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A Unified Spent Nuclear Fuel (SNF) Database and Analysis System

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Management of Spent Fuel from Nuclear Power Reactors:
An Integrated Approach to the Back End of the Fuel Cycle

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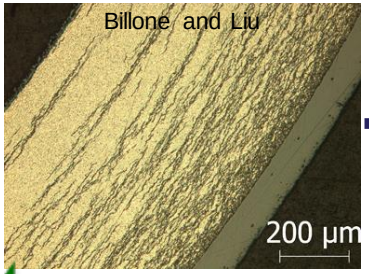
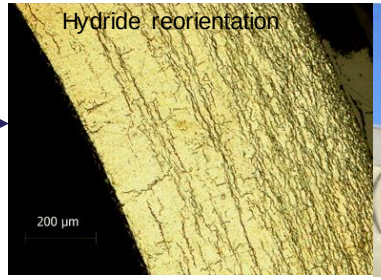
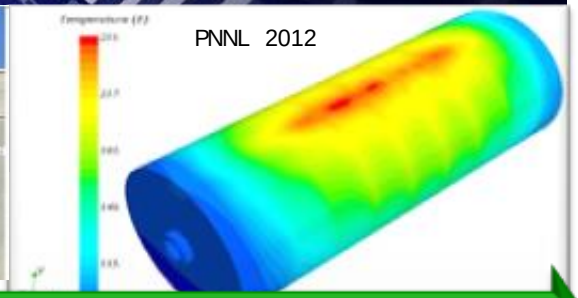
The key to a strong foundation in an integrated SNF management system is a reliable source of information

- **Need to establish a data and analysis system that can be sustained for the long-term**
- **Capability to assess and understand actual conditions versus hypothetical bounding scenarios typically used for licensing (i.e., realistic margins)**
  - Limited or bounding information can increase risk as well as expenses
  - Data needs to address questions on spent fuel issues are diverse and change over time (system aging)
- **Inform decision making with the best information available**
  - Minimize/mitigate financial, dose, and operational risk
  - Support safety confidence and R&D prioritization







Integration of data with analyses to address emerging issues

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All SNF management activities start with understanding the characteristics of the SNF

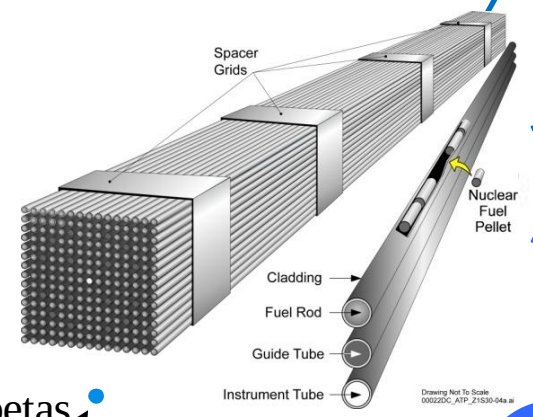
Fuel cycle decisions
Safeguards
Storage
SNF characteristics
Safety
Transportation
Disposal

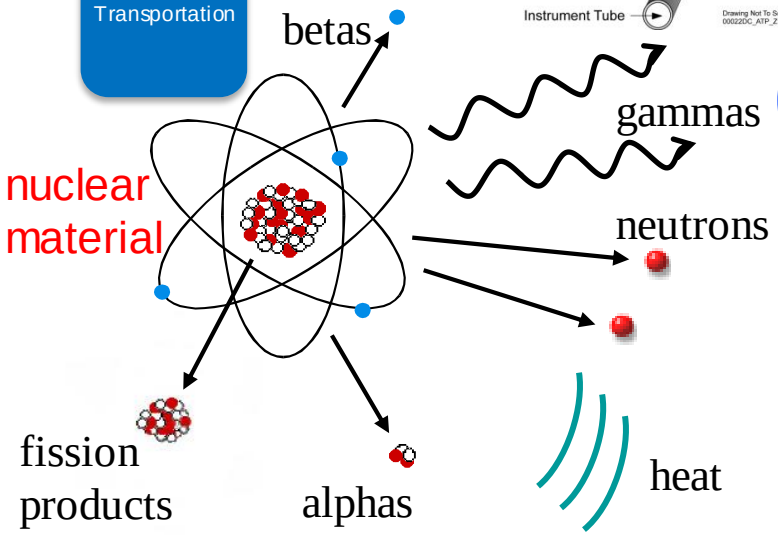
Decay Heat
- Corrosion / degradation
- Structural integrity
- Annealing

Radiation source
- Dose
- Containment
- Self-protection

Composition
- Criticality safety
- Material accountability
- Material recovery

Waste acceptance
- Transportation
- Interim storage
- Repackaging
- Repository





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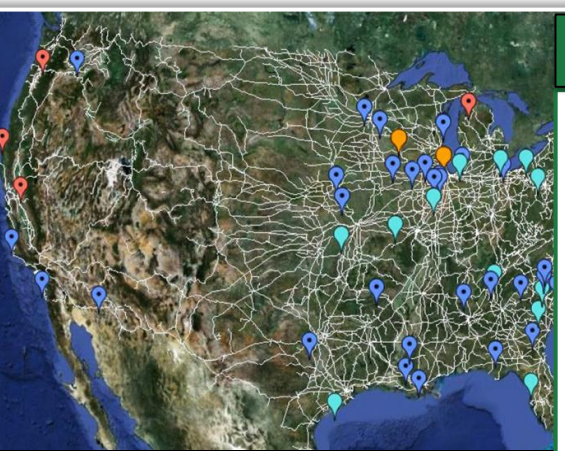
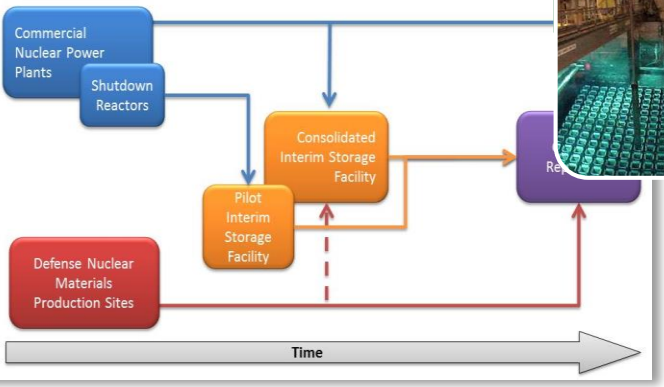
An integrated database and analysis system has been established for managing the nations SNF

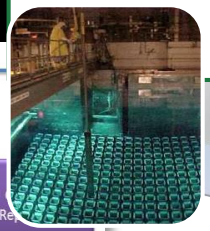
Used Nuclear Fuel Storage Transportation & Disposal Analysis Resource and Data System (UNF-ST&DARDS)



Map of operational and shut-down rea sites

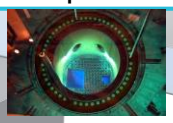


859 data
- Assembly ID
- Assembly type
- Initial enrichment
- Discharge burnup
- Cycle start and end dates

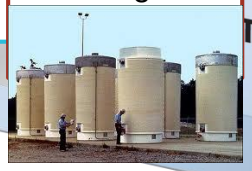


Assembly data
- Geometric configuration
- Materials of construction
- Design dimensions
- Control components

Reactor data
- Cycle specific burnup
- Soluble boron
- Rod insertion history
- Batch loadings
- Axial burnup profiles
- Moderator temperature

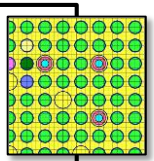


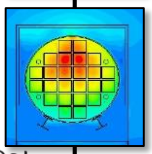
Cask data
- Geometric configuration
- Materials of construction
- Design dimensions
- Cask loading patterns
- Component loading

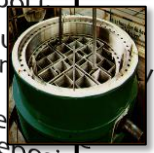


System Analysis Tools

Models
- Depletion: Triton, ORIGEN
- Thermal: COBRA-SFS
- Criticality: KENO-VI
- Dose
- Containment
- Fuel Performance







Repository

Template Engine

T&DARDS

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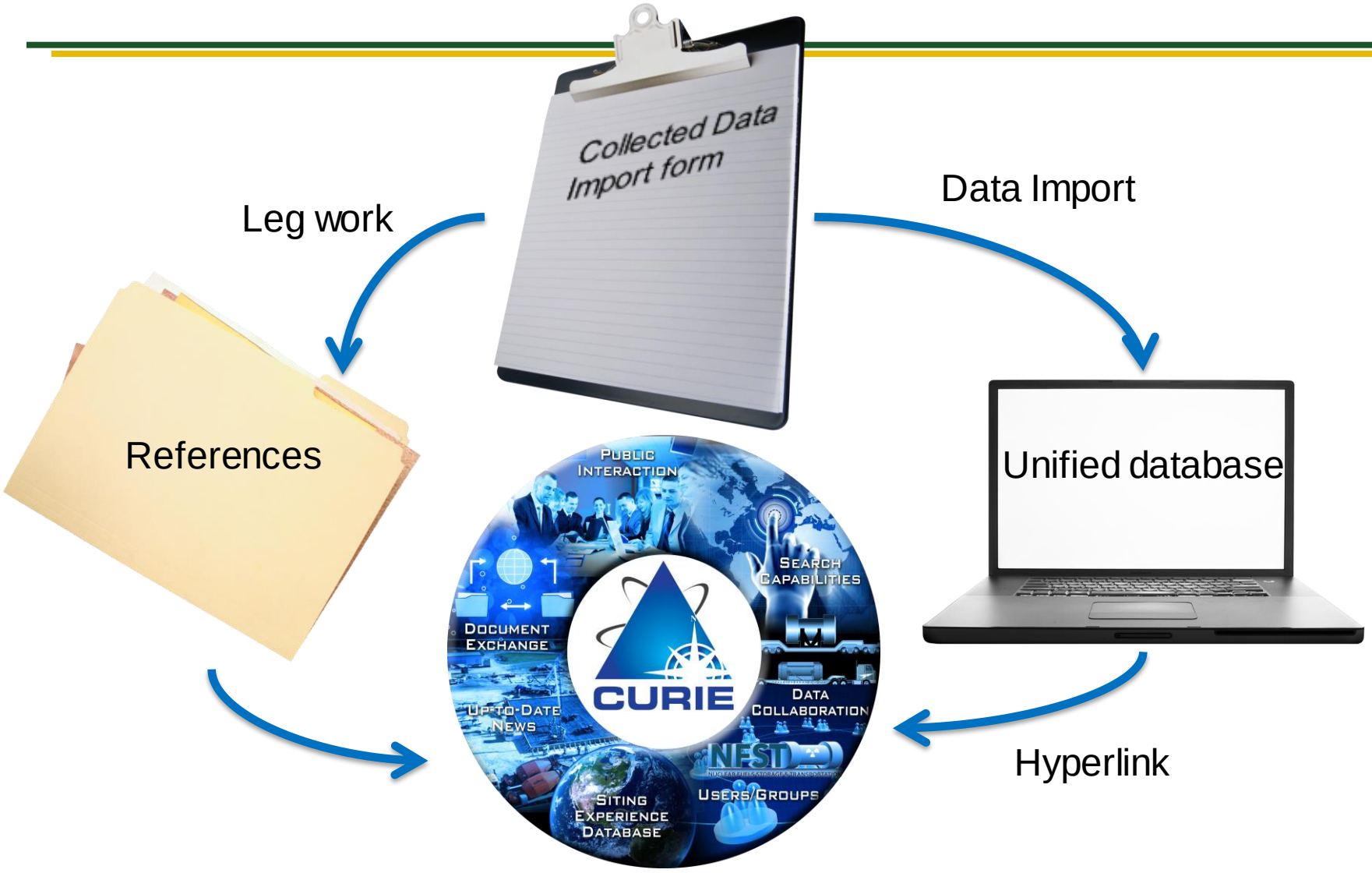
Reference traceability is integrated into the Unified Database



'View Reference' (curie.ornl.gov)

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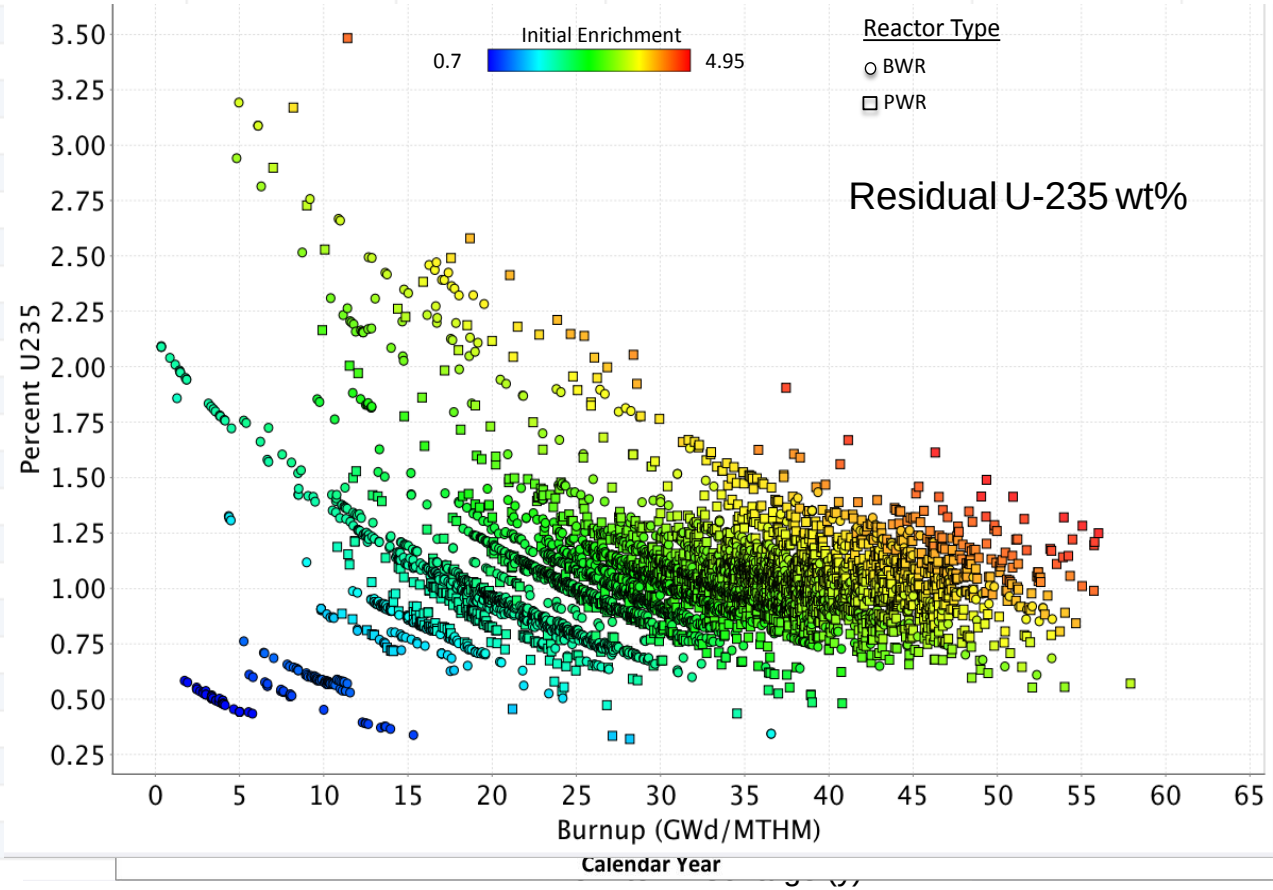
UNF-ST&DARDS performs assembly-specific and cask-specific analyses to streamline SNF characterization

- **Unified database contains assembly-specific attributes for ~150,000 fuel assemblies (in process of updating to ~250,000)**

assembly_id	initial_enrichment	max_burnup_mwd_per_mthm	evaluation_date	decay_heat_w	u235_atom_per_barn_cm	specific_type
A 01	3.02	19321	2025-01-01	139.35143	0.00658787	XHN15W
A 02	3.02	19517				
A 03	3.02	19408				
A 04	3.02	19384				
A 05	3.02	19278				
A 06	3.02	19408				
A 07	3.02	19549				
A 08	3.02	26163				
A 09	3.02	19613				
A 10	3.02	19583				
A 11	3.02	19463				
A 12	3.02	19506				
A 13	3.02	19384				
A 14	3.02	19529				
A 15	3.02	19583				
A 16	3.02	19529				
A 17	3.02	19078				
A 18	3.02	26163				
A 19	3.02	19613				
A 20	3.02	19278				
A 21	3.02	19506				
A 22	3.02	26489				
A 23	3.02	19613				
A 24	3.02	25672				



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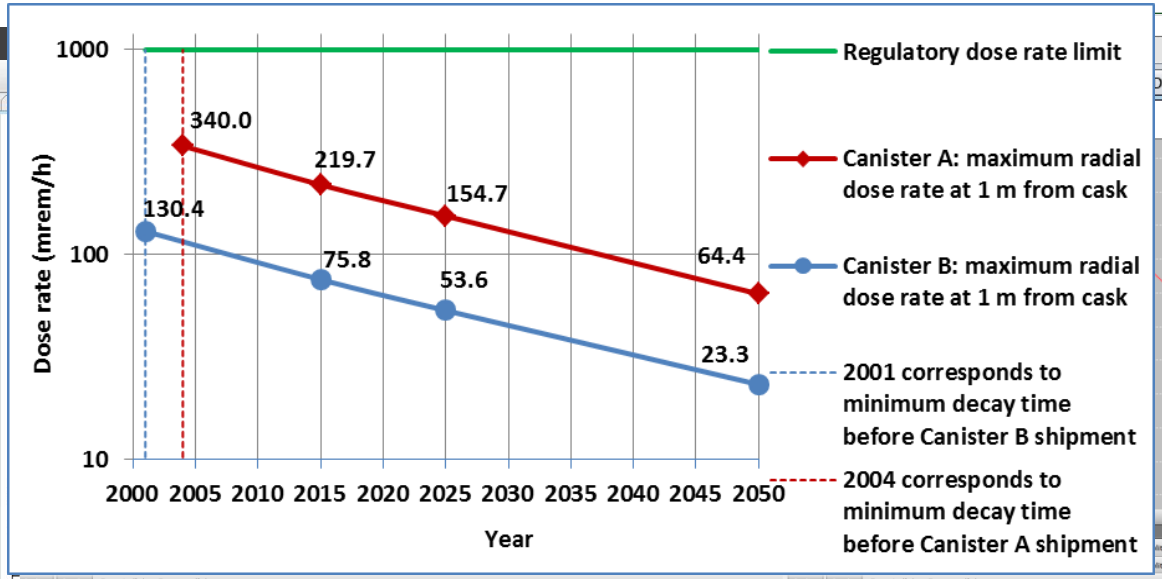
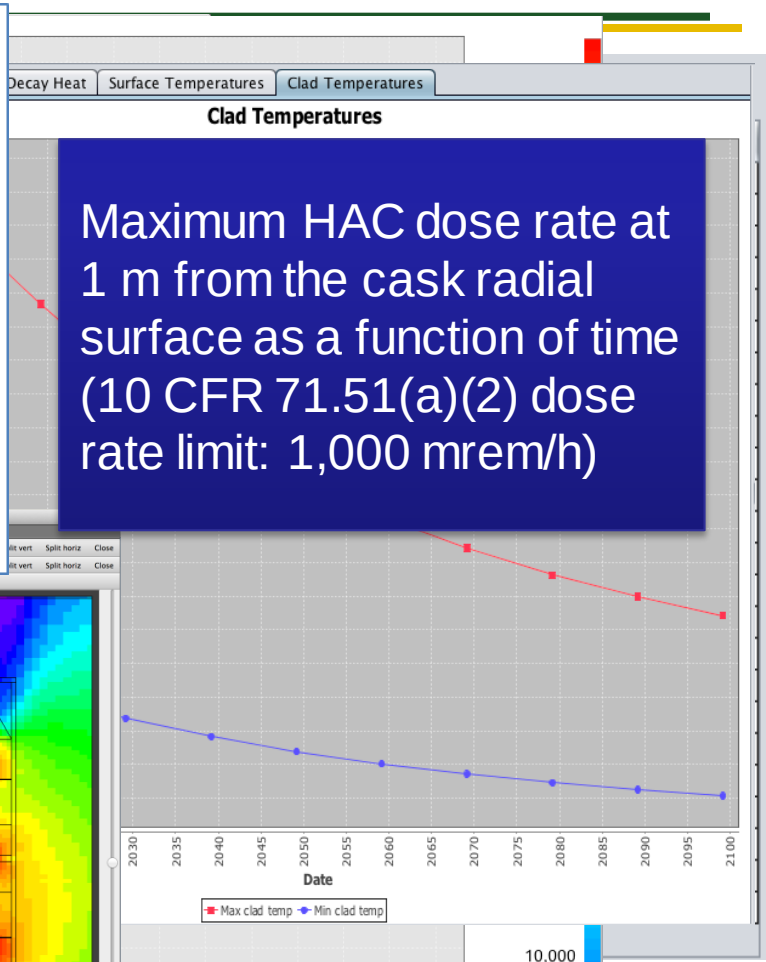
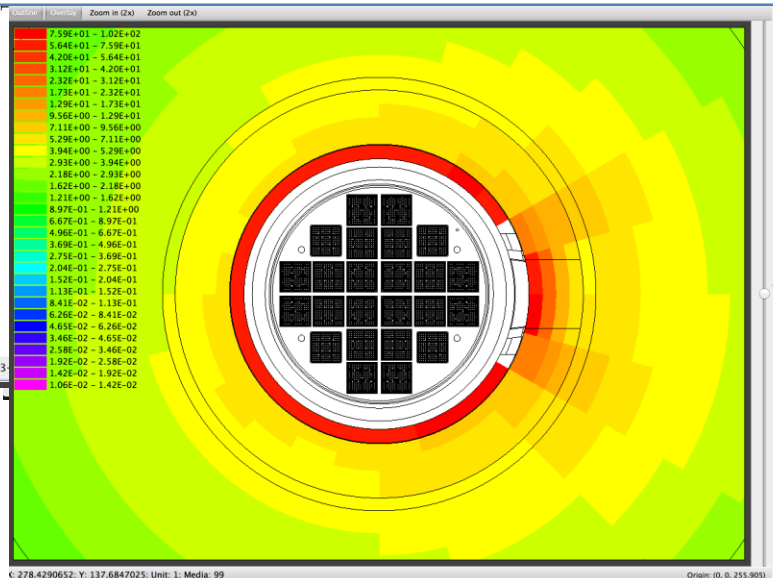
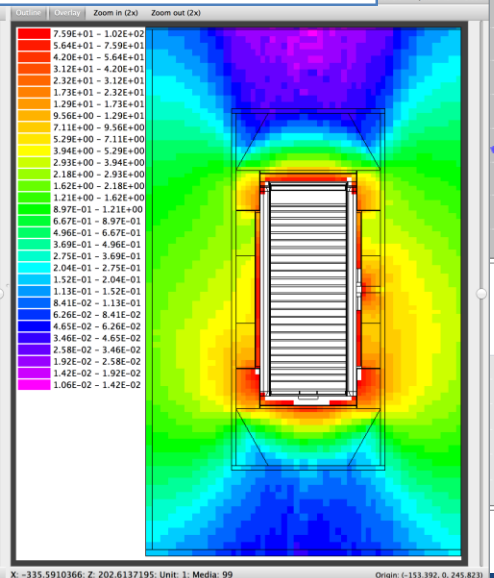
UNF-ST&DARDS provides interactive visualization capabilities to facilitate data analysis and results interpretation





Maximum HAC dose rate at 1 m from the cask radial surface as a function of time (10 CFR 71.51(a)(2) dose rate limit: 1,000 mrem/h)





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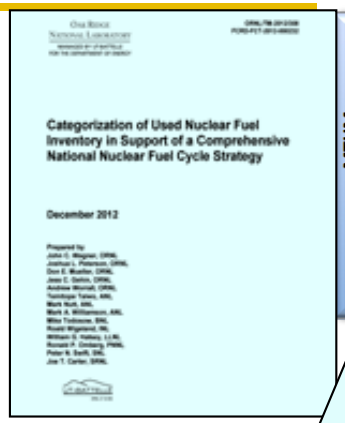
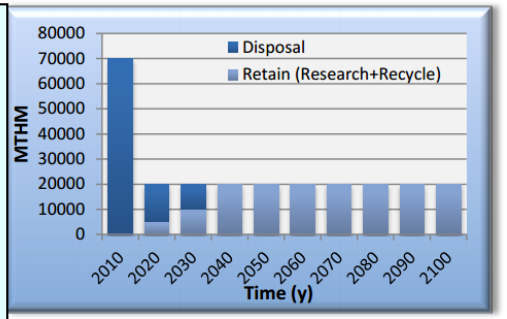
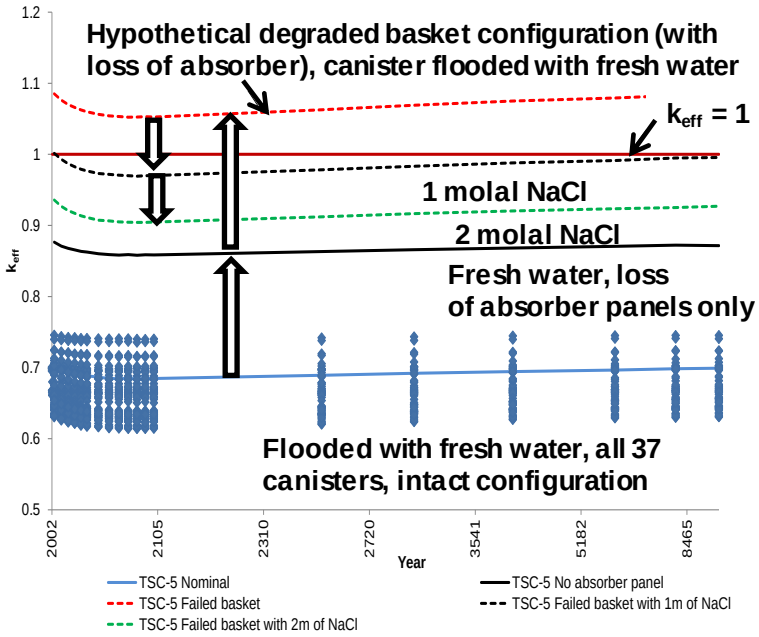
UNF-ST&DARDS is being applied to support various fuel cycle technology objectives

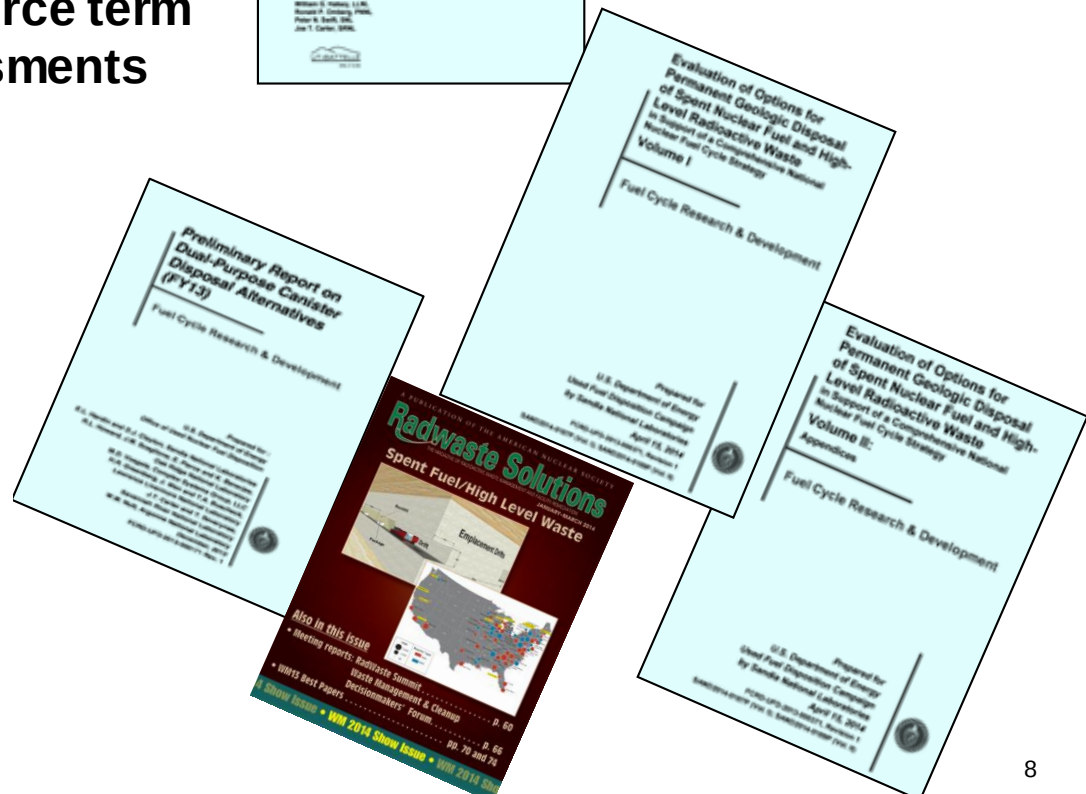
- UNF inventory categorization
- Waste form disposal options
- Feasibility of direct disposal of existing dual-purpose canisters (DPCs)
- Self-protection status and source term generation for security assessments


Categorization of Used Nuclear Fuel Inventory in Support of a Comprehensive National Nuclear Fuel Cycle Strategy

December 2012







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UNF-ST&DARDS is an integrating foundational resource for the safe, secure and sustainable management of SNF

Automated best-estimate used nuclear fuel analyses from reactor power production through disposition

- **A comprehensive system for analysis of the SNF from the time it is discharged from the reactor to the time it is disposed of in a geologic repository**
- **Provides the Unified Database**
  - Controlled source of technical data for the entire waste management system
  - Individual assembly- and cask-specific criticality, radiation dose, containment, and thermal analysis results
- **Characterizes spent fuel/systems that the nation will be managing for decades**
  - Best available information to inform decision making and address emerging issues

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Acknowledgement

- ORNL is leading a multi-national laboratory team and collaborating with industry to develop this enduring national capability

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