

Nuclear Data in the Regulatory Framework

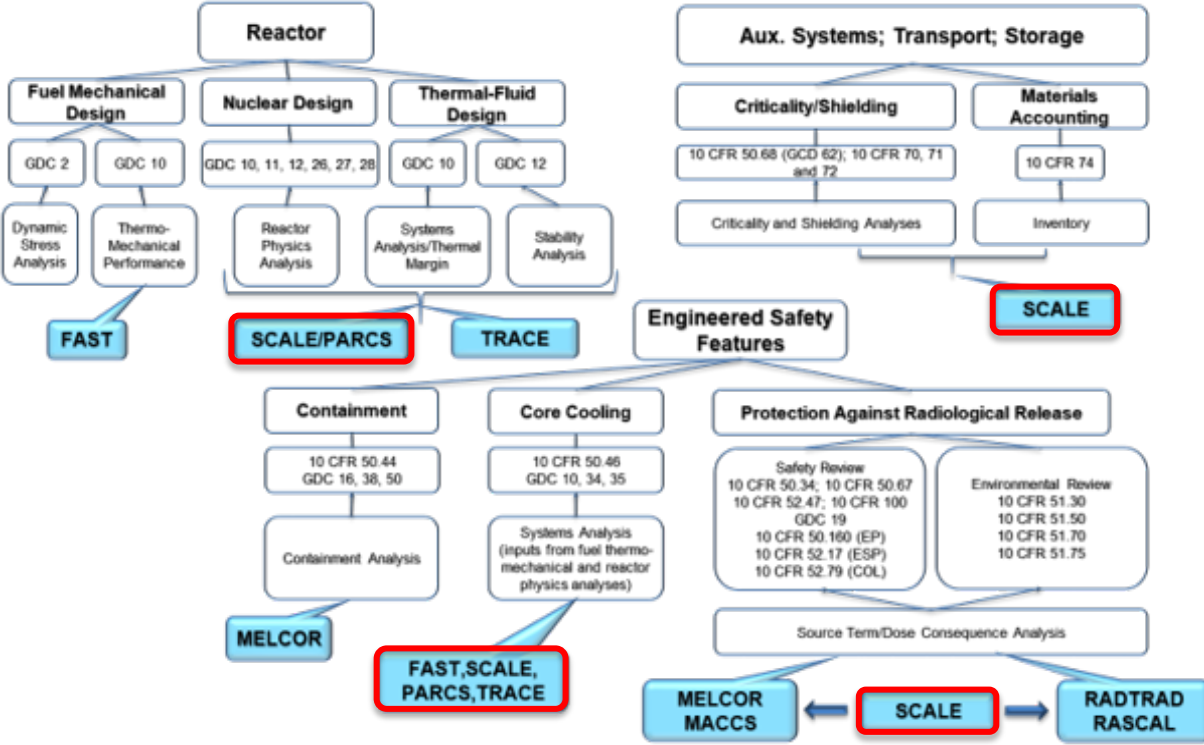
Workshop for Applied Nuclear Data Activities (WANDA) 2025

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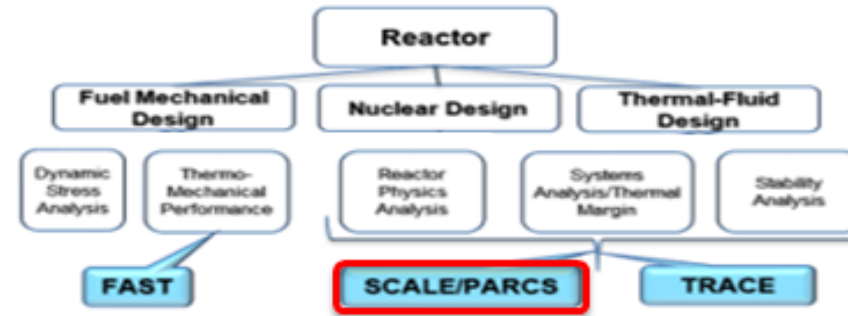
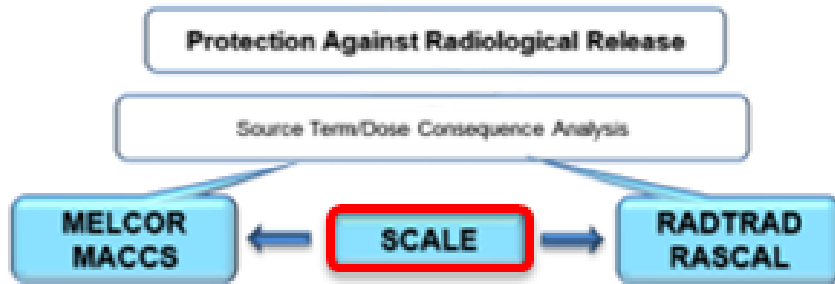
Nuclear Data in the Regulatory Framework

Where does Nuclear Data Fit within the NRC’s Regulatory Framework?
 Nuclear data is used throughout the NRC’s regulatory framework. Nuclear data support licensing activities in the Office of Nuclear Reactor Regulation (NRR) and Office of Nuclear Materials Safety and Safeguards (NMSS). Some activities include review of consolidated interim storage facilities, analyses of spent fuel pool criticality, and reactor physics analyses. All of these rely on quality nuclear data (e.g., ENDF/B), utilized through the neutronics computer code package SCALE.



At the NRC, nuclear data supports key current regulatory decision-making activities, such as reactor power uprates, new fuel designs, new transportation package designs, and advanced reactor designs.

NRC's Computational Tools for Regulatory Decision-Making



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



- Advanced core simulator
- Neutron flux solver and depletion for transient



- 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



Reactor & Source Term Analyses

- Radionuclide inventories & source term generation
- Reactor power distribution
- Depletion, eigenvalue, kinetics analyses
- Severe accident radionuclide transport

Dry Storage Systems & Transportation Package Analyses (10 CFR Part 71/72)

- Criticality safety
- Shielding & Dose
- Decay heat

- 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

LWR Activities at the NRC

Near-term ATF

Higher
burnup &
Increased
Enrichment

Chromium-
doped
fuels

Cr-coated
Zirconium
Cladding
Systems

Iron-based
claddings
(FeCrAl)

Long-term ATF

Metallic
Fuels

Silicon
Carbide
Cladding

Uranium
Silicide
Fuels

Uranium
Nitride
Fuels

Does the NRC envision any nuclear data needs for LWRs, including ATF?

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.

Non-LWR Activities at the NRC

Technology & Reactor Type	Key Design Characteristics	
High-Temperature Gas-Cooled Reactors (HTGRs)	<p style="text-align: center;"><u>Fast Spectrum Systems**</u></p> <ul style="list-style-type: none"> • Uranium carbide fuel • Silicon carbide cladding • Helium-cooled 	<p style="text-align: center;"><u>Thermal Spectrum Systems**</u></p> <ul style="list-style-type: none"> • TRISO particle (<20 wt.% U-235) fuel • Graphite moderated • Helium-cooled <div style="border: 1px solid black; border-radius: 10px; background-color: #D9EAD3; padding: 5px; text-align: center; width: fit-content; margin: 0 auto;">X-Energy Xe-100**</div>
Fluoride salt-cooled Reactors (FHRs)	<p style="text-align: center;"><u>Thermal Spectrum Systems***</u></p> <ul style="list-style-type: none"> • TRISO particle (<20 wt.% U-235) fuel • Graphite moderated, • Molten fluoride salt cooled (Flibe) <div style="border: 1px solid black; border-radius: 10px; background-color: #D9EAD3; padding: 5px; text-align: center; width: fit-content; margin: 0 auto;">Kairos Power Hermes I & Hermes II***</div>	
Molten Salt-fueled Reactors (MSRs)	<p style="text-align: center;"><u>Fast Spectrum Systems</u></p> <ul style="list-style-type: none"> • Uranium-chloride salt fueled 	<p style="text-align: center;"><u>Thermal Spectrum Systems***</u></p> <ul style="list-style-type: none"> • Molten fluoride salt, fueled with UF₄ <ul style="list-style-type: none"> • LiF, BeF₂, UF₄ (< 20 wt.% U-235) • Graphite moderated
Sodium-cooled Fast Reactors (SFRs)	<p style="text-align: center;"><u>Fast Spectrum Systems*</u></p> <ul style="list-style-type: none"> • High-assay LEU (HALEU) metallic fuels • Sodium coolant <div style="border: 1px solid black; border-radius: 10px; background-color: #D9EAD3; padding: 5px; text-align: center; width: fit-content; margin: 0 auto;">TerraPower Natrium*</div>	

* Applications submitted (e.g., construction permit, operating license, etc.)

** Pre-application activities (e.g., topical reports, white papers, etc.)

*** Approved Construction Permit

Non-LWR Nuclear Data Needs

- [NUREG/CR-7289](#)
 - Assessment on key nuclear data relevant to reactor safety analysis in selected non-LWR technologies

Does the NRC envision any nuclear data needs for non-LWRs?

NUREG/CR-7289 identified many key isotopes for the various types of non-LWR designs on the horizon. This assessment also identified missing nuclear data. Examples include:

- Many non-LWR designs are graphite-rich. Thus, complete nuclear data sets for graphite would be important. One key missing nuclear data identified was missing graphite thermal scattering uncertainty data.
- Nuclear data related to the salts (e.g., Flibe) under consideration. Some salts make use of Lithium-7. Large uncertainty in $\text{Li-7}(n,\gamma)$ has found to be a dominating contributor to impacting reactivity effects.
- Understanding the differences between nuclear data libraries which impact reactivity (ENDF/B VII.1 to VIII.0) (e.g., Cl-35)



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

Nuclear Data Assessment for Advanced Reactors

Manuscript Completed: August 2021
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DNCSH program will address these identified data needs by generating new graphite scattering and Cl-35 cross-section data, which includes new measurements, evaluations, and validation.

Summary - Nuclear Data Needs & Interests

Key Data Needs & Interests

- TSL data, including uncertainties
- Fission yields , including uncertainties
- Decay constants & branching ratio, including uncertainties
- Recoverable energy data, including uncertainties

Key data needs & interests revolve around isotopes that support near- and longer-term concepts (ATF/HBU/LEU+, non-LWRs, and fusion).

Nuclear Data Related Research Activities

- Supported recent efforts to begin assessing ENDF/B-VIII.1 for NRC-applications
 - Understanding changes in k-effective and/or nuclide inventories with different ENDF/B libraries (VII.1, VIII.0, and VIII.1)
- Efforts underway to automate testing of new evaluated nuclear data libraries to support NRC-related assessments within SCALE
 - Quickly assess ENDF/B beta released libraries, allowing for greater opportunities for collaboration