

ATTACHMENT A - SCHEDULE

A.1 PURPOSE OF GRANT

The purpose of this Grant is to provide support to the "Nuclear Reactor Instrumentation and Control and Digital Implementation" 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: | \$150,000 |
| 2. Total Obligated Amount: | \$150,000 |
| 3. Cost-Sharing Amount: | \$0 |
| 4. Activity Title: | Nuclear Sector Technician Education and Placement Project |
| 5. NRC Project Officer: | Randi Neff |
| 6. DUNS No.: | 940020381 |

B. SPECIFIC

- | | |
|-------------------|---------------|
| RFPA No.: | HR-10-968 |
| FFS: | N/A |
| Job Code: | T8453 |
| BOC: | 4110 |
| B&R Number: | 0-8415-5C1116 |
| Appropriation #: | 31X0200 |
| Amount Obligated: | \$150,000 |

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
Personnel	\$24,242.00
Fringe	\$19,554.00
Travel	\$2,000.00
Supplies	\$ 818.00
Contractual	\$70,085.00
Total Direct Cost	\$116,699.00
Indirect Cost	\$33,301.00
Yearly Total	\$150,000.00

All travel must be in accordance with the University of Florida 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 \$150,000 for the (1) year period.
2. NRC hereby obligates the amount of \$150,000 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

Nuclear Reactor Instrumentation and Control and Digital Implementation

This part describes the project in detail. Section 1 gives an introduction and background information, Section 2 discusses the objectives of the project, Section 3 describes the technical aspects of the project, Section 4 gives the logical path for accomplishing the goals, Section 5 describes the contributions of the collaborating institutions, suggestions for project evaluation are outlined in Section 7, Section 6 gives the approach on Project Evaluation, Section 7 gives the expected deliverables and products, Section 8 gives the budget and execution period of the project, and Section 9 discusses how the proposed project addresses the evaluation criteria

1. INTRODUCTION, BACKGROUND, AND RELEVANCE OF THE PROJECT

The commercial nuclear industry is seeing resurgence as evidenced by the increasing number of applications for plant construction and operation, and the life extension of operating reactors. The next generation reactors will be designed to have longer fuel cycles, with continued operation and minimum maintenance outages. These and other operational needs of nuclear reactor systems necessitate the development and implementation of reliable and efficient instrumentation and control (I&C) systems that should also overcome the obsolescence of vendor supplies. The implementation of digital I&C systems is being considered by nuclear utilities for system upgrades in current reactors, and for next generation of nuclear reactors. For these reasons, there is an urgent need to train the next generation nuclear engineers and I&C personnel in the areas of instrumentation, controls, and digital systems.

Digital instrumentation and control (I&C) are incorporated in many systems in a wide range of industries. These include fossil-fueled power plants, chemical and petrochemical industries, aerospace industry, metals manufacturing, pulp and paper, pharmaceuticals, food and beverage, electric power distribution, and many others. The process industry has experienced a large growth in digital implementation over the past 30 years. Some nuclear power plant applications include core protection calculations, diesel generator load sequencing, a few reactor protection systems, and plant radiation monitoring systems [1]. Several applications to plant control systems are also available. Transition to digital I&C has its own growing pain. The modern day digital controllers are hierarchical and multi-layered in their architecture, with local control functions, supervisory control level and coordination, and top level 'control manager' with data analysis and high-level decision-making. This latter includes safety system operations. Regulatory issues dominate nuclear power applications.

The early study of digital I&C in nuclear power plants (NPP) was reported by the National Research Council in a report entitled, "Digital Instrumentation and Control Systems in Nuclear Power Plants: Safety and Reliability Issues (1997)" [1]. This report details the need for transition to digital I&C, its features, technical issues, regulatory issues, and licensing

regulations criteria. Currently, except for Interim Staff Guides (ISGs), there is no NRC regulation for licensing a digital safety/protection system. However, since year 2000, Duke Energy has been trying to license an AREVA's TXS safety system for its Oconee power plant. Because of various NRC requirements and concerns, the system design has been modified significantly. After 10 years of hard work on various aspects of this system, Duke Energy is expecting approval of its application this year. Besides the regulatory issues, limited experience of both parties, that is, licensee and regulator, has slowed down both the preparation and review processes significantly. In addition, this exercise has demonstrated the need for training and education of engineers, scientists, and regulators in various areas including:

- Limitations, performance, and reliability of digital systems
- Redundancy requirement and Common Cause Failure (CCF)
- Diversity and Defense in Depth (D3) Analysis
- Failure Modes Effect Analysis (FMEA) of the digital system
- Software Verification & Validation (SV&V)
- Cyber security
- Human-Machine Interface (HMI)
- Various planning documentation for development of application software
- NRC regulations and IEEE standards for Digital Protection and Control Systems
- Accident scenarios, and methodologies for their simulation and mitigation
- Engineered Safety Feature Actuation System (ESFAS) for maintaining fuel integrity

1.1 Related past and ongoing projects by the PI and Co-PI.

In this section, we will give a summary of previous and/or ongoing relevant projects at both institutions.

1.1.a University of Florida - UFTR Digital Protection and Control Systems Upgrade

Because of the above realization, in September 2007, Prof. Haghghat started a major initiative on design, licensing and implementation of a fully digital control/protection system for the University of Florida Training Reactor (UFTR). For this project, Progress Energy Florida provided \$675,000, and AREVA NP and Siemens Co. agreed to provide the TELEPERM XS (TXS) safety system and T-3000 control system along with significant engineering support for design, licensing and implementation. Further, State of Florida has provided \$425,000 for renovation, Department of Energy has provided funds for procurement of Nuclear Instrumentation (NI) and sensors, and more recently the Florida Energy Sustainability Consortium (FESC) has provided \$308,000 for licensing activities. This project is scheduled to be completed by June 2011.

Thus far, with support from AREVA and Siemens and the use of experience from the Oconee application, the UF group has developed a TXS design with one redundancy. As shown in Fig. 1, this system includes four major segments including Acquisition and Processing (AQP) of signals from NIs and sensors; Monitoring Service Interface (MSI) for communication with the Main Control Room (MCR) systems including Service Unit (SU) for software maintenance, Quality Display System (QDS) for operator information and action, and Gateway (GW) for connection to the non-safety T-3000 control system.

For the above system, with support from the AREVA licensing engineers, the UF group has already prepared numerous documents, and has initiated formal pre-application meetings with the NRC. It is worth noting for this activity, because of limited expertise of the non-power branch, the UFTR is being reviewed by the licensing personnel from the power reactor branch.

This project will be very beneficial to commercial nuclear power industry, because, besides

providing the means of training highly qualified engineers and scientists in the area of digital control and protection of nuclear reactors, it will provide an environment for training personnel from commercial nuclear utilities and government agencies, it may contribute to the development of new regulations on licensing digital safety/protection systems, and provide a benchmarking environment for measuring performance and reliability of hardware and software of digital systems and algorithms. To this effect, in the recent 2009 NPIC&HMIT conference, former NRC Commissioner and current Deputy Assistant Secretary of Nuclear Energy, Dr. Pete Lyons, stated the following:

"AS another notable example of digital evolution, the University of Florida is partnering with Areva and Siemens to install a two-channel digital safety system in its 1950s, 100 kw, Argonaut reactor. At first, this may appear as logical as putting fuel injection on a Model A, but I am encouraged that this project will provide significant insights and further advance the digital evolution. It should serve to expose a new generation of scientists and engineers to the challenges of digital applications in a nuclear environment as well as provide a platform for additional research at the University of Florida and at other participating schools. "

1.1.b University of Tennessee - Review of Digital I&C and Nuclear Plant Monitoring

The University of Tennessee is working with Entergy Nuclear in reviewing the status of digital I&C in nuclear power plants, and the current status of implementation of plant monitoring and diagnostics methods. Dr. Upadhyaya is a co-author of the ORNL report on *Instrumentation, Controls, and Human-Machine Interface Technology Development Roadmap for Grid-Appropriate Reactors*. The University of Tennessee has developed a multivariate experimental flow control loop that is being used for testing digital control algorithms and for on-line monitoring and diagnostics of sensors and field devices. This activity is part of a DOE-funded NERI research grant program.

One of the areas of Dr. Upadhyaya's research is the use FPGA in reactor safety systems. Currently there is no ready-to-use NRC document for FPGA-based safety systems. The regulatory review is being performed on a case-by-case basis. A case study of implementation at the Wolf Creek Generation Station (WCGS), and many other implementation examples are available. Information is also available from NRC digital I&C license application reviews, Workshop on the Application of FPGA in Nuclear Power Plants (October 2008), Topical Meeting on Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (NPIC & HMIT 2009), NRC NUREG reports, and IAEA technical reports. As an example of utility initiative, Entergy's Commitment to Innovation is outlined in an article by Mahoney et al., Nuclear Plant Journal, July-August 2009 [2]. This project will prepare lectures on this important topic.

2. PROJECT OBJECTIVE AND CURRICULUM DEVELOPMENT TASKS

The objective of this project is to develop comprehensive undergraduate and graduate courses that will include instrumentation, digital I&C, and case studies of digital control implementation in current commercial reactors (e.g., Oconee plant), and the UFTR research reactor.

The contents of these courses will include the following important topics:

Control strategies, fundamentals of linear system control theory, design of classical controllers, introduction to modern control systems, digital devices such as the field programmable gate arrays (FPGA), issues (e.g., 03, Cyber Security, FMEA, etc.) and methodologies for their analysis with examples of applications of digital I&C in operating reactors, development of I&C systems for the UFTR, and NRC regulatory guides and

positions and IEEE standards related to digital I&C.

These courses would provide a sound background in digital I&C systems and devices in nuclear power plants. It also addresses issues affecting implementation, licensing and performance of digital protection and control systems.

The following specific curriculum development tasks will be performed in order to accomplish the project objective. This collaborative effort between the University of Florida and the University of Tennessee will bring together the expertise of the two institutions in addressing the important issues of curriculum development in digital systems for reactor protection and control.

Task 1 - Design of classical controllers. Principles of reactor control strategies, including load following and long-term base-load operational control.

Task 2 - Digital systems and devices, including programmable logic controllers and field programmable gate arrays (FPGA).

Task 3 - Introduction to modern control methods and application to reactor systems. Control features of multi-modular reactors, steam mixing, and co-generation.

Task 4 - Examples of applications of digital I&C for upgrading in current power reactors.

Task 5 - Major issues affecting performance and reliability of a digital protection system, and licensing and regulatory issues facing digital protection systems.

Task 6 - Digital I&C implementation in the UF Test Reactor.

3. TECHNICAL DESCRIPTION OF THE PROJECT

3.1. Developments in Digital I&C for Nuclear Power Plants

As stated in Reference 1, the reason for the transition to digital I&C is: *'Digital electronics are free of the drift that afflicts analog electronics, so they maintain their calibration better. They have improved system performance in terms of accuracy and computational capabilities. They have higher data handling and storage capacities, easier to use, and more flexible in application.'* Specifically, digital systems have the features of fault tolerance, signal validation, self-testing, process and equipment monitoring and diagnostics, and thus result in higher reliability. Some of the larger instrument manufacturers have incorporated smartness in the devices with the above features, and thus provide improved communication in a network. Because of these and other reasons, digital I&C applications will increase in plant life extension applications, and in the design of new and next generation nuclear reactors. An excellent example of the state-of-the-art fully digital I&C system is the Tomari-3 pressurized water reactor (PWR) in Japan, supplied and built by Mitsubishi Heavy Industries. For further information on the Mitsubishi's 1,700 MWe U.S. Advanced PWR (US-APWR) refer to www.MNES-US.com.

There are challenges in the U.S. to the transition from analog to digital implementation. Some of these are listed in Ref. [1].

- Uncertainty in new technology.
- Limited experience with digital systems in nuclear power plants.
- Some technical problems in digital I&C applications.
- Lengthy and possibly increased cost of licensing process.
- *Lack of consensus between the USNRC and the industry on issues underlying evaluation and adoption of digital I&C technology.* An increasing implantation of digital I&C in U.S. NPPs is an indication that satisfactory resolution can be achieved, at least for some applications.

Above statements provide further reasoning for the need for development of courses and

training materials addressing various issues and concerns associated with design, licensing and implementation of digital systems.

The regulatory framework includes adherence to safety standards, procedural framework for evaluating digital upgrades (10CFR50.59) and standards development for new plants (10CFR52). The USNRC has been working with nuclear industry and professional societies for developing standards for digital I&C applications in nuclear power plants. Several NRC Interim Staff Guides (ISG) and other industry (e.g.; ANS, IEEE, and ASME) standards have been developed. Some of the documents are ANS/IEEE-ANS 7.4.3.2, ANS/IEEE-Std-1012-1986, ASME NQA 2A-1990, NRC Regulatory Guide 1.152, and others. Nuclear regulatory Research (NRR) supports research in areas relevant to the evaluation and regulation of digital I&C technology.

These issues will be discussed as part of the development of the course material.

3.2. Course Modules: Nuclear Power Plant Dynamics, Control, and Digital I&C Systems

The performance of the project tasks will be distributed between the investigators at the University of Florida and the University of Tennessee. The tasks will be completed during a one year project period. The course contents will be tailored for dissemination to undergraduate and graduate level students. The course modules are listed below.

1. Reactor kinetics and dynamics,
2. Basic features of linear and nonlinear dynamic systems, and modeling principles.
3. Reactor systems in PWRs and BWRs.
4. Time-domain simulation of pressurized water reactors.
5. Frequency domain analysis of linear systems and reactor systems.
6. Design of classical controllers.
7. Principles of reactor control strategies, including load following and long-term operational control.
8. Introduction to digital systems and devices, including programmable logic controllers and FPGAs.
9. Introduction to modern control methods and application to reactor systems.
10. Control features of multi-modular reactors, steam mixing, and co-generation.
11. Examples of applications of digital I&C in current power reactors.
12. Major issues affecting performance and reliability of a digital protection system.
13. Digital I&C features in new design reactors.
14. Digital I&C implementation in the UFTR and hands-on experimental modules
15. Licensing and regulatory issues facing digital protection systems.
16. Course material dissemination.

Each of the course modules will have the following components:

1. Description in text form.
2. Examples and Worksheets.
3. PowerPoint presentation.

The course modules will be developed using the following resources:

1. Monographs on control systems and digital I&C.
2. Reports on various aspects of digital I&C, and roadmaps for current and future nuclear plants.
3. Resources from the current curriculum on basic theory and nuclear applications.
4. Resources from nuclear utilities on digital I&C implementation.
5. Resources from the analysis performed for the UFTR digital I&C design, licensing,

implementation, and benchmarking
6. Workshops and engineering publications.

4. LOGICAL PATH TO WORK ACCOMPLISHMENT

The proposed project is a collaborative effort between the University of Florida (UF) and the University of Tennessee (UT). Both the institutions have well-established Nuclear Engineering programs with educational and research accomplishments in various areas of nuclear systems dynamics, instrumentation, and controls. The project efforts will be distributed between the two investigators and their graduate students. The value of this project is enhanced by the use of the UFTR systems for understanding the implementation and operational characteristics of digital I&C systems. The following specific steps provide the logical path to accomplishing the goals of the project.

- Step 1: Identify the specific modules to be developed and upgraded by UF and UT. Perform necessary review of literature for use in developing course modules.
- Step 2: Develop course modules to include both text and PowerPoint slides on the module tasks listed in Section 3. Develop problem solving exercises and worksheets for each module.
- Step 3: Review literature on digital devices (such as data transmission, programmable logic controllers, FPGAs, and wireless transmission technology) to provide as primers on these topics.
- Step 4: Develop specific modules on digital I&C implementation (which includes discussion on design, licensing requirements and related planning, analyses, and benchmarking), and hands-on exercises via virtual instruments and internet communication.
- Step 5: Deliver the course during the second year of the project both in-class and synchronous distant delivery. Develop short courses for delivery to industry personnel.

5. CONTRIBUTIONS BY THE COLLABORATING INSTITUTIONS AND PROJECT MANAGEMENT

The course/curriculum development consists of tasks performed by the University of Florida and the University of Tennessee, both of which have nationally ranked Nuclear Engineering programs. The project investigators have proven expertise in education and research in nuclear system dynamics and controls, reactor operations, information extraction from digital measurements, reactor instrumentation, and related areas. A part of the course development task will involve improving the presentation of the course contents by examples, and relating them to current developments in reactor I&C systems. Research scientists and students will work in teams on projects that address the design and implementation of modern control devices and features that are relevant to nuclear reactors.

The specific work responsibilities are indicated in the Project Management Flow Sheet in Fig. 2. The project division is as follows:

- Objective 1: University of Florida - Development of curriculum material related to digital I&C implementation, hardware systems, and regulatory issues.
- Objective 2: University of Tennessee - Development of curriculum material related to control theory, reactor applications, and digital I&C systems.

6. PROJECT EVALUATION

The curriculum development project will be evaluated quarterly by two experts - Dr. Wes Hines, Professor of Nuclear Engineering, University of Tennessee, and Mr. John Mahoney, Entergy Nuclear, Jackson, MS. Quarterly progress reports and a Project Report will be prepared and

distributed to project evaluators. Periodic project meetings will be held with the evaluators and the NRC senior personnel. These meetings will include the project investigators and the research scientists and graduate students who will be assigned to the project.

7. EXPECTED PRODUCT AND DELIVERABLES

It is expected that the output of this project would be a complete two-semester course material on reactor dynamics, controls, digital I&C systems, and their licensing implementation. The deliverables will include a comprehensive text of the course materials with examples and worksheets, PowerPoint slides for class lectures, and examples of applications to the UFTR. The deliverables will also include Worksheets for student learning and interactive laboratory modules that will be executed via the internet data transmission. The course material can be tailored for delivery as a one-week or a two-week short course. It is anticipated that a full-length textbook will be developed as a result of this collaborative course development project. Table 1 shows the project milestones and the schedule of milestones.

8. PROJECT EXECUTION PERIOD AND BUDGET

This project will be performed by Prof. Alireza Haghghat (PI), University of Florida, and Prof. Belle Upadhyaya (Co-PI), University of Tennessee, over a period of one year with a total budget of \$150,000. The project investigators will work with a research scientist, Dr. Gabriel Ghita, from the University of Florida and undergraduate and graduate students from both institutions. The tasks of Dr. Ghita are to assist with materials on design, safety, licensing and implementation of digital systems, and the students are to acquire and compile the material needed for the various course modules. Both research scientists and students will work on the hardware systems associated with the UFTR and provide assistance in testing digital devices. Note that Dr. Ghita currently works with Prof. Haghghat on the UFTR digital system upgrade project.

9. ADDRESSING EVALUATION CRITERIA

In this section, we attempt to address all the criteria used for evaluation of our application.

9.1. Criterion 1

This proposal will develop undergraduate and graduate courses in the area of digital I&C for reactor protection and control. The use of digital systems for protection and control of existing reactors and next generation reactors is essential, because the existing analog systems have become obsolete, and are problematic, because they are expensive to maintain, do not offer the flexibility of digital systems, and require larger safety margins. On the other hand, the digital systems have new concerns such as software integrity, cyber security, and common cause failure. These issues have to be addressed during design and licensing.

Proposed courses not only discuss the fundamentals of control methodologies, but also through the use of UFTR digital upgrade project will provide real-life information on hardware design, implementation, licensing and benchmarking. These courses and short courses not only will enable us to train highly qualified graduates, but also will be beneficial to personnel from nuclear utilities, vendors, and government agencies, because of the use the UFTR digital upgrade, which uses industry standard TXS protection and T-3000 control systems, and with assistance from AREVA and Siemens engineers is following the Interim Staff Guides (ISG) prepared for power reactor applications.

In summary the proposed courses are very unique and highly beneficial for improvement of reactor safety and operations. For further information, see Sections 1-3.

9.2 Criterion 2

We have put together a unique team. The UF team brings its significant capability in reactor modeling/analysis, reactor designs, its experiences with the UFTR digital control upgrade, and

the UT team brings its vast experience in reactor instrumentation, controls, and on-line monitoring methodologies. This collaboration brings together all the necessary expertise, experience and benchmarking environments, which will lead to development of highly beneficial courses and short courses. For further information, see Sections 4-7. Also, to ensure that the curriculum development includes the most up to date and relevant NRC and industry methods and guidance in the area of instrumentation and control, we will seek collaboration from a senior member of the NRC regulatory staff in the development of the material.

9.3 Criterion 3

Both institutions offer excellent nuclear engineering programs, and are highly respected. Both institutions teach courses in reactor design, theory, and modeling and simulation. They have outstanding faculty who are engaged in important research on reactor I&C, simulation and analysis, and both institutions have all the necessary laboratories and facilities for offering an outstanding nuclear engineering curriculum. The ongoing work in the UFTR digital control upgrade provides the group with a unique capability which currently does not exist in any university in the United States to reflect an industrial setting.

It is important to emphasize that both departments celebrated their 50th anniversary in the last two years, and enjoy tremendous support from their respective administrations. For further information, see Figures 3 and 4 which provide one-page overviews of both institutions, respectively.

9.4 Criterion 4

As indicated in the curriculum vitae provided in part E, the PI, Professor Alireza Haghghat, and Co-PI, Prof. Belle Upadhyaya, have proven record in subject areas and have experience in development and delivery of courses both in university settings. Their research activities have addressed various aspects of R&D applied to power reactors. Further, Dr. Ghita, a research scientist, has hands-on experience with reactor system upgrades.

9.5 Criterion 5

This curriculum development project will incorporate innovations in material presentation and dissemination to different audiences. The course material will be divided into 12 modules. The course material dissemination for these instructional modules will include narrative text, classroom presentations in PowerPoint, student worksheets, and laboratory exercises.

9.6 Criterion 6

We believe we have an excellent team with all the necessary experience and expertise to be able to accomplish the goals of this project with an effective cost. Further information is provided in Section 8.

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 CFR 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.i Edison.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 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 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 from 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.”