

BUDGET INFORMATION - Non-Construction Programs

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Year 2	77.006	\$	\$	\$ 100,000.00	\$	\$ 100,000.00
2.						
3.						
4.						
5. Totals		\$	\$	\$ 100,000.00	\$	\$ 100,000.00

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				Total (5)
	(1) Year 2	(2)	(3)	(4)	
a. Personnel	\$ 51,030.00	\$	\$	\$	\$ 51,030.00
b. Fringe Benefits	11,977.00				11,977.00
c. Travel	3,000.00				3,000.00
d. Equipment	0.00				
e. Supplies	0.00				
f. Contractual	0.00				
g. Construction	0.00				
h. Other	0.00				
i. Total Direct Charges (sum of 6a-6h)	66,007.00				\$ 66,007.00
j. Indirect Charges	(b)(4)				(b)(4)
k. TOTALS (sum of 6i and 6j)	\$ 100,000.00	\$	\$	\$	\$ 100,000.00
Program Income	\$	\$	\$	\$	\$

Information in this report was prepared in accordance with the Freedom of Information Act, exemptions 1 & 2. 8-10-2000

SECTION C - NON-FEDERAL RESOURCES

	(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS
8.	Year 2	\$	\$	\$	\$
9.					
10.					
11.					
12.	TOTAL (sum of lines 8-11)	\$	\$	\$	\$

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13.	Federal	\$	\$	\$	\$
14.	Non-Federal	\$			
15.	TOTAL (sum of lines 13 and 14)	\$	\$	\$	\$

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

	(a) Grant Program	FUTURE FUNDING PERIODS (YEARS)			
		(b) First	(c) Second	(d) Third	(e) Fourth
16.	Year 2	\$	\$	\$	\$
17.					
18.					
19.					
20.	TOTAL (sum of lines 16 - 19)	\$	\$	\$	\$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges:		22. Indirect Charges:	
23. Remarks:			

EDU08-44

1) **Project Title:** Graduate Certificate Program in Nuclear Power Engineering

2) **Names of Contacts and Affiliations:**

Larry R. Foulke, Adjunct Professor and Director of Nuclear Programs,
University of Pittsburgh, Pittsburgh, PA 15261

(b)(6)
Email: lrf4@pitt.edu

Ex. 6

3) **Funding Request:** \$100,000 for Year Two of Grant NRC-38-07-505

4) **Statement of Objectives and Benefits:**

The objective of this project is to develop an innovative set of nine graduate courses in nuclear power engineering for engineering students in traditional disciplines. To earn the certificate, students will complete five of these courses. Included in the set is a five-course sequence specifically focused on safe nuclear plant operations. Students from any of the University of Pittsburgh School of Engineering's seven MS degree programs may complete the certificate as part of their master's degree program. A major strength of this program is the integration of facilities and resources from the local nuclear power community. A distance education component is being developed to support the delivery of course work to other educational institutions, and nuclear vendors and utilities. If future NRC funding support is forthcoming, a course in nuclear security will be developed in conjunction with the University's Center for National Preparedness, and a course in Nuclear Environmental Issues will be developed in conjunction with the School of Engineering's Mascaró Sustainability Initiative. These later courses will cover such topics as non-proliferation, nuclear security and environmental technology.

This project has the following benefits that promote workforce growth and improvement for the commercial nuclear power industry:

- It will provide a special and unique focus on safe commercial nuclear reactor plant operations. Coursework will be developed with input from program constituencies and will focus on major missing competencies in employees identified by the constituencies.
- It will exploit the important resources - staff, facilities, models, and equipment - available from constituencies in Southwestern Pennsylvania.
- Through distance education facilities, the program will reach students many of whom are engineers working in the nuclear profession without the benefit of formal educational courses in nuclear engineering.

Project Description

This project supports coursework and curriculum development for graduate level nuclear engineering education with a focus on nuclear operations and safety. Specifically, the University of Pittsburgh School of Engineering is developing a 15-credit graduate certificate in nuclear power engineering. The certificate is designed so that it may be combined with graduate coursework in any one of the School's seven MS degree programs (Bioengineering, Chemical, Civil, Electrical and Computer, Industrial, Materials Science and Mechanical Engineering). In this manner, MS students will be able to earn the certificate by taking no more than two additional graduate level courses. Further, by focusing on nuclear operations and safety, we not only fulfill a recognized educational need, but have also designed a program that takes advantage of the unique industrial resources in the Pittsburgh area. Integrating these resources into our graduate coursework will greatly enhance student learning. Thus, the purpose of this proposal is to continue the necessary funding to fully develop a strong academic program that integrates key industrial resources available in the Southwestern Pennsylvania with the University of Pittsburgh's outstanding educational capabilities.

Specifically, this proposal will enhance the academic coursework started with Year One Funding under Grant NRC-38-07-505 in the nuclear engineering certificate program. This program has strong appeal to both students with a BS degree in nuclear engineering as well as students with a BS degree in one of the other engineering fields who plan to or are already working in the nuclear power field. Hence, the program is designed with sufficient flexibility to accommodate students from a wide spectrum of engineering disciplines.

As part of this initiative, a body of well-structured graduate courses has been and continues to be created. The full program will consist of a set of nine courses from which students will select five to earn the certificate. Included among these nine courses will be the five-course sequence especially pertinent to nuclear plant operation and safety. These five will cover key subjects in nuclear plant dynamics and control, materials, transport phenomena, operational safety, reactor interfaces with the balance of the plant, and integrated power plant operations. The other four courses will cover nuclear materials, heat transfer and fluid flow, nuclear security and environmental issues. With future funding support, the last two courses will be developed in conjunction with the University's Center for National Preparedness and the School's Mascaró Sustainability Initiative respectively.

The program is targeted at the following types of students:

- Practicing engineers currently in or aspiring to a leadership role in the nuclear industry,
- Engineering professionals who desire a graduate degree in their field with a focus on safe nuclear plant operations,
- New graduates with a minimum of a bachelor's degree in a technical discipline, and
- Professionals who manage multidisciplinary teams for project design or management in the nuclear industry.

This program is an important component of the School's energy and sustainability initiatives. The School of Engineering at the University of Pittsburgh has had a long-term interest in energy, with particular foci in fossil fuel based energy and power. More recent initiatives are focusing on sustainable energy resources as well as more innovative and long-term solutions including approaches to the hydrogen economy.

In addition, this program addresses a regional need. Strong growth in the global demand for power is projected for the next half-century and beyond. This growth provides great opportunities for the nuclear industry, particularly companies located in southwestern Pennsylvania such as Westinghouse Electric and First Energy Nuclear Operating Corporation (FENOC). While great opportunities now await these companies, all are preparing for the impact of workforce and technology development neglect that was dominant in the nuclear and power industries in the 1980s and 1990s. The majority of engineering and other technical talent in these fields is preparing to retire over the next decade, just as these companies are poised to experience strong growth in demand for their products and services. As a result of the many years of workforce development neglect, there are precious few young employees with adequate training that are ready to fill the impending technical talent gap. Westinghouse Electric, for example, is hiring hundreds of new engineers in the Pittsburgh area. These new hires will need continuing education in nuclear engineering, and this project provides the only graduate nuclear engineering courses presently available in the Pittsburgh region. This proposal specifically addresses this gap by developing and implementing several innovative educational outreach programs.

Innovative Instructional Approaches

The School of Engineering has been a national leader in creating innovative educational programs over the past two decades. At the undergraduate level these have included an integrated freshman curriculum (bringing together mathematics, physics, chemistry and engineering courses and faculty), a study abroad education initiative that has enabled approximately a quarter of our graduates to have participated in an international experience, a cooperative educational program with a participation rate in excess of 50% of the eligible students, an innovative "pillars" chemical engineering curriculum (that vertically integrates core courses), and a series of state-of-the-art classrooms that facilitate active and cooperative learning. Graduate initiatives have included a combined MS/MBA program, an NSF funded IGERT program in sustainability that includes an eight-month research rotation in Brazil, and a series of off-campus MS programs for working engineers, the most recent of which will begin this September in Taiwan. In addition the School of Engineering faculty have been active in conducting serious engineering education research in conjunction with colleagues throughout the country as well as with the University's well-known Learning Research and Development Center.

For this project we build upon a number of education innovations. In particular we:

- Utilize instructional approaches that take advantage of the experience and knowledge of practicing nuclear engineers in the local service areas of Western Pennsylvania as well as the full-scale models and replica simulators available in our service area.
- Integrate desktop simulation software to provide "laboratory" experiences that facilitate a better understanding of plant operations and promote the development of intuition regarding plant transient behavior.
- Incorporate our distance education capabilities to outreach to a larger body of students outside of the local service area, many of whom are engineers working in the nuclear profession who could substantially benefit from formal educational courses in nuclear engineering but who do not have access to a local university.
- Utilize "reverse" distance learning in order to bring field and plant operations into the classroom to enhance the educational value.

- Utilize activity-based, student-centered learning rather than straight lecturing to enhance learning. We are developing student-centered learning activities that can be used as in class learning exercises to reinforce key concepts.
- Tailor the level of rigor of our curriculum to both satisfy the academic requirements for graduate level education and the student knowledge perspective. To do this we blend theory with "operational so-whats." That is, we link theoretical concepts covered in class with day-to-day operational significant events at the plant or work facility. Example questions that are posed to students include:
 1. What approximations can you make to this equation? What assumptions must you make to do this?
 2. Can you make a back-of-the-envelope approximation? If so, how is the risk of error increased?
 3. Point Kinetics requires that k be close to unity. How much of a limitation does this pose relative to use in the plant?
 4. You are talking about plant dynamics with one of your people who does not have knowledge of calculus and differential equation. How can you explain the concept of a transfer function to that person?
 5. Component xyz in the balance of plant is showing degraded performance; how does this affect the reactor core?

Infrastructure, Teaching Competencies and Subject Matter Expertise

The program infrastructure draws upon a rich body of faculty from constituents under the supervision of a Director of Nuclear Studies (Dr. Foulke, an adjunct full professor) who works closely with the two co-Principal Investigators for this project to ensure academic quality: Drs. Chyu and Shuman. Dr. Chyu is Chair of the Department of Mechanical Engineering and Materials Science; Dr. Shuman is the Associate Dean for Academic Affairs. The Program's faculty, almost all of whom hold PhD degrees, will bring needed expertise, relevance and current competencies to the coursework. This is particularly important since one emphasis of the program is on commercial nuclear reactor plant operations.

All the adjunct instructors, while experienced, participated in a specially designed workshop supported by the Year-One funding. The workshop was conducted by regular faculty who had designed and taught courses by distance delivery methods. The workshop was aimed at ensuring that courses developed by this grant are taught at the proper level, with the appropriate coverage, and that enhancements from the industrial sector are used to the fullest extent possible. Each course is being approved the workshop principals and then reviewed by an Advisory Committee consisting of academic and industrial representatives. Each time that a course is taught, it will be evaluated, and revised as appropriate.

By focusing on operations, our program differs substantially from the more traditional nuclear engineering programs. Specifically, traditional graduate study in nuclear engineering focuses on fission reactor physics, fuel management, fusion, core design, thermal-hydraulics, and applications of radiation science to mankind. None of the existing MS Nuclear Engineering programs to our knowledge have a focus on nuclear plant operations and safety. Yet, a survey of 30 facilities that we conducted in designing the proposed program revealed that knowledge of commercial nuclear plant operations was frequently cited by potential employers as one of the major missing competencies of not only new employees, but also experienced engineers. This is of particular concern given the rather substantial hiring needs within our tri-state region.

Specifically, our program bridges a serious communications gap among engineering disciplines that support safe operation of nuclear power plants. Given the close proximity of Westinghouse Nuclear Energy Systems, the Beaver Valley Power Station managed by First Energy Nuclear Operating Company, and the Bettis Atomic Power Laboratory run by Bechtel, there is not only a robust market for graduates but also a rich pool of experienced faculty prospects. Most of these potential instructors have over 25 years experience in the nuclear industry and are widely recognized in their particular area of expertise. Because the needs of our constituencies go beyond the unique and primary focus of nuclear plant operations, there are good prospects for further development of coursework as well as the potential for rigorous research projects with School of Engineering faculty.

Indeed, we expect that this graduate initiative will stimulate faculty research in materials, mechanical, electrical, and industrial engineering programs at the institution. For example, the School of Engineering faculty are currently involved in research projects directed at hydrogen production from water. Research efforts with Westinghouse Electric have been directed at the generation and transport of thermal energy needed for the thermochemical cycles and electrolysis processes. Clearly advanced reactor designs will be required for the next-generation (GEN IV) nuclear power plants that must operate at the temperatures required for the water-splitting production of hydrogen. Computational and experimental research has established the hydraulic and heat transfer (radiation and convection) requirements of gas-cooled fast reactors - capable of providing thermal energy at 1000K - and very-high temperature reactor systems up to 1250 K.

As noted, leadership of the program is provided by Larry Foulke who has an earned doctorate in nuclear engineering, P.E. registration (nuclear) in the State of Pennsylvania, and experience in reactor operations. Dr. Foulke has also had a broad base of experience at both Bettis and Westinghouse, is well-known in the nuclear industry, and will provide program flexibility and innovation. Supervision and guidance will be provided by Dr. Minking Chyu (Professor of Mechanical Engineering and Chair of the Department of Mechanical Engineering and Materials Science) and Dr. Larry Shuman (Associate Dean for Academic Affairs and Professor of Industrial Engineering). Dr. Chyu has a degree in nuclear engineering and has done extensive research in the energy area, most recently on developing fuel cells and advanced turbine applications to energy and heat transfer problems. Dr. Shuman is widely recognized for his contributions to engineering education and engineering education research including a focus on assessment and engineering ethics. He will be responsible for the evaluation aspects of this project. Their two-page CVs are included as part of this proposal.

Participating faculty drawn from the local nuclear energy community who can provide depth and breadth of coverage are a program strength. There is a wealth of active professionals supplemented by recent retirees who can be called upon to both assist with the development and teaching of regular course offerings, modules and directed study. The School of Engineering already provides a wide array of complementary courses related to nuclear operations and safety in mechanical, industrial, materials and electrical engineering. These direct ties to the School's six departments will further create program flexibility enabling it to accommodate students from all areas and allow for future enhancement that could include management and leadership dimensions (in conjunction with the Katz Graduate School of Business).

The program builds upon a developing companion undergraduate certificate program in nuclear engineering that began in the Fall Term of 2006. To date, 660 credit hours of undergraduate

nuclear engineering coursework have been delivered to School of Engineering students. The undergraduate certificate is also open to students from all six departments (as well as the Engineering Physics program), enabling them to combine a special three course nuclear engineering sequence with two complementary departmental courses.

Provided below are brief capsules of CV's of individuals who are retired or who are active professionals at Westinghouse, Bechtel Bettis, Inc., and the Beaver Valley Nuclear Station and who are being used as instructors for the graduate nuclear engineering certificate program at the University of Pittsburgh. They will be involved in both course development and instruction under the leadership of the Principal Investigator, Dr. L. R. Foulke, and the oversight of Drs. Chyu and Shuman.

Larry R. Foulke, Principal Investigator, Adjunct Professor and Director of Nuclear Programs, University of Pittsburgh. PhD Nuclear Engineering, MIT (b)(6) Instructor, Bettis Reactor Engineering School (1969-1972). Adjunct Associate Professor of Nuclear Engineering, Penn State University (1984-1988). Retired as Chief Scientist, Space Engineering Activity, Bechtel Bettis, Inc. U.S. Army Reactors Group, Nuclear Power Field Office, Ft. Belvoir, VA. Trained as a nuclear plant engineer and received honorable discharge as Captain, U.S. Army Corps of Engineers (1966 - 1968). Bettis Atomic Power Laboratory, Manager of various activities including Performance Analysis, Safeguards and Plant Analysis, Environmental Engineering, Safety Analysis, Laboratory Operational Safeguards including Materials Accountability and Physical Security (1972 - 1980). Responsible for managing the preparation of the Safety Analysis Report and the Environmental Impact Statement for the Light Water Breeder Reactor. Westinghouse Electric Corporation, Manager Pittsburgh Operations Training Center (1980 to 1985) and Manager Simulator Product Development (1985 - 1990). Trained to be SRO Certified Instructor. Member of Various Safety Review Committees at both Bettis and (W) (1972 - 1984). Registered Professional Engineer, PA License PE 053016E (1997 - present). Member of Review Committee for Los Alamos Nonproliferation Division (2006-present).

David Helling, Senior Personnel. B.S., Mathematics, Miami University, Oxford, Ohio (b)(6) Expect M.E. in Nuclear Engineering from Penn State University in 2007. Certified as online educator by California State University, Hayward, CA. Currently completing Masters of Education. Lead, Commercial Nuclear Training Programs for Westinghouse (9/01 to present). Over thirty-five years of experience in navy and commercial nuclear power plant operations, maintenance and training. Extensive experience in the operations and maintenance of navy nuclear power plants and in commercial nuclear power plant operations and training. Certified by the US Nuclear Regulatory Commission as a Senior Reactor Operator (SRO) in 1993 and qualified as a nuclear trained engineer by the United States Navy Nuclear Power School, 1972. During naval career, worked extensively in training and operations positions. Performed hundreds of reactor and plant start-ups and shutdowns, performed numerous accident drills and responded to several plant emergencies. Taught this material to both enlisted and officer students throughout navy career.

David Griesheimer, Ph.D. in Nuclear Engineering, University of Michigan (b)(6) Currently Senior Engineer at the Bechtel Bettis, Inc. Graduated Distinguished Honors Scholar from the University Honors Scholars Program. Non-thesis duties included assisting faculty with undergraduate and graduate level nuclear engineering courses by grading and instructing students in commonly used computer codes such as MCNP and ORIGEN2. Portz Scholar national award for outstanding undergraduate research, National Collegiate Honors Council, 1999. Naval Nuclear Propulsion Fellowship for Ph.D. studies in Nuclear Engineering, 2001-

2005. Part of the software development team for a new Monte Carlo based reactor analysis code. Registered Engineer Intern (EI) in state of Ohio. Expect to take PE exam in 2008.

David Haser, University of Pittsburgh, MBA Youngstown State University, Pennsylvania P.E. 053357-E. Nuclear Regulatory Commission licensed Senior Reactor Operator in charge of Operating an 880 megawatt nuclear power station (First Energy Corporation, Beaver Valley Unit 2, 1988 to present). Directs operating personnel of 880-megawatt base load nuclear generating station on a shift basis in all situations that occur. These include startup, power operations, testing, shutdown, refueling and any casualty situations that occur. Technical liaison to Ohio Emergency Management Agency to brief the Adjunct General of Ohio, the Deputy Director of OEMA and either the Governor of Ohio or his representative during an actual incident at the plant or during the annual emergency preparedness plan drills.

David Aumiller, Ph.D. Nuclear Engineering, Pennsylvania State University (b)(6) Principal Engineer at Bechtel Bettis, Inc. Lead Safety Code Developer for the Naval Reactors Program. Co-inventor of the RELAP5-3D based coupled code system. Served as a Teaching Assistant while in graduate school. Guest Lecturer at the Bettis Reactor Engineering School, a Master's equivalent program taught at Bettis. Developed and taught the Heat Transfer and Fluid Flow course for the Bettis Early Start Program for recent hires at Bettis. 2004 Recipient Bechtel Excellent Technical Paper Award. 2002-2003 Chairman of the International RELAP5-3D User's Group. Invited participant at the DOE Conference "Advanced Simulations - A Critical Tool for Future Nuclear Fuel Cycles." Invited participant at DOE GEN IV workshop on Thermal-Hydraulic Tools.

Vincent Esposito, Sc.D., Nuclear Engineering, University of Virginia. Master of Business Administration, Valedictorian - University of Pittsburgh. Executive Master of Business Administration Program, Katz School of Business. Currently Vice-President, Westinghouse Asian Fuel Business. Responsible for fuel business associated with Japan, Korea, Taiwan and China. Provided interface on Russian activities for Westinghouse until 2005. 1986 Corporate Incentive Award for Westinghouse response to Three Mile Island, 1979. Instructor (part-time) Carnegie Mellon University Graduate School, Pittsburgh, PA. Experience in teaching graduate level evening courses in Thermal Fluids and Numerical Methods receiving excellent reputation from prior teaching position. Experience in safety analysis methodology, licensing, nuclear fuel design/analysis and steam generator technology. Electric Power Research Institute representative for Commercial Nuclear Fuel Division and interface at the management level with Nuclear Regulatory Commission. Previously responsible for nuclear power plant simulator design and manufacturing plus training of utility personnel for nuclear related activities. Previously responsible for loss of coolant accident (LOCA) large and small break, containment mass and energy release, emergency core cooling requirements, licensing for analytical models and NRC interactions. Established functional requirements for ECCS systems and interface with fuel requirements.

Melissa Hunter, Ph. D. Nuclear Engineering, Penn State University (b)(6) Principal Engineer, Westinghouse Nuclear, formerly Manager, Safety Assessments, Reactor Safety Subdivision, Bechtel Bettis, Inc., (2005-2006). Instructor, Applied Nuclear Physics, Bettis Reactor Engineering School, Taught graduate level course to Navy officers and Bettis employees (1991 - 1996). Teaching Assistant, Department of Nuclear Engineering, Penn State University, Teaching assistant for several graduate and undergraduate nuclear engineering courses.

John Metzger, Ph.D., Nuclear Engineering, University of New Mexico (b)(6) Currently Advisory Engineer, Bettis Atomic Power Laboratory. Instructor, Bettis Reactor Engineering

School. Previously responsible for university research in space-nuclear power and propulsion system design, analysis and modeling; CFD analysis, thermal-hydraulic design, analysis, equipment specification, computer modeling of nuclear and non-nuclear power systems and components; control systems analysis; application of statistical uncertainty to the determination of control setpoints; and analysis of hydrodynamic phenomenon; general overall systems analysis and computer modeling. State University of New York at Stony Brook, Research Associate Professor in Mechanical Engineering - Department representative to the College of Engineering and Applied Science (1998-2005).

Richard Siergiej, Ph.D. Electrical Engineering, Lehigh University, Bethlehem PA, (b)(6)
Manager, Advanced Electrical Concepts, Advanced Design Development, Bechtel Bettis, Inc. Manages development efforts in next generation instrumentation and control technologies for advanced naval nuclear propulsion technology. Responsible for the next generation instrumentation and control laboratory. Managed alternate energy conversion power electronics development. Led study on Boiling Water Reactor technology. Lecturer for the Westinghouse Science Honors Institute, 1998 to 2001.

Andrea Maioli, Ph.D. Nuclear Engineering, Politecnico di Milano (Italy) (b)(6) Senior Engineer with Westinghouse Nuclear. Involved in the design and CFD analysis of the IRIS advanced PWR; responsible for IRIS Probabilistic Risk Assessment. Conducting Risk Analyses for current and advanced nuclear power plants in the Risk Analysis Method group. Conducting thermal hydraulic analysis with the LOCA Integrated Services group. Taught seminars on Probabilistic Risk Assessment techniques held during the Reliability Analysis and Risk Assessment undergraduate level courses at Politecnico di Milano, Department of Nuclear Engineering - Spring Semester 2003.

Bruce Berquist, Ph.D. Ph.D. Physical Chemistry, University of Pittsburgh (b)(6)
Advisory Scientist, Material Technology Activity, Bechtel Bettis, Inc. Developed several classified fabrication processes using new materials for use in advanced naval reactor designs, some of which are in production. Lead Instructor of the Bettis Reactor Engineering School (BRES) materials course since 1994. Taught many Chemistry courses at the Pennsylvania State University, McKeesport Campus

Michael Burke, Ph.D., Manager, Materials Center of Excellence, Westinghouse Electric Company. M.S. University of Pittsburgh (USA) Metallurgical Engineering 1977; Ph.D. University of Sheffield (UK) Metallurgy (b)(6) Over 25 years experience in managing materials development and implementation programs for advanced power generator systems. He has led innovative programs to develop Robotic Welding, Metal Matrix Composites, Directionally Solidified and Single Crystal Superalloys and Ceramic Matrix Composites. He was the "core competency" leader for Advanced Gas Turbine Materials at Siemens Power Generation Corporation. In his present position he is responsible for coordinating materials technology development efforts for existing and new commercial power plants.

Courses to be Developed

We are requesting funding from the NRC to continue orderly and timely development of a series of courses that will comprise the certificate program. Students will have an eventual menu of nine nuclear power engineering courses from which to select five. Among these will be five courses that specifically emphasize nuclear plant operations. Students who successfully complete five of these courses will earn the nuclear power engineering certificate; students would also complete five to seven additional courses in order to earn an engineering master's

degree (depending on the student's major). Brief synopses of the courses to be developed are given below:

ENGR 2101: Nuclear Core Dynamics

This course reviews the mathematics of nuclear reactor kinetics. Linear systems of ordinary differential equations are solved by state vector techniques, Laplace transform techniques, or finite difference techniques including the treatment of discretization errors resulting from various finite differencing approximations. A review of the physics of nuclear kinetics is followed by treatments of the kinetics equations including the effect of uncertainties, approximate solutions, and the interpretation of experiments to measure kinetics parameters. Representations and the physical basis of reactivity feedback mechanisms are treated. Lumped and distributed parameter models of fuel, coolant, fission products, and selected plant components are derived and applied to develop quantitative static relationships and qualitative dynamic results for transient conditions. The course provides an introduction to reactor protection and safety analysis.

ENGR 2102: Nuclear Plant Dynamics and Protection

This course provides an integrated engineering examination of a nuclear power plant from the perspective of instrumentation and control systems used to infer the condition of the nuclear plants and its systems, control its normal operation, and provide protection during transient situations as well as assess core damage during severe accident situations. Dynamic simulations of plant systems are constructed and interfaced. Students will apply previous knowledge of analog, digital, and microprocessor electronics techniques to nuclear power plant design and operation and reactor protection and safety considerations that influence the design of the reactor plant. A major outcome of this course will be an integrated understanding of the interaction between the physics of nuclear plant control (reactivity and heat balance) and the control and protection systems. This understanding will be essential for the successful completion of the Integrated Nuclear Power Plant Operations course.

ENGR 2103: Integration of Nuclear Plant Systems with the Reactor Core

This course examines design bases for major systems and components that are needed to transform fission energy into electrical energy and synthesizes how the systems function in an integrated fashion. Student examine a typical nuclear power plant and those components and systems of the nuclear plant complex that have the potential for affecting core power, and whose failure could be an initiating event for a plant transient. The emphasis is on how operations of and faults in those systems and components can influence reactivity and core behavior. Through classroom discussions and the use of simulation models the students will assess engineering problems and operational problems that have been experienced in historical nuclear plant operations. Intended outcomes are an aptitude for predicting transient behavior of the integrated plant with a command of reactivity management and control, coolant inventory control, and core heat removal that are important for safe and efficient operation of a nuclear plant complex.

ENGR 2104: Nuclear Operations Safety

This course will review the development of reactor safety concepts, the emergence of safety strategies and culture, and the perspectives of severe accidents and how they can be mitigated. Risk-influenced regulatory practices will be introduced and quantitative use of probabilistic risk assessment will be described in terms of its use as a guide to intelligent decision-making. The characteristics of accident progression in the reactor vessel and containment in the unlikely event of core melting and relocation of fuel material will be explained. Offsite impacts of such severe accidents will be introduced. Source terms, dispersion of radionuclides, and dose

projections will be developed for both conservative and realistic evolutions. Protective actions and emergency preparedness will be introduced. This course will cover the regulatory aspects of nuclear operations and the roles that the NRC, INPO, WANO and the IAEA play and what impact each has on plant operations. An introduction into regulatory requirements, the Safety Analysis Report, nuclear safety and licensing, and whistle-blower rules will be provided.

ENGR 2105: Integrated Nuclear Power Plant Operations

This course provides a capstone hands-on-simulator and classroom experience to promote understanding how the integrated plant works and what challenges the operator faces, and to help an engineer be able to "speak operations" with the operations staff. Use of the simulator is an effective way for students to understand accident control and Emergency Operating Procedures, and how the control room interfaces with the rest of the plant. Emphasis is placed on understanding plant characteristics and controls, rather than on developing control manipulation skills. Intended outcomes are an aptitude for predicting transient behavior of the integrated plant and a command of reactivity management and control that is important for efficient operation of a nuclear plant complex. The course presumes knowledge of the major systems in a nuclear power plant and will emphasize how operations of and faults in those systems and components can affect reactivity and core transient behavior.

ENGR 2110: Nuclear Materials

This course presumes that students have the knowledge base needed to understand materials issues associated with the design and operation of nuclear power plants, such as basic concepts of physical metallurgy, a mechanistic and microstructural-based view of material properties, and basic metallurgical principles. This course will cover the metallurgy and phase diagrams of alloy systems important in the design of commercial nuclear power plants. The microstructural changes that result from reactor exposure (including radiation damage and defect cluster evolution) are discussed in detail. The aim is to create a linkage between changes in the material microstructure and changes in the macroscopic behavior of the material. Also discussed is the corrosion of cladding materials as well the effects of irradiation on corrosion performance, as well as the effects of primary and secondary coolant chemistry on corrosion. Both mathematical methods and experimental techniques are emphasized so that theoretical modeling is guided by experimental data. Materials issues in current commercial nuclear reactors and materials issues in future core and plant designs are covered.

ENGR 2115: Heat Transfer and Fluid Flow in Nuclear Plants

This course provides advanced knowledge to promote understanding and application of thermal and hydraulic tools and procedures used in reactor plant design and analysis. It assumes that the student has a fundamental knowledge base in fluid mechanics, thermodynamics, heat transfer and reactor thermal analysis. The focus of the course is on physical and mathematical concepts useful for design and analysis of light water nuclear reactor plants. Applications of mass, momentum, and energy balances are combined with use of water properties to analyze the entire reactor plant complex as a whole. Principles are applied through the application of major industry codes to specific cases.

ENGR 2120: Nuclear Plant Security

This course will be designed in conjunction with colleagues at the University's Center for National Preparedness. This broad, multidisciplinary, collaborative enterprise engages the University's scientists, engineers, policy experts, and clinical faculty in issues related to security and safety. Members of the Center possess expertise in biomedical research, public health, medicine, national security policy, engineering, and information technology. The Center synthesizes efforts in place in the Faculty of Arts and Sciences, the Graduate School of Public

Health, the Graduate School of Public and International Affairs, and the Schools of Engineering, Information Sciences, Law, Medicine, and Nursing. Research, education, and training are the foundation of this enterprise. The Center communicates the innovative research of the University's faculty to the broader public through the educational and training programs in which students, policymakers, and other interested parties participate. The Center supports research and applications that are directed at the University's numerous constituencies. The Center contributes to local, state, and national preparedness.

This course will provide an in-depth overview of security measures related to nuclear materials and nuclear facilities. While the course will focus on the security issues at a nuclear facility, security practices during the acquisition, transportation and disposal of nuclear materials will also be discussed. Topics will include: regulation, material control, recordkeeping, threat assessment, physical and cyber security systems, access, deterrence, testing and exercises. The course will use a case-based approach to explore design, regulation, policy and best practices in security both from a national and international perspective. Threats from natural (e.g. earthquakes, hurricanes, etc.) and man-made (e.g. theft, sabotage, etc.) events also will be seriously addressed.

ENGR 2130: Environmental Issues and Solutions for Nuclear Power

This course will be developed in conjunction with University of Pittsburgh faculty with an interest in environmental issues impacting the nuclear power industry including School of Engineering faculty involved with the Mascaro Sustainability Initiative, faculty from the Department of Civil and Environmental Engineering and faculty from the Graduate School of Public and International Affairs.

The course will address such topics as sustainable energy resources, engineering and societal ethical concerns, risk analysis, and future energy supplies in general and as each of these topics relates to such specific issues as the nuclear fuel cycle, nuclear reactor safety, nuclear waste disposal and transportation, and GEN IV and the hydrogen economy. Students will better understand the socio-economic issues surrounding achieving a sustainable nuclear power future as it impacts fuel acquisition, plant operation and waste disposal.

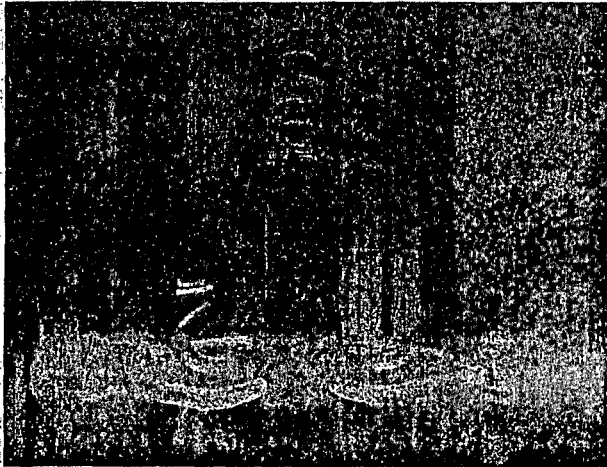
Academic Focus of the Proposed Program

The core focus of the current certificate program is on nuclear safety and plant operation. The program will accommodate students from all engineering disciplines and can be adjusted in the future to include management and leadership dimensions, non-proliferation, nuclear security and environmental technology.

Distance Learning and Reverse Distance Learning

In the Summer of 2008, the second offering of the course ENGR2101, Nuclear Core Dynamics, is expected to be re-designed for distance delivery provided that appropriate facilities can be scheduled at local constituencies. The School of Engineering has been utilizing its distance learning capabilities to offer joint courses with Rice University and the University of Tulsa. We have also used it to interact with universities in England and Brazil. We will utilize this same technology to offer courses at remote sites. The technology will enable the instructor to see and hear all of the students "live" as well as allow the students to see the instructor and students at

both the University of Pittsburgh classroom and any other facilities linked into the system. Further, by archiving lectures, students will be able to review the course at their leisure.



We are also working with colleagues at the University's Visual Information Systems Center who are developing virtual models of nuclear power plants for Westinghouse as shown in the Figure. A unique feature of these models is the incorporation of both human and machine intelligence into the software. As a result, students are able to tour a virtual facility, either on their own, or with an avatar "guide." As the models are developed, they will also enable students to interact with professional engineers as they use the model. In this manner, we can bring the professional directly into our classroom. This will be one way that we plan to utilize

distance and "reverse" distance learning to bring additional expertise to the classroom. We received a \$100,000 grant from the DOE to develop an initial module for instruction.

Projected Enrollment

We are assuming that the average student will take 2.5 years to complete the program. Given that assumption, and a steady-state enrollment of 72 students with 30 MS/Certificate graduates per year we project the following:

Year	New students	Total enrolled	Number of MS Graduates
2007 -	24	24	0
2008	24	48	0
2009	30	68	10
2010	30	72	26
Steady state	30	72	30

Evaluation

Both formative and substantive evaluations will be conducted of the program. The program will be assessed against its objectives and outcome criteria as follows:

- Number of applications and enrollments in the program. The extent to which we are able to meet or exceed our projected targets. If we do not exceed our targets, determine the reasons why we did not.
- Quality of admitted students – GRE scores, undergraduate affiliation and performance (GPA), quality and length of work experience.
- Student satisfaction – students will thoroughly evaluate each course. Students will also complete a comprehensive "graduation survey" at the end of the program. We will conduct

focus groups with a sample of 2008, 2009 and 2010 graduates to better understand the program from the students' perspective, as well as to identify areas for improvement.

- Placement statistics – number of graduates placed, quality of companies hiring, starting salaries, etc. for students who enter without a full-time position. For students who are already employed in the nuclear industry prior to graduation we will determine the program's impact on the employment situation; e.g., did they receive an increase, position change, etc., upon graduation. We will follow-up each year with both groups to track their progress and estimate the program's impact on their future success. Surveys will be designed, piloted tested and administered online using OS³ – the School of Engineering's Online Survey System.
- Employer satisfaction – we will develop a comprehensive instrument to survey employers of our graduates; we will attempt to conduct focus groups of local employers (second line supervisors to preserve confidentiality).
- Reputation – impact of the program on reputation/ranking of the School of Engineering and the various Engineering departments.
- Budgetary impact – revenues and costs of the program.

Schedule for Course Offerings

Given the funding from the grant, the proposed schedule for the nuclear courses is as follows:

Term	ENGR 2101	ENGR 2102	ENGR 2103	ENGR 2104	ENGR 2105
Fall 2007	C				
Spring 2008		IP	IP		
Summer 2008	X			X	
Fall 2008		X	X		
Spring 2009	X			X	
Summer 2009		X	X		
Fall 2009	X			X	X
Spring 2010		X	X		
Summer 2010				X	X
Term	ENGR 2110	ENGR 2115	ENGR 2120	ENGR 2130	
Fall 2007		C			
Spring 2008	IP				
Summer 2008					
Fall 2008		X			
Spring 2009	X				
Summer 2009					
Fall 2009		X	X		
Spring 2010	X			X	
Summer 2010					

X = Planned
 C = Completed
 IP = In Progress

Major Milestones in Course Development and Delivery

Task	Date	Action Party
Delivery of inaugural course - ENGR 2101	Complete	Foulke, Helling
Delivery of inaugural course - ENGR 2115	Complete	Aumiller, Esposito
Syllabus development for ENGR 2102	Complete	Foulke, Helling, and Adjuncts
Syllabus development for ENGR 2103	Complete	Helling
Syllabus development for ENGR 2110	Complete	Berquist, Burke, Wiezorek
Syllabus approvals by Advisory Committee	Late	Advisory Committee
Delivery of inaugural courses, ENGR 2102, ENGR 2103, and ENGR 2110	In progress	Foulke, Helling, Siergiej, Haser, Metzger, Burke, Berquist
Evaluation of ENGR 2101 and ENGR 2115	Spring Term 2008	Shuman and evaluation team
Syllabus development for ENGR 2104	March 2008	Foulke, Hunter, Maioli
Delivery of inaugural course, ENGR 2104	Summer Term 2008	Foulke, Hunter, Maioli
Syllabus approvals by Advisory Committee	April 2008	Advisory Committee
Evaluation of ENGR 2102, ENGR 2103 and ENGR 2110	Summer Term, 2008	Shuman and evaluation team
Repeat delivery of course - ENGR 2101 to fill the pipeline	Summer Term 2008	Foulke, Helling, Adams
Repeat delivery of ENGR 2102, ENGR 2103, and ENGR 2115	Fall Term 2008	Adjuncts
Evaluation of ENGR 2104	Fall Term 2008	Shuman and Evaluation team
Repeat delivery of ENGR 2101, ENGR 2104, and ENGR 2110	Spring 2009	Adjuncts
Repeat delivery of ENGR 2102, and ENGR 2103	Summer 2009	Adjuncts
Repeat delivery of ENGR 2101, ENGR 2104, and ENGR 2115. Inaugural delivery of ENGR 2105	Fall 2009	Adjuncts
Syllabus development for ENGR 2105	Summer 2009	Helling, TBD
Syllabus development and approval for ENGR 2120	Deferred	Center for Emergency Preparedness
Modification of first set of courses for e-learning	Summer and Fall 2009	Foulke, and Adjuncts
Delivery of inaugural course - ENGR 2120	Deferred	Center for Emergency Preparedness faculty
Syllabus and approval for ENGR 2130	Deferred	MSI Faculty
Evaluation of ENGR 2120	Deferred	Shuman and Evaluation team
Delivery of inaugural course - ENGR 2130	Deferred	MSI Faculty
Evaluation of ENGR 2130	Deferred	Shuman and Evaluation team
Modification of second set of courses for e-learning	Deferred	Center for Emergency Preparedness faculty and MSI faculty

Equipment Requests Associate with the Proposed Program

The proposed project has no equipment requests. Distance learning equipment will be provided by the University of Pittsburgh. Access to an advanced control room, replica, real-time simulator will be provided by Westinghouse.

Improvement of Nuclear Education Infrastructure

The proposed project will develop and implement an improved nuclear education infrastructure, teaching competencies, subject matter expertise, and skills in serving students in significant nuclear programs as described above.

Curriculum Development

The development of teaching guides and source books will be a major product of the proposed project. We expect to be able to use relevant, non-proprietary information from First Energy Nuclear Operating Company and Westinghouse Energy Systems in the development of teaching materials. Any textbooks that may ensue from this development would not use funding from this grant.

Summary of Results from Past Nuclear Regulatory Commission Funding:

The University of Pittsburgh currently has an Educational Grant NRC-38-07-505. A Progress Report on that grant was submitted to the NRC on February 28, 2008.

Summary of Relevant Current Funding Support:

The University of Pittsburgh currently receives funding support from the NRC under grant NRC-38-07-505 that runs from September 1, 2007 to August 31, 2008. A Six-Month Progress Report for that grant was submitted to the NRC on February 28, 2008. The current proposal is applying for continuation of that grant.

The current grant work involves approximately 70 percent of the work effort of the principal investigator. Being retired, this work activity is shared only with writing of papers, speaking to civic and professional groups about energy policy and nuclear engineering, and teaching an undergraduate course in nuclear engineering at the University of Pittsburgh. The principal investigator devotes approximately eight person-months per year to the development and delivery of the project described in this proposal.

All other adjunct instructors are fully employed by local constituents. They develop their course material and provide instruction on their own time outside of their normal job requirements. In the initial development and teaching of each course, it is estimated that the total time commitment per course is one person-month of effort, which is shared by multiple adjuncts for each course.

The principal investigator for the project continuation proposed by this grant application also contributes to a DOE grant for development of a visual, interactive tour of the containment interior of a pressurized water reactor that can be used for undergraduate and graduate level instruction. Students and professionals seldom get to see the components inside the containment structure and the opportunity to see inside the reactor coolant system is essentially non-existent. This work is expected to provide an educational tool for a tour of the containment interior and it will be a first step towards eventual development of an educational tour inside the reactor coolant system using the visual technology developed by the Visual Information Systems Center (VISC) of the University of Pittsburgh who will build the virtual model of the containment interior.

Principal Investigator Larry R. Foulke
Principal Investigator and Adjunct Professor and Director of Nuclear Programs
University of Pittsburgh, Email: lrf4@pitt.edu

Education:

- BS Nuclear Engineering, Kansas State University (b)(6)
- MS Nuclear Engineering, Kansas State University (b)(6)
- PhD Nuclear Engineering, MIT (b)(6)
- Fulbright Fellowship, University of Oslo and Institute for Atomenergi, Kjeller, Norway (b)(6)

Academic Experience:

- Instructor, Bettis Reactor Engineering School (1969-1972)
- Adjunct Associate Professor of Nuclear Engineering, Penn State University (1984-1988)

Work Experience:

- U.S. Army Reactors Group, Nuclear Power Field Office, Ft. Belvoir, VA. Honorable discharge as Captain, U.S. Army Corps of Engineers (1966 - 1968)
- Bettis Atomic Power Laboratory, Reactor Methods Development (1968 - 1972)
- Bettis Atomic Power Laboratory, Manager of various activities: A1W and PWR Performance Analysis, Safeguards and Plant Analysis, Environmental Engineering, Safety Analysis, Laboratory Operational Safeguards (1972 - 1980)
- Westinghouse Electric Corporation, Manager Pittsburgh Operations Training Center (1980 to 1985) and Manager Simulator Product Development (1985 - 1990)
- Bettis Atomic Power Laboratory, Manager Reactor Methods (1990 - 2002)
- Bettis Atomic Power Laboratory, Consultant in Nuclear Engineering (2002 - 2004), Chief Scientist, Space Engineering (2004 - 2006)
- Member of Various Safety Review Committees at both Bettis and (W) (1972 - 1984)
- Adjunct Professor and Director of Nuclear Programs, Univ. of Pittsburgh (2006-present)

Honors and Awards

- Fellow of Accreditation Board for Engineering and Technology (ABET)
- Engineering Hall of Fame, Kansas State University (2003 - present)
- Library Trustee of the Year 2000, Allegheny County Library Association

Professional Activities:

- Member American Nuclear Society (ANS) (1966 - present)
- President ANS (2003 - 2004)
- Chair of Various Committees, ANS; currently Chair of ANS Public Policy Committee
- Member ASME and INMM (2002 - 2004)
- Registered Professional Engineer, PA License PE 053016E (1997 - present)
- Member ABET Technology Accreditation Commission (1984 - 1993)
- Chair ABET Technology Accreditation Commission (1991 - 1992)
- Member ABET Engineering Accreditation Commission (2000 to 2003)
- Member Advisory Board for Inst for Simulation and Training, UCF (1986 - 1990)
- Member Advisory Board for Nuclear/Chemical Engineering Department, Univ. of New Mexico (1998 - present)
- Member of Review Committee for Los Alamos Nonproliferation Division (2006-present)
- Publications: Fifteen unclassified NS&E, Trans ANS or WAPD-TM's during professional years from 1963 - 1972; ten in conference proceedings during Westinghouse years from 1980 - 1990; over 100 classified or NOFORN technical publications within NR Program in management years. (See attached for partial list)

Larry Foulke Publications in Space-Time Kinetics:

- "Investigations in Spatial Reactor Kinetics," *Nucl. Sci. Eng.* 17, p. 528 (1963)
"The Use of Oscillation Tests to Investigate Flux Tilting," *Trans ANS* 9, 1 (1966)
"Application of the Natural Mode Approximation to Space-Time Reactor Problems," *Nucl. Sci. Eng.* 30, p. 419 (1967)
"On the Use of Effective Delayed Neutron Fractions for Few-Group Space-Time Analysis," WAPD-TM-938 (1970)
"Space-Time Methods for Movable Fuel Problems," WAPD-TM-968 (1970)
"A New Static Flux Synthesis Model for Movable Material Reactor Problems," WAPD-TM-978 (1970)
"Improved Spatial Differencing for Space-Time and Static Movable Material Diffusion Problems," *Trans ANS* 13, 2, p. 618 (1970)
"Examination of Errors Introduced by the Few-Group Diffusion Theory Approximation in Space-Dependent Kinetics Calculations," *Trans. ANS* 13,2 (1970)
"Improved Spatial Differencing for the Solution of Space-Time Problems with Movable Material," *Nucl. Sci. Eng.* 44, p.72 (1971)
"A Summary of Space-Time Synthesis Strategy and a Review of Space-Time Synthesis Experience," WAPD-TM-1103 (1973)

Larry Foulke Publications in Training and Simulation

- "An Innovative Training Program for the Management of Technical Issues," *Trans. ANS*, 45, p. 191 (1983)
"Industry Wide Job/Task Analysis: Getting to What's Necessary and Sufficient," *Trans. ANS* 46, p. 704 (1984)
"Improvements in Training Effectiveness and Job Performance," International Nuclear Power Plant Thermal Hydraulics and Operations Topical Meeting, American Nuclear Society, Taipei, (1984)
"Training Capability Required to Meet Manpower Needs during Plant Operations," International Nuclear Power Plant Thermal Hydraulics and Operations Topical Meeting, American Nuclear Society, Taipei, (1984)
"Manpower Development in the U. S. Nuclear Power Industry," The Fifth Pacific Basin Nuclear Conference, Seoul, Korea (1985)
"A Generalized Multi-Node Steam Line Model for Real Time Simulation," *Sim Series, Vol 24, No. 1, Society for Computer Simulation* (1991)
"An Examination of Transient Accuracy," *Sim Series, Vol 24, No. 1, Society for Computer Simulation* (1991)
"Performance-Based Principles for University Education," *Trans ANS*, 68, p. 18 (1993)
"A New Nuclear Education Program at the University of Pittsburgh," CONTE 2007 (2007)

Larry Foulke Publications in Policy Publications

- "The Status and Future of Nuclear Power in the United States," *Nuclear News*, (February 2003)
"Burning Bright: Nuclear Energy's Future," National Center for Policy Analysis, <http://www.ncpa.org/pub/ba/ba51:1/> (March 2005)
"Dispelling the Myths About Nuclear Power," National Center for Policy Analysis, <http://www.ncpa.org/pub/ba/ba508/>, (March 2005)
"Diversity in nuclear—Issues, initiatives, and improvements," *Nuclear News*, (August 2005)
"ENC Concluding Remarks," *Nuclear Plant Journal*, Vol. 24, No. 1, January-February, 2006)

Larry Foulke Publications in Other

- "Assessment of the Environmental Impacts Associated with the Operation of the Light Water Breeder Reactor at Shippingport" (1976) (Manager of Activity)
"Assessment of the Environmental Impacts Associated with the Commercial Operation of a Conceptual Uranium-Thorium Fuel Cycle" (1976) (Manager of Activity)
"Final Safety Analysis Report for the Light Water Breeder Reactor" (1976) (Manager of Activity)

David W. Helling
(b)(6)
e-mail: hellindw@westinghouse.com
Co-Principal Investigator

Ex. 6

Qualifications in Brief

- Over twenty-five years of training management and leadership experience with responsibility for program development, project management, organizational development, and business development. Served for nine years as Manager, Training and Operational Services, for Westinghouse Electric Company.
- Over thirty-five years of experience in navy and commercial nuclear power plant operations, maintenance and training. Extensive experience in the operations and maintenance of navy nuclear power plants. Emphasis in commercial nuclear power plant operations and training. Certified by the US Nuclear Regulatory Commission as a Senior Reactor Operator (SRO) and qualified as a nuclear trained engineer by the United States Navy.
- Responsible for all commercial operations, maintenance, engineering, and instrumentation and control training programs for Westinghouse Training and Operational Services.
- Recognized across the nuclear industry as an accomplished instructor with both technical and educational skills.

Education

- B.S., Mathematics, Miami University, Oxford, Ohio (b)(6)
- Completed one year of graduate study in physics. Interrupted for military service during Viet Nam war.
- Have completed all course work for M.E. Nuclear Engineering, Penn State University, State College, PA. Expect to obtain degree in 2007.
- Certified as online educator by California State University, Hayward, CA. Currently completing Masters of Education with Cal State
- Nuclear Regulatory Commission, Senior Reactor Operator Certification, Docket No. 55-900, January, 1993.
- United States Navy Nuclear Power School, 1972.
- Qualified as Navy Engineer by Naval Reactors, 1977.

Experience

WESTINGHOUSE ELECTRIC COMPANY

9/01 – Present

Lead, Commercial Nuclear Training Programs

- Lead for all commercial training programs for Westinghouse Training and Operational Services. This includes responsibility for developing Strategic Partnering relationships with key nuclear utility training organizations. This effort is designed to produce training partnering/teaming relationships between Westinghouse Training and Operational Services and customers' training organizations that will result in enhanced training performance and improved financial performance for both members of the partnership.
- Teach an extensive number of technical and organizational development programs in the areas of operations, transient and accident analysis, instrumentation and control, and management and leadership. Have exceptional classroom and online training experience. Instrumental in the development and implementation of advanced student-centered learning methodologies within Westinghouse training.

1/93 - 9/01

Manager, Training and Operational Services

- Responsible for commercial nuclear utility training in the areas of operations, maintenance, instrumentation and control, and engineering. Also responsible for Internal Training for the Nuclear Services Division. Extensive experience in organizational development, organizational alignment and culture change. Strong technical knowledge of Westinghouse Pressurized Water Reactors. Solid understanding of the nuclear training industry and its training requirements. In this position, had sales, budget, and staffing responsibility. Led the transition of the training organization from a traditional classroom training group to a performance-based mixture of classroom, hands-on, and e-learning training techniques.

6/84 - 12/92

Manager, Instrumentation and Control Training

- Responsible for commercial nuclear utility Instrumentation and Control training. Supervised training program development, classroom training, and hands-on training in the Module Training Trailers. Instrumental in implementation of the mobile hands-on I&C equipment training.

6/81 - 5/84

Manager, Technical Training and Development

- Responsible for the development of Senior Reactor Operator Training programs and Advanced Technical Training programs such as Transient and Accident Analysis, Station Nuclear Engineer, and Shift Technical Advisor.

9/79 - 5/81

Lead Training Engineer

- Conducted training programs and developed training materials for operations, engineering, station nuclear engineer, and Shift Technical Advisor programs.

9/70 - 8/79

U.S. NAVY NUCLEAR POWER PROGRAM

- Electronic technical and nuclear trained officer. Served as Station Officer (responsible for two reactor plants) on U.S.S. Enterprise, Leading Engineering Officer of the Watch at nuclear training prototype in Idaho Falls, Idaho, and navigator of U.S.S. South Carolina. Extensive Operations experience. Qualified as engineer. Left Navy with rank of lieutenant.
- During naval career, worked extensively in training and operations positions. Performed hundreds of reactor and plant start-ups and shutdowns, performed numerous accident drills and responded to several plant emergencies. This experience provided an outstanding appreciation for the operational characteristics and behaviors of pressurized water reactors. Taught these concepts to both enlisted and officer students throughout navy career.

Minking K. Chyu.

Leighton Orr Professor and Chairman
Department of Mechanical Engineering and Materials Science
University of Pittsburgh
Pittsburgh, PA 15261
(412) 624-9784 (voice)/(412) 624-4846 (fax)
mkchvu@engr.pitt.edu

Principal Research Interests:

Heat and Mass Transfer, Gas Turbine Energy and Power Systems, Fuel Cells

Education:

Ph.D. University of Minnesota, Mechanical Engineering, Heat Transfer, (b)(6)
Major Thesis Advisors: Drs. Richard J. Goldstein and Suhas V. Patankar
M.S. University of Cincinnati, Engineering Sciences & Applied Mechanics, (b)(6)
B. S. National Tsing Hua University, Nuclear Engineering, Taiwan, (b)(6)

Ex-6

Academic Experience:

9/2006-present	Mechanical Engineering and Materials Science Department Chair	University of Pittsburgh
1/2000- 8/2006	Mechanical Engineering Department Chair	University of Pittsburgh
1/2000- present	Leighton Orr Endowed Chair Professor	University of Pittsburgh
1/1999- 12/1999	Visiting Professor	National Tsing Hua University
7/1994- 12/1999	Professor	Carnegie Mellon University
7/1990- 6/1994	Associate Professor	Carnegie Mellon University
7/1987- 6/1990	Assistant Professor	Carnegie Mellon University
1/1985- 6/1987	Assistant Professor	Arizona State University

Ex-6

Honors and Awards:

Best Paper Award - 8th International Heat Transfer Conference,
San Francisco, August, 1986
Research Incentive Award - Arizona State University, 1987
Air Force Summer Research Fellow (b)(6)
NASA/ASEE Summer Research Fellow (b)(6)
Certificate of Recognition - NASA-Marshall, 1988, 1989, 1991, 1992
Department of Energy Faculty Research Fellow (b)(6)
Fellow, American Society of Mechanical Engineers (ASME) 1997
DOE Advanced-Turbine-System Faculty Fellow (b)(6)
Leighton Orr endowed Professorship - University of Pittsburgh, 2000
Engineer of the Year Award, ASME - Pittsburgh, 2002
Associate Fellow, American Society of Aeronautics and Astronautics, (b)(6)

Publications:

Five Most Relevant Papers

P. W. Li, L.A. Schaefer, and M.K. Chyu, "Multiple Processes in Solid Oxide Fuel Cells," Chapter 1,
Transport Phenomena in Fuel Cells, WIT Press, 2005.

- P. W. Li, M. K. Chyu, "Electrochemical and Transport Phenomena in Solid Oxide Fuel Cells," Invited Review Paper, ASME J. Heat Transfer, Vol. 127, Dec. 2005, pp. 1344-1362.
- P. W. Li, S. P. Chen and M. K. Chyu, "Novel Gas Distributors and Optimization for High Power Density in Fuel Cells," J. Power Sources, Vol. 140, 2005, pp. 311-318.
- P.W. Li, S.P. Chen, M.K. Chyu, "To Achieve the Best Performance through Optimization of Gas Delivery and Current Collection in Solid Oxide Fuel Cells," ASME J. Fuel Cell Science and Technology, Vol. 3, Issue 2, 2006, pp. 188-194.
- F.J. Cunha, M.T. Dahmer and M.K. Chyu, "Thermal-Mechanical Life Prediction System for Anisotropic Turbine Components," ASME J. Turbomachinery, Vol. 128, Issue 2, 2006, pp. 240-250.

Five Recent Related Papers:

- N.Q. Wu, K. Ogawa, M.K. Chyu and S.X. Mao, "Failure Detection of Thermal Barrier Coatings using Electrochemical Impedance Spectroscopy," Thin Solid Films, Vol. 457, 2004, pp. 301-306.
- A.J. Kassab, E. Divo, J.S. Kapat and M.K. Chyu, "Retrieval of Multi-Dimensional Heat Transfer Coefficient Distributions Using an Inverse-BEM-Based Regularized Algorithm: Numerical and Experimental Examples," Engineering Analysis with Boundary Elements, Vol. 29, 2005, pp. 150-160.
- N. Wu, Z. Chen, J. Xu, M.K. Chyu and S. X. Mao, "Impedance-metric Pt/YSZ/Au-Ga₂O₃ sensor for CO detection at high temperature," Sensors & Actuators B 110, 2005, pp. 48-53.
- N. Wu, M. Zhao, J. Zheng, C. Jiang, B. Myers, S. Li, M.K. Chyu, S. X. Mao, "Porous CuO-ZnO Nanocomposite for Sensing Electrode of High-Temperature CO Solid-State Electrochemical Sensor", Nanotechnology, Vol. 16, 2005, 28782881.
- F.J. Cunha and M.K. Chyu, "Trailing-Edge Cooling for Gas Turbines," Invited Review Paper, AIAA J. Propulsion and Power, Vol. 22, No. 2, 2006, pp.286-300.

Synergistic Activities (ongoing)

- Advisory Board Member, Center for Advanced Energy and Environment, National Tsing Hua University, Taiwan (2004-present)
- ASME HTD Committee in Membership Development and Recognition (2005-2007)
- International Centre for Heat and Mass Transfer (ICHMT), Scientific Council (1998-present)
- Advisory Board Member, Institute of Nuclear Energy Research, Taiwan (2006-2009)
- Associate Editor, ASME Journal of Heat Transfer, (2006-2009)
- Guest-Editor, "Turbine Sciences and Technology," AIAA J. Propulsion and Power Special Issue (2006)

Collaborators & Other Affiliations

Collaborators

Alain Kassab, Central Florida University, Pei-Wen Li, University of Arizona, Tom I-P. Shih, Iowa State University, Terry Simon, University of Minnesota

Previous Graduate Students:

Ph.D.: O. Alaqal, D. J. Bizzak, A. K. Briggs, H. Ding, Y-C. Hsing, R. Issa, H. K. Moon, V. Natarajan, C-H. Yen, Y. Yu

M.S: A.U. Ahmed, S. Atabek, D. Bivins, J. S. Kapat, K. Kausar, K. Kitagawa, T. Kerzmann, C. Limbichai, Y. Lu, O.B. Ojo, S. Satar, L. Sirinek, M. Wu, , T. Zhang