NEUP Nuclear Energy University Program
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Fuel-to-Coolant Thermomechanical Behaviors Under Transient Conditions

PI: Nicholas R. Brown, University of Tennessee

Collaborators: Wade Marcum, Oregon State University
Giovanni Pastore, University of Tennessee
Charles Folsom, Idaho National Laboratory
Christina Jones, Framatome

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ABSTRACT:

We will enhance the prediction of thermo-mechanical fuel-to-coolant (F2C) heat transfer under transient conditions by using a coupled analysis and experiment approach**. Our effort is relevant to both high-burnup (> 62GWd/t) fuel applications and Accident Tolerant Fuel. The primary objectives of our proposal are to:**

1. Enhance the mechanistic transient and radiation models for critical heat flux in safety analysis (TRACE and RELAP) and
2. Improve the mechanistic modeling of F2C heat transport by coupling thermo-mechanical analysis (BISON) to thermal hydraulic analysis (TRACE and RELAP5-3D).

We will develop, validate, and demonstrate a novel coupling of thermo-mechanical and thermal hydraulic tools that will result in much more accurate prediction of F2C heat transfer during Anticipated Operational Occurrences (AOOs) and Design Basis Accidents (DBAs) of interest to our industry partner. We will also enhance the modeling of critical heat flux (CHF) in these tools by modifying the models to mechanistically account for transient [1], radiation induced activation effects [2], and material impacts [3]. This proposal is highly synergistic with integral fuel tests being conducted using the Transient Reactor Test (TREAT) facility to elucidate F2C heat transfer characteristics. Our approach will aim to help validate and develop representative fuel systems models. **We will leverage past experience at INL coupling TRACE to BISON, but also use the features of RELAP5-3D related to tailoring of the boiling curve to assist with thermal hydraulic model calibration.**

[1] Lee, S.K. et al., 2020. *International Journal of Heat and Mass Transfer* 158, 119970.
[2] Hernandez, R. et al., 2020. *Progress in Nuclear Energy* 123, 103303.
[3] Lee, S.K. et al., 2020. *Nuclear Technology* 206, 339-346.