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

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-HQ-12-G-38-0077		FROM: 08/31/2012 TO: 08/31/2014	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	Private Institution of Higher ED DUNS: 002257350 NAICS: 611310	Syracuse University 113 Browne Hall Syracuse, NY 13244-1200 Email:

8. PROJECT TITLE:

A Broad Based Nuclear Engineering Track at Syracuse University

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 See Program Description AND APPENDIX A-PROJECT GRANT PROVISIONS	[X] PROGRESS AND FINAL [ ] FINAL ONLY [ ] OTHER (Conference Proceedings)	Mr. Lawrence Tavlarides Syracuse University 113 Browne Hall Syracuse, NY 13244-1200 Email:

12. NRC PROGRAM OFFICE (NAME and ADDRESS)	13. ACCOUNTING and APPROPRIATION DATA	14. METHOD OF PAYMENT
NRC Attn: Tanya Parwani-Jaimes Office of the Chief Human Capital Officer MS: GW5A06 (301) 492-2308 11545 Rockville Pike Rockville, Maryland 20852 Email:	APPN. NO: 31X0200 B&R NO: 2012-84-51-K-134 JOB CODE: T8453 BOC NO: 4110 OFFICE ID NO: HR-12-303 FAMIS: GR0216	[ ] 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	$200,000.00	NRC	$200,000.00
PREVIOUS OBLIGATION		RECIPIENT	$199,859.00
TOTAL	$200,000.00	TOTAL	$399,859.00

This action provides funds for Fiscal Year 2012 in the amount of $200,000.00

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

U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn: Shashi Malhotra, Email:
Mail Stop: TWB-01-B10M
Rockville MD 20852

18.	19. NRC CONTRACTING OFFICER
Signature Not Required	Sheila Bumpass (Signature) 08/31/12 (Date) NAME (TYPED): Sheila Bumpass TITLE: Grants 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 ADM002

ATTACHMENT A - SCHEDULE

A.1 PURPOSE OF GRANT

The purpose of this Grant is to provide support to the "Syracuse University– A Broad Based Nuclear Engineering Track at Syracuse University" as described in Attachment B entitled "Program Description."

A.2 PERIOD OF GRANT

1. The effective date of this Grant is August 31, 2012. The estimated completion date of this Grant is August 31, 2014.

2. Funds obligated hereunder are available for program expenditures for the estimated period: August 31, 2012 – August 31, 2014.

A. GENERAL

1. Total Estimated NRC Amount:	$200,000.00
2. Total Obligated Amount:	$200,000.00
3. Cost-Sharing Amount:	$199,859.00
4. Activity Title:	A Broad Based Nuclear Engineering Track at Syracuse University
5. NRC Project Officer:	Tanya Parwani-Jaimes
6. DUNS No.:	002257350

B. SPECIFIC

RFPA No.:	HR-12-303
FAIMIS:	GR0216
Job Code:	T8453
BOC:	4110
B&R Number:	2012-84-51-K-164
Appropriation #:	31X0200
Amount Obligated:	$200,000.00

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**
Personnel	$ 59,574.00	$61,363.00
Fringe Benefits	$ 11,767.00	$12,120.00
Travel	$ 2,000.00	$ 2,000.00
Supplies	$ 1,341.00	$ 1,350.00
Total Direct Charges	$ 74,682.00	$76,833.00
Indirect Charges	$ 23,898.00	$24,587.00
Yearly Total	**$98,580.00**	**$101,420.00**

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is $399,859.00 including a cost share amount of $199,859.00 by the University for a two year period.

2. NRC hereby obligates the amount of $200,000.00 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 Grants 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

A BROAD BASED NUCLEAR ENGINEERING TRACK AT SYRACUSE UNIVERSITY

Innovative Structural Approaches: The Nuclear Engineering Track (NET) of the Energy Systems Minor (Fig. 1) at the L. C. Smith College of Engineering & Computer Science (LCS) of Syracuse University (SU) has numerous innovative approaches to enhance student learning due in large part to significant participation of Constellation Energy (CENG) – Nine Mile Point (NMP) plant, and Oak Ridge National Laboratory (ORNL). LCS has long standing relations with both of CENG and ORNL, and as articulated in their strong letters of support, they will provide significant contributions to this initiative at no cost.

CENG and ORNL will make available *experiential learning* to our NET students. Specifically, CENG will provide internships during the academic semesters and co-ops in the summer for 2 to 3 NET students per year where they will be involved with plant related experiences. Similarly, ORNL will support at least one qualified LCS NET student per year for our summer or academic semester internship research program at ORNL to work on scientific projects that will include hands-on experiences with advanced experimental and computational methods. Alternatively, a student may work with a NET faculty on a research or design project at SU. CENG has made its facilities available at the NMP plant for several real world experiences and has permitted the students to tour their Boiling Water Reactor plants and interact with personnel explaining the functional aspects. CENG-NMP will provide staff as adjunct professors to assist in curriculum development, offer courses or provide invited lectures for courses taught by LCS faculty. ORNL personnel will be invited to prepare several key lectures (2-4 per year) in topics of their expertise and of interest to particular courses. Also, ORNL will offer an elective Laboratory Research Study course for interested NET students taking part in the ORNL internship or co-op program.

There is interest among ORNL staff and LCS faculty to collaborate in research and secure grants to support graduate students interested in nuclear engineering. These students could take the NUC 500-level courses. The students can execute part of their research at ORNL using the Radiological Engineering Development Center. Consequently, our NET students will be excellent prospects for nuclear industry and research positions. A recent DOE-NEUP grant [Tavlarides, 2011] with collaborators from Georgia Institute of Technology, Prairie View Texas A&M and ORNL on "Sorption Modeling and Off Gas Treatment"1 will provide another venue for NET students to participate in collaborative research at LCS or ORNL. In addition LCS has received a DOE grant [Tavlarides, 2010] for equipment to support our Nuclear Engineering Track course NUC520 to understand design and operation of relevant separation processes.

A University Champion from the Nuclear Regulatory Commission, Dr. M. Norato, has recently been assigned to SU. Through this relationship we will explore programs for internships in research and engineering experiences for our students at NRC.

Further, another important innovative educational approach is that SU is collaborating with Onondaga Community College (OCC) who is developing an A.A.S. in Nuclear Engineering Technology. LCS and OCC have a long history of providing pathways to transfer students. Through a new articulation agreement, graduates of OCC's nuclear technology program can transfer as juniors in one of the LCS engineering programs and complete our NET, thus creating an additional pathway for these students with associate degrees to continue their studies at the baccalaureate level. This will be further enhanced as OCC has recently received an NRC Curriculum Development Grant [McColgin, 2011].

Timeline of Proposed Activities: LCS has an approved Energy Systems Minor; the NET will be a component of this program. Accordingly, NET will start Fall-2012. The timeline for the program's major activities is shown in Fig. 2. NET course scheduling for each discipline is listed in Table 1. Funds are sought to develop, then assess, revise and improve only NUC510, NUC520 and NUC570 listed in Table 1. The other courses (MAE548 and MAE551, and a predecessor of NUC530) have been offered regularly at SU for years; no NRC funds are sought for their development. NUC201 has been offered Spring-2011 with 21 students from 4 engineering disciplines. NUC520 will be offered Spring-2012. While NUC201 and NUC530 have already been developed, they will be revised and updated; funds are sought for that purpose.

Improvements Resulting from Project: The proposed project will make a substantial improvement to the L.C. Smith College of Engineering and Computer Science *educational infrastructure* in that a Nuclear Engineering Track will add a nuclear tract to the existing Energy Systems Minor. Our NET is designed such that all our engineering students regardless of specific discipline can enter the program. Accordingly, this newly developed infrastructure will permit our College to prepare engineers for the nuclear engineering profession with a knowledge base to learn how to design, operate and manage nuclear power facilities in a safe and reliable manor in the Northeast USA and beyond. Our articulation agreement with Onondaga will permit their interested students with an A.A.S. in nuclear engineering technology to secure a baccalaureate degree in engineering with our NET and be a greater asset to the nuclear industry. Further, a portion of our graduates will take advanced degrees and become the next generation of engineering research scientists enabling them to take positions in our National Laboratories and the nuclear industry at large. These individuals will address the challenging issues in the nuclear industry such as nuclear safety, design of Generation IV reactors, nuclear fuel reprocessing, and non-proliferation issues.

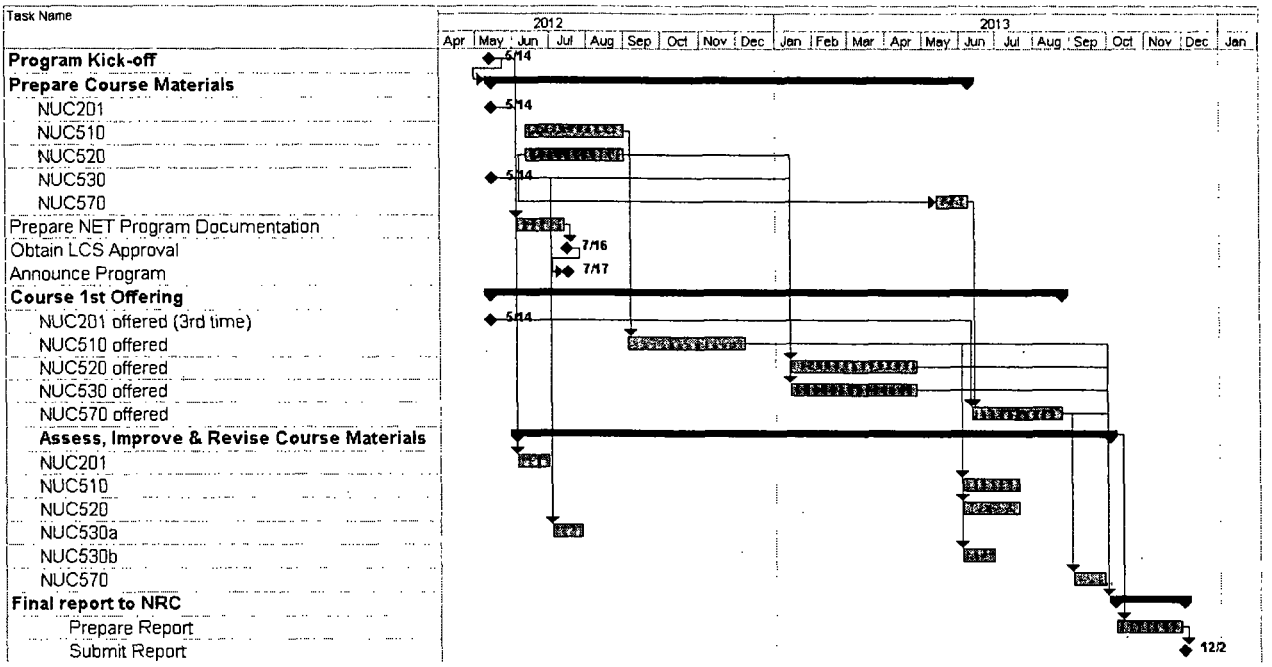

Figure 2 Project Timeline

The funds will improve faculty *subject matter expertise* by freeing time to prepare course material. The project will foster closer interactions with CENG staff through visits to the NMP plants whereby our faculty will understand plant operation procedures, experimental laboratory methods used in power plant monitoring, and safety methods employed throughout the facility. Further, CENG provided two engineers to co-teach NUC201 in Spring-2011 with Prof. T. Turnipseed of SU's College of Law and LCS and Prof. H. E. Khalifa of LCS. Prof. Turnipseed has BS and MS degrees in Nuclear Engineering from Mississippi State and MIT, respectively. These and other CENG personnel will assist in classes taught by other LCS faculty who will benefit from knowledge shared, curriculum development, and understanding nuclear safety issues. Similarly, interactions with ORNL personnel, who will also deliver special lectures, will benefit our faculty as we learn from their expertise. Faculty *skills* in the target disciplines will also be developed through the above mentioned visits to the CENG facilities and interactions with ORNL staff by learning various experimental techniques and studying CENG-NMP training materials, developed in accordance with guidance from the National Academy for Nuclear Training under the auspices of the Institute of Nuclear Power Operations.

Project Academic Focus: Nuclear safety will be integrated into the NET courses as they are developed based on the information we receive from CENG-NMP, ORNL and literature references. For example, in the NUC510 course on Nuclear Power Plant Design, Operation and Safety will describe various nuclear accidents or incidents, their severity, and procedures in place to prevent them. These include: (1) the Japanese Fukushima nuclear power plant incident as a result of the off shore earthquake and tsunami that occurred on March 11, 2011 will be reviewed. Revised safe guards developed and/or being implemented by the Nuclear Regulatory Commission for US nuclear power plants will be discussed. (2) The level-7 major accident at Chernobyl, USSR resulting in external release of radioactive material radiologically equivalent to more than tens of thousands of terabecquerels of 131I; and (3) the level-5 accident with offsite risk at Three-Mile Island near Harrisburg, PA, which had the potential to release radioactive materials [IAEA, 2001]. In the latter case some radioactive gas was released but not enough to

cause any dose above background levels to local residents. Lectures will be provided by CENG staff on the developing and latest safety standards employed to protect the nuclear core. These lectures will include "Defense in Depth Strategies" and redundancy of systems to ensure nuclear safety. The visits to the Nine Mile Point plants can highlight these issues. Similarly, in the NUC520 course on Radiochemistry, Nuclear Fuel Reprocessing and Nonproliferation, the Fukushima incident and other examples of accidents that have occurred at reprocessing plants and sites leading to liquid and gaseous releases such as fires, explosions and loss of coolant will be described and discussed [Schneider, 2001].

Expert ORNL staff will be invited to present lectures on nonproliferation and other topics at SU or through distance learning. We will work with both CENG-NMP and ORNL to have lectures and demonstrations delivered through distance learning systems so that students can participate and interact from our classrooms.

Two other methods to introduce the student to nuclear safety issues will be through a nuclear engineering seminar series, and inclusion of nuclear engineering design projects in required discipline-specific senior design courses for the NET students. For the former a set of six seminars will be presented through the NET program in which speakers will be asked to highlight nuclear safety issues in their presentations. The students will be required to attend these zero credit seminars, and have a dedicated lunch with the speaker. For the latter, NET students required to take a design course as part of their curriculum will select a project that emphasizes nuclear safety. For example, NET students in chemical engineering taking the CEN576 design course will be given projects on nuclear fuel reprocessing. Options are: (1) an adsorption column system design for off gas capture and treatment in concert with the recent DOE research grant received1; (2) the safe design of the lanthanides-actinides separation stage using centrifugal contactors for the TALSPEAK (trivalent actinide-lanthanide separation by phosphorus reagent extraction from aqueous komplexes) process in nuclear fuel reprocessing (centrifugal contactors experiments will be functional for the NUC520 course); and (3) design and evaluate the use of adsorption columns to remove cesium (137Cs) and strontium (90Sr) in fuel reprocessing, as opposed to solvent extraction using centrifugal contactors, and the safety implications and possible explosions if cooling water flow fails in the column heat exchangers.

Our faculty has the advantage to interact with CENG-NMP and ORNL staff for other design. project suggestions. A potential project at CENG-NMP could be to understand plant retrofitting safeguards against earthquakes. Another could be to perform design calculations for minimum pipe wall thicknesses in areas where Flow Accelerated Corrosion is present. The NET faculty will interact with CENG-NMP professionals who will assist in nuclear engineering design projects. Furthermore, a college wide committee is developing a cross-disciplinary design experience that would prepare students from different departments to work collaboratively and to function effectively in an industrial environment. This collaborative approach will be considered for NET students as well.

Innovative Instructional Approaches to Enhance Student Learning: Various innovative instructional techniques to *enhance student learning* include the NUC570 course on Experiential Studies at ORNL, CENG or SU. The student will work with a research scientist on a project leading to a report that will be the basis for the grade. The students will use state-of-the-art equipment and computational facilities. For the ORNL experience they will be introduced to facilities such as the Radiochemical Engineering Development Center, which contains 9 hot cells wherein chemical processing equipment for dissolution, solvent extraction, ion exchange and precipitation are accessible. These and other such facilities may be used in their internship.

The support lectures given by CENG-NMP and ORNL staff to the classes as mentioned above will introduce the students to experts in the topics on which they lecture. Similarly, the nuclear engineering seminar series to be offered will introduce the students to experts in the nuclear safety field and other related topics. The students will have lunch with the speakers and have an opportunity to ask questions then as well as during the seminar to better understand the topic. LCS has the technology and experience to incorporate *distance learning* into this program. We will work with our partners to explore opportunities to have distance access to lectures, seminars and demonstrations at ORNL and CENG-NMP.

Further, the *experiential learning* mentioned above will be a major enhancement of the student's development. These include visits to CENG-NMP for several real-world experiments and the tour of their BWR plants with engineers assisting in the experience and explaining the facilities. A valuable aspect of the program will enable students to have the opportunity to experience coop or internship studies at CENG or ORNL. This "hands on" training with plant or research engineers will have a significant impact on their education.

Project Emphases on Curricula and Individual Courses: The curriculum developed for the program has been designed to permit students of all engineering disciplines in LCS to pursue the NET within the existing SU minor degree structure. The required courses can be taken within the social sciences and technical elective course options for all the engineering disciplines. The program structure is shown in Table 1. NUC510, 520, 530 and 570 will be offered starting Fall-2012, along with the existing MAE551 and 548. To launch the program, NET sophomores will take NUC201 in Spring-2012 and can take NUC510, 520 and 530 in the following 2012-13 academic year. The 500-level courses at SU may be taken for graduate credit to motivate additional graduate enrollment. Support is requested only to develop NUC510, 520 and 570, and to assess, revise and update NUC201, 510, 520, 530 and 570.

The proposed outlines of the NUC courses are as follows:

NUC201: Introduction to Nuclear Engineering & Reactor Safety *(Prof. Turnipseed + Adjunct Professors from CENG-NMP)*

The course will have primary objectives to introduce the student to: 1. the importance of nuclear energy to society, 2. nuclear and radiological engineering, 3. nuclear energy production, 4. radioactive waste, 5. reactor safety.

Topics to be cover include: **1.0.** World Energy Consumption-Present and Future Projections: **1.1.** Projected World Energy Resources and the Role of Nuclear Energy; **1.2.** Environmental Impact of Energy Sources; **1.4.** World Nuclear Power Industry. **2.0.** Introduction to Nuclear Physics & Chemistry: **2.1.** History of Nuclear Science and Applications; **2.2.** Basic Concepts of Nuclear Chemistry -- 2.2.1. Atoms and Nuclei, 2.2.2. Radioactivity, 2.2.3. Radiation Types, Sources and Detection, 2.2.4. Nuclear Processes. **3.0.** Description of Nuclear Reactors: **3.1.** Nuclear Plant Tour; **3.2.** Advanced Nuclear Reactors: Generation IV; **3.3.** World Nuclear Power Industry; **3.4.** Nuclear Facility Regulation. **4.0.** Nature and Quantity of Power Plant Nuclear Waste: **4.1.** Nuclear Waste Reprocessing Concepts; **4.2.** Nuclear Waste Long Term Storage Issues. **5.0.** Reactor Safety: **5.1.** Neutron Population Growth; **5.2.** Assurance of Safety; **5.3.** Emergency Core Cooling and Containment; **5.4.** Fukushima Earthquake and Tsunami Incident and Lessons Learned; **5.5.** Chernobyl Accident and Lessons Learned; **5.6.** Three Mile Island Accident and Lessons Learned; **5.7.** Safe Onsite Storage of Spent Nuclear Fuel.

The course will feature experiential learning through trips to CENG-NMP for a tour of their BWR plant and interaction with personnel explaining the functional aspects. Real world experiences will be used to illustrate some key radiological concepts to students. Further, CENG-NMP personnel will present invited lectures on Nuclear Reactor safety, "Defense in Depth Strategies", and redundancy of systems to ensure nuclear safety.

Textbook: Nuclear Energy: An Introduction to the Concepts, Systems, and Application of Nuclear Processes, R. L. Murray, Butterworth-Heinemann, 2009.

NUC510: Nuclear Power Plant Design, Operation and Safety *(Prof. Khalifa)*

The objectives of this course is to introduce the student to the basics of fission reactor design and control, nuclear power plant design and safety, and to provide an understanding of nuclear power plant design criteria, thermal efficiency and safety. Issues involved in design, operation and safety will be discussed. Design problems will be included.

The following topics will be covered in this course. **1.0.** Introduction: **1.1.** Properties of Nuclei, **1.2.** Binding Energy/Mass Defect; **1.3.** Fission and Fusion Reactions; **1.4.** Release of Energy by Nuclear Reaction; **1.5.** Initiation of Nuclear Reactions; **1.6.** Chain Reactions; **1.7.** Role of Moderator; **1.8.** Nuclear Cross-section; **1.9.** Reaction Rates; **1.10.** Transmutation of Fertile Materials and Breeding. **2.0.** Fission Reactors: **2.1.** Reactor Terminology; **2.2.** Nuclear Reactor Components; **2.3.** Nuclear Fuel; **2.4.** Types of Nuclear Power Reactors: LWR (PWR, BWR), CANDU reactor, HTGCR, Advanced Gen IV Reactors, Fast Breeder Reactor (FBR). **3.0.** Nuclear Reactor Theory: **3.1.** Multiplication Factor and Reactivity Coefficient; **3.2.** Criticality; **3.3.** Neutron Absorption and Scattering Cross Sections; **3.4.** Neutron Diffusion; **3.5.** Delayed Neutrons; **3.6.** Reactor Kinetics; **3.7.** Control of Reactor Operation; **3.8.** Core Design; **3.9.** Fuel Consumption. **4.0.** Thermo-fluid-dynamics of Fission Reactors: **4.1.** Heat Generation and Energy Transfer in Reactor Core; **4.2.** Core Heat Removal; Boiling Heat Transfer – Critical Heat Flux; **4.3.** Void Coefficient; **4.4.** Thermo-fluid-dynamics of 2-Phase Flow in BWR and PWR's Steam Generators. **5.0.** Nuclear Energy Conversion: **5.1.** Light Water Reactor Power Plants (PWR and BWR); **5.2.** CANDU Reactor Power Plant; **5.3.** HTGCR Power Plant (Gas-Steam and Gas-Gas); **5.4.** Steam Power Cycles; **5.5.** Nuclear Steam Power Plant Components: Steam Generators, Pressurizers (PWR), Nuclear Steam Turbines, Moisture Separators, Feedheaters, Condensers; **5.6.** HTGCR/Gas Turbine Plant, Closed Brayton Cycle; **5.7.** Advanced Nuclear Energy Conversion Systems; **5.8.** Fusion Power. **6.0.** Nuclear Reactor Safety: **6.1.** Safety Characteristics of LWRs, Gas-cooled reactors and FBRs; **6.2.** Radiation Protection and Shielding; **6.3.** Decay heat management; **6.4.** Loss of Coolant accidents; **6.5.** Nuclear Reactor Accidents Case Studies (Three Mile Island, Chernobyl, Fukushima Da-Ichi); **6.6.** Safety Improvements in Advanced Gen IV Reactors.

Expert ORNL staff will be invited to present relevant lectures through distance learning using video conferencing (see Dr. J. L. Binder's ORNL letter).

Prerequisites: NUC201 and MAE551.
Textbook: Introduction to Nuclear Engineering, J. R. Lamarsh and A. J. Baratta, 3rd Ed., Prentice Hall, 2001 (*tentative selection*). Other sources will be reserved in the library.

NUC520: Radiochemistry, Nuclear Fuel Reprocessing & Nonproliferation *(Prof. Tavlarides)*
The course will have four primary objectives: 1. develop an understanding of radiochemistry as applicable to nuclear reactors and nuclear fuel reprocessing; 2. develop an awareness of nonproliferation issues through detection and monitoring; 3. develop an understanding of

nuclear fuel reprocessing and design issues, nuclear waste vitrification for storage, and storage facility requirements; 4. develop an understanding of safety issues in nuclear fuel reprocessing.

Topics to be considered include: **1.1.** Atomic Theory and Nuclei; **1.2.** Radioactivity, Radioactive Decay, Decay Law, and Types and Rate of Decay; **1.3.** Decay Chains; Batch Decay, Continuous Production, and Continuous Production and Shut-down; **1.4.** Nuclear Processes; **1.5.** Radiation and Materials; **1.6.** Fission Process. **2.1.** Key Issues on Nonproliferation; **2.2.** Advanced Radiation Detectors; **2.3**. Nuclides Detection and Accounting in Power Plants and Reprocessing Facilities. **3.0** Nuclear Fuel Cycle **4.1.** Spent Nuclear Fuel Inventory in USA; **4.2.** Nuclear Fuel Reprocessing Methods/Facilities: PUREX at Hanford, WA, UP3 at La Hague, France, and THORP at Sellafield, England; **4.3.** The UREX +1a Process - 4.3.1. Sorption Capture of Radioactive Gases, 4.3.2. Solvent Extraction for Separation of Nuclides and Fission Products, 4.3.3. Adsorption for Separation of Nuclides; **4.4.** Vitrification Process for Fission and Nuclear Waste Products; **4.5**. Requirements of Nuclear Waste Storage Repositories. **5.0.** Reprocessing Facility Safety Issues; **5.1.** Probabilistic Risk Assessment; **5.2.** Case Study 1: Cooling Water Failure Example for 137Cs/90Sr Adsorption Column; **5.3.** Case Study 2: Safety Issues for Nuclear Waste Acceptance and Storage at Reprocessing Sites.

Expert ORNL staff will be invited to present lectures on nonproliferation and other topics at SU or through distance learning using video conferencing (see Dr. J. L. Binder's ORNL letter).
Textbooks and References: 1. Benedict, Manson; Pigford, Thomas H.; Levi, Hans Wolfgang; Nuclear Chemical Engineering. McGraw-Hill 2nd Ed, 1981. 2. Lieser, Karl Henrich; Nuclear and Radiochemistry. Wiley-VCH, 2nd Ed., 2001. 3. Croff, A.G., Wymer, R. G., Tavlarides, L. L., Flack, J. H., Larson, H.G.; Background, Status, and Issues related to the Regulation of Advanced Spent Nuclear Fuel Recycle Facilities. ACNW&M White Paper. U.S.NRC, June, 2008.
Prerequisite: NUC201.

NUC530: Electric Power Generation and Distribution *(Prof. P. K. Ghosh)*
This course will introduce the students to energy conversion and electric power generation. The course objectives include: a) development of a clear understanding of the fundamental principles governing the electric power generation; b) learning about electric power generation and distribution systems; c) developing the knowledge base necessary for the design and analysis of AC machines, transformer; d) learning about onsite power system design within the Nuclear power plant; and e) developing a general understanding of the diverse safety issues related to power generation and delivery in nuclear power plants.

Our tentative plan is to cover following topics in this course: **0.0.** Electromagnetic Coupling. **1.0.** AC Circuits; **1.1.** Single-Phase Circuits; **1.2.** Three-Phase Systems. **2.0.** Transformers; **2.1.** Transformer Operation; **2.2.** Transformer Equivalent Circuit. **3.0.** AC Machines; **3.1.** Synchronous Generators; **3.2.** Equivalent Circuit; **3.3.** Speed and Frequency. **4.0.** Power Distribution Systems. **5.0.** Power Measurements. **6.0.** Balanced and Unbalanced Polyphase Systems. **7.0.** On-site Power System Design in the Nuclear Power Plant; **7.1.** Voltage and Frequency Limitations; **7.2.** Emergency Power Sources; **7.3.** Emergency Generators; **7.4.** Alternative Power Sources; **7.5.** Battery Capacity and Charging Requirements; **7.6.** Load Rejection and Loss-of-Load events. **8.0.** Grid Stability and Safety Issues associated with the Nuclear Power Plant. **9.0.** Design Standards and Safety Regulations for the Power System in the Nuclear Power Plant. **10.0**. Case Study: Past Grid Failure and Lessons Learned.

Textbooks and References: 1. S. J. Chapman: Electric Machinery & Power System Fundamentals. 2. J. Grainger and W. L. Stevenson: Power System Analysis. 3. Fitzgerald,

Kingsley and Umans: Electric Machinery. 4. National Research Council: Digital Instrumentation and Control Systems in Nuclear Power Plants: Safety and Reliability Issues. In addition, class notes will be provided.

NUC570: Experiential Studies *(Prof. Tavlarides – Coordinator; ORNL, CENG-NMP advisors)* NET students will have the option to participate in research projects and experiences with experimental methods at ORNL, CENG-NMP, or SU. The program at ORNL was initiated in 2002, and during 2010 had over 50 supported participants (see supporting letter by ORNL). NET students, especially those interested in graduate studies, will be encouraged by NET faculty to apply to ORNL either during summers or academic semesters. Their application will describe their field(s) of interest, and those accepted by the program coordinators will be assigned a research mentor at ORNL. At least one qualified student will be funded by ORNL.

The NET students participating in the ORNL program may take a 3-credit laboratory research study during their internships. The laboratory research study will be on an individual basis between the student and the research mentor, in communication with the NET faculty advisor who approves the assignment. It is expected that a NET student taking a laboratory research study will carry out a literature review on the research topic, perform the research, write a report using a general journal article format, and defend the results in a presentation (oral or poster) at ORNL. Further the student will be introduced to facilities such as the Radiochemical Engineering Development Center which may be used for their studies or for an understanding of experimental methods used in processing radiochemicals.

Two or three NET students per year will participate in the CENG-NMP internship program involving plant related experiences, and may have the internship structured for the experiential studies course. The internship will be for the summer or for an academic semester. The student will be assigned a project with her/his mentor at CENG-NMP, in consultation with the NET faculty advisor who approves the assignment. The student will write a report on the project experience according to procedures employed at CENG-NMP.

In both cases the mentor will evaluate and grade the performance of the student performance and communicate the grade to the NET faculty advisor.

Also, NET students can apply to conduct a research or design experience with a NET faculty advisor, who will define the project. The student will execute a literature survey; conduct experiments or computations or execute a design project; prepare a final report and make a presentation to a NET faculty committee. The NET advisor will grade the performance. ***Prerequisites:*** NUC201.

Implementation: The NET is designed and implemented as a preferred Energy Systems Minor option to students in all engineering programs in the LSC. As such, it not only gives the students a well-focused set of courses, but also recognizes the students' contribution by awarding them a minor degree, indicated in the students' official transcript. Hands-on learning experiences, including summer internships and capstone projects are built into the program to further motivate students and prepare them for a career in the nuclear industry.

Sustainability: Financial and other support acquired from nuclear and electric utility industry partners as well as government and regulatory agencies will help develop courses, experiential learning opportunities, and other program components. The long-term sustainability of the program will come from the tuition generated by the program courses. The engineering courses in NET are available as technical electives to all students with appropriate background, thus

serving a population broader than the students in the NET program, and practically guaranteeing that once developed, these courses will be tuition supported.

We anticipate, based on the upcoming demand for engineers in the nuclear power industry, that there will be extensive internship and employment opportunities in the nuclear field. Our industry and/or adjunct professors, and seek to employ our graduates in their nuclear power plant facilities. Our ORNL partner has agreed to provide at least one internship per year for qualified applicants and mentor students in the experiential learning course. Also, expert ORNL staff will be invited to present lectures on nonproliferation and other topics at SU or through distance learning using video conferencing.

Quantifiable Criteria to Demonstrate Program is Sustainable: The following criteria will be used to demonstrate and track the sustainability of the NET:

1. Institutional commitment: SU will introduce the proposed courses, and offer them according to the schedule shown in Fig.2. The timely completion of the course development and the regular scheduling of the courses with qualified instructors will demonstrate this criterion.

2. Tuition-supported courses: The initial offering of the courses in NET will be guaranteed by SU, regardless of their enrollment. Long-term sustainability of the program requires sufficient enrollment. Tuition revenue of the courses will be utilized to track financial sustainability.

3. Student demand: SU and our industry partners will collaborate to attract a critical mass of students to NET. Furthermore, the articulation program with OCC will aid both sustainability of both institutional programs and provide an impetus for students to enroll in OCC's program with the opportunity to transfer to the LCS NET program. The number of first-year and transfer students who enroll in NET will be tracked to demonstrate this criterion.

4. Industry support: The demand for and the success of NET is strongly correlated to the support from the industry who will employ its students. The number of NET students who are employed as summer interns and graduates who are hired for full-time positions in the nuclear industry will be tracked to demonstrate this criterion.

Outcomes Assessment and Continuous Curriculum Improvement: All undergraduate major programs in the LCS are ABET accredited, the foremost accreditation agency for engineering programs. The outcomes of the NET courses will be assessed regularly, and the program will be an integral part of the College's continuous curriculum improvement process.

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 this URL to the Office of Management and Budget Cost Circulars is included for reference to:
A-21 (now 2 CFR 220)
A-87 (now 2 CFR 225)
A-122 (now 2 CFR 230
A-102:

http://www.whitehouse.gov/omb/circulars_index-ffm

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.

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 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

§ 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 and 2 CFR 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 VI 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 VI, 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's 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 should 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, 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, § 215.40-48
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 must be in accordance with the Grantee's Travel Regulations or the US Government Travel Policy and Regulations at: www.gsa.gov/federaltravelregulation and the per diem rates set forth at: www.gsa.gov/perdiem, absent Grantee's travel regulation. Travel costs for the grant must be consistent with provisions as established in Appendix A to 2 CFR 220 (J.53). All other travel, domestic or international, must not increase the total estimated award amount.

Domestic Travel:
Domestic travel is an appropriate charge to this award and prior authorization for specific trips are not required, if the trip is identified in the Grantee's approved program description and approved budget. Domestic trips not stated in the approved budget require the written prior approval of the Grants Officer, and must not increase the total estimated award amount.

All common carrier travel reimbursable hereunder shall be via the least expensive class rates consistent with achieving the objective of the travel and in accordance with the Grantee's policies and practices. Travel by first-class travel is not authorized unless prior approval is obtained from the Grants Officer.

International Travel:
International travel requires PRIOR written approval by the Project Officer and the Grants Officer, even if the international travel is stated in the approved program description and the approved budget.

The Grantee shall comply with the provisions of the Fly American Act (49 USC 40118) as implemented through 41 CFR 301-10.131 through 301-10.143.

Property and Equipment Management Standards
Property and equipment standards of this award shall follow provisions as established in 2 CFR 215.30-37.

Procurement Standards
Procurement standards of this award shall follow provisions as established in 2 CFR 215.40-48

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 and retain title 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 for this award shall follow OCOI requirements set forth in Section 170A of the Atomic Energy Act of 1954, as amended, and provisions set forth at 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 an intra-agency Appeal Board to review a grantee appeal of an agency action, if required, which will consist of the program office director, the Deputy Director of Office of Administration, and the Office of General Counsel.

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 215.60-62.

Monitoring and Reporting § 215.50-53

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 or deducted from the total project cost allowable cost as directed by the Grants Officer or the terms and conditions of award.
- Budget Revision – 2 CFR 215.25
  - The Grantee is required to report deviations from the approved budget and program descriptions in accordance with 2 CFR 215.25,and request prior written approval from the Program Officer and the Grants Officer.
  - The Grantee is not authorized to rebudget between direct costs and indirect costs without written approval of the Grants Officer.

- The Grantee is authorized to transfer funds among direct cost categories up to a cumulative 10 percent of the total approved budget. The Grantee is not allowed to transfer funds if the transfer would cause any Federal appropriation to be used for purposes other than those consistent with the original intent of the appropriation.
- Allowable Costs – 2 CFR 215.27

b. **Federal Financial Reports**

The Grantee shall submit a "Federal Financial Report" (SF-425) on a semi-annual basis for the periods ending March 31 and September 30, 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 is due within 90 days after expiration of the award. The report should be submitted electronically to: Grants_FFR@NRC.GOV. ***(NOTE: There is an underscore between Grants and FFR).***

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 should 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 may 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 on a semi-annual basis unless otherwise authorized by the Grants Officer. Performance reports should be sent to the Program Officer at the email address indicated in Block 12 of the Notice of Award, and to Grants Officer at: Grants_PPR.Resource@NRC.GOV. ***(NOTE: There is an underscore between Grants and PPR).***

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 Office of Chief Human Capital Officer (OCHO) requires the submission of the semi-annual progress report on the SF-PPR, SF-PPR-B, and the SF-PPR-E forms. The submission for the six month period ending March 31st is due by April 30th, or any portion thereof. The submission for the six month period ending September 30th is due by October 31st or any portion thereof.

d. 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.

As part of the OCHO grant awards, in addition to the customary performance progress report requested on the SF-PPR, SF-PPR-B, and SF-PPR-E forms, HR requires the following metrics to be reported on by the awardees as follows:

Curriculum Development Awards

1. Overall number of new courses developed in NRC designated STEM areas (including the names of the courses);
2. Number of students enrolled in new STEM courses;
3. Number of these enrolled students retained in STEM major.

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 hereby 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 Leadership of Reducing Text Messaging While Driving
Pursuant to EO 13513, Grantees should encourage employees, sub-awardees, and contractors to adopt and enforce policies that ban text messaging while driving company-owned, rented vehicles or privately owned vehicles when on official Government business or when performing any work for or on behalf of the Federal Government.

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."

Trafficking In Victims Protection Act Of 2000 (as amended by the Trafficking Victims Protection Reauthorization Act of 2003)

Section 106(g) of the Trafficking In Victims Protection Act Of 2000 (as amended, directs on a government-wide basis that:

"any grant, contract, or cooperative agreement provided or entered into by a Federal department or agency under which funds are to be provided to a private entity, in whole or in part, shall include a condition that authorizes the department or agency to terminate the grant, contract, or cooperative agreement, without penalty, if the grantee or any subgrantee, or the contractor or any subcontractor (i) engages in severe forms of trafficking in persons or has procured a commercial sex act during the period of time that the grant, contract, or cooperative agreement is in effect, or (ii) uses forced labor in the performance of the grant, contract, or cooperative agreement." (22 U.S.C. § 7104(g)).

Executive Compensation Reporting

2 CFR 170.220 directs agencies to include the following text to each grant award to a non-federal entity if the total funding is $25,000 or more in Federal funding.

Reporting Subawards and Executive Compensation.

a. *Reporting of first-tier subawards.*

1. *Applicability.* Unless you are exempt as provided in paragraph d. of this award term, you must report each action that obligates $25,000 or more in Federal funds that does not include Recovery funds (as defined in section 1512(a)(2) of the American Recovery and Reinvestment Act of 2009, Pub. L. 111–5) for a subaward to an entity (see definitions in paragraph e. of this award term).

2. *Where and when to report.*

i. You must report each obligating action described in paragraph a.1. of this award term to *http://www.fsrs.gov.*

ii. For subaward information, report no later than the end of the month following the month in which the obligation was made. (For example, if the obligation was made on November 7, 2010, the obligation must be reported by no later than December 31, 2010.)

3. *What to report.* You must report the information about each obligating action that the submission instructions posted at *http://www.fsrs.gov specify.*

b. *Reporting Total Compensation of Recipient Executives.*

1. *Applicability and what to report.* You must report total compensation for each of your five most highly compensated executives for the preceding completed fiscal year, if—

i. the total Federal funding authorized to date under this award is $25,000 or more;

ii. in the preceding fiscal year, you received—

(A) 80 percent or more of your annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

iii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at *http://www.sec.gov/answers/execomp.htm*

2. *Where and when to report.* You must report executive total compensation described in paragraph b.1. of this award term:

i. As part of your registration profile at *http://www.ccr.gov*

ii. By the end of the month following the month in which this award is made, and annually thereafter.

c. *Reporting of Total Compensation of Subrecipient Executives.*

1. *Applicability and what to report.* Unless you are exempt as provided in paragraph d. of this award term, for each first-tier subrecipient under this award, you shall report the names and total compensation of each of the subrecipient's five most highly compensated executives for the subrecipient's preceding completed fiscal year, if—

i. in the subrecipient's preceding fiscal year, the subrecipient received—

(A) 80 percent or more of its annual gross revenues from Federal procurement contracts (and subcontracts) and Federal financial assistance subject to the Transparency Act, as defined at 2 CFR 170.320 (and subawards); and

(B) $25,000,000 or more in annual gross revenues from Federal procurement contracts (and subcontracts), and Federal financial assistance subject to the Transparency Act (and subawards); and

ii. The public does not have access to information about the compensation of the executives through periodic reports filed under section 13(a) or 15(d) of the Securities Exchange Act of 1934 (15 U.S.C. 78m(a), 78o(d)) or section 6104 of the Internal Revenue Code of 1986. (To determine if the public has access to the compensation information, see the U.S. Security and Exchange Commission total compensation filings at *http://www.sec.gov/answers/execomp.htm).*

2. *Where and when to report.* You must report subrecipient executive total compensation described in paragraph c.1. of this award term:

i. To the recipient.

ii. By the end of the month following the month during which you make the subaward. For example, if a subaward is obligated on any date during the month of October of a given year (*i.e.,* between October 1 and 31), you must report any required compensation information of the subrecipient by November 30 of that year.

d. *Exemptions*

If, in the previous tax year, you had gross income, from all sources, under $300,000, you are exempt from the requirements to report:

i. Subawards,

and

ii. The total compensation of the five most highly compensated executives of any subrecipient.

e. *Definitions.* For purposes of this award term:

1. *Entity* means all of the following, as defined in 2 CFR part 25:

i. A Governmental organization, which is a State, local government, or Indian tribe;

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

v. A Federal agency, but only as a subrecipient under an award or subaward to a non-Federal entity.

2. *Executive* means officers, managing partners, or any other employees in management positions.

3. *Subaward:*

i. This term means a legal instrument to provide support for the performance of any portion of the substantive project or program for which you received this award and that you as the recipient award to an eligible subrecipient.

ii. The term does not include your procurement of property and services needed to carry out the project or program (for further explanation, see Sec. __ .210 of the attachment to OMB Circular A–133, "Audits of States, Local Governments, and Non-Profit Organizations").

iii. A subaward may be provided through any legal agreement, including an agreement that you or a subrecipient considers a contract.

4. *Subrecipient* means an entity that:

i. Receives a subaward from you (the recipient) under this award; and

ii. Is accountable to you for the use of the Federal funds provided by the subaward.

5. *Total compensation* means the cash and noncash dollar value earned by the executive during the recipient's or subrecipient's preceding fiscal year and includes the following (for more information see 17 CFR 229.402(c)(2)):

i. *Salary and bonus.*

ii. *Awards of stock, stock options, and stock appreciation rights.* Use the dollar amount recognized for financial statement reporting purposes with respect to the fiscal year in accordance with the Statement of Financial Accounting Standards No. 123 (Revised 2004) (FAS 123R), Shared Based Payments.

iii. *Earnings for services under non-equity incentive plans.* This does not include group life, health, hospitalization or medical reimbursement plans that do not discriminate in favor of executives, and are available generally to all salaried employees.

iv. *Change in pension value.* This is the change in present value of defined benefit and actuarial pension plans.

v. *Above-market earnings on deferred compensation which is not tax-qualified.*

vi. Other compensation, if the aggregate value of all such other compensation (e.g. severance, termination payments, value of life insurance paid on behalf of the employee, perquisites or property) for the executive exceeds $10,000.