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Assignment 1, Neutral particle transport and NNSA NA-22 mission

NE 255 Numerical Simulation in Radiation Transport

9-16-2016

*Look through the National Nuclear Security Administration (NNSA) Nonproliferation Program (NA-22) website. Spend some time understanding what their mission is and what programs they fund to accomplish that mission. Write a few paragraphs about how you think neutral particle transport and new developments in that field might fit into what NNSA NA-22 is doing.*

The core mission of the NNSA NA-22 is “to develop and implement policy and technical solutions to eliminate proliferation-sensitive materials and limit or prevent the spread of materials, technology, and expertise related to nuclear and radiological weapons and programs around the world.” Neutral particle transport is a cross-cutting technology applicable to many aspects of the NNSA nonproliferation mission and are incredibly versatile in that they represent a technical solution that potentially has policy or functional applications. In the following paragraphs, I break the mission into two pieces. The first focuses on the elimination of proliferation-sensitive materials. The second relates to preventing the spread of all-things-weapons.

Eliminating proliferation-sensitive materials is a critical part of nonproliferation. By decreasing inventory of these materials, we decrease the risk that they are used for weapons-purposes. One of the best ways to eliminate highly enriched fissile material is to down-blend it and burn it in a nuclear power reactor. Doing so takes advantage of its high energy density and renders it unusable for proliferation activities. Neutral particle transport can be important in designing new low-enriched fuels and determining how they can be used in today’s reactors. Based on the designs, policy agreements can be introduced to eliminate weapons materials internationally. For example, the US and Russia have/had an agreement that the US would down-blend and burn fissile material from former Soviet weapons.

Limiting the spread of weapons materials, technology, and knowledge is a tall order that requires numerous detection and monitoring capabilities. Transport simulations can play an integral role in managing and monitoring fissile materials. In particular, they could be used to develop detectors for weapons materials or covert reactors. These could be used to monitor compliance with treaties and reduce smuggling. Based on neutron detection and informed by transport simulation results, we can measure spontaneous fissions from Cm-244 in spent fuel and apply the Pu/Cm-244 ratio technique to validate material accountancy to prevent fissile material diversion.

NNSA NA-22: Some programs relevant to neutral particle transport (or applications thereof)

* Material management and minimization:
  + Conversion: reducing the civilian use of and demands for weapon-grade nuclear material
    - Convert program – minimizing use of HEU
    - Establish a reliable supply of Mo-99 w/o HEU
  + Nuclear material removal
  + Material disposition
    - Dispose of weapons-grade materials by producing low-enriched fuel/targets
* Global material security: help partner countries secure and account for nuclear weapons, nuclear/radiological materials.
  + International nuclear security: improve the security of proliferation-sensitive materials in key countries
    - Upgrade and sustain security, material control and accounting
    - Develop national-level security infrastructure in regulations, inspections, and transportation
  + Nuclear smuggling detection and deterrence
    - Install/deploy fixed and mobile detectors at borders, ports, etc
    - Increase global understanding of nuclear forensics
* Nonproliferation and arms control
  + International nuclear safeguards
    - Develop and transfer safeguards tools, technologies and approaches to improve safeguardability of fuel cycle facilities
    - Improve the implementation of agreements by foreign partners
  + Nuclear controls
  + Nuclear verification
    - Implement current and developing arms reduction and nonproliferation transparency treaties/agreements
    - Develop technologies to support monitoring for those treaties and to detect covert weapons programs or nuclear material diversion
  + Nonproliferation policy
* Research and development: innovate technical capabilities to detect, identify, and characterize weapons programs, diversion of materials, and nuclear detonations
  + Proliferation detection
    - Support technology to detect and characterize weapons programs
    - Support nuclear treaty monitoring and verification tools
    - Support cross-cutting technologies like simulations, algorithms, and modeling applicable to multiple NNSA and the interagency missions
  + Nuclear detonation detection
    - Space sensors
    - Ground-based
    - Nuclear forensics