

<b>INTERAGENCY AGREEMENT</b>		1. IAA NO. NRC-HQ-60-11-I-0003/M0006		PAGE OF 1 2	
2. ORDER NO.		3. REQUISITION NO. RES-15-0394		4. SOLICITATION NO.	
5. EFFECTIVE DATE 07/30/2015		6. AWARD DATE 07/30/2015		7. PERIOD OF PERFORMANCE 09/01/2011 TO 11/30/2015	
8. SERVICING AGENCY NAVAL SURFACE WARFARE CENTER NSWC ALC: DUNS: +4: INDIAN HEAD EXPLOSIVE ORDINANCE DIS TECHNOLOGY DIVISION 1767 STRAUSS AVE STE 201 INDIAN HEAD MD 20640-5150  POC Pam Speake TELEPHONE NO: 301-744-6771			9. DELIVER TO HERNANDO CANDRA US NUCLEAR REGULATORY COMMISSION OFFICE OF NUCLEAR REGULATORY RESEARCH 11555 ROCKVILLE PIKE ROCKVILLE MD 20852		
10. REQUESTING AGENCY ACQUISITION MANAGEMENT DIVISION ALC: 31000001 DUNS: 040535809 +4: US NUCLEAR REGULATORY COMMISSION ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE ROCKVILLE MD 20852-2738  POC Sandra Nesmith TELEPHONE NO. 301-415-6836			11. INVOICE OFFICE US NUCLEAR REGULATORY COMMISSION ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE MAILSTOP 03-E17A NRCIPACRESOURCE.NRC.GOV ROCKVILLE MD 20852-2738		
12. ISSUING OFFICE US NRC - HQ ACQUISITION MANAGEMENT DIVISION MAIL STOP TWEN-5E03 WASHINGTON DC 20555-0001			13. LEGISLATIVE AUTHORITY Energy Reorganization Act of 1974		
			14. PROJECT ID V6241		
			15. PROJECT TITLE SNFP VULNERABILITIES TO THREATS		
16. ACCOUNTING DATA 2015-X0200-FEEBASED-60-600001-11-2-130-1021-253A					
17. ITEM NO.	18. SUPPLIES/SERVICES	19. QUANTITY	20. UNIT	21. UNIT PRICE	22. AMOUNT
	NRC-HQ-60-11-I-0003  TITLE: SNFP Vulnerabilities to Threats Master IAA: N/A SUMMARY OF CHANGES:  The purpose of this modification is to (1) add additional within scope tasks (subtasks 3.8 and 3.9); (2) incorporate the Supplemental Statement of Work modifications; (3) increase the authorized cost ceiling by \$100,000.00 from \$501,000.00 to \$601,000.00; and (4) provide Continued....				
23. PAYMENT PROVISIONS			24. TOTAL AMOUNT \$50,000.00		
25a. NAME AND TITLE HIGGINS, ROY DAVID 936		25b. DATE 08/05/2015		26a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING) <i>Roy Higgins</i>	
25c. NAME AND TITLE Roy Higgins, Financial Management Analyst		25d. DATE 08/05/2015		26b. SIGNATURE OF CONTRACTING OFFICER <i>Jeffrey R. Mitchell</i>	
				26c. DATE 7/30/2015	

incremental funding in the amount of \$50,000.00.

Accordingly the agreement is modified as follows:

The modified Statement of Work (Addendum No. 3)  
is hereby incorporated into this Agreement.

The new authorized cost ceiling is \$601,000.00

This modification provides incremental funding in  
the amount of \$50,000.00, thereby increasing the  
total obligations for this Agreement from  
\$501,000.000 to \$551,000.00.

All other terms and conditions remain unchanged.

Attachment: Supplemental Statement of Work,  
Addendum No. 3

NSWC PI: Reid McKeown

NRC COR: Hernando Candra

DUNS: 040535809

TAS: 31X0200.320

ALC: 31000001

**STATEMENT OF WORK**  
Job code No. V6241  
Contract: NRC-HQ-60-11-I-0003  
Addendum No. 003

**TITLE:** Spent Nuclear Fuel Pool (SNFP) Vulnerabilities to Postulated Security Threats

**SUMMARY OF MODIFICATIONS:**

- Add Subtasks 3.8 and 3.9
- Execute plan for completion

**MODIFICATION TO STATEMENT OF WORK**

The purpose of this modification is add two new subtasks to Task 3 and to execute specific plans for the completion of the research and delivery of research products.

Due to the nature of the work undertaken in this agreement, there is no planned travel anticipated during the execution of this effort.

**SubTask 3.8 Energy Deposition into Fuel Material and Determination of Respirable Mass**

The determination of respirable fuel mass from the underwater (UNDEX) explosion is a very challenging analysis since there is not any software currently available to address this issue. However, there are several approximate indirect approaches to solve this problem that can be used in connection with the numerical modeling done with DYSMAS. The approach developed by Sandia National Laboratory for spent fuel vulnerability studies which uses energy deposition will be adopted in this study for respirable mass conversion.

DYSMAS code was used for UNDEX calculations of high explosive (HE) detonations on top of SFNP fuel racks to determine the amount of energy deposited into the fuel material. The results will be post processed and plotted in iso-contours of energy levels that decrease with range from the HE charge. Sandia's approach will then be used to convert this energy deposition to evaluate how much fuel mass gets broken down into respirable particles. The DYSMAS results will also be processed to determine how much of the fuel material is ejected from the SNFP pool during the explosion and subsequent explosion bubble pulsations.

Tracking the ejected fuel materials would require some additional new programming to be incorporated in the existing DYSMAS code similar to the "reactive burn" routines used in hydrocodes.

This subtask includes the following efforts:

- Determine the amount of energy deposited into the fuel material.
- Plot of iso-contours of energy deposition levels in the pool.

- Evaluate how much fuel mass gets broken down into respirable particles based on these energy levels.
- Determine how much fuel mass is ejected from the SNFP pool during the explosion.
- Evaluate respirable particle mass that gets scrubbed by water during explosion.

**SubTask 3.9 DYSMAS Coupled Calculations of SNFP Structure Response to UNDEX**

In reference to SubTask 3.8 above a representative BWR SNFP was selected for this study. Under this task, the Indian Head staff will use DYSMAS code to perform fluid structure coupled analysis to evaluate the structural response subjected to UNDEX for 50 and 150 lbs. charges centered in the pool at the top of the fuel rack. The analysis will be performed for both 1) a pool with water without fuel rack assembly and 2) a pool with water and homogeneous fuel rack material in the pool. The results of these analyses will be included in the general Task 3 (Parametric Modeling and Analysis) as defined in the previous SOW.

This subtask includes the following level of efforts:

- Performed DYMAS coupled fluid-structure analysis subjected to two charges of under water explosion.
- Evaluate the results that can be included in the general Task 3 specified in the previous SOW.

**DELIVERABLES/SCHEDULES (UNCHANGED)**

<b>Tasks</b>	<b>Current Statement of Work</b>
Task 1: Review of SNFP configuration Kickoff meeting Develop calculation matrix	11/1/2011 (No change)
Task 2: Develop SNFP-like sample calc. Install Dysmas at NRC  Dysmas training	11/1/2011 (sample calc.) 9/1/2013, partially installed on 3/25/2013  12/1/2013 (Training)
Task 3: Parametric Analysis	9/30/2015
Task 4: Briefing and Report	11/30/2015