



Updates on PIRT Exercise Implementation

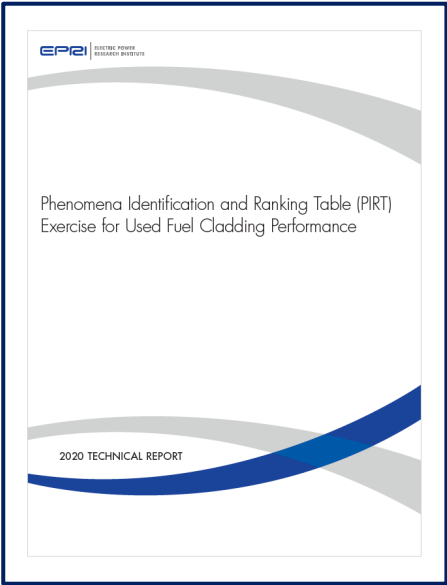
NRC Risk-Informed Showcase



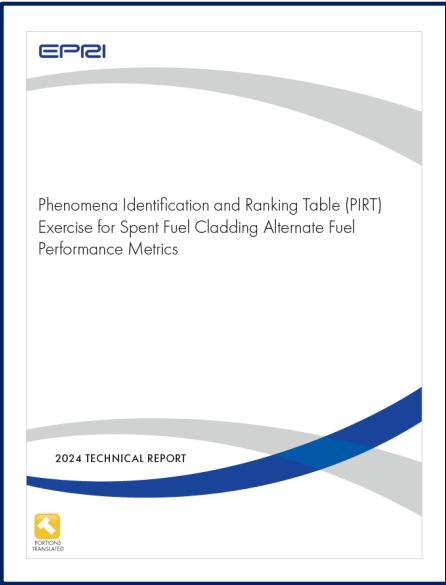
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February 19, 2026

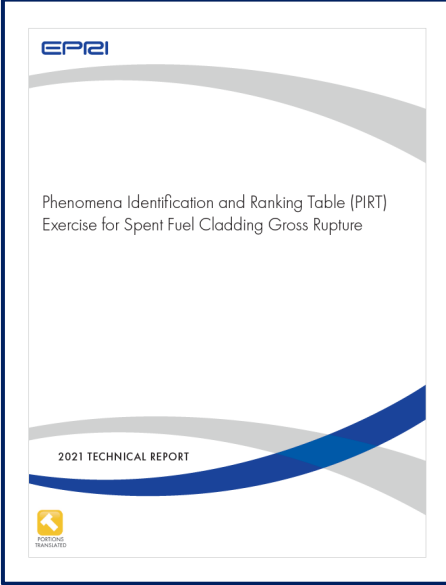
Phenomena Identification Ranking Tables



EPRI 3002018439
Used Cladding Performance (2020)



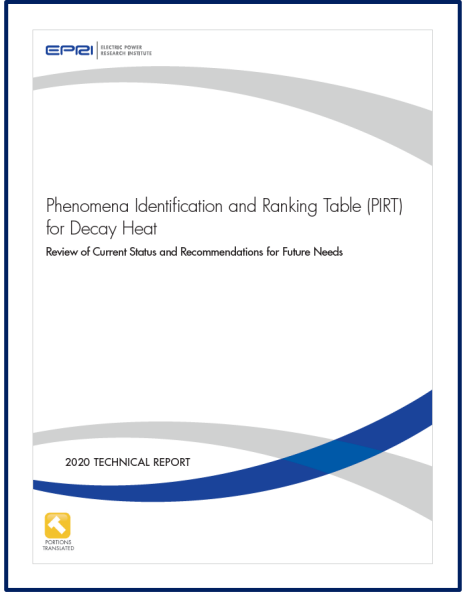
EPRI 3002023961
Alternative Fuel Performance Metrics (2024)



EPRI 3002020929
Cladding Gross Ruptures (2021)



EPRI 3002018441
Thermal Modeling (2020)



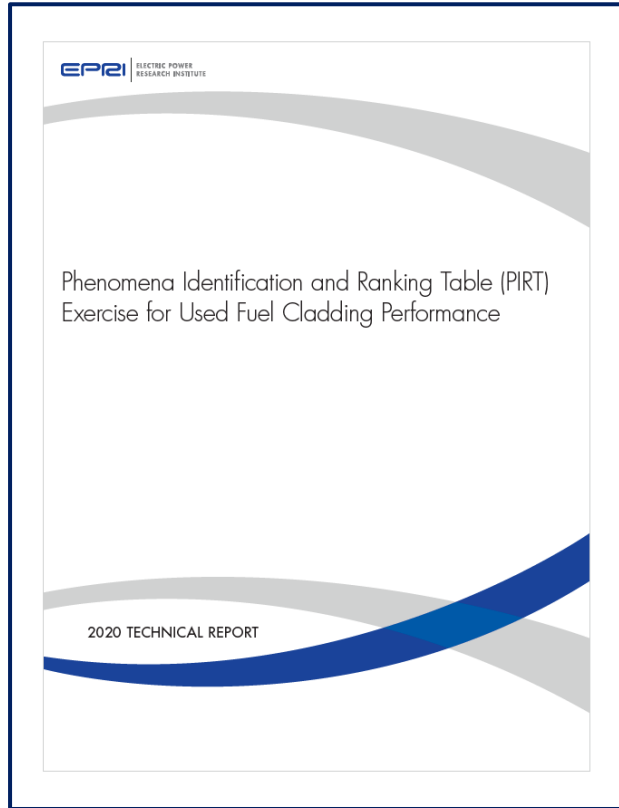
EPRI 3002018440
Decay Heat (2020)

Document consensus on phenomena/parameters important to used fuel cladding, thermal modeling and decay heat analyses



Used Cladding Performance

Used Fuel Cladding Performance (2020)



EPRI 3002018439

Conclusions:

- No cliff-edge effect associated with the current recommended peak cladding temperature limit (PCT) for normal conditions.
- Extent or consequences of cladding rupture may be minor.
- Good state of knowledge of most parameters at current PCT; lower confidence at higher PCTs due to limited testing.

Recommendations:

- Implement a graded approach to protect against gross rupture.
- Discuss the definition of gross rupture with subject matter experts in used fuel and other safety disciplines.

PIRT confirmed technical basis per NUREG-2214 and identified opportunity to risk inform cladding gross ruptures

Alternative Performance Metrics (2024)



EPRI 3002023961

Conclusions:

- Higher PCTs (450°C/500°C) are technically plausible; limited publicly available data, especially for modern zirconium alloys.
- Current operational temperatures are far below 400°C, driven by conservatism in regulatory guidance and vendor methodologies.

Recommendations:

- Conduct additional testing and modeling on annealing effects.
- Perform creep tests accounting for non-uniform temperature profile.
- Evaluate alternative cladding failure criteria beyond yield stress to better capture the structural capacity of fuel rods.
- Investigate synergistic effects among key phenomena.

EPRI leading effort to evaluate options for alternative structural performance metrics to provide flexibilities

Gross Ruptures (2021)



EPRI 3002020929

Proposed redefinition:

A cladding gross rupture corresponds to a fuel cladding failure resulting in fuel material release (fragments of various sizes) that would require precautions beyond those that are routinely used at sites to load intact or canned fuel, to prevent significant fuel material release during handling (loading and unloading).

Other key findings:

- Most relocated fuel would be non-aerosol particulates; does not represent a safety concern due to confinement/containment maintenance.
- Efforts should continue to minimize any type of fuel failures.

EPRI sponsoring effort to develop chemistry-based criteria for gross rupture identification

Gross Rupture Topical Report

- **Why are we developing new criteria?**

- Current size-based definition of gross rupture is difficult to implement and leads to conservative classification as damaged fuel for most failures, even if non-gross.
- Recognize improved fuel reliability has reduced frequency of gross ruptures.
- Plants have decades of coolant chemistry and radiochemistry data that reflect fuel cladding condition.

- **Benefits of chemistry-based approach**

- Provides objective, data-driven, and risk-informed basis for identifying gross ruptures associated with fuel washout.
- Leverages existing coolant chemistry and radiochemistry monitoring data.
- Reduces need for additional fuel movements for inspection and sipping campaigns, and use of damaged fuel cans in dry storage systems.

Criteria consistent with PIRT redefinition of gross ruptures

Gross Rupture Topical Report

■ Technical Approach

- Systematic evaluation of historical coolant chemistry and radiochemistry data to define signatures specific to cladding gross ruptures associated with fuel washout.
- Development of criteria for both PWRs and BWRs, reflecting differences in operational conditions and fuel behavior.

■ Tiered evaluation framework

- A structured framework that screens potential gross ruptures using chemistry-based criteria, with additional confirmatory evaluation or fuel qualification testing only when needed.

■ Ongoing activities / next steps:

- Continued benchmarking and refinement of PWR- and BWR-specific criteria.
- Tabletop review of draft topical report with industry experts.
- Finalize topical report documenting technical basis, methodology, and application guidance.

Topical Report planned to be submitted to NRC by Q4 CY2026

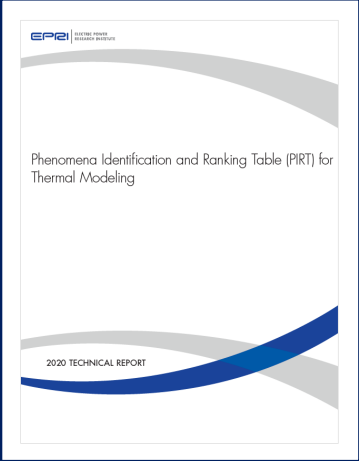


Thermal and Decay Heat Modeling

Thermal and Decay Heat Modeling PIRTs

Thermal Modeling PIRT

“Five key phenomena... could immediately realize a significant reduction in bias or uncertainty compared to typical existing practice.” (Ambient air temperature; Pool/cooling jacket temperature; Space discretization; Decay heat; Individual modeler variability.)



EPRI 3002018441

Decay Heat PIRT

“The measured decay heat range for publicly available PWR data is larger than for BWR assemblies.... New Clab measurements will improve the data set by providing data with significantly improved measurement uncertainty over the full range of data.”



EPRI 3002018440

Benchmark & Validation Activities

HBURC Thermal Modeling Benchmarks:

- Evaluate modeler variability per as-loaded conditions (including decay heat/ambient conditions)
- Double-blind round robin - EPRI 3002013124 (2020):
 - 4 submissions – Steady-state PCT overprediction range: +25°C to +59°C
- International benchmark – EPRI 3002032045 (2024):
 - 12 submissions – Steady-state PCT prediction range: -7°C to +25°C

Decay Heats – EPRI 3002026549:

- EPRI –SKB collaboration report published in 2024
- Clab: 267 measurements with low uncertainty / Up to 1630 W
- **Significant improvement in publicly available decay heat measurements (both BWR/PWR)**
- **Ongoing validation efforts using ORIGEN, POLARIS and SNF**





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