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

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-38-10-978		FROM: 7/1/2010 TO: 6/30/2012	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: 076248616	University of Kansas Center for Research Inc. 2385 Irving Road Lawrence, Kansas 66045

8. PROJECT TITLE:
Innovative Nuclear Engineering Materials and Corrosion Modules for Enhancement and Expansion

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)	University of Kansas Center for Research, Inc. Attn:Ronald Dougherty Email: Dougherty@ku.edu 785-864-3181

12. NRC PROGRAM OFFICE (NAME and ADDRESS)	13. ACCOUNTING and APPROPRIATION DATA	14. METHOD OF PAYMENT
NRC Attn: Randi Neff Office of Human Resources MS: GW5A6 (301) 492-2301 11545 Rockville Pike Rockville, Maryland 20852	APPN. NO: 31X0200 B&R NO: 0-8415-5C1116 JOB CODE: T8453 BOC NO: 4110 OFFICE ID NO: RFPA: HR-10-978	[ ] 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	$150,000	NRC	$150,000	This action provides funds for Fiscal Year in the amount of See Page Two
PREVIOUS OBLIGATION		RECIPIENT		
TOTAL	$150,000	TOTAL	$150,000	

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

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

18.	19. NRC CONTRACTING OFFICER
Signature Not Required	Sheila Bumpass (Signature) 7/1/2010 (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 "Innovative Nuclear Engineering Materials and Corrosion Modules for Enhancement and Expansion" as described in Attachment B entitled "Program Description."

A.2 PERIOD OF GRANT

1. The effective date of this Grant is July 1, 2010. The estimated completion date of this Grant is June 30, 2012.

2. Funds obligated hereunder are available for program expenditures for the estimated period: July 1, 2010 – June 30, 2012.

A. GENERAL

1. Total Estimated NRC Amount:	$150,000
2. Total Obligated Amount:	$150,000
3. Cost-Sharing Amount:	$0
4. Activity Title:	Innovative Nuclear Engineering Materials and Corrosion Modules for Enhancement and Expansion
5. NRC Project Officer:	Randi Neff
6. DUNS No.:	076248616

B. SPECIFIC

RFPA No.:	HR-10-978
FFS:	N/A
Job Code:	T8453
BOC:	4110
B&R Number:	0-8415-5C1116
Appropriation #:	31X0200
Amount Obligated:	$150,000

A.3 BUDGET

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

	Year 1	Year 2
Direct Participant Cost	$52,299.00	$51,417.00
Indirect Cost	$24,576.00	$21,708.00
Yearly Total	**$76,875.00**	**$73,125.00**

All travel must be in accordance with the University of Kansas Center for Research Inc. Travel Regulations or the US Government Travel Policy absent Grantee's travel regulation.

A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES

1. The total estimated amount of this Award is $150,000 for two (2) year period.

2. NRC hereby obligates the amount of $150,000 for program expenditures during the period set forth above and in support of the Budget above. The Grantee will be given written notice by the Contracting Officer when additional funds will be added. NRC is not obligated to reimburse the Grantee for the expenditure of amounts in excess of the total obligated amount.

3. Payment shall be made to the Grantee in accordance with procedures set forth in the Automated Standard Application For Payments (ASAP) Procedures set forth below.

Attachment B – Program Description

Innovative Nuclear Engineering Materials and Corrosion Modules for Enhancement and Expansion

B.1 Introduction

The current world concern about climate change due to greenhouse gases introduced into the atmosphere has kindled interest in forms of energy production which provide environmentally friendly alternatives to fossil fuels.[1] In the hunt for such alternatives, it has become increasingly apparent that nuclear power generation is one of the most responsible methods of meeting the energy demands of the world - - *even* for a world which is actively working to reduce those demands.[2,3] Nuclear energy production results in relatively small amounts of CO_2 and other greenhouse gases as compared to fossil fuels and is available on demand and at controllable production levels (unlike the popular renewable energy sources). These energy production comparisons/tradeoffs *have* been well understood by engineers and scientists for some time, but public concern *over* safety issues regarding radioactive materials and the nuclear waste produced has hindered general acceptance of this form of energy production. Although the world is working to increase its usage of renewable energy, it is clear that, for the foreseeable future, renewable forms will not be able to provide more than a few percent of the world's energy demands. In addition, world events *have* repeatedly demonstrated the difficulty of foreign oil dependence. For these reasons, nuclear energy production is currently experiencing a renaissance with significant growth potential ahead.

However, since the nuclear industry has been in a roughly 30-year-long dormant period, as far as construction of new capacity is concerned, this has diminished the attractiveness of the field to engineering students, and updated/innovative educational programs to train a new generation of engineers for the coming expansion must be addressed.[4,5] The Big 12 Engineering Consortium (EC) is vigorously tackling this issue.

The basic holdup for the nuclear industry has largely been safety issues, driven by high profile incidents such as Three Mile Island and Chernobl. Material science plays one of the forefront roles in guaranteeing safe operation of nuclear reactors. therefore, the University of Kansas (KU), as part of the Big 12 EC (Section B.11), is proposi g to develop a state-ofthe-art set of easy-to-access on-line modules/courses which can oth help NE practicing professionals get up-to-speed on the latest materials develoPfents and help novice engineering (BS) students learn basic and advanced materials. Th~ modules/courses being proposed are specifically designed for NE applications. This is critica , as there appears to be a serious lack of easily accessible up-to-date material science cours s in the NE field.

The proposed courses will be composed of a series of stand alone modules covering the topics of interest, which can [and will] be combined into segments up to full-fledged 3credit hour university courses. These full-fledged courses will be taught *live* in the classroom as well as on-line using WebEx, Adobe Connect Pro or comparable software. In addition, as needed modules will be taught to NE professionals already in the field. The 2 courses are:

Materials Requirements and Selection for NE Applications and
Corrosion and Degradation of Materials in NE and in Reactor Operation and Design

These courses will carefully/thoroughly explore engineering materials needs, availability, and capability for NE applications through unique organization of 30 on-line modules. As with other Big 12 EC

NE courses, the modules proposed herein will be available for many universities. Thus each university will not need to perform repetitious work in developing its own modules. These modules will be taught, using current sophisticated equipment/software, by an outstanding materials expert with 40 years of experience, Dr. Carl E. Frahme. The *variety* of teaching mechanisms to be employed will assist students! professionals having different preferred learning modes to absorb the material readily/well.

Project leadership will be provided by Dr. Ronald L. Dougherty, who has taught engineering students for 25 years (at KU and Oklahoma State U.) through classroom and distance learning venues, is an expert in thermal radiative transfer [conservation relations/equations are directly applicable to neutron transport] and who has repeatedly taught Powerplant Engineering (with nuclear powerplants as a major component). He will *develop* and teach 4 modules on nuclear energy conversion and powerplants. Being Chair of the ME Dept. at KU (KU-ME), Dr. Dougherty has been, and will continue to be, enthusiastic in promoting NE education. In addition, Dr. Stuart R. Bell, Dean of Engineering at KU, is an NE graduate from Texas A&M University, who knows the fundamentals and importance of an NE education. He is fully supportive of this project, as detailed in his letter (see Appendix).

Besides the support of KU and the Big 12 EC, the local engineering industry which is involved with NE has also indicated its need/support for this educational project. Letters of support are included in the Appendix from Greg M. *Graves,* CEO of Burns & McDonnell (Kansas City), *Steve* Rus, Nuclear Director of Black & Veatch (KC), Terry J. Garrett, Vice President Eng. of Wolf Creek Nuclear Operating Corp. (Burlington), and Mark McLachlan, Engineering Services Director of AmerenUE (Fulton, MO). The first thee of these letters were included in the EC's 2009 NRC proposal for NE courses. Their support is *even* stronger now; and although dated for the 2009 proposal, the letters still represent their viewpoints in 2010.

Thus, we at KU, as well as the rest of the Big 12 EC, are prepared and committed to providing long-term, top quality education in NE for students and professionals across the Big 12 and the nation, developing and teaching unique on-line applied material science courses for the NE field. A survey of web-available courses shows that existing courses are not as readily accessible nor as modular in nature as those proposed herein. In the future, we plan to grow into additional course offerings (e.g., materials for nuclear: medical applications, instrumentation and controls, and weapons); and plan to continually improve/update the courses proposed herein as new material science developments become available.

B.2 Innovative Instructional Approaches B.2.a
Organization

The 2.5 hour modules, and the courses derived from combinations of those modules, will be designed to be versatile and readily updatable in today's highly demanding and changing environment. Thus, each module will be stand-alone and web-based, having a support structure with its own associated resources (examples/homework-problems/solutions and examinations) and straightforward access. In addition, modules will be combinable into larger segments - - from day-long workshops to as large as full-fledged 3-credit hour university courses. The web-based structure, which has been used by the Big 12 EC since its inception in 2007 and by KU in using the WebEx vehicle, allows the busy professional to continue his/her education on his/her schedule, instead of having to match a university day/night class schedule. KU-ME's experience with using WebEx will make the modules straightforward to deliver/record. In addition, many of the references (Section B.10) for the modules/ courses will be subscribed to on-line by KU-ME, so that professionals/students can access them from any internet-connected location.

As with the modules themselves, all of the associated module materials/structure will also be easily combinable to support the larger segments (i.e., workshops and full-fledged courses). Following module formulation, the efficacy of both the individual modules and the full 3-credit hour courses will be tested, obtaining feedback from NE practicing professionals, BS engineering students, course instructors, and Big 12 EC collaborators - - then modifying the modules based upon that feedback. Due to the time limits of a 2-year grant proposal, it will not be possible to re-teach all of the revised modules/courses, but representative modules/courses will be re-taught, as outlined in Sects. B.3 and F.1.

Once these NE material science modules/courses *have* been successfully demonstrated, further modules will be *developed* in a *variety* of NE areas by the EC (e.g., materials for nuclear: medical, instrumentation, controls, and weapons applications). This project is then a pilot program which is the

beginning of a unique educational system that will be supported by recognized/reputable educators/experts in engineering, specifically for NE.

B.2.b Content Delivery

There have been a number of important advances in recent years in instructional methods. Although the live classroom format remains the "gold standard", use of online broadcasting and recording of lectures has opened new opportunities to increase the reach and effectiveness of US universities.

It is the goal of this project not only to develop a series of modules in two material science areas of interest in nuclear technology, but to use the latest online instructional technologies to reach the broadest audience possible and to do so in very flexible ways. The modules will be combinable to produce short study segments on narrow topics, to develop 1credit courses, and to develop two separate 3-credit university level courses. The following options will serve to illustrate the possible ways that these modules will be utilized:

- Offered in pre-recorded format for viewing and study on an on-demand basis as short subjects, and as full courses.
- Taught as classroom courses with a live instructor, and broadcast live from the classroom to remotely-connected students, who will be able to ask live questions and receive live answers, just as if they were also in the classroom.
- Available in "recorded" format with instructor availability as needed and requested through a variety of media (email, discussion boards, wikis, Skype, WebEx, etc.).

As a specific example, Dr. Frahme has been using the WebEx Learning Center to broadcast and record all live classroom lectures of KU-ME's fundamental ***Science of Materials*** course (ME 306) over the past 4 semesters. This has been well-received by students, as it allows them to attend in person or remotely, to view recorded lectures when studying for exams, and to review recorded lectures to learn concept» missed the first time. There have been students who went overseas near the end of the cdurse, but were able to complete it due to the well-organized web access. The cost of hardware to the professionals/students will be minimal, under $50 for headphones/microphone and webcam, with no added cost for software. This means that a specially equipped classroom with video cameras, sound systems, etc. is not necessary, making our techniques attractive to any university which is interested in reaching the greatest number of potential students possible.

The modules and courses will first be taught "live" in the classroom and over the web, so that students may view them in person or remotely in real time, but also may review them as often as needed any time after the real-time broadcasts occur. The instructor will be available through phone, email, discussion boards, wikis, podcasts, WebEx, Adobe Connect Pro, Skype, etc. to answer questions and assist in improving professional/student learning. Once feedback information has been incorporated into revision of the modules, the second and some later offerings will be given on a regular basis again as classroom courses. However, they will also be offered in "recorded-only" format, with the instructor being available through a variety of means to assist in professional/student learning. This will allow the courses to have much greater time flexibility, since students will be able to view previously "live" lectures at will. Feedback will again be obtained in order to compare the two methods, with the goal of making the recorded broadcast method at least as effective as the live lecture, thus allowing the instructor to have more time to focus on helping individual professionals/students with questions/needs instead of repeating the recorded material.

B.2.c Module Testing

Practicing professionals will come from companies such as AmerenUE, Black & Veatch, Burns & McDonnell, and Wolf Creek Nuclear Power Station in Kansas [where KUEngineering alumni and students currently work] (see letters of support in the Appendix).

Students, from a variety of backgrounds, will initially come from the Big 12 EC universities. Thus, there will be several sources of input on the efficacy of the modules/courses from the learner's perspective. In the future, students/professionals will be drawn from across the US and from those US professionals who are traveling the world.

c. Develop survey questionnaires for students and working professionals to provide feedback on the course.

5. Coordination of Big 12 NE Course Development Activities by K-State Leadership Team (July 1, 2010 - June 30, 2011)
   Kansas State University, as Managing Partner of the Big 12 EC, will ensure coordination across the Big 12 partner universities and accomplishment of proposed curriculum activities. The central EC staff will provide ongoing communication and coordination support, including: planning inter-institutional meetings and conference calls, supporting curriculum development activities, documenting agreements and next steps, and facilitating enrollment and student support across institutions.

The Big 12 EC has been functioning smoothly for over two years, and therefore provides a perfect venue for testing the modules and courses - - allowing us to disseminate the courses throughout the participating Big 12 universities, as well as having the framework in place for broadcasting to non-member institutions and companies. Due to the Big 12 EC's resources, it will also be possible to develop future modules through which experts from other Big 12 institutions provide information related to these material science modules.

Regarding the modules, most (30) will be focused on the material science aspects of NE, with a few preliminary modules (10) designed to be refresher or fundamentals courses on basic material science, neutron transport and energy production, as well as current and emerging nuclear powerplant technologies. These fundamentals modules will be used to motivate the need for state-of-the-art materials being employed in optimal designs to handle the issues of NE powerplants due to pressure, temperature, corrosion and radioactivity.

B.2.d Summary

In summary, this wide range of options will make the modules extremely versatile, providing greater instructional versatility than is generally available now; and module combinability will allow straightforward incorporation into future course offerings. The result is optimized use of instructor and learner time, and a streamlined path to educational goals, allowing broad dissemination of these critical technical topics to any group of nuclear industry people - - available wherever/whenever there is a computer-internet connection. In addition, the fundamental structure assures longevity, through support and distribution by an extensive Big 12 EC network, and support by local NE-employing companies. This methodology will thus be the cornerstone for development of a variety of modules which have NE applications.

B.3 Schedule Timeline and Milestones

Two courses [of 30 modules] will be developed, given in preliminary test teaching, then taught in a regular classroom environment with internet broadcasting/recording, evaluated, and revised as needed. The first course will be taught a second time at the end of year two. Over the 2 years, 10 additional Precursor modules will be developed to provide prerequisites.

B.3a Year One Tasks *(Table B.1)*

1. Development of Course 1: July 1, 2010 - Dec. 31, 2010.
   a. Develop course materials, including review of previous similar courses, develop course

b.
KU and the EC are US-wide providers of optimal educational products for those who have been in the NE field for parts of careers and for those who are just starting out in the field.

Of course, the PI and Collaborators at KU and in the Big 12 EC will gain valuable experience in managing and delivering such modules/courses, as the concept of completely independent but combinable modules is relatively new for a traditional university setting. In addition, KU project personnel will have assembled extensive documentation and material on Material Science as applied to NE - - a valuable resource for us as well as the US. Combining both of these aspects, management/delivery and technical expertise, the result will lead to innovative research proposals to the NRC [and other agencies] in the area of NE Materials - - with the goal of advancing the state-of-the-art in this area of research, while providing additional forefront educational content.

Lastly, with better trained professionals and entry level engineering graduates in the critical area of

B.3b Year Two Tasks *(Table B.1)*

1. Obtain feedback on Course 1 and modify. (July 1 - Oct. 31,2011)
2. Test teach Course 2 in a controlled environment, using potential students/industry representatives. Make final modifications before the first teaching of the full course. (July 1 - Aug. 15, 2011)
3. Teach Course 2 in classroom, including broadcasting/recording over the internet to remote students/professionals as a regular 3-credit course. (Aug. 15 - Dec. 15, 2011)
4. Re-teach Course 1 in recorded format, over the internet to remote students/professionals as a regular 3-credit course; obtain feedback. (Jan. 15 - May 15, 2012)
5. Obtain feedback on Course 2 and modify. (Nov. 1,2011 - March 31,2012)
6. Coordination of Big 12 NE Course Development Activities by K-State Leadership Team (July 1, 2011 - June 30, 2012) - - Refer to Task 5 of Year One for Scope.

NE Material Science, NE developments will advance at an accelerated pace, yielding much improved powerplant productivity and safety, with possible applications to other areas such as nuclear medicine, instrumentation, controls, and weapons.

B.4 Improved Infrastructure, Competencies, Expertise, and Skills

As discussed in Section B.2, this project will solidify and confirm KU-ME's [and the Big 12 EC's] ability to develop and disseminate top quality courses [specifically in NE Materials] to a wide variety of students and practicing professionals. Due to the readily combinable module arrangement, this project will also add more than the equivalent of two new courses to those available from KU and from the EC. These two results are key in demonstrating that

8.5 Academic Focus: Materials and Corrosion for NE

Material Science and Corrosion are the major foci of this project. There will be 4 [Precursor] modules developed to provide motivation in showing why material science is so important in NE situations. These modules will give a brief overview of neutron transport and nuclear energy production, showing that extremely high pressures and temperatures, coupled with radioactive sources, in a powerplant make it essential to develop and employ the best materials possible, knowing that the higher the pressures and temperatures are, the higher is the theoretical efficiency of the powerplant. There will also be 6 Precursor modules in fundamental material science - - to provide a basis for the main 30-module/2-course developments.

In the 30 main modules, the properties which are critical in producing a safe, reliable powerplant, while at the same time minimizing expenses and planning for continuous nondestructive evaluation of the status of chosen materials in their life-cycles, will be analyzed and presented as benefits/drawbacks to be considered in materials selection. In addition, since corrosion plays a critical role in materials failure, corrosion in a nuclear powerplant environment will be examined in detail, accounting for radiation damage, cyclic loading, stress due to extreme temperature/pressure conditions, prevention/mitigation measures, and cost factors. Alternatively, non-metals substitutions will be investigated with tradeoffs as compared to metals considered and explained. In all cases, the extent to which nondestructive testing is reliable in detecting and preventing materials failure/weakness in NE applications will be covered.

8.6 Project Emphasis: Stand-Alone Modules and Courses

As presented in Section B.2, this project is targeted toward developing 2.5 hour on-line stand-alone educational modules, having independent sets of homework/solutions, exercises, quizzes and exams associated with each module. However, these modules will also be designed for ready combination into day-long workshops and full-fledged 3- hour university courses. As with the modules, the ancillary materials will also be easily combinable for relatively quick assemblage into reasonable meldings, yielding larger learning segments.

The modules are envisioned for use in training practicing professionals, getting them quickly up-to-speed in a new or targeted area, or for providing fast-hitting refresher experiences - - thus, being very cost/time effective for professionals. In order to get the module/course information effectively/efficiently delivered to the professionals/students as quickly as possible, prerequisite modules will also be developed for "getting started" with the basics of material science, and all modules will have clear designations as what/which
modules are required (prerequisites) to advance to follow-on modules. Thus, the critical path of learning needed to obtain a desired end result (area of learning/expertise) will be established and published - - optimizing time spent in learning.

Once this overall arrangement of modules which are easily combinable into courses [different courses for different people, depending upon their backgrounds and what prerequisite modules are needed] is achieved, teaching the courses will have its own challenges in making sure that the courses are managed by an expert [or experts] who can answer questions and direct the professionals/students so that they make progress in a timely manner. This is an advanced paradigm for achieving learning goals as quickly as a student is ready and able, minimizing time spent.

Combining the modules into 1-credit to 3-credit hour courses is envisioned for training BS engineering students in the variety of NE areas from fundamentals to practical applications, thus yielding graduates who are well-prepared to contribute significantly in the NE industry. These graduates will then be able to handle NE designs, processes, maintenance issues, construction requirements, and operational issues in effective ways.

In both the module and course cases, the on-line nature of the modules will allow professionals and students to fit their schedules. Professionals with busy/travel schedules can keep up with the modules, and students who want to review/repeat lessons will be able to do so at their own speed - - optimizing the time of everyone who studies the modules. In addition, the on-line modules will allow the course/module instructors to focus on helping each student individually, through use of emails.phonecalls.Skype.WebEx.texting.etc .. to get the assistance which is needed at the time which it's needed, instead of repeating live lectures each time a new set of professionals/students begins their studies.

Our goal will be to manage module/course oversight so that both professionals and students can take the modules/courses and obtain assistance in virtually a 24/7 format - thus keeping the educational process moving forward without major delays. This will be a challenge, but is necessary to seriously address and resolve; and this will be where the major cost of module/course development will be spent - - in making sure that any prerequisitebased combination of modules will be viable learning instruments for professionals/students.

The resulting modules/courses will contribute to the EC's ability to provide a full NE curriculum to students via the web - - assisting with a large cross-section of available courses from which to choose and focus one's career/studies. In addition, the NE industry will have additional easily accessible resources with which to maintain their professionals' currency.

B.7 Institutional Implementation and Sustainability

With the design of this educational material being 2.5 hour building block modules, each module can be directly modified as needed when new engineering knowledge is available, and the modifications will have little/no impact on the. other modules. Although taught "live" the first time, once the modules are recorded, these modules and courses can be used with or without a "live" instructor. When using recorded lectures, the instructor can then focus on helping students with individual problems and not be required to re-lecture for each segment of the modules/courses - - leaving more time to promote learning from wherever a student is starting. In addition, with the design being combinable modules having clearly

designated prerequisite modules, such combined module "courses" [or learning segments] should be extremely popular with professionals and students alike because they will only need to study what is required to achieve specific learning goals. Such demand will assist in these modules [and future similarly designed modules] thriving in a sustainable manner.

Over the past 2 years, KU-ME has established capabilities in distance education through the web (e.g., WebEx and Adobe Connect Pro) - - this knowledge is readily available and will make implementation relatively straightforward for us. In addition, with Dr. Frahme having offered courses through KU-ME for the past 18 months, that important relationship is
well established; and even if Dr. Frahme would need to move away from Kansas, the relationship could be easily continued at any distance - - because it is web-based. This webbased process means that he can teach/facilitate a course from any location in the world (accounting for time zone differences) and can help students with questions/problems by email,discussionboards, Skype,WebEx, etc. So, we envision the modules to last for many years in the future, with them being modified to fit changing needs during those years.

The University of Kansas is committed to the Big 12 EC program and to this proposal (see KU Dean Bell's letter of support in the Appendix); and, with the Big 12 EC Universities involved and supportive, the survival of the modules/courses is not dependent upon only one university - - giving further assurance of long-term sustainability.

B.8 Quantifiable Program Demonstration Criteria

There are a series of criteria/assessments which will be developed in order to determine the quality and success of this educational project. We will be looking at Learning Goal Assessment, Module Assessment, and Overall Assessment - - with feedback clearly arranged to insure that modules and processes are properly modified to result in continuous improvement. In addition, for success and sustainability, Marketing will be key to attracting professionals and students to the program. These aspects are described in the following.

Learning Goal Assessment: In addition to the learning material developed, each module will have problem sets which are directly related to the topic(s) covered; and where possible, the module software will "coach" the student/practicing-engineer in solving the problems correctly. In order to determine the efficacy of a given module, a companion assessment module will be developed which allows the student/professional to provide feedback on the effectiveness of the module and its instructor as well as the support structure. This feedback will be employed to update and improve the modules for final production. In addition, similar feedback will be solicited every time that the modules/courses are offered so as to provide information for continuous improvement.

Module Effectiveness: Criteria will be developed (a few examples are shown below) for the success of each module. During the testing phase of each module, KU/Big 12 EC students and practicing professional engineers, as well as NRC representatives if possible, will study the module and provide feedback. Based upon that feedback, the module will be modified as needed. After each module has been tested, modules for a given overall topic (e.g., Materials Selection for NE Applications, and Corrosion as Applied to NE) will be combined into one-credit hour and three-credit hour university courses, then tested using students and practicing professionals, with feedback again obtained. Exam instruments will also be developed for this phase of the testing. (All module testing will be performed with both independent usage of the modules and with instructor-guided usage of the modules, with comparisons compiled.) Naturally, this will require considerable time and effort from the PI/Collaborators, which is reflected in the Budget and its narrative/justification (Sect. F).

Example criteria for sustainability evaluation:

1) enrollment - - students and professionals will "vote with their feet" by choosing the courses which they feel will provide the maximum benefit.
2) questionnaires, different for BS students and practicing professionals - experienced professionals' feedback will be most important, since they have dayto-day firsthand viewpoints as to what is needed for them to be successful in the industry. Students and professionals will be asked about the balance between theory and application of the modules, engagement with the instructor, preparation (prerequisite knowledge) required for the modules, time required to complete the modules, success of automated module "coaching",

and degree to which a given module prepared the person for the next module.

3) live WebEx discussions will be recorded, wherein, after the module/course grades/assessments have been submitted, the students/professionals are asked to provide feedback on the best aspects of the course and those aspects which need improvement. This should help us see which topics need further/less emphasis/repetition in order for optimally effective/timely learning experiences.

Final Results and Marketing: Throughout this process, the goal will be to develop easyto-use, clearly understood, highly successful modules for learning through a wide variety of outreach modes. Upon completion of the modules, it will be necessary to work with all Big 12 EC and supporting company representatives in marketing the modules as well as determining the cost for use of each module - - within the Consortium, within supporting companies/ organizations, and external to these groups.

In order to promote the modules/courses, advertisements will be placed on the American Nuclear Society's website (www.ans.org). These ads will link to the Big 12 EC NE Program website (http://www.big12engg.org), which will then link to KU-ME's website (http://www.me.engr.ku.edu). In addition, a number of nuclear industry companies [especially those who have been supportive of the Big 12 EC; for example companies, refer to letters of support in the Appendix] will be contacted to inform them of the educational opportunities.

B.9 Course Descriptions

During the July 1, 2010 to June 30, 2012 project time frame, KU-ME will actively develop, teach, evaluate, and refine 30 lesson modules, which will be designed for standalone use and for combination into 1-credit hour and 3-credit hour courses. In addition, 10 "precursor" modules (six on fundamental materials and four on nuclear energy conversion and nuclear powerplants) will be developed for use by students or industry professionals who do not have the prerequisite education needed to master the two main technical topics (i.e., 30 modules) in material science and corrosion. The two main courses will offer students the opportunity to learn about the materials/corrosion aspects of NE topics. (Note that KU is an active participant in the Big 12 EC NE Program, but the modules/courses developed will be independent; and they do not require that other Big 12 EC development proposals be funded.)

Development: Forty 150 minute long online modules will be developed for three overall topics (prerequisites, material science applied to NE, corrosion applied to NE). Each of these modules will be stand-alone and cover a specific topic as described in the following pages.

These modules will be combinable (within and/or across the three overall topics), such that five of them will yield a 1-credit hour university course, and fifteen of them will yield a full 3-credit university course. The modules can be studied independently by students and/or practicing engineers who want to learn more about each specific topic. In the first instance, the modules can be used and supplemented by an instructor whose discussion of the topic can be done in person, transmitted "live" over the internet, and recorded and retrieved for viewing. Since this is material which is currently not available to our students, these modules will greatly enhance our students' understanding of materials and corrosion with regard to nuclear applications. The on-line modularized feature will allow students to take the modules/courses at their own pace, re-order the modules if needed, ask questions by email, discussion board, Skype, WebEx, texting, etc. as necessary, and digest the material well.

Precursor Modules: There are 10 modules in this set which will be used to motivate, and provide training in prerequisite topics for, the study of Material Science for NE applications. The focus will be on the characteristics of NE powerplants which demand optimization of materials used for efficiency, safety, and smooth operations and on non-nuclear basic materials science needed for the two main course topics. These topics will be developed as time permits over the 2-year life of the project. (See Refs. in Sects. B.1 Oa & B.1 Ob.) Precursor Topic 1 (PT -1): Introduction to Fission, Fusion, Decay Rates, Energy Release Rates, Neutron Transport, Cross-sections, Types of Reactors and Control of Reactors; prerequisites: basic chemistry and physics (2 mods.)

These modules provide the fundamentals of nuclear energy, how neutrons are transported and energy is produced in a nuclear reaction, as well as today's prominent reactor types - - a basis for materials selection with regard to radiation safety/protection. Precursor Topic 2 (PT-2): Introduction to Standard Reactor/Powerplant Systems· PWR, BWR, GCR, HTGR, PHWR, Breeder Reactors, Along with

Developing Concepts in Nuclear Powerplants; prerequisite: thermodynamics & PT-1 (2 mods.) These modules provide a brief introduction to [or refresher in] the various standard NE powerplant designs, and pressures & temperatures reached, as well as power produced - - yielding a basis for materials needs in withstanding extreme conditions in a "must not fail" situation. In addition, future concept powerplant directions are discussed.

Precursor Topic 3 (PT -3): Introduction to Material Science; prerequisites: basic chemistry, physics, algebra, trigonometry (or equivalent; instructor's permission) (6 mods.) These modules provide a background in material science for those who have not had such training or need a refresher, because a fundamental background in material science is a necessary prerequisite for the two main courses described below. These modules will be based on the KU undergraduate course *Science of Materials,* ME 306, taught by Dr. Frahme. Thus, the components for this topic will be taken from ME 306, with significant organization/effort needed to put them into this project's framework.

Course 1: Materials Requirements and Selection for NE Applications

(15 on-line modules, 2% hours each [actual time]; listed below, numbered from 1 - 15.) This course is designed to discuss the selection and use of proper materials in nuclear environments, with an eye toward enhancing safe and long-term economical operation. The renewed interest in nuclear power makes materials selection, and the evaluation of newer materials, of great importance. These modules will provide better knowledge of material science as it relates to the nuclear industry. At this time, prerequisites are for the entire course [or all modules]: university level material science course or equivalent; or degree or background in NE; or PT-1, PT-2 & PT-3 (above). As the modules are developed, we may find that fewer prerequisite modules are required - - to be adjusted accordingly with individual modules showing prerequisites. (See Refs. in Sect. B.10c.)

1-3. Review of Materials Available and Their Properties: All potential materials, even those not appropriate for critical nuclear applications, will be discussed. Properties such as mechanical strength (including fatigue factors), corrosion resistance, radiation resistance and shielding, fabrication, availability, and cost will be covered.

4-5. Review of the Critical Properties Required in Materials for Nuclear Applications: Nuclear applications impose an additional set of requirements on materials. Stringent safety requirements and the nature of nuclear environments are part of the issue.

6-8. Review of Materials Typically Selected for Nuclear Applications by Usage Area: Materials that have traditionally been selected and thus have a performance history in nuclear applications will be discussed.

8-10. Selection Criteria by Application Area, Including Cost/Safety/Maintenance Factors: Each of the major application areas will be covered in relation to its materials requirements and criteria.

11. Discussion of Selection Tradeoffs: Balancing such factors as safety, cost, and maintenance will be discussed.

12-13. Discussion of New and Alternative Materials for Current and New Generation Reactors: The field of material science (including metals, ceramics, polymers, and composites) is continually producing new candidate materials for nuclear applications.

Many of these were not available when currently operating reactors were designed and commissioned. These materials will be discussed with emphasis on their nature, properties, potential benefits and disadvantages/problems, cost, etc.

14-15. Using NOT and Other Methods to Monitor Ongoing Materials Performance, Degradation, and Maintenance Needs: Monitoring reactor components and materials operational performance is critical to safe economical operation. Evaluation of materials in operating reactors by non-invasive methods will be discussed, including the limitations.

Course 2: Corrosion and Degradation of Materials in NE and in Reactor Operation & Design (15 on-line modules, 21!z hours each [actual time]; numbered from 1 - 15) Corrosion of materials presents ongoing challenges in NE and in the safe and economical operation of nuclear reactors and equipment. This set of course modules is designed to discuss corrosion in the nuclear environment in depth. At this time, prerequisites are for the entire course or all modules: Course 1 (or equivalent); degree or background in NE or PT-1, PT-2 & PT-3 (above). As the modules are

developed, we may find that fewer prerequisite modules are required- - these will be adjusted accordingly, and individual modules will show only the required prerequisites. (See Refs. in Sect. B.1 Od.)

1. Introduction to Basic Corrosion Concepts and Mechanisms
2. Corrosion of Various Types of Metals: Covers corrosion resistance and corrosion mechanisms for various metal types.
3. Corrosion of Ceramics, Polymers, and Composites: Covers corrosion resistance and corrosion mechanisms for various non-metallic materials.
4. Corrosive Nuclear-related Fluids and Environments: Discusses the corrosive media and materials in nuclear environments, including the effects of radiation on corrosion.
5. Selecting and Designing with Metals in Nuclear-related Environments: Nuclear environments complicate metals and alloys selection and the engineering design of reactors and associated equipment.
6. Selecting and Designing with Other Materials in Nuclear-related Environments: Nuclear environments complicate non-metallic materials selection and the engineering design of reactors and associated equipment.
7. Corrosion Considerations in Piping/Tubing, Containment Vessels and Non-liquid Exposed Surfaces: Each of the major components of nuclear reactors must be covered separately in relation to corrosion risk and performance.
8. Effects of Stress, Cyclical Loading, Radiation on Corrosion Rates: Corrosion rates can be dramatically and negatively impacted by applied stress, cyclical loading (fatigue problems), and radiation.
9. Corrosion under "Normal Operating Conditions" and under "Emergency Conditions": Corrosion degradation under normal operating conditions in nuclear environments is discussed to provide a baseline for operations. Corrosion degradation under emergency operating conditions in nuclear environments is discussed to assess how such conditions impact corrosion phenomena and might lead to failures.
10. Radiation Degradation of and Damage to Materials: In addition to corrosion, high levels of radiation can degrade materials in a benign environment and accelerate degradation when a corrosive environment exists. This will be discussed in this module.
11-12. Calculated Life, Length of Service and Safe Operation for Metals and NonMetals: Estimating safe lifetime limits for various materials in the many nuclear environments is important for nuclear design and material selection. This is particularly important for components that cannot be replaced or accessed during operations and thus must perform until scheduled shutdowns occur.
13. **Economic Considerations as They Relate to Corrosion:** Cost factors in materials selection and thus reactor design cannot be ignored and will be discussed. Cost of materials, operating lifetime, and maintenance will be included.
14. **Corrosion Protection, Prevention, and Mitigation Measures:** Since all materials are subject to corrosion, methods of protection, prevention, and mitigation (including repair) are discussed with the goal of extending useful life and maximizing safety.
15. **NOT and Other Methods to Monitor Levels of Corrosion:** Ongoing monitoring of corrosion is essential to assure safe operation and to determine when repairs or replacements are needed.

8.10 Reference Materials for Module Development and Use

Following are the reference materials which will be used to develop the proposed modules.

8.10a References for Powerplant Engineering Modules PT-1 & PT-2

Introduction to Nuclear Engineering, *JR.* Lamarsh, A.J. Baratta, Prentice-Hall, 2001 (ISBN 0-201-82498-1).

Nuclear Systems I: Thermal Hydraulic Fundamentals, N.E. Todreas, Taylor & Francis, 1993 (ISBN 1-56032-051-6); & M.S. Kazimi, 2001 (ISBN 1-56032-911-4).

Nuclear Systems II: Elements of Thermal Design, N.E. Todreas, Taylor & Francis, 1990, ISBN-13: 9781560320791.

Powerplant Technology. M.M. El-Wakil, October 2002 ed., McGraw-Hili, ISBN-13: 9780072871029.

8.10b Reference for Material Science Modules PT-3

Fundamentals of Materials Science and Engineering, 3rd ed., William D. Callister, Jr., David G. Rethwisch, John Wiley & Sons, 2008, ISBN 978-0-470-12537-3.

8.10c References for Course 1

Properties and Selection Set, ASM Handbook Volume 01 & 02, ASM International, ISBN 10: 0-87170-378-5 and 0-87170-377-7.

Introduction to Materials Science for Engineers, 6th ed., James F. Shackelford, PrenticeHall, ISBN 0-13-142486-6.

Fundamentals of Radiation Materials Science: Metals and Alloys, Gary S. Was, Springer Publishing, ISBN-10: 3540494715,ISBN-13: 978-3540494713.

"Materials for Advanced Energy Generation", Charles Parker, ASM International, Advanced Materials & Processes, Vol. 166, Issue 1, January 2008.

Characterization and Testing of Materials for Nuclear Reactors: Proceedings of a Technical Meeting Held in Vienna, 29 May-2 June 2006 (Iaea-Tecdoc Series), Inti Atomic Energy Agency (May 31, 2007), ISBN-1 0: 920103007X, ISBN-13: 978-9201030078.

8.10d References for Course 2

Corrosion Engineering Handbook, 2nd ed - 3 Volume Set (Corrosion Technology), Philip A. Schweitzer, CRC, 2006, ISBN-10: 0849396476, ISBN-13: 978-0849396472.

Corrosion: Fundamentals, Testing, and Protection, ASM Handbook Volume 13A, 2003, ISBN 10: 0-87170-705-5, ISBN 13: 978-0-87170-705-5.

Corrosion: Materials, ASM Handbook Volume 13B, 2005, ISBN 10: 0-87170-705-5

Corrosion: Environments and Industries, ASM Handbook Volume 13C, 2006, ISBN 10: 0-87170-705-5, ISBN 13: 978-0-87170-709-3.

"Corrosion of Linings & Coatings: Cathodic and Inhibitor Protection and Corrosion Monitoring," Phillip A. Schweitzer, from Corrosion Engineering Handbook, 2nd ed., 2006, ISBN-10: 0849382475, ISBN-13: 978-0849382475.

Corrosion in Nuclear Applications (The Corrosion monograph series), Warren E. Berry, John Wiley & Sons Inc., 1971, ISBN-10: 047107120X, ISBN-13: 978-0471071204.

"Forms of Corrosion," Failure Analysis and Prevention, ASM Handbook, Vol. 11, pp. 761795,2002.

"Fundamentals of Metallic Corrosion: Atmospheric and Media Corrosion of Metals," P. A. Schweitzer, Corrosion Engineering Handbook, 2nd ed., 2006, ISBN-10: 0849382432.

Handbook of Corrosion Engineering, Pierre Roberge, McGraw-Hili, 1999, ISBN-10: 0070765162, ISBN-13: 978-0070765160.

"High-Temperature Gaseous Corrosion Testing," David A. Shifler (Naval Surface Warfare Center), from Corrosion: Fundamentals, Testing, & Protection, ASM Handbook Volume 13A, pp. 650-681, 2003, ISBN 10: 0-87170-705-5, ISBN 13: 978-0-87170-705-5.

High-Temperature Corrosion & Materials Applications, G.Y. Lai, 2007, ISBN:978-0-87170853-3.

Handbook of Corrosion Data, 2nd ed., Ed. by B. Craig & D. Anderson, 1995, ISBN:978-0-87170-518-1.

Corrosion of Weldments, ed. by J. R. Davis, 2006, ISBN: 978-0-87170-841-0. Stress-Corrosion Cracking: Materials Performance and Evaluation, Ed. by R. H. Jones, 1992, ISBN: 978-0-87170-441-2.

Ninth International Symposium on Environmental Degradation of Materials in Nuclear Power Systems: Water Reactors, F. Peter Ford (Editor), Stephen M. Bruemmer (Editor), Gary S. Was (Editor), Minerals, Metals, & Materials Society; 9th edition (December 2000),1227 pages, ISBN-10: 0873394755, ISBN-13: 978-0873394758.

B.11 The Big 12 EC Structure and Collaboration Among Its Members

The Big 12 EC was formed in May 2008 primarily to address the escalating need for engineers who have a basic knowledge of NE.[4,5] The Big 12 universities started offering fully on-line NE courses in Spring 2007. By Fall 2009, more than 90 students had enrolled to take the Big 12 NE courses. Drawing on Big 12 offerings, Iowa State University and Texas Tech University are newly offering NE minors, and Kansas State University is revising institutional policy to allow for delivery of a fully online minor for post-

BS working professionals. The EC currently offers 9 online courses in NE (Table B.2). The Big 12 faculty agree that there's still a need to develop and offer more fully online courses, as well as modularized lessons that can be incorporated into non-nuclear courses to reach students outside the NE major.

TABLE B.2. COURSE OFFERINGS AVAILABLE THROUGH THE BIG 12 EC

COURSE	TITLE	TEACHING SCHOOL
NE 300	Introduction to Nuclear and Radiation Engineering Concepts	UT
NE 301	Principles of NE	TAMU
NE 302	Fulfilling Madame Curie's Dream	MU
NE 500	Elements of NE	K-State
NE 600	Energy Systems and Resources	MU
NE 601	Radiation Protection and Shieldina	K-State
NE 602	Nuclear Reactor Enqineerina	UT
NE 603	Nuclear Reactor Theorv	TAMU
NE 604	Nuclear Reactor Analvsis	TAMU

In addition to the proposal outlined herein, the Big 12 universities are proposing three additional interrelated and complementary educational projects:

Prop. 1: PRA and Fire Protection; PIs: Bill Dunn, Carolyn Heising, Tushar Ghosh, JD Brown Prop. 2: Health Physics; PIs: Brian Robertson, Bill Jordan, Carolyn Skurla, Bill Dunn
Prop. 3: Reactor Experiments; PIs: Sheldon Landsberger, Dan Reece, Bill Dunn, Mo Hosni
which will enable collaborative development and *delivery* of fully online 3-credit courses for the benefit of students who are degree-seeking at Big 12 universities and practicing professionals who are seeking to re-tool.
These 4 independent proposals are designed to:

- Enhance and expand collaboration among engineering faculty at the Big 12 universities and encourage interactions to develop user-friendly educational offerings.
- Support development of new and innovative educational lessons, modules, and courses, including virtual laboratory experiments for both distance and on-campus education.
- Increase interest of students from other disciplines in NE.
- Promote proactive recruitment and training of students interested in the nuclear area.
  Advance long-term collaborative efforts among Big 12 universities to ensure sustainability in addressing critical workforce issues.
- Engage the nuclear industry to continually enhance education and training of their current and future employees.

New programs in NE are expensive to initiate, so leveraging existing programs with collaborative online 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 online delivery and broadly offered so more students *have* access to distance nuclear education opportunities. Thus, the Big 12 EC developed shared online offerings, reduced duplication by a course rotation that includes the new courses, and increased access points for students not currently at Big 12 universities with NE programs.

The Consortium places the Big 12 universities in a prime position to graduate engineers who are ready to enter the nuclear energy industry and related professions. However, due to the industry's low profile over the last 30 years, many students are not aware of opportunities in the nuclear field. The 4 proposals of the Big 12 will spotlight the nuclear field for all to see.

Through concentrated efforts to reach new students, the EC has encouraged more students to consider a career in NE. *Over* the past 3 years, the EC has incentivized students to study NE by offering online courses at an affordable price and by making scholarships available. The EC strives to provide students with the best education possible, requiring continual updating of curriculum and creation of new virtual and hands-on experiences.

B.11a Innovative Instructional Approaches and Techniques

The general intent of the proposed educational material is to make expert-developed content available as fully online 3-credit courses and modularized lessons that can be injected into *various* courses and curricula. The bridging goal is to produce more graduates who are aware of nuclear science and NE so they can make informed, intelligent decisions and tackle jobs that require knowledge of the discipline. Experiential learning supported by the latest and most relevant research, techniques, and practices will enable more students to be primed to enter the workforce. Additionally, the proposed modules will be developed with adherence to the Quality Matters course quality standards (http://www.qualitymatters.org/) and *Distance Learning Course Assessment Guidelines* of the EC's Assessment Committee.

EC universities that develop the modules and 3-credit courses deliver them in an online format so that students anywhere can participate without being on campus. Following the EC's enrollment and financial model, students can enroll through a home university and pay tuition/fees there. The home university provides the teaching university with student enrollment information via the ExpanSIS Data System (www.expansis.org) used by the EC. Using ExpanSIS, the teaching university provides the home university with students' grades at the semester's end. Campus coordinators at the teaching and home universities support the students during the enrollment process, during the semester, and until grades have been submitted for the official transcript. Students receive credit from their home university as if for a traditional, single-institution course. There is no need to transfer credit between institutions.

Attachment C – Standard Terms and Conditions

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

Preface

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

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

To assist with finding additional guidance for selected items of cost as required in 2 CRF 220, 2 CFR 225, and 2 CFR 230 these URLs to the Office of Management and Budget Cost Circulars are included for reference:

A-21 (now 2CFR 220): http://www.whitehouse.gov/omb/circulars/a021/print/a021.html
A-87 (now 2CFR 225): http://www.whitehouse.gov/omb/circulars/a087/print/a087-all.html
A-122 (now 2CFR 230): http://www.whitehouse.gov/omb/circulars/a122/print/a122.html
A-102, SF 424: http://www.whitehouse.gov/omb/circulars/a102/print/a102.html
Form 990: http://www.irs.gov/pub/irs-pdf/i990-ez.pdf

Any inconsistency or conflict in terms and conditions specified in the award will be resolved according to the following order of precedence: public laws, regulations, applicable notices

published in the Federal Register, Executive Orders (EOs), Office of Management and Budget (OMB) Circulars, the Nuclear Regulatory Commission's (NRC) Mandatory Standard Provisions, special award conditions, and standard award conditions.

By drawing funds from the Automated Standard Application for Payment system (ASAP), the recipient agrees to the terms and conditions of an award.

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

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

1. Applicability of 2 CFR Part 215

a. All provisions of 2 CFR Part 215 and all Standard Provisions attached to this grant/cooperative agreement are applicable to the Grantee and to sub-recipients which meet the definition of "Grantee" in Part 215, unless a section specifically excludes a sub-recipient from coverage. The Grantee and any sub-recipients must, in addition to the assurances made as part of the application, comply and require each of its sub-awardees employed in the completion of the project to comply with Subpart C of 2 CFR 215 Part 180 and include this term in lower-tier (subaward) covered transactions.

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

2. Award Package

Grant Performance Metrics:

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

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

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

§ 215.41 Grantee responsibilities.
The Grantee is obligated to conduct such project oversight as may be appropriate, to manage the funds with prudence, and to comply with the provisions outlined in 2 CFR 215.41 Within this framework, the Principal Investigator (PI) named on the award face page, Block 11, is responsible for the scientific or technical direction of the project and for preparation of the

project performance reports. This award is funded on a cost reimbursement basis not to exceed the amount awarded as indicated on the face page, Block 16., and is subject to a refund of unexpended funds to NRC.

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

Subgrants
Appendix A to Part 215—Contract Provisions

Sub-recipients, sub-awardees, and contractors have no relationship with NRC under the terms of this grant/cooperative agreement. All required NRC approvals must be directed through the Grantee to NRC. See 2 CFR 215.180 and 215.41.

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

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

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

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

Modifications/Prior Approval
NRC prior written approval may be required before a Grantee makes certain budget modifications or undertakes particular activities. If NRC approval is required for changes in the grant or cooperative agreement, it must be requested of, and obtained from, the NRC Grants

Officer in advance of the change or obligation of funds. All requests for NRC prior approval must be made, in writing (which includes submission by e-mail), to the designated Grants Specialist and Program Office no later than 30 days before the proposed change. The request must be signed by both the PI and the authorized organizational official. Failure to obtain prior approval, when required, from the NRC Grants Officer may result in the disallowance of costs, termination of the award, or other enforcement action within NRC's authority.

Lobbying Restrictions

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

The Grantee shall comply with provisions of 31 USC § 1352. This provision generally prohibits the use of Federal funds for lobbying in the Executive or Legislative Branches of the Federal Government in connection with the award, and requires disclosure of the use of non-Federal funds for lobbying.

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

§ 215.13 Debarment And Suspension.

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

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

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

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

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

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

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

'Debarment, Suspension, Ineligibility, and Voluntary Exclusion

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

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

Implementation of E.O. 13224 -- Executive Order On Terrorist Financing
The Grantee is reminded that U.S. Executive Orders and U.S. law prohibits transactions with, and the provision of resources and support to, individuals and organizations associated with terrorism. It is the legal responsibility of the Grantee to ensure compliance with these Executive Orders and laws. This provision must be included in all contracts/sub-awards issued under this grant/cooperative agreement.
Award Grantees must comply with Executive Order 13224, Blocking Property and Prohibiting Transactions with Persons who Commit, Threaten to Commit, or Support Terrorism. Information about this Executive Order can be found at: www.fas.org/irp/offdocs/eo/eo-13224.htm.

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

Travel
Travel is an appropriate charge to this award and prior authorization for specific trips are not required, as long as the trip is identified in the Grantee's original program description and original budget. All other travel, domestic or international, must not increase the total estimated award amount. Trips that have not been identified in the approved budget require the written prior approval of the Grants Officer.

Travel will be in accordance with the US Government Travel Regulations at: www.gsa.gov/federaltravelregulation and the per diem rates set forth at: www.gsa.gov/perdiem.

Travel costs to the grant must be consistent with provisions as established in Appendix A to 2 CFR 220 (J.53)

Property Management Standards
Property standards of this award shall follow provisions as established in 2 CFR 215.30.

Equipment procedures shall follow provision established in 2 CFR 215.34.

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

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

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

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

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

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

Records retention and access requirements for records of the Grantee shall follow established provisions in 2 CFR 215.53.

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

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

Conflict Of Interest Standards of this award shall follow provisions as established in 2 CFR 215.42 Codes of Conduct.

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

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

c. The Grants Officer will promptly acknowledge receipt of the request for review and shall forward it to the Director, Office of Administration, who shall appoint a review committee consisting of a minimum of three persons.

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

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

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

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

Monitoring and Reporting § 215.51

a. Grantee Financial Management systems must comply with the established provisions in 2 CFR 215.21

- Payment – 2 CFR 215.22
- Cost Share – 2 CFR 215.23
- Program Income – 2 CFR 215.24
  - Earned program income, if any, shall be added to funds committed to the project by the NRC and Grantee and used to further eligible project or program objectives.
- Budget Revision – 2 CFR 215.25
  - In accordance with 2 CFR 215.25(e), the NRC waives the prior approval requirement for items identified in sub-part (e)(1-4).
  - The Grantee is not authorized to rebudget between direct costs and indirect costs without written approval of the Grants Officer.
  - Allowable Costs – 2 CFR 215.27

b. **Federal Financial Reports**

Effective October 1, 2008, NRC transitioned from the SF–269, SF–269A, SF–272, and SF–272A to the Federal Financial Report (SF-425) as required by OMB:
http://www.whitehouse.gov/omb/fedreg/2008/081308_ffr.pdf
http://www.whitehouse.gov/omb/grants/standard_forms/ffr.pdf
http://www.whitehouse.gov/omb/grants/standard_forms/ffr_instructions.pdf

The Grantee shall submit a "Federal Financial Report" (SF-425) on a quarterly basis, for the periods ending 3/31, 6/30, 9/30 and 12/31, or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. A final SF-425 shall be submitted within 90 days after expiration of the award.

Period of Availability of Funds 2 CFR § 215.28

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

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

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

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

Automated Standard Application For Payments (ASAP) Procedures

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

Audit Requirements

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

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

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

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

III. Programmatic Requirements

Performance (Technical) Reports

a. The Grantee shall submit performance (technical) reports electronically to the NRC Project Officer and Grants Officer as specified in the special award conditions in the same frequency as the Federal Financial Report unless otherwise authorized by the Grants Officer.

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

Unsatisfactory Performance

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

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

Other Federal Awards With Similar Programmatic Activities

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

Prohibition Against Assignment By The Grantee

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

Site Visits

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

IV. Miscellaneous Requirements

Criminal and Prohibited Activities

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

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

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

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

American-Made Equipment And Products

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

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

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

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

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

Publications, Videos, and Acknowledgment of Sponsorship
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."