U.S. NUCLEAR REGULATORY COMMISSION
NOTICE OF GRANT/ASSISTANCE AWARD

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-27-10-1120		FROM: 09/30/2010 TO: 09/29/15	Pursuant to Section 31b and 141b of the Atomic Energy Act of 1954, as amended

5. TYPE OF AWARD	6. ORGANIZATION TYPE	7. RECIPIENT NAME, ADDRESS, and EMAIL ADDRESS
[X] GRANT [ ] COOPERATIVE AGREEMENT	DUNS:603503991 Public/State Controlled Institution of Higher Ed.	RFCUNY - CITY COLLEGE CONVENT AVE & 138TH ST NEW YORK NY 100319101

8. PROJECT TITLE:
New York Nuclear Research Opportunities Program (NY- NROP)

9. PROJECT WILL BE CONDUCTED	10. TECHNICAL REPORTS ARE REQUIRED	11. PRINCIPAL INVESTIGATOR(S) NAME, ADDRESS and EMAIL ADDRESS
PER GOVERNMENT'S/RECIPIENT'S PROPOSAL(S) DATED 05/05/2010 AND APPENDIX A-PROJECT GRANT PROVISIONS	[X] PROGRESS AND FINAL [ ] FINAL ONLY [ ] OTHER (Conference Proceedings)	Dr. Masahiro Kawaji The Research Foundation CUNY - The City College 230 West 41st Street New York, New York kawaji@me.ccny.cuny.edu

12. NRC PROGRAM OFFICE (NAME and ADDRESS)	13. ACCOUNTING and APPROPRIATION DATA	14. METHOD OF PAYMENT
U.S. Nuclear Regulatory Commission Ms. Tuwanda Smith Mail Stop 03H8 (301) 415-7394 Office of Small Business & Civil Rights 6003 Executive Boulevard Rockville, MD 20852	APPN. NO: 31X0200 B&R NO: 07P-15-5C1-161 JOB CODE: N7316 BOC NO: 4110 OFFICE ID NO: SDB-27-10-1120 FFS-SBC10339	[ ] ADVANCE BY TREASURY CHECK [ ] REIMBURSEMENT BY TREASURY CHECK [ ] LETTER OF CREDIT [X] OTHER (SPECIFY) Electronic ASAP.gov (See Remarks in Item #20 "Payment Information")

15. NRC OBLIGATION FUNDS		16. TOTAL FUNDING AGREEMENT	
THIS ACTION	$110,000.00	NRC	$549,994.00
PREVIOUS OBLIGATION		RECIPIENT	$0.00
TOTAL	$110,000.00	TOTAL	$549,994.00

This action provides funds for Fiscal Year 2010 in the amount of $110,000.00

17. NRC ISSUING OFFICE (NAME, ADDRESS and EMAIL ADDRESS)

U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn: Mr. Michael Mills (301) 492-3621
Mail Stop: TWB-01-B10M
Washington, DC 20555
Michael.Mills@nrc.gov

18. Acceptance of or objections to the Terms and Conditions of Award must be Emailed to the NRC Issuing Office (Block #17) within three (3) business days following the Award issue date. NRC considers lack of response as acceptance by the grantee of the terms and conditions of award.

19. NRC CONTRACTING OFFICER

Sheila Bumpass 9/29/2010
(Signature) (Date)

NAME (TYPED) Sheila Bumpass

TITLE Contracting Officer

TELEPHONE NO. 301-492-3484

20. PAYMENT INFORMATION

Payment will be made through the Automated Standard Application for Payment (ASAP.gov) unless the recipient has failed to comply with the program objectives, award conditions, Federal reporting requirements or other conditions specified in 2 CFR 215 (OMB Circular A110).

21. Attached is a copy of the "NRC General Provisions for Grants and Cooperative Agreements Awarded to Non-Government Recipients. Acceptance of these terms and conditions is acknowledged when Federal funds are used on this project.

22. ORDER OF PRECEDENCE
In the event of a conflict between the recipient's proposal and this award, the terms of the Award shall prevail.

23. By this award, the Recipient certifies that payment of any audit-related debt will not reduce the level of performance of any Federal Program.

TEMPLATE - ADM001 SUNSI REVIEW COMPLETE OCT 04 2010 ADM002

ATTACHMENT A - SCHEDULE

A.1 PURPOSE OF GRANT

The purpose of this Grant is to provide support to The Research Foundation, CUNY – The City College, for the project "entitled "New York – Nuclear Research Opportunities Program (NY-NROP)."

A.2 PERIOD OF GRANT

1. The effective date of this Grant is September 30, 2010. The estimated completion date of this Grant is September 29, 2015.

2. Funds obligated hereunder are available for program expenditures for the estimated period: September 30, 2010 – September 29, 2011. Continued funding is subject to the availability of additional funding.

A. GENERAL

1. Total Estimated NRC Amount:	$549,994.00
2. Total Obligated Amount:	$110,000.00
3. Cost-Sharing Amount:	$ 0.00
4. Activity Title:	"New York – Nuclear Research Opportunities Program (NY-NROP)"
5. NRC Project Officer:	Tuwanda Smith
6. DUNS No.:	603503991

B. SPECIFIC

RFPA No.:	SDB-27-10-1120
FFS:	SBC10339
Job Code:	N7316
BOC:	4110
B&R Number:	07P-15-5C1-161
Appropriation #:	31X0200
Amount Obligated:	$110,000.00

A.3 BUDGET

Revisions to the budget shall be made in accordance with Revision of Grant Budget in accordance with 2 CFR 215.25.

	Year 1	Year 2	Year 3	Year 4	Year 5
Direct Participant Cost	$109,140	$108,779	$108,659	$108,759	$108,765
Indirect Cost	$ 811	$ 1,220	$ 1,305	$ 1,233	$ 1,233
NRC Yearly Total	**$109,951**	**$109,999**	**$109,964**	**$109,992**	**$109,998**

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is $549,994.00 for a five (5) year period.

2. NRC hereby obligates the amount of $110,000.00 for program expenditures during the period set forth above and in support of the Budget above. The Grantee will be given written notice by the Contracting Officer when additional funds will be added. NRC is not obligated to reimburse the Grantee for the expenditure of amounts in excess of the total obligated amount.

3. Payment shall be made to the Grantee in accordance with procedures set forth in the Automated Standard Application for Payments (ASAP) Procedures set forth below.

Attachment B – Program Description

I. INTRODUCTION

New York currently produces 445.2 trillion BTUs of nuclear energy at six reactors. But there is a shortage of nuclear engineers and other workers associated with nuclear energy production. The New York Governor's Task Force on Diversifying the New York State Economy through Industry-Higher Education Partnerships has noted the well-documented national shortage of nuclear engineers and recommended that the State's colleges actively seek partnerships with New York's nuclear power producers to establish collaborative research and training programs (Task Force Final Report, December 14, 2009).

To this end, financial support is requested through the NRC Minority Serving Institutions Program for the "**New York - Nuclear Research Opportunities Program (NY-NROP)**" to be administered by the newly established Energy Institute at the City College of the City University of New York (CCNY). The Energy Institute focuses on advanced electricity generation and storage technologies, in particular, existing and advanced nuclear reactors which are currently operating or will be constructed in the US over the next ten to twenty years. As CCNY is a minority and a Hispanic Serving Institution, the proposed program will provide minority students with the research experience, advanced knowledge and skills needed to pursue successful careers in the nuclear industry and government agencies such as NRC and DOE.

A total funding of $549,994 is requested over a period of five years (an average of $110,000 per year) to enable a total of 5 Master of Engineering (M.Eng.) students and one Ph.D. student to conduct research in the Nuclear Thermal-hydraulics and Safety Research Laboratory of the Energy Institute directly advised by Principal Investigators of this proposal who are faculty members in the Grove School of Engineering including Professors Masahiro Kawaji, Sanjoy Banerjee, Yiannis Andreopoulos, Charles Watkins, Taehun Lee and Dan Steingart.

The NROP students will conduct numerical and experimental investigations of thermal-hydraulics problems relevant to the design, operation and safety of nuclear reactors. The NROP students will be American citizens or permanent residents enrolled in the Grove School of Engineering at CCNY, and selected based on their past academic performance, interests and motivation to pursue careers in the nuclear field. Some students will be drawn from two other minority serving institutions in the New York area: Medgar Evers College and Lehman College.

The City University of New York (CUNY), the largest urban university in the US with 220,000 full time students and 230,000 continuing education students, has selected the energy field as one of its major research and education thrust areas by establishing the Energy Institute at its flagship campus, City College of New York, and investing a substantial amount of resources. The Energy Institute is located in the Grove School of Engineering and its founding Director, Distinguished Professor Sanjoy Banerjee, is a member of the Advisory Committee on Reactor Safeguards (ACRS) and chairs the Thermal hydraulics Sub-Committee.

The Project Director and PI of this proposal is Masahiro Kawaji, who is Professor of Mechanical and Chemical Engineering at CCNY and a member of the Energy Institute responsible for nuclear engineering programs. Prof. Kawaji has been conducting multiphase flow and heat transfer research related to nuclear reactor thermal-hydraulics and safety for over 25 years at CCNY and the University of Toronto in Canada, where he served as Acting Chair of the Department of Chemical Engineering and Applied Chemistry. He is a Fellow of the Canadian Academy of Engineering, ASME and the Chemical Institute of Canada.

Other Principal Investigators of this proposal include Profs. Yiannis Andreopoulos, Charles Watkins and Taehun Lee of the Mechanical Engineering Department, and Prof. Dan Steingart of the Chemical Engineering Department at CCNY. Prof. Andreopoulos received a Nuclear Engineering Education Grant from NRC in 2009 to start the Nuclear Engineering Concentration program for undergraduate students at City College. Prof. Charles Watkins, former Dean of Engineering at CCNY, who specializes in numerical simulation of thermo-fluids phenomena, will collaborate with Prof. Lee who holds a Nuclear Engineering Faculty Development Grant from NRC. Prof. Lee was the recipient of the 2005 J.H. Wilkinson Fellowship from the Mathematics and Computer Science Division at the Argonne National Laboratory, the most prestigious postdoctoral fellowship in computational mathematics, before joining the City College as Assistant Professor in 2006. He has pioneered the Finite Element/Spectral Element Method-based Lattice Boltzmann Model to study flows in complex geometry, which is directly applicable to nuclear reactor thermal-hydraulics and safety research. Finally, Prof. Steingart will apply his expertise in electrochemistry to advise NROP scholars in corrosion research in connection with the aging and life extension of nuclear reactors.

The Nuclear Engineering Concentration program funded by NRC's Education Grant has attracted over 37 undergraduate students to the Reactor Physics course taught in the Spring semester of 2010. Among the students enrolled, 15 outstanding students have been awarded scholarships from NRC's Undergraduate Scholarship Grant. Many of them are from minority groups, have GPA's above 3.5 and are interested in pursuing a graduate degree program in nuclear engineering at City College and other graduate schools. The proposed Nuclear Research Opportunities Program will enable us to recruit M. Eng. and Ph.D. students from among these students as well as other outstanding students from Medgar Evers College and Lehman College. The NROP scholars will be able to gain experimental and numerical research experience in nuclear energy production and will also interact with other graduate students supported by nuclear engineering fellowships from industry. Mitsubishi Nuclear Energy Systems has already provided CCNY with two graduate fellowships in nuclear engineering annually.

The NROP scholars will be expected to study nuclear engineering subjects and conduct reactor engineering research under the guidance of CCNY professors and collaborators at Medgar Evers College (Prof. M. Patwary, Dean of School of Science, Health and Technology) and Lehman College (Prof. V. Pan of Dept. of Math and Computer Science, who is an internationally recognized leader in computer science research). In addition to four nuclear engineering courses offered under the NE Concentration program, the NROP scholars will be able to take other graduate courses closely related to nuclear engineering. Thus, they will be able to not only gain research experience but also advance their knowledge of reactor physics, thermal hydraulics, nuclear safety, and numerical simulation in order to pursue a successful professional career in the nuclear engineering field.

2. OBJECTIVES

The **NY Nuclear Research Opportunities Program** will engage qualified students from under-represented minority groups in nuclear reactor thermal-hydraulics and safety research at City College of New York. A total of five students will be selected to pursue a Master of Engineering program. Each NROP scholar in the M. Eng. program will receive an annual stipend of $16,000 and tuition fees to conduct research for two years. Additionally, one Ph.D.

student will be supported by NROP with an annual stipend of $30,000 and tuition fees for four years. All NROP scholars will receive free health insurance coverage worth about $3,000 per year from the Grove School of Engineering. NROP scholars will also be given a total research budget of $40,200 over five years to purchase PCs and lab supplies from the NROP grant.

The NROP scholars will be advised by experienced researchers in the Reactor Thermal-hydraulics and Safety Research Laboratory. The Laboratory is being equipped with the latest equipment for experimental and numerical research with the funds provided by CCNY, City University of New York, NRC and DOE. The NROP scholars will be trained to conduct cutting edge research and acquire latest skills needed in the design, regulation, construction and operation of current and future nuclear power plants in the US.

3. INVOLVEMENT OF UNDER-REPRESENTED MINORITY STUDENTS

The City College of New York has a vast experience in educating women and under-represented minority students, and is the premier minority institution in the U.S., located in the Harlem area of the New York City. It is America's oldest public university, predating the land grant colleges by two decades, and has been the primary route to advancement for generations of native and newly immigrated New Yorkers for 160 years. CCNY is first in NY State and 10th nationally in graduating minority engineers, 5th nationally in conferring graduate degrees on minority students and a top producer of African-American engineering PhDs. City College is 9th in the US in the number of its graduates that have gone onto earn PhD degrees; 9 of its alumni have received the Nobel Prize.

The Grove School of Engineering enrolls the largest number of under-represented minority students amongst New York State's public engineering schools. The PIs of this proposal have advised many minority graduate students in the past. Prof. Lee is currently advising two minority students and two female students for their Ph.D. degrees, and Prof. Kawaji has advised two female Ph.D. students and six female Master of Applied Science students in Canada.

4. PROPOSED RESEARCH AND TRAINING PROGRAM

The nine NROP students selected will conduct experimental and/or numerical investigations advised by faculty members of the Energy Institute, Grove School of Engineering at CCNY and co-advisors at Medgar Evers College and Lehman College. In order to ensure the research topics are relevant to the nuclear industry, the details of the research work will be discussed with an Advisory Board being established for the Nuclear Engineering Concentration.

4.1 Nuclear Thermal-Hydraulics and Safety Research Laboratory

The City University of New York has invested in excess of $1,000,000 into the establishment of the Nuclear Thermal-hydraulics and Safety Laboratory at City College. The new Laboratory is located on the second floor of the Engineering Building (Steinman Hall at Convent Avenue and 140th Street in New York) and adjoins the Electrical and Thermal Energy Storage Laboratory of the Energy Institute. The existing laboratory space is being renovated to provide 2,000 sqft of well designed laboratory space equipped with a water recirculation system, compressed air supply, high voltage AC lines, high current-low voltage DC power supplies, lab benches, and fume hoods. Flow loops are being constructed with different test sections to be used to investigate thermal-hydraulics phenomena of interest to the nuclear industry, involving single-phase gas and liquid flows, gas-liquid two-phase flows, and phase change heat transfer (boiling and condensation).

In addition to the basic flow loops and individual test sections, advanced instrumentation are being purchased with the funds from CCNY, CUNY, NRC and DOE. A high-speed imaging system capable of recording up to 50,000 frames per second for flow visualization, Particle Image Velocimetry (PIV) hardware and software for velocity field measurements, and a liquid film thickness sensor with a 0.01 micron resolution have been acquired. Additionally, an infrared

imager that can record the surface temperature distributions at a rate of 30 frames per second, a nanosensor that can profile surfaces with a nanometer resolution, and a Mach-Zehnder interferometer for two-dimensional temperature profile measurements are also available. This well-equipped thermal-hydraulics research laboratory will enable NROP scholars to acquire advanced skills in conducting thermal-hydraulics experiments, and knowledge in the design and use of advanced instrumentation.

A computational facility available at the Energy Institute includes a 200-node computer cluster. This system along with the CUNY High Performance Computing Facility at College of Staten Island will be available for the NROP scholars to run advanced simulation models based on our own source codes, commercial CFD packages (e.g., FLUENT, CFX, STAR-CD), reactor safety analysis codes (e.g., TRACE), and reactor simulation software (e.g., PCTRAN). Additionally, NROP scholars will be able to gain access to NY BLUE, an 18,000 node High Performance Computing facility located at the Brookhaven National Lab.

4.2 Graduate Study in Nuclear Engineering at City College of New York

NROP scholars will have an opportunity to study nuclear engineering in depths by taking courses offered by the Grove School of Engineering. The following four courses are available for senior undergraduate and Master of Engineering students: Reactor Physics and Engineering; Reactor Thermal Hydraulics; Nuclear Reactor Safety; Nuclear Power Plant Design and Operation. More advanced versions of the above courses will be developed for NROP scholars and other graduate students.

In addition, the NROP scholars will be able to take currently available graduate courses in the Mechanical and Chemical Engineering Departments which are relevant to the design and operation of nuclear reactors such as Conduction and Convection Heat Transfer, Advanced Computational Fluid Mechanics, Finite/Spectral Element Analysis in Fluid Dynamics, Interfacial Flows and Transport Phenomena, Applied Stress Analysis, Mechanical Vibrations, Thermal Systems Design, Mechanics and Physics of Material Behavior, Physical Properties of Material, Steam and Gas Turbines, Composite Materials, Advanced Materials Engineering, Nanotechnology, and Energy Engineering Systems. Additional courses will be developed in the future covering nuclear fuel cycle, waste management, and nuclear materials, with assistance obtained from experts at Brookhaven National Lab, and nuclear industry.

Furthermore, the following graduate courses on project management are also available: Management Concepts for Engineers, Economics and Investment Analysis of Engineering Projects, Project Management, Decision and Planning Techniques for Engineers. The above courses will surely provide the NROP students with the necessary knowledge and skills to successfully pursue professional careers in the nuclear industry.

4.3 Research Projects

The research projects proposed for NROP students include experimental and numerical investigations of liquid film dryout and Departure from Nucleate Boiling (DNB) phenomena in fuel channels, enhancement of Critical Heat Flux for uprating the reactor power, development of an X-ray PTV technique for advanced two-phase flow measurement, investigation of supercritical CO_2 flow and heat transfer for next-generation reactors, microfluidic electrochemistry for nuclear energy applications, and improvement of two-phase flow models and reactor safety analysis codes. Each of these projects is briefly described below.

Development of an X-Ray PTV Technique (Banerjee)

In thermal-hydraulics studies, it is often necessary to measure velocity distributions in gas-liquid mixtures flowing through metal pipes, but conventional techniques such as laser-based PIV can not be used. Thus, a new X-ray technique will be developed to measure velocity distributions in metal pipes using a Particle Tracking Velocimetry (PTV) principle. A row of multiple X-ray tubes will be placed on one side of a metal pipe and a row of miniature

scintillation detectors will be placed on the opposite side of the pipe. The X-ray tubes will be activated with short pulses to generate fan-shaped X-rays consecutively. The X-rays which travel through the metal pipe wall and gas-liquid mixture are detected by the X-ray detectors.

Special tracer particles will be developed using hollow metal particles which possess large X-ray attenuation coefficients such as tungsten but can be made to match the density of the carrier liquid. The position of each tracer particle will be determined from the X-ray detector signals using an algorithm similar to that used in Computed Tomography. From the changes in the tracer particle positions detected, the velocity of each particle will be computed to yield an instantaneous velocity distribution in the liquid phase.

Liquid Film Dryout and CHF Phenomena (Kawaji)

At high heat fluxes, the reactor coolant flowing through a fuel bundle boils and forms a two-phase flow of steam and water film on the fuel rod surface. The liquid film is sheared by a high-speed vapor flow and the film thickness would generally decrease in the flow direction. If the reactor power is too high, the liquid film can be completely vaporized from the fuel rod surface at the fuel channel exit, a Critical Heat Flux (CHF) condition due to film dryout is reached usually at the fuel channel exit resulting in a rapid excursion of the local fuel rod temperature. To investigate the liquid film behavior on a heated fuel rod surface, a highly sensitive liquid film thickness sensor that can measure the transparent liquid film thickness with a resolution of 10 nanometers will be used. The effects of spacers separating the neighboring fuel rods and gap sizes between the fuel rods on the liquid film thickness distribution will be investigated experimentally. Better spacer and fuel bundle designs can be adopted by the nuclear utilities to increase the reactor power keeping the safety margin intact. The experimental data obtained will also be used to compare with and validate the predictions of numerical models described below.

Molecular Dynamics Simulation of DNB Phenomena (Watkins)

Prevention of the departure from nucleate boiling (DNB) as heat flux is increased in PWR cores is necessary to avoid film boiling and dryout at the critical heat flux (CHF). Thermal and fluid phenomena related to DNB have been studied extensively at the macroscale level to enable the reactors to operate at ever higher core heat fluxes. However, understanding of the basic thermal and fluid physics underlying DNB is still incomplete. Improved understanding of the molecular-level thermal transport and phase transition processes, including DNB, can lead to further improvements in core power density, heat transfer performance, plant efficiency, and safety. In particular, it will permit molecular-scale engineering of heat transfer surfaces and coolant fluids to optimize system performance.

The proposed research will employ molecular dynamics (MD) and a hybrid molecular dynamics/direct simulation Monte Carlo (MD/DSMC) simulation method to study important DNB-related boiling phenomena. It will investigate the fundamental mechanisms that can lead to increases in CHF on nano-engineered surfaces. For example, a porous nano-engineered surface can be created by spontaneous deposition of nanoparticles from a nanofluid coolant onto a solid substrate during cooling. This type of surface has been shown recently to increase the CHF due to wetting enhancement. Another surface, which was recently developed at Brookhaven National Laboratory, enhances wetting through facilitating formation of microbubbles in nano-engineered surface cavities on a surfactant-coated substrate. It is not yet known how this type of surface performs in a boiling application but its thermal performance during boiling will be determined as part of this research.

The proposed work builds on the previous work of Watkins and his collaborators on the development of a hybrid MD/DSMC method for multiscale molecular simulation and on their MD investigation of the liquid/vapor interface. The hybrid method has recently been tested successfully on nonequilibrium vapor/liquid/solid interfacial systems. This research will also complement the work of Lee on mesoscale bubble dynamics using Lattice Boltzmann methods

described below. We will investigate the potential for combining the two approaches into a multiscale simulation.

Lattice Boltzmann Model Simulation of DNB Phenomena (Lee)

The goal of this research is to investigate the DNB mechanism by developing a mesoscopic computational method based on the Lattice Boltzmann Method (LBM). Here, DNB is assumed to be triggered by local microscopic phenomena on a partially wetting solid surface. It begins in a thin layer of liquid adjacent to the heated surface at a certain spot. This layer is almost quiescent because the fluid is nearly immobile in the close vicinity of any solid surface, and independent of the fluid velocity far from the heated surface. The phenomena at this scale feel only the averaged values of macroscopic flow variables and do not depend on the details of the flow regime which should not change the DNB mechanism. On the other hand, the contribution of the microscale hydrodynamic motion to the DNB triggering mechanism is still unclear. For instance, "bubble crowding" hypothesis postulates that in the vicinity of the triple contact line between liquid-vapor interface and solid surface, the rate of evaporation might be faster than the fluid supply. When the contact line recedes, the bubble nucleation site becomes dry. Once the fluid is lacking near the contact line, the bubble interface could change its curvature and increase the pressure distribution around the contact line and change the rate of liquid supply towards the contact line.

Through direct simulations of the contact line dynamics due to evaporation using the state-of-the-art LBM, the DNB triggering mechanism can be understood in more detail. Unlike conventional numerical methods based on discretization of macroscopic governing equations, and unlike the molecular dynamics methods, which are based on molecular representation with complicated molecule collision rules, LBM is based on microscopic models and mesoscopic kinetic equations for particle distribution functions; by tracking the evolutions of the particle distribution functions, it simulates fluid flows and then accumulates the distributions to obtain macroscopic averaged properties. Some attractive features of LBM are its easy handling of complex geometries, the data localization and the scalability in massively parallel computation due to the local collision and streaming processes. A thermal LBM will be developed in the proposed research, to handle adjustable Prandtl number, arbitrary specific heat ratio, a wide range of temperature variations, better numerical stability during phase change, and full thermo-hydrodynamic consistency. High-order discretizations based on Finite Element and Spectral Element approximations of the lattice Boltzmann equations will also be considered.

Supercritical CO_2 Reactor (Andreopoulos)

The use of supercritical carbon dioxide (S-CO_2) in recompression Brayton cycles in energy conversion systems for advanced nuclear reactors promises simplicity in configuring the cycle and high thermal efficiency benefits which, combined with reduced size of turbomachinery components i.e. high specific power have the potential of significantly reducing the cost of construction and maintenance of new nuclear power plants. These benefits are due to sharp property variations of S-CO_2 near its critical point where the sharp increase in density reduces the work of compression while increasing the high power conversion efficiency. At the same time these property variations of S-CO_2 introduce additional complications in the development of analytical and computational tools needed to devise stability and control strategies for the involved thermal hydraulics processes. One particular challenge relates to the ability in predicting transient and dynamic behavior of thermal-hydraulic systems which use S-CO_2. Many physical phenomena occurring in such systems are complex and coupled under both normal and accident situations.

The primary objective of the proposed research is to design an experimental facility to study transient phenomena related to the thermal-hydraulics of S-CO_2 for the dual purpose of generating benchmark data to validate computational fluid dynamic (CFD) analyses and for increasing our physical understanding of S-CO_2 behavior. It has been also reported that the

details and fundamental reasons for the enhanced or reduced convective heat transfer of S-CO_2 are yet to be found. Thus, there is a need for understanding and predicting the thermal hydraulics of S-CO_2, particularly the transient thermal hydraulic response of systems in which co-existence of S-CO_2 and liquid CO_2 or gas or choked flow is possible. This need requires a test bed with simplified geometry and well controlled boundary conditions which will allow detailed model validation.

Plant dynamics and safety analysis with specific accident scenarios will be simulated in which the control system may not be able to effectively maintain the desired CO_2 conditions near the critical point. The proposed research consists of several tasks. The first task involves the challenge to design a unique experimental facility in which controlled situations representing sudden pressure losses will be simulated (see Figure 1). The second task is associated with the development of a time dependent CFD code which will be able to predict the transient performance of the system, its stability characteristics and its transient response.

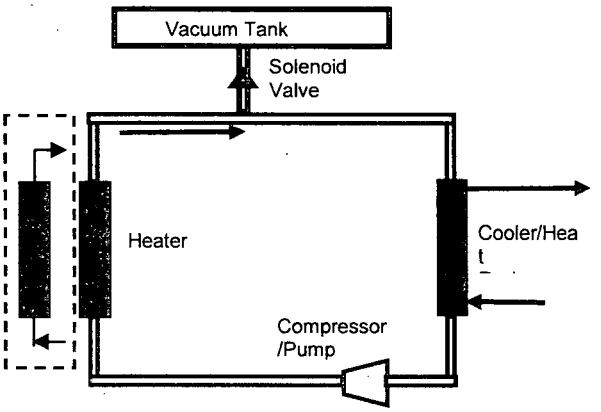

Figure 1: Schematic of high temperature S-CO_2 facility

Microfluidic Electrochemistry for Nuclear Energy Applications (Steingart)

The goal of this project is to introduce NROP scholars to a significant issue in modern nuclear processes via microfluidic electrochemistry. Corrosion in reactors is a significant issue through many forms. Pressurized, high-temperature water leads to the long-term corrosion of steels, and the ternary alloys that prevent short-term failure have unknown consequences for long-term reactions. Due to the high temperature (~300°C) and significant pressures (~150 bar) involved in nuclear reactors, few university laboratories have the facility to examine corrosion phenomena in significant detail under the actual operating conditions. Our laboratory has been experimenting with corrosion analysis in microfluidic arrays. Using custom microfluidic chambers with state of the art electrochemical analysis, we can examine minute potential changes as a function of electrolyte condition and electrode stability. In this project, NROP scholars will adapt our tools for relevance in the nuclear industry, modifying the chambers for high temperature and pressure and then varying electrolyte composition to simulate the harsh environs of an operating nuclear reactor. The small size of the setup will mitigate the safety concerns for such conditions as well as minimizing the cost of each rig, allowing students to realize many different conditions and examine the complex map of corrosion failure mechanisms.

Improvement of Reactor Safety Analysis Codes (Kawaji, Banerjee and Lee)

In solving the two-fluid models used in existing thermal-hydraulic analysis codes such as TRACE, TRAC and RELAP5, sets of constitutive relations are typically required for the interfacial area and drag, wall-to-fluid area and friction, and heat and mass transfer coefficients, for each two-phase flow regime. When the mass, momentum and energy equations are solved in 1-D or 3-D, the two-phase flow regime at a given location and time is determined based on the flow regime transition criterion and applicable constitutive equations are selected. The current two-fluid models assume the flow regime transition to occur suddenly and instantaneously whenever the flow regime transition criterion is satisfied at a given point in space and time, although the actual transitions in two-phase flow regimes would occur gradually over a certain distance and period of time. This introduces instabilities in numerical calculations. Thus, we will develop a new approach to implementing gradual flow regime transitions and

alternative sets of constitutive relations for developing two-phase flows. The new approach will be adopted into the existing codes and improvements in their predictive abilities will be evaluated.

Recent advances in computational technology have also made direct numerical simulations (DNS) involving gas-liquid interface motions possible. The interface motion can be modeled by using interface tracking or capturing techniques developed in the past. The adoption of the DNS approach is, however, unrealistic for full system analyses since the reactor systems are too complex and large. Thus, NROP scholars will be asked to improve the accuracy of a two-fluid modeling approach and to use the DNS approach for detailed analyses of complex thermal-hydraulic phenomena.

5. RESEARCH EXPERIENCE AT DOE'S NATIONAL LABORATORIES

Each year, two NROP scholars will be given a summer internship opportunity to spend three months at DOE's National Laboratories as indicated in the attached supporting letters from Brookhaven and Argonne National Laboratories. They will be provided with an additional stipend of $3,000 to cover their travel expenses and extra housing costs during their three-month stay. Such an opportunity to gain experience in nuclear-related research at major research institutions outside CCNY will enable them to interact with other experts conducting research similar to their own, and help them obtain permanent positions after their graduation. In five years, a total of 10 NROP students will be able to participate in this summer internship program.

6. RECRUITMENT PLAN AND STRATEGIES

Six NROP scholars will be recruited and admitted into the NROP over five years according to the following recruitment schedule.

January, 2011:	1 M. Eng. student
August, 2011:	2 M. Eng. students and 1 Ph.D. student
August, 2013:	2 M. Eng. students

They will start their studies either in the Fall or Spring semester, so their enrolment will span over multiple academic years as shown below.

Year 1	ME1	ME2	ME3			PhD1
Year 2	ME1	ME2	ME3			PhD1
Year 3				ME4	ME5	PhD1
Year 4				ME4	ME5	PhD1
Year 5						PhD1

Five M.Eng. students and one Ph.D. student will be recruited from among the current undergraduate students majoring in engineering and science at CCNY, including those students enrolled in the Nuclear Engineering Concentration and the current (15) and future NRC Scholars. Additionally, in order to provide minority students graduating from other Minority Serving Institutions in the New York City area who are interested in pursuing nuclear engineering at the graduate level, collaborations will be established with Lehman College and Medgar Evers College, which are also Minority Serving Institutions but do not have an engineering program. Faculty members at those Colleges will be involved in both the recruitment effort and joint advising of the research work undertaken by the NROP scholars at CCNY.

An announcement of the NY-Nuclear Research Opportunities Program will be made at CCNY, Lehman College and Medgar Evers College as soon as the grant is awarded. All the undergraduate students interested in entering a Master of Engineering program and conducting

nuclear engineering research starting in the Fall semester of 2010 and a Ph.D. program in the Fall semester, 2011, will be informed of the research and study opportunity and application process. In particular, students from under-represented minority groups, women and persons with disabilities will be strongly encouraged to apply. The research opportunities will also be advertised through our websites, by sending flyers to Physics, Chemistry, Math and Computer Science Departments at all senior Colleges and Universities in the New York City area, and distributing flyers at ANS, AIChE and ASME meetings.

To attract the student interests in nuclear engineering, special information sessions and seminars have been held in the Grove School of Engineering to explain research opportunities in the graduate program and job opportunities in the nuclear industry. Dr. John T. Larkins and Ms. Randi Neff from NRC's Office of Human Resources, Mr. Dion Sunderland who is the Chair of the New York Metro section of ANS, Drs. James Misevich and David Diamond from Brookhaven National Lab, Dr. Kent Wardle from Argonne National Lab, and Dr. S.K. Choi from Korea Atomic Energy Research Institute have given invited talks and met with CCNY students in the past six months. In the future, additional speakers from the nuclear reactor vendors, nuclear utilities (e.g., Entergy), component manufacturers (e.g., Babcox & Wilcox), National Laboratories, and government agencies such as NRC and DOE will also be invited.

7. NROP SCHOLAR SELECTION

In order to select the most-qualified graduate students for the NY-Nuclear Research Opportunities Program, the following application and selection process will be established. An announcement will be made to senior undergraduate students at CCNY, Lehman College and Medgar Evers College in the summer of 2010 with an application deadline of August 15, 2010. The applicants will be asked to describe their interests in pursuing a M.Eng. program and a professional career in the nuclear engineering field. To be eligible, the applicants must be US citizens or permanent residents and meet the graduate admission standards at CCNY. In the second year, applicants to the Ph.D. program will be recruited in the same manner.

A Selection Committee consisting of the Director of the Energy Institute as well as the PI and Co-PIs of this proposal will evaluate the applications. Interviews with each candidate on a short list will be conducted by the Selection Committee. The NROP scholars selected will be announced through the Grove School of Engineering Newsletter, Nuclear Engineering Concentration and the Energy Institute websites.

As long as the NROP scholar maintains a GPA higher than 3.3 and makes satisfactory progress in research as required, the scholar will be eligible to receive a stipend for two years in an M.Eng. program and for four years in a Ph.D. program.

8. NROP SCHOLARS' CAREER DEVELOPMENT

Special seminars will be organized for the NROP scholars and other students in our nuclear engineering program. The seminar speakers will be invited from National Laboratories, nuclear industry, and government agencies such as NRC and DOE to enable our students to learn about the latest advances in nuclear reactor technology and find job opportunities in the nuclear field. CCNY and the Energy Institute have already developed collaborating relationships with Argonne and Brookhaven National Laboratories for potential internship positions in nuclear-related research, and will also seek collaborative research opportunities with Sandia, Oak Ridge and Idaho National Laboratories. In addition, efforts are being made to build relationships with nuclear reactor vendors to enhance the NROP scholars' research relevance to the nuclear industry and to provide minority students with internship and permanent job opportunities in the nuclear industry. The local utilities which operate nuclear power plants (e.g., Entergy Corporation and Indian Point reactors), or are planning to construct new nuclear power plants (e.g., PSE&G in New Jersey), are also being approached to provide internship and job opportunities.

The NROP scholars will also be encouraged to attend Workshops of interest to their career and present their research findings at international conferences as often as possible. They will be able to meet with other researchers from around the world and gain an international perspective in the nuclear field.

9. MANAGEMENT STRUCTURE

The Nuclear Research Fellowship Program at CCNY will be administered by a Steering Committee composed of the Director of the Energy Institute, PI and Co-PIs of this proposal. The Steering Committee will be fully responsible for reviewing the applications, selecting the NROP scholars, subsequently monitoring their research progress and evaluating the success of NY-Nuclear Research Opportunities Program. The Steering Committee will monitor the progress of the NROP scholars by regularly examining their course work and research. An External Advisory Board will also be established to provide suggestions and guidance on the NROP activities. The Board will consist of the representatives from nuclear industry, Brookhaven National Laboratory, and government agencies. The NROP scholars will be required to present their research findings to the Steering Committee and Advisory Board at least once a year. The Committee and Board members will in turn provide the students with constructive advice on the current and future directions of their research as well as job search. The NROP scholars will be encouraged to approach the Steering Committee and Board members for guidance related to their study and research as needed.

10. EVALUATION OF PROGRAM EFFECTIVENESS AND SUCCESS

The effectiveness and success of the NY Nuclear Research Opportunities Program at CCNY will be evaluated using the following criteria.

a) *Number and quality of NROP applicants in terms of their GPA's, and the level of interest in conducting nuclear engineering research and obtaining M.Eng. and Ph.D. degrees.*

If the number of qualified applicants from minority groups is more than double the number of positions available, it would be considered to indicate an attractive program.

b) *Actual number and quality of NROP scholars who complete M.Eng. and Ph.D. programs and receive respective degrees.*

This MSIP grant will be considered to have been successful if 7 M.Eng. and 2 Ph.D. students all complete their degree programs.

c) *Number of publications and conference presentations arising from the research conducted by NROP scholars.*

Each NROP scholar will be expected to write at least one paper every two years and have it published in peer-reviewed conference proceedings or journals. Thus, if all the NROP scholars (7 M.Eng. and 2 Ph.D. students) publish more than 11 papers in five years, this program will be deemed to have successfully met this criterion.

d) *Success in obtaining internship positions and/or permanent jobs in National Laboratories, nuclear industry (such as reactor vendors, component manufacturers, and nuclear utilities), government agencies or academia.*

All NROP scholars will have an opportunity to get research experience as a summer intern at one of the National Labs. They will also have many opportunities to meet with people from nuclear industry, National Labs and government agencies. Thus, if 80% or 7 out of 9 NROP scholars find nuclear-related jobs after graduation, this program will be considered a success.

11. INSTITUTIONAL SUPPORT

The Grove School of Engineering will make a cash contribution to the NY-Nuclear Research Opportunities Program totaling $66,000 to provide the nine NROP scholars with health insurance. A letter from Dean of Engineering at CCNY, Prof. Joseph Barba, is attached.

The City University of New York has provided funding in excess of $4,000,000 to renovate and enhance various laboratories at the Energy Institute including the Thermal-hydraulics and Safety Research Laboratory. The Grove School of Engineering at CCNY has also contributed $100,000 towards the purchase of equipment and instruments to be used for thermal-hydraulics and safety research. The Energy Institute will also provide free access to the 200-node computer cluster for computational work by the NROP scholars. These enhancements in research infrastructure and facilities enable the NROP scholars to master the use of the state-of-the-art instruments and equipment in research.

At the Departmental level, a search for a new faculty member in the nuclear engineering field is underway in the Mechanical Engineering Department. The NRC Nuclear Engineering Education Grant and a Faculty Development Grant received by the Mechanical and Chemical Engineering Departments are also acting as a catalyst to rapidly expand the nuclear engineering education and research programs. A new computer laboratory has been set up for running nuclear reactor simulation software, and new thermal-hydraulics experiments are being developed for the students enrolled in the Nuclear Engineering Concentration. The Department of Mechanical Engineering has already invited four researchers from the Brookhaven and Argonne National Laboratories to give seminars and meet with our students in the past nine months. The travel support for the seminar speakers has been and will continue to be provided by the Mechanical and Chemical Engineering Departments and the Energy Institute.

Attachment C – Standard Terms and Conditions

The Nuclear Regulatory Commission's Standard Terms and Conditions for U.S. Nongovernmental Grantees

Preface

This award is based on the application submitted to, and as approved by, the Nuclear Regulatory Commission (NRC) under the authorization 42 USC 2051(b) pursuant to section 31b and 141b of the Atomic Energy Act of 1954, as amended, and is subject to the terms and conditions incorporated either directly or by reference in the following:

- Grant program legislation and program regulation cited in this Notice of Grant Award.
- Restrictions on the expenditure of Federal funds in appropriation acts, to the extent those restrictions are pertinent to the award.
- Code of Federal Regulations/Regulatory Requirements - 2 CFR 215 Uniform Administrative Requirements For Grants And Agreements With Institutions Of Higher Education, Hospitals, And Other Non-Profit Organizations (OMB Circulars), as applicable.

To assist with finding additional guidance for selected items of cost as required in 2 CRF 220, 2 CFR 225, and 2 CFR 230 these URLs to the Office of Management and Budget Cost Circulars are included for reference:

A-21 (now 2CFR 220):	http://www.whitehouse.gov/omb/circulars/a021/print/a021.html
A-87 (now 2CFR 225:	http://www.whitehouse.gov/omb/circulars/a087/print/a087-all.html
A-122 (now2 CFR 230	http://www.whitehouse.gov/omb/circulars/a122/print/a122.html
A-102, SF 424:	http://www.whitehouse.gov/omb/circulars/a102/print/a102.html

Form 990: http://www.irs.gov/pub/irs-pdf/i990-ez.pdf

Any inconsistency or conflict in terms and conditions specified in the award will be resolved according to the following order of precedence: public laws, regulations, applicable notices published in the Federal Register, Executive Orders (EOs), Office of Management and Budget (OMB) Circulars, the Nuclear Regulatory Commission's (NRC) Mandatory Standard Provisions, special award conditions, and standard award conditions.

By drawing funds from the Automated Standard Application for Payment system (ASAP), the recipient agrees to the terms and conditions of an award.

Certifications and representations. These terms incorporate the certifications and representations required by statute, executive order, or regulation that were submitted with the SF424B application through Grants.gov.

I. Mandatory General Requirements

The order of these requirements does not make one requirement more important than any other requirement.

1. Applicability of 2 CFR Part 215

a. All provisions of 2 CFR Part 215 and all Standard Provisions attached to this grant/cooperative agreement are applicable to the Grantee and to sub-recipients which meet the definition of "Grantee" in Part 215, unless a section specifically excludes a sub-recipient from coverage. The Grantee and any sub-recipients must, in addition to the assurances made as part of the application, comply and require each of its sub-awardees employed in the completion of the project to comply with Subpart C of 2 CFR 215 Part 180 and include this term in lower-tier (subaward) covered transactions.

b. Grantees must comply with monitoring procedures and audit requirements in accordance with OMB Circular A-133. < http://www.whitehouse.gov/omb/circulars/a133_compliance/08/08toc.aspx >

2. Award Package

Grant Performance Metrics:

The Office of Management and Budget requires all Federal Agencies providing funding for educational scholarships and fellowships as well as other educational related funding to report on specific metrics. These metrics are part of the Academic Competitiveness Council's (ACC) 2007 report and specifically relates to Science, Technology, Engineering, and Mathematics (STEM) curricula.

Service Agreement

A signed service agreement and resume are required for all student recipients of scholarships or fellowships funded by the US Nuclear Regulatory Commission. The Service Agreement is attached to the Terms and Conditions.

§ 215.41 Grantee responsibilities.
The Grantee is obligated to conduct such project oversight as may be appropriate, to manage the funds with prudence, and to comply with the provisions outlined in 2 CFR 215.41 Within this framework, the Principal Investigator (PI) named on the award face page, Block 11, is responsible for the scientific or technical direction of the project and for preparation of the project performance reports. This award is funded on a cost reimbursement basis not to exceed the amount awarded as indicated on the face page, Block 16., and is subject to a refund of unexpended funds to NRC.

The standards contained in this section do not relieve the Grantee of the contractual responsibilities arising under its contract(s). The Grantee is the responsible authority, without recourse to the NRC, regarding the settlement and satisfaction of all contractual and administrative issues arising out of procurements entered into in support of an award or other agreement. This includes disputes, claims, protests of award, source evaluation or other matters of a contractual nature. Matters concerning violation of statute are to be referred to such Federal, State or local authority as may have proper jurisdiction.

Subgrants
Appendix A to Part 215—Contract Provisions

Sub-recipients, sub-awardees, and contractors have no relationship with NRC under the terms of this grant/cooperative agreement. All required NRC approvals must be directed through the Grantee to NRC. See 2 CFR 215.180 and 215.41.

Nondiscrimination
(This provision is applicable when work under the grant/cooperative agreement is performed in the U.S. or when employees are recruited in the U.S.)

No U.S. citizen or legal resident shall be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity funded by this award on the basis of race, color, national origin, age, religion, handicap, or sex. The Grantee agrees to comply with the non-discrimination requirements below:

Title VI of the Civil Rights Act of 1964 (42 USC §§ 2000d et seq)
Title IX of the Education Amendments of 1972 (20 USC §§ 1681 et seq)
Section 504 of the Rehabilitation Act of 1973,as amended (29 USC § 794)
The Age Discrimination Act of 1975, as amended (42 USC §§ 6101 et seq)
The Americans with Disabilities Act of 1990 (42 USC §§ 12101 et seq)
Parts II and III of EO 11246 as amended by EO 11375 and 12086.
EO 13166, "Improving Access to Services for Persons with Limited English Proficiency."
Any other applicable non-discrimination law(s).

Generally, Title VII of the Civil Rights Act of 1964, 42 USC § 2000e et seq, provides that it shall be an unlawful employment practice for an employer to discharge any individual or otherwise to discriminate against an individual with respect to compensation, terms, conditions, or privileges of employment because of such individual's race, color, religion, sex, or national origin. However, Title VII, 42 USC § 2000e-1(a), expressly exempts from the prohibition against discrimination on the basis of religion, a religious corporation, association, educational institution, or society with respect to the employment of individuals of a particular religion to perform work connected with the carrying on by such corporation, association, educational institution, or society of its activities.

Modifications/Prior Approval

NRC prior written approval may be required before a Grantee makes certain budget modifications or undertakes particular activities. If NRC approval is required for changes in the grant or cooperative agreement, it must be requested of, and obtained from, the NRC Grants Officer in advance of the change or obligation of funds. All requests for NRC prior approval must be made, in writing (which includes submission by e-mail), to the designated Grants Specialist and Program Office no later than 30 days before the proposed change. The request must be signed by both the PI and the authorized organizational official. Failure to obtain prior approval, when required, from the NRC Grants Officer may result in the disallowance of costs, termination of the award, or other enforcement action within NRC's authority.

Lobbying Restrictions

The Grantee will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

The Grantee shall comply with provisions of 31 USC § 1352. This provision generally prohibits the use of Federal funds for lobbying in the Executive or Legislative Branches of the Federal Government in connection with the award, and requires disclosure of the use of non-Federal funds for lobbying.

The Grantee receiving in excess of $100,000 in Federal funding shall submit a completed Standard Form (SF) LLL, "Disclosure of Lobbying Activities," regarding the use of non-Federal funds for lobbying within 30 days following the end of the calendar quarter in which there occurs any event that requires disclosure or that materially affects the accuracy of the information contained in any disclosure form previously filed. The Grantee must submit the SF-LLL, including those received from sub-recipients, contractors, and subcontractors, to the Grants Officer.

§ 215.13 Debarment And Suspension.

The Grantee agrees to notify the Grants Officer immediately upon learning that it or any of its principals:

(1) Are presently excluded or disqualified from covered transactions by any Federal department or agency;

(2) Have been convicted within the preceding three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, tax evasion, receiving stolen property, making false claims, or obstruction of justice; commission of any other offense indicating a lack of business integrity or business honesty that seriously and directly affects your present responsibility;

(3) Are presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b); and

(4) Have had one or more public transactions (Federal, State, or local) terminated for cause or default within the preceding three years.

b. The Grantee agrees that, unless authorized by the Grants Officer, it will not knowingly enter into any subgrant or contracts under this grant/cooperative agreement with a person or entity that is included on the Excluded Parties List System (http://epls.arnet.gov).

The Grantee further agrees to include the following provision in any subgrant or contracts entered into under this award:

'Debarment, Suspension, Ineligibility, and Voluntary Exclusion

The Grantee certifies that neither it nor its principals is presently excluded or disqualified from participation in this transaction by any Federal department or agency. The policies and procedures applicable to debarment, suspension, and ineligibility under NRC-financed transactions are set forth in 2 CFR Part 180.'

Drug-Free Workplace
The Grantee must be in compliance with The Federal Drug Free Workplace Act of 1988. The policies and procedures applicable to violations of these requirements are set forth in 41 USC 702.

Implementation of E.O. 13224 -- Executive Order On Terrorist Financing
The Grantee is reminded that U.S. Executive Orders and U.S. law prohibits transactions with, and the provision of resources and support to, individuals and organizations associated with terrorism. It is the legal responsibility of the Grantee to ensure compliance with these Executive Orders and laws. This provision must be included in all contracts/sub-awards issued under this grant/cooperative agreement.
Award Grantees must comply with Executive Order 13224, Blocking Property and Prohibiting Transactions with Persons who Commit, Threaten to Commit, or Support Terrorism. Information about this Executive Order can be found at: www.fas.org/irp/offdocs/eo/eo-13224.htm.

Procurement Standards. § 215.40
Sections 215.41 through 215.48 set forth standards for use by Grantees in establishing procedures for the procurement of supplies and other expendable property, equipment, real property and other services with Federal funds. These standards are furnished to ensure that such materials and services are obtained in an effective manner and in compliance with the provisions of applicable Federal statutes and executive orders. No additional procurement standards or requirements shall be imposed by the Federal awarding agencies upon Grantees, unless specifically required by Federal statute or executive order or approved by OMB.

Travel
Travel is an appropriate charge to this award and prior authorization for specific trips are not required, as long as the trip is identified in the Grantee's original program description and original budget. All other travel, domestic or international, must not increase the total estimated award amount. Trips that have not been identified in the approved budget require the written prior approval of the Grants Officer.

Travel will be in accordance with the US Government Travel Regulations at: www.gsa.gov/federaltravelregulation and the per diem rates set forth at: www.gsa.gov/perdiem.

Travel costs to the grant must be consistent with provisions as established in Appendix A to 2 CFR 220 (J.53)

Property Management Standards
Property standards of this award shall follow provisions as established in 2 CFR 215.30.

Equipment procedures shall follow provision established in 2 CFR 215.34.

Procurement Standards
Procurement standards of this award shall follow provisions as established in 2 CFR 215.40.

Intangible and Intellectual Property
Intangible and intellectual property of this award shall generally follow provisions established in 2 CFR 215.36.

Inventions Report - The Bayh-Dole Act (P.L. 96-517) affords Grantees the right to elect title and retain ownership to inventions they develop with funding under an NRC grant award ("subject inventions"). In accepting an award, the Grantee agrees to comply with applicable NRC policies, the Bayh-Dole Act, and its Government-wide implementing regulations found at Title 37, Code of Federal Regulations (CFR) Part 401. A significant part of the regulations require that the Grantee report all subject inventions to the awarding agency (NRC) as well as include an acknowledgement of federal support in any patents. NRC participates in the trans-government Interagency Edison system (http://www.iedison.gov) and expects NRC funding Grantees to use this system to comply with Bayh-Dole and related intellectual property reporting requirements. The system allows for Grantees to submit reports electronically via the Internet. In addition, the invention must be reported in continuation applications (competing or non-competing).

Patent Notification Procedures- Pursuant to EO 12889, NRC is required to notify the owner of any valid patent covering technology whenever the NRC or its financial assistance Grantees, without making a patent search, knows (or has demonstrable reasonable grounds to know) that technology covered by a valid United States patent has been or will be used without a license from the owner. To ensure proper notification, if the Grantee uses or has used patented technology under this award without license or permission from the owner, the Grantee must notify the Grants Officer. This notice does not necessarily mean that the Government authorizes and consents to any copyright or patent infringement occurring under the financial assistance.

Data, Databases, and Software - The rights to any work produced or purchased under a NRC federal financial assistance award are determined by 2 CFR 215.36. Such works may include data, databases or software. The Grantee owns any work produced or purchased under a NRC federal financial assistance award subject to NRC's right to obtain, reproduce, publish or otherwise use the work or authorize others to receive, reproduce, publish or otherwise use the data for Government purposes.

Copyright - The Grantee may copyright any work produced under a NRC federal financial assistance award subject to NRC's royalty-free nonexclusive and irrevocable right to reproduce, publish or otherwise use the work or authorize others to do so for Government purposes. Works jointly authored by NRC and Grantee employees may be copyrighted but only the part authored by the Grantee is protected because, under 17 USC § 105, works produced by

Government employees are not copyrightable in the United States. On occasion, NRC may ask the Grantee to transfer to NRC its copyright in a particular work when NRC is undertaking the primary dissemination of the work. Ownership of copyright by the Government through assignment is permitted under 17 USC § 105.

Records retention and access requirements for records of the Grantee shall follow established provisions in 2 CFR 215.53.

Organizational Prior Approval System
In order to carry out its responsibilities for monitoring project performance and for adhering to award terms and conditions, each Grantee organization shall have a system to ensure that appropriate authorized officials provide necessary organizational reviews and approvals in advance of any action that would result in either the performance or modification of an NRC supported activity where prior approvals are required, including the obligation or expenditure of funds where the governing cost principles either prescribe conditions or require approvals.

The Grantee shall designate an appropriate official or officials to review and approve the actions requiring NRC prior approval. Preferably, the authorized official(s) should be the same official(s) who sign(s) or countersign(s) those types of requests that require prior approval by NRC. The authorized organization official(s) shall not be the principal investigator or any official having direct responsibility for the actual conduct of the project, or a subordinate of such individual.

Conflict Of Interest Standards of this award shall follow provisions as established in 2 CFR 215.42 Codes of Conduct.

Dispute Review Procedures
a. Any request for review of a notice of termination or other adverse decision should be addressed to the Grants Officer. It must be postmarked or transmitted electronically no later than 30 days after the postmarked date of such termination or adverse decision from the Grants Officer.

b. The request for review must contain a full statement of the Grantee's position and the pertinent facts and reasons in support of such position.

c. The Grants Officer will promptly acknowledge receipt of the request for review and shall forward it to the Director, Office of Administration, who shall appoint a review committee consisting of a minimum of three persons.

d. Pending resolution of the request for review, the NRC may withhold or defer payments under the award during the review proceedings.

e. The review committee will request the Grants Officer who issued the notice of termination or adverse action to provide copies of all relevant background materials and documents. The committee may, at its discretion, invite representatives of the Grantee and the NRC program office to discuss pertinent issues and to submit such additional information as it deems appropriate. The chairman of the review committee will insure that all review activities or proceedings are adequately documented.

f. Based on its review, the committee will prepare its recommendation to the Director, Office of Administration, who will advise the parties concerned of his/her decision.

Termination and Enforcement. Termination of this award by default or by mutual consent shall follow provisions as established in 2 CFR 215.60,

Monitoring and Reporting § 215.51

a. Grantee Financial Management systems must comply with the established provisions in 2 CFR 215.21

- Payment – 2 CFR 215.22
- Cost Share – 2 CFR 215.23
- Program Income – 2 CFR 215.24
    - Earned program income, if any, shall be added to funds committed to the project by the NRC and Grantee and used to further eligible project or program objectives.
- Budget Revision – 2 CFR 215.25
    - In accordance with 2 CFR 215.25(e), the NRC waives the prior approval requirement for items identified in sub-part (e)(1-4).
    - The Grantee is not authorized to rebudget between direct costs and indirect costs without written approval of the Grants Officer.
    - Allowable Costs – 2 CFR 215.27

b. **Federal Financial Reports**

Effective October 1, 2008, NRC transitioned from the SF–269, SF–269A, SF–272, and SF–272A to the Federal Financial Report (SF-425) as required by OMB:
http://www.whitehouse.gov/omb/fedreg/2008/081308_ffr.pdf
http://www.whitehouse.gov/omb/grants/standard_forms/ffr.pdf
http://www.whitehouse.gov/omb/grants/standard_forms/ffr_instructions.pdf

The Grantee shall submit a "Federal Financial Report" (SF-425) on a quarterly basis for the periods ending 3/31, 6/30, 9/30, and 12/31 or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. A final SF-425 shall be submitted within 90 days after expiration of the award.

Period of Availability of Funds 2 CFR § 215.28

a. Where a funding period is specified, a Grantee may charge to the grant only allowable costs resulting from obligations incurred during the funding period and any pre-award costs authorized by the NRC.

b. Unless otherwise authorized in 2 CFR 215.25(e)(2) or a special award condition, any extension of the award period can only be authorized by the Grants Officer in writing. Verbal or written assurances of funding from other than the Grants Officer shall not constitute authority to obligate funds for programmatic activities beyond the expiration date.

c. The NRC has no obligation to provide any additional prospective or incremental funding. Any modification of the award to increase funding and to extend the period of performance is at the sole discretion of the NRC.

d. Requests for extensions to the period of performance shall be sent to the Grants Officer at least 30 days prior to the grant/cooperative agreement expiration date. Any request for extension after the expiration date shall not be honored.

Automated Standard Application For Payments (ASAP) Procedures

Unless otherwise provided for in the award document, payments under this award will be made using the Department of Treasury's Automated Standard Application for Payment (ASAP) system < http://www.fms.treas.gov/asap/ >. Under the ASAP system, payments are made through preauthorized electronic funds transfers, in accordance with the requirements of the Debt Collection Improvement Act of 1996. In order to receive payments under ASAP, Grantees are required to enroll with the Department of Treasury, Financial Management Service, and Regional Financial Centers, which allows them to use the on-line method of withdrawing funds from their ASAP established accounts. The following information will be required to make withdrawals under ASAP: (1) ASAP account number – the award number found on the cover sheet of the award; (2) Agency Location Code (ALC) – 31000001; and Region Code. Grantees enrolled in the ASAP system do not need to submit a "Request for Advance or Reimbursement" (SF-270), for payments relating to their award.

Audit Requirements

Organization-wide or program-specific audits shall be performed in accordance with the Single Audit Act Amendments of 1996, as implemented by OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations." http://www.whitehouse.gov/omb/circulars/a133/a133.html Grantees are subject to the provisions of OMB Circular A-133 if they expend $500,000 or more in a year in Federal awards.

The Form SF-SAC and the Single Audit Reporting packages for fiscal periods ending on or after January 1, 2008 must be submitted online.

1. Create your online report ID at http://harvester.census.gov/fac/collect/ddeindex.html
2. Complete the Form SF-SAC
3. Upload the Single Audit
4. Certify the Submission
5. Click "Submit."

Organizations expending less than $500,000 a year are not required to have an annual audit for that year but must make their grant-related records available to NRC or other designated officials for review or audit.

III. Programmatic Requirements

Performance (Technical) Reports

a. The Grantee shall submit performance (technical) reports electronically to the NRC Project Officer and Grants Officer as specified in the special award conditions in the same frequency as the Federal Financial Report unless otherwise authorized by the Grants Officer.

b. Unless otherwise specified in the award provisions, performance (technical) reports shall contain brief information as prescribed in the applicable uniform administrative requirements 2 CFR §215.51 which are incorporated in the award.

c. The submission for the six month period ending March 31st is due by April 30th. The submission for the six month period ending September 30th is due by October 31st.

Unsatisfactory Performance

Failure to perform the work in accordance with the terms of the award and maintain at least a satisfactory performance rating or equivalent evaluation may result in designation of the Grantee as high risk and assignment of special award conditions or other further action as specified in the standard term and condition entitled "Termination".

Failure to comply with any or all of the provisions of the award may have a negative impact on future funding by NRC and may be considered grounds for any or all of the following actions: establishment of an accounts receivable, withholding of payments under any NRC award, changing the method of payment from advance to reimbursement only, or the imposition of other special award conditions, suspension of any NRC active awards, and termination of any NRC award.

Other Federal Awards With Similar Programmatic Activities

The Grantee shall immediately provide written notification to the NRC Project Officer and the Grants Officer in the event that, subsequent to receipt of the NRC award, other financial assistance is received to support or fund any portion of the program description incorporated into the NRC award. NRC will not pay for costs that are funded by other sources.

Prohibition Against Assignment By The Grantee

The Grantee shall not transfer, pledge, mortgage, or otherwise assign the award, or any interest therein, or any claim arising thereunder, to any party or parties, banks, trust companies, or other financing or financial institutions without the express written approval of the Grants Officer.

Site Visits

The NRC, through authorized representatives, has the right, at all reasonable times, to make site visits to review project accomplishments and management control systems and to provide such technical assistance as may be required. If any site visit is made by the NRC on the premises of the Grantee or contractor under an award, the Grantee shall provide and shall require his/her contractors to provide all reasonable facilities and assistance for the safety and convenience of the Government representative in the performance of their duties. All site visits and evaluations shall be performed in such a manner as will not unduly delay the work.

IV. Miscellaneous Requirements

Criminal and Prohibited Activities

a. The Program Fraud Civil Remedies Act (31 USC §§ 3801-3812), provides for the imposition of civil penalties against persons who make false, fictitious, or fraudulent claims to the Federal government for money (including money representing grant/cooperative agreements, loans, or other benefits.)

b. False statements (18 USC § 287), provides that whoever makes or presents any false, fictitious, or fraudulent statements, representations, or claims against the United States shall be subject to imprisonment of not more than five years and shall be subject to a fine in the amount provided by 18 USC § 287.

c. False Claims Act (31 USC 3729 et seq), provides that suits under this Act can be brought by the government, or a person on behalf of the government, for false claims under federal assistance programs.

d. Copeland "Anti-Kickback" Act (18 USC § 874), prohibits a person or organization engaged in a federally supported project from enticing an employee working on the project from giving up a part of his compensation under an employment contract.

American-Made Equipment And Products
Grantees are herby notified that they are encouraged, to the greatest extent practicable, to purchase American-made equipment and products with funding provided under this award.

Increasing Seat Belt Use in the United States
Pursuant to EO 13043, Grantees should encourage employees and contractors to enforce on-the-job seat belt policies and programs when operating company-owned, rented or personally-owned vehicle.

Federal Employee Expenses
Federal agencies are generally barred from accepting funds from a Grantee to pay transportation, travel, or other expenses for any Federal employee unless specifically approved in the terms of the award. Use of award funds (Federal or non-Federal) or the Grantee's provision of in-kind goods or services, for the purposes of transportation, travel, or any other expenses for any Federal employee may raise appropriation augmentation issues. In addition, NRC policy prohibits the acceptance of gifts, including travel payments for Federal employees, from Grantees or applicants regardless of the source.

Minority Serving Institutions (MSIs) Initiative
Pursuant to EOs 13256, 13230, and 13270, NRC is strongly committed to broadening the participation of MSIs in its financial assistance program. NRC's goals include achieving full participation of MSIs in order to advance the development of human potential, strengthen the Nation's capacity to provide high-quality education, and increase opportunities for MSIs to participate in and benefit form Federal financial assistance programs. NRC encourages all applicants and Grantees to include meaningful participations of MSIs. Institutions eligible to be considered MSIs are listed on the Department of Education website:
http://www.ed.gov/about/offices/list/ocr/edlite-minorityinst.html

Research Misconduct
Scientific or research misconduct refers to the fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. It does not include honest errors or differences of opinions. The Grantee organization has the primary responsibility to investigate allegations and provide reports to the Federal Government. Funds expended on an activity that is determined to be invalid or unreliable because of scientific misconduct may result in a disallowance of costs for which the institution may be liable for repayment to the awarding agency. The Office of Science and Technology Policy at the White

House published in the Federal Register on December 6, 2000, a final policy that addressed research misconduct. The policy was developed by the National Science and Technology Council (65 FR 76260). The NRC requires that any allegation be submitted to the Grants Officer, who will also notify the OIG of such allegation. Generally, the Grantee organization shall investigate the allegation and submit its findings to the Grants Officer. The NRC may accept the Grantee's findings or proceed with its own investigation. The Grants Officer shall inform the Grantee of the NRC's final determination.

Publications, Videos, and Acknowledgment of Sponsorship

Publication of the results or findings of a research project in appropriate professional journals and production of video or other media is encouraged as an important method of recording and reporting scientific information. It is also a constructive means to expand access to federally funded research. The Grantee is required to submit a copy to the NRC and when releasing information related to a funded project include a statement that the project or effort undertaken was or is sponsored by the NRC. The Grantee is also responsible for assuring that every publication of material (including Internet sites and videos) based on or developed under an award, except scientific articles or papers appearing in scientific, technical or professional journals, contains the following disclaimer:

> "This [report/video] was prepared by [Grantee name] under award [number] from [name of operating unit], Nuclear Regulatory Commission. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the view of the [name of operating unit] or the US Nuclear Regulatory Commission."

2010 Scholarship Program
Service Agreement

1. This service agreement is required for all student recipients of scholarships (hereinafter referred to as the "recipient") funded by the U.S. Nuclear Regulatory Commission (NRC) through Howard University.

2. This agreement confirms the recipient's obligations to maintain satisfactory academic progress and serve 6 months in nuclear-related employment for each full year of academic support. The employment may be with nuclear-related industry, State agencies, Department of Energy laboratories, the NRC or other Federal agencies, or academia in the recipients' sponsored fields of study.

3. The scholarship recipient must:

   a. remain matriculated in the degree program for the field of study for which the scholarship was approved,

   b. maintain satisfactory academic progress in the recipient's field of study, and

   c. maintain a course load of at least 12 credit hours per semester as a full-time student in good standing.

4. If a recipient fails to maintain satisfactory academic progress, the scholarship will be terminated and the recipient could be obligated to repay the NRC the full amount of the scholarship/fellowship.

5. If a recipient receives any subsequent scholarship(s) through this program, the service obligation periods will be consecutive.

6. At the discretion of the NRC, the service obligation period may be delayed to allow the recipient to continue a subsequent degree program immediately following that sponsored under this program. For example, if a recipient receives a scholarship to earn a baccalaureate degree, he/she may request and be permitted to delay fulfilling their service obligation until after they complete a subsequent terminal degree program. Any such requests must be made to the NRC before a student enrolls in a subsequent degree program. If a student enrolls in a subsequent degree program before or without NRC approval, and the NRC does not subsequently approve the request, the NRC will not be held liable for any expenses incurred to dis-enroll, or for failure to otherwise meet the terms of this service obligation. Recipients only incur a service obligation to NRC for funded periods of study.

7. If the student receives no employment offers or does not accept any of the offers received, the student is not relieved of the service obligation, unless, pursuant to this service agreement, the student applies for and receives a waiver from the NRC. Implicit in the waiver request is data or explanation by the student that efforts to secure employment in a nuclear-related field were undertaken. This can be in the form of job searches, referrals, etc. Absent a waiver from the NRC, rejection of one or more job offers could trigger the service agreement obligation.

8. If a recipient voluntarily leaves the employment of an approved employer in a field related to nuclear power during the period of obligated post-academic service, the recipient may immediately become liable to the U.S. Government for repayment of the entire amount of the assistance provided under the scholarship for which the service obligation has not been fulfilled.

9. By accepting this scholarship/fellowship, I agree to provide the NRC with current contact information (address, telephone, email), and employment information, subject to the provisions of the Privacy Act, for as long as I remain under obligated service. This information will be used solely for the purposes of verifying appropriate nuclear related employment in compliance with the service obligation requirements of this service agreement. In accordance with the Privacy Act, providing this information is voluntary; however, failure to do so may result in removal from the scholarship/fellowship program and/or repayment of all scholarship/grant money received. Contact information should be reported to: eduscholar@nrc.gov.

10. By signing this agreement, the recipient certifies that he or she has read this agreement and agrees to all of the obligations it entails.

Scholarship Recipient	Date
Institution Program Coordinator	Date
NRC Office of Small Business & Civil Rights Minority Serving Institutions' Program	Date