



**AREVA**

forward-looking energy

# **Draft Regulatory Guide Comments Meeting: *AREVA Hydrogen Model Perspectives***

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# Hydrogen Models

- ▶ **AREVA's preference is to proceed with AREVA models**
  - ◆ Already in development and submitted for various applications
  - ◆ Proprietary testing databases
  - ◆ Extensive knowledge about material specific phenomena
  - ◆ More realistic, reduces need for extra conservatism
  
- ▶ **Comments on NRC Proposal**
  - ◆ Proper characterization is necessary to prevent future misinterpretation
  - ◆ Different methods and approaches for calculating hydrogen contents should be acceptable
  - ◆ Derivation of PWR material HPUF is inherently tied to the underlying oxidation model
  - ◆ Zr-2 FRAPCON database

# Hydrogen Models

## ▶ BWR Zr-2 Data

### ◆ The PNNL model is relatively recent, but does not include more recent data published by AREVA and WES

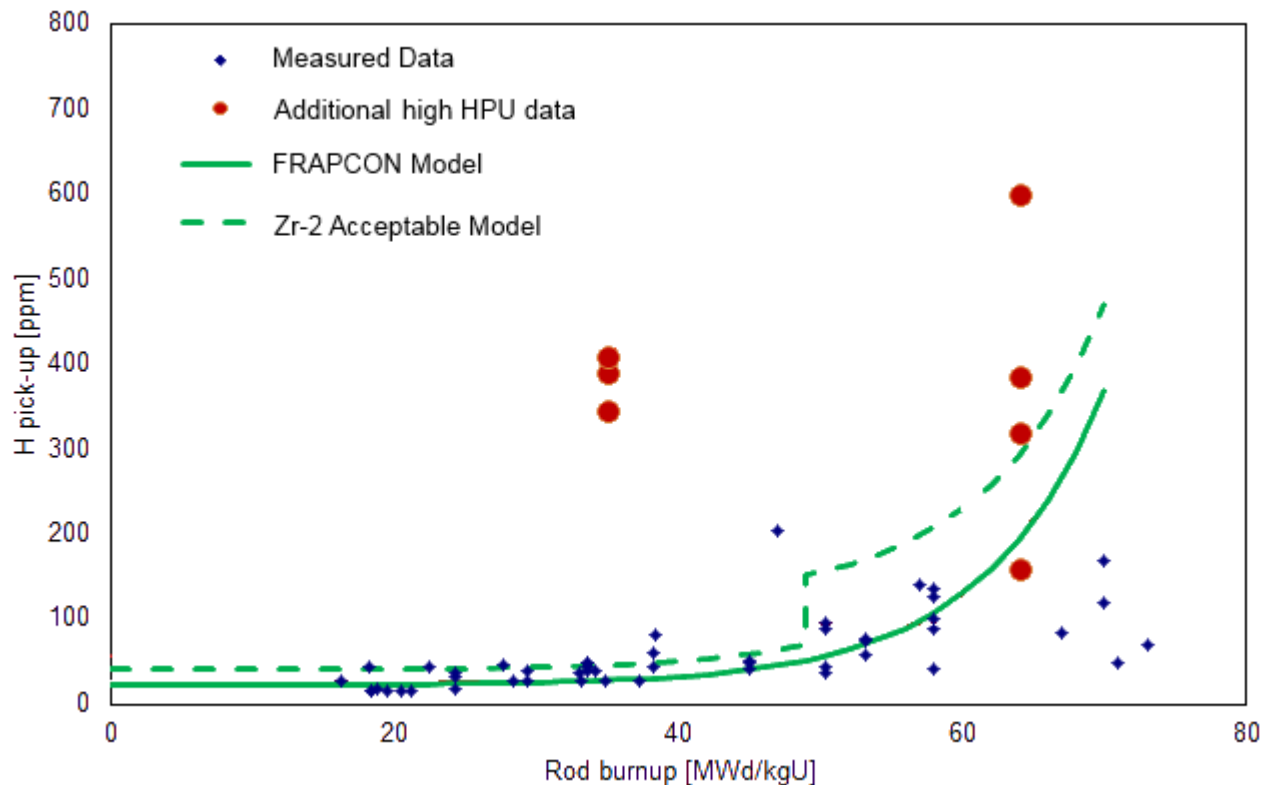
- Nissen, K.L. “Hydrogen Update of BWR Fuel Rods: Power History Effects at Long Irradiation Times” Proceedings of Top Fuel 2014
- Zhou, G. et al. “Corrosion and Hydrogen Uptake Behavior and Modeling for Modern PWR Cladding Materials at High Burnup” Proceedings of Top Fuel 2009

### ◆ Additional data showed enhanced HPU in certain conditions

- Enhanced HPU is correlated with high/low power histories
- Increased HPU even at medium burnups of ~40 GWd/MTU
- Phenomenon causes difficulties for direct burnup-to-hydrogen content correlation

# Hydrogen Models

- ◆ Red points display the additional high HPU data



# Hydrogen Models

## ▶ For vendor specific submittals, upper bound hydrogen models are unnecessary

### ◆ Previous positions

- Interim RIA Guidance (2007, ML070220400): “Similar to PWR oxidation, a best-estimate nodal hydrogen concentration is judged sufficient to address the local cladding properties.”
- DG-1263: “To apply the analytical limit in Figure 2 to an individual fuel rod (or fuel rod grouping), the allowable CP-ECR should be based on predicted peak circumferential average hydrogen content for the individual rod (or fuel rod grouping).”

### ◆ ECR limits already incorporate conservatism

- Additional conservatism on the input used to determine the limit is not necessary

# Hydrogen Models



▶ **Questions? Comments?**