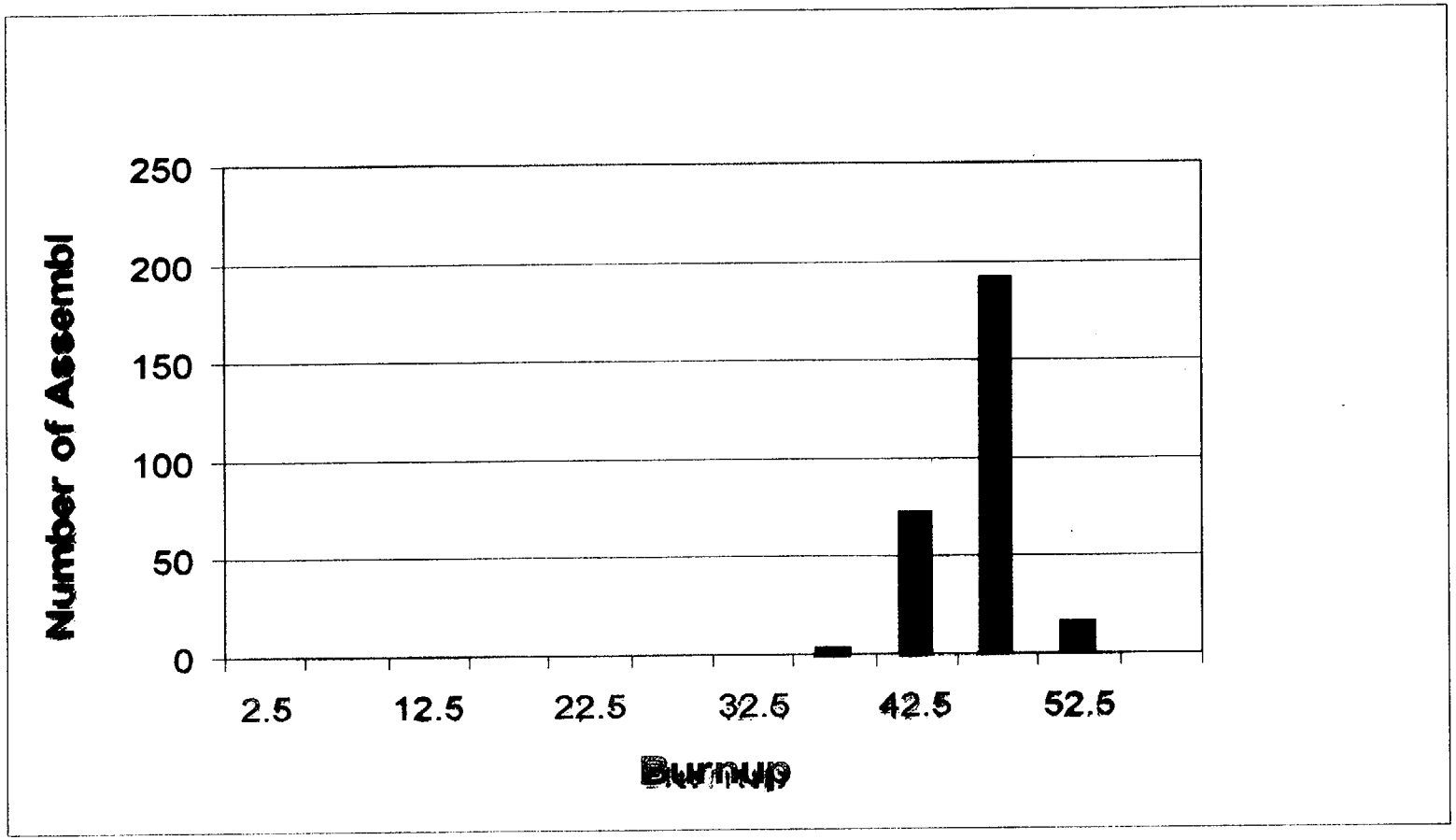
# ABB CE PWR
# Fuel Performance Update

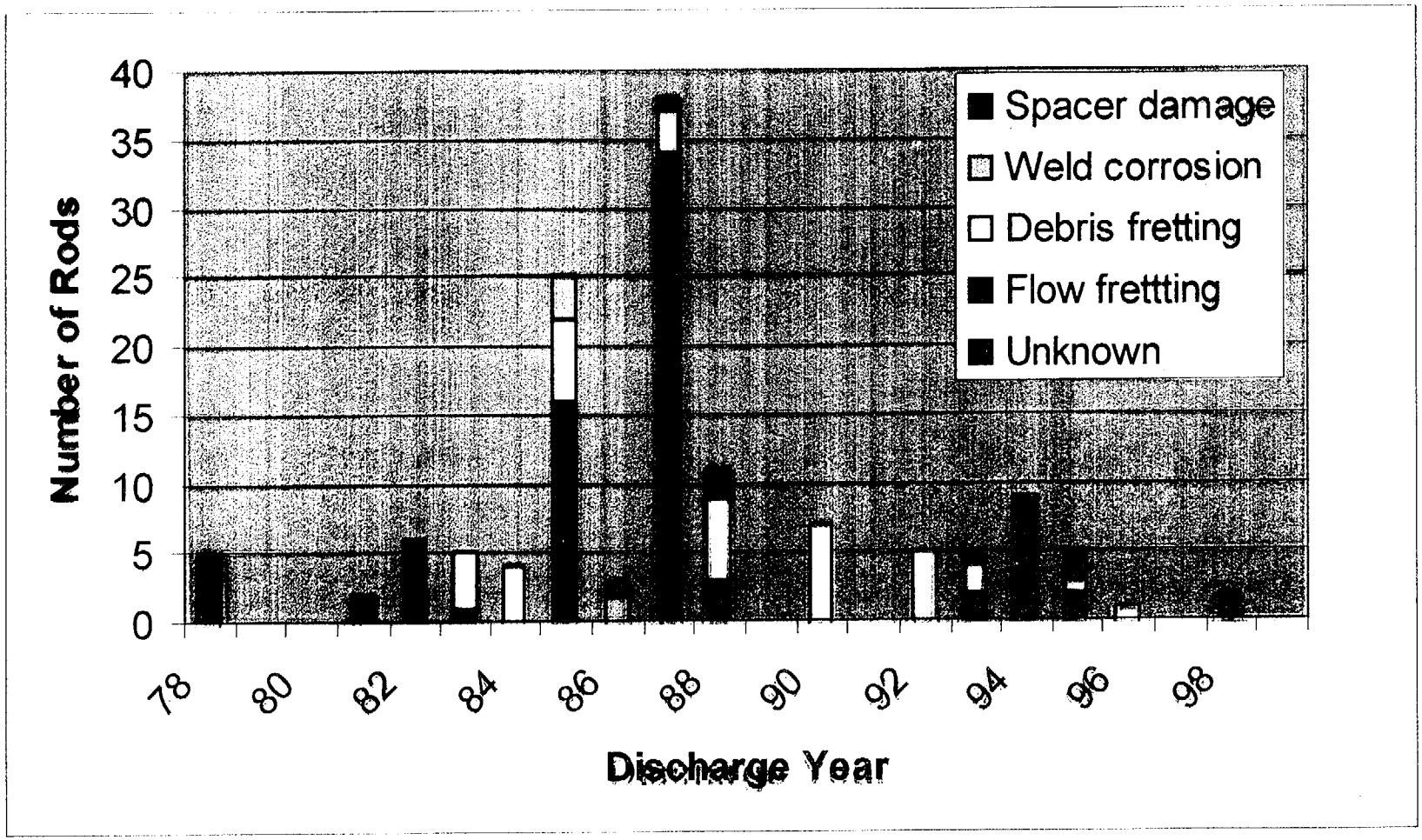
George P. Smith, Jr.

ABB Combustion Engineering Nuclear Power Inc.

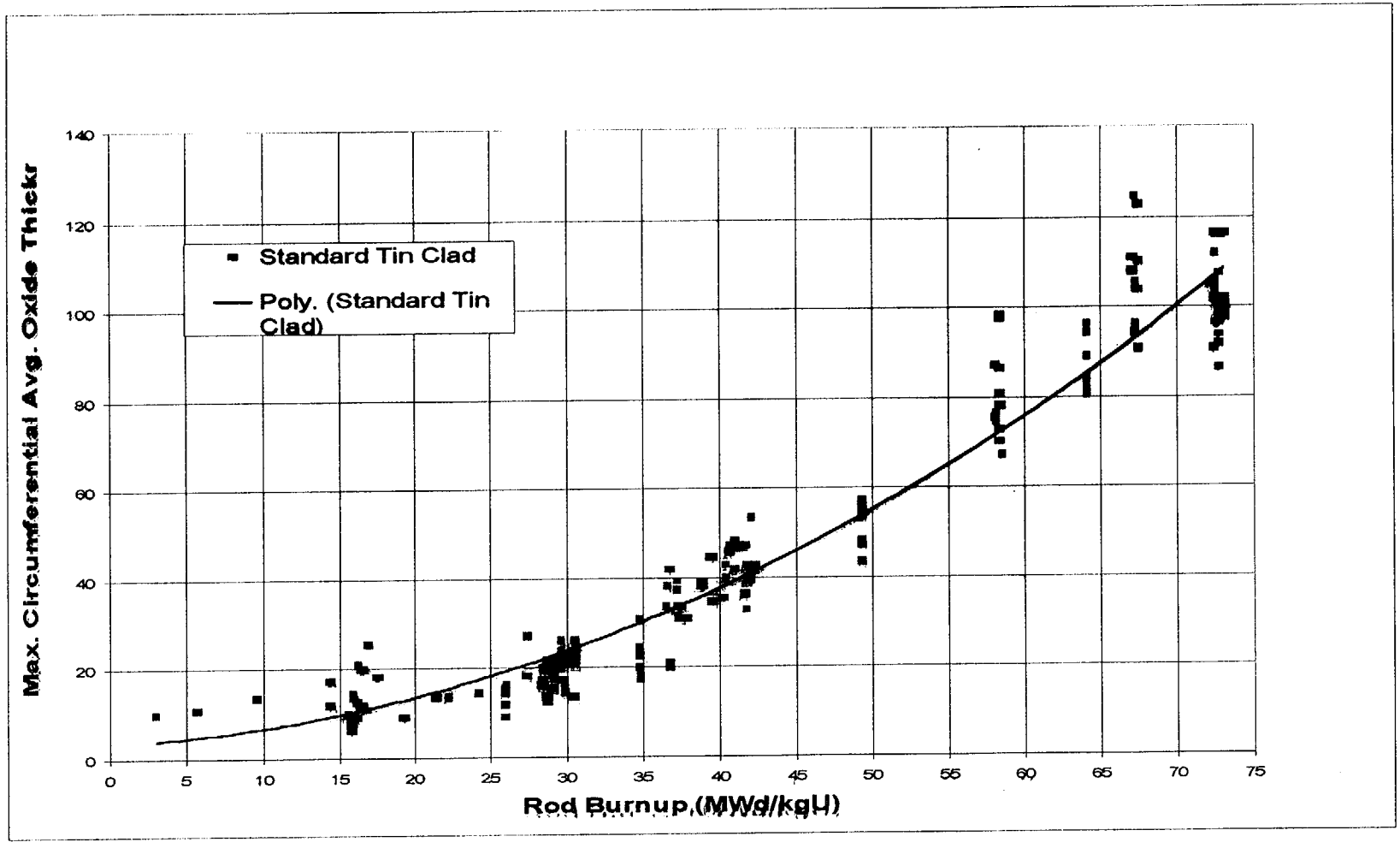
# Discharge Burnup Distribution US PWR Fuel 1999 (prelim.)



# Total PWR Rods Failed by Discharge Year



# Max Circumferential Average Oxide for Standard Tin Zircaloy-4 in Typical 15x15



# Advanced Alloy for Increased Oxidation Margin

- **Alloy A**
  - Zirconium, tin, niobium alloy
    - Outside the ASTM Spec. for Zircaloy-4
    - Requires NRC approval for use
  - Displays corrosion resistance and dimensional stability superior to Zircaloy-4
- **Lead Test Rods introduced in 1994**
  - Examination data confirm excellent performance to 69 MWd/kgU
- **Lead Fuel Assembly introduced in 1997**
  - exam after 2nd 18-month cycle just completed

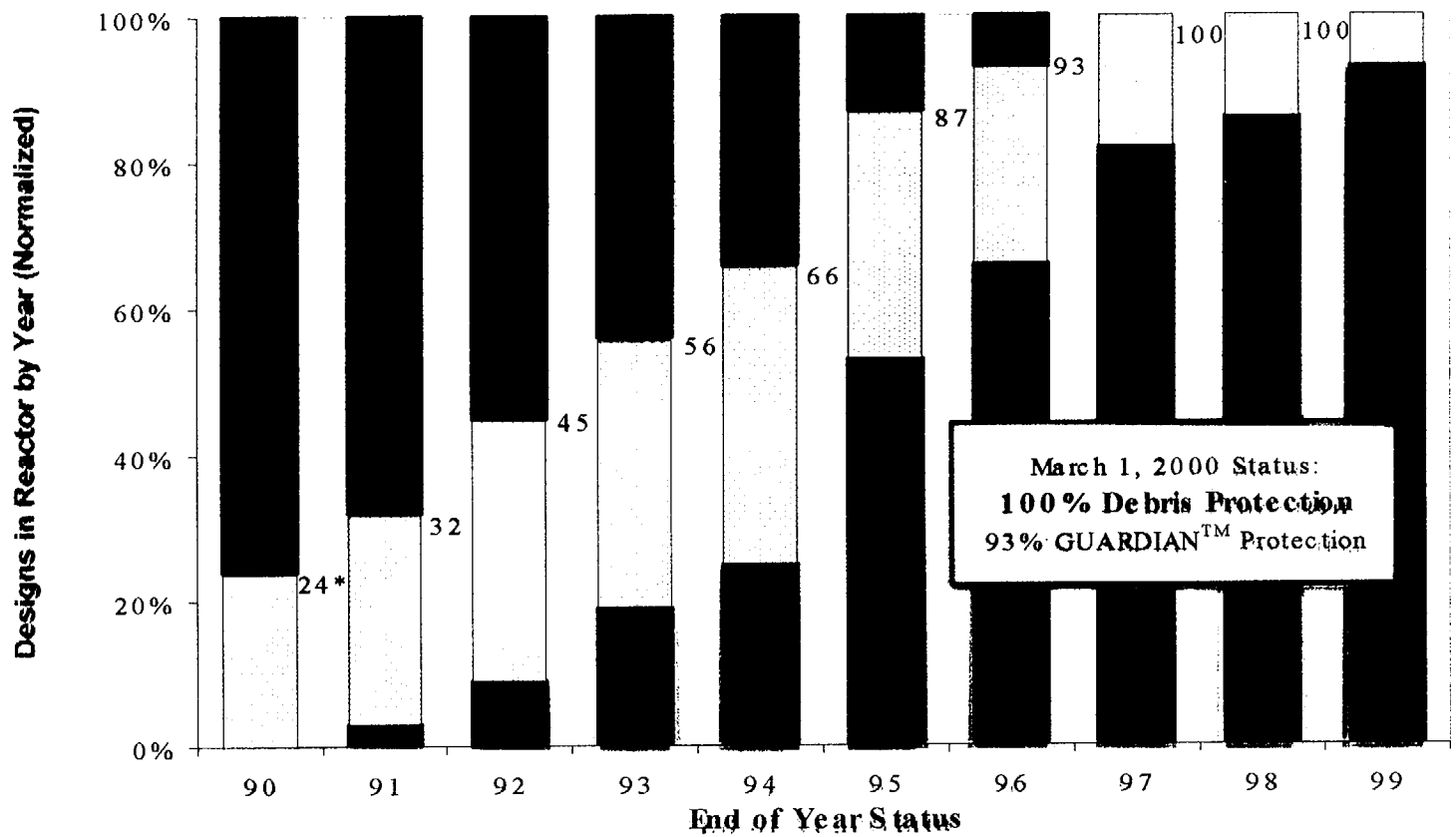
ABB

## Grid-to-Rod Fretting

- **Grid-to-rod fretting is the only remaining significant failure mechanism**
- **Advanced grid design with improved rod support features dramatically increases grid-to-rod fretting margin**
  - improvement demonstrated in ex-core endurance testing
  - improvement confirmed in Lead Fuel Assembly performance

ABB

# Progress Toward Complete Debris Protection

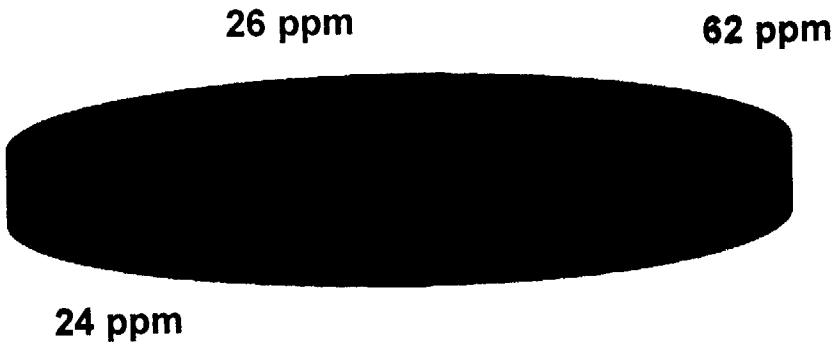



■ Small Flow Hole LEF ■ GUARDIAN™ □ Long End Caps ■ No Debris Protection

* Percent of major fuel batches protected at year end

ABB

# Fuel Rod Failure Rate in PPM by Cause



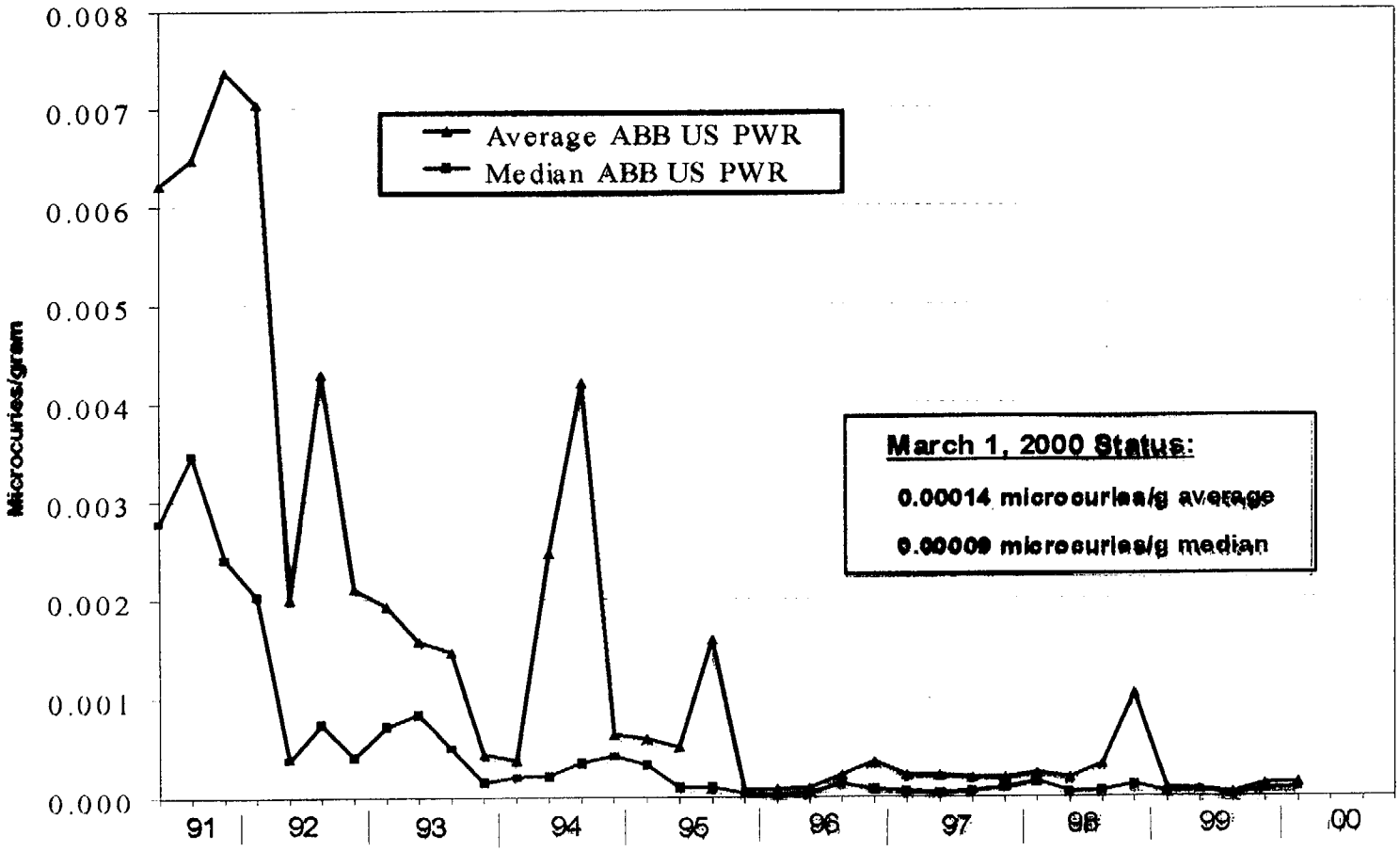

Fuel Fabricated 1984-1991 (930K Rods)

Fuel Fabricated 1992-1999 (975K Rods)

- Debris Wear
- Unknown Source
- Grid-to-Rod Wear

ABB

# Corrected Coolant I-131 Activity vs Time (INPO Method)



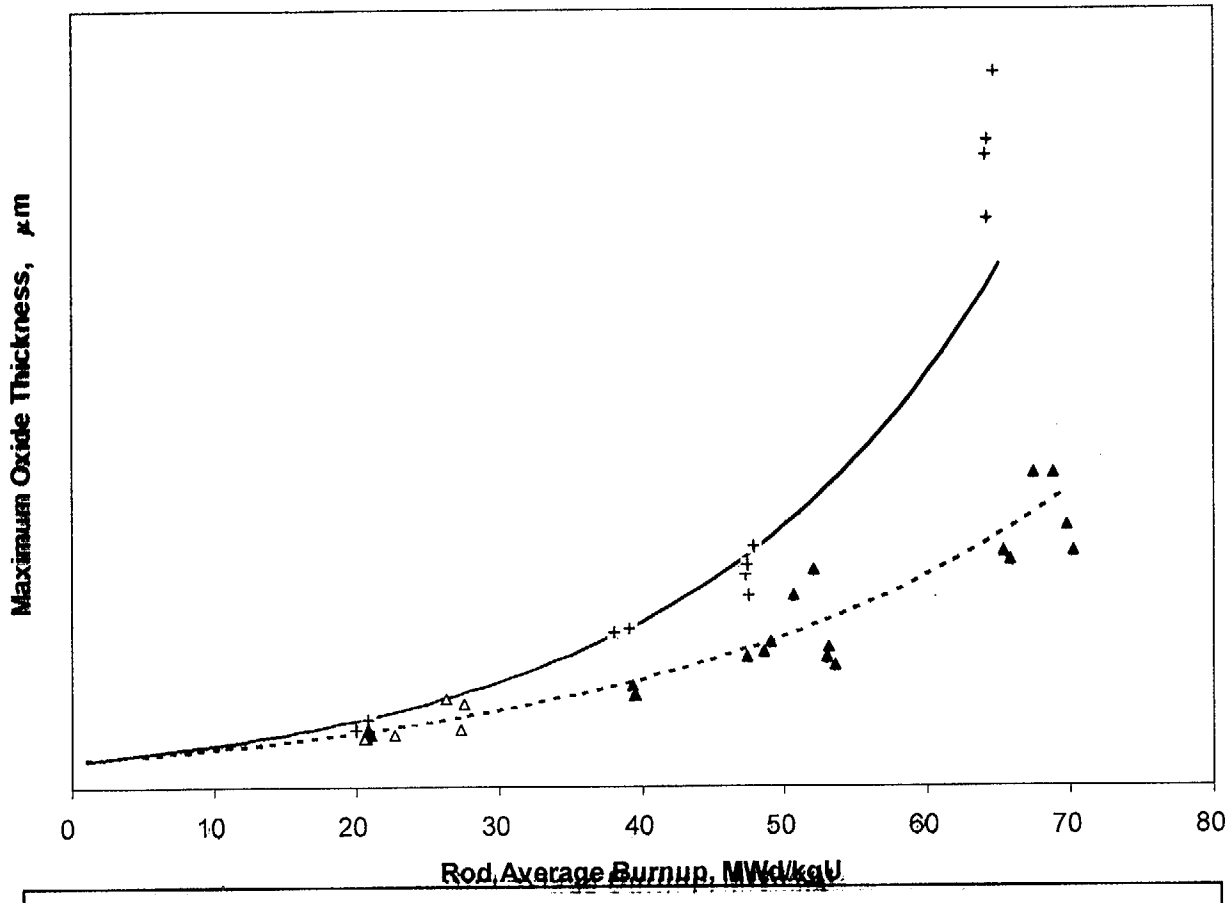

ABB

# Fuel Performance Summary

- **ABB CENP fuel continues to perform very well**
- **Only remaining failure mechanism is grid-to-rod fretting at low levels**
  - number of failures has been reduced in modern fuel
  - design improvements in progress to eliminate
- **Advanced clad will maintain oxide margin under increased fuel duty and burnup**

ABB

# OPTIN and Alloy A Cladding Corrosion




Alloy A oxide thickness about half that of OPTIN

ABB