Pacific Northwest National Laboratory

Overview of capabilities supporting advanced nuclear technology development.
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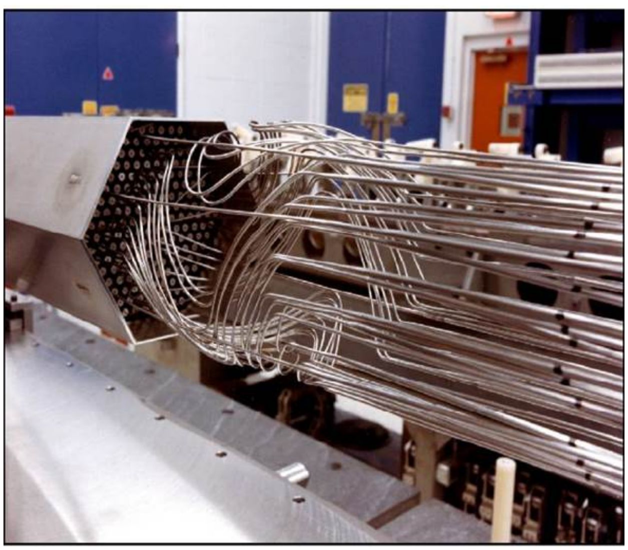
1. Fast Reactor Core/Plant Design and Analysis

At PNNL we steward the design information, operating experience, and safety data from the Fast Flux Test Facility (FFTF) – a sodium cooled fast reactor operated adjacent to PNNL for 10 years – to support industry and DOE-NE in resolving core and plant performance questions for new reactor concepts. We have systematized development of reports characterizing, assessing and helping resolve design, operational and safety issues by adaptation of FFTF insights generated under a major DOE program. For almost two decades, PNNL has managed the knowledge preservation program on behalf of DOE with the charter of maintaining, retrieving and analyzing FFTF records. We have retained senior staff who worked on FFTF during its design and operation who bring first-hand experience. Designers of the current generation of advanced fast reactors have the ability to tap this experience.



FFTF fuel open test assembly showing instrument leads

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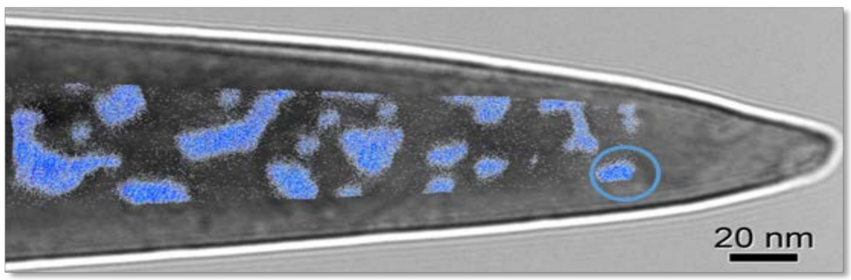
2. Advanced Nuclear Materials

PNNL integrates atomic-resolution chemical imaging, materials processing, surface modification, mechanical testing, post-irradiation examination, and multiscale modeling to understand extreme environment interactions in advanced nuclear materials. By coupling experiment, theory and modeling, we develop unprecedented understanding of nano- and meso-scale processes in materials subjected to neutron irradiation, high temperatures, mechanical stresses, transmutation, gas accumulation, and corrosives. Our expertise is applied to both performance evaluation of existing materials and to development of new materials for fuels, cladding, structural materials, and wasteforms.



The combination of high-resolution transmission electron microscopy and atom probe tomography reveals details of intergranular oxidation in a Ni-based alloy

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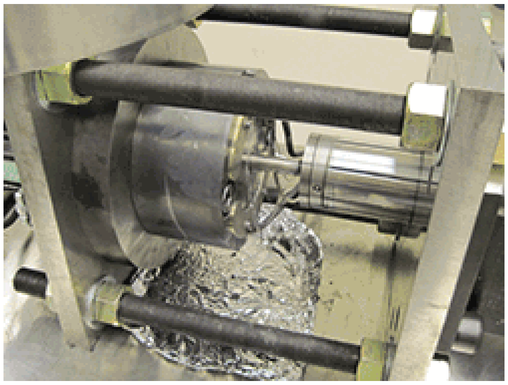
3. Advanced Nuclear Fuels

At the Pacific Northwest National Laboratory we design and develop fabrication processes for new and innovative fuels and cladding materials. We develop advanced extrusion techniques for both uranium-molybdenum and uranium-zirconium alloys, and perform both extrusion and pilgering process development for oxide dispersion cladding as well as other innovative cladding concepts. Our hot cells, mechanical test frames and microscopy assets allow the testing of new fuels and clad as well as nano-level evaluation of materials performance.



Extrusion press capable of ternary metal fuel fabrication

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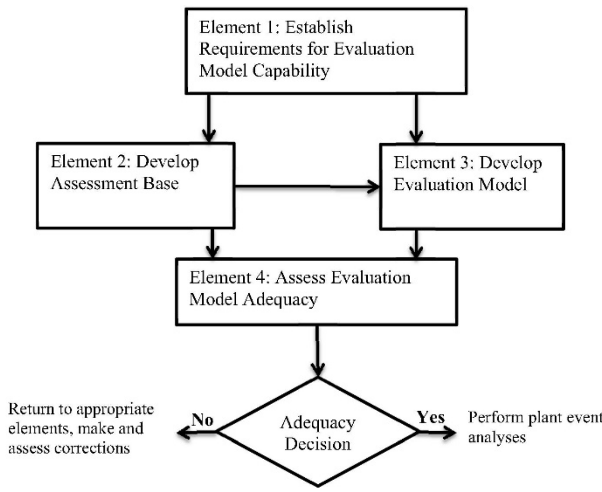
4. Analytical Model Development for Nuclear Safety Analysis

Development and refinement of software-based analytical capabilities for predicting the behavior of a nuclear system is critical through all project phases, from pre-conceptual through detailed design. Pacific Northwest National Laboratory has extensive experience in planning, executing, and validating software for use in quality-assured nuclear safety analysis under the NRC's Regulatory Guide 1.203 framework. From planning and performing Phenomena Identification and Ranking Table (PIRT) assessments, and implementing novel fluid property models for design-specific features, through collection, dedication, and analysis of legacy data, PNNL staff have supported a wide range of LWR and Gen IV concepts through the entire software development lifecycle. This experience offers GAIN collaborators critical insight and understanding of requirements associated with predicting nuclear plant behavior for nuclear safety analysis. PNNL can suggest techniques to progressively satisfy requirements as the design project advances.



Elements of the Evaluation Model Development and Assessment Process - EMDAP (Reg Guide 1.203)

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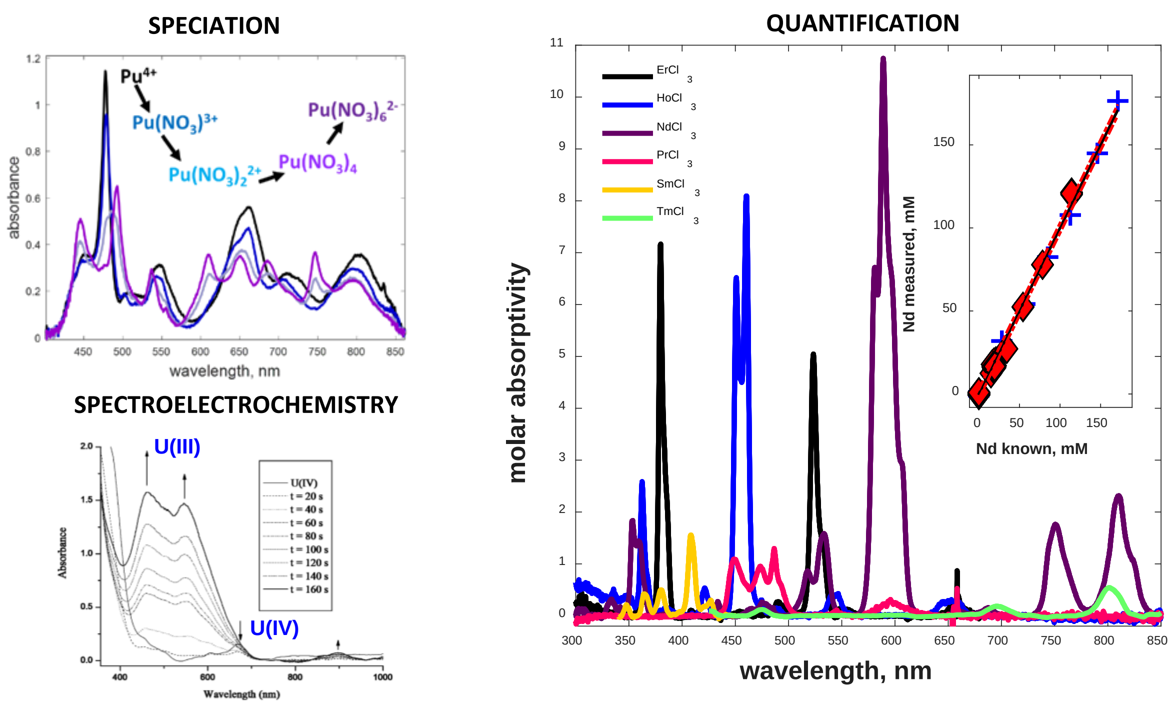
5. Reactor Chemistry

Pacific Northwest National Laboratory stewards radiochemistry capabilities and facilities that are essential in addressing challenges related to development of advanced reactor systems. PNNL's capabilities are focused on designing materials, sensors, and systems that will perform in the extreme environments expected in the next generation of reactors. For example, PNNL is developing approaches to controlling materials corrosion in molten salt reactors by developing real-time spectroscopic sensing tools. Combining spectroscopic and electrochemical methods to probe speciation and redox states of uranium and fission products in a molten salt reactor will enable the monitoring and control of materials corrosion. This work is conducted in laboratories and test beds at PNNL's Radiochemical Processing Laboratory, a Category 2 nuclear facility housing hot cells and glove boxes to support bench- and pilot-scale testing of chemical systems.



Quantitative measurement of actinides and fission products in molten salt solutions

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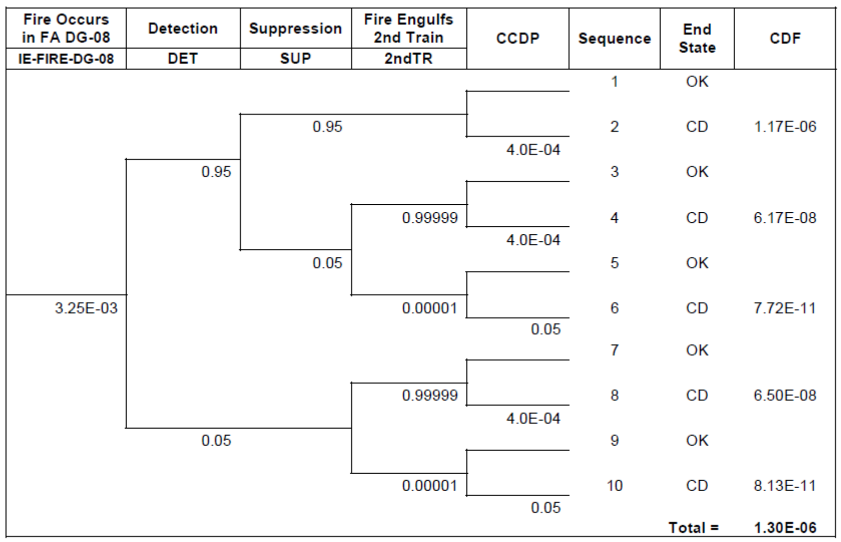
6. Probabilistic Risk Assessment Supporting Reactor Licensing

PNNL has been highly engaged supporting NRC in establishment of the process for License Amendment Requests (LARs) for conversion to risk-informed, performance-based compliance programs. We developed safety evaluation templates for risk-informed programs and led efforts to assess LARs for fire protection programs, technical specifications, and seismic qualification. We have also developed design–specific review standards for the certification of small modular reactors. PNNL staff are on the AMSE Committee developing and overseeing trial implementation of the ASME/ANS PRA Standard for non-LWR reactors. This experience makes us a key resource for helping prepare risk-informed bases for reactor concept development, certification and licensing.



PRA Event Tree Supporting NFPA-805-based Risk-Informed Fire Protection Compliance

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