U.S. DEPARTMENT OF ENERGY

Rickover Fellowship Program

In Nuclear Engineering

Student Deadline for Applications for 2010-2011
January 15, 2010

Awards Announced April 2010

PREPARED FOR
U.S. DEPARTMENT OF ENERGY, NAVAL REACTORS DIVISION
BY
KNOLLS ATOMIC POWER LABORATORY,
BETTIS ATOMIC POWER LABORATORY

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AN INTRODUCTION TO THE RICKOVER FELLOWSHIP PROGRAM IN NUCLEAR ENGINEERING

This program is designed to meet the needs of the Naval Reactors Division of the U.S. Department of Energy (DOE) for appropriately trained personnel for the maintenance and development of science and engineering technology as it pertains to naval nuclear propulsion. The program will assist in preparing students for roles in naval nuclear propulsion and will support the broader objective of advancing fission energy development through the research efforts of the fellows. The technical areas with greatest interest include reactor physics, nuclear materials science and engineering, radiation shielding technology, thermal hydraulics, and computational fluid dynamics.

APPLICATION PROCEDURES

ELIGIBILITY

Students with undergraduate degrees in the physical sciences or engineering are eligible to apply for the Rickover Fellowship Program in Nuclear Engineering. The program is open to all individuals who will be starting graduate studies or graduate students who are currently enrolled in a qualified course of study (see technical areas) but have not yet selected a thesis topic. The award is limited to 48 months maximum for doctoral candidates. Awards may be limited to less time than the maximum in some situations.

Applicants must be U.S. citizens. Applicants may *not* be dual citizens. Employees of the DOE Naval Reactor Programs and their contractors are not eligible for the Rickover Fellowship Program in Nuclear Engineering. Title VII of the Civil Rights Act of 1964, as amended, prohibits discrimination in hiring, promotion, discharge pay, fringe benefits, job training, classification, referral, and other aspects of employment, on the basis of race, color, religion, sex or national origin.

APPLICATION DEADLINE

Application forms will be available from approximately September through early January. Applications from previous years or from other fellowship programs may not be used. Completed applications will be accepted through January 15th for fellowships beginning the following September. An application consists of the following sections:

Background Information including References (3 Required)
Statement of the Applicant's Academic and Career Goals
List of Current and Planned Courses
Transcripts (Undergraduate **and** Graduate Transcripts Required)
GRE scores (ETS reporting code is 5949)
Authorization for Release of Information Form

Please Note: All parts of the application must be received at the Medical University of South Carolina (MUSC) by January 15th. GRE scores are required for a complete application. Late and/or incomplete applications will not be reviewed for awards.

Electronic applications can be found at http://www.musc.edu/RFP.

COMPLETED APPLICATIONS

Mail completed applications to:

Medical University of South Carolina
Special Programs Office, Rickover Fellowship Program
19 Hagood Avenue, HOT 304-H4
MSC 851
Charleston, South Carolina 29425-8510

Please include the fellowship program name and your name on all of your correspondence to MUSC.

FELLOWSHIP OBLIGATIONS

ENROLLMENT

During the fellowship period, fellows are expected to be registered and enrolled as full-time graduate students, and must perform study and research within the objectives of the fellowship program. During the summer, fellows should be involved in full-time research related to the completion of their degrees, be enrolled in classes, or be on practicum assignments. Refer to the Practicum section of this booklet for a description of these assignments.

TERMS OF APPOINTMENT

Each fellow must agree to the conditions contained in the letter of appointment including provisions for obtaining a security clearance. A fellow must agree that at the end of the appointment period to become employed by either Knolls Atomic Power Laboratory (KAPL) or the Bettis Atomic Power Laboratory (Bettis). The required employment period will be 1 year for every two years of support.

ANNUAL RENEWAL OF FELLOWSHIP

Each fellowship appointment is renewed annually through a renewal application process. The renewal is based upon the fellow's academic performance and course of study. These forms along with current official transcripts must be submitted to MUSC by January 15th of each year. It is required that a DOE security clearance be obtained prior to renewal. In addition, evaluation of the fellowship program continues for five years after the fellow has completed the program and periodically thereafter. Fellows must inform MUSC of their current addresses and must complete any evaluation/assessment questionnaires sent by MUSC for program information and/or evaluation.

SECURITY CLEARANCE

At the beginning of the fellowship appointment, all Rickover Fellows will be required to complete applications for an “L” clearance with the U.S. Department of Energy. This clearance will allow the Rickover Fellow to interact more freely with KAPL and Bettis engineering and scientific staff and to become a part of the Naval Reactors nuclear propulsion community. In most cases, it will take approximately 6 months for a Rickover Fellow to receive clearance. If clearance is not granted, the Rickover Fellow will be allowed to complete the current year’s appointment. No renewal appointments, however, will be granted to Rickover Fellows who are not able to obtain a security clearance. Please note that all theses and research projects will be performed in non-classified areas.

PRACTICUM

Rickover Fellows are required to participate in at least two practica for at least three months at a DOE Naval Reactor research laboratory to gain applied experience. A DOE Security clearance must be obtained and maintained for each practicum. The first practicum is normally held during the summer at the end of the first year of the fellowship. The two laboratories available for the practicum are the Knolls Atomic Power Laboratory and the Bettis Atomic Power Laboratory. The Knolls Atomic Power Laboratory is located in Schenectady, New York. The Bettis Atomic Power Laboratory is located in Pittsburgh, Pennsylvania. Both Bettis and KAPL are operated for the DOE by Bechtel Marine Propulsion Company (BMPC), a wholly owned subsidiary of the Bechtel Corporation. Individuals who should be contacted regarding practicum assignments are listed on page nine (9) of this booklet. Prior internships or similar appointments to DOE facilities may NOT be substituted for the practicum requirement associated with this fellowship.

QUALIFIED ACADEMIC AREAS

Rickover Fellows must be enrolled in an academic course of study and pursue research applicable to the science and engineering programs for the Rickover Fellowship Program in Nuclear Engineering. A fellow's academic program must be structured so that it supports one of the following research areas:

AREAS OF RESEARCH

REACTOR PHYSICS

- Research on data for modeling nuclear phenomena including their improvement and assessment against worldwide experiments
- Development of advanced Monte Carlo techniques to solve the neutron transport equation for complex material arrangements in three-dimensional geometries using novel variance reduction procedures
- Improvements in methods using the diffusion theory approximation for calculating core neutronic behavior with burn up in the design of reactors
- Development and application of accurate and efficient deterministic methods for solution of the neutron transport equation for realistic, three-dimensional reactor core geometries.
- Investigation of procedures with improved accuracy and efficiency for evaluation of important reactor design parameters
- Development of advanced experimental techniques (e.g. measurement of sub-criticality, determination of fissile content in spent fuel)

MATERIALS SCIENCE

- Performance prediction of nuclear fuels
- High temperature reactor materials
- Advanced materials for use in neutron environments
- Corrosion in nuclear environments
- Fission product attack of materials at high temperature
- Instrumentation for in-core measurement
- Fundamental studies of neutron and fission fragment damage to materials including computational material science studies

THERMAL HYDRAULICS AND COMPUTATIONAL FLUID DYNAMICS

- Measurements and modeling of the characteristics of thin liquid films in two-phase flow
- Measurements and modeling of void fraction, velocity and interfacial area in two- phase flow regimes under a wide range of conditions
- Mechanistic modeling of critical heat flux in the nucleate boiling and departure from nucleate boiling (DNB) regime
- Direct measurement and modeling of wall shear and pressure drop in two-phase flow
- Measurement and modeling of the size of liquid droplets and entrainment rates in annular two-phase flow
- Investigation of the calculational stability of various two-phase flow source terms
- Measurements and modeling of transient two-phase flow
- Development of a single-phase and/or two-phase Computational Fluid Dynamics (CFD) validation, uncertainty quantification and best-estimate plus uncertainty design methods
- Measurement of single-phase and/or two-phase flow field quantities required to validate CFD methods
- Development of new turbulence models for internal, anisotropic flows for application to CFD

SHIELDING

- Improved parallel efficiency in deterministic transport calculations
- Discontinuous mesh computations for large 3D problems
- Application of Monte Carlo to large scale shielding problems
- Hybrid Monte Carlo/deterministic shielding methods

THESIS RESEARCH

Rickover Fellows must perform their PhD thesis research in one of the areas listed in the previous section. A KAPL or Bettis scientific staff member is generally assigned to the fellow's graduate committee by the fellow's university. All thesis work will be in non-classified areas. Thesis research assignment forms must be completed by the fellows and submitted to MUSC for approval. All forms are provided by MUSC.

EVALUATION OF APPLICATIONS

When an application is received, the staff at MUSC reviews the application to ensure that the applicant meets the basic criteria and has submitted all required application materials. If time permits, the staff will attempt to contact applicants who have submitted an incomplete application. However, it is the applicant's responsibility to check with MUSC to ensure that an application is complete.

After an application is checked and designated complete, it is submitted, along with all other complete applications, to a review panel. The review panel is composed of Naval Reactors prime contractor personnel, who are directly responsible for analysis and research in nuclear science and engineering areas applicable to the program. The panel reviews each application and selects award recipients. Applications are reviewed on the basis of grades, GRE scores, career and goals statements, areas of research intent, and references. Professional personnel needs of the DOE Naval Reactors research program are also considered.

The number of awards given each year is dependent on the available funding and the qualifications of the candidates. Some applicants who do not receive awards are selected for "Honorable Mention" status. This status recognizes their achievements and places them on a list for a possible award should additional funding become available.

MUSC will notify applicants of their award status. Notification usually occurs in early April of each year. Once fellowships are awarded, MUSC handles the administration of the fellowship

for the Naval Reactors Program. Questions about stipends, payment of tuition and fee, practicum assignments, travel, etc. should be referred to MUSC. Shortly after acceptance of the appointment, an advisor from one of the Naval Reactors Prime Contractor Laboratories will contact the fellowship recipient. This advisor is tasked to aid the recipient in selecting a research topic, if necessary, and location for the first practicum and, as previously mentioned, will be assigned to the fellow's graduate committee.

PROGRAM BENEFITS

Fellows receive a monthly stipend in the amount of $2,200. The fellow's basic stipend is augmented by an additional $500 (prorated) dislocation allowance each month during the practicum. Stipends are mailed each month directly to the fellow or deposited directly into the fellow's bank account.

The Office of Naval Reactors attempts to provide adequate funding to its participants for meeting the costs of graduate school. No other student support that requires work or any other obligation such as teaching or research assistantship can be accepted. Other awards, prizes, and similar type payments (including veteran's benefits) that do not require a service may be accepted without a reduction in the stipend. Please contact MUSC if you have a question regarding accepting the Rickover Fellowship in conjunction with any other award, prize, or similar type payment.

TUITION AND FEES

The Fellow's required tuition and fees are paid by MUSC directly to the participating university upon receipt of invoice. Optional, refundable, and penalty fees (such as late registration and duplication fees) are not payable by MUSC. Health insurance fees will be paid by MUSC only if they are certified to be required for all graduate students at the Fellow's university. All tuition and fee charges must be certified to be consistent with those made to regular graduate students and necessary for enrollment into the graduate program.

In August of each year, MUSC notifies the bursar's office at each university regarding invoicing procedures for fellowship students. Students will receive a copy of this correspondence and should retain this copy for use in discussing any billing errors with their university's bursar office.

PRACTICUM

Travel expenses will be reimbursed for the Fellow to travel to/from the practicum site providing that the distance is more than 50 miles one way from the Fellow's university. Transportation expenses for travel actually performed will be paid. Travel by private automobile will be reimbursed at the current government rate per mile; travel by air will be reimbursed at the cost of the lowest commercial airfare. No expenses are paid for food or lodging at the practicum site. All travel must be authorized in advance by MUSC.

DOE Security Clearance is required for the practicum. In addition, the Laboratories require a physical exam, including drug screening, conducted at the Laboratory where the practicum will be performed. Travel expenses for travel to complete the physical exam will be reimbursed.

CONFERENCE TRAVEL

Fellows have the opportunity, dependent upon available funding, to attend national or international conferences. Reimbursement for conference travel is only approved when the student is presenting a paper or poster. Requests for travel funds should be made in writing to the fellowship office at MUSC at least two months before the anticipated travel dates.

STUDENT ASSISTANCE AWARDS

All Rickover Fellows have the opportunity to apply for student assistance awards. These awards may be used for the purchase of laboratory equipment, instrumentation, software, computer hardware etc. They are restricted to one grant per Rickover Fellow and the maximum amount is $10,000 for the duration of the Rickover Fellow's appointment. All student assistance awards must receive a 100% cost share from the university. Applications for student assistance must be requested through MUSC. The approval of the awards is contingent on need and relevance to the research of the Rickover Fellow.

APPOINTMENT OF LABORATORY MENTOR TO THE RICKOVER FELLOW'S COMMITTEE

It is expected that every effort will be made to appoint the Rickover Fellow's mentor from either KAPL or Bettis to the Rickover Fellow's Graduate Committee. The Fellow's host university will arrange this appointment and the program administrators will assist to ensure that this appointment is finalized. Opportunities may be provided to faculty advisors to interact with the Fellow's sponsoring laboratory. This may include short-term visits to the sponsoring laboratory.

EXTERNAL RELEASE OF INFORMATION

REQUIRED APPROVALS OF RESEARCH INFORMATION

The abstract of the thesis research will be checked for consistency with one of the topical areas listed in the program description, or in a pre-approved list of generic thesis topics. Each fellow is required to keep a notebook describing accomplishments made while on a practicum assignment at one of the two Naval Reactors Laboratories. The notebooks will be reviewed at the laboratories for classified material and external release of information after the completion of each practicum. After the notebooks have been approved, material contained therein may be published, presented, displayed, or released, to anyone outside of the Rickover Fellowship Program in Nuclear Engineering (including the academic institution). A similar review will be performed on the final draft of the undefended thesis. Two weeks should be allowed for this final review. The KAPL or Bettis mentor will assist the fellow in obtaining the required approvals.

PUBLICATION ACKNOWLEDGMENT

DOE and MUSC encourage fellows to publish reports and articles in scientific and engineering journals. The fellow must submit any articles, reports, or thesis to MUSC prior to submission for publication. All publications will show the joint affiliation of the fellow with the university and, if appropriate, with the laboratory in which the research was conducted, and should acknowledge fellowship support.

Fellowship support should be acknowledged in the following manner:

> *This research was performed under appointment to the Rickover Fellowship Program in Nuclear Engineering sponsored by Naval Reactors Division of the U.S. Department of Energy.*

RICKOVER FELLOWSHIP PARTICIPATING PRACTICUM CENTERS AND CENTER COORDINATORS

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