

U.S. NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

The RACKLIFE Methodology

Christopher Hunt

**Office of Nuclear Reactor Regulation/Division of Engineering
Steam Generator Tube Integrity and Chemical Engineering Branch
Public Meeting on Neutron Absorbing Material Degradation**

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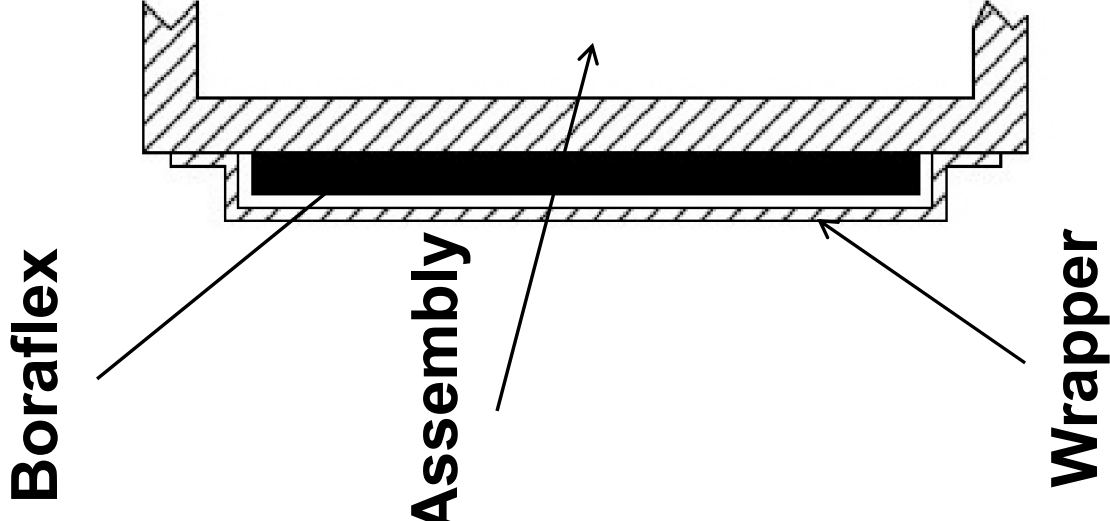


Outline

- Boraflex and Boraflex degradation
- Origin of RACKLIFE
- Regulatory history
- NRC main discussion topics
- Summary

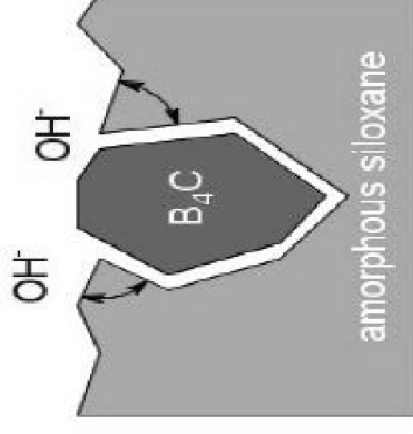
Boraflex

- B₄C particles bound in a silicone polymer matrix
- Cut into panels and placed in spent fuel storage racks
- Absorbs neutrons from stored fuel to assist in maintaining the spent fuel pool subcritical
- RACKLIFE modeling software and the BADGER in-situ testing method were developed by industry



Boraflex Degradation

- Two-step dissolution process:
 - Degradation of the silicone rubber polymer matrix to slightly soluble amorphous silica
 - Slow dissolution of amorphous silica, releasing B_4C from the panel
 - This effect is intensified by erosion
- Shrinkage



T.C. Haley, 2012



Boraflex Rack Life Extension: RACKLIFE

- Developed in the 1990's to predict the B¹⁰ content of Boraflex panels in the spent fuel pool
- Predictive code based on the chemical properties of Boraflex in a spent fuel pool environment
- Specific to Boraflex; cannot be used with another neutron absorbing material



History

- GL 96-04, “Boraflex Degradation in Spent Fuel Storage Racks” (ML031110008)
- IN 2012-13, “Boraflex Degradation and Corrective Actions in the Spent Fuel Pool” (ML121660156)
- Technical Letter Report, “Boraflex, RACKLIFE and BADGER: Description and Uncertainties” (ML12216A307)



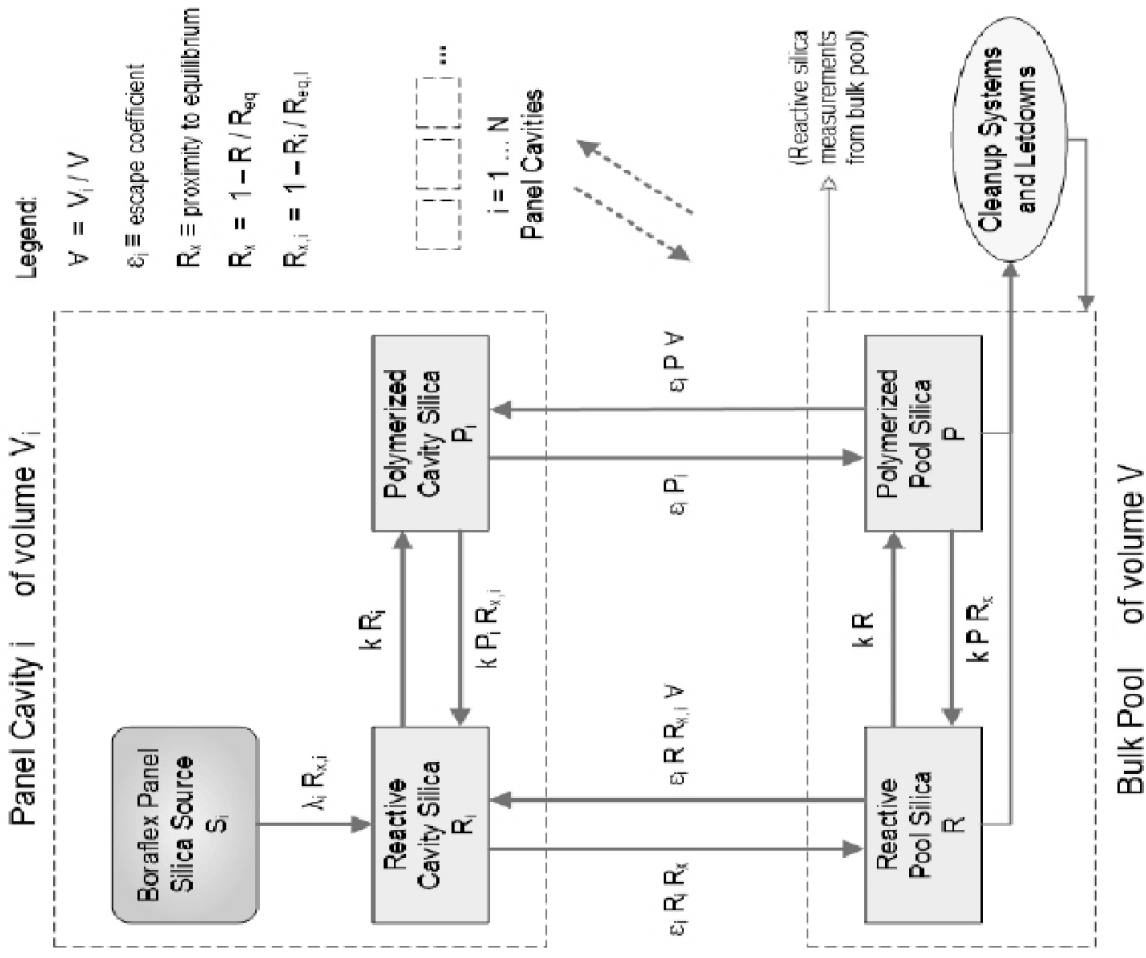
Main Discussion Topics

- Silica mass balance
- Escape coefficient
- Localized degradation
- Prediction assumptions
- Confirmatory testing

- Predicts boron carbide loss through silica mass balance equations

Uncertainties

- Approach uncertainty
- Accuracy of pool sample
- Sample frequency
- Accounting for cleanup system efficiency
- Accounting for letdowns (dilution events)

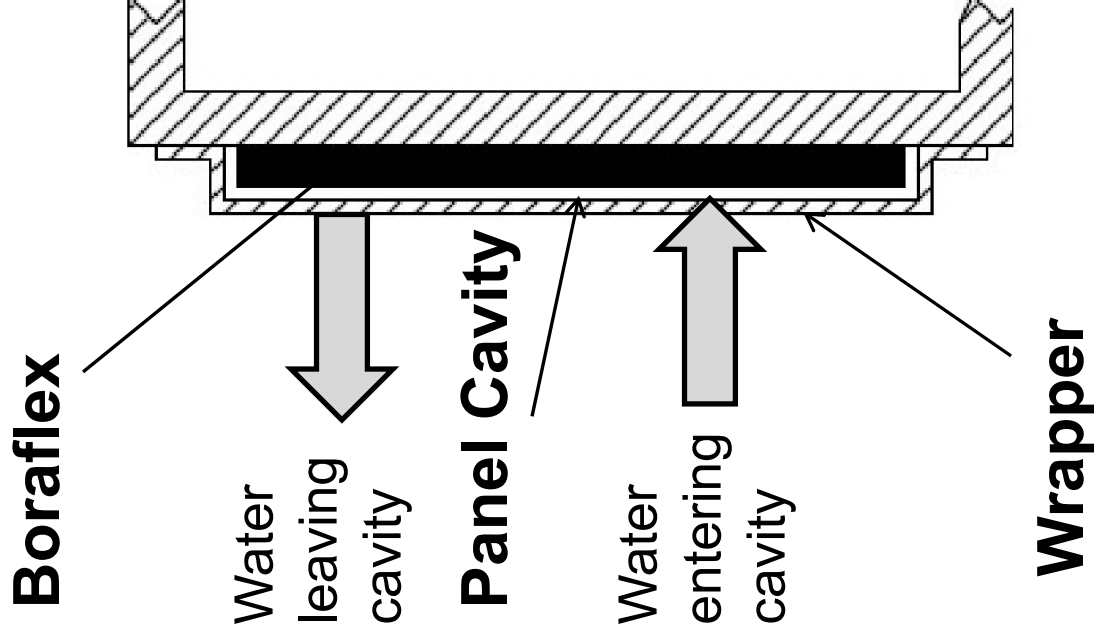


Escape Coefficient

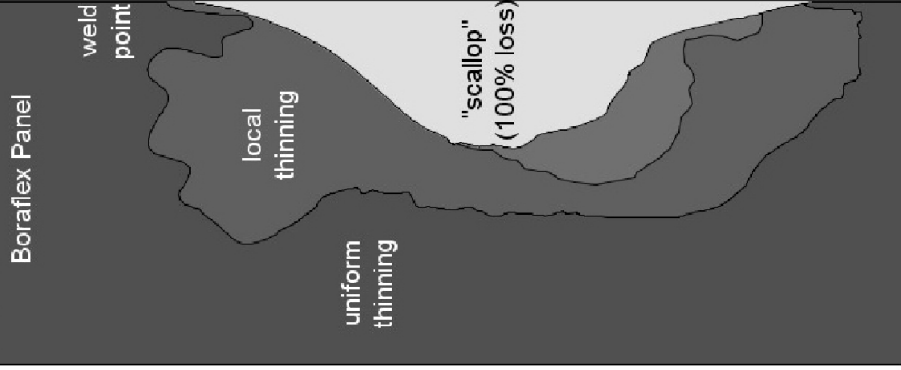
- Rate at which a particular panel cavity exchanges silica-laden water with the bulk pool
- Used to calibrate RACKLIFE to actual measured silica levels

Uncertainties

- Use of average escape coefficient



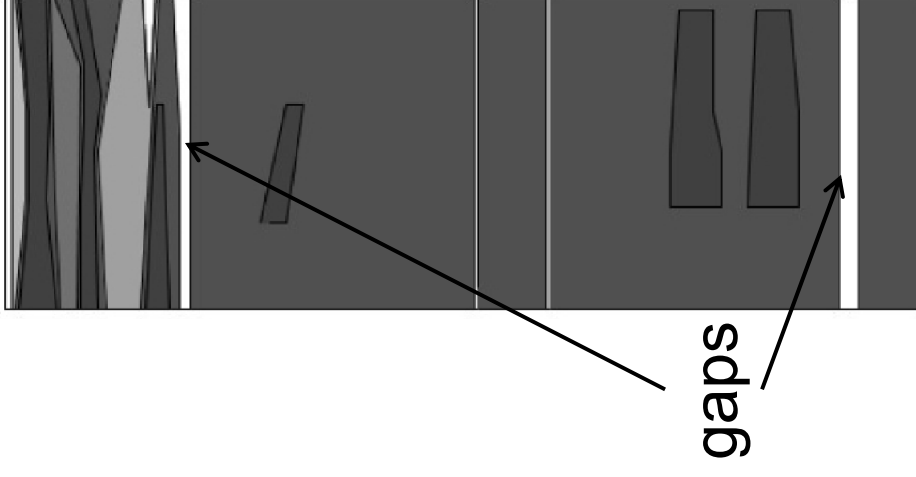
Localized Degradation



- Degradation of Boraflex panels in the spent fuel pool is not uniform

Uncertainties

- Use of average panel degradation
- Spatial effects not accounted for





Prediction Assumptions

- Exchange rate kinetics are estimated as linear
- Approach appears consistent for moderate levels of Boraflex loss when compared to in-situ testing data

Uncertainties

- Linear kinetics model may not be as accurate at higher levels of degradation



Confirmatory Testing

- RACKLIFE uses confirmatory testing to tune the predicted model to match actual pool conditions

Uncertainties

- Accuracy of confirmatory testing
- Frequency of confirmatory testing
- Number of panels scanned



Summary

- The uncertainties associated with RACKLIFE may impact the monitoring programs used to manage Boraflex and need to be understood and managed.
- The NRC staff is working with industry to gain more information on how these uncertainties are being addressed in order to assess the adequacy of monitoring programs.
- The NRC staff is considering a path forward, including the possibility of follow up action, based on the information gained through interaction with the industry and the Technical Letter Reports recently released.