

Nuclear Engineering Research Projects 2008-09

Development of Computationally-Efficient Algorithms to Combat the Curses of Dimensionality and Nonlinearity in Nuclear Reactor Analysis Calculations

Hany Abdel-Khalik
Idaho National Laboratory
\$70,000 per year for three years
9/30/09 – 9/30/12

In support of the lab's advanced modeling and simulation thrust (responding directly to the 'multi-scale simulation methodologies' from the call), this proposal will develop and demonstrate the application of novel algorithms for the effective transfer of information across-scales in order to combat two important challenges currently facing multi-scale models: the curses of dimensionality and nonlinearity. The significance of these two obstacles continues to increase as analysts shift towards higher resolution models to achieve higher accuracy. Higher accuracy is essential in order to support the role of simulation as a primary tool for advising the design decision making process. Higher accuracy is attained by shifting from reliance on macro-scale (phenomenological) low-dimensional models with loosely-coupled physics to micro-scale high resolution description of system behavior taking into account the tight coupling between the various forms of physics in order to understand the observed macroscopic behavior of the system. This modeling approach is referred to as multi-scale/multi-physics modeling. Obtaining a solution to a multi-scale/multi-physics model is challenged by the explosion in problem dimensionality incurred by the higher resolution description, and nonlinearity resulting from basic physics and pronounced by their tight coupling.

Development of Subspace-Based Hybrid Monte Carlo-Deterministic Algorithms for Reactor Physics Calculations

Hany Abdel-Khalik, Robin Gardner
Department of Energy NEUP
\$479,358
9/30/09 – 9/30/12

This project proposes the development of a mathematically-justified, computationally-efficient, and massively-parallelized framework for elucidating the coupling between Monte Carlo and deterministic models in order to achieve the following objectives: a) increasing the convergence of Monte Carlo calculations via enhanced biasing methods; b) enabling a reliable and efficient Monte Carlo inverse analysis; c) accumulation of sensitivity coefficients of all responses, including reactor core attributes, e.g., reactor design parameters, reactivity coefficients, flux and power distributions throughout the core, with respect to all basic input data, e.g., nuclear cross-sections data; d) estimation of all reactor core attributes uncertainties due to basic nuclear data uncertainties; and e) determination of energy-collapsed cross-sections for deterministic methods based on Monte Carlo solutions. To be performed routinely as part of the design process, most of these objectives are currently considered computationally intractable despite the anticipated growth in computer power. Finally, a number of reports will document the project deliverables, including quarterly,

annual, and the final report. Transfer of the capabilities being developed to other DOE laboratories will be facilitated through the laboratory collaborators.

Development of Reactor Physics Sensitivity Analysis, Uncertainty Quantification, and Data Assimilation Capability at INL for Validation Applications

Hany Abdel-Khalik
Idaho National Laboratory
\$125,000 per year for three years
11/15/08 – 11/15/11

The work performed under this subcontract is in support of an INL LDRD entitled: "Development of Reactor Physics Sensitivity Analysis, Uncertainty Quantification, and Data Assimilation Capability at INL for Validation Applications". NCSU will collaborate with INL on this LDRD. This subcontract describes NCSU's activities as they pertain to the LDRD deliverables during the period of November 1st 2008 till May 31st 2009. The overarching objective of NCSU's activities is to develop, adapt, and implement the Efficient Subspace Method (ESM) to the need of consistent data assimilation. In particular two strategies will be developed as part of this LDRD. The first one involves computation of sensitivity coefficient in multigroup structure using the ESM approach. Results will be compared against standard sensitivity coefficient computation using adjoint approach (performed at INL) and efficiency will be evaluated. The second approach will apply the ESM to a stochastic methodology involving Monte Carlo calculations. Eventually both approaches will be employed in a consistent data assimilation methodology applied to basic nuclear parameters.

Collaborative Effort for the Evaluation of New Uncertainty Quantification and, Verification and Validation Methodologies - Part B

Hany Abdel-Khalik
Idaho National Laboratory
\$65,000
3/1/09 – 9/30/09

This project is in support of INL's leading activity in the DOE NEAMS VU program. This program has the task to develop and define requirements and a methodology for validate the advanced simulation codes developed under other NEAMS itself. The NCSU focus is on the following two tasks. First: provide support for testing and implementation of the Efficient Subspace method at INL in the ERANOS code. ESM is one of the UQ candidate methods under consideration. Second: perform a review of the existing UQ/SA techniques and evaluate their applicability for high dimensional non linear tightly coupled physics simulation, and proposing new possible UQ/SA techniques to overcome deficiencies of existing methods.

Further Development of Adaptive Core Simulation Capability for Boiling Water Reactors

Hany Abdel-Khalik, Paul J. Turinsky,
Global Nuclear Fuels (GE Hitachi)
\$285,408
01/31/08 - 01/30/12

Nuclear power plants routinely take measurements of core observables as part of normal operations. These measurements are utilized to confirm the core is operating within established limits and to contrast predicted and measured

core attributes as part of the design methods certification process. Since design margins reduce the reload core designer's freedom, the introduction of design margin comes at an economic expense. This research will develop capability by building upon ongoing research on adaptive core simulation. Specific application will be to boiling water reactors, completed utilizing first virtual core observables followed by physical core observables.

A new Iterative Algorithm for Solving Multidimensional Radiation Transport Problems on Massively Parallel Computers

Yousry Y. Azmy
Los Alamos National Laboratory
 \$79,972
 06/01/08 - 09/30/09

This project seeks to devise a new parallel algorithm for solving the discrete ordinates approximation of the transport equation on massively parallel platforms. This should be an attractive alternative to the traditional mesh sweep. The new formulation decomposes the spatial domain into decoupled subdomains. The solution of the transport equation within each subdomain will be based on the direct solution of a matrix equation resulting from an integral formulation of the discretized transport operator. Success of the proposed algorithm on structured grids should lead to extension to unstructured grids.

Verification & Validation of Radiation Transport Numerical Methods, Codes, and Nuclear Data For Estimating Radiation Dose to Patients

Yousry Y. Azmy, Kenneth L. Miller
Centers for Disease Control
 \$73,193
 01/15/08 - 12/31/08

Advanced therapeutic and imaging techniques rely on radiation that is administered to the patient in a controlled manner. This research will establish valid computational procedures based on state-of-the-art computer codes and nuclear data for accurately estimating the detailed dose distribution to the vital organs of a patient exposed to a clinical radiation field. It will also allow for adjusting the exposure to the individual patient's characteristics to avoid overdose. The new computational tool will allow the physician and patient to make accurate and informed decisions about having radiation procedures performed when the patient is pregnant or potentially pregnant.

Nonlinear Acceleration Methods for Solving Multigroup Neutron Diffusion Equations

Dmitriy Y. Anistratov
Idaho National Laboratory, US DOE.
 \$24,371
 07/07/08-08/31/08

In a variety of reactor design calculations one needs to evaluate a critical parameter of a system and its fundamental mode. To perform neutronics computations for this important class of reactor physics problems, one needs to solve the multigroup transport (or diffusion) equation and determine an eigenvalue and the associated eigenfunction. It is proposed to develop and compare different multilevel methods for solving k-eigenvalue transport problems based on nonlinear projection and prolongation (restriction) operators.

Analysis of Curvilinear Geometry Characteristic-Based Particle Transport Discretizations

Dmitriy Y. Anistratov
Lawrence Livermore National Security, LLC
 \$45,960
 11/09/07 - 11/30/08

We will investigate the properties of a variety of characteristic methods for solving particle transport problems in 1D spherical and 2D r-z geometries. The methods that belong to this family will be studied to assess their accuracy and efficiency. We will analyze the behavior of the discretizations in optically-thick and diffusive regions, using the asymptotic diffusion limit analysis as well as a variety of special test problems. The expected results of this research will form the background for development of accurate and robust transport methods for 2D r-z geometry.

Attenuation of Gamma-Rays in New Concrete Forms, RB2C Enhancement Project

Mohamed A. Bourham, Sami H. Rizkalla
Grancrete, Inc.
 \$50,000
 05/01/2008 - 12/30/2009

Radiation shielding is important in any facility that produces radiation or uses radiation sources such as nuclear reactors, research labs, hospitals and pharmaceutical companies, and facilities with x-rays systems. New forms of concretes may provide better shielding than traditional concretes, especially if such new forms incorporate high density metals, compositions that include percentage of highly attenuating materials, or mixed with fibrous materials to maintain moisture content and eliminate crack propagation.

Challenges in Atmospheric-Plasma Aided Grafting of Biocidal Agents to Nonwoven

Marian McCord, Mohamed Bourham, Richard Vendetti
Nonwoven Cooperative Research Center
 \$50,000 (1st year) + \$22,000 (student support 2nd year + supplies and materials)
 05/01/2007 - 06/30/2009

Biocidal non-woven fabrics and paper products are important worldwide as the means by which prevention and safety against various microorganisms can be achieved. Biocidal materials are synthesized to kill or inhibit the growth of microorganisms such as bacteria, molds, and fungi and repel or kill disease-carrying insects. Atmospheric plasma treatment of textiles is an environmentally friendly, sustainable manufacturing process that holds enormous, untapped potential for the textile industry worldwide. This research utilizes atmospheric plasma-enhanced grafting of bioactive monomers onto non-woven materials including paper, followed by the addition of insecticidal antimicrobial agents.

Enhancing Electrostatic Properties and Hydroentangling Efficiency via Atmospheric Plasma Treatment

Marian McCord, Mohamed Bourham
Nonwoven Cooperative Research Center
 \$44,000 (student support for 2 years + supplies and materials)
 05/01/2007 - 06/30/2009

Atmospheric plasma treatment has been shown to be an economical and effective method for improving the properties of fibers and textiles, including increasing fiber and fabric

tensile strength, modulus, bending rigidity, friction, and wettability. These changes can be permanent depending upon selection of plasma processing parameters. Atmospheric plasma treatments can be integrated into a continuous nonwoven fabric manufacturing process, either before or after web forming. Because these treatments may be achieved without application of chemicals, they are inherently non-polluting. Exposure to fluorine gas plasmas prior to charging has been shown to prolong filter electret charge and enhance filtration.

Atmospheric Pressure Plasma-Electrospinning Hybrid Nanofiber Mat Production

Xiangwu Zhang, Marian McCord, Mohamed Bourham
Defense Threat Reduction Agency
 \$ 597,047
 06/02/2008 – 05/31/2011

This research combines atmospheric pressure plasma and electrospinning to obtain a new hybrid nanofiber mat production technology that provides protection from chemical and biological weapons. A hybrid technology marrying atmospheric pressure plasma and electrospinning will result in a viable, rapid, safe and economical nanofiber mat production system that can be scaled up to mass production levels. This atmospheric pressure plasma-electrospinning hybrid processing technology is capable of controlling nanofiber mat structures by selectively adjusting both electrospinning and plasma treatment parameters, and hence it can provide nanofiber mats with adjustable properties such as high aerosol barrier efficiency.

Faculty Development Program in Nuclear Engineering at NC State University

Mohamed Bourham and Yousry Azmy
Nuclear Regulatory Commission
 \$420,000
 08/01/2008 – 07/31/2011

This is a grant to support junior faculty development plans in support of education in nuclear science and engineering, to enable developing a workforce capable of the design, analysis and operation of existing and future nuclear facilities, and safe handling of nuclear materials. The program enables the Department of Nuclear Engineering at NC State University to attract, prepare, and retain outstanding, probationary tenure-track “junior” faculty in the thrust areas of the department, enhance their careers as world-class professors and researchers, and provide state-of-the-art tools, skills, and networks for preparation of the future nuclear engineering workforce.

Challenges in Advanced Nanofiber Wound Dressings

Marian G. McCord, Xiangwu Zhang and Mohamed A. Bourham
National Textile Center
 \$105,002
 05/01/2009 – 04/30/2010

Conventional textile-based wound dressings are cost-effective and highly absorbent, but used alone, fail to provide optimal wound healing conditions. Modern wound dressings often incorporate multiple non-textile components that provide advanced functionalities at a higher cost. Electrospun nanofiber dressings have demonstrated the potential to revolutionize wound care by providing enhanced moisture

management, barrier properties, and bioactivity. This project focuses on development and characterization of processes for deposition of nanofiber webs onto existing textile-based wound dressings to develop inexpensive wound care materials with enhanced wound healing capabilities. Atmospheric pressure plasma technology will be used to enhance the adhesion and durability of the nanofiber coating and to sterilize the composite dressings.

Applications of Sensitivity/Uncertainty Analysis to Optimum Instrumentation and Control of Next Generation Nuclear Power Systems

J. Michael Doster, Paul J. Turinsky, Hany Abdel-Khalik
USDOE (NERI-C)
 \$724,645
 10/01/2007 – 09/29/2010

Development and deployment of small-scale nuclear power reactors and their autonomous control and monitoring is part of the mission under the Global Nuclear Energy Partnership (GNEP) program. The research will investigate, develop, and validate advanced methods for sensing, controlling, monitoring, and diagnosing proposed small and medium sized export reactors (SMR) and apply it to the International Reactor Innovative & Secure (IRIS). The methodologies developed in this research can also be used for sensor deployment analysis, autonomous control, and monitoring, diagnosis and prognosis for other facilities related to the Advanced Fuel Cycle R&D Program and the Nuclear Hydrogen Initiative.

Associates Program Nuclear Techniques in Oil Well Logging Supporting the Center for Engineering Applications of Radioisotopes (CEAR)

Robin P. Gardner, Hany Abdel-Khalik
Baker Atlas, Halliburton, EXXON Mobil, Weatherford, Pathfinder, and Los Alamos National Laboratory
 \$100,000
 01/01/2009-12/31/2009

This Associates Program provides design and other applications of Monte Carlo simulation in support of CEAR. Specific units of research are selected by the center for investigation each year with input from the Associates Program members. CEAR was started in 1980 and is the oldest center in the University.

Developing an Inverse Approach to Monitoring for Special Nuclear Materials

Robin P. Gardner
Raytheon TI Systems
 \$200,000
 07/01/07 - 06/30/09

Mathematical techniques for the monitoring of cargoes for nuclear materials, using the LANL MCNP/MCNPX or similar types of Monte Carlo codes, and other procedures to accurately model gamma-ray scintillation detector response functions (DRF) based on the specific detector geometry, scintillator material, and PMT and surrounding materials of construction are being developed. These developed patches are being integrated into the Raytheon MCNP/MCNPX code package. An iterative technique that estimates how much of each identified radioisotope is in the spectrum is being developed in conjunction with this. This method would also include a linear-non-linear estimate of the amount and type of shielding that is involved based on the CURMOD code that has been developed here.

Very High Temperature Reactors Research Consortium

DOE -NERI C- University of Missouri - Columbia
Sudarshan Loyalka (University of Missouri, Columbia),
Robin P. Gardner (NCSU), Muthanna Al-Dahhan (Washington University)

\$945,076

09/30/07 - 09/29/10

An experimental program to characterize gas, FP, and particle flows as well as pebble motion in the complex geometries of pebble bed nuclear reactors (PBR's) is being pursued to characterize the flow of pebbles in a PBR. This is being done by developing an accurate experimental apparatus using radioactive tracers and three tracking detectors. Mathematical modeling of the pebble movement is also being pursued and checked with the experimental results that are obtained.

Development of Accurate and Fast Monte Carlo Spectral Simulation Algorithms for Proliferation Detection

Robin P. Gardner
NNSA of DOE
\$649,500
9/19/08 – 9/18/11

A program of research to develop more accurate and more efficient Monte Carlo simulation codes for proliferation detection of cargoes is being pursued. The non-linearity and anomalous flat continuum problems inherent to NaI detectors is incorporated into a semi-empirical detector response function (DRF) to accomplish greater accuracy while the DRF and an independent geometry mesh-based weight windows approach keyed by the solution to a simple adjoint diffusion model is incorporated to accomplish greater efficiency.

A High Accuracy Approach for the Efficiency Characterization of HPGE Detectors in an Extended Energy Range

Ayman I. Hawari
Los Alamos National Laboratory
\$183,783
10/01/02 - 07/31/07

The subcontractor shall evaluate properties of spectroscopic neutron detector cells. Some of these cells will contain the liquid scintillator NE213 and will be of different sizes. This evaluation will consist of evaluating the pulse-shape-discrimination performance and the energy resolution of each cell.

A Measurement of the Beta-Asymmetry of the Neutron Utilizing Ultracold Neutrons

Albert R. Young, Ayman I. Hawari, Bernard W. Wehring
National Science Foundation
\$576,000
08/15/04 - 07/31/08

The goal of the proposed experiment is to make use of UCN to ultimately provide at least an order of magnitude improvement in the precision to which the beta-asymmetry is known. The broader significance of this work stems in part from the nature of the beta-decay parameters, which

touch on fundamental understanding of the standard model of particle physics, and in part on the broader applicability of the superthermal UCN source technique we have helped to develop.

A Superthermal Ultra-Cold Neutron Source at NC State University

Paul R. Huffman, Robert Golub, Albert R. Young, Ayman I. Hawari, Bernard W. Wehring, Christopher R. Gould
National Science Foundation
\$900,000
07/01/04 - 06/30/08

The objective is to establish a university-based UCN facility with sufficient UCN intensity to allow world-class fundamental and applied research with UCN. To maximize the UCN yield, a solid ortho-D2 converter will be implemented coupled to two moderators, D2O at room temperature, to thermalize reactor neutrons, and solid CH4, to moderate the thermal neutrons to cold-neutron energies. Research areas being considered for the source include time-reversal violation in neutron beta decay, neutron lifetime determination, support measurements for a neutron electric-dipole-moment search, and nano-science applications.

Development of an Intense Positron Annihilation Spectrometry System for Nanophase Characterization

Ayman I. Hawari, Mohamed A. Bourham, Korukonda L. Murty, George A. Rozgonyi
National Science Foundation
\$999,563
09/01/05 - 08/31/08

Positron, with its affinity for open structures in matter, has been gaining an important role as a probe of nanostructure and in understanding the role of engineered nanovoids on macroscopic properties. Controlling and understanding the structure and behavior of vacancies and voids within a material requires understanding how the interaction between vacancies and impurities affects macroscopic properties. This major research is collaborative between NCSU, ORNL and University of Michigan to develop an intense positron beam facility at the NCSU PULSTAR reactor.

Implications of Graphite Radiation Damage on the Neutronic, Operational, and Safety Aspects of Very High Temperature Reactors

Ayman I. Hawari
US Dept. of Energy
\$749,903
06/01/07 - 05/31/10

In the prismatic and pebble bed designs of Very High Temperature Reactors, the graphite moderator is expected to reach exposures of 1021 to 1022 n/cm2 over the reactor lifetime. This exposure results in damage to the graphite structure. Studies of the thermal properties of irradiated graphite show changes in the thermal conductivity and (to a lesser extent) the heat capacity at fluences less than 1021 n/cm2. These properties depend on the behavior of atomic vibrations (phonons) in the solid. Therefore, it can be expected that any alterations in the phonon behavior that would produce changes in these properties would have an impact on thermal neutron scattering.

Multi-University Southeast INIE (Innovations in Nuclear Infrastructure and Education Program) Consortium

Ayman I. Hawari
US Dept. of Energy
 \$5,895,301
 09/10/03 - 09/09/08

In the prismatic and pebble bed designs of Very High Temperature Reactors, the graphite moderator is expected to reach exposures of 1021 to 1022 n/cm² over the reactor lifetime. This exposure results in damage to the graphite structure. Studies of the thermal properties of irradiated graphite show changes in the thermal conductivity and (to a lesser extent) the heat capacity at fluences less than 1021 n/cm². These properties depend on the behavior of atomic vibrations (phonons) in the solid. Therefore, it can be expected that any alterations in the phonon behavior that would produce changes in these properties would have an impact on thermal neutron scattering.

On-Line Fuel Failure Monitor for Fuel Testing and Monitoring of Gas Cooled Very High Temperature Reactors

Ayman I. Hawari, Mohamed A. Bourham
US Dept. of Energy
 \$498,429
 03/25/05 - 05/31/09

In the Very High Temperature Reactor, the fuel is based on the concept of the TRISO microsphere. The microsphere is composed of a UO₂ kernel surrounded by a porous pyrolytic graphite buffer, an inner pyrolytic graphite layer, a silicon carbide (SiC) coating, and an outer pyrolytic graphite layer. The enrichment of the fuel is expected to range from 4%–10% in U-235. Due to the hostile in-core conditions, it is anticipated that a certain number of TRISO microspheres will fail during reactor operation. We will study the development of fuel failure detection methods using passive gamma-ray spectrometry.

The UCNA experiment: Measuring Angular Correlations in Neutron Decay using Ultracold Neutrons

Albert R. Young, Ayman I. Hawari, Bernard W. Wehring
National Science Foundation
 \$210,000
 08/15/07 - 06/30/10

We measure the fundamental decay properties of the neutron using ultracold neutrons, or neutrons with velocities below about 8 m/s. These neutrons can be stored in material bottles, very highly polarized, and guided to well-shielded experiments, making them ideal for fundamental neutron physics measurements. This project is multidisciplinary, in that it is a collaboration between the nuclear engineering department and physics. The team making this proposal also founded the PULSTAR UCN source project, and will continue to develop local capabilities which are relevant to success in the PULSTAR UCN source.

2007 Nuclear Engineering Graduate Traineeship Program (GE)

Korukonda L. Murty, Man S. Yim
General Electric Co.
 \$42,319
 08/16/07 - 11/15/09

This grant is for the support of Nuclear Engineering Graduate trainee at GE Nuclear Energy Company. The student will spend 9 months (8/16/07-5/15/2008) attending Graduate School at NC State University and 6 months (5/16/2008-11/15/2008) at the sponsor's site completing his/her Masters research project.

A Multiscale Study of Ratcheting Failure Mechanisms in Austenitic and Ferritic Steel Welded Joints

Tasnim Hassan, Korukonda L. Murty
National Science Foundation
 \$326,500
 08/15/04 – 01/31/09

The main objective of the proposed study is to investigate the causes for the ratcheting fatigue failures of welded joints. It is anticipated that it is caused by either the residual stresses and/or heterogeneity in the dislocation substructures of welded joints. Under this grant support, a systematic set of fatigue tests on welded joints will be conducted and residual stresses will be measured at various stages of fatigue lives. A major part involves an investigation on the micro-structural processes of welded joint fatigue failures. The relationship between multiscale fatigue mechanisms of welded joints will be explored.

from May 15, 2006.

Creep Behavior as a Function of Grain Size in High Fluidity Zn-Al Die Casting Alloys

Carl C. Koch, Korukonda L. Murty
International Lead Zinc Research Organization, Inc.
 \$285,554
 01/01/07 - 12/31/09

This project is a study of the creep behavior of Zn-Al die casting alloys as a function of their grain size from the nanoscale up to conventional micron grain sizes. It involves the preparation, characterization, and mechanical testing of the Zn-Al alloys of interest for very thin section die castings.

Effect of Alloying and Thermo-Mechanical-Treatment on Anisotropic Creep and Deformation in Ti-Alloys

Korukonda L. Murty, Ron O. Scattergood
National Science Foundation
 \$518,000
 08/01/04 - 07/31/10

The proposal addresses the influence of thermo-mechanical-treatment (TMT) and alloying on deformation and creep anisotropy of titanium alloys. The study involves characterization of anisotropic biaxial creep of Ti alloys using closed-end internally pressurized thin-walled tubing superimposed with axial load. Cold-working leads to grain-shape anisotropy of the otherwise equiaxed grain structure of Rx materials. The effects of these variables on the deformation microstructures will be investigated along with deformation anisotropy following biaxial loading under varied stress-states and stress-levels. This is a renewal proposal of the project funded in 2001.

A Comparative Study of Welded ODS Cladding Materials for AFCI/GNEP Applications

Korukonda L. Murty
Department of Energy (subcontract to University of Idaho)
 \$100,430.
 10/01/08 - 09/30/10

The proposal is to investigate the characteristics of welded joints of two ODS alloys, MA956 and MA754 under unirradiated and irradiated conditions. These materials are first generation commercial alloys that will assist us to extend the work to more advanced ODS alloys for next generation nuclear plants. Major emphasis is on the characterization of as received materials and on the arrangements for irradiation in PULSTAR at NCSU and ATR at INL. This is a collaborative research with the University of Idaho, Missouri Science & Technical University, Boise State University, Idaho National Laboratory and Centerline Ltd.

Influence of Fast Neutron Irradiation on the Mechanical Properties and Microstructure of Nanostructured Alloys

Korukonda L. Murty
Idaho National Laboratory
 \$33,000
 08/28/08 - 09/20/10

The project involves irradiating nanograin structured metals in PULSTAR at NCSU and ATR at INL to investigate the effect of neutron radiation on stability and mechanical properties of nanograin structured metals. Both conventional and nanostructured metals such as Cu and Ni are being considered along with ultrafine grain sized steel. The relatively large number of interfaces in these materials are expected to result in relatively higher radiation resistance. However, insitu grain growth during radiation exposure might result in structural modifications. Emphasis here is on the mechanical behavior of this special class of metals following radiation exposure.

National Academy for Nuclear Training (NANT) Fellowship Program

Korukonda L. Murty
Institute of Nuclear Power Operations (INPO)
 \$25,000
 07/01/08 - 12/31/09

The grant is to support one Nuclear Engineering graduate student as an INPO fellow. The selected fellow is expected to work on nuclear power related project and is generally selected as a masters in nuclear engineering candidate.

Plasma Application Laboratory Construction

Applied Materials Inc.
Steven Shannon
 \$117,000 (\$37,000 gift donation + \$80,000 equipment donation)
 01/15/08 - 01/14/09

Startup of a plasma applications lab to study phenomena in low pressure radio frequency discharges.

Development and Utilization of Mathematical Optimization in Advanced Fuel Cycle Systems Analysis

Paul J. Turinsky
US Dept. of Energy
 \$321,699
 03/13/06 - 03/12/09

The project proposes developing capability to determine the optimum deployment strategies for reactor, fuel, fuel cycle facilities within constraints utilizing mathematical optimization. The DANESS code will be employed to model the fuel cycle. Optimization will be completed over a user specified planning horizon, which will allow the proper treatment of the impact of current decisions on future decisions. The developed capabilities will assure that optimum deployment strategies are determined with reduced personnel effort. Determination of the tradeoff surface using multi-objective mathematical optimization will provide quantitative data to decision makers on such items as the cost of margin.

Enhancement of Computational Facilities in Support of GNEP Research and Training

Paul J. Turinsky, Hany Abdel-Khalik, Dmitriy Y. Anistratov, Joseph M. Doster
US Dept. of Energy
 \$100,000
 09/01/07 - 08/31/08

This proposal requests support to enhance computational facilities that are utilized in GNEP related research and training. Specifically, 19 computer nodes (76 processors) and 10.5TB of NFS attached storage with tape backup are requested to be added to the NC State University IBM Blade Linux Cluster. Each computer node will support two 15130 Xeon processors with 8GB of memory. These are dual core processors, so each node has 4 cores and 2GB of memory per core. This addition of 19 nodes will increase the IBM Blade Linux Cluster to have a total of 194 computer nodes, a modest increase from the current number of computer nodes. Training of students, particularly graduate students who are our future researchers, will also benefit by providing better access to computational facilities that lead to greater efficiency in conducting research and learning.

Establishment, Planning and Development Activities for Academic Center of Excellence in Advanced Modeling and Simulation at North Carolina State University

Paul J. Turinsky
Battelle Energy Alliance, LLC
 \$894,998
 02/01/05 - 09/30/09

The objectives of this subcontract are to enable university involvement in the National University Consortium (NUC) and to facilitate the administrative activities related to the development of the University Academic Center of Excellence (UACE) at North Carolina State University in Advanced Modeling and Simulation.

GAANN: Interdisciplinary Doctoral Program in Scientific Computation

Duane K. Larick, Harvey T. Banks, Paul J. Turinsky
US Dept. of Education
 \$127,881
 08/15/07 - 08/14/10

Supporting students in scientific computing.

Managing Model Data Introduced Uncertainties in Simulator Predictions for Generation IV Systems via Optimum Experimental Design

Paul Turinsky, Hany Abdel-Khalik
DOE NERI
\$1,058,037.00

03/22/06 - 03/21/10

If uncertainties of complex engineering systems were understood then appropriate design margins could be utilized. The proposed research addresses understanding and management of uncertainties that originate due to uncertainties of physical data utilized in modeling and simulation. It will incorporate aspects of sensitivity and uncertainty analysis, inverse theory and mathematical optimization. The developed capabilities will be applied to a Generation IV nuclear energy system. The uncertainties of key design attributes originating due to nuclear data uncertainties for the nuclear core will be determined and optimum experimental design utilizing the INL ZPPR facility as a test basis will be completed.

Scoping Study Addressing Potential Manners of Reducing Nuclear Fuel Cycle Costs for the Palo Verde Nuclear Generating Station

Paul J. Turinsky, Paul M. Keller
Arizona Public Service Co.
\$202,540
06/01/06 - 03/30/08

Nuclear fuel cycle costs have been increasing because of the increasing price of uranium ore. Nuclear fuel vendors have introduced fuel assembly design improvements that have improved economics but perhaps at the expense of improving fuel performance as indicated by the unfavorable trend of the related INPO metric. This scoping study will assess what improvements can be made in fuel cycle costs, considering replacement power costs and the difficulty of making such improvements considering the issues of implementation cost, engineering effort, maturity of technology, and licensing and plant modifications required.

Collaborative Effort For the Evaluation of New Uncertainty Quantification, Verification, and Validation Methodologies-Part A

Paul J. Turinsky
\$85,000.00
5/6/09-9/30/09

INL has been designated by the US Department of Energy (DOE) as the lead DOE laboratory with regard to the Verification and Validation, and Uncertainty Quantification (VU) tasks within the Nuclear Energy Advanced Modeling and Simulation (NEAMS) program. NC State University, having expertise in VU, has been requested by INL to provide assistance to the laboratory on their technical tasks under their NEAMS VU activities. This proposal defines the scope of work for one of two activities, i.e. Part A, for NC State University and the associated budget. Specifically, NC State will (1) support the review of existing V&V and UQ procedures and evaluate their applicability in different field (e.g. reactor physics, non linear coupled simulation) using simple examples to communicate the procedures employed; and, (2) will review VU procedures and requirements from various organizations such as NRC, DOE, ASME, ANS, etc.

2005 Nuclear Engineering Graduate Traineeship Program

Man S. Yim
General Electric Nuclear Energy
\$82,264
08/16/05 - 06/30/08

This grant is for the support of two Nuclear Engineering Graduate trainee at GE Nuclear Energy Company. Each trainee will spend 9 months (8/16/05-5/15/06) attending Graduate School at NCSU and 6 months (5/16/06-11/15/06) at the sponsor's site completing his/her master research project.

2007 Nuclear Engineering Graduate Traineeship Program with Duke Energy

Man S. Yim
Duke Energy Corp. (Duke Power)
\$39,286
08/16/07 - 11/15/08

This grant is for the support of one Nuclear Engineering Graduate trainee at Duke Power Company. The trainee will be attending Graduate School at NCSU and spending some time at the sponsor's site completing his/her master research project.

CONTACT INFORMATION

For more information about the Department of Nuclear Engineering at NC State University, visit the department's website:

www.ne.ncsu.edu