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

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-38-10-983		FROM: 7/1/2010 TO: 6/30/2011	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	*Public State-Controlled Institution of Higher ED* DUNS: 105300446	Virginia Commonwealth University 800 East Leigh Street Suite 113 Richmond, VA 23298

8. PROJECT TITLE:

Development of Undergraduate and Graduate Nuclear Instrumentation and Simulation Laboratories

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)	Virginia Commonwealth University Attn:Jeffrey Siebers Email: jsiebers@mcvh-vcu.edu 804-628-4709

12. NRC PROGRAM OFFICE (NAME and ADDRESS)	13. ACCOUNTING and APPROPRIATION DATA	14. METHOD OF PAYMENT
NRC Attn: Randi Neff Office of Human Resources MS: GW5A6 (301) 492-2301 11545 Rockville Pike Rockville, Maryland 20852	APPN. NO: 31X0200 B&R NO: 0-8415-5C1116 JOB CODE: T8453 BOC NO: 4110 OFFICE ID NO: RFPA: HR-10-983	[ ] 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	$140,000	NRC	$140,000	This action provides funds for Fiscal Year in the amount of See Page Two
PREVIOUS OBLIGATION		RECIPIENT		
TOTAL	$140,000	TOTAL	$140,000	

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

U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn: Sheila Bumpass
Mail Stop: TWB-01-B10M
Rockville MD 20852

18.	19. NRC CONTRACTING OFFICER
Signature Not Required	Sheila Bumpass 7/1/2010 (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.

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ATTACHMENT A - SCHEDULE

A.1 PURPOSE OF GRANT

The purpose of this Grant is to provide support to the "Development of Undergraduate and Graduate Nuclear Instrumentation and Simulation Laboratories" as described in Attachment B entitled "Program Description."

A.2 PERIOD OF GRANT

1. The effective date of this Grant is July 1, 2010. The estimated completion date of this Grant is June 30, 2011.

2. Funds obligated hereunder are available for program expenditures for the estimated period: July 1, 2010 – June 30, 2011.

A. GENERAL

1. Total Estimated NRC Amount:	$140,000
2. Total Obligated Amount:	$140,000
3. Cost-Sharing Amount:	$0
4. Activity Title:	Development of Undergraduate and Graduate Nuclear Instrumentation and Simulation Laboratories
5. NRC Project Officer:	Randi Neff
6. DUNS No.:	105300446

B. SPECIFIC

RFPA No.:	HR-10-983
FFS:	N/A
Job Code:	T8453
BOC:	4110
B&R Number:	0-8415-5C1116
Appropriation #:	31X0200
Amount Obligated:	$140,000

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
Direct Participant Cost	$113,676.00
Indirect Cost	$26,324.00
Yearly Total	**$140,000.00**

All travel must be in accordance with the Virginia Commonwealth University Travel Regulations or the US Government Travel Policy absent Grantee's travel regulation.

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is $140,000 for one year period.

2. NRC hereby obligates the amount of $140,000 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

Development of Undergraduate and Graduate Nuclear Instrumentation and Simulation Laboratories

B. Project Description

Nuclear engineering and medical physics share the need for graduates to have strong laboratory skills in radioactive material handling, radiation detection, radiation measurement, and radiation transport simulation. The Medical Physics Graduate Program within the Department of Radiation Oncology at VCU is collaborating with the Nuclear Engineering Program within the Department o Mechanical Engineering on the development of the University's first nuclear instrumentation instructional laboratories. The shared, interdisciplinary laboratories will provide hands-or experience in radiation measurements and simulations Medical Physics and Nuclear Engineering~ students at both the undergraduate and graduate levels, and will significantly strengthen the curriculum in both departments.

Undergraduate labs will concentrate on hands-on use and experience with radiation detectors and radioactive material handling, and radiation measurement. In addition to practical radiation measurement laboratory modules, graduate courses would be supplemented with use of Monte Carlo simulation techniques to replicate, confirm, and probe the laboratory experiences. In the laboratory environment, we will take advantage of the commonality of the nuclear engineering an< medical physics applications in radiation detection, measurement, and simulation.

This curriculum development training project directly addresses the NRC's need to have a competent workforce of nuclear engineers who work with NRC regulated special nuclear materials and nuclear by-product materials, as well as competent health and medical physicist workforce who medically use NRC regulated by-product materials for the diagnosis and treatment of humans.

B.1. Background -- Description of existing educational programs

8.1.1. VCU Nuclear Engineering Programs

In January, 2009 the State Council of Higher Education in Virginia (SCHEV) approved a new MS degree program in Mechanical and Nuclear Engineering at VCU. Simultaneously, a new Nuclear Engineering PhD concentration was developed and is currently offered within the Mechanical Engineering Department. In the fall of 2009, the first class of students was enrolled in a new undergraduate Nuclear Engineering track within Mechanical Engineering. This undergraduate program was developed under an NRC-funded curriculum development grant. The first year of the NRC grant established the courses for the Nuclear Engineering track within the Mechanical Engineering department. The second year of the NRC grant develops additional courses and technical electives which will be eventually used to convert the track into an independent undergraduate degree program. These new graduate and undergraduate programs were initiated in response to the growing demand for nuclear engineers in three primary hiring sectors: electrical utilities, national labs and the federal government. Currently approximately 25 new students are enrolled in the undergraduate nuclear engineering track and approximately 25 graduate

students are enrolled in the new nuclear engineering MS and PhD programs. Rapid enrollment growth in both the undergraduate and graduate programs is expected with a total projected steady-state enrollment of 150 students (100 undergraduate and 50 graduate).

The NRC-funded undergraduate track in Nuclear Engineering has a required course in Radiation Safety and Shielding, which is taken in the spring semester of the junior year. The curriculum also includes a required nuclear engineering technical elective to be taken in the senior year. The proposed undergraduate nuclear engineering measurements laboratory course will first be piloted as a senior technical elective but will become a required course complimentary to the existing shielding course when the track is converted into a degree program. The graduate level measurements and simulations laboratory being developed in parallel for Medical Physics graduate students will also be available as a technical elective for Nuclear Engineering MS and PhD students.

8.1.2. VCU Medical Physics Graduate Program

To meet the growing demand for trained medical physicists, VCU recently developed a Medical Physics Graduate Program. The program matriculated its first PhD students in the fall of 2004, and its first MS students in the fall of 2007. The program, housed in the VCU School of Medicine, was developed accordance with American Association of Physicists in Medicine (AAPM) Report 79 guidelines for academic medical physics graduate programs (AAPM, 2002). Faculty members in the program come from the Departments of Radiation Oncology, Radiology, and the Office of Environmental Health and Safety. The program currently has 10 MS students and 22 PhD student enrolled.

Students enrolled in the program take didactic course work in Radiological Physics and Radiation Dosimetry, Health Physics, Radiation Biology, Medical Imaging (CT and MR), Nuclear Medicine, and Radiation Therapy. Additionally, students take Clinical Rotations courses, where they receive hands-on experience dealing with practical medical physics problems and day-today medical physics activities.

The proposed graduate level nuclear instrumentation measurement and simulation laboratory course will at first be offered as a special topics elective course within our program. This allows us to quickly make the course content available to the students. As explained in further detail below, in addition to basic radiation measurements labs, students in the course will also receive practical training in routine material handling, radiation survey and measurement techniques that are required as a part of the preceptor training program for training of future authorized medical physicists and radiation safety officers.

*B.2. **Proposed course descriptions***

The proposed grant will be used to add measurement and computational laboratory components to the nuclear engineering and medical physics programs at VCU. Laboratory components will be added to both the undergraduate- and graduate-level curricula. Measurement laboratory modules will focus on radiation detection and measurement, including radiation-shielding quantification. The computational laboratory modules will concentrate on the use of Monte Carlo radiation transport simulations to re-enforce the measurement lab experience.

B.2.1. Undergraduate laboratory course

The goal of the undergraduate laboratory course is to give students practical experience with radiation detection systems so they can better understand their operation, and to enhance their understanding of the physical processes involved in radiation detection, radiation interactions, attenuation and shielding. The undergraduate laboratory course will be designed to compliment the existing undergraduate course Radiation Safety and Shielding (EGRN 330), which covers the fundamentals of radiation safety and shielding with focus on sources of radioactivity, interaction of radiation with matter, biological effects of radiation, radiation dosimetry, attenuation of gamma rays and neutrons, and effectiveness of shielding methods. Topics to be explored in the laboratory environment include:

- ~ Radioactive source characteristics including measurement of half-life and the inverse square fall of from point sources.
- ~ Material attenuation characteristics for alpha, beta, and gamma radiations.

~ Detector characteristics for a Geiger counter, including the charge collected vs. voltage as a detector goes through ionization, proportional counting, and Geiger-Mueller ranges and measuring and correcting for detector dead-time characteristics.

~ Gamma ray spectroscopy with a low resolution NaI detector and a high resolution HPGe detector. Topics to be explored include analysis of spectral features including peak-toCompton ratio and energy resolution as a function of gamma-ray energy. The labs will include energy resolution measurements, measurement of photo-peak efficiency, and determining escape peaks and overall detector efficiency. Students will use spectroscopic techniques to identify an unknown radioactive source. With both high and low resolution detectors, students will be able to perform a comparative analysis of the systems performance.

~ Use of alpha spectroscopy with silicon charged-particle detectors to study detector characteristics, the properties of alpha-emitting isotopes, and the interactions of heavy charged particles with matter. Students will perform energy calibrations, determine the energy of an unknown alpha source, determine absolute activity of an alpha source, determine decay ratios for a known alpha source, measure the Bragg curve, and measure stopping powers in known materials.

~ Use of beta spectroscopy surface barrier detectors to study detector characteristics, the properties of beta-emitting isotopes, and the interactions of beta particles with matter. In the laboratory, students will measure the beta particle decay spectrum, create Kurie plots to determine the maximum beta decay energy, and determine the ratio of beta emission to electron conversion (conversion ratios) for known radio-isotopes.

~ Measuring alpha and beta particle energies and attenuation.

~ Learning the importance of time, distance, and shielding in radiation protection

~ Additional topics as determined by the course developers commensurate with the materials covered in the EGRN 330 course.

B.2.2. Graduate instrumentation and simulation laboratory course

The goal of the graduate-level course is to give students hands on experience with radiation material handling procedures, radioactivity testing procedures, research-grade and field-grade radiation measurement systems, and radiation transport simulation techniques that will be used extensively in their future nuclear engineering or medical physics careers. The course will be designed to supplement existing coursework in nuclear engineering (Nuclear Safety, EGRN 640, and Nuclear Radiation and Shielding, EGRN 650), as well as in medical physics (Radiological Physics and Radiation Dosimetry, PHYS 563, and Advanced Radiation Therapy Physics which includes transport theory and computational dosimetry, PHYS 633). The new course will develop curricula that currently do not exist within our two programs. The teaching in this course will be designed to meet the requirements of NRC medical use training and experience to enable instructor (preceptor) attestation of the training. In addition to having students make radiation measurements, where applicable, experimental setups will be simulated with the Monte Carlo codes MCNP5 or MCNPX for comparison. Laboratory modules to be considered for development include:

~ Measure and simulate the attenuation and propagation of gamma rays from point sources, and inter-compare measurement and simulation results. Simulations will be with MCNP and 1 D or 2D multi-group discrete ordinates codes.

~ Measure and simulate NaI and/or HPGe gamma spectroscopy detectors, including the energy dependence of the detector efficiency.

- Measure and simulate neutron and/or mixed neutron/photon radiation environments to acquaint students with the characteristics of neutron sources, detectors, and interactions.
    - Possible radiation sources to be investigated include an 18 MV linear accelerator, a 252Cf source, and a reactor environment.
    - Detectors systems to be studied include REM counters, tissue equivalent proportional counter-based detectors, and thermoluminescent dosimeter (TLD) systems.
        - A field-grade REM meter in conjunction with a field-grade (neutron insensitive) survey

meter (Roentgen meter)

- A neutron tissue-equivalent proportional counter-based detector which utilizes ICRP-60 event-size to quality factor conversion factors, which also permits direct output of the event-size spectra, allowing independent student-based evaluation of neutron and gamma components of the radiation dose and dose equivalent
- Paired TLD dosimeters: use of 6Li-based TLD-600, (6Li has a high thermal neutron cross-section) with 7Li-based TLD-700 and/or natural lithiumbased TLD-100 to separate out the neutron and photon components of a mixed radiation field.

o Measurements/simulations to be performed in the lab include determination of neutron attenuation of concrete (and potentially other shielding materials), neutron transmission along mazes, including comparison with accepted shielding models, using TLD-600 with and without a moderator to understand the concept of neutron albedo, using paired neutron sensitive / neutron insensitive detectors to separate neutron and photon components of dose equivalent, and additional concepts commensurate with the content of the supporting didactic courses. For the accelerator and reactor environments, labs would evaluate the adequacy of the radiation shielding with respect to design and regulatory limits and intercompare measurement and MCNP5/MCNPX simulation results.

- Radiation measurements in high intensity photon or electron fields with ionization chambers, solid state detectors, and scintillators.
- Radiation measurement and safety for high-dose rate and low-dose rate brachytherapy sources, including source activity measurements, source calibration, source handling procedures, and wipe testing.
- Radiation measurement and safety for nuclear medicine facilities, including well counter quality control/quality assurance procedures measuring detector sensitivity, constancy, minimum detectable activity, chi-squared tests, and wipe tests for package receiving nuclear medicine laboratory area surveys.
- Proportional counter laboratory, using a thin walled proportional counter to explore the properties of gas counters and their uses. In particular, the thin walled proportional counter would be used to measure low energy x-rays and the mass absorption coefficient of materials at low energies.
- A health physics laboratory, in which field-grade / commercial-grade instruments will be used to measure radiation dose levels, identify isotopes, and evaluate the effectiveness of radiation shielding materials.
- Biological uptake laboratory, in which students are introduced to radiation measurements in medicine, including the uptake of radionuclides in both plants and animals. The concepts and techniques studied in this laboratory will be applicable to both medically necessitated intentional uptake of radionuclides and unintentional uptake of radionuclides, such as that following a release from a nuclear reactor, from a nuclear detonation, or from nuclear terrorism.

~ Additional topics as determined by the course developers commensurate with the materials covered in the graduate nuclear engineering and medical physics curriculum as related to radiation detection, measurement, and protection.

B.3. Program Attributes

B.3.1. Innovative instructional approaches or techniques to enhance student learning

It is well-established that hands-on laboratory experiences are among the most effective means for reinforcing course lecture and textbook material. This is particularly true for radiation measurements because, unlike other concepts in physics and engineering, such as pressure, temperature and optical detection, the detection and quantification of ionizing radiation is outside the realm of human sensory experience. In radiation measurement, many new concepts such as pulse height analysis for energy determination must be learned and reinforced in the laboratory.

Furthermore, laboratory course develop on-the-fly problem solving skills. In the process of completing a

lab, students are required not only tackle the problem presented by the lab, but also debug the laboratory setup. Importantly, laboratory courses reinforce the useful skills of applying the scientific method to progressing from purpose, to methods, results and conclusions - skills that are valuable far beyond laboratory environments.

Our proposed curriculum has multiple innovative aspects:

- The proposed labs utilize both research-grade and field-grade nuclear instrumentation. Use of research-grade (component-based) instrumentation allows realization of the individual parts that comprise a radiation detection system and allow investigation of each individual component's properties. This strengthens a student's understanding of the fundamentals nuclear instrumentation and radiation measurements. The use of "allin-one" field-grade instrumentation demonstrates an integrated system, where the specifics of operation are hidden from the user. With these instruments, the practical aspects of radiation measurements in actual work place environments can be explored, with all the benefits and limitations of an integrated instrument. Throughout their careers, successful nuclear engineers and medical physicists will proficiently utilize both types of systems.
- The graduate labs combine experimental measurements with simulation laboratories of said same experiments in the same lab course. This will allow the students to better grasp important differences between experimental measurement and simulation results. By using Monte Carlo methods to simulate the labs, the students will be able to better understand counting statistics, detector efficiency, and detector resolution issues.
- Several graduate labs will be performed in working facility environments on operational equipment. This will provide direct experience using techniques that will be used in the workplace. Students will perform leakage tests and wipe tests on clinically used radioactive sources, wipe test a nuclear medicine lab, measure radiation levels around a clinical medical accelerator for the purposes of shielding verification, and measure radiation levels at a nuclear power plant.

  Dominion Virginia Power is an important partner in many of the new nuclear engineering educational initiatives at VCU. In particular, the new MS degree program in Mechanical and Nuclear Engineering was created, in part, to provide advanced educational opportunities for Dominion employees. VCU has been granted access to Dominion power plant facilities for activities such as tours and demonstrations on reactor simulators and we anticipate that this important partnership will continue and that a radiation measurements field activity will be developed and performed on site at the nuclear power plant.
- Several of the laboratory modules will meet the requirements for the *Medical Use Training and Experience And Preceptor Attestation* required (NRC Form 313a).

8.3.2. Infrastructure and competencies

This proposed nuclear instrumentation laboratory curriculum development grant will significantly improve VCU's education infrastructure, teaching competencies, and subject matter expertise, thereby improving the educational programs of both graduate and undergraduate students in Nuclear Engineering and Medical Physics. Currently, neither program has a nuclear instrumentation laboratories or any other suitable mechanism to provide students hands on exposure to nuclear instrumentation, material handling, or radiation measurements.

Educational Infrastructure: Two essential infrastructure elements are required to develop and execute a successful laboratory course, equipment and curriculum. This program provides support for faculty to develop and implement the curriculum infrastructure required for an effective laboratory course. In addition to developing learning objectives, procedures, and other curricular materials, in developing the course, faculty will assemble and test the laboratory equipment and execute the laboratory procedures. Additional lab-specific infrastructural elements will also be put into place. For example, approvals to perform radiological uptake studies will be required from the University's Institutional Animal Use and Care Committee, in accordance with federal animal welfare regulations.

This proposal also funds laboratory equipment necessary to create the graduate and undergraduate nuclear instrumentation laboratories in Nuclear Engineering and Medical Physics. The funded equipment would be used for basic student laboratory studies and to make practical radiation measurements and surveys in clinical and reactor environments.

In addition to curricular and laboratory hardware infrastructure, this lab will provide a forum for improving the computer software infrastructure. Monte Carlo radiation transport simulation programs MCNP and MCNPX, industry standards for nuclear engineers and medical physics, will be used in the graduate level course. The Radiation Shielding Information Computational Center (RSIC) provides MCNP/MCNPX license free of charge to Nuclear Engineering educational programs and NRC-funded programs. We will use MCNP/MCNPX to simulate the measurement laboratories, thereby enhancing the student learning experience.

Teaching competencies and subject matter expertise: The proposed curriculum provides a venue for instructors to demonstrate direct application of the principles of radiation detection, measurement, and simulation to students. Subject matter knowledge is formed and solidified in via physical experiences. Nuclear instrumentation and measurement laboratories provide a mechanism for students to have perceptible experiences with subject matter that is not perceived by normal human senses. Unlike other physical properties of materials, radiation energy, radioactivity, and radiation dose are not immediately perceivable by humans (unless the radiation dose is excessive). The proposed labs will allow students to connect intangible radiation concepts to tangible observations. Students will measure energy spectra of gamma, beta, and alpha sources, half-lives of radioactive sources, attenuation of uncharged particles, ranges of charged particles, inverse square relationships, and a plethora of other concepts radiation concepts which are covered in their didactic coursework, thereby improving their understanding of these basic concepts.

Additional fundamental subject matter for students is an understanding of nuclear instrumentation which will be used in their future careers. The proposed labs provide students with the opportunity to understand fundamental electronics and how component-based instrumentation can be interconnected to form a useful composite element. Furthermore, with field-grade instruments, students learn the importance of system integration, as well as the benefits and pitfalls of such systems.

A major goal of nuclear engineering and medical physics educational programs is to develop student problem solving skills. Laboratory modules, such as those proposed here, inherently address student problem solving - directly by requiring the student to address the research question on hand and indirectly by requiring the student to assess and debug problems with the laboratory setup. In labs, students are expected to interpret unexpected results and perform further experimentation to further understanding of the observed result.

Another core competency that the lab modules develop is student communication skills. Communication skills are enhanced by requiring written lab reports, requiring students to present purpose, methods, results and finding, and conclusions/interpretations. Furthermore, prescriptive laboratories provide a direct venue for students to self-evaluate the instructional process.

Subject matter knowledge and problem solving skills are further enhanced in the graduate level labs by combining radiation measurement and Monte Carlo simulations. These allow students to further understanding the limitations of each method.

Skills in serving students in the target disciplines: Radiation detection and quantification is essential in the targeted disciplines (Nuclear Engineering and Medical Physics) addressed in this proposal. The hands-on nuclear measurements laboratories will compliment and reinforce the didactic educational experiences of students. The following are examples of specific skills which will be developed by the laboratory modules:

- Basic laboratory skills in working with radioactive materials and scientific instrumentation

- Radioactive material handling procedures
- Working knowledge of component based nuclear instrumentation including various radiation detectors, amplifiers, pulsers, and multichannel analyzers.
- Experience with field-grade nuclear instrumentation
- A practical understanding detector limitations (background, electronic noise, energy resolution, efficiency, ...)
- Measurement and interaction characteristics of neutron, gamma, and beta radiations
- Simulation experience with the MCNP Monte Carlo code- an industry standard for NE
- Practical experience in radioactive material contamination surveying techniques
- Practical experience in measuring workplace radiation sources, such as nuclear reactors, brachytherapy sources, and linear accelerators.
- After completion of the labs, provides a venue for attestation of students' knowledge required for radiation safety officers, authorized users, and authorized medical physicists.

8.3.3. Academic focus areas:

This proposal addresses academic focus areas in nuclear safety, security, and environmental protection. Each of these focus areas requires in-depth knowledge of radiation measurement techniques, radiation interaction mechanisms, and in the safe handling of radioactive materials. Radiation detection and measurement is an important component of the Nuclear Engineering curriculum. Nuclear engineers must have a solid understanding of the available methods for quantifying and attenuating penetrating radiation including gamma rays, neutrons and alpha and beta particles. Radiation measurement tools are used in nuclear power plants for worker safety and security. Radiation measurements are also used for safety and security during the entire nuclear fuel cycle and for environmental monitoring and protection.

In medical centers, authorized medical physicists are responsible for the safe handling, usage, and maintaining the security of NRC regulated byproduct material. In this proposal, students will learn safe handling procedures and make measurements within clinical working environments.

8.3.4. Project emphasis

This projects emphasis is on the development of curricula and teaching materials for two laboratory courses which share common equipment and laboratory facilities and supplement the didactic coursework taught to undergraduate and graduate nuclear engineers and graduate medical physicists. The undergraduate lab course will primary focused towards nuclear engineers. Details of the proposed undergraduate course can be found in Section 8.2.1. The proposed graduate interdisciplinary level course will be will provide hands-on experience in radiation measurements and simulations to medical physicists and nuclear engineers. Details of the proposed graduate level course are given in Section 8.2.2.

This project will develop teaching materials, including laboratory procedures and manuals for individual lab modules for the above mentioned courses. The lab equipment will also be assembled and tested as a part of this proposal.

8.3.5. Demand, capability, capacity, and sustainability

Demand: Continued program growth due to a long-term need for medical physicists and nuclear engineers is expected in both educational programs. The medical physics and nuclear engineering programs at VCU were developed to address projected shortfalls of trained professionals in these areas. Nuclear Engineering is recovering from an extended period of stagnation where numerous academic programs were curtailed or even eliminated. An unprecedented number of new nuclear plants are being planned resulting in a dramatic increase in the demand for well-trained nuclear engineers. The demand for nuclear engineers will far exceed the graduation rate of existing nuclear engineering departments and the new graduate and undergraduate Nuclear Engineering programs at VCU were established in partnership with the Dominion Virginia Power specifically to address this pending shortage. Therefore, we anticipate strong continued growth of the program.

Capability: As described in Section 8.3.6 below, VCU has the faculty expertise in place to develop and implement the laboratory courses proposed in this application.

The facilities to be used for this lab course are adequate. The Mechanical Engineering department will provide approximately 600 square feet of instructional laboratory space in support of the proposed radiation measurements laboratory. The laboratory will be located within Engineering East hall, a state of the art facility which opened in the fall, 2008 semester.

The graduate level lab course will also use clinical facilities at the VCU Medical Center as well as Dominion Virginia Power's nearby reactor facilities. Labs in VCUs division of Nuclear Medicine labs can be used to support the wipe testing and animal uptake laboratories and VCU Radiation Oncology facilities can be used for high-dose rate (HDR) and low dose rate brachytherapy source testing and handling procedures, radioactive seed material handling and shipping procedure labs, and radiation shielding measurements around an HDR source and a linear accelerator.

Furthermore, VCU has equipment which can be used in the labs including

- TLO reader - for read out of thermoluminescent dosimeters (TLO) used in laboratories.
- Ionization chambers, diodes, and electrometers for measuring linear accelerator output and dose distributions around HOR sources
- Liquid scintillation counter -- The Office of Environmental Health and Safety has a liquid scintillation counter that will be used for the labs.
- Radiation sources - The Office of Environmental Health and Safety has an inventory of radiation sources that may be used for calibrating and testing radiation detectors used in the labs.

Capacity: The nuclear engineering undergraduate program at VCU has a projected steady state enrollment of 100 students spread over a four-year course of study. Therefore, the proposed undergraduate course will be served by approximately 20 nuclear engineering students each year. The nuclear engineering graduate MS and PhO programs at VCU have a projected steady state enrollment of 50 students. It is anticipated that a significant fraction of these students will enroll in the graduate level nuclear instrumentation course. The VCU Medical Physics graduate program enrolls ~7 MS and ~6 PhD students per year, corresponding with steady state enrollments of ~14 MS and ~25 PhO students. We anticipate that the majority of the medical physics students would enroll in the nuclear instrumentation course. Overall, the graduate level course is expected to have 15-20 students per calendar year. The undergraduate and graduate level courses will be offered in opposite semesters, thereby enabling multiple sections to be taught without significant disruption of the laboratory equipment. With ~10 students per lab section, multiple sections will significantly increase the overall capacity of the program. Furthermore, the lab modules will be designed so that different students can be simultaneously working on different labs, thereby minimizing the need for multiple replicate lab equipment setups.

Sustainability: VCU has made a long-term commitment to medical physics and nuclear engineering education and research. The University fully supported the development of these new programs, has committed salary lines and research assistantship lines to these new programs, and sees these programs as being in direct alignment with the Universities goals of being a nationally recognized learning-centered research university and maintaining VCU as one of the nation's leading academic medical centers.

The VCU medical physics program is one of two programs in the Commonwealth of Virginia, the other being a small program at Hampton University. In the past decade, VCU has become a national leader in Medical Physics research, holding several major grants, including a Program Project Grant from the National Institutes of Health - one of only three medical physics programs in the nation to do so. The graduate program, founded in 2004, is currently seeking accreditation by the Commission on Accreditation of Medical Physics Educational Programs. The program is supported by the VCU Graduate School, which provides tuition remission and research assistantships for the first two years of study for VCU PhD students. After that time, the students are supported by faculty research grants. Additional support for faculty salaries comes from the School of Medicine. The VCU medical physics graduate program is directly inline with the Universities goals to offer nationally and internationally recognized

graduate programs in the sciences - particularly, health related sciences. The program's faculty and administration are committed to the addition of nuclear instrumentation laboratory courses to the program due to the known benefits they will have for the program.

Nuclear Engineering seeks to be the leading provider of Nuclear Engineering education in the State of Virginia with a full suite of both undergraduate and graduate NE programs. The proposed nuclear instrumentation course is a key ingredient in both our graduate and undergraduate programs. The University has committed multiple new faculty lines for the new Nuclear Engineering programs and we have enrolled both undergraduate and graduate students. In addition, strategic partnerships have been formed with key stakeholders such as Virginia Dominion Power and the Virginia Chapter of the American Nuclear Society. Dominion is a strong supporter of the programs and has provided seed funding over the last three years. A student branch of the Virginia-ANS has just been initiated at VCU and the School of Engineering plans to host the annual ANS Workshop for middle school science teachers beginning in the summer of 2010. We are fully committed to build and sustain the Nuclear Engineering programs at VCU.

The laboratory courses and modules developed by this program are ensured sustainability by their unique role in the student learning process and that fact that they will be required courses in the graduate program. After an initial period of being an elective, the undergraduate and graduate labs will become required courses in the program Nuclear Engineering program, ensuring sustainability of the laboratory modules beyond the targeted grant completion.

Similarly, for medical physics graduate students, the course will initially be an elective, enabling prompt implementation of the course work. As this is the only hands-on experience that PhD and MS students will have at radiation measurements and laboratory training in radioactive material handling, students who plan future careers in health physics, nuclear medicine, or radiation oncology will be highly encouraged to enroll in this course. Since this course addresses laboratory guidelines set forth in AAPM Report 197, *Academic program recommendations for graduate degrees in medical physics,* it is anticipated that this course will become a mandatory course requirement to acquire and maintain program accreditation by the Commission on Accreditation of Academic Medical Physics Education Programs (CAMPEP).

B.3.6. Faculty expertise

Dr. Jeffrey Siebers, PI, has a BS in Applied Math, Engineering, and Physics; with ∞ concentration in **Nuclear Engineering,** an MS in Health Physics, and a Ph.D. in Medica Physics, concentrating on neutron measurements, radiation shielding, detection, anc measurement. In addition to his thesis work, Dr. Siebers has extensive experience in detectol development and testing including the design and fabrication of ionization chambers anc secondary emission monitors for direct measurements of proton beams, calorimetr) measurements, and measurement with Faraday cups, diodes, scintillators, diamond detectors and other radiation detectors. Dr. Siebers has substantial experience in the use of Monte Carle codes, including the use of MCNP and MCNPx for neutron shielding verification and design. Dr Siebers teaches the graduate level course on radiation dosimetry in the VCU medical physic~ graduate program (PHYS 563). In addition to overseeing this project, Dr. Siebers will creatE laboratory modules for the medical physics graduate course, create University course approva documentation, and shepherd the courses through the University approval process.

Dr. Tepper received his Ph.D in Engineering Physics from the University of California at San Diego. Dr. Tepper has extensive experience in radiation detection and measurement, including development of high resolution ionization chamber gamma-ray spectrometers and has studied the transport properties of room temperature semiconductor radiation detector materials. Dr. Tepper has been developing optical fluorescence measurement techniques for the detection and identification of trace levels of uranium in soil. Dr. Tepper has served on the organization committee of the annual SPIE Meeting on Hard X-ray and Gamma-Ray Detection and has performed radiation detector research for the National Nuclear Security Agency, the Defense Threat Reduction Agency and the Domestic Nuclear Detection Office. Drs.

Mohamed Gad-elHak and Dr. Gary Tepper developed the undergraduate and graduate programs in nuclear engineering at VCU.

Dr. Mohamed Gad-el-Hak has a Ph.D in Fluid Mechanics from Johns Hopkins University. Prior to joining VCU, he was a Professor of Aerospace and Mechanical Engineering at the University of Notre Dame. Dr. Gad-el-Hak teaches courses in thermodynamics, fluid flow, and heat transfer. Dr. Tepper and Gad-el-Hak will co-develop the nuclear engineering undergraduate laboratory and work with Dr. Siebers on the graduate course.

Dr. Jeffrey Williamson has a BA degree in philosophy, mathematics, and physics and a Ph.D. degree in biophysical sciences concentrated on experimental and Monte Carlo characterization of brachytherapy radiation sources. He has extensive experience with deterministic and Monte Carlo radiation transport calculations, brachytherapy dosimetry and related radiation therapy topic. He has extensive experience in low energy photon dosimetry, including radiochromic film, TLD, and plastic scintillators. He teaches Phys 633, which is a novel combination of transpor1 theory and numerical simulations applied to advanced radiation therapy treatment planning and dosimetry problems. Dr. Williamson will create laboratory modules for the graduate leve course.

Dr. Jianqiao Luo has a Ph.D. in Biomedical Science and Medical Physics from Oakland University. He served as a research associate in Nuclear Medicine Imaging at the University of Michigan. He has active research in the evaluation of SUV in PET and PET-CT imaging, radiation dosimetry in radionuclide therapy, particularly with V-gO microspheres, and animal imaging using gamma-cameras and microSPECT. Dr. Luo teaches the Nuclear Medicine component of Phys 635 in the medical physics graduate program. On this project, Dr. Luo will create lab modules on radiation safety procedures and measurements in a Nuclear Medicine lab, including performing wipe tests, and well counter quality control/quality assurance procedures. Dr. Luo will work with Dr. Siebers in developing the animal imaging student laboratory.

B.3.7. *Timeline or milestone chart of activities proposed in this project covering the period of performance.*

Task	Summer 2010	Fall 2010	Spring 2011	Summer 2011	Fall 2011	Spring 2012
Undergraduate NE course						
Create / refine course syllabus	x	x	x	x	x	x
Create / refine lab modules and manuals	x	x	x	x	x	x
Prepare University course approval paperwork	x	x	x			
Secure University approval			x	x		
Order lab equipment	x	x	x	x	x	
Setup / test lab equipment			x	x	x	x
Offer "special topics" reduced scope course					x	
Offer full course (Fall 2012)						
Joint NE-medical physics graduate level course						
Create / refine course syllabus	x	x	x	x	x	x
Create / refine lab modules and manuals	x	x	x	x	x	x
Prepare University course approval paperwork	x	x	x			

Secure University approval			x	x		
Prepare, submit, and acquire animal welfare approval			x	x	x	
Order lab equipment	x	x	x	x		
Setup / test lab equipment		x	x	x	x	
Offer special topics reduced scope course - Special topics courses can be offered prior to University approval - This initial course will offer a limited number of lab modules with limited scope			x			
Offer full course						x

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 (now 2CFR 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 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 FY 2010 HR curriculum development 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:

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

§ 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.

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

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