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

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-04-10-173		FROM: 10/1/2010 TO: 09/30/2013	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
☐ GRANT ☒ COOPERATIVE AGREEMENT	DUNS: 161202122	UNIVERSITY OF WISCONSIN SYSTEM RESEARCH & SPONSORED PROGRAMS Atnn: Stephanie Gray 21 N PARK ST STE 6401 MADISON WI 537151218 608-262-3822

8. PROJECT TITLE:
Research in Support of VHTR Safety Performance

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 Revised 07/30/2010 AND APPENDIX A-PROJECT GRANT PROVISIONS	☒ PROGRESS AND FINAL ☒ FINAL ONLY ☐ OTHER (Conference Proceedings)	University of Wisconsin Attn: Todd R. Allen 1500 Engineering Drive Madison, WI 53706 Phone: 608-265-4083 Email: allen@engr.wisc.edu

12. NRC PROGRAM OFFICE (NAME and ADDRESS)	13. ACCOUNTING and APPROPRIATION DATA		14. METHOD OF PAYMENT
US Nuclear Regulatory Commission Office of Nuclear Regulatory Research Attn: Sudhamay Basu Mail Stop: CSB-03-A07M Washington, DC 200555 301-251-7521	APPN. NO:	31X0200.060	☐ ADVANCE BY TREASURY CHECK ☐ REIMBURSEMENT BY TREASURY CHECK ☐ LETTER OF CREDIT ☒ OTHER (SPECIFY) Electronic ASAP.gov (See Remarks in Item #20 "Payment Information")
	B&R NO:	060-15-171-172	
	JOB CODE:	K6003	
	BOC NO:	4110	
	OFFICE ID NO:	(04) RES	

15. NRC OBLIGATION FUNDS		16. TOTAL FUNDING AGREEMENT	
THIS ACTION	$100,000.00	NRC	$300,000.00
PREVIOUS OBLIGATION	$ 0.00	RECIPIENT	0.00
TOTAL	$100,000.00	TOTAL	$300,000.00

This action provides funds for Fiscal Year 10 in the amount of $100,000.00

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

U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn: Robin T. Barnes
Mail Stop: TWB-01-B10M
Washington, DC 20555

18.	19. NRC CONTRACTING OFFICER	
SIGNATURE NOT REQUIRED	Sheila Bumpass (Signature)	9/28/2010 (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 OCT 04 2010 ADM002

NRC-04-10-173

ATTACHMENT A - SCHEDULE

A.1 PURPOSE OF GRANT

The purpose of this Cooperative Agreement is to provide "Research in Support of VHTR Safety Performance" as described in Attachment B entitled "Program Description."

A.2 PERIOD OF GRANT

1. The effective date of this Cooperative Agreement is October, 1, 2010. The estimated completion date of this Grant is September 30, 2013.

2. Funds obligated hereunder are available for program expenditures for the estimated period: October 1, 2010 thru September 30, 2011.

A. GENERAL

1. Total Estimated NRC Amount:	$300,000.00
2. Total Obligated Amount:	$100,000.00
3. Cost-Sharing Amount:	$ 0.00
4. Activity Title:	Research in Support of VHTR Safety Performance
5. NRC Project Officer:	Sudhamay Basu
6. DUNS No.:	161202122

B. SPECIFIC

RFPA No.:	RES-10-173
FFS:	RES-C10-880
Job Code:	K6003
BOC:	4110
B&R Number:	060-15-171-172
Appropriation #:	31X0200.060
Amount Obligated:	$100,000.00

A.3 BUDGET

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

	Year 1	Year 2	Year 3
Direct Participant Cost	$69,953	$70,057	$70,166
Indirect Cost F&A (48.5%)	$30,047	$29,943	$29,834
NRC Yearly Total	**$100,000**	**$100,000**	**$100,000**

All travel must be in accordance with the University of Wisconsin's 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 $300,000 for the three year period.
2. NRC hereby obligates the amount of $100,000 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

High Temperature Gas-cooled Reactors (HTGRs), are helium-cooled, graphite-moderated, thermal spectrum systems with a target outlet temperature as high as 950 to 1000°C and a 60year operating lifetime. [1]. Basic technology for the HTGR has been established in previous HTGR plants (e.g., DRAGON, Peach Bottom, AVR, THTR, and Fort St. Vrain). These past designs represent the two primary core configurations commercially favored for gas reactors; the solid-block prismatic or the pebble-bed core [2, 3]. This project proposes a task that will generate understanding critical to the safe performance of HTGRs.

The fuel form envisioned for the HTGR is the TRISO fuel particle, consisting of a kernel of uranium dioxide (or uranium oxy-carbide, UCO) surrounded by a spherically-layered composite about 1 mm in diameter. The composite layer is comprised of a porous graphite buffer layer and a SiC coating between two very dense layers of pyrolytic carbon (PyC). The PyC-SiC-PyC layers are termed the TRISO coating. The main purpose of the TRISO coating is to enforce maximum retention of fission products (gases, Cs, Ag, etc.) under normal and accident conditions. Understanding the mechanism of fission product transport through the SiC is critical to the safety of a gas-cooled reactor and this proposed task will continue work to understand the primary transport paths for the fission product cesium.

References

[1] G.O. Hayner, E.L. Shaber, R.E. Mizia, R.L. Bratton, W.K. Sowder, R.N. Wright, W.E. Windes, T.C. Totemeier, K.A. Moore, W.R. Corwin, T.D. Burchell, J. M. Corum, J. W. Klett, R.K. Nanstad, L.L. Snead, P.L. Rittenhouse, R.W. Swindeman, D.F. Wilson, T.E. McGreevy, R. Jones, and F. Gardner,"Next Generation Nuclear Plant Materials Research and Development Program Plan", INEEL/EXT-04-02347, Idaho National Laboratory, September 2004.

[2] E. Wallace, R. Matzie, R. Heiderd, and J. Maddalena, "From field to factory: Taking advantage of shop manufacturing for the pebble bed modular reactor", Nuc. Eng. and Design, 236 (2006) 445-453.

[3] A. Koster, H. Matzner, and D. Nicholsi, "PBMR design for the future", Nuc. Eng. And Design, 222 (2003) 231-245.

Task 1: Cs Diffusion in SiC for TRISO Fuel Fission Production Retention

1.1. Introduction: Numerous studies have demonstrated that Cs can be released from TRISO fuels, particularly at elevated temperatures [1.1-1.5]. However, the dominant mechanisms governing this release (e.g., volume vs. grain boundary diffusion) are not known, making prediction of behavior under different conditions (e.g., changes in SiC microstructure, presence of different fission products, changing temperature profiles, etc.) highly uncertain. In this work we focus on the diffusion of Cs through SiC, which likely provides the most restrictive barrier to Cs release. We focus on diffusion couple experiments to determine both the magnitude and mechanisms for Cs transport through SiC. The proposed work extends studies from a previous NRC cooperative agreement to consider the effects of irradiation and coupling of Cs absorption and diffusion to other defects and impurities.

1.2. Previous Results: The focus of our experimental work to date with the NRC has been measuring Cs diffusion in unirradiated chemical vapor deposition (CVD)-SiC Constant source Cs vapor/solid SiC diffusion couples have been exposed to elevated temperatures and their concentration profiles have been measured by Secondary Ion Mass Spectroscopy (SIMS). The Cs concentration profile (Figure 1.1) is characterized by a volume diffusion front and a short circuit diffusion tail. These results suggest Type B kinetics (according to Harrison's classification [1.6]), where both volume diffusion and grain boundary diffusion mechanisms are active in the transport of Cs in CVD-SiC. Fitting the diffusion couple data to analytic models [1.7, 1.8] yields values for volume (D_v) and grain boundary (D_{gb}) diffusivity at 1200 ^{o}C of 1.8×10^{-18} m^2/s and 1.0×10^{-15} -to 1.0×10^{-12} m^2/s, respectively.

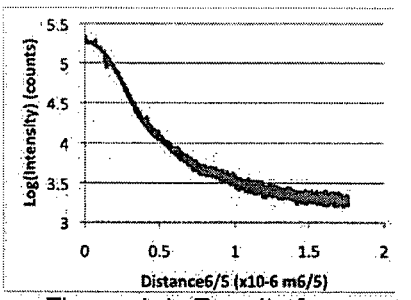

Figure 1.1. Results from Cs/SiC 1200°C/100 hr diffusion couple.

The focus of our modeling work to date with the NRC has been using molecular modeling methods to predict and understand Cs diffusion in SiC. Our calculations predict volume diffusion to occur primarily through migration of a $(C_{Sc}\text{-}2V_{Si})^{3-}$ charged defect cluster (for n-type SiC) with an activation energy of 5.5 eV, in good agreement with previously reported experimental values of about 5.2 [1.5] to 5.3 eV [1.1]. Initial results from grain boundary diffusion modeling predict strong segregation, but no grain boundary short-circuit diffusion paths have been identified. The predicted solubility of Cs in SiC is found to be extremely low, inconsistent with measured release data and our own diffusion couple experiments. These results suggest Cs incorporation may be a more complex process than simple substitutional or interstitial incorporation in the SiC lattice, potentially involving coupling to other impurities and/or defects.

The above results are the first direct measurements of Cs transport in SiC, as well as the first identification of the method for volume diffusion of Cs in SiC. These results have suggested key mechanisms and magnitudes for Cs transport in SiC. However, the work to date does not consider irradiation effects and implies that unexpected Cs-defect coupling to impurities or radiation-induced defects may play a major role in absorption and diffusion. We therefore propose to extend our previous studies to consider irradiation effects in SiC. An understanding and quantification of these issues is essential to reliable prediction of Cs transport under different normal and accident conditions.

1.3. Radiation Effects on Cs Diffusion in SiC: An understanding of the radiation dependence of Cs diffusion in SiC is essential to determining the ability of SiC to retain Cs fission products under the neutron radiation present during operation. Irradiation of SiC can affect the transport of Cs through two mechanisms: (i) enhanced point defect concentrations and (ii) creation of new extended defect structures. These two mechanisms will be explored through an experimental approach.

We will irradiate SiC and analyze Cs/SiC diffusion couples for both unirradiated and irradiated SiC. Within the scope of this proposal, experimental constraints require that the diffusion couple studies be performed *ex-situ*, by which we mean after the SiC has been irradiated. During the *ex-situ* diffusion couple experiments, the radiation-induced point defects will anneal out and the effects of the mechanism labeled as (i) are therefore included only partially, before annealing is complete. The kinetically stable extended defects responsible for mechanism (ii) above will persist during the diffusion couple experiments. Therefore, comparison of the Cs/unirradiated-SiC and Cs/irradiated-SiC diffusion couples will directly establish the effects of radiation-induced extended defects in SiC on the Cs diffusion. In particular, the proposed experiments will assess if extended defect structures observed in irradiated SiC serve to trap Cs and/or act as fast diffusion pathways. To examine mechanism (i), a coupled series of implantations followed by irradiation could indicate if persistent point defects created during fuel operation are necessary for accelerated diffusion in TRISO particles.

The ion beam user facility at the University of Wisconsin-Madison (UW) has the capabilities to carry out proton irradiations across a variety of controlled temperatures (up to 1400 ^{o}C) and doses, which will allow a range of damage types and levels to be created in the SiC. Diffusion couples will then be constructed using the same constant source Cs vapor/solid SiC approach we developed in the previous NRC project (results of which are described above in Section 1.2, Previous Results). Depth profiling experiments will then be carried out in the constant damage, near-surface region to determine the dependence of the diffusion coefficient of Cs in SiC on irradiation temperature and dose. SIMS will be conducted using the ion beam accelerator facility at the Pacific Northwest National Laboratory Environmental Molecular Sciences Laboratory. SIMS is a non-destructive technique with a detection limit of ~1 ppm and nanoscale depth resolution.

1.5. Task 1 Timeline and Milestones: The proposed work will consist of the following timeline, activities, and deliverables.

1.6.

Year	Activities	Deliverables
1	• Continue Cs/SiC diffusion couples for unirradiated SiC and look for interaction of Cs with oxygen in SiC • Irradiation of SiC and characterization of irradiated samples	Report and presentation to the NRC
2	• Run Cs/SiC diffusion couples for irradiated SiC • Initial analysis of effects of irradiation on Cs diffusion from diffusion couples	Report and presentation to the NRC
3	• Complete analysis of effects of irradiation on Cs diffusion from diffusion couples	Report and presentation to the NRC

References:

[1.1] Fuel Performance and Fission Product Behavior in Gas Cooled Reactors IAEA TECDOC-978 Nov. (1997).

[1.2] H. Nabielek, Symposium 10 Discussion: SiC for Fuel at 33rd ICACC, Amer. Ceram. Soc., Daytona Beach, FL. Jan. 21 (2009).

[1.3] H.J. Allelein, *Spaltproduktverhalten Speziell Cs 137 in HTR TRISO Brennstoffteilchen,*

Kernforschungsanlage Jülich GmbH, Institut für Reaktorentwicklung, Jül, 1695 (1980).

[1.4] W. Amian and D. Stover, *Diffusion of Silver and Cesium in Silicon-Carbide Coatings of Fuel Particles for High-Temperature Gas-Colled Reactors,* Nucl. Tech. **61**, 475 (1983).

[1.5] K. Minato, T. Ogawa, K. Fukuda, H. Sekino, H. Miyanishi, S. Kado, and I. Takahashi, *Release behavior of Mettalic Fission-Products from HTGR Fuel-Particles at 1600° to 1900°C,* J. Nucl. Mater. **202**, 47 (1993).

[1.6] L.G. Harrison, " Influence of dislocations on diffusion kinetics in solids with particular reference to the alkali halides," Trans. Faraday Soc. 57 (1961).

[1.7] T. Suzuoka, "Lattice and grain boundary diffusion in polycrystals," Trans. Jap. Inst. Metals, 1, 2 (1961).

[1.8] Y. Mishin, C. Herzig, J. Bernardini, and W Gust,, "Grain boundary diffusion: fundamentals to recent developments," International Materials Review, 42, 4 (1997).

[1.9] M. Di Ventra and S.T. Pantelides, *Oxygen stability, diffusion, and precipitation in SiC: Implications for thin-film oxidation*, Journal of Electronic Materials **29**, 353 (2000).

[1.10] H.J. Hrostowski and R.H. Kaiser, "The solubility of oxygen in silicon," J. Phys.Chem. Solid, 9 (1959) 214.

The Nuclear Regulatory Commission's
Standard Terms and Conditions for U.S. Nongovernmental Cooperative Agreements/Grants

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:

- Cooperative Agreement program legislation and program regulation cited in this Notice of Cooperative Agreement/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 cooperative 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 (now2 CFR 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 cooperative Agreement/grant are applicable to the recipients and to the sub-recipients which meet the definition of "Recipient" in Part 215, unless a section specifically excludes a sub-recipient from coverage. The Recipient 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. Recipient 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 Recipient's responsibilities.

The Recipient is obligated to conduct such project oversight as may be appropriate, to manage 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 Recipient of the contractual responsibilities arising under its contract(s). The Recipient 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, and 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.

Sub Agreements

Appendix A to Part 215—Contract Provisions

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

Nondiscrimination

(This provision is applicable when work under the Cooperative Agreement/Grant 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 Recipient 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 Recipient makes certain budget modifications or undertakes particular activities. If NRC approval is required for changes in the Cooperative Agreement or Grant,

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's prior approval must be made, in writing (which includes submission by e-mail), to the designated Grants Officer 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 Recipient 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 Recipient 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 Recipient 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 Recipient must submit the SF-LLL, including those received from sub-recipients, contractors, and subcontractors, to the Grants Officer.

§ 215.13 Debarment And Suspension.

The Recipient 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 Recipient agrees that, unless authorized by the Grants Officer, it will not knowingly enter into any subagreement or contracts under this Cooperative Agreement/Grant with a person or entity that is included on the Excluded Parties List System (http://epls.arnet.gov).

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

'Debarment, Suspension, Ineligibility, and Voluntary Exclusion

The Recipient 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 Recipient 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 Recipient 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 Recipient to ensure compliance with these Executive Orders and laws. This provision must be included in all contracts/sub-awards issued under this Cooperative Agreement/Grant award. Recipient 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 Recipient 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 Recipient 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 Recipient'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 Recipient 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 Recipient the right to elect title and retain ownership to inventions they develop with funding under an NRC Cooperative Agreement award ("subject inventions"). In accepting an award, the Recipient 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 Recipient 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 Recipients to use this system to comply with Bayh-Dole and related intellectual property

reporting requirements. The system allows for Recipient 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 Recipients, 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 Recipient uses or has used patented technology under this award without license or permission from the owner, the Recipient 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 Recipient 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 Recipient 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 Recipient employees may be copyrighted but only the part authored by the Cooperative Agreement 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 Recipient 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 Recipient 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 Recipient 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 Recipient 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 Recipient'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 Recipient 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. Recipient 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 Recipient 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 Recipient 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/Cooperative Agreements/standard_forms/ffr.pdf
http://www.whitehouse.gov/omb/Grants/standard_forms/ffr_instructions.pdf

The Recipient shall submit a "Federal Financial Report" (SF-425) on a quarterly basis for the periods ending 3/31, 6/30, 9/30 and 12/31or 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 Recipient may charge to the Cooperative Agreement/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 Cooperative Agreement/Grant 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, Recipients 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. Recipients 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 Recipients 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 Cooperative Agreement/Grant -related records available to NRC or other designated officials for review or audit.

III. Programmatic Requirements

Performance (Technical) Reports

a. The Recipient 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 Recipient organization 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 Recipient 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 Cooperative Agreement

The Recipient 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 Recipient or contractor under an award, the Recipient 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 Cooperative Agreement/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

Recipients 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, Recipient 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 Recipient 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 Recipient'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 Recipient 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 Recipients 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 Recipient 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 Recipient organization shall investigate the allegation and submit its findings to the Grants Officer. The NRC may accept the Recipient's findings or proceed with its own investigation. The Grants Officer shall inform the Recipient 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 Recipient 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 Recipient 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 [Recipient organization 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."