INTERAGENCY AGREEMENT

1. IAA NO.	PAGE	OF
31310019F0017	1	15

2. ORDER NO.	3. REQUISITION NO.	4. SOLICITATION NO.
	RES-19-0215	

5. EFFECTIVE DATE	6. AWARD DATE	7. PERIOD OF PERFORMANCE
08/01/2019	06/12/2019	08/01/2019 TO 09/30/2023

8. SERVICING AGENCY
PACIFIC NORTHWEST NAT LAB
ALC:
DUNS: 000000000 +4:
US DEPARTMENT OF ENERGY
PACIFIC NORTHWEST SITE OFFICE
PO BOX 350 MS K9-42
RICHLAND WA 99352

POC [redacted]
TELEPHONE NO. [redacted]

9. DELIVER TO
MARGARET AUDRAIN
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 O3-E17A
ROCKVILLE MD 20852-2738

12. ISSUING OFFICE
US NRC - HQ
ACQUISITION MANAGEMENT DIVISION
MAIL STOP TWFN-07B20M
WASHINGTON DC 20555-0001

13. LEGISLATIVE AUTHORITY
Energy Reorganization Act of 1974

14. PROJECT ID

15. PROJECT TITLE
CHLORIDE-INDUCED STRESS CORROSION CRACK GROWTH RAT

16. ACCOUNTING DATA
2019-X0200-FEEBASED-60-60D001-60B102-1032-33-6-199-253D-33-6-199-1032

17. ITEM NO.	18. SUPPLIES/SERVICES	19. QUANTITY	20. UNIT	21. UNIT PRICE	22. AMOUNT
	OE Contractor Account Number DE-AC05-76RL01830 Agreement No. 31310019N0001 Task Order No. 31310019F0017 Title: Chloride-Induced Stress Corrosion Crack Growth Rates in Realistic Canister Environments The NRC and Pacific Northwest National Laboratory (PNNL) hereby enter into this Agreement for the project entitled "Chloride-Induced Stress Corrosion Crack Growth Rates in Realistic Continued ...				

23. PAYMENT PROVISIONS	24. TOTAL AMOUNT
	$100,000.00

25a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (SERVICING)		26a. SIGNATURE OF GOVERNMENT REPRESENTATIVE (REQUESTING)	
		Sandra R. Nesmith	
25b. NAME AND TITLE	**25c. DATE**	**26b. CONTRACTING OFFICER**	**26c. DATE**
		SANDRA R. NESMITH	07/18/2019

Canister Environments."

Period of Performance: August 1, 2019 - September 30, 2023

Consideration and Obligations:

(a) Authorized Ceiling $370,487.00

(b) The amount presently obligated with respect to this DOE Agreement is $100,000.00. When and if the amount(s) paid and payable to the DOE Laboratory hereunder shall equal the obligated amount, the DOE Laboratory shall not be obligated to continue performance of the work unless and until the NRC Contracting Officer shall increase the amount obligated with respect to this DOE Agreement. Any work undertaken by the DOE Laboratory in excess of the obligated amount specified above is done so at the DOE Laboratory's sole risk.

The following document is hereby made a part of this Agreement:

Attachment No. 1: Statement of Work (with PNNL Response)

[X] Non-fee Recoverable Work

CAC: KF0042/R-2016-STO-0001 "NB-SFST-STORAGE (DRY CASK, TRANSPORTATION)-336199-NO

[redacted]

NRC COR: Margaret Audrain, margaret.audrain@nrc.gov, 301-415-2133

DUNS: 040535809 TAS: 31X0200.320
ALC: 31000001

This agreement is entered into pursuant to the authority of the Energy Reorganization Act of

Continued ...

1974, as amended (42 U.S.C 5801 et seq.). This work will be performed in accordance with the NRC/DOE Memorandum of Understanding dated November 24, 1998. To the best of our knowledge, the work requested will not place the DOE and its contractor in direct competition with the domestic private sector.
Master IAA: 31310019N0001

STATEMENT OF WORK (SOW)

NRC Agreement Number	NRC Agreement Modification Number	NRC Task Order Number (If Applicable)	NRC Task Order Modification Number (If Applicable)
31310019N0001		31310010F0017	

Project Title
Chloride-Induced Stress Corrosion Crack Growth Rates in Realistic Canister Environments

Job Code Number	B&R Number	DOE Laboratory
	33-6-199-1032	Pacific Northwest National Laboratory (PNNL)

NRC Requisitioning Office	Period of Performance
RES	08/01/2019 – 09/30/2023

NRC Form 187, Contract Security and Classification Requirements	
☐ Applicable ☒ Not Applicable	☐ Involves Proprietary Information ☐ Involves Sensitive Unclassified
☒ Non Fee-Recoverable	☐Fee-Recoverable (If checked, complete all applicable sections below)
Docket Number (If Fee-Recoverable/Applicable) N/A	**Inspection Report Number (If Fee Recoverable/Applicable)** N/A

CAC
KF0042/R-2016-STO-0001 “NB-SFST-STORAGE (DRY CASK, TRANSPORTATION)-336199-NO.

CONTRACTING OFFICER'S REPRESENTATIVE

Contracting Officer's Representative
Name: Margaret T Audrain
Agency: U.S. Nuclear Regulatory Commission
Office: NRC
Mail Stop: T10-A36
Washington, DC 20555-0001
E-Mail: Margaret.audrain@nrc.gov
Phone: 301-415-2133

Alternate Contracting Officer's Representative
Name: Matthew A Hiser
Agency: U.S. Nuclear Regulatory Commission
Office: NRC
Mail Stop: T10-A36
Washington, DC 20555-0001
E-Mail: Matthew.Hiser@nrc.gov
Phone: 301-415-2454

STATEMENT OF WORK (SOW)

(Interagency Agreements)

Contents

DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

1.0 BACKGROUND

The U.S. Nuclear Regulatory Commission (NRC) licenses dry storage of spent nuclear fuel under the provisions of Title 10 of the Code of Federal Regulations (10 CFR), Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste." According to 10 CFR 72.42, the initial licensing term may be up to 40 years, after which the license may be renewed for periods up to 40 years. The requirements for license renewal include time-limited aging analyses (TLAAs) to demonstrate that structures, systems, and components (SSCs) important to safety (ITS) will continue to perform their intended function during the period of extended operation and a description of aging management programs (AMPs) for issues that could affect the ITS SSCs.

During the mid-2000s, the NRC started looking at the potential for chloride induced stress corrosion cracking (CISCC) of welded stainless-steel canisters. The NRC's interest in CISCC was driven in part by the results of testing conducted in Japan by CRIEPI (Kosaki 2008; Hayashibara et al., 2008; Mayuzumia et al., 2008; Shirai et al., 2011; Tani et al., 2009). Both the NRC (Caseres and Mintz, 2010; He at al., 2014) and the Electrical Power Research Institute (EPRI) (Gordon et al., 2005; 2006) published reports summarizing operating experience reviews, testing results, and analyses.

The initial work conducted by CRIEPI, EPRI and the NRC led to many public meetings between the NRC and industry representatives, including dry storage system (DSS) vendors and users and the Nuclear Energy Institute (NEI). The NRC identified the potential for CISCC as a significant issue (ML12319A440 NRC, 2012) and a NRC/NEI Regulatory Issues Resolution Protocol (RIRP) (ML16208A202 NRC, 2016) was issued to address the technical information needs in light of storage renewals. In addition, EPRI formed the Extended Storage Collaboration Program to address CISCC and other DSS aging management issues. EPRI published reports on assessing CISCC susceptibility, evaluating CISCC growth, development of inspection systems for DSS and aging management guidance (Fuhr et al., 2013, 2014, 2015, 2017, Gorman et al., 2014).

As a result of these efforts, the NRC developed and issued revised standard review plan for storage system renewals that included example aging management programs (ML16179A148 NRC, 2016). In late 2017, NRC staff released for public comment draft regulatory guidance for DSS license renewal, NUREG-2214 titled, *Managing Aging Process in Storage (MAPS),*

(ML17289A237). NUREG-2214 addresses credible aging degradation mechanisms and appropriate aging management activities for DSS license renewal. One of the potential degradation mechanisms identified in NUREG-2214 that could challenge the confinement safety function in dry storage is CISCC of austenitic stainless-steel canisters. A final version of NUREG-2214 addressing public comments is expected to be published by NRC in 2019.

In addition to NRC regulatory guidance, The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code is developing Code Case N-860, "Examination Requirements and Acceptance Standards for Spent Nuclear Fuel Storage and Transportation Containment Systems," which is currently in draft form. This Code Case provides guidance for CISCC aging management, including inspection scope, method and frequency as well as flaw assessment and evaluation (should any be found by inspection). The expected CISCC crack growth rate (CGR) plays a significant role in both the inspection frequency and flaw assessment portions of the Code Case, which includes a very basic crack growth rate model to be used for flaw analyses.

In addition to the ASME Code activities, other recent developments include evaluations of surface deposits harvested from actual spent fuel storage canisters that have shown that the chemistry on the surface of the canister may be less aggressive than previously expected (Bryan and Enos, 2014; Bryan and Schindelholz, 2017). These analyses show the presence of nitrate and sulfate containing salts, sodium chloride (NaCl) in a partially decomposed state deficient in chloride, and a lack of magnesium chloride (MgCl). These observations of actual deposits may be significant for both the conditions under which deliquescence can occur as well as the brine chemistry that forms when the deposited salts deliquesce. The apparent absence of MgCl in observed deposits would both tend to reduce the likelihood of CISCC and CGR because the deliquescence of chloride salts such as NaCl require higher humidity that could only occur at lower temperatures. Chloride depletion and the presence of appreciable amounts of inhibiting anions such as nitrate and sulfate (Leckie and Uhlig 1966; Sedriks 1996; Szklarska-Smialowska 2005; Cook et al., 2017) may be sufficient to inhibit the initiation of localized corrosion after temperatures of the dry storage system cool and deliquescence of the deposited salts occurs at elevated relative humidity values.

In light of these recent observations of actual canister deposits and the development of an ASME code case, the need for data on CISCC CGR of austenitic stainless steels in realistic conditions is very clear. There is currently quite limited data on CISCC crack growth and significant questions remain, particularly related to environmental effects, including temperature, salt composition, and humidity, on the CGR in realistic canister conditions.

2.0 OBJECTIVE

The objectives of this project are: (1) to validate an effective CGR testing system for the CISCC CGR of austenitic stainless steels and (2) generate data on CISCC CGR of stainless steels in realistic canister conditions, including the effects of key environmental conditions such as temperature, salt composition and relative humidity. The results of this research will be used to inform regulatory decisions regarding aging management for CISCC, including potentially susceptibility assessments and inspection frequencies.

3.0 SCOPE OF WORK/TASKS

PNNL shall provide all resources necessary to accomplish the tasks and deliverables described in this statement of work (SOW).

PNNL shall perform the pre-test and post-test characterization of test materials which is required to understand the cracking phenomenology. This includes microscopy, mechanical testing, chemical analyses, and other appropriate analytical techniques.

PNNL shall document the progress of the project in Monthly Letter Status Reports and support monthly status update teleconferences with the NRC COR.

PNNL shall prepare the deliverables described in Section 4.0 of this SOW. PNNL is responsible for conformance to NRC standards for the publication of NUREG/CR reports, including technical editing and preparing the final “camera-ready” copy for publication.

PNNL staff shall travel to and participate in meetings, workshops, and conferences where NRC COR determines that there is a programmatic need to disseminate the results of research findings and engage with the technical community.

The specific tasks for the scope of work are described in this section. The time at which the tasks begin and end will be dependent on variances in test duration and NRC’s ongoing evaluation of testing priorities.

Task 1 – Proof Tests in Immersed Conditions for CISCC Crack Growth

The objective of this task is to validate the performance of the CISCC crack growth test systems through initial proof tests in immersed conditions in order to be prepared to begin tests in humid air conditions without immersion.

The tests in Task 1 will confirm the consistent performance of the test system and inform the appropriate test design for subsequent tests in more realistic conditions. Goals of these initial proof tests include but are not limited to: direct current potential drop (DCPD) calibration of the 4-point bend specimen, the effect of a notched vs. smooth specimen surface, and the basic response of stainless steel in aqueous chloride environments as a function of temperature.

Completion of this task will be determined by NRC COR before the testing in Task 2 of this Task Order is started.

Deliverable: A technical letter report (TLR) documenting the validation of the CISCC crack growth test systems and the initial results from tests in immersed conditions.

Task 2 – CISCC Crack Growth Testing in Humid Air Environments

The objective of this task is to perform CISCC crack growth tests in humid air environments representative of realistic canister conditions. Tests will seek to generate data on CISCC CGR of stainless steels in realistic canister conditions, including the effects of key environmental conditions such as temperature, salt composition and relative humidity. Important testing parameters to be controlled include temperature, humidity, salt loading, salt composition, and applied stress intensity.

To support the number of specimens desired for testing, the NRC COR may authorize PNNL to transfer equipment previously used for PWSCC testing under contract NRC-HQ-25-14-D-0001, Task Order NRC-HQ-60-15-T-0008 to be repurposed for CISCC testing under this task order.

The activities required for this task are:

Task 2.1: CISCC Testing

> CISCC crack growth testing will be informed by the proof testing in Task 1 and the test plan developed under Task 4 of NRC-HQ-60-17-D-0006. The focus and order of testing will be defined in a test matrix prior to the start of testing, which must be approved by the NRC COR and may be updated and adjusted as test results become available. PNNL shall perform CISCC crack growth testing on austenitic stainless-steel samples using the available test systems as described in the NRC-approved test matrix.

Task 2.2: Material Characterization

PNNL shall perform post-test examinations which may include microscopy, mechanical testing, chemical analyses and other appropriate analytical techniques. The

characterization techniques will be reviewed and approved by the NRC COR prior to their use.

Deliverable: A NUREG/CR report documenting the results of CISCC CGR testing in realistic canister environments.

Task 3 – Participate in EPRI ESCP Meetings

As needed, one staff member from PNNL shall attend meetings of the EPRI Extended Storage Collaboration Program (ESCP) to present results and progress to the technical community, including EPRI, academia and other researchers. All travel must be approved by the NRC COR prior to the trip.

4.0 LIST OF DELIVERABLES

As indicated in the table below, PNNL will prepare one TLR and one NUREG/CR report during the period of performance for this task order, summarizing the details of the test methods, results and analyses of the data generated in each task. A draft of the TLR shall be delivered to NRC within 12 months of the commencement of the task order, with 30 days to incorporate NRC comments and finalize the TLR. A draft of the NUREG/CR report shall be delivered to NRC within 42 months of the commencement of the task order, with 30 days to incorporate NRC comments and begin the NUREG publication process.

Task Number	Deliverable Description	Due Date
1	Draft TLR on results from Task 1	NLT 16 months from the commencement of this task order.
1	Final TLR on results from Task 1	30 working days after receipt of NRC comments on the Draft TLR

Task Number	Deliverable Description	Due Date
2	Draft NUREG/CR on results from Task 2	NLT 42 months from the commencement of this task order.
2	Final NUREG/CR on results from Task 2	30 working days after receipt of NRC comments on the Draft NUREG/CR
All	Per SOW Section 8.1, Monthly Letter Status Reports (MLSRs)	NLT than 20th of the following month

5.0 ESTIMATED LABOR CATEGORIES, KEY PERSONNEL AND LEVELS OF EFFORT

The table below estimates the labor categories and levels of effort for each fiscal year covered by this task order. The table entries indicate the total number of hours anticipated for the work scope.

Key Personnel

PNNL proposes the following individuals for this task order:

6.0 CERTIFICATION AND LICENSE REQUIREMENTS

N/A

7.0 MEETINGS AND TRAVEL

The travel anticipated for this task order is listed in the table below for planning purposes only. All travel is subject to the availability of funds and requires written Government approval from the Contracting Officer (CO), unless otherwise delegated to the COR.

Task Order Anticipated Travel			
Location	**Purpose**	**Travelers**	**Dates**
Charlotte, NC	EPRI Extended Storage Collaboration Program (ESCP) Meeting	1	November 2019
Charlotte, NC	EPRI Extended Storage Collaboration Program (ESCP) Meeting	1	November 2020
Charlotte, NC	EPRI Extended Storage Collaboration Program (ESCP) Meeting	1	November 2021
Charlotte, NC	EPRI Extended Storage Collaboration Program (ESCP) Meeting	1	November 2022

All travel requires written Government approval from the CO, unless otherwise delegated to the COR.

8.0 REPORTING REQUIREMENTS

PNNL is responsible for structuring the deliverables to current agency standards. PNNL must submit deliverables free of spelling and grammatical errors and shall conform to requirements stated in this section.

8.1 Monthly Letter Status Report (MLSR)

PNNL must provide a Monthly Letter Status Report which consists of a technical progress report and financial status report. This report will be used by the sponsoring agency to assess the adequacy of the resources utilized by the servicing agency to accomplish the work contained in this SOW and to provide status of the servicing agency progress in achieving tasks and producing deliverables. The report shall include agreement/order summary information, work completed during the specified period, milestone schedule information, problem identification and resolution, travel plans, and staff hour summary. Copies must be sent to the COR and AMD at ContractsPOT.Resource@nrc.gov.

8.2 Technical Letter Reports and NUREG/CR Reports

PNNL must prepare NUREG/CR reports in accordance with the standards provided by the NRC.

9.0 REQUIRED MATERIALS, FACILITIES, HARDWARE/SOFTWARE

N/A

10.0 APPLICABLE PUBLICATIONS (CURRENT EDITIONS)

N/A

11.0 DATA RIGHTS

The NRC shall have unlimited rights to and ownership of all deliverables provided under this agreement/order, including reports, recommendations, briefings, work plans and all other deliverables. All documents and materials, to include the source codes of any software, produced under this agreement/order are the property of the NRC with all rights and privileges of ownership/copyright belonging exclusively to the NRC. These documents and materials may not be used or sold by the servicing agency without prior written authorization from the CO. All materials supplied to the NRC shall be the sole property of the NRC and may not be used for any other purpose. This right does not abrogate any other Government rights.

12.0 PROPERTY TO BE AQUIRED BY DOE LABORATORY

The DOE Laboratory has purchased equipment for systems under previous Agreements with the NRC for use in laboratory studies similar to that described in this task order. Under this task order, these systems will be used for the current program. To ensure accuracy, the components of the systems must be serviced for quality assurance in data acquisition. Similarly, some of the expendable equipment items/parts such as seals, gaskets, flanges, busing and filaments etc. are required for proper usage of the existing equipment; of which some of the items are consumables and are for one time use only. The DOE Laboratory is not authorized to expend funds for general maintenance costs under this task order. The NRC Property Clauses delineated under the Agreement are hereby applicable to this task order for the disposition of any equipment/property.