

N.E. DEPARTMENT STRATEGIC PLAN

2004-2005 and 2005-2008

I. MISSION

The Department of Nuclear Engineering has four primary missions, those being as follows:

- Provide a quality education at both the undergraduate and graduate levels to students who desire to pursue careers in nuclear science and engineering;
- Develop research programs in areas of emphasis related to applications of nuclear science and engineering;
- Assist industries and government in North Carolina, nationally and internationally in their efforts to apply these nuclear technologies to the betterment of the economy and the environment — in a safe, effective, and innovative manner; and
- Enhance, promote and utilize the PULSTAR research reactor and associated facilities in an exemplary manner, leading to national recognition as a premier 1 MW Nuclear Reactor Program dedicated to research, teaching, and extension.

II. STRATEGIC POSITION

The Department of Nuclear Engineering at NC State is among the strongest nuclear engineering departments in the U.S. As the first nuclear engineering department and the first non-government reactor facility in the U.S., the Department has built a reputation that goes back to the beginnings of the beneficial civilian applications of nuclear science and engineering. The Department started with emphasis on the graduate program, and as the nuclear field matured, it has maintained a balanced undergraduate and graduate program. A steady advancement of the Department's research programs has contributed to enhancement of the graduate program over the years. At the same time, the undergraduate enrollments rose during the rapid construction phase, and then declined with the operation phase of a large number of nuclear power plants that now provide over 20% of the nation's electricity. As with other nuclear engineering departments nationwide, the decline in enrollments that has been experienced over the past decade has been reversed. Our recently implemented undergraduate and graduate recruiting programs have resulted in expected Fall '04 undergraduate and graduate enrollments of about 110 and 50 students, respectively, meeting our enrollment goals. This is a reflection of the effective outreach program implemented, changing national perspective on nuclear power, strong employment opportunities for NE graduates, excellent reputation held by the department's faculty and facilities, and of the vigorous support the Department receives from industry. The current employment level in the nation is high for nuclear engineers; however, this has been cyclical in the past. Even during down turns in employment opportunities, our graduates at all degree levels have been able to find employment opportunities. With the increased enrollment, which will translate shortly into increased degree production, increased efforts on graduates' employment placement will likely need to be pursued. Given the aging population of the nuclear work force, the 20 year lifetime extension of nearly all operating nuclear power plants, global warming concerns, new demands for engineers to develop and manage radioactive materials management technologies, and the national commitment to nuclear power, we believe the long term professional career prospects for our graduates is bright. In particular, the current strong federal government support for the development of advanced nuclear power plants and their associated fuel cycles, specifically the Generation IV program and the Advanced Fuel Cycle Initiative (AFCI), and the serious interest by domestic electric utilities in pursuing nuclear power to expand their base load generation capacities, assisted by the 2010 Program and the pending National Energy Act, indicate that a renaissance in nuclear power has begun. Additional professional career opportunities exist for our graduate students due to wider employment opportunities in using nuclear technology in medicine and industrial applications.

We are viewed by others as the top NE Department in the southeast, and among the top half-dozen NE Departments nation-wide. Many nuclear engineering programs throughout the country either have folded or merged with other departments. Thus we, being one of the few remaining strong programs in the nation, are now poised to be an even more major player in several areas of the nuclear industry. The department's faculty has been effective in obtaining sponsored research support from various funding institutions (NIH, DOE, DOD, NSF and industry). The department ranks second in Department of Energy (DOE) Nuclear Engineering Education Research (NEER) awards, and is the lead institution in the DOE INIE consortium for the southeast. Two industrial supported research centers, Electric Power Research Center (EPRC) and Center for Engineering Applications of Radioisotopes (CEAR), are recognized as the premier university research centers in their areas of focus. We have had limited success in participating in Generation IV concept development and the Advanced Fuel Cycle Initiative, which needs to be addressed. Our recent successful partnering as one of five universities that partnered with the Battelle Energy Alliance via the National University Collaborators to operate the Idaho National Laboratory provides us a unique opportunity to improve our success. Opportunities for university research in space nuclear power via the Prometheus Project have not yet matured, but represent potentially substantial opportunities depending on DOE NR administration of this project. Likewise, medical areas such as radiation treatment planning and diagnostics represent sponsored research opportunities that need to be better capitalized upon. Use of our reactor program facilities in teaching, research, and nuclear services has been reinvigorated, with major modifications and upgrades underway. New opportunities are being explored. Via strong efforts of the faculty and administration of the

Department in obtaining industrial support, funding has been obtained to offset shortfalls in state provided operating budget and support new initiatives.

Major challenges that have not been achieved all involve faculty research, in regard to external funding support level and establishing recognized, significant centers of excellence. It is acknowledged that the current graduate student enrollment cannot be sustained without increased research funding once the vacant faculty position is filled.

III. PROGRAM GOALS AND OBJECTIVES

Long-range Goals

Goal 1: *Expand the quality and size of the graduate-student program of research in the current main research thrust areas of the Department - fission power, fusion/plasma engineering, and radiation applications - while increasing emphasis on radiological engineering issues.*

Objectives to be achieved during 2004-2005:

- 1.1 Maintain enrollment at ~50 students and recruit high quality students by:
 - obtaining funds from State and research (Federal and Industry) grants
 - establishing industry-sponsored fellowships
 - attracting more national fellowship students
 - expanding the pool of students supported by national fellowships
 - maintaining and expanding industry and laboratory funded traineeships
 - attracting government-/self-supported qualified international students
 - maintaining 60-70% U.S. citizens or permanent residents
 - retaining existing good students
 - continuing & enhancing NE Open House and other Outreach Programs
 - encouraging highly qualified NE undergraduates for a graduate study
 - continuing to develop student pipelines (e.g., Georgia Tech, New Mexico, Kansas State, Texas A&M, Tennessee)
 - presenting seminars at other universities (targeting the pipeline schools, in particular) and laboratories (especially during summer)
- 1.2 Achieve contract research funding level of ~ \$160k/year per FTE teaching faculty (exclusive of INIE funding).
- 1.3 Provide high quality graduate education by:
 - providing good research advising and mentoring – Students should be given ample opportunities for
 - o mastery of fundamental knowledge
 - o development of critical thinking, problem solving, and computational skills
 - o conducting independent/original research
 - o effectively communicating scientific and technical information (oral and written)
 - actively and continuously monitoring students' academic progress toward their degree completion
 - providing travel support for students to national ANS meetings
 - planning to reinstate the teaching fellow position in AY0-06
 - continuing graduate students outstanding research awards
 - conducting on-going graduate program/course reviews
 - better utilizing IAC to support NE graduate program (program review/funding support)
 - enhancing the quality of student life
 - improving the sense of community within the department
- 1.5 Work with Idaho National Laboratory to implement the proposed model of NCSU's Academic Center of Excellence (ACE) in Advanced Modeling and Simulation.

Objectives to be achieved during 2005-2008:

- 1.6 Maintain enrollment at ~50 students and continue attracting high quality students – by continuing objective 1.1 and reinforcing supporting actions/activities.
- 1.7 Increase graduate degree production rates by decreasing time for a masters degree to ~2 years, for a doctorate to ~5 years, in the case of students with undergraduate degrees in nuclear engineering; about 1 year longer for other undergraduate majors, resulting in graduation rates of 12 masters and 3 PhDs per year at equilibrium.
- 1.8 Enhance the effectiveness of faculty advising for timely and successful completion of degrees.
- 1.9 Increase contract research funding by 10% per year, resulting in a funding level of ~ \$210k/year per FTE faculty at the end of this time period (exclusive of INIE funding).

- 1.10 Increase the productivity of NE faculty by effectively assigning and distributing teaching and administrative duties.
- 1.11 Complete a comprehensive review of graduate program and graduate courses.
- 1.12 Critically examine the need for graduate curriculum/PhD qualifying exam revision.
- 1.13 Assess needs for expanding research areas beyond what is currently covered by the existing faculty.
- 1.14 Develop an enhanced advising system for our students to develop into future leaders by:
- developing Professional Development Guidelines (in collaboration with Graduate School)
 - better utilizing the existing weekly seminar series
 - providing training in ethics, policy, societal issues, and leadership (through utilizing existing resources and enhancing curriculum if necessary)
 - involving successful NCSU NE alumni to support professional development of our students
 - providing opportunities for teamwork practices
 - providing opportunities for teaching, e.g. teaching fellow
 - actively supporting student's job placement
- 1.15 Continue development of centers of excellence with industrial and national laboratories support; in particular, further develop the existing strongly supported activities in radiation applications including medical applications and nuclear power, reinvigorate activities in applied plasmas, and nurture the development of radiological engineering.
- 1.15 Develop partnerships with national laboratories and industrial research laboratories in all areas of our research and in applications of our reactor facilities. In particular, continue to develop the INL supported Center of Excellence in Modeling and Simulation in conjunction with the new Consortium that has been awarded the contract to administer INL. These could include joint research projects, traineeship assignments, summer appointments for faculty, adjunct faculty appointments, equipment sharing, etc.
- 1.16 Work with the joint NC State/UNC-CH biomedical engineering program to identify and pursue joint research opportunities.

Goal 2: *Review and develop “as appropriate” undergraduate curriculum and maintain a stable student enrollment.*

Objectives to be achieved during 2004-2005:

- 2.1 Recruit 25-30 NEU freshmen with average GPAs and SAT scores well above the university average.
- 2.2 Continue to offer Nuclear Engineering Departmental merit scholarships as necessary to improve recruiting and retention.
- 2.3 Expand undergraduate research scholarship(s) to all students qualified to attend graduate school through a combination of departmental and national scholarships.
- 2.4 Continually improve the “Young Investigators’ Summer Program in Nuclear Technology & Applications”, which recruits some of the highest quality freshmen for the COE and the Department. Continue obtaining support from ANS and maintain increased support from utilities.
- 2.5 Maintain teaching NE courses for non-NE majors, and non-NE courses to achieve 150 SCH/FTE.
- 2.6 Administer and support the offering of NE courses for the Progress Energy BS degree program in nuclear technology through conclusion of second cohort group of students.

Objectives to be achieved during 2005-2008:

- 2.7 Recruit 25-30 NEU freshmen with average GPAs and SAT scores well above the university average.
- 2.8 Matriculate 20-25 students per year into the NE sophomore curriculum, along with 3 to 5 external transfer students per year, resulting in a graduation rate of 15-20 BS per year at equilibrium.
- 2.9 Maintain teaching NE courses for non-NE majors, and non-NE courses to achieve 150 SCH/FTE.
- 2.10 Maintain external support for the “Young Investigators’ Summer Program in Nuclear Technology & Applications”, and periodically conduct Teachers’ Workshop on Nuclear Science and Engineering.
- 2.11 Continue implementation of ABET 2000 requirements towards transition into steady-state ABET.
- 2.12 Increase undergraduate students’ research and design experience, projects, seminar presentations, participation in graduate courses, and summer practicum experiences.
- 2.13 Via incorporation into nuclear engineering courses and model curricula that utilize the freedom that exists in satisfying university general educational and nuclear engineering requirements, improve undergraduate student skills beyond technical knowledge required to function as a professional, addressing such items as written and verbal communications, financial analysis, project planning and management, and teamwork.
- 2.14 Support, and participate in, the college and university programs to improve recruiting of minorities and females, whom demographics indicate will be the majority of future student populations.
- 2.15 Administer students’ summer internships, Co-Ops and placements with nuclear industry.

Goal 3: *Enhance the value of the Nuclear Reactor Program to the Department, the University, and the U.S. - in the three functions of teaching, research, and service.*

Objectives to be achieved during 2004-2005:

- 3.1 Advance Nuclear Reactor Program recognition as a scientific resource for use by the State of North Carolina academic community by developing, promoting and operating state-of-the-art materials nondestructive examination facilities, and offering enhanced service capabilities including NAA.
- 3.2 Pursue collaborations with other academic departments on the NCSU campus to promote the utilization of the PULSTAR reactor in scientific research and to develop joint proposals.
- 3.3 Outreach to other academic institutions and government laboratories to establish technical collaborations and pursue joint proposals.
- 3.4 In addition to DOE, consider the availability of funding opportunities at agencies such as NSF, NIH, etc. and begin the development of proposals for submittal to these agencies.
- 3.5 Pursue the establishment of an accelerator-based pulsed neutron source as an additional unique probe within the NRP.
- 3.6 Attempt to continue the trend (that started in 2003) for increased levels of reactor sharing funding and promote well targeted reactor instrumentation funding.
- 3.7 Strongly promote the involvement of undergraduate and graduate students in the PULSTAR reactor through reactor operator training and technical/scientific research.
- 3.8 Continue to grow the staffing of the NRP to meet the demands of the expansion in research and service activities.

Objectives to be achieved during 2005-2008:

- 3.9 Establish the NRP as nationally recognized center for the development of methods and instrumentation in nondestructive examination of materials.
- 3.10 Diversify the sources of funding in support of academic research at the NRP, in particular focusing on the opportunities presented by NC State being part of the Battelle Energy Alliance that will operate Idaho National Laboratory.
- 3.11 Establish a strong base of collaborative activities on the local and national levels, via an organizational structure and culture that undertakes an aggressive outreach activity and strong technical support program for users of NRP facilities.
- 3.12 Decommission and remove the SPWR Facility to free space for other activities appropriate for the R3 bay.
- 3.13 Develop a 1-semester course on the utilization of nuclear methods in nondestructive examination.
- 3.14 Pursue acquiring new fuel for the PULSTAR reactor and upgrading its power to 2-MWth.
- 3.15 Pursue hosting a national technical event at the PULSTAR reactor.

Goal 4: *Implement a faculty development plan that encourages faculty to further develop and enhances their teaching abilities and subject breadth.*

Objectives to be achieved during 2004-2005:

- 4.1 Aggressively pursue local and national recognition of appropriate faculty members, as manifested by Fellow appointments, national academic/professional awards, publication honors, and election to professional society national offices. Facilitate the nomination of at least one faculty member to the National Academy of Engineering.
- 4.2 Actively mentor junior faculty members.

Objectives to be achieved during 2005-2008:

- 4.3 Attract outstanding soft-money research faculty or staff in areas of growing research excellence.
- 4.4 Capitalize on being part of the Battelle Energy Alliance (BEA) Team that will operate INL by pursuing the establishment of two 50-50 BEA- NC State funded faculty positions in Nuclear Engineering.

Goal 5: *Develop the infrastructure necessary for a world-class academic department, and development of Burlington Engineering Laboratories and radiation uses.*

Objectives to be achieved during 2004-2005:

- 5.1 Pursue aggressively corporate and individual major contributions to the Department, including discretionary funds and matching grants. While State funding is adequate only to maintain an acceptable program; this private support can provide the margin for excellence.
- 5.2 Implement a capital expenditures long-range plan for updating teaching equipment, computing facilities, and laboratory facilities.*†
- 5.3 Increase storage capabilities to support needs of administrative and research activities.
- 5.4 Complete move from east side of South BEL to renovated space on the east side of 4th floor of North BEL.
- 5.5 Renovate two classrooms in North BEL to produce high technology classrooms.

Objectives to be achieved during 2005-2008:

- 5.5 Continue supporting and provide a regular upgrade plan for computer workstations or PC's for graduate student and staff, and seek to establish a computer hardware capability to support higher end scientific computing needs.*†
- 5.6 Maintain an ongoing solicitation of corporate and individual major contributions to the Department.
- 5.7 Complete renovation of South BEL to provide additional graduate student office space.

P.S. Markers (* and †) appearing on text denotes the following:

* Requires additional State resources.

† Expected to be funded by additional private support through grants and gifts.

Goal 6: *Improve the internal and external perceptions about the quality of the Department.*

Objectives to be achieved during 2004-2005:

6.1 Communicate verbally on-campus the successes of the faculty, staff and students.

Objectives to be achieved during 2005-2008:

6.2 Communicate verbally on-campus the successes of the faculty, staff and students.

6.3 Publish annually the Department's newsletter and annual report, staggered by six months, and distribute widely internally and externally.

6.4 Improve national ranking by USN&WR to be in the top five in both the undergraduate and graduate categories.