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"Department of Energy and Commonwealth Edison Company Support of Nuclear Engineering Education"

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Gilbert A. Emmert
Department Chair
Nuclear Engineering Program
University of Wisconsin - Madison

Summary

This grant provided support for nuclear engineering education at the University of Wisconsin under the DOE/Utility Matching Grant Program; the DOE support was matched by funding from Commonwealth Edison Company. During this period, DOE provided $129,100 and Commonwealth Edison provided $150,000. The support was used primarily for improvement of instructional laboratories, upgrading the nuclear reactor laboratory, undergraduate scholarships, upgrading existing courses in nuclear engineering and developing new courses, and other improvements in the departmental infrastructure.

Instructional Laboratory Improvements

NEEP 371 Thermosciences Laboratory

This laboratory focuses on thermal hydraulics with experiments of particular relevance to nuclear engineering and is a required course in the undergraduate nuclear engineering curriculum. Improvements have been made to this laboratory include the addition of a computer-based data acquisition system, replacement of out-moded equipment, and the addition of new experiments on free and forced convection heat transfer and boiling heat transfer. The convection experiment equipment replaces an inadequate experiment previously used by another department. The boiling experiment represents an addition to the course that has long been desired. Both of these experiments will serve to enhance laboratory instruction in heat transfer concepts.

NEEP 427 Nuclear Instrumentation Laboratory and NEEP 428 Nuclear Reactor Laboratory

These two laboratories are used for required courses in the undergraduate nuclear engineering curriculum. NEEP 427 is concerned with nuclear instrumentation and radiation measurements; NEEP 428 uses the nuclear reactor for a series of experiments demonstrating reactor behavior. These labs have been significantly upgraded by the replacement of outdated equipment and decayed isotope sets, and the addition of new equipment. This has extended the capabilities of the courses and the instructional environment for the students. New power supplies and scalars have permitted the retirement of earlier items, some of which were 25 years old and difficult to repair. Two helium 3 neutron detectors have been added and incorporated into the neutron detection experiment. A deep solid state beta detector has been acquired to be used to demonstrate the interaction of electrons in matter. A computer-based gamma ray spectroscopy has also been added.

Nuclear Reactor Laboratory Improvements

Substantial improvements have been made to the UW Nuclear Reactor Laboratory has a result of this grant. These include improvements to the reactor instrumentation and control systems and upgrading of radiation survey equipment.

Health physics instruments were upgraded by replacing the electronics packages of our rem-response neutron survey meters (1970 models) with modern readout devices. This makes these instruments equivalent to those being sold by vendors today. Process pH and conductivity equipment dating from the early sixties was replaced with modern equipment. A replacement gamma ionization chamber (used for readout of reactor power when in pulsing mode) was purchased. In addition, a thermocouple and millivolt calibration unit was purchased for use in reactor console instrument channel calibrations. This instrument replaced the 1958 model potentiometer which has been in use since construction of the reactor laboratory. An alpha/beta/gamma counting system was added and the transient control rod

was replaced; the existing transient control had failed and needed to be replaced in order to maintain the capability to pulse the reactor.

New Course Development

NEEP 234 Principles and Practice of Nuclear Power Operations

This course introduces students to the various aspects of nuclear reactor operations, including the practical aspects of reactor theory, reactor kinetics, monitoring, and control, radiation survey procedures and health physics including federal regulations. The course covers all subjects which must be known by a person seeking an operating license for the UW nuclear reactor. The course is taken as an elective by undergraduate students. This courses utilizes extensively the nuclear reactor laboratory and nuclear instrumentation laboratory discussed above.

Catalog description:
NEEP 234 — PRINCIPLES AND PRACTICES OF NUCLEAR REACTOR OPERATIONS. II alternate years; 4 cr. One hour lecture five days per week. An additional three hours per week is required for practical applications, including operation of the reactor.

NEEP 271 Engineering Problem Solving I

This is a new course designed to introduce sophomore students in nuclear engineering to engineering computational tools so that better use of computers can be made throughout the curriculum. The computational tools are applied to nuclear engineering problems so the students learn nuclear engineering while learning about the computational tools.

Catalog description:
NEEP 271 — ENGINEERING PROBLEM SOLVING I. I; 3 cr. Solution of engineering problems using computers. The emphasis will be on nuclear engineering problems, including radioactive decay, nuclear cross sections, scattering, and criticality. P: Math 222, Physics 201.

NEEP 602 Engineering Problem Solving II

This course is a continuation of NEEP 271, Engineering Problem Solving I, which was initiated to introduce sophomore students in nuclear engineering to engineering computational tools so that better use of computers can be made throughout the curriculum. NEEP 602 is for juniors and prepares the students for the more extensive computational work they will encounter in their senior level reactor theory and reactor design courses. The computational tools are applied to nuclear engineering problems so the students learn nuclear engineering while learning about the computational tools. NEEP 602 is a temporary number until the course obtains final approval.

NEEP 574 Methods for Probabilistic Risk Analysis of Nuclear Power Plants
This course was initiated as an elective for advanced undergraduate students and M.S. level graduate students to expose them to PRA applied to nuclear power plants. It is cross-listed with the Industrial Engineering department.

Catalog description:
NEEP 574 — METHODS FOR PROBABILISTIC RISK ANALYSIS OF NUCLEAR POWER PLANTS. II; even yrs., 3 cr. Methods for risk and reliability analysis of engineered systems, particularly as applied in the nuclear power industry. Fault trees and event trees, Bayesian data analysis, probabilistic risk management. Some familiarity with nuclear plant safety systems is helpful, but not required. P: Stat 311 or Math 431 or Cons Inst.

Course Upgrades

NEEP 405 Nuclear Reactor Theory and NEEP 406 Nuclear Reactor Analysis
The department has acquired a cost-free license to use the Studsvik codes, CASMO and SIMULATE, for educational purposes. This has allowed us to upgrade the computational aspects of our two reactor theory courses, NEEP 405 and NEEP 406; the students now utilize CASMO and SIMULATE as part of their coursework and thereby become familiar with state-of-the-art computer codes being used in the nuclear industry. The organization of these two courses has been greatly modified and both courses are now required courses in the undergraduate curriculum.

Undergraduate Scholarships

Fourteen outstanding undergraduate students were granted scholarships in amounts ranging from $500 to $1,000 per year. The scholarships are renewable until graduation, depending on the student's academic performance and rate of progress toward the BSNE degree. The scholarship award winners that graduated either took employment in the nuclear power industry, or went on to graduate study in nuclear engineering.

Graduate Student Support and Research

The grant was used to provide support to three M.S. students in the nuclear power engineering area during the grant period; the students were engaged in research concerned with nuclear power reactors. The topics were severe accident modeling for nuclear reactor safety, and radiation damage to reactor pressure vessels and how to reduce it. Two M.S. theses specific to Commonwealth Edison needs were prompted by the stronger connection between the nuclear engineering department and Commonwealth Edison that has resulted from this program during the grant period. One thesis was concerned with the use of a transport code (DORT) to calculate calibration values for the power range detector at Zion Nuclear Plant

Unit 1 and led to improved calibration values for the detector. The other was concerned with the effect of variable Doppler temperature coefficients on transient analysis and was applied to the Zion, Byron, and Braidwood reactors at ComEd. M.S. theses related to nuclear fuel cycles at the Dresden and Lasalle reactors were also initiated during the grant period and completed subsequently.

M.S. theses:

Tracy Ann Cartwright, "Effect of a Variable Doppler Temperature Coefficient Model on Transient Analysis", Nov. 1994.

Michael Shackelford, "Using DORT to Predict Current at Startup for Power Range Detector Calibration", Dec. 1994.