



Fast Reactor Fuel Testing Considerations

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Changing the World's Energy Future

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Fast Reactor Fuel Testing Considerations

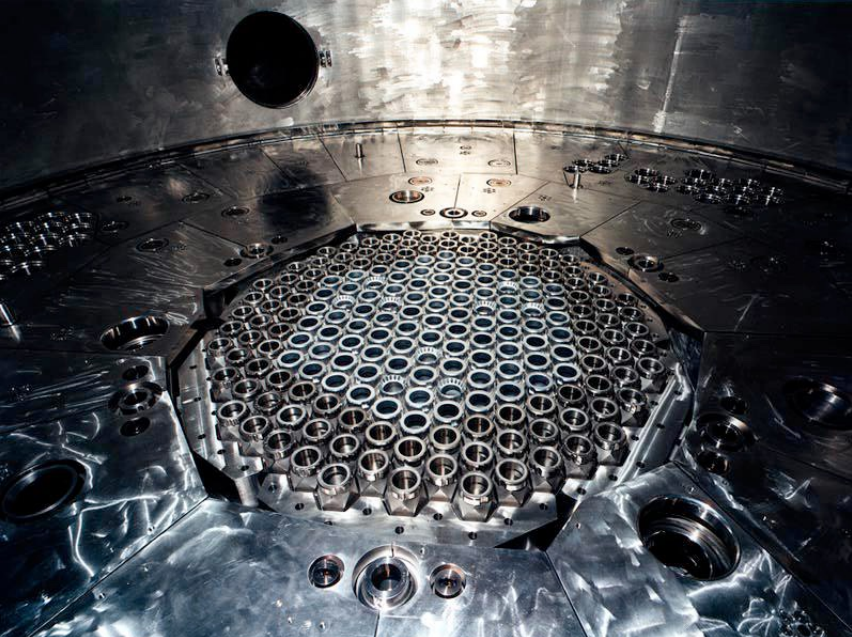
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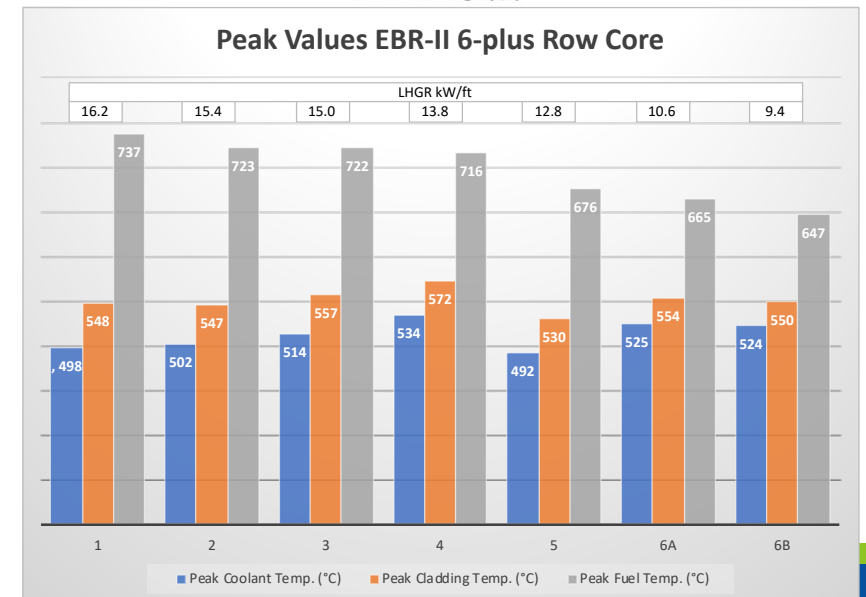
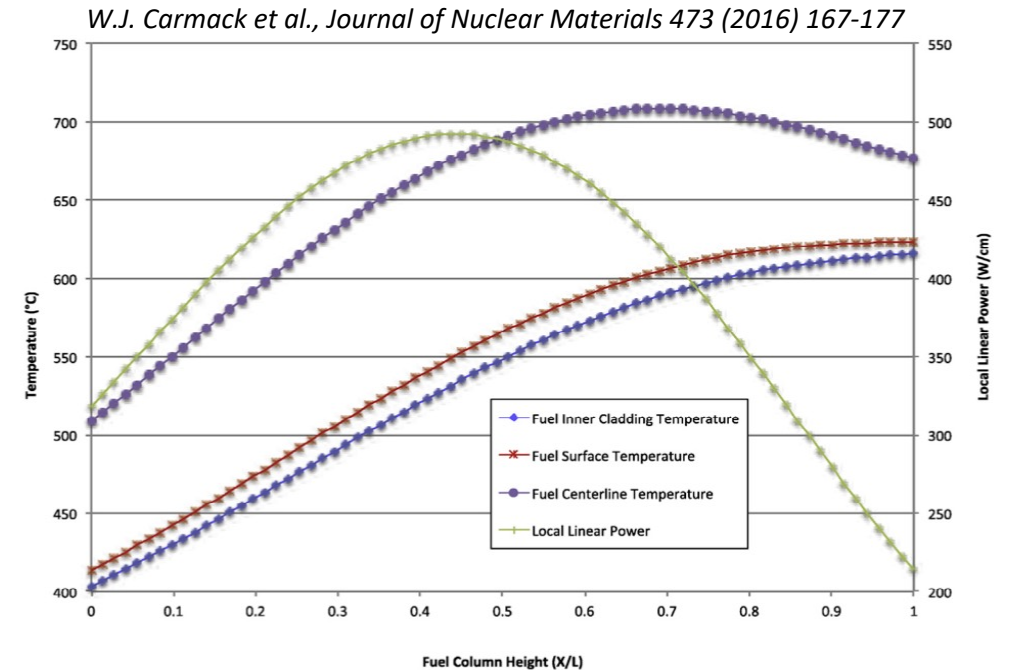
ANS Virtual Annual Meeting 2021

Purposes for Irradiation Testing

- Proof of Concept (up through TRL 3)
 - *Small, simple tests* at relevant conditions
 - Special effects testing to gauge specific phenomena
- Proof of Principle (TRLs 4 through 6)
 - Testing of assemblies and rods at range of conditions and of parameters to investigate design space and establish limits
 - Includes assessment of off-normal behavior
 - Investigate fuel performance phenomena leading to fuel failure
 - Determine failure thresholds
- Proof of Performance (TRLs 7 through 9)
 - Testing of reference fuel designs at full-scale, or prototypic scale, at prototypic conditions and upper ranges
 - Sufficient quantities to provide statistical variation within specifications

Testing Conditions of Interest

- Fuel and cladding temperature
 - Radial and axial dependence matter
 - So, linear heat generation rate (LHGR) and coolant temperature
 - Coolant velocity and chemistry (esp. for dynamic effects and for corrosion/compatibility effects)
- Burnup rate → time at temperature, and fission product accumulation
 - Prototypic or representative fission product effects are essential for FGR and plenum pressure, FCCI, swelling and FCMI
- Flux
 - Total flux for LHGR
 - Fast flux ($E > 0.1$ MeV) for neutron radiation effects in structural materials



Testing Accommodations

- Measurement or calculation of $\phi(r,z,E)$ and dm/dt or assembly ΔP
- In-pile measurements and core characterization to reduce uncertainties in LHGR, coolant temperatures, coolant flow, flux/fluence, fast flux/fluence
 - Even just a measurement of assembly outlet temperature can helpfully reduce uncertainties in fuel and cladding temperatures
- Experiment vehicles that allow tailored flow rates
- Irradiation testing volume and/or testing positions
 - Instrumented test positions for selected irradiations and experiments
 - Considerable value in open-core positions for fueled assemblies