

Kaushik Banerjee

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Summary

Ph.D. Nuclear Engineer with experience developing and applying mathematical and computational methods for radiation shielding, criticality safety, and reactor analyses with particular expertise in Monte Carlo radiation transport and burnup credit criticality safety analyses for the spent fuel storage, transportation, and disposal.

Education

- University of Michigan: **Ph.D.**, Nuclear Engineering and Radiological Sciences, 2005 – 2009
- Kansas State University: **M.S.**, Nuclear Engineering, 2003 – 2005
- Bengal Engineering College, Shibpore, India: **B.E.**, Metallurgical Engineering, 1997 – 2001

Appointments

- October 2013 – Present: **Senior R&D Staff, Used Fuel Systems**, Oak Ridge National Laboratory
Supervisor: John M. Scaglione, Dr. John C. Wagner (former)
 - March 2013 – September 2013: **R&D Staff, Radiation Transport**, Oak Ridge National Laboratory
Supervisor: Dr. Robert E. Grove
- Responsibilities:

1. Provide R&D support to the Department of Energy (DOE)'s spent nuclear fuel management programs, Nuclear Regulatory Commission (NRC), and nuclear industries involve in spent nuclear fuel research and management

Major projects:

- **UNF-ST&DARDS:** Leading the development of a comprehensive, integrated data and analysis tool—the Used Nuclear Fuel-Storage, Transportation & Disposal Analysis Resource and Data System (UNF-ST&DARDS). UNF-ST&DARDS currently supports used nuclear fuel cask-specific as-loaded safety analysis including criticality, thermal and dose evaluations, as well as results visualization.
- **Direct disposal of dual-purpose canisters (DPCs):** Leading the R&D effort to (a) assess the post-closure criticality safety of DPCs and (b) investigate various canister fill materials that could be used

in existing and future DPCs to mitigate the potential for post-closure criticality in a disposal environment and time frame through moderator displacement and or neutron absorption.

- **SCALE (Mavric)/Shift integration project:** Principal investigator for high performance Shift Monte Carlo code integration with SCALE code system.
 - **Chloride-Induced Stress Corrosion Cracking Breach Dose Consequence Assessment Input – Material Available for Release (MAR):** Principal investigator developing realistic MAR for subsequent use in a dose assessment by EPRI to support dry storage operators for developing aging management programs (AMPs).
- December 2012 – March 2013: **Principal Nuclear Engineer**, Holtec International, Marlton, NJ
January 2010 – December 2012: **Senior Nuclear Engineer**, Holtec International, Marlton, NJ
Supervisor: Dr. Stefan Anton
Responsibilities:
 1. Shielding analyses of dry spent fuel storage, transfer and transport casks
 - **First point of contact** and **Subject Matter Expert** for all shielding related analyses at Holtec International.
 - Performed and reviewed shielding analyses using SAS2H, ORIGEN-S and MCNP for Holtec International’s HI-STORM and HI-STAR systems.
 - Lead author of shielding chapters for the HI-STORM FSAR and HI-STAR SAR and any other licensing documents.
 - Lead investigator for the HI-STORM, HI-STORM UMAX and HI-STAR design optimization to reduce dose rates.
 - Assisted in preparing proposals, including research and development of new dry storage cask design.
 2. Containment analyses of dry spent fuel transportation cask
 3. Criticality safety analyses for dry and wet spent fuel storage with burnup credit application, using MCNP/CASMO and SAS2/ORIGEN-ARP/KENO (utilizing STARBUCS module). One of the authors of Criticality chapters for all Holtec International’s licensing applications
 4. Criticality benchmarking and validation of the MCNP code
 5. Depletion uncertainty analyses
 6. Involved in Holtec International’s **Small Modular Reactor (SMR)** project
 7. Validation and maintenance of all Holtec approved Nuclear Engineering computer programs
 - 2005 – 2009: **Graduate Student Research Assistant**, University of Michigan, Ann Arbor, MI
Advisor: Dr. William R. Martin
Projects:

1. Acceleration of Monte Carlo fission source convergence with the Kernel Density Estimator
 2. Higher order Monte Carlo tallies using the Kernel Density Estimator
 3. Unbounded variance estimation of Monte Carlo point detector and surface crossing flux tallies
 4. Coupled Nuclear-Thermal-Hydraulic calculations for VHTR
- 2003 – 2005: **Graduate Student Research Assistant**, Kansas State University, Manhattan, KS
Advisor: Dr. William L. Dunn
Projects:
 1. Detection of Subsurface Defects Using X-ray Scanning
 2. Remote Detection of Conventional Explosive Materials
 - 2002 – 2003: **Technical Marketing Engineer**, Electrosteel Castings Limited, Calcutta, India
Responsibility:
 1. Engineering design of potable and storm water system

Dissertations

1. **Ph.D. Dissertation:** “Kernel Density Estimator Methods for Monte Carlo Radiation Transport” – advised by Dr. William R. Martin, University of Michigan, Ann Arbor, MI (December 2009).
2. **M.S. Dissertation:** “Determination of Subsurface Defects Using X-ray Scanning” – advised by Dr. William L. Dunn, Kansas State University, Manhattan, Kansas (August 2005).

Refereed Journal Articles

1. L. Jin and **K. Banerjee**, “Variance Estimation in Monte Carlo Eigenvalue Simulations Using Spectral Analysis Method,” Accepted for publication in *Nuclear Science and Engineering*.
2. R. M. Cumberland and **K. Banerjee**, “Baselining a Spent Nuclear Fuel Cask Shielding Model,” *Radwaste Solutions*, **25(1)**, 34-39, Spring 2018 (**Invited**).
3. L. Jin, **K. Banerjee**, S. P. Hamilton, G. G. Davidson, “Improving Variance Estimation in Monte Carlo Eigenvalue Simulation,” *Annals of Nuclear Energy*, **110**, 692-708 (2017).
4. J. B. Clarity, **K. Banerjee**, H. K. Liljenfeldt, W. J. Marshall, “As-Loaded Criticality Margin Assessment of Dual-Purpose Canisters Using UNF-ST&DARDS,” *Nuclear Technology*, **199(3)**, 245-275 (2017).
5. J. Peterson, B. van den Akker, R. Cumberland, P. Miller, **K. Banerjee**, “UNF-ST&DARDS’ Unified Database and the Automatic Document Generator,” *Nuclear Technology*, **199(3)**, 310-319 (2017).
6. G. Radulescu, **K. Banerjee**, R. A. Lefebvre, P. Miller, and J. M. Scaglione, “Containment Analysis Capability of UNF-ST&DARDS,” *Nuclear Technology*, **199(3)**, 299-309 (2017).

7. G. Radulescu, **K. Banerjee**, R. A. Lefebvre, P. Miller, and J. M. Scaglione, "Shielding Analysis Capability of UNF-ST&DARDS," *Nuclear Technology*, **199(3)**, 276-288 (2017).
8. R. A. Lefebvre, J. M. Scaglione, J. L. Peterson, P. Miller, G. Radulescu, **K. Banerjee**, K. R. Robb, A. B. Thompson, H. Liljenfeldt, and J. P. Lefebvre, "Development of Streamlined Nuclear Safety Analyses Tool for Spent Nuclear Fuel Applications," *Nuclear Technology*, **199(3)**, 227-244 (2017).
9. **K. Banerjee**, K.R. Robb, G. Radulescu, J.M. Scaglione, J.C. Wagner, J.B. Clarity, R.A. LeFebvre, and J.L. Peterson, "Estimation of Inherent Safety Margins in Loaded Commercial Spent Nuclear Fuel Casks," *Nuclear Technology*, **195(2)**, 124-142 (2016).
10. **K. Banerjee**, and W. R. Martin, "Kernel Density Estimation Method for Monte Carlo Point Detector and Surface Crossing Flux Tallies," *Nuclear Science and Engineering*, **174**, 30-45 (2013).
11. **K. Banerjee**, and W. R. Martin, "Kernel Density Estimation Method for Monte Carlo Global Flux Tallies," *Nuclear Science and Engineering*, **170**, 234-250 (2012).
12. **K. Banerjee**, and W. L. Dunn, "On X-ray Back-Scattering to Detect Hidden Cracks in Multi-Layer Structures," *Applied Radiation and Isotopes*, **65**, 176-182 (2007).
13. W. L. Dunn, **K. Banerjee**, A. Allen, and J. van Meter, "Feasibility of a Method to Identify Targets That Are Likely to Contain Conventional Explosives," *Nuclear Instruments and Methods in Physics Research B*, **263**, 179-182 (2007).

Conference Papers

1. G. Radulescu, T. M. Miller, **K. Banerjee**, D. E. Peplow, "Detailed SCALE Dose Rate Evaluations for a Consolidated Interim Spent Nuclear Fuel Storage Facility," *Trans. Am. Nucl. Soc.* **118(1)**, Philadelphia, PA (June 2018).
2. R. Cumberland and **K. Banerjee**, "Baselining a Spent Nuclear Fuel Cask Shielding Model," *Trans. Am. Nucl. Soc.* **117(1)**, 1203-1205, Washington, D.C. (October 2017).
3. G. G. Davidson and **K. Banerjee**, "Toward On-the-Fly Dose Analysis Using the Shift Monte Carlo Code," *Trans. Am. Nucl. Soc.* **117(1)**, 1178-1181, Washington, D.C. (October 2017).
4. J. B. Clarity, **K. Banerjee**, W. J. Marshall, H. K. Liljenfeldt, "A Burnup Credit Approach for Margin Estimation of Loaded Boiling Water Reactor Canisters in UNF-ST&DARDS," American Nuclear Society Nuclear Criticality Safety Division Topical Meeting, September 10-15, 2017, Carlsbad, NM.
5. **K. Banerjee**, and J.M. Scaglione, "Spent Nuclear Fuel Canister Capacity: Have the Limits Been Reached?" *Proc. of Institute of Nuclear Materials Management (INMM) - 58th Annual meeting*, July 16-20, 2017, Indian Wells, California.
6. J. Lei, **K. Banerjee**, S.P. Hamilton, and G.G. Davidson, "Variance Estimation in Monte Carlo Eigenvalue Simulations Using Spectral Analysis Method," *Trans. Am. Nucl. Soc.* **116(1)**, 533-535, San Francisco, CA (June 2017).
7. R.A. Joseph, A. Myers, J. Jarrell, J. Peterson, and **K. Banerjee**, "SNF Data Visualization on the Centralized Used Fuel Resource for Information Exchange

- (CURIE) Website,” *Trans. Am. Nucl. Soc.* **116(1)**, 225-228, San Francisco, CA (June 2017).
8. **K. Banerjee**, H. Liljenfeldt, P.L. Miller, J.L. Peterson, R.A. Joseph III, J.B. Clarity, G. Radulescu, R.A. Lefebvre, and J.M. Scaglione, “Consolidating Data on Spent Nuclear Fuel into a Unified Database,” *Trans. Am. Nucl. Soc.* **115(1)**, 279-282, Las Vegas, IL (November 2016).
 9. **K. Banerjee**, K.R. Robb, G. Radulescu, P.L. Miller, J.M. Scaglione, J.M. Cuta, and H. Liljenfeldt, “UNF-ST&DARDS: A Unique Tool for Automated Characterization of Spent Nuclear Fuel and Related Systems,” *PATRAM 2016*, Japan Society of Mechanical Engineers and Atomic Energy Society of Japan, Kobe, Japan (September 2016).
 10. S.P. Hamilton, G.G. Davidson, T.M. Evans, and **K. Banerjee**, “Accelerated Monte Carlo Fission Source Convergence with Fission Matrix and kernel Density Estimators,” *Trans. Am. Nucl. Soc.* **114(1)**, 385-387, New Orleans, LA (June 2016).
 11. **K. Banerjee**, J.M. Scaglione, and J.C. Wagner, “A proposed Spent Nuclear Fuel Storage and Transportation Licensing Approach Using As-loaded Analysis,” *Trans. Am. Nucl. Soc.* **113**, 257-271, Washington, DC (November 2015).
 12. J.B. Clarity, **K. Banerjee**, and J.M. Scaglione, “A Methodology for Fuel Assembly Design Characterization,” *Trans. Am. Nucl. Soc.* **113**, 294-297, Washington, DC (November 2015).
 13. G. Radulescu, R.A. Lefebvre, P.L. Miller, A.B. Thompson, **K. Banerjee**, and J.M. Scaglione, “Containment Analysis Capability of UNF-ST&DARDS,” *Trans. Am. Nucl. Soc.* **113**, 269-272, Washington, DC (November 2015).
 14. G. Radulescu, R.A. Lefebvre, **K. Banerjee**, P.L. Miller, and J.M. Scaglione, “Shielding Analysis Capability of UNF-ST&DARDS,” *Trans. Am. Nucl. Soc.* **113**, 262-264, Washington, DC (November 2015).
 15. **K. Banerjee** and J.M. Scaglione, “Criticality Safety Analysis of As-loaded Spent Nuclear Fuel Casks,” Proceedings for International Conference on Nuclear Criticality Safety, September 2015, Charlotte, NC.
 16. J.M. Scaglione, R.A. Lefebvre, **K. Banerjee**, G. Radulescu, and K.R. Robb, “A Unified Spent Nuclear Fuel Database and Analysis System,” Proceedings for International Conference on Management of Spent Fuel from Nuclear Power Reactors, June 2015, Vienna, Austria.
 17. **K. Banerjee**, J.M. Scaglione, J.C. Wagner, and R.A. Lefebvre, “Criticality Safety Assessment for As-Loaded Spent Fuel Storage and Transportation Casks,” The Workshop on Operational and Regulatory Aspects of Criticality safety, May 19-21 2015, Albuquerque, NM.
 18. J.M. Scaglione, J.C. Wagner, and **K. Banerjee**, “A Potential New Approach to Demonstrating Criticality Safety of Spent Fuel Storage and Transportation Casks,” The Workshop on Operational and Regulatory Aspects of Criticality safety, May 19-21 2015, Albuquerque, NM.
 19. **K. Banerjee**, J.M. Scaglione, and J.B. Clarity, “Subcriticality Demonstration Options for Direct Disposal of Dual-Purpose Canisters,” The Workshop on Operational and Regulatory Aspects of Criticality safety, May 19-21 2015, Albuquerque, NM.

20. R.T. Jubin, **K. Banerjee**, and T. Severynse, "Evaluation of Filler Materials to Control Post-closure Criticality of Dual Purpose Canisters," International High-Level Radioactive Waste Management Conference, April 12-16, 2015, Charleston, SC.
21. E.L. Hardin, E. Kalinina, R. Howard, **K. Banerjee**, and, J.M. Scaglione, "A Case for Direct Disposal of SNF in Existing DPCs," International High-Level Radioactive Waste Management Conference, April 12-16, 2015, Charleston, SC.
22. **K. Banerjee**, J.M. Scaglione, and J.B. Clarity, "Disposability of Loaded U.S. Dual-Purpose Canisters from a Criticality Standpoint," International High-Level Radioactive Waste Management Conference, April 12-16, 2015, Charleston, SC.
23. E.L. Hardin, **K. Banerjee**, J. Carter, R. Clark, R. Howard, E. Kalinina, and J.M. Scaglione, "Investigation of Dual-Purpose Canister Direct Disposal Feasibility," 2015 WM Symposia, Phoenix, Arizona (14th-19th March, 2015).
24. **K. Banerjee**, J.M. Scaglione, R.A. LeFebvre, G. Radulescu, and K.R. Robb, "Streamlining Analysis Capabilities for Used Nuclear Fuel Management," 2015 WM Symposia, Phoenix, Arizona (14th-19th March, 2015).
25. **K. Banerjee**, J.M. Scaglione, and R.A. LeFebvre, "Integrated Data and Analysis Tool for Used Nuclear Fuel Management," *Trans. Am. Nucl. Soc.* **111**, 338-341, Anaheim, CA (November 2014).
26. J.M. Scaglione, **K. Banerjee**, K.R. Robb, and R.A. LeFebvre, "The Used Nuclear Fuel Storage, Transportation, and Disposal Analysis Resource and Data System," *Proc. of Institute of Nuclear Materials Management (INMM) - 55th Annual meeting*, July 20-24, 2014, Atlanta, Georgia.
27. **K. Banerjee**, and J.M. Scaglione, "Feasibility of Direct Disposal of Dual Purpose Canisters from Criticality Perspective," *Proc. of Institute of Nuclear Materials Management (INMM) - 55th Annual meeting*, July 20-24, 2014, Atlanta, Georgia.
28. J.M. Scaglione, J.L. Peterson, **K. Banerjee**, K.R. Robb, and R.A. LeFebvre, "Integrated Data and Analysis System for Commercial Used Nuclear Fuel Safety Assessments," *Proc. WM2014*, Phoenix, Arizona, USA (March 2014).
29. Gokhan Yesilyurt, **Kaushik Banerjee**, Etienne de Villèle, John C. Lee, and W. R. Martin, "Coupled Nuclear-Thermal-Hydraulic Calculations for VHTRs," *Trans. Am. Nucl. Soc.* **102**, 519-521, San Diego, California (June 2010).
30. **K. Banerjee**, and W. R. Martin, "Kernel Density Estimation Method for Monte Carlo Tallies with Unbounded Variance," *Trans. Am. Nucl. Soc.* **101**, 430-432, Washington, DC (November 2009). **(Best Paper Award)**
31. **K. Banerjee**, and W. R. Martin, "Applying the Kernel Density Flux Estimator to Estimate Flux at a Point," *Trans. Am. Nucl. Soc.* **100**, 294-296, Atlanta, Georgia (June 2009).
32. **K. Banerjee**, and W. R. Martin, "Kernel Density Estimated Global Flux Tallies," *Proc. M&C Topical Meeting*, American Nuclear Society, Saratoga Springs, NY (May 2009).
33. **K. Banerjee**, and W. R. Martin, "Monte Carlo Global Scalar Flux Estimation with Kernel Density Estimator," *Trans. Am. Nucl. Soc.* **99**, 346-347, Reno, NV (November 2008). **(Best Paper Award)**.

34. **K. Banerjee**, and W. R. Martin, “A Proposed Kernel Density Estimator Method for Monte Carlo Eigenvalue Calculations,” *Proc. PHYSOR-08*, Interlaken, Switzerland (September 2008).

Conference Abstracts

1. **K. Banerjee**, and J.M. Scaglione, “Spent Nuclear Fuel Canister Capacity: Have the Limits Been Reached?” 2017 WM Symposia, Phoenix, Arizona (March 2017).
2. R. Devoe, J.M. Scaglione, **K. Banerjee**, and R. LeFebvre, “Automated Dry-Cask Storage Criticality Analysis Using CSAS6 Templates,” *ANS Student Conference*, Pennsylvania State University (March 2014).
3. J.M. Scaglione, **K. Banerjee**, R.L. Howard, and E.M. Pierce, “Impacts of Groundwater Ionic Species on Spent Fuel,” *American Chemical Society National Meeting*, Dallas, Texas (March 2014).
4. **K. Banerjee**, and W. R. Martin, “Using Kernel Density Estimation for Monte Carlo Tallies with Unbounded Variance,” *21st International Conference on Transport Theory*, Politecnico di Torino, Italy (July 2009).
5. **K. Banerjee**, and W. L. Dunn, “Determination of Subsurface Defects Using X-ray Scanning,” *6th International Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications*, Hamilton, Canada (June 2005).
6. W. L. Dunn, **K. Banerjee**, and A. Allen, “Feasibility of a Method to Identify Targets That Are Likely to Contain Conventional Explosives,” *6th International Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications*, Hamilton, Canada (June 2005).

Selected Presentations

1. UNF-ST&DARDS: A Unique Tool for Automated Characterization of Spent Nuclear Fuel and Related Systems: *PATRAM 2016* (September 2016), Kobe, Japan (**Plenary Presentation**)
2. Used Nuclear Fuel Storage, Transportation, and Disposal: the US perspective (December 2015), Indian Institute of Technology, Kanpur, India (**Invited**)
3. Spent Fuel Storage and Transportation Systems (March 2012). *Kansas State University*, Kansas (**Invited**)
4. Kernel Density Estimator Methods for Monte Carlo Radiation Transport (March 2012). *Kansas State University*, Kansas (**Invited**)
5. Kernel Density Estimator Methods for Monte Carlo Radiation Transport (November 2010). *Brookhaven National Lab*, NY (**Invited**)
6. Kernel Density Estimator Methods for Monte Carlo Radiation Transport (October 2009). *Physical and Life Sciences, LLNL*, Livermore, California (**Invited**)

Awards and Honors

- Mathematics and Computation division’s (ANS) **Best summary and presentation award**, ANS winter conference (2009), Washington DC
- Mathematics and Computation division’s (ANS) **Best summary and presentation award**, ANS winter conference (2008), Reno, Nevada
- Rackham Travel Grant to present at the ANS winter conference, Washington, DC

- Rackham International Travel Grant to present at the PHYSOR-'08 conference, Interlaken, Switzerland
- Nominated for Outstanding Graduate Research Assistant in the year 2005, Kansas State University, Manhattan, KS
- Honor member of the honor society for Nuclear Science and Engineering, Alpha Nu Sigma
- National Scholarship by Govt. of India for outstanding performance in the Secondary Exam (1995-2001)

Grants

- **K. Banerjee (PI)**, G.G. Davidson, S.R. Johnson, T.M. Evans, "Development and Investigation of Advanced Monte Carlo Fission Source Convergence Acceleration Methodologies," ORNL LDRD (Seed) Funding, FY 2015-2016, \$190,000.

Services and Activities

- **Guest Editor:** special issue of Nuclear Technology journal on a spent nuclear fuel data and analysis tool
- Master's Thesis **Committee Member:** Mudit Mishra, Indian Institute of technology, Kanpur
- Mentoring Summer Technical Interns
- Sponsored and **supervised a group of four students:** senior year design project at Pennsylvania State University (NuCE 431W Section 3 Design Course, 2012)
- **Reviewer:** Journal of Computational Physics, Nuclear Science and Engineering, Progress in Nuclear Energy, Journal of Hazardous Materials, and Annals of Nuclear Energy
- **Reviewer for Transactions:** American Nuclear Society, PHYSOR
- Held the post of General Secretary of Society of Student Metallurgists (1999 – 2000), Bengal Engineering College, Shibpore, India
- Held the post of Treasurer of Society of Student Metallurgists (1998 – 1999), Bengal Engineering College, Shibpore, India

Teaching Experience

- **Provided introductory nuclear engineering training to all new employees** at Holtec International.
- Graduate Student Instructor in the Mechanical and Nuclear Engineering Department at Kansas State University from Fall 2003 through Winter 2005 for Thermodynamics II (ME 523) and Heat Transfer (ME 573). Responsibilities included preparing homework solutions, grading homework and exams, holding office hours, conducting weekly review sessions, and delivering lectures (occasionally).

Computer Skills

- Extensive experience with FORTRAN (77, 90), C, C++, SQL, PYTHON, JAVA, PERL, UNIX utilities (SED and AWK) and MATLAB, including software development for research projects

- Conversant with MCNP5, SCALE, CASMO, RELAP5, and EGS4

Summer Internships

- Tata Infotech Ltd. (2001), as a C & C++ programmer
- Bhilai Steel Plant, Under Steel Authority of India Limited (2000)

Professional Membership

- Professional member of American Nuclear Society (ANS)