Assessment of Critical Data for Qualification of U-10Mo Monolithic Fuel

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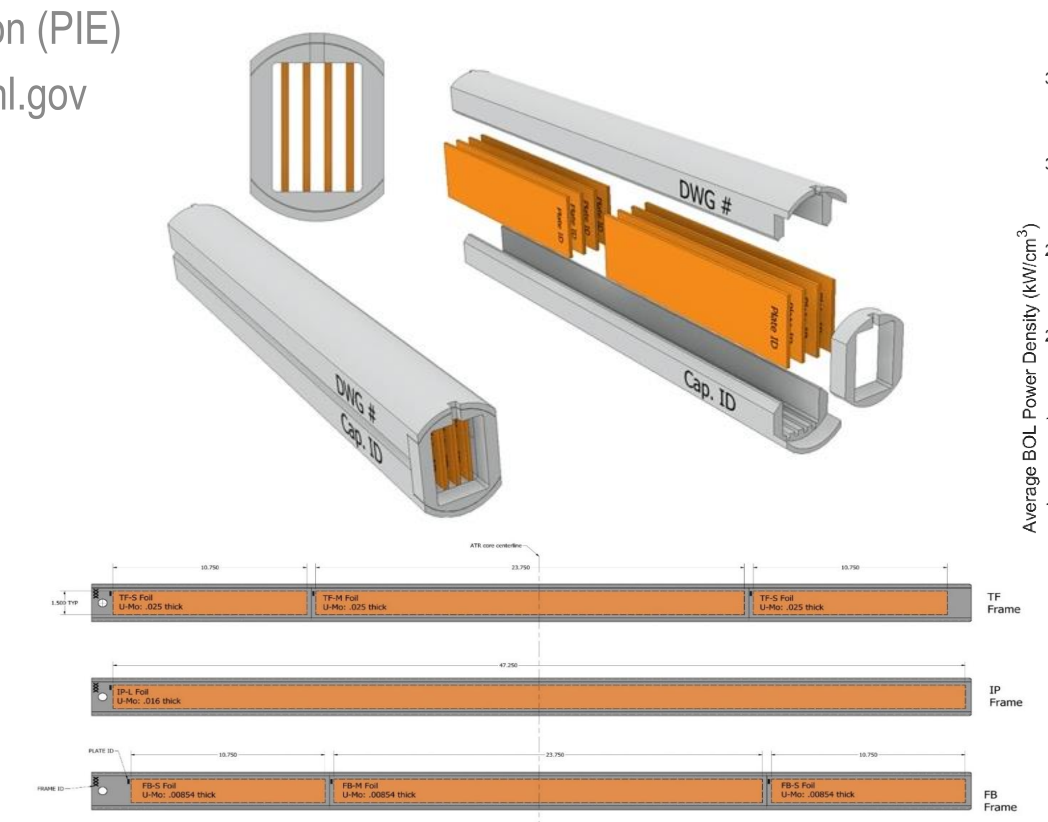
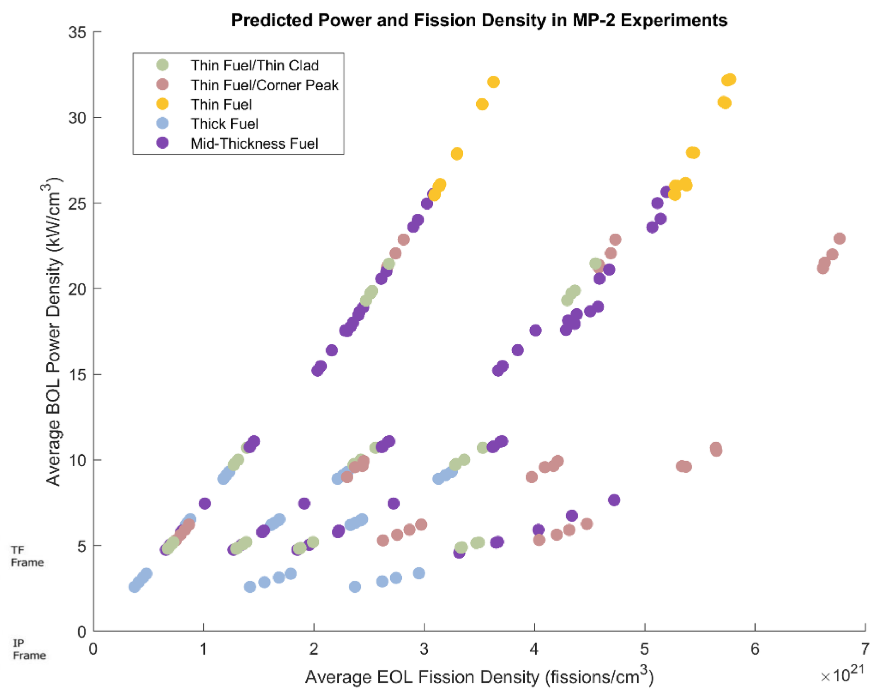
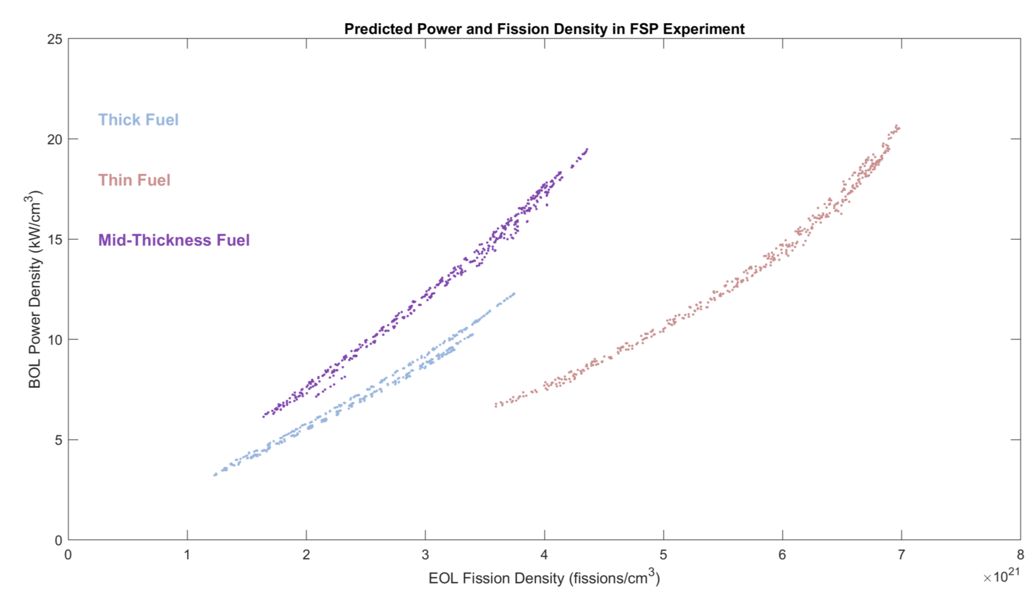
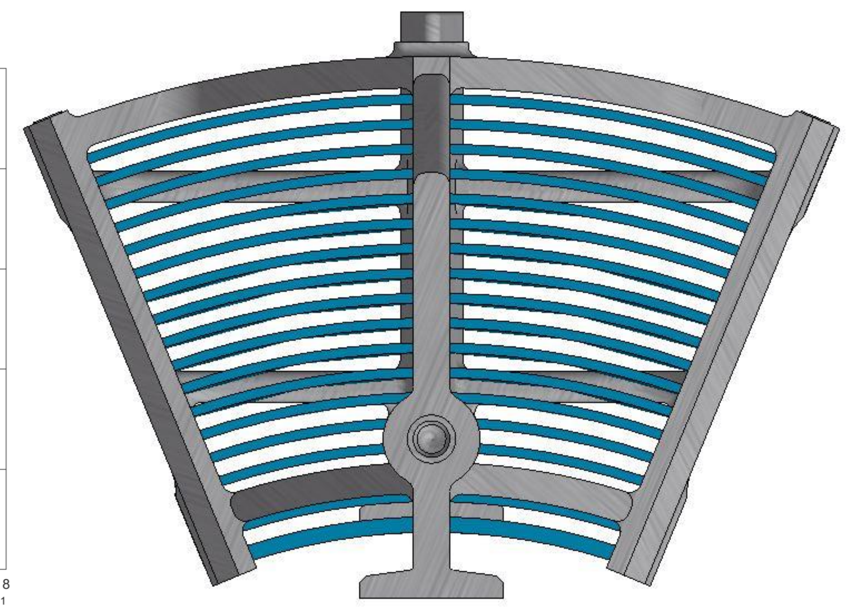
In the coming years, the United States High Performance Research Reactor Fuel Qualification (USHPRR-FQ) Project will conduct three unique irradiation tests in support of generic qualification of U-10Mo monolithic fuel through the U.S. Nuclear Regulatory Commission (NRC). Data gathered from these tests will be used to compile a topical report that establishes fuel properties and limiting performance behavior of U-10Mo monolithic fuel under normal and off-normal operating conditions. Fuel qualification requirements have previously been documented. An assessment has been performed to identify critical post-irradiation data to be collected and how it will support qualification. A minimum number of samples is recommended for post-irradiation measurements that are used to define fuel performance or properties. Experiment designs are evaluated to confirm that reactor operational ranges are covered and analysis can be performed to evaluate the impact of variables such as fission density, power density, fuel thickness, and geometry on performance and properties.









Requirements	R1.2.3: Fuel performance and structural stability shall be maintained so that reactor coolant flow keeps fuel-plate heat transfer and/or temperatures within the reactor safety analysis envelope							
	R 1.2.3a Establish, through irradiation testing under normal USHPRR operating conditions, that fuel-performance-related phenomena (e.g., swelling, creep) do not result in geometry changes that lead to a loss of coolability due to flow instability				R 1.2.3b Establish, through post-irradiation testing, that irradiation-induced degradation of properties (bond strength, fuel strength) does not lead to conditions (e.g., fuel-meat fracture, blistering) that result in a loss of coolability under anticipated transient conditions			
Measurement	Visual Exam	Profilometry	In-canal Meas.	Immersion Density	Optical Microscopy	Blister threshold testing	LFA, DSC	Bend Testing
Data Collected	Images	Plate Thickness	Channel Gap or Plate Thickness	We and dry plate masses	Images	Temperature of plate blistering	Thermal Properties	Mechanical Properties
Primary measurements/data are used to define fuel performance or properties s**econdary** measurements/data confirm fuel behavior.								
Data Type	Secondary	Primary	Secondary	Secondary	Secondary	Primary	Primary	Primary

	Profilometry	Blister Threshold Testing	Thermal Properties Measurements	Mechanical Properties Measurements
Sample Size	All Irradiated Plates	40 mini-plates with supplemental FSP and ET plates.	28 mini-plates with supplemental samples from FSP and ET plates	14 mini-plates, 7 samples from FSP, and supplemental samples from ET.
Basis of Recommendation	Based on statistical analysis assuming behavior in-line with historical experiments	Profilometry measurements are non-destructive and may be performed on all plates and test trains. Based on statistical analysis assuming behavior in-line with historical experiments.	Based on limited measurement resources. Statistical assessment was not performed due to limited historical data set. Reevaluation recommended after collection and analysis of MP-1 thermal properties data.	Based on limited measurement resources. Statistical assessment was not performed due to limited historical data set. Reevaluation recommended after collection and analysis of MP-1 mechanical properties data.
Data Form and Range	$T_b = A \cdot f_d^{\,B}$ f_d is fission density which ranges from 0.6 to 7x10^{21} fissions/cm^3	$S(\%) = A \cdot {f_d}^2 + B \cdot f_d$ f_d is fission density which ranges from 0.3 to 7x10^{21} fissions/cm^3	Specific Heat Capacity: Table of values vs temperature vs fission density and Thermal Conductivity: $K = A + B \cdot T + C \cdot f_d + D \cdot T \cdot f_d$ T is temperature and f_d is fission density which ranges from .8 to 7x10^{21} fissions/cm^3	Tabulated values of Young's modulus and ultimate bending strength for fission densities from .4 to 7x10^{21} fissions/cm^3

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