MRT Methodologies for Application to Nuclear Safeguards, Safety and Security

Professor Alireza Haghighat

Virginia Tech

Wednesday April 6

Hill Hall 202

Abstract. I will introduce the audience to the novel *Multi-stage, Response-function Transport (MRT)* methodologies and tools for real-time simulation of problems in nuclear systems. He will reason that the MRT methodology can be classified as a *physics-based computational methodology*. In a MRT methodology, the problem of interest is partitioned into stages based on its physics, and each stage is represented by a response function or set of coefficients. These stages are combined into a linear system of equations which are solved iteratively using the pre-calculated functions and/or coefficients. To determine these functions or coefficients, a set of fixed-source Monte Carlo and adjoint deterministic calculations are performed for different material compositions and physical/geometric conditions. The MRT methodology has been applied to a few real-world problems including spent fuel pool safeguards, simulation of cargo containers with special nuclear materials, criticality safety and security of spent fuel pools and cask, and medical image reconstruction. I will elaborate on novel methodologies developed for spent nuclear fuel safeguards, safety and security applications. Specifically, he will introduce the following computational tools:

1) INSPCT-S tool (INSPCT-S, Inspection of Nuclear Spent fuel-Pool Calculation Tool ver. Spreadsheet) developed for the inspection of spent nuclear fuel pools. INSPCT-S uses computation and experimental results to identify potential fuel diversion in a spent fuel pool in real-time.

2) RAPID (Real-time Analysis spent fuel Pool and cask In-situ Detection) developed for determination of axially-dependent pin-wise fission density, eigenvalue, and subcritical multiplication in a spent fuel pool or cask.

Biography. Dr. Haghighat is professor of the Virginia Tech Nuclear Engineering Program, Mechanical Engineering Department. He is the Director of Nuclear Science and Engineering Lab (NSEL) at the Virginia Tech Research Center at Arlington, VA. He is former (2001-2009) Chair of the University of Florida (UF) Nuclear & Radiological Engineering (NRE) Department and former (2008-2010) Director of UF Training Reactor. Prior to Florida, Professor Haghighat was a faculty member at the Pennsylvania State University for 15 years.

Professor Haghighat is a fellow of the American Nuclear Society (ANS). He leads the Virginia Tech Theory Transport Group (VT^3G). Over the past 29 years, Professor Haghighat has been involved in the development of new particle transport methodologies and large computer codes for modeling and simulation of nuclear systems including reactors, nuclear security and safeguards systems and medical devices. He led the development of the PENTRAN 3-D parallel Sn Transport, A^3MCNP (Automated Adjoint Accelerated MCNP) Monte Carlo code systems, TITAN 3-D Hybrid code system, INSPCT-s (Inspection of Nuclear Spent fuel-Pool Calculation Tool) tool for monitoring spent nuclear fuel, AIMS (Active Interrogation for Monitoring of Special nuclear materials) for detection of SNM via active interrogation, (CPXSD (Contributon Point-wise Cross-Section Driven) package for automatic problem-dependent multigroup cross-sections, RAPID (Real-time Analysis spent fuel Pool In-situ Detection), and TITAN-IR (TITAN Image Reconstruction code system) for SPECT,

and a novel transport algorithm with efficient representation of angular dependency. He has published over 240 papers, received several best paper awards, and presented numerous invited workshops, seminars and papers nationally and internationally.

In Dec 2014, he published a textbook entitled 'Monte Carlo Methods for Particle Transport', CRC Press Taylor & Francis Group. He is recipient of the 2011 Radiation Protection Shielding Division's Professional Excellence Award, and recognition award from Office of Global Threat Reduction for his leadership & contributions to design and analysis for the University of Florida Training Rector HEU to LEU fuel conversion, 2009. Professor Haghighat is an active member of the American Nuclear Society, and has served at various leadership positions. He has served as Chair of the Reactor Physics Division (2012-13) and the Mathematics and Computation Division (2005-06), was co-founder of the Computational Medical Physics Working Group, and served as Chair of NEDHO (Nuclear Engineering Department Heads Organization) (2006-07).

Professor Haghighat contributed to the formation of the SUNRISE (Southeast Universities Nuclear Reactors Institute for Science and Education) not-for-profit organization, and served as Chairman of the Board of SUNRISE since June 2010-2013. Since Jan 2015, he has served as the founding Chairman of the Board of the VNEC (Virginia Nuclear Energy Consortium) non-profit organization; VNEC is engaged in the promotion of nuclear industry and education, support of new initiatives, and advocacy for the use of nuclear technology.