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

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

Fuel cycle decisions

Safeguards

SNF characteristics

Storage

Transportation

Disposal

Safeguards

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

Gammas

Betas

Neutrons

Fission products

Heat

Nuclear material

Nuclear Energy
An integrated database and analysis system has been established for managing the nation’s SNF.

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

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

- **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

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

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

**Models**

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

**Map of operational and shut-down reactor sites**

**System Analysis Tools**

**Consolidated Interim Storage Facility**

**Defensive Nuclear Materials Production Sites**

**Commercial Nuclear Power Plants**

**Shutdown Reactors**

**Time**
Reference traceability is integrated into the Unified Database.
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).

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![Loading map](chart.png)

- Isotopic concentrations
- Decay heat
- Radioactivity

- Cask-specific attributes
  - $k_{eff} = 1$ is critical
  - Initial Enrichment
  - Residual U-235 wt%
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).
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
UNF-ST&DARDS is an integrating foundational resource for the safe, secure and sustainable management of SNF

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