U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Nuclear Data in the Regulatory Framework

Workshop for Applied Nuclear Data Activities (WANDA) 2026

February 9, 2026

Lucas Kyriazidis
US Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Division of Systems Analysis

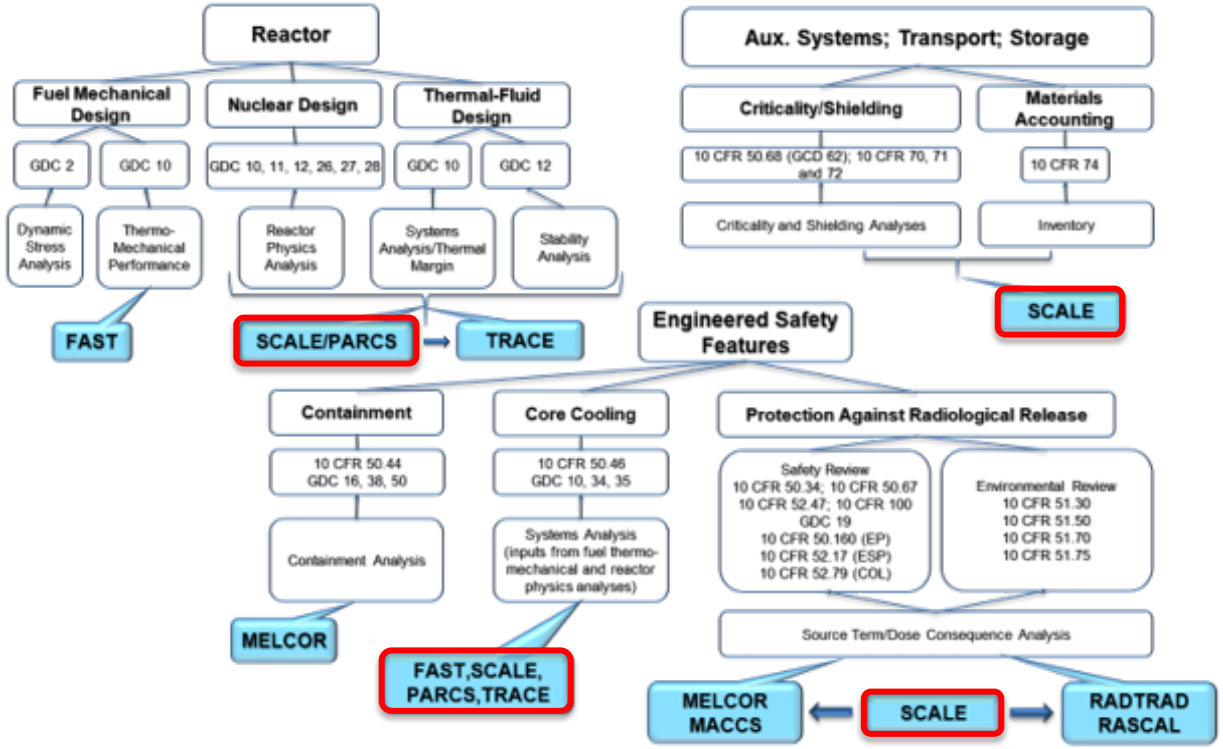
Nuclear Data in the Regulatory Framework

Nuclear data is essential across many regulatory areas:

- NRC licensing activities (independent & confirmatory analyses)
- Model development & validation of NRC's safety computer codes

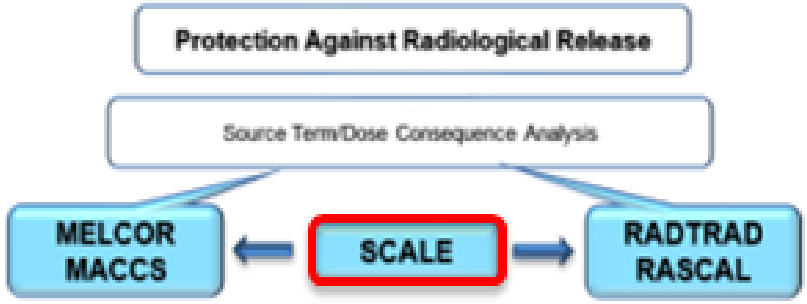
NRC relies on high-quality, comprehensive nuclear data for:

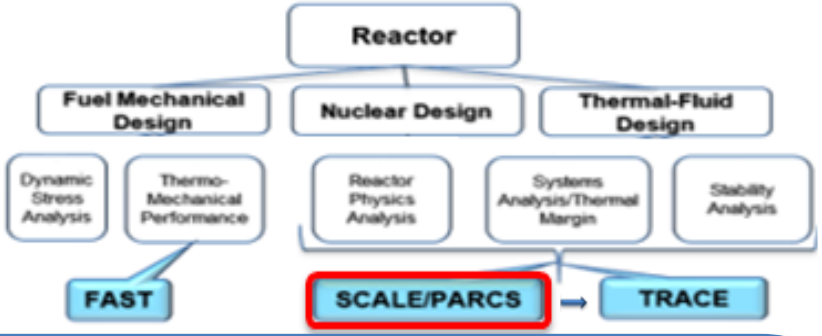
- Non-LWR construction permit licensing reviews
- Spent fuel pool criticality safety analyses
- Criticality, shielding, and decay heat analyses for storage and transportation
- Burnup credit analyses
- Performing accident safety analyses throughout the fuel cycle



Nuclear data supports NRC regulatory decision-making activities, such as reactor power uprates, new fuel designs, new transportation package designs, and advanced reactor designs.

Computational Tools Supporting Regulatory Decision-Making & Safety Analysis





scale

- Nuclear data & cross-section processing
- Decay heat, criticality safety, radiation shielding
- Radionuclide inventory & depletion generation
- Reactor core physics

- Design basis accidents & anticipated operational occurrences
- Couple thermal-hydraulic & neutronics response
- Core heat-up with transient progression

PARCS

- Core simulator (nodal diffusion for transport)
- Solutions for core-wide & assembly power
- Quasi-steady-state depletion – inter and intra fuel cycle analysis (fuel shuffle)
- Transient analysis (coupled to TRACE)

MELCOR

- Accident progression & source term characterization
- Thermal-hydraulic response of the reactor
- Core heat-up, degradation, and relocation
- Fission product release and transport behavior

Nuclear Data Supporting Regulatory Analyses

Nuclear Data Sources

Activation (JEFF-3.0/A)
Activation reactions

Fusion (FENDL)
Activation reactions

ENDF/B
Physics data
Thermal scattering law
Resonance data
Energy distributions
Fission yields, decay constants, decay energy
Recoverable energy
Delayed neutron data

Includes all applicable uncertainties

ORIGEN - Fuel Depletion, Decay, and Activation
- Decay Data – half lives, branching fractions, decay energy release
- Cross-sections
- Gamma ray production
- Fission product yields
- Neutron production data

Polaris / TRITON / KENO / MAVRIC / Shift – Radiation Transport
- Cross-sections
- Gamma ray production
- Fission product yields
- Neutron production data

ORIGEN reactor libraries – Assessed MG Cross-section libraries
- LWR Libraries – PWRs & BWRs
- Non-LWR libraries - SFRs, HTGRs, FHRs, Microreactors, MSRs.

- SCALE is the first step in processing nuclear data for developing problem-specific libraries
  - Confidence in SCALE's predictive solutions rely on **quality and complete nuclear data**
  - **Requires measured mean values and associated uncertainties**

Ongoing Activities at the NRC Impacted by Nuclear Data

Light Water Reactors

- Power Uprates
- Near-Term ATF
- Long-Term ATF

- Extended Enrichment – up to 10 wt.% U-235
- High burnup – up to 80 GWd/MTU
- New fuel designs – coated claddings, additive fuels, new claddings & fuel types

Non-Light Water Reactors

- Pebble-Bed Reactors (FHRs & HTGRs)
- Liquid Salt Fueled Reactors (MSRs)
- Sodium Fast Reactors
- Microreactors

- Spectrum – fast, epithermal, and thermal systems
- Fuel Forms – metallic, TRISO, uranium carbide, uranium silicide, molten salt
- Moderators – graphite, helium
- Coolants – helium, sodium

Fusion

- Neutron-activation & interaction nuclear data
- Neutron irradiation damage

Types of NRC nuclear data needs

Large uncertainties in nuclear data, such as cross-sections, fission yields, and decay data, can propagate into increased uncertainties in **key quantities of interests, used to support NRC activities (i.e., k-effective for criticality safety analyses, calculated reactivity coefficients for reactor physics applications)**. Key nuclear data activities, supporting the NRC, include ensuring nuclear datasets, including uncertainties are complete for the application areas mentioned.

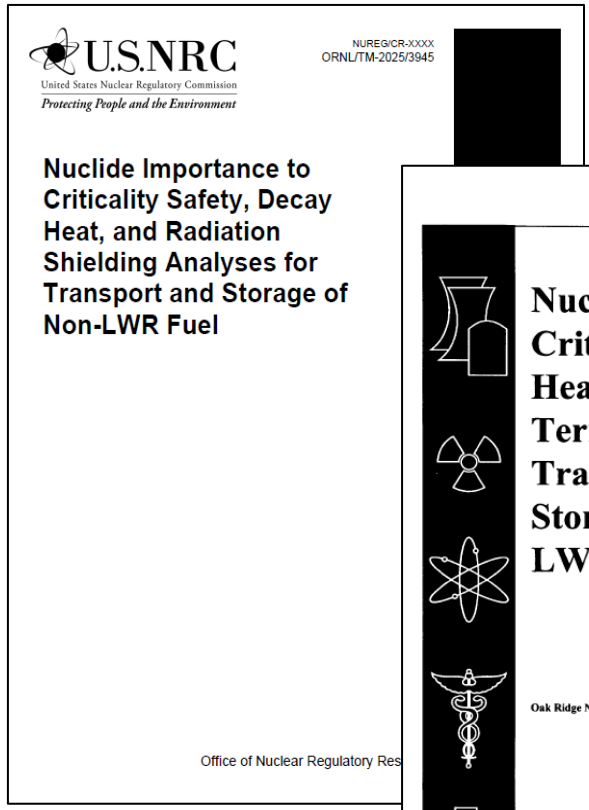
Research Supporting Identifying Key Nuclides Important to NRC-applications

Radionuclides of Interest

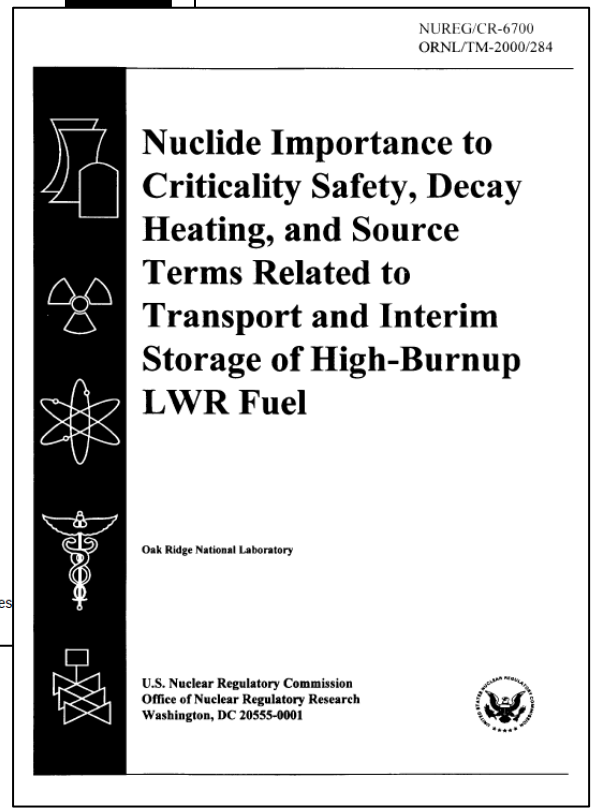
- Nuclear data needs focus on specific data that impact key quantities of interest that support regulatory applications
- Assessments identifying nuclide importance related to backend applications
  - LWRs – NUREG/CR-6700
  - Non-LWRs – NUREG/CR-TBD (ETA 2026)
- Focuses on nuclides that impact criticality, shielding, decay heat analyses

Identifying Nuclear Data Needs

1. Nuclides that impact key quantities that support NRC activities
2. High-quality and complete nuclear data evaluations, including comprehensive uncertainty information
3. Enables uncertainty quantification and sensitivity analyses for nuclides that exhibit significant bias in key NRC quantities of interest while having small reported uncertainties



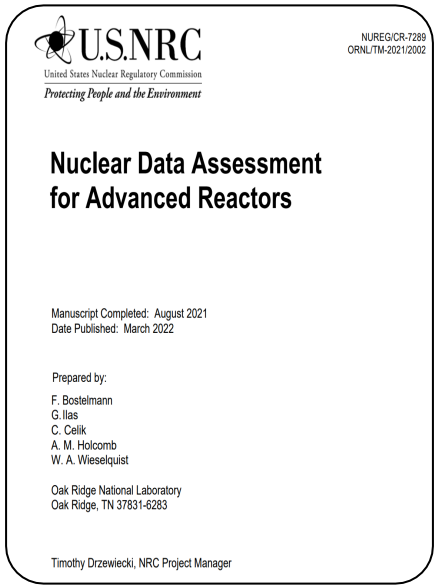
ETA 2026



NUREG/CR-6700

Reference: Nuclide Importance to Criticality Safety, Decay Heating, and Source Terms related to Transport and Interim Storage of High-Burnup LWR Fuel (NUREG/CR-6700, ORNL/TM-2000/284). Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, D.C. January 2001.

Non-LWR Nuclear Data Assessment – NUREG/CR-7289


U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG/CR-7289
ORNL/TM-2021/2002

Nuclear Data Assessment for Advanced Reactors

Manuscript Completed: August 2021
Date Published: March 2022

Prepared by:

F. Bostelmann
G. Ilas
C. Celik
A. M. Holcomb
W. A. Wieselquist

Oak Ridge National Laboratory
Oak Ridge, TN 37831-6283

Timothy Drzewiecki, NRC Project Manager

NUREG/CR-7289

- Identified key nuclear data relevant to reactor safety analysis for selected non-LWR technologies
  - Graphite-rich designs (pebble-bed systems)
    - » Complete nuclear data for graphite including thermal scattering law uncertainty data
  - Salt-based designs (fueled & cooled systems)
    - » Salts may make use of Lithium-7 (e.g., Flibe). Large uncertainty in Li-7(n,γ) has found to be a dominating contributor to impacting reactivity effects.
  - Impact of Nuclear Data Libraries
    - » Understanding the differences between nuclear data libraries which impact reactivity (ENDF/B VII.1 to VIII.0) (e.g., Cl-35)

DOE/NRC Collaboration for Criticality Safety Support for Commercial-scale HALEU Fuel Cycles and Transportation
New US program that addresses critical HALEU-related data needs

Ongoing experiments that will generate new graphite scattering and Cl-35 cross-section data, which includes new measurements, evaluations, and validation

1. **T**hermal/**E**pithermal e**X**periements (TEX) Additional Chlorine Configurations to Provide Validation for TerraPower's Molten Chloride Salt Fuel
2. High-Temperature Graphite Double Differential Scattering Cross Sections: Measurements, Evaluations, and Validation

Reference: Nuclear data assessment for advanced reactors (NUREG/CR-7289, ORNL/TM-2021/2002).
Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. March 2022.

Other Nuclear Data Related Research Activities at the NRC

Extensive SCALE validation completed across reactor physics, criticality safety, shielding, and spent fuel applications. Efforts can be leveraged to provide valuable feedback to the nuclear data evaluators and community.

- As new ENDF/B libraries are released, NRC assesses these libraries on their impacts to NRC-applications
  - ENDF/B VII.1 / VIII.0 / VIII.1
  - Assessment documented in SCALE validation reports
- Recent efforts to begin assessing ENDF/B-VIII.1 for NRC-applications underway
  - Understanding changes in k-effective and/or nuclide inventories with different ENDF/B libraries (VII.1, VIII.0, and VIII.1)
- New efforts underway to automate testing, in SCALE, of new evaluated nuclear data libraries
  - Rapidly assess ENDF/B beta & production libraries
  - Allows for greater opportunities for collaboration by providing evaluators feedback