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

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-HQ-11-G-38-0057		FROM: 8/22/2011 TO: 8/31/2012	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: 929773554 NAICS:611310	Kansas State University 2 Fairchild Hall Manhattan, KS 66506-1103

8. PROJECT TITLE:

Development of a Distance Education Course Sequence on Probabilistic Risk Assessment and Fire Protection

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)	Dr. William L. Dunn Department of Mechanical and Nuclear Engineering Email: dunn@mne.ksu.edu Phone: 785-532-5628

12. NRC PROGRAM OFFICE (NAME and ADDRESS)	13. ACCOUNTING and APPROPRIATION DATA		14. METHOD OF PAYMENT
NRC Attn: Tanya Parwani-Jaimes Office of Human Resources MS: GW5A06 (301) 492-2308 11545 Rockville Pike Rockville, Maryland 20852 Email: Tanya.Parwani-Jaimes@NRC.GOV	APPN. NO: B&R NO: JOB CODE: BOC NO: OFFICE ID NO: FAMIS:	31X0200 2011-84-51-K-134 T8453 4110 RFPA: HR-11-276 GR0065	[ ] 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	$184,791.00	NRC	$184,791.00	This action provides funds for Fiscal Year in the amount of See Page Two
PREVIOUS OBLIGATION		RECIPIENT	$0.00	
TOTAL	$184,791.00	TOTAL	$184,791.00	

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

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

18.	19. NRC CONTRACTING OFFICER	
Signature Not Required	Sheila Bumpass (Signature)	8/22/2011 (Date)
	NAME (TYPED) Sheila Bumpass	
	TITLE Contracting Officer	
	TELEPHONE NO. 301-492-3484	

20. PAYMENT INFORMATION

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

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

22. ORDER OF PRECEDENCE

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

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

TEMPLATE - ADM001

SUNSI REVIEW COMPLETE

ADM002

ATTACHMENT A - SCHEDULE

A.1 PURPOSE OF GRANT

The purpose of this Grant is to provide support to the "Development of a Distance Education Course Sequence on Probabilistic Risk Assessment and Fire Protection" as described in Attachment B entitled "Program Description."

A.2 PERIOD OF GRANT

1. The effective date of this Grant is August 22, 2011. The estimated completion date of this Grant is August 31, 2012.

2. Funds obligated hereunder are available for program expenditures for the estimated period: August 22, 2011 – August 31, 2012.

A. GENERAL

1. Total Estimated NRC Amount:	$184,791.00
2. Total Obligated Amount:	$184,791.00
3. Cost-Sharing Amount:	$0.00
4. Activity Title:	Development of a Distance Education Course Sequence on Probabilistic Risk Assessment and Fire Protection
5. NRC Project Officer:	Tanya Parwani-Jaimes
6. DUNS No.:	929773554

B. SPECIFIC

RFPA No.:	HR-11-276
FAIMIS:	GR0065
Job Code:	T8453
BOC:	4110
B&R Number:	2011-84-51-K-134
Appropriation #:	31X0200
Amount Obligated:	$184,791.00

A.3 BUDGET

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

Personnel	$27,008.00
Fringe Benefits	8,913.00
Contractual	100,649.00
Supplies	1,500.00
Total Direct Cost	138,070.00
Indirect Cost	46,721.00
Total	$184,791.00

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is $184,791 for the one-year period.
2. NRC hereby obligates the amount of $184,791 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

PROGRAM DESCRIPTION

A tremendous need exists for engineers with training in Nuclear Engineering (NE), due both to the expected growth of the nuclear industry in the coming years and to the lack of production of NE graduates over the last few decades (with the result that many of the current nuclear professionals are facing retirement soon). During the last period of rapid growth in nuclear technology, the nuclear industry fared poorly in dealing with the public and suffered badly when nuclear accidents, such as Three Mile Island and Chernobyl, occurred. The lesson for the nuclear industry is that its professionals should be well trained not only in traditional nuclear engineering topics but also in being able to articulate to the public the risks and benefits of nuclear technology. Thus, a need exists to educate nuclear engineering students in the areas of risk/benefit analysis, probabilistic risk assessment (PRA), safeguards, security, fire protection, and safety analysis. Of course, the primary benefit of such training is the safe design, construction, operation, maintenance, and regulation of nuclear facilities but a secondary benefit is that nuclear engineers will be better enabled to address public concerns over the safety of nuclear facilities and the risks associated with operating them.
This proposal addresses the need to train undergraduate engineering students in the general areas of reliability, risk analysis, PRA, and fire safety. Toward this end, a collaboration of five universities has been formed that proposes to develop a two-course sequence of undergraduate-level courses that will prepare students in the above mentioned areas. In order to reach as many students as possible, these courses will be developed in a distance-education format and offered on-line, initially through the Big 12 Engineering Consortium and then more broadly. The proposal is submitted by Kansas State University (KSU) but the work will be conducted with the help of Iowa State University (ISU), Oklahoma State University (OSU), University of Missouri-Columbia (UM-C), and University of Texas-Austin (UT-A). A productive collaborative arrangement has been developed, with each university supplying critical input based on that university's unique capabilities. More specifics about the courses are presented in the later section entitled "Academic Focus."

Assessment Plan and Milestones

The five Big 12 collaborating institutions will employ multiple strategies for determining success of the project. Project evaluation and curriculum assessment will be coordinated by Consortium staff, Mo Hosni and Dana Reinert, with the expert guidance of Dr. Ray Lewis, an external evaluator. Dr. Lewis has over 30 years experience in higher education and distance learning as a program officer for the Fund for the Improvement of Postsecondary Education (FIPSE), as the founding director of Oregon's statewide distance learning network (Oregon ED-NET), as a higher education consultant, and as the external evaluator for over twelve projects funded by

Federal agencies (Department of Education, HHS and USDA). He has a Ph.D. in political science from the Maxwell School at Syracuse University. Dr. Lewis is Director of the consulting firm Connections Associates, Portland, OR. The firm specializes in the analysis and solution of problems associated with the integration of information technologies into education, with a major focus on collaborations and partnerships.

The evaluation team also will engage the inter-institutional team of faculty, an instructional design expert with knowledge of the Quality Matters guidelines and a course review committee consisting of content experts from industry. The evaluation team, with oversight of the external evaluator, will (1) ensure quality instructional design, providing a framework with guidelines for collaborative development of the curriculum; (2) assist in structuring expectations and measures of success for the curriculum from a pedagogical point of view; and (3) provide an ongoing formative evaluation of the course that draws on instructional/student assessments. A key component will involve the course review committee, which will be designed to channel focused feedback from industry content experts to the faculty who are responsible for refining and finalizing the course content. The evaluation team will focus efforts on the following:

- Relevance to industry needs documented by feedback from course review committee of industry content experts
- Effectiveness of instruction as measured by grades and course evaluation surveys
- Satisfaction of participating students as measured by course evaluation surveys
- Enrollments in credit courses (compared to yearly projections)
- Student inquiries (students already at Big 12 and other schools, working professionals)
- Extent of use of modularized lessons in existing courses by faculty at Big 12 schools
- Job placement of graduates (impact to be realized beyond project period)

The course review committee will contain experts in fire safety and risk assessment from industry. The course sequence being proposed will involve participation of faculty from five partner schools, who will work collaboratively to design, develop, and assess two courses. To ensure high quality offerings, the faculty will be supported by instructional designers. The courses will be developed with adherence to the Distance Learning Course Assessment Guidelines developed by the Big 12 Consortium's Assessment Committee. Among other things, the curriculum will include assessment tools for evaluating Student Learning Outcomes (SLO), e.g., a list of relevant Educational Outcomes (a thru k) required by ABET and a corresponding assessment questionnaire. The faculty will share the newly developed modularized lessons via an on-line share-site.

The following tasks have been identified for successful completion of the proposed project.

Task 1. Modification of existing course (Reliability and Safety Engineering, taught oncampus at ISU by Dr. Carolyn Heising) to include more material specific to NE and to break it into three one-credit modules

Task 2. Construction of a syllabus and other materials for a junior-level distance course, NE 505, Reliability and Risk Analysis Fundamentals

Task 3. Taping of NE 505 modules

Task 4. Design of a second course, NE 605, Probabilistic Risk Assessment and Fire Safety, as a combination of three one-credit modules

Task 5. Construction of a syllabus and other materials for NE 605

Task 6. Taping of NE 605 modules

Task 7. Assessment of both courses

It is anticipated that, if this proposal is successful, funding will begin in March 2011. Based on this, the timeline shown in Table 1 is proposed:

Table 1. Proposed timeline.

Task/Months
Task 1: 1-3 months
Task 2: 1-3 months
Task 3: 3-7 months
Task 4: 7-15 months
Task 5: 15-16 months
Task 6: 17-21 months
Task 7: 5-24 months
Reporting: Semi-annually (PPR due every 6 months - 3/31 & 9/31)

Commitment letters from collaborators and industry
Letters of commitment from the collaborators are attached.
Course Outline
The goal of the proposed project is to design and produce a sequence of two related undergraduate distance-education courses that address reliability, risk analysis, and fire safety engineering. The impact will be that undergraduate students from many universities will be exposed to material that will better prepare them to design, safely operate, maintain, and regulate nuclear facilities, as well as to articulate the risks and benefits of nuclear technology.
Background of the Big 12 Engineering Consortium
In 2006, the U.S. Departments of both Energy and Education provided seed grants that supported the development of the Big 12 Engineering Consortium (the Consortium) and a NE course-sharing program. At that time, the four Big 12 schools with nuclear programs—KSU, Texas A&M University (TAMU), UM-C, and UT-A—joined forces to offer fully on-line nuclear courses to students at the other Big 12 institutions. The original focus was to reach students who are degree-seeking at any of the Big 12 institutions, but working professionals have also been attracted to the flexible program. Students can enroll through their own home school to take the NE courses taught by the Consortium.
The Big 12 schools started offering fully on-line NE courses in spring 2007. Initial enrollments were modest but enrollments continue to increase. Drawing on Consortium offerings, Iowa State University and Texas Tech University have developed NE minor programs and Kansas State University is revising institutional policy to allow delivery of a fully on-line minor for post-baccalaureate working professionals. As of Spring 2011, the Consortium currently will offer the eleven on-line NE courses listed in Table 2. Other distance courses are in development. The Consortium believes that there is a need to develop and offer more on-line courses in NE and related areas, and to develop modularized lessons that can be incorporated into other courses to reach students outside the NE major.

Table 2. Current offerings available through the Consortium.

Course - Title - Teaching school
NE 300 Introduction to Nuclear and Radiation Engineering Concepts UT-A
NE 301 Principles of Nuclear Engineering TAMU
NE 302 Fulfilling Madame Curie's Dream UM-C
NE 500 Elements of Nuclear Engineering KSU
NE 600 Energy Systems and Resources UM-C
NE 601 Radiation Protection and Shielding KSU
NE 602 Nuclear Reactor Engineering UT-A
NE 603 Nuclear Reactor Theory TAMU
NE 604 Nuclear Reactor Analysis TAMU

NE 505 Reliability and Safety Engineering ISU
NE 610 Reactor Operations Virtual Laboratory KSU

The Consortium places the Big 12 schools in a prime position to graduate engineers who are ready to enter the nuclear-energy and related industries. However, due to a low profile over the last 20 years, many students are not aware of the attractive job opportunities in the nuclear field. The projects being proposed by the Big 12 partners will shine a light on the nuclear field. For that reason, many nuclear companies have expressed their enthusiastic support for this Big 12 initiative. Building on conversations started during the 2008-2010 Big 12 Engineering Summit meetings, institutional leadership and industry representatives have been strengthening networks for ongoing dialogue and planning. One step in the process is development of a formal industry advisory board that will advise the Big 12 faculty on an ongoing basis. At the Consortium meeting held in Kansas City, MO, from 5-7 October 2009, industry leaders emphasized the need for engineers with training in probabilistic risk assessment, safety analysis, and fire protection technology. It is worth noting that, once identified, this need quickly became a focus of attention by many of the industry leaders. The current proposal directly addresses this need.

Academic Focus

The proposed project involves development and delivery of two related undergraduate courses that will be offered by distance education methods to students who attend Big 12 institutions. After these courses have been improved through careful evaluation and upgrade, the courses can then be made available world-wide. These courses, directed primarily at risk assessment, fire protection, and related safety methods for use at nuclear facilities, will help increase the pool of university graduates who have knowledge and expertise to deal with the nuclear renaissance that is now occurring world-wide. The courses will be concerned primarily with use of effective methods of reliability analysis, fault tree analysis, probabilistic risk assessment, fire protection technology, and related topics.

The first course is based on a course entitled "Reliability and Safety Engineering," which already is offered at ISU as an undergraduate course (directed at Junior- or Senior-level students), that addresses generic issues related to reliability, risk assessment, and safety analysis. A few changes will be made to this course in order to create a new 3-credit distance course, NE 505, Reliability and Risk Analysis Fundamentals that focuses more on issues involved in nuclear powerplant safety. The new Consortium course will consist of three one credit modules. This is a basic course whose main purpose is to provide the generic concepts and tools for risk-based safety analysis.

The second course is a completely new course whose topic areas include the fundamentals of fire science, Monte Carlo methods for PRA, and applications of PRA methods to fire risk assessment. The first module of the second course will introduce the basic concepts needed to understand combustion and fires; the second module will introduce Monte Carlo methods for PRA, and the third module will concern application of PRA to fire safety.

The expected course descriptions follow.

NE 505, Reliability and Risk Analysis Fundamentals. 3 credit hours; Prereq. Basic understanding of statistical concepts. Reliability and risk concepts. Probability theory. Vulnerability and risk assessment. Failure modes and effects analyses. Reliability block diagrams. Fault tree analysis and fault tree construction principles. Analysis and comparison of types of risk, including nuclear and environmental.

NE 605, Probabilistic Risk Assessment and Fire Safety. 3 credit hours; Prereq. NE 505 or equivalent. Fire science, Monte Carlo methods for probabilistic risk assessment, application of PRA methods to fire safety at nuclear facilities.

Of course, as the team completes the design and development of these two courses, minor changes in the course descriptions may result.
The three one-credit modules in NE 505 are listed below, along with the lead institution (listed first) and assisting institutions:
Module 1. Fundamental concepts involved in reliability and risk assessment ISU/KSU
Module 2. Tools for assessing risk and safety ISU/UM-C
Module 3. Methods applied to nuclear, environmental, and other risks ISU/UM-C
The three one-credit modules in NE 605, along with the lead institution (listed first) and assisting institutions are listed below:
Module 1. Fundamentals of fire science UT-A/OSU
Module 2. Monte Carlo methods for probabilistic risk assessment in fire KSU/UT-A/OSU
Module 3. Application of PRA to fire safety in nuclear systems OSU/UT-A/UM-C/KSU
These assignments are based on institutional expertise and will assure that the modules and courses are of high quality.
Module one of NE 505 will cover pertinent aspects of the theory of probability, will define risk in terms of both probability and consequence, and will discuss basic concepts related to reliability. The second module will introduce tools, such as fault tree analysis and reliability block diagrams, that can be applied to safety analysis of real-world issues. The third module will apply the concepts and methods addressed in the first two modules to consider and compare risks associated with various activities including but not limited to the nuclear industry. These three modules taken together make up a 3-credit course but each module could be used within other courses. For instance, a student who had taken a basic course on risk and safety analysis at some university could benefit from taking the third one-credit module that deals with applications to nuclear, environmental, and other risks. There is, of course, some risk of duplication, in the sense that some concepts covered within one of these modules will have been covered in some other course that a student at another university has taken. However, repetition is one of the best methods of learning and thus repeated exposure to some material only reinforces the concepts. Further, the module descriptions can be used to assure that no student takes a module whose content has been fully covered within an existing course.
Fire hazards represent a significant risk to facilities operating nuclear and radiological systems. The ability of a fire to loft and redistribute potentially radioactive aerosol particles is noted as being a primary motivator to analyze and characterize the risks of fire in such facilities. The fire science expertise of the UT investigator, Dr. O.A. (DK) Ezekoye, will be used to develop pedagogically sound and visually rich tools to teach students in nuclear or other engineering programs the fundamental issues in fire such that they are better able to a) make basic decisions about fire safety issues and b) interact with fire safety engineers in meaningful ways. The UT group will collaborate with both Kansas State University and Oklahoma State University researchers to develop course modules that address the fundamentals of fire science and expand such material to address risk based concepts such as propagation of uncertainty and development of cumulative distribution functions for fire hazards. The UT group will use the computational capability of the Texas Advanced Computation Center (TACC) to create highly refined simulations of common fire hazards in the nuclear facility environment.
The second module of the second course will introduce how Monte Carlo methods can be used in probabilistic risk assessment. As this is a one-credit module in an undergraduate course, coverage only will be at an introductory level. However, this module will build on the basic probability theory covered in the first module of Consortium course NE 505. Topics to be covered include sample means and variances, the law of large numbers, the Central limit theorem, pseudorandom number generation, sampling and scoring methods, and importance sampling as an example of variance reduction methods. This material will be based on Chapters 2-5 of the new book by Dunn and Shultis (in press). After these concepts have been covered, ways to apply Monte Carlo methods to PRA will be introduced. It is hoped that this

module will prepare undergraduate students for more advanced use of Monte Carlo in PRA in graduate courses, in graduate research, and in industry.
Risk assessment is a critical component of design, construction, operation and decommissioning of any nuclear facility. Fire Modeling is a fundamental requirement in the transition to a risk-informed approach to fire protection in nuclear facilities. As identified in a recent Government Office of Accountability report, the shortage of skilled personnel and the concerns about the costs involved in performing risk analyses could slow the desired transition to risk-based approaches to fire protection (GAO).1 The third component, on fire protection, of the second course will use output data from NUREG 1805 Tools, Fire Dynamics Simulator (DS), CFAST, Smokeview, and related fire modeling programs for nuclear facilities in PRA exercises. Fire modeling is a fundamental requirement in the transition to a risk informed approach to fire protection in nuclear facilities. As identified in a recent Government Office of Accountability report, the shortage of skilled personnel and the costs of performing risk analyses could slow the transition to risk based approaches to fire protection (GAO-08-747). Output data will be based upon scenarios using a data from actual and simplified situations. The data from a variety of fire models will be integrated into a risk assessment course work so that engineers will have familiarity with the capability and limitations involved in fire modeling. The data students generate from modeling exercises will be integrated into a scenario to illustrate the role that quantitative and qualitative engineering analysis are used to satisfy safety performance requirements, using NFPA standard 805 as the basis. Selection of appropriate models and limitations of the model will be based on NPA 805 Annex C.
Within the courses, issues such as the following will be addressed: what the term "defense in depth" means and how nuclear power plants have been designed to incorporate this concept; how PRA studies of nuclear power plants can complement deterministic analyses; what "configuration management" is and why configuration management is necessary in managing risk at nuclear power plants; methods used by nuclear utilities to incorporate risk insights into maintenance planning, especially for aging plants; and how PRA results are used by the NRC for risk-based regulation. For example, the "defense-in-depth" topic will address the following: multiple fission product barriers, redundancy, diversity, single failure criteria, and worst-case assumptions. This material will be covered with a view to the methods that should be applied to aging plants.
The two courses, NE 505 and MNE 605, will form a course sequence that will prepare students in PRA, fire safety, and reliability analysis. Of course, not all students will take both courses, but those who do will have a firm grounding in risk and reliability. A nuclear power plant PRA attempts to answer questions such as the following:
what can go wrong?
what is the probability that what can go wrong will go wrong?
what are the consequences if something does go wrong?
what is the best way to estimate the risks associated with some sort of failure?
how well can the risks be managed?

Probabilistic risk assessment of nuclear powerplants requires a multidisciplinary approach employing various methods that include system reliability, containment response modeling, and fission release and public consequence analyses. Among the PRA elements that will be considered are those shown in Figs. 1 and 2.
1 Government Accountability Office, GAO-08-747 "NRC's Oversight of Fire Protection at U.S. Commercial Nuclear Reactor Units Could Be Strengthened" p. 24.
Figure 1. PRA elements.
Figure 2. Elements to consider in a probabilistic risk assessment.

Standalone Modules

Each of the two courses, NE 505 and NE 605, will be stand-alone three-credit courses that are made available by distance techniques through the Consortium. Both courses, however, will be developed in a modular manner, so that portions can be used separately in other courses or offered as one-credit modules. A one-credit module will consist of about 15 class periods of about 40-50 minutes. A given class period will consist of a 40-50 minute lecture or several shorter sessions. This approach is important in that it will assist in the establishment of subject matter experts in specific areas for students that do not need to complete the entire course of study.

If a single lesson or one-credit module from NE 605 is taken, it may have different prerequisites than the entire 3-credit NE 505 course. As the modules are developed, appropriate prerequisites for each module will be determined. For instance, the fire safety portion of NE 605 could be taken as a one-credit elective course for students with prerequisites that might differ from those for a student wishing only to take the one-credit Monte Carlo portion of NE 605.

The proposed modular approach to nuclear education allows flexibility. The lessons can be incorporated into non-nuclear courses and thus expose a large student population to nuclear concepts; this will increase interest in taking the 3-credit courses, possibly as part of a certificate or minor program at one of the participating schools. The one-credit and 3-credit courses can be taken as technical electives as part of normal science and engineering curricula. Having one-credit electives available often is of value to students who only need one or two elective credits to complete a degree program.

As an example of how a module might be constructed, the preliminary outline of the second module of NE 605 will be discussed in some detail. This module is expected to consist of about fifteen lectures, each about 45-50 minutes long, on Monte Carlo methods for PRA. Those taking this module will be expected to have taken NE 505 and thus will be familiar with the concepts of probability and discrete and continuous random variables. Thus, the topics to be considered in this module include the following:

Sample mean, sample variance, and sample standard deviation (1 lecture)
Law of large numbers and Central limit theorem (2 lectures)
Pseudorandom numbers and methods for their generation 1 lecture)
Generic sampling and scoring methods (3 lectures)
Variance reduction techniques, with emphasis on importance sampling (2 lectures)
Application of Monte Carlo techniques to PRA in NE (6 lectures)

The actual number of lectures devoted to each topic may change, but the module is intended to cover all of these topics in sufficient detail to prepare students to understand the value of Monte Carlo as a tool in PRA. Each of the lectures will be taped by a professional in a classroom equipped for taping distance lectures. The lectures will be posted in .mp4 or similar format.

Letters of Support

Letters of support are appended at the end of this Project Description.

Status of the Courses

Both courses proposed will be elective offerings within the Big 12 list of courses. Although they are elective, they will likely become required by one or more Big 12 institutions as minor or option programs are established. Nevertheless, both courses will become routine offerings within the Big 12 Engineering Consortium that are offered, presumably on an annual basis. It is expected that NE 505 will be offered every fall while NE 605 will be offered every spring.

Course Level
Both courses are being developed to be offered at the undergraduate level. However, the second course, NE 605, will be developed as an advanced undergraduate course and thus will be a suitable offering for graduate credit.

Numbers of Students
The initial offering of each course will, presumably, attract modest numbers of students. However, within one or two years, it is expected that these course will reach 30-50 students per offering. This estimate is based on the experience of other Big 12 Engineering Consortium courses offered over the last several years.
Sustainability
The participating faculty members have formed a virtual department that transcends school and state borders. They meet regularly to discuss textbook selection, order of units, module content, and developments in the field. The faculty members specializing in nuclear engineering will share their expertise and help fill the gaps at schools that have limited NE expertise. In addition, the modularized lessons can be incorporated into existing non-NE courses to add new elements that were not previously available to students taking those courses. The faculty will have ongoing access to instructional design experts during the project. The Big 12 Engineering Consortium is an established program that is functioning to produce students educated in nuclear matters. The addition of these courses on PRA and fire safety will only enhance the course offerings. It is expected that these courses will become "favorites" of students taking Big 12 courses because they deal directly with important matters related to safety and reliability. These issues are being stressed within curricula around the country.

Innovative Instructional Approaches
The innovative approaches within this proposal include first the collaborative preparation and dissemination of distance courses, drawing on the distributed expertise within an established consortium. This obviates the need to start-from-scratch in advertising and promoting the courses. New programs in NE are expensive to initiate and thus leveraging existing programs by way of collaborative on-line education is a rational solution. The Big 12 Higher Education Strategy Council, consisting of leading education experts, has strongly recommended that existing NE courses be re-designed for on-line delivery and offered to a broad audience so that more students will have access to the at-a-distance nuclear education opportunities. In-line with the Council's advice, the Big 12 schools have developed the eleven shared on-line offerings identified in Table 1. These distance courses reduce duplication of effort and allow students at all universities access to the experts in given fields. Further, this approach allows access points for students who aren't currently admitted at a Big 12 school with a nuclear program.
The Big 12 Engineering Alliance has concrete benefits for students, faculty, institutions, and society. If any of the Big 12 schools decided to develop a new a single-institution NE program supported by a training reactor, their planning and development time would amount to several years, at minimum, and many more years with construction of the reactor. The Big 12 schools have decided to collaborate to ensure that all Big 12 students have the opportunity to learn about nuclear science and engineering and even experience working in a reactor, which they can do immediately through the new Virtual Laboratory course. Distance delivery of the courses allows students anywhere to take advantage of challenging and attractive training that prepares them to understand basic nuclear concepts.
Through efforts to reach new students, the Big 12 encourages more students to consider careers in NE. Over the past four years, the Big 12 has incentivized students to study NE by offering on-line courses at an affordable price and by making scholarships available to students. The Big 12 strives to provide students with the best education possible, which requires continual

updating of curriculum and creation of new courses, one-credit modules, and virtual experiments. The general intent of the proposed curriculum is to make expert-developed content available as fully on-line courses and as modularized lessons that can be injected into many different courses and curricula. The bridging goal is to produce more graduates who are aware of nuclear science and engineering so that they can make informed decisions as well as tackle jobs that require some knowledge of the NE discipline. Some of these students will be inspired to pursue advanced-degree study in NE.

Timeline

A project timeline is provided in Table 1.

Improvement in Infrastructure, Competencies, Expertise, and Skills

This curriculum development project will enhance the infrastructure at the four partner teaching schools and will have lasting effects on the Big 12 institutions and eventually on the nation. The courses will be offered in an on-line format, and will enhance the educational opportunities available to students who may be interested in NE but who have no NE program locally available. The new courses may entice students to consider the nuclear industry as potential for a rewarding career or for graduate studies. When the participating students graduate, they will have the advantage of being able to secure attractive positions with prestigious companies in the NE field. They will also have a basic understanding of reliability, PRA, and fire safety.

To motivate student interest in the impact of fire on nuclear facilities, we will review fire hazards from a historical perspective in nuclear power plants. Detailed analysis of the Brown's Ferry accident and subsequent NRC initiatives will take place. Discussion will focus on basic fire physics, codes and standards for these facilities, and analysis tools that shed insight on historical accidents. For fire physics, students will learn about the basic thermo-chemistry of fire (e.g., simple ways of predicting adiabatic flame temperatures). Next, we will discuss basic ways of organizing fire physics (premixed ignition, nonpremixed flame spread, entrainment and smoke filling, radiative feedback, etc.) and how these descriptors map to any given accident scenario. Precomputed simulations and videos of fire progression in various systems will be used to clarify the physics of fire and risks posed by fire. The students will be introduced to such tools such the NUREG 1805 spreadsheet tools, NIST-BFRL's Consolidated Fire and Smoke Transport (CFAST) code, and NIST-BFRL's Fire Dynamics Simulator (FDS). Team work will be emphasized in the class, and a team based homework assignment that will focus on a risk/hazard analysis for a particular fire scenario will constitute a portion of the module grade.

Institution's Capability and Capacity

KSU

The faculty members in the Department of Mechanical and Nuclear Engineering at KSU are well known as leaders in the areas of probabilistic risk assessment, radiation protection and shielding, radiation detection, and radiation applications. KSU has been developing and managing academic consortia for nearly 15 years, and will continue that tradition by staffing the Big 12 Engineering Consortium and this project. KSU also will guide strategic planning of marketing activities and ensure that attractive and inviting materials reach the hands of students.

Kansas State University provides coordination support for the Consortium and this project, with a small, but devoted, staff responsible for managing communications, financial records, and administrative documentation. The Consortium staff has been involved in facilitating the Big 12 NE activities since the collaboration began over three years ago, and will ensure the project follows the timeline and delivers the stated outcomes.

The proposed PI, Dr. William L. Dunn, participated in developing industry standard models and codes for estimating risks due to tornado-borne objects (Dunn and Twisdale 1979;

Twisdale and Dunn 1979; Twisdale and Dunn 1982), turbine missiles (Twisdale, et al. 1983), and high winds (Twisdale and Dunn, 1983). His TORMIS, TURMIS, and WINRISK Monte Carlo codes have been used in numerous plant licensing actions. He and his colleagues wrote four reports for the Electric Power Research Institute on tornado missile risk analysis—EPRI-NP-154 (Twisdale, et al. 1976), EPRI-NP 769 (Twisdale, et al. 1978), and Volumes one and two of EPRI-NP-2005 (Twisdale and Dunn 1981)—and one on turbine missile risk analysis—EPRI-NP-2749 (Twisdale, et al. 1984). Dr. Dunn has maintained an interest in Monte Carlo techniques and he and his colleague, Dr. Ken Shultis, have a publication agreement with Elsevier to publish a book entitled *Exploring Monte Carlo Methods*, which is nearing completion In addition, Dr. Shultis has published in the PRA literature (e.g., Shultis, et al. 1986; Pawha, et al. 1988) and has performed PRA research for the Nuclear Regulatory Commission, authoring or co-authoring six NRC reports, (Shultis 1979; Shultis, et al. 1981a; 1981b, 1981c, 1981d; Shultis, et al. 1982).

ISU

The college of engineering at ISU is one of America's premier institutions for delivering educational opportunities to students world-wide through the use of cutting-edge DE technologies. Drawing on their strengths, the ISU faculty team has proposed module topics that reflect their areas of focus for teaching and research. Dr. Carolyn Heising, Professor of Industrial, Mechanical and Nuclear Engineering at ISU, has taught reliability and risk assessment graduate and undergraduate course in reliability and probabilistic risk assessment (PRA) since 1980 when she was an assistant professor of nuclear engineering at MIT. The focus of her involvement will be in the teaching of fault tree analysis methods of reliability analysis as it applies to probabilistic risk assessment (PRA), common cause failure analysis, and event tree analysis. She has over 30 years of experience in the field of PRA both in research and teaching. Her main focus of research has been on improving the reliability and maintenance of nuclear power plants utilizing methods of reliability analysis, quality control and PRA. She has had extensive nuclear utility support for her research, including such companies as Florida Power and Light (FPL) at the St Lucie nuclear power plant, Omaha Public Power District (OPPD) at the Ft Calhoun nuclear power plant, and recent involvement with the Duane Arnold nuclear power plant located in Palo, Iowa operated by FPL. Further, her former students are employed with these utilities in management and engineering positions related to PRA.

OSU

Oklahoma State University has the nation's oldest academic program in fire protection, which has evolved significantly since 1937. The OSU faculty will build the fire protection offerings based on tested methods that integrate modeling with scenarios. The OSU Institute for Teaching and Learning Excellence will provide services to enable excellence in DE. Oklahoma State University has established a campus wide resource for educational excellence. The Institute for Teaching and Learning Excellence (ITLE) provides resources and support services to promote and enable excellence for every element of the teaching-learning transaction for both on-campus and distance education. There is a well developed capability with in ITLE for developing the innovative communications tools necessary to provide the realism necessary for this project to be effective. Animations and supporting materials will be developed using ITLE and other institutional resources to enhance classroom and distance delivery of the material

UM-C

The University of Missouri-Columbia NE program has been offered since 1964, and was ranked first for faculty scholarly productivity in 2007. The distinguished UM-C faculty has proudly extended its mission to include teaching nuclear courses to students at a distance.

Dr. Tushar Ghosh, the PI of the UM-C subcontract, is Professor in the Nuclear Engineering Program at UM-C and Director of Graduate Studies- Nuclear Science and

Engineering Institute. He has been Assistant Director and Group Leader of Indoor Air Research and Adsorption Studies at the Particulate Systems Research Center since June 1996. Dr. Goshar has two patents and is widely published in the literature, especially in risk-related areas such as air quality, chemical agents, and chemical weapons.

UT-A

The University of Texas at Austin has had a nuclear technical option in the college of engineering for more than fifty years. The University has provided strong support for Nuclear Engineering and has considered Nuclear Engineering to be an essential part of the engineering research and teaching portfolio. Nuclear Engineering at UT benefits from physical infrastructure such as the TRIGA nuclear reactor housed at the Nuclear Engineering Teaching Laboratory (NETL) at the J.J. Pickle Research Campus. The nuclear engineering program has broad impact and extensive collaboration across the Cockrell School of Engineering, the University of Texas, national laboratories, and academic partners around the world. Nuclear engineering teaching and research programs at UT cover health physics, environmental health and safety, radiation engineering, research reactor beam port experiments, radioactive waste management and reactor and computational nuclear engineering, homeland security and non-proliferation. Over the past decade, there have been a few projects and partnerships at UT that involve nuclear/radiological components and fire safety issues. Fire research activities at UT take place in both Civil Engineering (fire-structure research) and in Mechanical Engineering (experimental and computational fire research). In Mechanical Engineering, , the UT fire research group are expert users of reacting/fire computational fluid dynamics codes and perform research using large parallel processing versions of these codes. The fire research group routinely run simulations of up to 50 processors on the Texas Advanced Computing Center (TACC) Lonestar cluster. Lonestar is a 1300 node (5200 core) cluster. Lonestar is one of the largest and fastest academic computing resources in the country. Lonestar is configured with 10.4 TB of total memory and its peak performance is 55 TFLOPS. The combined resources of the nuclear engineering program and the fire research lab will be available to the proposed project to develop teaching modules on fire physics that are physically realistic and visually engaging.

Big 12 Consortium

The Big 12 Engineering Consortium (www.big12engg.org) will support the collaborative nuclear engineering program. The Consortium provides administrative leadership in the form of the Consortium Board of Directors, which consists of engineering deans and associate deans from each school. The Consortium policy and practice infrastructure was formed during three years of planning that involved inter-institutional teams of faculty, department heads, deans and associate deans of engineering, registrars, chief finance officers, financial aid directors, distance/continuing education directors, and chief academic officers, as well as higher education experts from state governing and coordinating boards, regional commissions, and accrediting associations. While still young, the Consortium has successfully bridged across institutions and is now working intensely to build on the solid foundation.

Sustainability

The existence of the Consortium greatly enhances the prospects for sustainability of the proposed effort. Based on past success, the Consortium is growing and will become a leading venue for NE education. The proposed development, delivery, assessment, and modification of a two-course sequence on nuclear safety issues will, if funded, provide a strong course sequence that can continue to be offered by the Consortium.

The schools that develop the 3-credit courses will deliver them in an on-line format so students anywhere can participate without having to travel to campus. Following the Big 12 Engineering Consortium enrollment and finance model, students will enroll through a home/enrolling school and pay tuition and fees to that institution. The home/enrolling school will

provide the teaching school with the student enrollment information via the ExpanSIS Data System (www.expansis.org) used by the Consortium. Using ExpanSIS, the teaching school will provide the home/enrolling school with the students' grades at the end of the semester. Campus coordinators at the teaching and home/enrolling schools will support the students during the enrollment process, during the semester, and until grades have been submitted for the official transcript. Students will receive credit from their home/enrolling school as if for a traditional, single-institution course. There will be no need to transfer credit among institutions. The practices described above are already in place and thus the new courses will benefit by having this existing structure that easily allows the courses to be re-offered in future years. Significantly, once the courses are developed under this proposed project, the tuition-sharing arrangement existing within the Consortium will provide funds to continue to offer the courses in the future.
Dr. Mo Hosni, Big 12 Consortium Director and NE Program Chair (and Immediate Past Head of K-State's Department of Mechanical and Nuclear Engineering), will oversee the Consortium staff. Dana Reinert, Big 12 Consortium Coordinator, plans the multi-institution meetings and conference calls, supports curriculum development activities, documents agreements and policies, and facilitates enrollment and student support across institutions. Eleven of the Big 12 institutions have committed to participating in the Big 12 Engineering Consortium. and the four interrelated projects being proposed. University of Colorado is in the process of joining the Consortium but is not currently interested in nuclear engineering. Multiple faculty members from the partner schools will actively contribute to the curriculum development and participate in the project activities.

Attachment C – Standard Terms and Conditions

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

Preface

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

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

To assist with finding additional guidance for selected items of cost as required in 2 CRF 220, 2 CFR 225, and 2 CFR 230 this URL to the Office of Management and Budget Cost Circulars is included for reference to:
A-21 (now 2 CFR 220)
A-87 (now 2 CFR 225)
A-122 (now 2 CFR 230
A-102: http://www.whitehouse.gov/omb/circulars_index-ffm

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

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

I. Mandatory General Requirements

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

1. Applicability of 2 CFR Part 215

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

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

2. Award Package

§ 215.41 Grantee responsibilities.

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

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

Subgrants

Appendix A to Part 215—Contract Provisions

Sub-recipients, sub-awardees, and contractors have no relationship with NRC under the terms of this grant/cooperative agreement. All required NRC approvals must be directed through the Grantee to NRC. See 2 CFR 215 and 215.41.

Nondiscrimination

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

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

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

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

Modifications/Prior Approval

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

Lobbying Restrictions

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

The Grantee shall comply with provisions of 31 USC § 1352. This provision generally prohibits the use of Federal funds for lobbying in the Executive or Legislative Branches of the Federal

Government in connection with the award, and requires disclosure of the use of non-Federal funds for lobbying.

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

§ 215.13 Debarment And Suspension.

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

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

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

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

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

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

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

'Debarment, Suspension, Ineligibility, and Voluntary Exclusion

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

Drug-Free Workplace

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

Implementation of E.O. 13224 -- Executive Order On Terrorist Financing
The Grantee is reminded that U.S. Executive Orders and U.S. law prohibits transactions with, and the provision of resources and support to, individuals and organizations associated with terrorism. It is the legal responsibility of the Grantee to ensure compliance with these Executive Orders and laws. This provision must be included in all contracts/sub-awards issued under this grant/cooperative agreement.

Award Grantees must comply with Executive Order 13224, Blocking Property and Prohibiting Transactions with Persons who Commit, Threaten to Commit, or Support Terrorism. Information about this Executive Order can be found at: www.fas.org/irp/offdocs/eo/eo-13224.htm.

Procurement Standards. § 215.40-48
Sections 215.41 through 215.48 set forth standards for use by Grantees in establishing procedures for the procurement of supplies and other expendable property, equipment, real property and other services with Federal funds. These standards are furnished to ensure that such materials and services are obtained in an effective manner and in compliance with the provisions of applicable Federal statutes and executive orders. No additional procurement standards or requirements shall be imposed by the Federal awarding agencies upon Grantees, unless specifically required by Federal statute or executive order or approved by OMB.

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

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

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

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

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

Property and Equipment Management Standards

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

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

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

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

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

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

Copyright - The Grantee may copyright any work produced under a NRC federal financial assistance award subject to NRC's royalty-free nonexclusive and irrevocable right to reproduce, publish or otherwise use the work or authorize others to do so for Government purposes. Works jointly authored by NRC and Grantee employees may be copyrighted but only the part authored by the Grantee is protected because, under 17 USC § 105, works produced by Government employees are not copyrightable in the United States. On occasion, NRC may ask the Grantee to transfer to NRC its copyright in a particular work when NRC is undertaking the primary dissemination of the work. Ownership of copyright by the Government through assignment is permitted under 17 USC § 105.

Records Retention and Access Requirements for records of the Grantee shall follow established provisions in 2 CFR 215.53.

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

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

Conflict Of Interest Standards for this award shall follow OCOI requirements set forth in Section 170A of the Atomic Energy Act of 1954, as amended, and provisions set forth at 2 CFR 215.42 Codes of Conduct.

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

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

c. The Grants Officer will promptly acknowledge receipt of the request for review and shall forward it to the Director, Office of Administration, who shall appoint an intra-agency Appeal Board to review a grantee appeal of an agency action, if required, which will consist of the program office director, the Deputy Director of Office of Administration, and the Office of General Counsel.

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

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

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

Termination and Enforcement. Termination of this award by default or by mutual consent shall follow provisions as established in 2 CFR 215.60-62.

Monitoring and Reporting § 215.50-53

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 or deducted from the total project cost allowable cost as directed by the Grants Officer or the terms and conditions of award.
- Budget Revision – 2 CFR 215.25
  - The Grantee is required to report deviations from the approved budget and program descriptions in accordance with 2 CFR 215.25,and request prior written approval from the Program Officer and the Grants Officer.
  - The Grantee is not authorized to rebudget between direct costs and indirect costs without written approval of the Grants Officer.
  - The Grantee is authorized to transfer funds among direct cost categories up to a cumulative 10 percent of the total approved budget. The Grantee is not allowed to transfer funds if the transfer would cause any Federal appropriation to be used for purposes other than those consistent with the original intent of the appropriation.
  - Allowable Costs – 2 CFR 215.27

b. **Federal Financial Reports**

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

Period of Availability of Funds 2 CFR § 215.28

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

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

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

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

Automated Standard Application For Payments (ASAP) Procedures

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

Audit Requirements

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

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

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

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

III. Programmatic Requirements

Performance (Technical) Reports

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

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

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

d. Grant Performance Metrics:

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

As part of the FY 2010 HR grant awards, in addition to the customary performance progress report requested on the SF-PPR, SF-PPR-B, and SF-PPR-E forms, HR requires the following metrics to be reported on by the awardees as follows:

Curriculum Development Awards

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

Unsatisfactory Performance

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

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

Other Federal Awards With Similar Programmatic Activities

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

Prohibition Against Assignment By The Grantee

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

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

IV. Miscellaneous Requirements

Criminal and Prohibited Activities

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

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

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

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

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

Federal Employee Expenses

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

Minority Serving Institutions (MSIs) Initiative

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

Research Misconduct

Scientific or research misconduct refers to the fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. It does not include honest errors or differences of opinions. The Grantee organization has the primary responsibility to investigate allegations and provide reports to the Federal Government. Funds expended on an activity that is determined to be invalid or unreliable because of scientific misconduct may result in a disallowance of costs for which the institution may be liable for repayment to the awarding agency. The Office of Science and Technology Policy at the White House published in the Federal Register on December 6, 2000, a final policy that addressed research misconduct. The policy was developed by the National Science and Technology Council (65 FR 76260). The NRC requires that any allegation be submitted to the Grants Officer, who will also notify the OIG of such allegation. Generally, the Grantee organization shall investigate the allegation and submit its findings to the Grants Officer. The NRC may accept the Grantee's findings or proceed with its own investigation. The Grants Officer shall inform the Grantee of the NRC's final determination.

Publications, Videos, and Acknowledgment of Sponsorship

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

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

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

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

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

Award Term

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

Reporting Subawards and Executive Compensation.

a. *Reporting of first-tier subawards.*

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

2. *Where and when to report.*

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

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

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

b. *Reporting Total Compensation of Recipient Executives.*

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

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

ii. in the preceding fiscal year, you received—

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

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

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

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

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

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

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

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

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

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

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

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

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

i. To the recipient.

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

d. *Exemptions*

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

i. Subawards,

and

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

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

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

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

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

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

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

3. *Subaward:*

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

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

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

4. *Subrecipient* means an entity that:

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

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

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

i. *Salary and bonus.*

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

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

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

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

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