

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

1. GRANT/AGREEMENT NO. NRC-HQ-11-G-38-0075		2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE FROM: 8/22/2011 TO: 8/31/2012	4. AUTHORITY Pursuant to Section 31b and 141b of the Atomic Energy Act of 1954, as amended
5. TYPE OF AWARD <input checked="" type="checkbox"/> GRANT <input type="checkbox"/> COOPERATIVE AGREEMENT		6. ORGANIZATION TYPE Public Institution of Higher ED DUNS: 153890272 NAICS:611310		7. RECIPIENT NAME, ADDRESS, and EMAIL ADDRESS Missouri System, University of Curators Of the University of Missouri 310 Jesse Hall Sponsored Programs Administration Columbia, MO 65211-1230
8. PROJECT TITLE: "Development of a Course in the Area of Reprocessing, Recycle Chemistry and Technology"				
9. PROJECT WILL BE CONDUCTED PER GOVERNMENT'S/RECIPIENT'S PROPOSAL(S) DATED See Program Description AND APPENDIX A-PROJECT GRANT PROVISIONS		10. TECHNICAL REPORTS ARE REQUIRED <input checked="" type="checkbox"/> PROGRESS AND FINAL <input type="checkbox"/> FINAL ONLY <input type="checkbox"/> OTHER (Conference Proceedings)		11. PRINCIPAL INVESTIGATOR(S) NAME, ADDRESS and EMAIL ADDRESS Missouri System, University of Curators of the University of Missouri Attn: Professor Tushar K. Gosh Nuclear Science and Engineering Institute Columbia, MO 65211-1230
12. NRC PROGRAM OFFICE (NAME and ADDRESS) NRC Attn: Tanya Parwani-James Office of Human Resources MS: GW5A08 (301) 492-2308 11545 Rockville Pike Rockville, Maryland 20852 Email: Tanya.Parwani-James@NRC.GOV		13. ACCOUNTING and APPROPRIATION DATA APPN. NO: 31X0200 B&R NO: 2011-84-51-K-134 JOB CODE: T8453 BOC NO: 4110 OFFICE ID NO: RFP: HR-11-267 FAIMS: GR0055		14. METHOD OF PAYMENT <input type="checkbox"/> ADVANCE BY TREASURY CHECK <input type="checkbox"/> REIMBURSEMENT BY TREASURY CHECK <input type="checkbox"/> LETTER OF CREDIT <input checked="" type="checkbox"/> OTHER (SPECIFY) Electronic ASAP.gov (See Remarks in Item #20 "Payment Information")
15. NRC OBLIGATION FUNDS THIS ACTION <u>\$124,366.00</u> PREVIOUS OBLIGATION <u>\$ 00.0</u> TOTAL <u>\$124,366.00</u>		16. TOTAL FUNDING AGREEMENT NRC <u>\$124,366.00</u> This action provides funds for Fiscal Year in the amount of See Page TWD RECIPIENT <u>\$ 0.00</u> TOTAL <u>\$124,366.00</u>		
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. Signature Not Required		19. NRC CONTRACTING OFFICER <u>Sheila Bumpass</u> <u>8/22/11</u> (Signature) (Date) NAME (TYPED) <u>Sheila Bumpass</u> TITLE <u>Contracting Officer</u> TELEPHONE NO. <u>301-492-3484</u>		
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 "Development of a Course in the Area of Reprocessing, Recycle Chemistry, and Technology" with the Missouri System, University of Curators of the University of Missouri, 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 21, 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: | \$124,366 |
| 2. Total Obligated Amount: | \$124,366 |
| 3. Cost-Sharing Amount: | \$0 |
| 4. Activity Title: | "Development of a Course in the Area of Reprocessing, Recycle Chemistry and Technology" |
| 5. NRC Project Officer: | Tanya Parwani-Jaimes |
| 6. DUNS No.: | 153890272 |

B. SPECIFIC

- | | |
|-------------------|------------------|
| RFPA No.: | HR-11-267 |
| FAIMIS: | GR0055 |
| Job Code: | T8453 |
| BOC: | 4110 |
| B&R Number: | 2011-84-51-K-134 |
| Appropriation #: | 31X0200 |
| Amount Obligated: | \$128,183 |

A.3 BUDGET

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

	Year 1
Direct Participant Cost	\$ 84,031
Indirect Cost (F & A)	\$ 40,335
Yearly Total	\$124,366

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is \$124,366.00 for the one-year period.
2. NRC hereby obligates the amount of \$124,366.00 for program expenditures during the period set forth above and in support of the Budget above. This grant program is fully funded. 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

The importance and necessity for reprocessing of spent fuels and recycling of chemicals that are used in the reprocessing are well known in the nuclear science and engineering community. The surge in construction of nuclear power plants worldwide and that are anticipated in the USA, will only increase the demand for uranium. There are two advantages of reprocessing spent fuels:

1. Extend the uranium fuel supply
2. Reduction in the final amount of wastes that need to be stored.

While uranium is reasonably abundant on the earth's crust, at some point, as higher-grade ores are used up, the cost and the energy required to extract uranium become prohibitive if only U-235 component is used. Fast breeder reactors with reprocessing can exploit the U-238 component comprising more than 99% of natural uranium.

A press release by the US DOE, following Secretary Chu's announcement of the Blue Ribbon Commission on America's Nuclear Future, noted that "In light of the Administration's decision not to proceed with the Yucca Mountain nuclear waste repository, President Obama has directed Secretary Chu to establish the Commission to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle. The Commission will provide advice and make recommendations on issues including alternatives for the storage, processing, and disposal of civilian and defense spent nuclear fuel and nuclear waste." Therefore, the reprocessing and disposition of used fuels are becoming more and more crucial.

The USA has not reprocessed any spent fuel in the last two decades, while countries including France, Japan, and India are routinely reprocessing the spent fuel. As a result not only the advancement of the technology has suffered, but also proper training of nuclear engineering work force to understand the chemistry and technology of reprocessing. Storing radioactive materials for thousands of years is not viewed positively by the general public. Therefore, reprocessing will play a significant role in public acceptance of the next generation of commercial power reactors in the United States. It is imperative that personnel involved in the licensing, operation, and education of the next generation of power reactors be trained in this area, particularly in:

- Understanding the fuel cycle of advanced Gen 3, 3+, and Gen 4 reactors.
- Understanding the modified open cycle.
- Understanding the waste generation (both radioactive and non-radioactive) and their remediation.
- Understanding the environmental impact of nuclear reactor operations by next generation reactors.
- Understanding the policies and regulations of various agencies including EPA, NRC, and DOT.
- Maintaining the release and emission levels below authorized limits in anticipation of changes in the regulations.
- Developing human and equipment resources for environmental management and risk prevention adapted to each site's specific characteristics.
- Designing processes and facilities that continually allow one to optimize consumption, reduce releases, waste and hazards, and recycle the materials and energies produced, and
- Used fuel disposition.

Students and work force dealing with reprocessing of spent fuel must be familiar with the issues discussed above. Most of the designs of Gen 3 and Gen 3+ reactors and their fuel cycles do not percolate to the nuclear engineering curriculum or into the current fuel cycle or nuclear waste management courses and as a result students are not adequately trained in this area.

The present US fleet of nuclear reactors mainly contains Generation II reactors. Generation 3 and 3+ are the Advanced Reactors that are planned for the construction of new nuclear plants. The several Generation 3 reactors are in operation in Japan and several others are under construction or ready to be ordered. Generation 4 designs are still on the drawing board and will not be operational before 2020 at the earliest. Third-generation reactors have the following features.

- A standardized design for each type to expedite licensing, reduce capital cost and reduce construction time,
- A simpler and more rugged design, making them easier to operate and less vulnerable to operational upsets,
- Higher availability and longer operating life – usually between 40 to 60 years,
- Reduced possibility of core melt accidents,
- Minimal effect on the environment,
- Higher burn-up to reduce fuel use and the amount of waste,
- Burnable absorbers ("poisons") to extend fuel life.

The greatest departure of Gen 3 and 3+ designs from second-generation designs is the high burn-up. This will certainly change the characteristics of the spent fuel composition and will need further adjustment during reprocessing. *There are three other issues that will be incorporated in the course: Proliferation/non-proliferation issues, Used fuel disposition, and Recycling or Green Chemistry.* The faculty involved in the project has an excellent background and understanding on these issues.

Conceptually reprocessing can take several paths, separating certain elements from the remainder, which becomes high-level waste:

- Separate U, Pu, (as today)

- Separate U, Pu+U (small amount of U)
- Separate U, Pu, minor actinides*
- Separate U+Pu all together,
- Separate U, Pu+actinides, certain fission products

Our students and work force must be familiar with all of these areas and we plan to address these issues in the proposed course. A key component of the separation process is the understanding of the thermodynamics of the separation process, thermodynamic calculations, such as Gibbs free energy, of various species in the solution, and their speciation. We will address this important aspect in the course.

Educating current generation of students and professionals in the design and operation of reprocessing plants is a top priority of US universities. Any new facility and technology should be able to handle spent fuels from not only from Generation II reactors (existing reactors), but also from Generation 3, 3+ and 4 reactors. Students and professionals should be familiar with their fuel cycles and various chemistry of the process. However, this information for Generation 3 and 3+ and Generation 4 reactors are not readily available to university nuclear engineering programs. Courses and training that are proposed in the project are therefore absolutely necessary to train the future students and workforce. One of the reasons for not reprocessing of spent fuel in the USA is the concern of proliferation of the technology leading to development of weapon grade materials. The proposed team of faculty is in a unique position to incorporate proliferation/nonproliferation issues in this course. The NSEI not only offers a course on Nonproliferation of WMD, but one of the members of the team, Dr. Prelas has co-authored a book on Nonproliferation issues. Also, the team includes faculty with Chemical Engineering background (Prof. Ghosh and Prof. Viswanath) to assist in the development of the recycling and green chemistry sections of the course.

B.2. Assessment Plan of Program, Benchmarks and Milestones

The project will be evaluated in the following three areas: (1) Course Materials, (2) Student Learning and Teaching Effectiveness, and (3) Effectiveness of Proposed National Dissemination Methods.

Course Materials:

The courses and materials will be evaluated for their accuracy, appropriateness of the contents, and adequacy. We will develop a set of questions for our Advisory Committee and other individuals familiar with the subject. Some sample questions can be as follows:

- a. Do you think the course material was accurate?
- b. Will material help the students getting employment with the agencies, such as NRC?
- c. Does the material reflect basic and fundamental information on the subject?
- d. Is the material adequate for NRC?
- e. Is there any further need for supplemental material?

The questions for the students can be as follows:

- Did the covered material correspond to what you expected from the course announcement?
- Did you find the material well-motivated?
- Do you think the total amount of material covered in the course is too much/too little?

Was the material evenly distributed over the semester?

Student Learning and Teaching Effectiveness:

We will concentrate on the effectiveness of the course material and its impact on learning by students. We will administer a survey at two points in time --mid-semester and end of semester -- to the target students and to a comparison group in other engineering courses. We are expecting that students taking this course will also take other engineering course at the same time, thus, providing a good comparison with engineering courses. We will compare survey results for the experimental courses with the typical courses, and we will compare the results for students of different majors, for example, different engineering majors. The survey will measure the interest in the course, and general interest in understanding the subject matter. When we administer the survey, we will add 5-10 items that assess current event knowledge specific to that time that are NOT covered in the courses in order to tell whether students in the target courses are motivated to monitor current events more than other students. The current event items will be different for each administration because what is current will change. As part of the surveys, we will request the email address of each student. Six weeks after the end of the course, we will email a survey to each student that assesses their knowledge of some course content, current event knowledge, and continuing motivation. In order to measure continuing motivation, we will ask whether the students have learned more about course content on their own, after the course ended. Relevant learning activities might include taking another course on similar topics, watching a television show, reading a book or article, or asking questions of an expert.

The Nuclear Science & Engineering Institute at the University of Missouri has a standard teaching evaluation form for evaluating the teaching effectiveness of the instructor and the course content. This evaluation will provide an excellent evaluation of the course materials by the students and feed back for further improvement of the course materials and on delivery of the course. In addition to standard learning types, performance and effectiveness will also be compared relative to under-represented groups such as women and minorities.

At the end of the semester students will also be evaluated concerning the course and the material. Students will be asked to comment on the strengths and weaknesses of the course materials as well as their perception of its effectiveness.

This course will also be subjected to "Quality Assurance method" to assess the effectiveness of the course, to learn how to improve the quality of instruction, and the quality of the contents of the course. We will develop a set of questions to assess this part. Some typical questions can be as follows:

- a. What is the reason for you to take this course?
 - b. Do you rate the course as easy or difficult?
-

- c. Beside the classroom, how many hours/week did you spend on this course.
- d. Did you have adequate background to take this course?
- e. Was the student assessment techniques were appropriate for the course.
- f. Did this class challenge you to learn course materials, concepts, and skills?

Both qualitative and quantitative methods will be used to assess the course. Quantitative assessment may not be the appropriate way as the understanding and analytic capabilities of individuals in the groups can be very different. Formative information outline in the form of questions under course assessment will be used for revision and improvement of the courses. A summative evaluation, on the other hand, is directed at judging whether to expand, reduce or eliminate your use of educational technology. A given evaluation can have both purposes. Formative evaluation will be counted twice and the students will be given the results of the first evaluation.

B.3. Course Outline

The course materials will be drawn from our collective experience in this area. We will not only use the recent literature, but also survey other universities and nuclear industry to have a better understanding of their needs. This will help us to formulate the course better. Our partnership with Callaway Nuclear Power Plant will be another asset for obtaining information and developing methodology for addressing related issues.

The course will be complemented by developing virtual laboratory exercise modules that will make student familiar with sample collection methodology, instrument requirement, and data interpretation. During testing and evaluation of materials, students will be working with the personnel at the Callaway Nuclear Power Plant for the hands-on-training at the real world environment. Also, various model/software available to simulate decay heat, transport through transportation casks, process design using ASPEN, etc will be introduced to students, who will run case studies as a part of homework assignments with these models to have an understanding of how to input, validate and interpret the data. The example of a laboratory exercise is given below. The feedback will be used to fine tune the materials.

Tentative topics for the course

Section 1: Introduction and Review (2 lectures)

- 1.1 Importance of Nuclear Energy
- 1.2 Uranium Supply and Demand
- 1.3 Overview of Reprocessing/Recycling
- 1.4 Radioactive Waste Classification

Section 2: Fuel Cycle and Waste Generation (4 lectures)

- 2.1 Overview of Once-through Cycle
- 2.2 Overview of Closed Cycle
- 2.3 Overview of modified open cycle
- 2.4 Uranium Mining and Milling
 - 2.4.1 Methods of Mining
 - 2.4.2 The Tailings Problem
 - 2.4.3 Wastes Generated
- 2.5 Conversion and Enrichment
 - 2.5.1 Purification of U_3O_8
 - 2.5.2 Conversion to UF_6
 - 2.5.3 Enrichment Techniques
 - 2.5.4 Wastes Generated
- 2.6 Fuel Fabrication
 - 2.6.1 Types of Reactor Fuels
 - 2.6.1.1 LWR Pellets
 - 2.6.1.2 Triso Fuel
 - 2.6.1.3 MOX Fuel
 - 2.6.1.4 Metallic Fuel
 - 2.6.1.5 Molten Salt Reactor Fuel
 - 2.6.2 Types of Fuel Cladding
 - 2.6.3 Pellet Production
 - 2.6.4 Wastes Generated
- 2.7 Power Operations
 - 2.7.1 Reactors in Current Operation
 - 2.7.1.1 Types of Reactor
 - 2.7.1.2 Spent Fuel Generated
 - 2.7.1.3 Storage Capacity (Dry and Wet)
 - 2.7.2 Projected Reactors
 - 2.7.2.1 Types of Reactor
 - 2.7.2.2 Spent Fuel Generation
- 2.8 Re-Processing or Repository
 - 2.8.1 Current Policy (Foreign and Domestic)
 - 2.8.2 Challenges associated with Re-Processing
 - 2.8.3 Challenges associated with Repository
- 2.9 Used fuel disposition

Section 3: Re-Processing (10-12 lectures)

- 3.1 Description of Re-Processing Plant
 - 3.1.1 Receipt of Spent Fuel
 - 3.1.1.1 Necessary Decay
 - 3.1.1.2 Conditions of Spent Fuel
 - 3.1.1.3 Transportation
 - 3.1.1.3.1 Challenges
 - 3.1.1.3.2 Cask Design
 - 3.1.1.4 Material Inventory at Receipt

- 3.2 Fuel Dismantling
- 3.3 Separation Process
 - 3.3.1 Thermodynamics of Separation Processes
 - 3.3.2 Partition coefficients, chemistry, and speciation
 - 3.3.3 Techniques Available
 - 3.3.3.1 Urex+
 - 3.3.3.2 Purex
 - 3.3.3.3 Other
 - 3.3.4 Chemicals Involved
 - 3.3.4.1 Separation of Actinides, chemistry, partition, and speciation
 - 3.3.4.2 Separation of Pu and U
 - 3.3.5 Off-Gas Capturing/Venting Techniques
- 3.4 Non-LWR Reactors
 - 3.4.1 Differences in Re-processing
 - 3.4.1.1 Chemistry
 - 3.4.1.2 Fuel Removal
 - 3.4.1.3 Non-fuel Material Removal/Disposal
- 3.5 Thorium Fuel Cycle

Section 4: Recycling Waste-stream (8-10 lectures)

- 4.1 Acid From Mining
 - 4.1.1 Methods of Recovery and Recycle
 - 4.1.2 Tailings
- 4.2 Recycling of Re-processing Chemicals
 - 4.2.1 Purex Technique
 - 4.2.2 Urex+ Technique
 - 4.2.3 Non-LWR Reactors
 - 4.2.4 Thorium Fuels
- 4.3 Non-Fuel Materials
 - 4.3.1 Spent Fuel Tubes
 - 4.3.2 Other Fuel Assembly Materials
 - 4.3.3 Fission Product Gases

Section 5: Chemical Engineering Unit Operations (5 -6 lectures)

- 5.1 Evaporators
- 5.2 Concentrators
- 5.3 Ion exchangers

Section 6: Proliferation, Non-proliferation and Safeguard of Nuclear Materials (5-6 lectures)

Section 7: Used fuel Disposition

- 7.1 Storage
- 7.2 Transportation
- 7.3 Disposal

Laboratory Exercise 1: Groundwater monitoring for tritium

1. The materials will be developed to study the plant site of a commercial nuclear power plant for past tritium releases to the environment and obtain any plant data on tritium detected in the environment.

2. We will then design a sampling plan for the site to characterize the current situation of levels of tritium in groundwater for a selected area of the plant site.
3. Protocol for obtaining samples for tritium analysis per the sample plan will be demonstrated.
4. Samples will then be analyzed for tritium at a laboratory capable of detecting environmental levels of tritium. The process will be captured in video.
5. Based on analytical data for tritium, the methodology will be formulated for determining the source of any tritium found in groundwater.

Some of the training module at the plant will include the following

1. Radiation detection principals.
2. Use of nuclear methods to study the environment.
3. Power plant chemistry: secondary chemistry control, primary chemistry control, chemical reactivity control by boron levels in the primary circuit, demineralizer operation, raw water system chemistry control, and microbiological influenced corrosion control in raw water systems
4. Power plant radiochemistry: analytical techniques used and how to interpret radiochemical data, e.g. what does the presence of lack of a particular nuclide in reactor cooling water indicate.

B.4. Course Plan and Sustainability

Our plan is to develop the course as a 3 credit hour university/college course. A single course for both seniors and graduate students will be developed. About 40 to 45 lectures of 1 and 1/2 hour will be developed in power point along with study guidelines and notes for each lecture. Several (3 to 4) laboratory exercises will be developed to complement the lectures. The laboratory exercises will contain both the sample collections and their analysis. The facility at Callaway Nuclear Power Plant will be used to train and familiarized the students on various analytical techniques for analysis of the samples. Videos will be created during this laboratory exercises. The nature of the course is summarized below:

- This will be an elective course or non-nuclear engineering students
- This will be a required course for Master's students in nuclear engineering
- The course will be developed as a single course for both undergraduate seniors and graduate students (At the University of Missouri-Columbia, a course can be designated for both undergraduate (seniors) and graduate levels with different requirements. A significant number of courses are taught this way.)
- We are anticipating an enrollment of 10-12 students during each offering
- The criteria for sustainability will be, if the course could be offered every year with 10-12 students for the next five years.

All the lectures will be converted for distance learning and teaching at other institutions. We are already using this technology for delivering our courses via internet.

This course will be follow up to our existing Nuclear Fuel Cycle course. This may eventually lead to development of an emphasis area for the Master Students and as a collateral field for PhD students. The Institute already has these provisions in the curriculum. Our plan is to develop the course materials during the first six months of the grant period and beta-test at the

NSEI, and then improve, modify and disseminate nationally (beta-test with our partner institution, such as Big 12 Consortium).

Nuclear Science & Engineering Institute will work with Callaway Nuclear Power Plant of AmerenUE, St. Louis for internship during summer or one semester co-op at the power plant. As noted earlier, Nuclear Science & Engineering Institute has also developed a minor in Nuclear Engineering for our science and engineering students. Nuclear Science & Engineering Institute faculty is also teaching via internet to students at the Polytechnic University of Puerto Rico (PUPR), our another partner institution. We expect all these activity to grow in the near future.

B.5. Innovative Instructional Approach and Techniques to Enhance Student Learning

The use of innovative teaching methods helps to sustain student's interest and make the learning process more productive and interesting. The techniques that will be adopted are: case studies, group discussion, virtual laboratories brainstorming, audiovisual presentation, assignments, seminars, quiz and assigning project works, along with the availability of CDs, audio and video of lectures on the Web. We will also prepare worksheets, manuals and audiovisual aids to supplement these novel teaching strategies. For better understanding by the students, the mixed-model approach of combining lectures with hands-on activity sessions will also be conducted. It is suggested that innovative assessment approaches like presentation, dioramas, student displays and projects are beneficial to student learning. The author concluded that problem-based learning would place students in the active role of problem solvers and confronts them with a real-world situation.

B.6. Time Line and Milestone Chart

The materials for the course will be developed over 6 months. Once the materials are ready, we will offer it as a 3-credit hour course in the following semester. The data will be obtained for evaluation purpose and will be used for further modification and fine tuning of the course. The milestones of this project are given below:

- Course development
- Field testing and classroom offering of the course
- Data Collection, data analysis and evaluation
- Course modification
- Course preparation for distance offering
- Distance education beta testing

The time line for various activities is shown below in Figure 1. We plan to carry out all of the activities irrespective of the funding commitment beyond the first year.

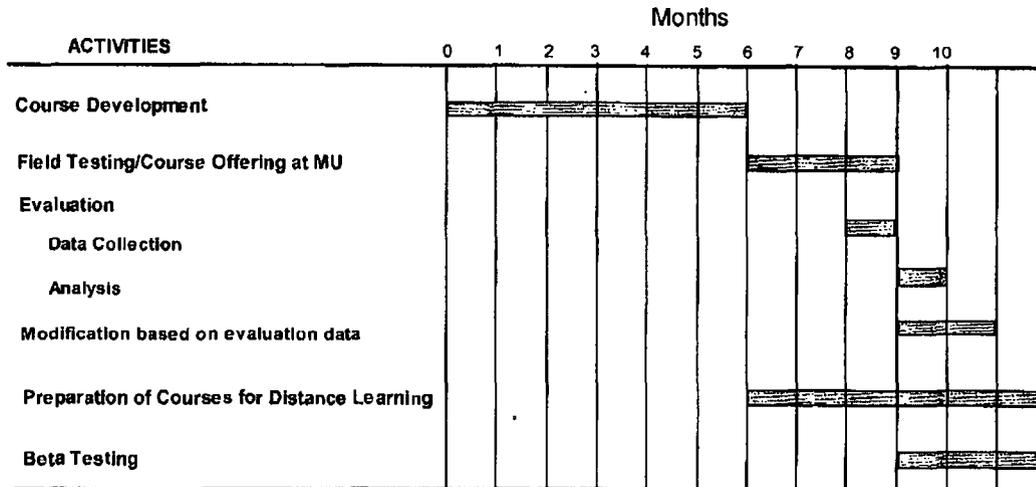


Figure 1. Timeline for the proposed project

The deliverables from this project are as follows:

1. Educational materials for the course on reprocessing, recycling and used fuel disposition. There will be about 30 slides in Power Point for each lecture along with several pages write up or class notes for each lecture. We will also include references at the end of each lecture notes.
2. CDs and videos for national dissemination.
3. All the lectures in Tegrity of the Blackboard for national dissemination.
4. All the lectures in streaming video format for national dissemination.

B.7. Innovation and Effectiveness in Advancing the Educational Infrastructure

The innovation is in the course content. As mentioned earlier, the course will address the following:

- Basic nuclear engineering concepts
- Various chemical engineering unit operations
- Use of chemical engineering process simulation software, such as ASPEN, to understand the process design and simulation of reprocessing plants. Effect of various parameters on operations can be studied.
- Proliferation/non proliferation and safeguard issues
- Recycling and green chemistry
- Discussion of modified open cycle
- Discussion of various components and aspects of used fuel disposition campaign.

The complex nature of reprocessing and recycling chemistry requires that students should not only be provided with basic, fundamental concepts, but also hands-on-experience. The educational materials, therefore, should be prepared accordingly. Our approach will include the followings:

- Educational materials for class room lecture

- Laboratory exercises to make students familiar with various instruments that are used in the field. The virtual demonstration will be made using Tegrity of the Blackboard.
- Training in the nuclear power plant. Both video and Tegrity of the Blackboard modules will be prepared.

These topics are essential for the design and operation of the plants. Students in this course will have basic familiarization of the flow diagram of a reprocessing plant, function of various component of the plant, For example, how a pump works or what kind of pump is necessary in acidic environment, what involved in the design of a digester/reactor, what kind of analytical instruments used be used, what is going to be the radiation effect on materials and how that determines the selection process, etc. will be the part of the curriculum. For problem based section, a problem will be identified and then basic tools necessary for solving the problem will be discussed. Educational materials will address the following needs of students. They will provide basic knowledge and understanding of the tools. The next step will be the applications of the knowledge in solving the problem. We will be using a total system approach for education and training. The objective is to ensure that a student is able to meet the challenges posed by the field to an individual and to a team focused on solving complex multidisciplinary problems. Our goal is to train experts in a specialty, but to encourage teamwork through the individual contribution to an integrated multidisciplinary project.

We will provide formal On-The-Job training (OJT) required to become qualified in the area of reprocessing and recycling. The ADDIE (Analyze, Design, Develop, Implement, and Evaluate) process will be used. The OJT portion of the training is a key part of this process to meet the Evaluate portion of ADDIE. NSEI will collaborate and partner with Callaway Nuclear Power Plant of AmerenUE for development of formal training and OJT materials in visual media.

All course materials will be tested via classroom, WEB based training, or a combination of the two. Computer based self study exercises will be a part of this program. PowerPoint lesson presentations will be extensively used. The Einstruction Clicker Response System (CPS) will be used in the presentation of material.

This innovative approach for presenting the required material will improve the education infrastructure of the United States as it will be available for students across the country. Once students view the OJT materials, the OJT can be performed at any of the current operating commercial nuclear power plants in the United States. Completion of this course of study will increase the expertise of students, and enhance teaching competencies of instructors.

B.8. Proposed Approach and Collaborative Linkages

The educational materials will be developed based on our expertise in this field and through collaboration and partnership with the Callaway Nuclear Power Plant. In the last several years, the PI and the participating faculty have introduced a number of courses at the NSEI and incorporated various latest technologies in the classroom and courses. Other new technologies, such as animation and virtual touring will be incorporated in these courses.

The objective is to develop a sustainable educational infrastructure in the area of reprocessing and recycling beyond the NRC funding period. The only way to sustain the program beyond NRC funding period is to make the course materials relevant to the industry and challenging to the students. Once students understand the value of such course in getting employment or view the reprocessing area challenging and its importance to make the USA

energy self-sufficient, the enrollment could be sustained. Therefore, we plan to make the course content challenging and fulfilling to the students.

B.9. Dissemination Plan

We have an on going collaboration with the Polytechnic University of Puerto Rico (PUPR). We are offering courses to PUPR students using a live internet transmission. If necessary, PUPR can be a Beta Test Center for the courses. PUPR is also interested in a Minor in Nuclear Engineering so that the job prospects of their students are enhanced. Also, we will offer the course to our Big 12 consortium partners. We plan to disseminate the courses nationally in the following manner: (1) through Distance education using the internet, (2) through CDs, and (3) through videos.

Dissemination through Distance Education using Internet:

The dissemination of educational materials from this project will rely on information technology and electronic distribution. The primary repository for information related to this project will be a locally-maintained web page. This web page will provide descriptive details of the project concept and progresses. Following completion of the grant period, the completed course materials will be made available through this page. This web page will serve as the principal contact point for interested parties. Funds have been allocated in the budget for maintaining this electronic media during the grant period. Following completion of the grant period these pages will be maintained by Nuclear Science and Engineering Institute.

We will use the Tegrity of the Blackboard. The video viewer can position a pointer to a point in time where a table of contents appears, then that entry can be added at the correct time offset with the click of a button.

Other Means of Dissemination

The results of this proposal will be published in journals such as the Journal of Engineering Education, Chemical Engineering Progress, and other professional society journals. It is anticipated that a number of technical articles will result from this grant. In addition, travel funds have been included in the budget to allow faculty to attend and present results of this research at various conferences. The likely choice will be the American Society of Engineering Education (ASEE) Frontiers in Education Annual Conference.

B.10. Institutional Capabilities and Capacity Building

Institutional Commitment:

The University of Missouri-Columbia (MU) fully understands the value and importance of development of educational infrastructure in Nuclear Engineering. The Nuclear Science & Engineering Institute (NSEI) at MU was established in 2002 and currently is one of the leaders in the campus in interdisciplinary education. The interaction of NSEI with various departments and groups both within the campus and industry has allowed them to develop excellent interdisciplinary educational programs.

Dr. Ghosh is the Project Director and will be responsible for overall administration of the program. An administrative assistant in NSEI will assist Dr. Ghosh in his duties. The NSEI will

provide the release time, if necessary, during the academic year to Dr. Ghosh so that he can fully devote to the project. The entire participating faculty has agreed to devote at least 10% of the time to the program and their individual role is explained later in "Key Personnel" section.

Adequacy of Institutional Resources:

Resources necessary to complete the project are available to the project director. The University of Missouri-Columbia (MU) is a Carnegie Class 1 Research Institution and has been engaged in engineering research for many years with an excellent record of performance on contracts with both government agencies and with private industry. Research funding at MU was approximately \$167 million last year with contracts varying from several hundred dollars to the multimillion dollar level. The faculty has worked together on multidisciplinary projects in the past and has developed effective working relationships which will assure an integrated, compatible, and productive team effort.

The University maintains an up-to-date collection of technical books and journals, which is also accessible through the MU mainframe computer. In addition, the outstanding collection of the nearby Linda Hall Library in Kansas City is readily accessible.

Potential for Academic Enhancement:

The Nuclear Science & Engineering Institute offers Masters and PhD degrees in nuclear engineering, a minor in nuclear engineering to science and engineering students from other departments, and a graduate certificate to graduates to other non-nuclear students. Within our Masters program, we offer emphasis area in Medical Physics, Health Physics, and Nuclear Power. In the PhD program students must have a collateral field of study. Therefore, reprocessing and recycling can be easily added as a specialized field of study. The proposed program will enhance our academic capability in the following way:

1. This will help us to attract students into the program
2. To educate students with diverse background. As mentioned above, this program (courses) can be incorporated in the existing curriculum easily.
3. This will provide an opportunity for the participating faculty to diversify their understanding of the Generation 3, 3+, 4 reactors and reprocessing and recycling issues.
4. Enhance our collaboration with the Callaway Nuclear Power Plant of AmerenUE and to train our students in the plant.

Plans for Project Continuation:

As noted earlier, one of our main objectives is to incorporate the proposed courses into an emphasis area for both master and PhD students. Once the course structure and its materials are developed, it is expected to be self sustaining. The project continuation will depend mainly on the student interest and enrolment in this area. With the 100% increase in the graduate student enrolment in our program in the last 3 years and overwhelming interest among our undergraduate students in the nuclear power area, a healthy enrolment in this course could be sustained. We plan to offer this course once each year.

B.10. Key Personnel

The team will be composed of faculty from the Nuclear Science & Engineering Institute at the University of Missouri-Columbia (MU) and personnel from the Callaway Nuclear Power Plant

(to be identified later). Prof. Tushar K. Ghosh will be the Project Director. Prof. Ghosh will be responsible for overall management of the program including reporting to NRC. The role of various personnel in the project is briefly described below.

Prof. Tushar K Ghosh is a Professor at the Nuclear Science & Engineering Institute (NSEI) and is an expert in nuclear waste management. He has developed the course on Fuel Cycle and Nuclear Waste Management at NSEI. He has co-authored a book on Indoor Air Quality that includes a chapter on risk assessment. He has also co-authored two more books; however, his experience in developing the course on "Scientific and Technological Aspect of Terrorism and Counterterrorism" will be valuable in developing the proposed curriculum. He, along with Prof. Viswanath and Prof. Prelas coordinates this course in which they had about 15 instructors lecturing on various topics. All the instructors were requested not only to prepare power point presentation, but also notes for their portion of the lecture. The lecture notes were eventually used to compile the book "Science and Technology of Terrorism and Counterterrorism." This experience will be used to develop the proposed curriculum.

Sudarshan K. Loyalka is a Curators' Professor. He is a Fellow of both the American Physical Society (since 1982) and the American Nuclear Society (since 1985). He has published more than 170 papers and he has advised approximately 70 graduate students. He has received numerous awards for his research and teaching including the David Sinclair Award (1995) of the American Association for Aerosol Research and the Glenn Murphy Award (1998) of the American Association for Engineering Education. Prof. Loyalka will be involved with the risk assessment, modeling and code description part of the curriculum. He has taught courses on Thermal Hydraulics, Reactor Physics, Neutron Transport, and Inverse Methods. He is also involved in modeling of radionuclide transport in various media and risk assessment. He will contribute in developing course materials for modeling, radionuclide transport, and assessments.

Mark A. Prelas received the Presidential Young Investigator Award in 1984, was named a fellow of the American Nuclear Society in 1999 and was a William C. Foster Fellow with the U.S. Department of State in 1999-2000. He has worked in the areas of arms control for weapons of mass destruction, in the development of NBC sensors, in the synthesis and in direct energy conversion and in gaseous electronics. He has published over 200 papers, 5 books and holds 12 patents. Prof. Prelas has developed about 6 courses during his tenure at NSEI and is a leading expert in delivering courses through internet and other multi-media.

Dabir S. Viswanath is a Fellow of both the American Institute of Chemical Engineers and the American Institute of Chemists. He has advised over 50 graduate students, and has published over 140 peer reviewed papers and 4 American Petroleum Institute monographs. Prof. Viswanath will develop the section on transport properties of various chemicals and radionuclides that are necessary for transport of these hazards through air, liquid, and soil. He will be responsible for training of the students on compliance with the NRC, EPA, DOT rules, regulations, and policies.

B.11. Budget and Cost Effectiveness

We are requesting \$124,366 for the first year for the project. All the requested funds are according to the guidelines established by the NRC. The faculty support is requested for both

academic month and summer month. Academic month salary is requested so that the faculty can obtain necessary release from the Institute and devote their time during academic year in the project. We have also requested \$5,000 for hiring undergraduate students to assist in the literature review, gathering materials, conducting survey, and collecting data. Funding has also been requested for copying literary materials and copyright fees. We plan to attend both ANS and ASEE conferences and to present our educational materials to a broader audience.

Although 1 month AY salary is requested in the budget, Prof. Ghosh will get necessary release time from the Nuclear Science & Engineering Institute to work and supervise the project during academic year. Other faculty will also commit necessary time beyond that requested in the budget. The contribution of the university when considering these release time is expected to be 50% of the request amount.

Literature Citation

1. Federal Guidance Report 13: Cancer Risk Coefficients for Environmental Exposure to Radionuclides PDF, EPA 402-R-99-001 September 1999 (Includes radionuclide-specific lifetime radiogenic cancer risk coefficients for the U.S. population, based on age-dependent intake, dosimetry, and risk models). Update to the Federal Guidance Report No. 13, CD Supplement (April, 2002)
2. Uncertainties in Cancer Risk Coefficients for Environmental Exposure to Radionuclides [ORNL/TM-2006/583 January 2007], This report is from a joint study by EPA and Oak Ridge National Laboratory on uncertainties of the federal guidance report risk coefficients for both ingestion and inhalation of radionuclides.
3. *Estimating Radiogenic Cancer Risks*, [EPA 402-R-93-076 June 1994], This document presents a revised methodology for EPA's estimation of cancer risks due to low-LET radiation exposures developed in light of information that has become available since the publication of BEIR III, especially new information on the Japanese atomic bomb survivors.
4. Addendum: *Uncertainty Analysis*, [EPA 402-R-99-003], The analysis describes a method for estimating the uncertainties in EPA's risk projections for cancer risk from low-LET radiation exposures.
5. *Federal Guidance Report 12: External Exposure to Radionuclides In Air, Water, and Soil*, [EPA 402-R-93-081 September 1993], Includes exposure-to-dose coefficients for general application, based on the 1987 Federal Radiation Protection Guidance.
6. *Federal Guidance Report 11: Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, [EPA 520/1-88-020 September 1988], Includes derived guides for control of occupational exposure and exposure-to-dose conversion factors for general application, based on the 1987 Federal Radiation Protection Guidance.
7. Health Effects Assessment Summary Tables (HEAST) Radionuclides Table, These tables contain radionuclide slope factors for estimating cancer risks at sites managed under the Comprehensive Environmental Response, Compensation, and Liability Act. EPA has developed these cancer slope factors for ingestion, inhalation and external exposure to radionuclides in units of picocuries (pCi).
8. Ingestion and inhalation slope factors are central estimates in a linear model of the age-averaged, lifetime attributable radiation cancer incidence (fatal and nonfatal cancer) per unit of activity inhaled or ingested, expressed as risk/pCi.
9. *Documenting Ground-Water Modeling at Sites Contaminated with Radioactive Substances*, [EPA/540-R-96-003]
10. *A Technical Guide to Ground-Water Model Selection at Sites Contaminated with Radioactive Substances*, [EPA/402-R-94-012]

11. Soil Screening Guidance for Radionuclides: User's Guide, EPA Document Number: EPA/540-R-00-007
12. Soil Screening Guidance for Radionuclides: Technical Background Document, EPA Document Number: EPA/540-R-00-006, October 2000
13. Guidance for Data Usability in Risk Assessment (Part B), Final, United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC 20460, Publication 9285.7-09B PB92 -963362 May 1992
14. Guidance for conducting risk assessments and related risk activities for DOE-ORO environmental management program, BJC/OR-271, April 1999.
15. Quantitative uncertainty analysis of superfund residential risk pathway models for soil, ground water: white paper, ORNL, DE-AC05-84OR21400, 1996.
16. B. L. Cohen, The hazards of nuclear power, <http://russsp.org/BLC-4.html>

Attachment C – Standard Terms and Conditions

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

Preface

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

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

To assist with finding additional guidance for selected items of cost as required in 2 CFR 220, 2 CFR 225, and 2 CFR 230 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.

- o 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 hereby notified that they are encouraged, to the greatest extent practicable, to purchase American-made equipment and products with funding provided under this award.

Increasing Seat Belt Use in the United States

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

Federal Leadership of Reducing Text Messaging While Driving

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

Federal Employee Expenses

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

Minority Serving Institutions (MSIs) Initiative

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

<http://www.ed.gov/about/offices/list/ocr/edlite-minorityinst.html>

Research Misconduct

Scientific or research misconduct refers to the fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. It does not include honest errors or differences of opinions. The Grantee organization has the primary responsibility to investigate allegations and provide reports to the Federal Government. Funds expended on an activity that is determined to be invalid or unreliable because of scientific misconduct may result in a disallowance of costs for which the institution may be liable for repayment to the awarding agency. The Office of Science and Technology Policy at the White House published in the Federal Register on December 6, 2000, a final policy that addressed

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

Publications, Videos, and Acknowledgment of Sponsorship

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

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

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)).

Executive Compensation

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.