

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

<b>1. GRANT/AGREEMENT NO.</b> NRC-HQ-12-G-27-0086	<b>2. MODIFICATION NO.</b>	<b>3. PERIOD OF PERFORMANCE</b> FROM: 09/28/2012 TO: 09/27/2014	<b>4. AUTHORITY</b> Pursuant to Section 31b and 141b of the Atomic Energy Act of 1954, as amended												
<b>5. TYPE OF AWARD</b>  <input checked="" type="checkbox"/> GRANT <input type="checkbox"/> COOPERATIVE AGREEMENT	<b>6. ORGANIZATION TYPE</b>  Historically Black Colleges & Universities DUNS: 879941318 NAICS: 611310	<b>7. RECIPIENT NAME, ADDRESS, and EMAIL ADDRESS</b>  Morgan State University 1700 East Cold Spring Lane Baltimore, MD 21251 Email: <a href="mailto:mildred.ofosu@morgan.edu">mildred.ofosu@morgan.edu</a>													
<b>8. PROJECT TITLE:</b> The Preparation of Precursors and Models for the Immobilization of Technetium Wastes															
<b>9. PROJECT WILL BE CONDUCTED PER GOVERNMENT'S/RECIPIENT'S PROPOSAL(S) DATED</b>  See Program Description AND APPENDIX A-PROJECT GRANT PROVISIONS	<b>10. TECHNICAL REPORTS ARE REQUIRED</b>  <input checked="" type="checkbox"/> PROGRESS AND FINAL <input type="checkbox"/> FINAL ONLY <input type="checkbox"/> OTHER (Conference Proceedings)	<b>11. PRINCIPAL INVESTIGATOR(S) NAME, ADDRESS and EMAIL ADDRESS</b>  Dr. Santosh K.Mandal Department of Chemistry – Morgan State University 1700 East Cold Spring Lane Baltimore, MD 21251 Email: <a href="mailto:santosh.mandal@gmail.com">santosh.mandal@gmail.com</a> ; Phone : (443)885-1665													
<b>12. NRC PROGRAM OFFICE (NAME and ADDRESS)</b> NRC Attn: Tuwanda Smith, Esquire Office of Small Business & Civil Rights MS: O3H06 (301) 415-7394 11545 Rockville Pike Rockville, Maryland 20852 Email: <a href="mailto:Tuwanda.Smith@NRC.GOV">Tuwanda.Smith@NRC.GOV</a>	<b>13. ACCOUNTING and APPROPRIATION DATA</b> APPN. NO: 31X0200 B&R NO: 2012-7P-51-K-167 JOB CODE: L2284 BOC NO: 4110 OFFICE ID NO: SDB-12-059 FAMIS: GR0259	<b>14. METHOD OF PAYMENT</b>  <input type="checkbox"/> ADVANCE BY TREASURY CHECK <input type="checkbox"/> REIMBURSEMENT BY TREASURY CHECK <input type="checkbox"/> LETTER OF CREDIT <input checked="" type="checkbox"/> OTHER (SPECIFY) Electronic ASAP.gov (See Remarks in Item #20 "Payment Information")													
<b>15. NRC OBLIGATION FUNDS</b>  <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%;">THIS ACTION</td> <td style="width:50%; text-align: right;">\$80,000.00</td> </tr> <tr> <td>PREVIOUS OBLIGATION</td> <td style="text-align: right;">_____</td> </tr> <tr> <td><b>TOTAL</b></td> <td style="text-align: right;"><b>\$80,000.00</b></td> </tr> </table>	THIS ACTION	\$80,000.00	PREVIOUS OBLIGATION	_____	<b>TOTAL</b>	<b>\$80,000.00</b>	<b>16. TOTAL FUNDING AGREEMENT</b>  <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%;">NRC</td> <td style="width:50%; text-align: right;">\$200,000.00</td> </tr> <tr> <td>RECIPIENT</td> <td style="text-align: right;">_____</td> </tr> <tr> <td><b>TOTAL</b></td> <td style="text-align: right;"><b>\$200,000.00</b></td> </tr> </table> <p style="text-align: right; margin-top: 10px;">This action provides funds for Fiscal Year 2012 in the amount of \$80,000.00</p>			NRC	\$200,000.00	RECIPIENT	_____	<b>TOTAL</b>	<b>\$200,000.00</b>
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<b>17. NRC ISSUING OFFICE (NAME, ADDRESS and EMAIL ADDRESS)</b>  U.S. Nuclear Regulatory Commission Div. of Contracts Attn: Shashi Malhotra, Email: <a href="mailto:Shashi.malhotra@nrc.gov">Shashi.malhotra@nrc.gov</a> Mail Stop: TWB-01-B10M Rockville MD 20852															
<b>18.</b>  Signature Not Required	<b>19. NRC CONTRACTING OFFICER</b>  <table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:60%; text-align: center;"><i>Sheila Bumpass</i></td> <td style="width:40%; text-align: right;">09/13/12</td> </tr> <tr> <td style="text-align: center;">(Signature)</td> <td style="text-align: right;">(Date)</td> </tr> <tr> <td>NAME (TYPED)</td> <td style="text-align: right;">Sheila Bumpass</td> </tr> <tr> <td>TITLE</td> <td style="text-align: right;">Grants Officer</td> </tr> <tr> <td>TELEPHONE NO.</td> <td style="text-align: right;">301-492-3484</td> </tr> </table>			<i>Sheila Bumpass</i>	09/13/12	(Signature)	(Date)	NAME (TYPED)	Sheila Bumpass	TITLE	Grants Officer	TELEPHONE NO.	301-492-3484		
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<b>20. PAYMENT INFORMATION</b>  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).															
<b>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.</b>															
<b>22. ORDER OF PRECEDENCE</b> In the event of a conflict between the recipient's proposal and this award, the terms of the Award shall prevail.															
<b>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.</b>															

**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 "Morgan State University - The Preparation of Precursors and Models for the Immobilization of Technetium Wastes" as described in Attachment B entitled "Program Description."

**A.2 PERIOD OF GRANT**

1. The effective date of this Grant is September 28, 2012. The estimated completion date of this Grant is September 27, 2014.

2. Funds obligated hereunder are available for program expenditures for the estimated period: September 28, 2012– September 27, 2014.

**A. GENERAL**

1. Total Estimated NRC Amount:	\$200,000.00
2. Total Obligated Amount:	\$80,000.00
3. Cost-Sharing Amount:	\$0.00
4. Activity Title:	The Preparation of Precursors and Models for the Immobilization of Technetium Wastes
5. NRC Project Officer:	Tuwanda Smith, Esquire
6. DUNS No.:	879941318

**B. SPECIFIC**

RFPA No.:	SDB-12-059
FAIMIS:	GR0259
Job Code:	L2284
BOC:	4110
B&R Number:	2012-7P-51-K-167
Appropriation #:	31X0200
Amount Obligated:	\$80,000.00

**A.3 BUDGET**

Revisions to the budget shall be made in accordance with Revision of Grant Budget in accordance with

	<b>Year 1</b>	<b>Year 2</b>
Personnel	\$ 28,106.00	\$ 29,511.00
Fringe	\$ 4,301.00	\$ 4,516.00
Travel	\$ 2,160.00	\$ 2,160.00
Equipment	\$ 17,184.00	\$ 0.00
Supplies	\$ 5,050.00	\$ 11,971.00
Other	\$ 23,500.00	\$ 28,000.00
Total Direct Costs	\$ 80,301.00	\$ 76,158.00
<u>Indirect</u>	<u>\$ 19,699.00</u>	<u>\$ 23,842.00</u>
<b>Total</b>	<b>\$100,000.00</b>	<b>\$100,000.00</b>

## **A.4 AMOUNT OF AWARD AND PAYMENT PROCEDURES**

1. The total estimated amount of this Award is \$200,000.00 for a two year period.
2. NRC hereby obligates the amount of \$80,000.00 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 Grants 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**

#### **The Preparation of Precursors and Models for the Immobilization of Technetium Wastes**

##### **Background and Technical Approach**

###### **The Technetium Problem**

The remediation of nuclear wastes containing radioactive and highly volatile technetium compounds as well as a host of other troublesome radioactive and non-radioactive components poses special problems that have not yet been solved. The formulation of waste forms suitable for permanent isolation and storage and processing routes capable of incorporating these troublesome waste species under conditions which optimize the properties of the waste form (e.g. chemical durability) requires an understanding of the representative chemical and structural environments of the crystal lattice and/or glass matrix.

This project will be focused on the design of methods for the immobilization of technetium, a hazardous radioactive element that is produced in significant quantities as a by-product of uranium fission.<sup>1</sup> All isotopes of technetium are radioactive. The isotope that presents the greatest environmental problem is <sup>99</sup>Tc with a half-life of approximately 212,000 years.<sup>1</sup> Most compounds of technetium that are expected to be encountered during waste processing treatments are extremely volatile (e.g., Tc<sub>2</sub>O<sub>7</sub> boils at 3110C).<sup>2</sup> It is estimated that there is approximately 1300kg of Tc dispersed in liquid and sludge wastes at the Hanford facility.<sup>2</sup> In addition to technetium, however, the wastes contain a myriad of other components such as sodium and other metal ions, nitrates, nitrites, halides, phosphates, and sulfates. At Hanford, Savannah River and various other sites throughout the world, the preferred method of stabilizing such chemically complex nuclear waste streams (including those containing technetium) is vitrification.<sup>3</sup> Crystalline<sup>4</sup>, 5 and cement materials<sup>6</sup> have also been evaluated as waste forms to stabilize wastes containing technetium and other species. These and other methods of waste stabilization currently being implemented or investigated are often not sufficiently effective to contain the technetium without problems associated with hazardous volatilization, leaching of technetium from the waste form and costly/low through-put processing schemes.

###### **Problems of technetium immobilization**

(1) Volatility. Under most instances where TcO<sub>4</sub><sup>-</sup> is the predominant form of technetium in the liquid waste, salts of this ion (mainly alkali ions, e.g., CsTcO<sub>4</sub>, KTcO<sub>4</sub>, etc.) are formed during waste drying. When heated, these MTcO<sub>4</sub> alkali pertechnetates rapidly dissociate to M<sub>2</sub>O (g/l) and Tc<sub>2</sub>O<sub>7</sub> (g). The highly volatile Tc<sub>2</sub>O<sub>7</sub> (boiling point of 3110C), which is formed over a large

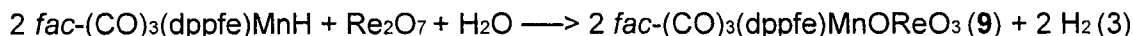
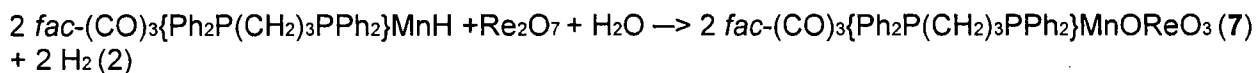
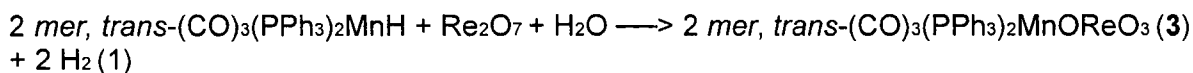
surface area, is rapidly released from the partially melted feed by the remaining open porosity. Even when reduced Tc(IV) compounds are present, e.g. TcO<sub>2</sub>, alkali pertechnetates are believed to form. Together with certain other compounds in the waste, these pertechnetate (and perrhenate) compounds form molten salts in the temperature range of approximately 375-6200C, coating the large surface area of the conglomerated unreacted feed particles. To date, efforts to immobilize wastes containing technetium by vitrification methods generally suffer considerably from the technetium volatility problem and require the off-gases and collected particulates to be recycled back into subsequent melts. It was shown that during initial vitrification at temperatures between 900 and 13500C, technetium/rhenium volatility is between 40-98% depending on the feed chemistry.<sup>2</sup> This is costly, inefficient, and poses risks for releases into the environment. Volatilization of technetium compounds during waste processing results in formation of metal pertechnetate condensates (e.g. CsTcO<sub>4</sub>) and Tc<sub>2</sub>O<sub>7</sub> in downstream off-gas collection systems. The condensates must be recycled back into subsequent melts. The work proposed here involves converting potential condensed Tc off-gases into other waste forms.

(2) Low binding affinity. In the oxidizing and strongly basic conditions found in the pretreated Hanford Site double shell slurry feed (DSSF) low level waste (LLW), the soluble technetium occurs predominantly in the +7 oxidation state in the form of the pertechnetate anion, TcO<sub>4</sub><sup>-2</sup>. The four oxo ligands have a tetrahedral geometry around the Tc ion, and the complex ion has no dipole moment. The oxo ligands are strongly bonded to the Tc ion, which has formally a +7 oxidation state. As a result, the oxo ligands have very low basicity and thus, a very low binding affinity for Lewis acids and Lewis acid supports, which might be used to separate and immobilize it. Due to this very low binding affinity, it seems highly unlikely that any solid state materials stable in typical wastes will be capable of selectively extracting technetium species from solution by the conventional ion exchange processes. There have been efforts to separate technetium compounds from the waste stream by using ion exchange resins and/or extraction methods.<sup>7</sup> Also, pertechnetate (TcO<sub>4</sub><sup>-</sup>) can be precipitated and isolated using triphenylarsonium or quaternary ammonium salts or extracted using pyridine recovery process in which NH<sub>4</sub>TcO<sub>4</sub> is the isolated product,<sup>7</sup> however, these treatments and Tc forms do not solve the volatility problem since these forms of technetium still require immobilization by incorporation into the traditional or other novel waste forms as discussed above.

(3) Reduced technetium species in some wastes. For example, supernate samples from several complex concentrate waste (CCW) tanks at the Hanford Site, which contain large concentrations of complexing organics, exhibit a distribution in the technetium environment between TcO<sub>4</sub><sup>-</sup> (approximately 20-40%) and most likely a Tc (IV) species (60-80%).<sup>3b</sup> The presence of a large concentration of organics, including complexants, is most likely stabilizing the reduced form of technetium.<sup>2</sup> These complex-associated Tc (IV) species are even more difficult to ion exchange out of solution using conventional materials and methods.<sup>3</sup> Furthermore, as stated above, in spite of their reduced state, such species will still be converted to the more volatile pertechnetates when heated in air in the course of vitrification.

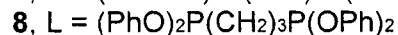
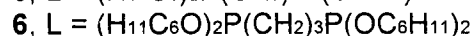
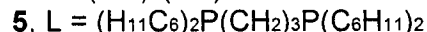
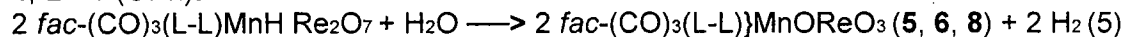
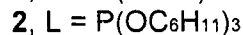
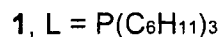
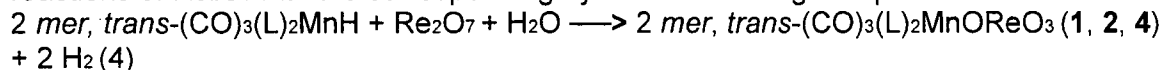
(4) Technetium leachability from the waste form. For the direct vitrification of certain waste streams (i.e., no technetium ion-exchange step), technetium concentrations in typical alkali borosilicate LLW glasses can be in the 1-5 wt% range. At these concentrations of technetium in homogeneous alkali borosilicate glass, accelerated<sup>8</sup>, congruent<sup>9</sup>, and decelerated<sup>9</sup> leaching of technetium compared to the dissolution of typical indicators of glass matrix itself- B and Na - have all been reported. These different technetium leachability behaviors are due to a combination of differences in glass formulation, feed chemistry, and testing conditions. In low level waste glasses, technetium generally represents the major radionuclide to be stabilized;

therefore, technetium leachability from these glasses will be a primary concern. Current standards for waste glass chemical durability, which based on the literature cited above, may or may not be meaningful for predicting technetium leachability. An understanding of how technetium is incorporated into a given glass matrix in relation to the feed chemistry, and in particular, how it pertains to predicting the leachability of technetium with respect to other components in the glass, is crucial; however, little work has been performed in this area. Antonini, et al. studied the structure and chemistry of technetium incorporated into borosilicate glass waste forms using X-ray absorption spectroscopy (XAS).<sup>10</sup> This study indicated that the technetium occurred predominantly as Tc (IV) which is unusual considering that melt redox studies indicated that it should occur as Tc (VII) under similar conditions.<sup>11</sup> These types of We have been studying the reactions of Re<sub>2</sub>O<sub>7</sub> with transition metal alkoxides, hydrides, and related other complexes during the last several years. We have observed that the reactions of Re<sub>2</sub>O<sub>7</sub> with the manganese(I) hydride complexes, *mer, trans*-(CO)<sub>3</sub>(PPh<sub>3</sub>)<sub>2</sub>MnH, *fac*-(CO)<sub>3</sub>{Ph<sub>2</sub>P(CH<sub>2</sub>)<sub>3</sub>PPh<sub>2</sub>}MnH, and *fac*-(CO)<sub>3</sub>(dppfe)MnH yield the corresponding perrhenato complexes, *mer, trans*-(CO)<sub>3</sub>(PPh<sub>3</sub>)<sub>2</sub>MnOReO<sub>3</sub> (**3**) *fac*-(CO)<sub>3</sub>{Ph<sub>2</sub>P(CH<sub>2</sub>)<sub>3</sub>PPh<sub>2</sub>}MnOReO<sub>3</sub> (**7**) and *fac*-(CO)<sub>3</sub>(dppfe)MnOReO<sub>3</sub> (**9**) respectively, according to eqs. 1-3:<sup>14</sup>



The perrhenato complexes, **3**, **7**, and **9** were obtained in very high yield. We characterized the perrhenate complexes spectroscopically using FT-IR and FT-NMR techniques and X-ray crystal structure determinations.

In a similar manner, we will prepare six new perrhenato complexes **1**, **2**, **4-6**, and **8** from the reactions of Re<sub>2</sub>O<sub>7</sub> with the corresponding hydrides according to eqs. 4 and 5:



All of these manganese hydrides are obtained by refluxing Mn<sub>2</sub>(CO)<sub>10</sub> with the corresponding ligands in 1-pentanol. The hydrides are very stable. Unlike other metal carbonyl hydrides, they can be easily manipulated in air. Additionally, the perrhenato complexes, **1-9** contain relatively low percentage of phosphorus. Thermal treatments of the perrhenate/pertechetate precursors with silicate or borosilicate should generate multidimensional solid state forms based on covalent binding of the oxometallates in silicate or borosilicate matrices. These might assume the form of new ceramics or even vitrified forms suitable for long term storage. The organic components of the perrhenate complexes will be converted to volatile organic compounds, CO<sub>2</sub>, and H<sub>2</sub>O at high temperatures during the vitrification. We call the oxometallates, **1-9** as

"precursor forms". The M2O7 form of the technetium reagent could be obtained from the off-gas collections of the routine vitrification processing. All products will be characterized by the usual physical and chemical methods, IR and NMR spectroscopy. Whenever possible, materials that exist in crystalline forms, will be characterized by single crystal X-ray diffraction analysis in order to establish the details of the molecular structures and bonding. Preparation of selected technetium precursors will be done at PNNL's radiological facilities.

## **b) Preparation and Analysis of Immobilized Forms**

**Ceramics.** Ceramics have been considered for waste forms to immobilize technetium. When heated, borate anions are dehydrated and transformed into 1-, 2- and 3-dimensional solid state materials. For example, the thermal condensation of boron oxides with calcium oxide leads to polymeric structures (1-dimensional BO<sub>2</sub> chain) of CaB<sub>2</sub>O<sub>4</sub>.<sup>15</sup> At higher temperatures (4000-6000C) the organic components will degrade and also be eliminated from the material. This procedure is used routinely in the synthesis of porous aluminosilicates,<sup>16</sup> aluminophosphates<sup>17</sup> and titanosilicates.<sup>18</sup> Recent studies have shown that PO<sub>4</sub><sup>3-</sup> groupings can be co-condensed with boron oxides to yield polymeric structures having covalently bound PO<sub>4</sub><sup>3-</sup> groupings, e.g., Ca [BPO<sub>5</sub>] and Ba [B(PO<sub>4</sub>)<sub>3</sub>].<sup>19</sup> PO<sub>4</sub><sup>3-</sup> is isoelectronic to the MO<sub>4</sub><sup>-</sup> ions, M=Tc, Re. It should be possible to link MO<sub>4</sub><sup>-</sup> ions in somewhat similar fashions to bind them more permanently for long term storage. Generally, ceramic waste form preparation will initially involve traditional calcinations, pressing, and sintering operations typically performed in ceramics processing. Form systems that do not densify sufficiently to reduce the leachable surface area, hot pressing will be performed.

**Vitrified forms.** The drying, calcinations, and vitrification of simulated Hanford DSSF waste spiked with NH<sub>4</sub>TcO<sub>4</sub> and NH<sub>4</sub>ReO<sub>4</sub> into Na<sub>2</sub>O-CaO-B<sub>2</sub>O<sub>3</sub>-Al<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> based glass systems has been studied and reviewed at PNNL.<sup>2a, 20</sup> These studies have indicated that rhenium is a good surrogate for technetium in terms of their extremely similar high volatility, chemical and physical properties. Once appropriate rhenium-containing precursors have been successfully synthesized and characterized and the details of their preparation and structures have been established, evaluation of their potential to serve as feeds for waste form preparation will begin. Each of the rhenium-containing precursors to be evaluated will be mixed with dry chemical reagents-SiO<sub>2</sub>, H<sub>3</sub>BO<sub>3</sub>, NaNO<sub>3</sub>, KNO<sub>3</sub>, CaCO<sub>3</sub>, AlOOH, and sugar (a reductant) – in appropriate amounts depending on the final glass composition, rhenium-loading, and melt reduction conditions desired. Melts will be conducted in platinum or alumina crucibles, depending on the reducing conditions used at temperatures ranging from 1150-13500C. In parallel, glasses of identical compositions will be prepared using KReO<sub>4</sub> (the most likely form of Re/Tc that would occur in untreated LLW2) form glasses. Portions of these quenched glasses will then be dissolved using standard glass characterization procedures developed at PNNL's analytical chemistry facilities and the elemental composition of the resulting solutions analyzed using inductively coupled plasma mass spectrometry (ICP-MS) and X-ray fluorescence (XRF) spectroscopy, again using procedures well established at PNNL.

The remaining portions of the glasses prepared from these initials melts will be ground, remelted at the same temperature they were first melted at for an additional two hours, and quenched again on stainless steel. Since such a second melting will most likely increase the volatility of Re/Tc, elemental analysis on the glasses for assessment of melt volatility behavior will be performed on the first set of prepared glasses. This second melting is designed to assure homogeneity in the glass samples used for chemical durability measurements.

Analyses. The immobilized forms will be ground into powders and evaluated for chemical durability using the product consistency test (PCT). In this evaluation, the ground samples are corroded in water at 90°C for 7 days and the leachate analyzed for elemental content using ICP-MS.<sup>12</sup> Precise experimental details of the PCT evaluation are described as an ASTM standard procedure.<sup>21</sup> This will enable us to assess the influence of immobilizing the rhenium in the form of a precursor by the redox chemistry, volatility, and leachability from the waste form. These initial results will enable us to narrow the choices for preparing technetium-containing precursors in furnaces contained in radiological fume hoods and glove boxes at PNNL.

Characterization of these synthesized technetium-precursors as well as the waste forms prepared from them will involve the use of PNNL's analytical chemistry facilities, which routinely handles radioactive samples. Techniques such as ICP-MS, XRF, Raman, powder XRD, SEM, and TEM will be performed on the appropriate samples. Additionally, the oxidation state and site symmetry of technetium and rhenium, e.g., TcO, Tc<sup>4+</sup>, Tc<sup>7+</sup>, tetrahedral or octahedral coordination, etc., will be determined in the precursors and in the glass samples using X-ray absorption near edge structure (XANES) and electron paramagnetic resonance (EPR) spectroscopies. The different oxidation states of many metals, including Tc and Re, give characteristic (fingerprint) XANES spectra which allow researchers to determine routinely the redox chemistry of these species in complex matrices without the need for chemically dissolving the matrix.<sup>6,10,13</sup> Through PNNL's collaboration with the Actinide Chemistry Group at Lawrence Berkeley National Laboratory (LBNL), experiments on radioactive samples are readily accomplished at LBNL and at the Stanford Synchrotron Radiation Laboratory (SSRL). For phase-separated samples, these techniques are also sensitive to the phase (e.g., TcO<sub>2</sub> precipitates, Tc<sup>4+</sup> in a silicate-rich amorphous phase, Tc<sup>4+</sup> in a borate-rich phase, etc.) in which the technetium and rhenium species are located. This will enable us to assess the effects of composition and precursor chemistry on the environment of technetium, rhenium and other metal species. These effects in turn can be correlated to the observed behavior (e.g., phase distribution, technetium and rhenium leachability, etc.) of the waste form. The number and distances of the nearest-neighbor coordination environment (primarily oxygen) around technetium and rhenium in these materials will be determined using X-ray absorption fine structure spectroscopy (XAFS), also at SSRL.<sup>3b,6,10,13</sup> This information will be valuable in establishing the chemical and structural environment of the technetium and rhenium incorporated into the waste form. We will determine how the effects of batch chemistry and processing conditions influence whether technetium enters the oxide structure as Tc(VII)-(O) tetrahedral, Tc(IV)-(O) octahedral, or as some separated phase, such as Tc, TcO<sub>2</sub>, or KTcO<sub>4</sub>. Again, these effects can be correlated to the observed phase distribution and chemical durability of the waste form.

### **MSU Work**

Our studies are focused on the development of procedures for the incorporation of rhenium oxides into manganese hydrides and subsequent transformation of the corresponding perrhenato complexes into ceramic or vitrified forms. We have prepared three manganese perrhenato complexes and characterized them by FT-IR, FT-NMR, single crystal x-ray diffraction techniques (see Fig. 1-3) to determine composition, structural and bonding arrangements and the nature of the rhenium incorporation. We would like to prepare six new perrhenato complexes, **1**, **2**, **4-6**, and **8**. We would like to transform the perrhenato complexes, **1-9** into ceramic and vitrified forms.

## **PNNL Work**

Efforts will be made to duplicate the MSU results employing technetium in place of rhenium in PNNL's "hot" furnace facilities. Radioactive and ceramic samples will be further analyzed for elemental composition using techniques already developed for analyzing such samples. The phase distribution in radioactive ceramic samples will also be determined using powder X-ray diffraction (XRD). The chemical durability of both radioactive and non-radioactive ceramics will be evaluated using product consistency tests at PNNL. These effects in turn can be correlated to the observed behavior (e.g., phase distribution, technetium and rhenium leachability, etc.) of the waste form. Further studies of the chemical and structural environment of technetium (and rhenium) during each stage of processing for a variety of ceramic compositions will be evaluated. Contradictions most likely can be related to the mode of formation of the waste form, but have yet to be fully studied.

The work proposed here may provide the means of incorporating technetium species into the final waste glass more homogeneously, in a preferred oxidation state, which may thus enhance the waste form durability with respect to technetium. Many waste glasses that are reportedly homogeneous and which meet sodium and boron leachability standards have actually been determined to exhibit phosphorous-, chromium-, or other minor component-induced heterogeneities at an extremely fine scale (nanometers) using techniques such as solid state nuclear magnetic resonance, Raman spectroscopy, and magnetization measurements.<sup>12,13</sup> The uncertainty in technetium leachability behavior that already exists in homogeneous glasses may thus be compounded in these finely separated analogs. Knowing how technetium partitions to the various phases within the glass would be useful in modifying the feed chemistry or the target glass composition to prevent segregation of the technetium to the non-durable phase. Once again, however, no thorough study of this sort has been undertaken.

## **OBJECTIVES**

The goal of this work is to develop chemical methods for reducing the technetium volatility problem and at the same time improving technetium immobilization by enhancing its incorporation into durable glass and ceramic forms.

Since there are no non-radioactive forms of technetium, much of the preliminary (screening and testing) work for this project will be focused on the use of non-radioactive surrogates that have strongly similar chemical properties to the technetium oxides. Recent studies have shown that oxo forms of rhenium (e.g., the heptoxide,  $\text{Re}_2\text{O}_7$ ) has similar chemical properties to the oxides of technetium, and thus should serve as an excellent surrogate for the study of the immobilization of technetium oxide forms. All successful preliminary studies involving the rhenium oxide will be duplicated and confirmed by using the radionuclide of interest,  $^{99}\text{Tc}$  itself.

In future, this project will be a collaboration combining the expertise of an inorganic chemist at the Morgan State University (MSU) and a materials scientist at the PNNL laboratory in Hanford, Washington. The work at MSU will be focused on preparing and structurally characterizing various precursor forms containing rhenium. The work at PNNL will be focused on duplicating any promising results obtained at MSU by using technetium. Once the precursor forms that suitably incorporate technetium have been identified, then efforts to prepare immobilized forms will be undertaken.

## **Research Tasks and Project Schedule**



### a) Precursor Forms

We believe that the most effective method for immobilizing oxide forms of technetium will be through the formation of "covalent" bonds to the support medium. Since borosilicate glass matrices appear to present the most effective and economical media for storage of immobilized radioactive wastes, we have decided to try to prepare new chemical forms of the technetium oxides that we shall refer to as *precursor forms* that can subsequently be transformed and/or incorporated into more homogeneous ceramic or vitrified forms with minimal volatilization that would be suitable for permanent storage.

This project will be conducted during 2012-14. We propose to involve one faculty member at MSU. Quarterly progress reports will be submitted to NRC. The specific tasks to be conducted include the following:

#### Tasks for Year 1 (September 28, 2012 – September 27, 2013)

- Synthesize and Characterize *mer, trans*-(CO)<sub>3</sub>{P(C<sub>6</sub>H<sub>11</sub>)<sub>3</sub>}<sub>2</sub>MnOReO<sub>3</sub> (1).
- Synthesize and Characterize *mer, trans*-(CO)<sub>3</sub>{P(OC<sub>6</sub>H<sub>11</sub>)<sub>3</sub>}<sub>2</sub>MnOReO<sub>3</sub> (2).
- Synthesize and Characterize *mer, trans*-(CO)<sub>3</sub>{P(C<sub>6</sub>H<sub>5</sub>)<sub>3</sub>}<sub>2</sub>MnOReO<sub>3</sub> (3).
- Synthesize and Characterize *mer, trans*-(CO)<sub>3</sub>{P(OC<sub>6</sub>H<sub>5</sub>)<sub>3</sub>}<sub>2</sub>MnOReO<sub>3</sub> (4).
- Synthesize and Characterize and *fac*-(CO)<sub>3</sub>{(C<sub>6</sub>H<sub>11</sub>)<sub>2</sub>P(CH<sub>2</sub>)<sub>3</sub>P(C<sub>6</sub>H<sub>11</sub>)<sub>2</sub>}<sub>2</sub>MnOReO<sub>3</sub> (5)
- Transform 1-5 into ceramic and vitrified forms.
- Analyze the ceramic and vitrified forms.
- Document the research findings (Technical reports summarizing the research results will be prepared and submitted for publication).

#### Tasks for Year 2 (September 28, 2013 – September 27, 2014)

- Synthesize and Characterize *fac*-(CO)<sub>3</sub>{(H<sub>11</sub>C<sub>6</sub>O)<sub>2</sub>P(CH<sub>2</sub>)<sub>3</sub>P(OC<sub>6</sub>H<sub>11</sub>)<sub>2</sub>}<sub>2</sub>MnOReO<sub>3</sub> (6)
- Synthesize and Characterize and *fac*-(CO)<sub>3</sub>{Ph<sub>2</sub>P(CH<sub>2</sub>)<sub>3</sub>PPh<sub>2</sub>}<sub>2</sub>MnOReO<sub>3</sub> (7)
- Synthesize and Characterize *fac*-(CO)<sub>3</sub>{(PhO)<sub>2</sub>P(CH<sub>2</sub>)<sub>3</sub>P(OPh)<sub>2</sub>}<sub>2</sub>MnOReO<sub>3</sub> (8)
- Synthesize and Characterize and *fac*-(CO)<sub>3</sub>{dppfe}MnOReO<sub>3</sub> (9)
- Transform 6-9 into ceramic and vitrified forms.
- Analyze the ceramic and vitrified forms.
- Document the research findings (Technical reports summarizing the research results will be prepared and submitted for publication).

### Backup Plan

We have demonstrated that Re<sub>2</sub>O<sub>7</sub> can be easily incorporated into manganese hydrides. Therefore, we do not anticipate any difficulty in incorporating Re<sub>2</sub>O<sub>7</sub> into new manganese hydride complexes, 1, 2, 4-6, and 8. We believe that the transformation of the precursor forms oxometallates (1-9) into ceramic and vitrified forms is a simple task. In case, we fail, we will convert molybdenum hydrides<sup>22</sup> into the corresponding perrhenato complexes. We will try to transform them into ceramic and vitrified forms.

### EXPECTED RESULTS AND IMPACT

The expected results from this project include:

**Technical Results:** We expect that we will be able to incorporate Re<sub>2</sub>O<sub>7</sub> into the nine manganese hydrides to yield the corresponding precursor forms or oxometallates.

We also expect that these oxometallates can be transformed into ceramic and vitrified forms. It is expected that the MSU results will be duplicated employing technetium in place of rhenium in PNNL's hot furnace facility enabling us to immobilize technetium nuclear wastes.

**Educational Results:** The proposed research will be of great benefit to the Department of Chemistry and the MSU by creating opportunities for HBCU students and the PI to engage in research in chemical sciences and nuclear waste disposal. The PI, who is an inorganic chemist, will gain experience in materials science. This will help him to pursue future research in materials and related sciences. The research project will strengthen departmental capability in chemical research and nuclear waste disposal by:

- increasing the number of faculty and students actively engaged in research.
- broadening the undergraduate experiences of chemistry majors by actively involving them in research to attract and retain in the Department's academically superior HBCU students,
- increasing the number of students who enter professions involved in research,
- improving the academic climate by developing students' skills in experimental design and interpretation of data, research techniques, use of state-of-the-art instrumentation, and writing and presenting professional papers,
- increasing the competitiveness of students applying to graduate schools,
- enhancing the visibility, professional standing, and mentoring skills of the PI through his involvement in research,
- increasing the number of graduates in chemistry,
- increasing the number of HBCU graduates entering graduate schools in the chemical sciences, and
- increasing the number of successful students with research doctorates embarking on careers in chemical and material sciences.

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

**Preface**

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

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

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

A-21 (now 2 CFR 220)  
A-87 (now 2 CFR 225)  
A-122 (now 2 CFR 230)  
A-102:

[http://www.whitehouse.gov/omb/circulars\\_index-ffm](http://www.whitehouse.gov/omb/circulars_index-ffm)

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

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

**I. Mandatory General Requirements**

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

**1. Applicability of 2 CFR Part 215**

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

of the project to comply with Subpart C of 2 CFR 215 and include this term in lower-tier (subaward) covered transactions.

b. Grantees must comply with monitoring procedures and audit requirements in accordance with OMB Circular A-133.

[http://www.whitehouse.gov/omb/circulars/a133\\_compliance/08/08toc.aspx](http://www.whitehouse.gov/omb/circulars/a133_compliance/08/08toc.aspx)

## **2. Award Package**

### **§ 215.41 Grantee responsibilities.**

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

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

### **Subgrants**

#### **Appendix A to Part 215—Contract Provisions**

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

### **Nondiscrimination**

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

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

Title VI of the Civil Rights Act of 1964 (42 USC §§ 2000d et seq)

Title IX of the Education Amendments of 1972 (20 USC §§ 1681 et seq)

Section 504 of the Rehabilitation Act of 1973, as amended (29 USC § 794)

The Age Discrimination Act of 1975, as amended (42 USC §§ 6101 et seq)

The Americans with Disabilities Act of 1990 (42 USC §§ 12101 et seq)

Parts II and III of EO 11246 as amended by EO 11375 and 12086.

EO 13166, "Improving Access to Services for Persons with Limited English Proficiency."

Any other applicable non-discrimination law(s).

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

#### **Modifications/Prior Approval**

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

#### **Lobbying Restrictions**

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

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

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

#### **§ 215.13 Debarment And Suspension.**

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

- (1) Are presently excluded or disqualified from covered transactions by any Federal department or agency;
- (2) Have been convicted within the preceding three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or

destruction of records, making false statements, tax evasion, receiving stolen property, making false claims, or obstruction of justice; commission of any other offense indicating a lack of business integrity or business honesty that seriously and directly affects your present responsibility;

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

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

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

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

'Debarment, Suspension, Ineligibility, and Voluntary Exclusion

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

#### **Drug-Free Workplace**

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

#### **Implementation of E.O. 13224 -- Executive Order On Terrorist Financing**

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

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

#### **Procurement Standards. § 215.40-48**

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

## **Travel**

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

### **Domestic Travel:**

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

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

### **International Travel:**

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

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

### **Property and Equipment Management Standards**

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

### **Procurement Standards**

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

### **Intangible and Intellectual Property**

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

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

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

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

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

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

**Organizational Prior Approval System**

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

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

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



## **Dispute Review Procedures**

- a. Any request for review of a notice of termination or other adverse decision should be addressed to the Grants Officer. It must be postmarked or transmitted electronically no later than 30 days after the postmarked date of such termination or adverse decision from the Grants Officer.
- b. The request for review must contain a full statement of the Grantee's position and the pertinent facts and reasons in support of such position.
- c. The Grants Officer will promptly acknowledge receipt of the request for review and shall forward it to the Director, Office of Administration, who shall appoint an intra-agency Appeal Board to review a grantee appeal of an agency action, if required, which will consist of the program office director, the Deputy Director of Office of Administration, and the Office of General Counsel.
- d. Pending resolution of the request for review, the NRC may withhold or defer payments under the award during the review proceedings.
- e. The review committee will request the Grants Officer who issued the notice of termination or adverse action to provide copies of all relevant background materials and documents. The committee may, at its discretion, invite representatives of the Grantee and the NRC program office to discuss pertinent issues and to submit such additional information as it deems appropriate. The chairman of the review committee will insure that all review activities or proceedings are adequately documented.
- f. Based on its review, the committee will prepare its recommendation to the Director, Office of Administration, who will advise the parties concerned of his/her decision.

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

## **Monitoring and Reporting § 215.50-53**

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

- Payment – 2 CFR 215.22
- Cost Share – 2 CFR 215.23
- Program Income – 2 CFR 215.24
  - Earned program income, if any, shall be added to funds committed to the project by the NRC and Grantee and used to further eligible project or program objectives or deducted from the total project cost allowable cost as directed by the Grants Officer or the terms and conditions of award.
- Budget Revision – 2 CFR 215.25
  - The Grantee is required to report deviations from the approved budget and program descriptions in accordance with 2 CFR 215.25, and request prior written approval from the Program Officer and the Grants Officer.

- The Grantee is not authorized to rebudget between direct costs and indirect costs without written approval of the Grants Officer.
- The Grantee is authorized to transfer funds among direct cost categories up to a cumulative 10 percent of the total approved budget. The Grantee is not allowed to transfer funds if the transfer would cause any Federal appropriation to be used for purposes other than those consistent with the original intent of the appropriation.
- Allowable Costs – 2 CFR 215.27

**b. Federal Financial Reports**

The Grantee shall submit a "Federal Financial Report" (SF-425) on a semi-annual basis for the periods ending March 31 and September 30, or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. A final SF-425 is due within 90 days after expiration of the award. The report should be submitted electronically to: Grants\_FFR@NRC.GOV.  
**(NOTE: There is an underscore between Grants and FFR).**

**Period of Availability of Funds 2 CFR § 215.28**

- a. Where a funding period is specified, a Grantee may charge to the grant only allowable costs resulting from obligations incurred during the funding period and any pre-award costs authorized by the NRC.
- b. Unless otherwise authorized in 2 CFR 215.25(e)(2) or a special award condition, any extension of the award period can only be authorized by the Grants Officer in writing. Verbal or written assurances of funding from other than the Grants Officer shall not constitute authority to obligate funds for programmatic activities beyond the expiration date.
- c. The NRC has no obligation to provide any additional prospective or incremental funding. Any modification of the award to increase funding and to extend the period of performance is at the sole discretion of the NRC.
- d. Requests for extensions to the period of performance should be sent to the Grants Officer at least 30 days prior to the grant/cooperative agreement expiration date. Any request for extension after the expiration date may not be honored.

**Automated Standard Application For Payments (ASAP) Procedures**

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

### **Audit Requirements**

Organization-wide or program-specific audits shall be performed in accordance with the Single Audit Act Amendments of 1996, as implemented by OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

<http://www.whitehouse.gov/omb/circulars/a133/a133.html> Grantees are subject to the provisions of OMB Circular A-133 if they expend \$500,000 or more in a year in Federal awards.

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

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

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

### **III. Programmatic Requirements**

#### **Performance (Technical) Reports**

a. The Grantee shall submit performance (technical) reports electronically to the NRC Project Officer and Grants Officer on a semi-annual basis unless otherwise authorized by the Grants Officer. Performance reports should be sent to the Program Officer at the email address indicated in Block 12 of the Notice of Award, and to Grants Officer at:

Grants\_PPR.Resource@NRC.GOV. (***NOTE: There is an underscore between Grants and PPR.***)

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

c. The Office of Small Business & Civil Rights (SBCR) requires the submission of the semi-annual progress report on the SF-PPR, SF-PPR-B, and the SF-PPR-E forms. The submission for the six month period ending March 31<sup>st</sup> is due by April 30<sup>th</sup>, or any portion thereof. The submission for the six month period ending September 30<sup>th</sup> is due by October 31<sup>st</sup> or any portion thereof.

#### **Unsatisfactory Performance**

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

Failure to comply with any or all of the provisions of the award may have a negative impact on future funding by NRC and may be considered grounds for any or all of the following actions:

establishment of an accounts receivable, withholding of payments under any NRC award, changing the method of payment from advance to reimbursement only, or the imposition of other special award conditions, suspension of any NRC active awards, and termination of any NRC award.

#### **Other Federal Awards With Similar Programmatic Activities**

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

#### **Prohibition Against Assignment By The Grantee**

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

#### **Site Visits**

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

### **IV. Miscellaneous Requirements**

#### **Criminal and Prohibited Activities**

- a. The Program Fraud Civil Remedies Act (31 USC §§ 3801-3812), provides for the imposition of civil penalties against persons who make false, fictitious, or fraudulent claims to the Federal government for money (including money representing grant/cooperative agreements, loans, or other benefits.)
- b. False statements (18 USC § 287), provides that whoever makes or presents any false, fictitious, or fraudulent statements, representations, or claims against the United States shall be subject to imprisonment of not more than five years and shall be subject to a fine in the amount provided by 18 USC § 287.
- c. False Claims Act (31 USC 3729 et seq), provides that suits under this Act can be brought by the government, or a person on behalf of the government, for false claims under federal assistance programs.
- d. Copeland "Anti-Kickback" Act (18 USC § 874), prohibits a person or organization engaged in a federally supported project from enticing an employee working on the project from giving up a part of his compensation under an employment contract.

#### **American-Made Equipment And Products**

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

#### **Increasing Seat Belt Use in the United States**

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

#### **Federal Leadership of Reducing Text Messaging While Driving**

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

#### **Federal Employee Expenses**

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

#### **Minority Serving Institutions (MSIs) Initiative**

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

#### **Research Misconduct**

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

#### **Publications, Videos, and Acknowledgment of Sponsorship**

Publication of the results or findings of a research project in appropriate professional journals and production of video or other media is encouraged as an important method of recording and reporting scientific information. It is also a constructive means to expand access to federally funded research. The Grantee is required to submit a copy to the NRC and when releasing

information related to a funded project include a statement that the project or effort undertaken was or is sponsored by the NRC. The Grantee is also responsible for assuring that every publication of material (including Internet sites and videos) based on or developed under an award, except scientific articles or papers appearing in scientific, technical or professional journals, contains the following disclaimer:

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

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

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

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

### **Executive Compensation Reporting**

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

Reporting Subawards and Executive Compensation.

#### *a. Reporting of first-tier subawards.*

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

#### *2. Where and when to report.*

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

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

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

b. *Reporting Total Compensation of Recipient Executives.*

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

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

ii. in the preceding fiscal year, you received—

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

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

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

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

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

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

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

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

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

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

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

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

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

i. To the recipient.

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

d. *Exemptions*

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

i. Subawards,

and

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

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

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

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

ii. A foreign public entity;

iii. A domestic or foreign nonprofit organization;

iv. A domestic or foreign for-profit organization;

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

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



3. *Subaward*:

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

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

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

4. *Subrecipient* means an entity that:

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

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

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

i. *Salary and bonus*.

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

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

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

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

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