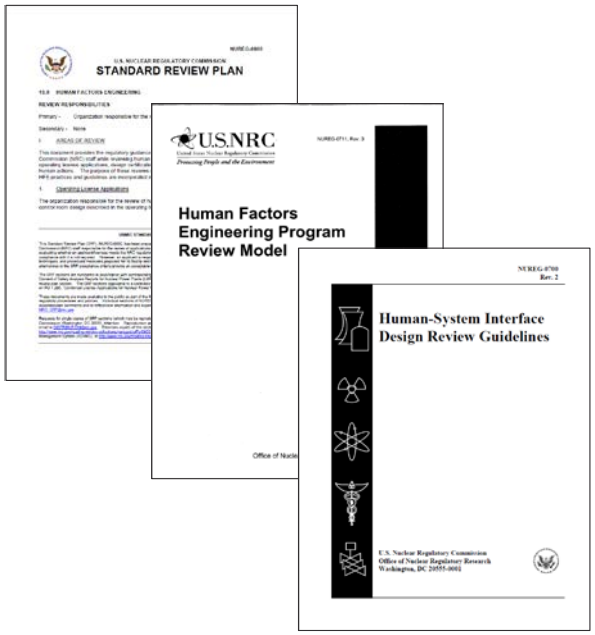
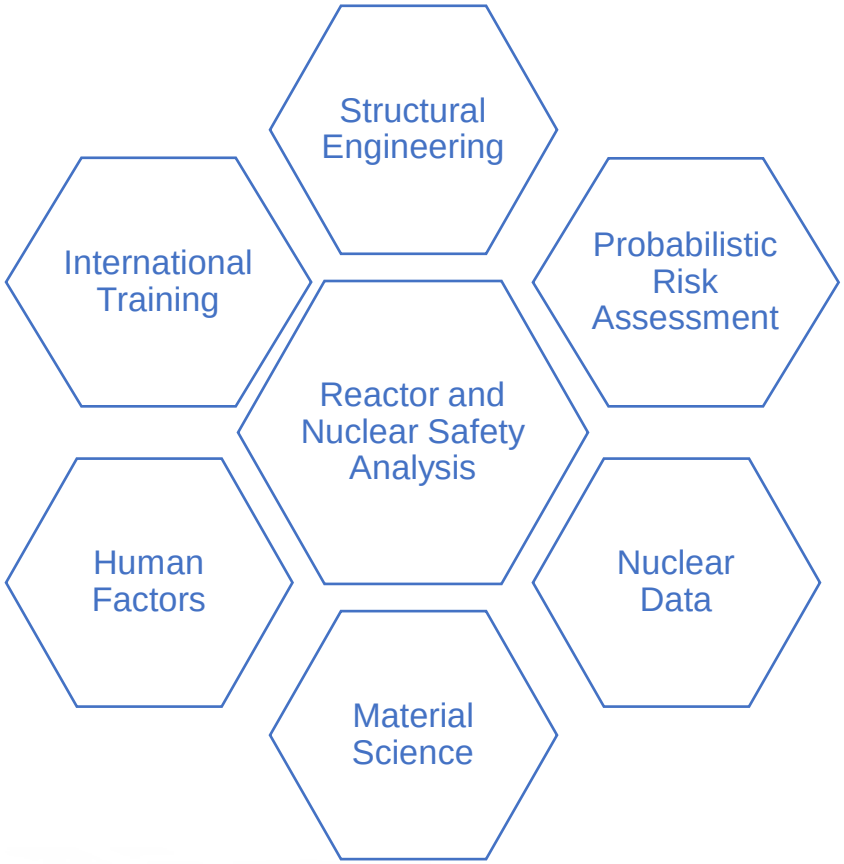
Nuclear Science and Technology Department Capabilities

BROOKHAVEN NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

Nuclear Science and Technology Department Capabilities

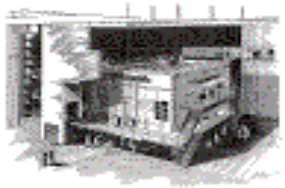


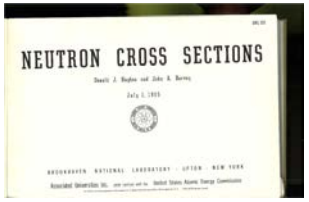


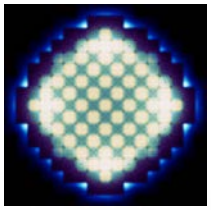
BNL Nuclear Energy Programs

- NNDC – 1952*
- Technical Support for NRC – 1974*
- International Nuclear Safety Program – 1986*
- Accelerator Transmutation of Waste – 1991
- Proliferation Resistant Reactors – 1996*
- Advanced Nuclear Fuels*
- Materials in Radiation Environments*

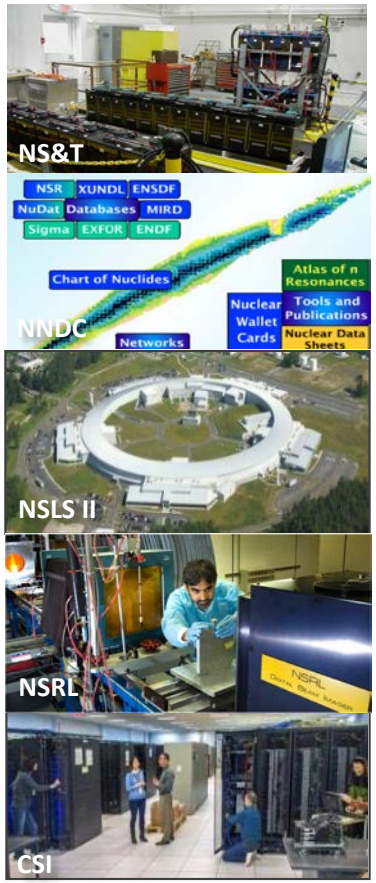
* Continuing program







Advanced Reactor Development Support



BNL/DOE Facilities

Relevant Capabilities

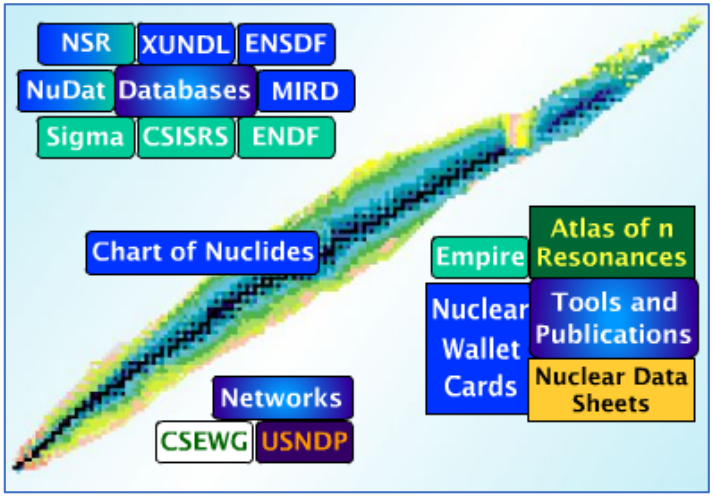
- Radioactive materials characterization
- Reactor simulations
- Control room design/human factors
- Reactor licensing
- International commercialization

Partners/Joint Appointments

University | *National Lab* | *Industry*

Stony Brook University
Idaho National Laboratory
UMASS LOWELL
Oak Ridge National Laboratory
Managed by UT-Battelle for the Department of Energy
Westinghouse
NIST
NSUF
U.S.NRC
NASA

National Nuclear Data Center



Nuclear Science References (NSR)
All nuclear physics articles indexed according to content

EXFOR
Compiled nuclear reaction data

XUNDL
Compiled nuclear structure and decay data

ENSDF
Recommended nuclear structure and decay data

ENDF – Data needed in many applications: design, operation, and decommission nuclear reactors. Recommended particle transport and decay data with a strong emphasis on neutron-induced reaction data

Nuclear Data Sheets
Journal devoted to the publication of nuclear data articles

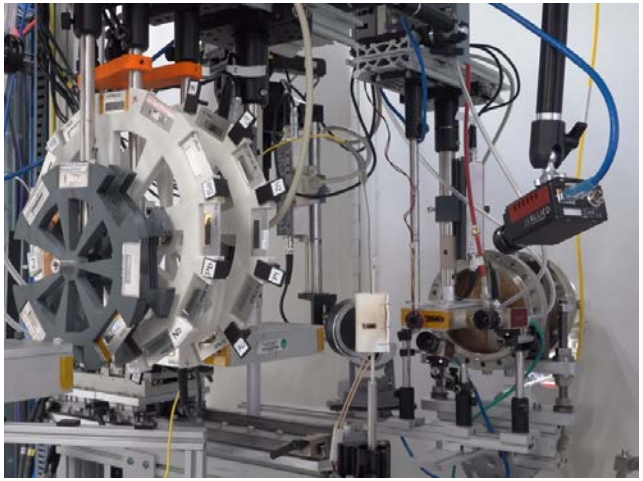
Web dissemination
www.nndc.bnl.gov

Molten Salts in Extreme Environments

Mission: To provide fundamental and predictive understanding/models of molten salt chemistry, including effects of solutes, impurities, and radiation

- Physics and chemistry of molten salts
- Interactions with solutes (actinides, fission products, corrosion products) and radiation
- Interactions with and degradation of reactor materials

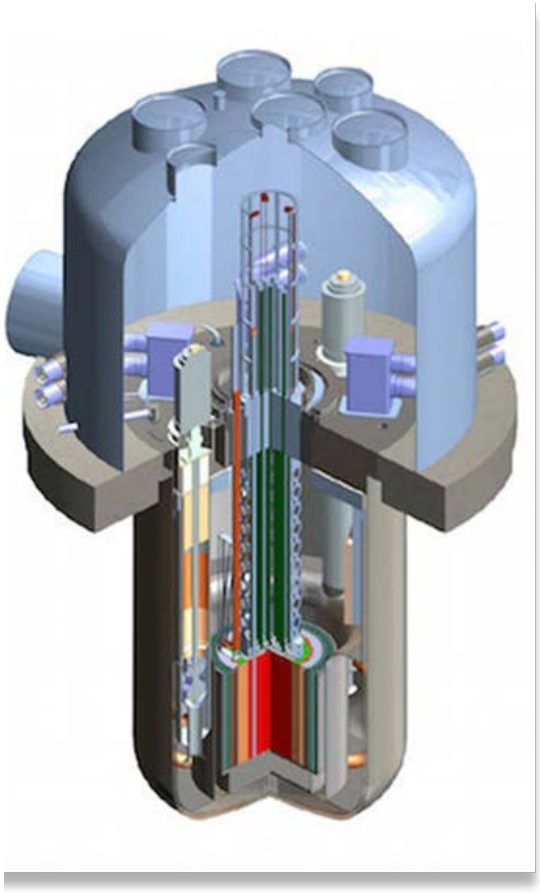
The experimental techniques developed can be applied to real reactor systems – engineering alloys and salts



Custom made in situ furnace for molten salt studies (25ºC to 700ºC)

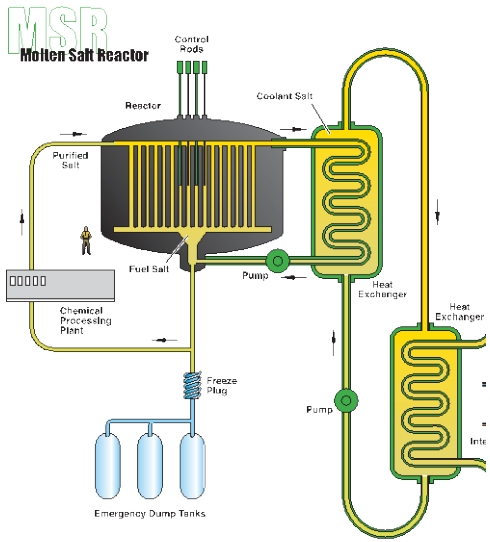
Supporting NRC Reactor Licensing

- Technical support on safety and licensing issues for power, research, test, and special purpose reactors.
- Reviews of licensee submittals (e.g., design certification, topical reports, life extension).
- Lead on many Phenomena Identification and Ranking Tables (PIRTs).
- Support for PRA Level 2 & 3 studies, nuclear power plant accident consequence analysis and emergency preparedness.
- Review of industry standard for safety-related composite modular and steel structures.
- Human factors issues.
- International regulatory support.



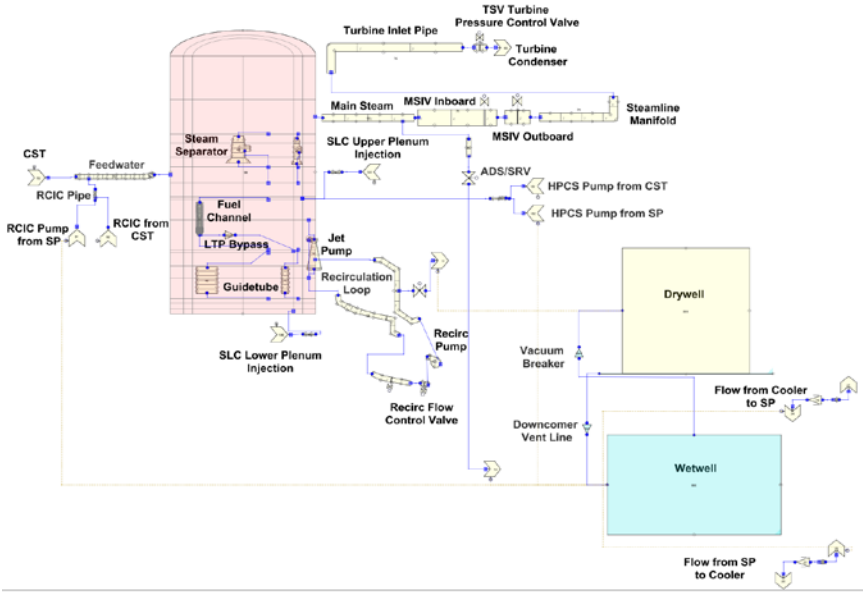
Advanced Reactor Analysis Activities

- Research phenomena important in Modeling and Simulation of advanced reactor designs
- Technical and regulatory issues of microreactors
- Regulatory impact of advanced reactor designs



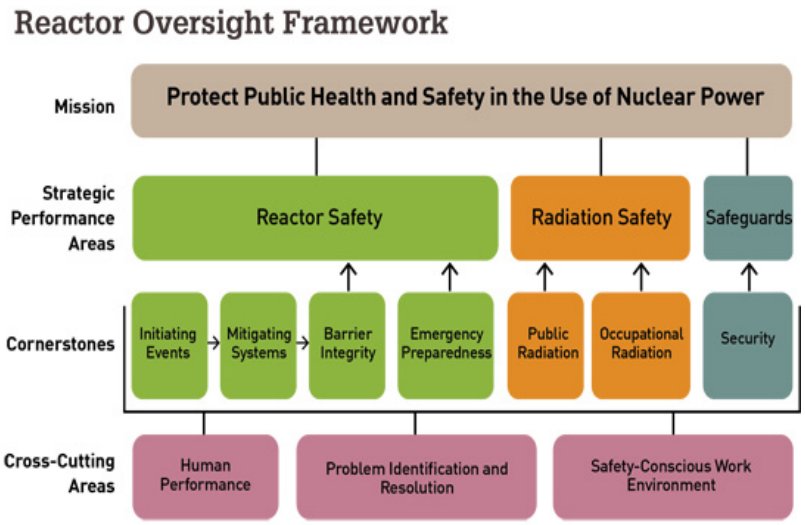
Reactor Safety Support

- Support NRC in revising the Standard Review Plan (NUREG-0800)
- Design reviews of advanced designs
- LOCA methodology for PWR and BWR
- Accident tolerant fuel – fuel and cladding
- Extensive model development to perform coupled transient neutronics and thermal-hydraulic analysis
- Research reactor core conversion (LEU to HEU)



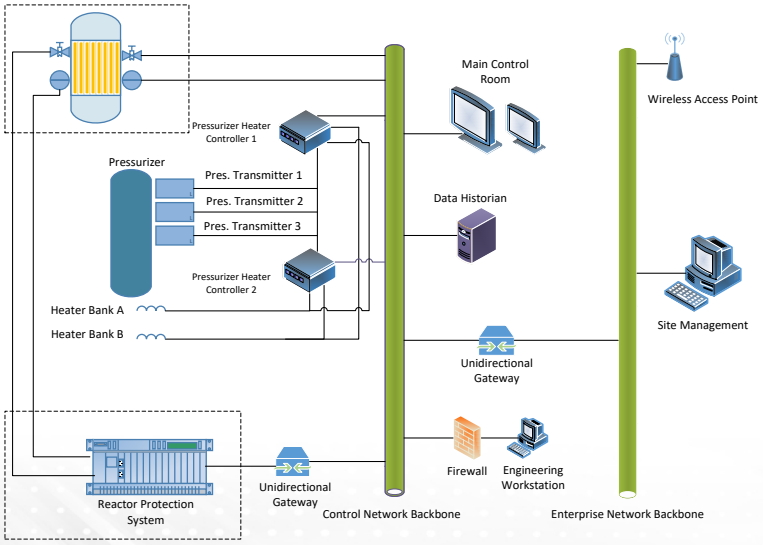
PRA Methodology, Applications, and Guidance

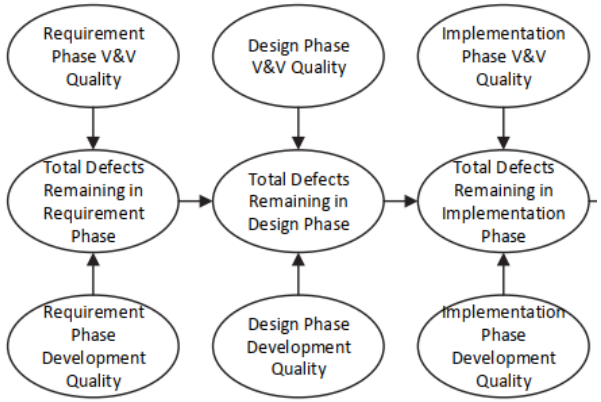
- **PRA Methodology Development**
  - Level 1, 2, and 3; full power and shutdown PRAs
  - Methodology of PRA applications
- **Risk-informed Technical Specifications**
  - Handbook of Methods for Risk-based Analyses of Technical Specifications – 1994
  - Development of AP1000 Standard Technical Specifications
- **Risk-informed Inspections and Reactor Oversight Process**
  - Plant-specific models for Significance Determination Process
  - Technical basis for At-Power Significance Determination Process



Digital I&C System Reliability

- Quantify the probability of digital system failure caused by software bugs through statistical testing
- Estimate the probability of software failure on demand-based quality of the development process through Bayesian analysis





- Evaluate the system-level impact of cyber-attacks against digital control systems

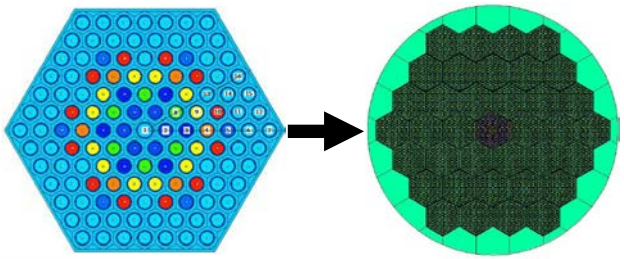
Human Factors Engineering (HFE)

- Research on integrating human crews into complex systems
- Develop HFE guidelines for the review of human-system interface designs
- Perform safety reviews of new and modernized plant designs
- Use of technology improving crew performance and reliability

International Regulatory Assistance

- International program to improve nuclear safety in Eastern Europe → Ukraine, Armenia
- Provide nuclear regulatory support for countries establishing new nuclear programs – Poland, Vietnam, and Thailand
- Program Categories
  - Plant Safety Analysis – FSARs, PRA
  - Regulatory/Legislative Activities – Licensing support
- Implementation
  - Training in regulatory methods and procedures, and inspection techniques
  - Transferring analytical techniques
  - Providing and training use of equipment

VVER-440 Spent Fuel Isotopic Benchmark



Seismic/Technical Assistance to NRC

- Technical Review of Design Certification Applications; Evaluation of Structures, Fuel Racks, Piping, License Renewal Applications (2001 to 2008)

- Assistance in developing improved regulatory guidance for design/analysis of Seismic Cat I SSCs

- Spent Fuel Storage Cask Accidental Drop Analysis

Support for DOE-NE

- Evaluation of advanced nuclear systems (reactors and accelerator-driven-systems (ADS) and fuels cycles

- Actively supporting NE programs:
  - Advanced Fuels, Fuel Cycle Options, Material Protection Accounting & Control Technologies
  - Nuclear Fuel Cycle & Supply Chain - Systems Analysis & Integration, Advanced Fuels, and LWR Modeling & Analysis
  - Advanced Reactor Technologies - Proliferation Resistance & Physical Protection