AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 13

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
P00003	See Block 16C	NMSS-20-0016	

6. ISSUED BY CODE NRCHQ

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

7. ADMINISTERED BY *(If other than Item 6)* CODE

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*

SOUTHWEST RESEARCH INSTITUTE
ATTN PAUL MALDONADO
6220 CULEBRA RD
SAN ANTONIO TX 782385166

CODE 007936842 FACILITY CODE

(x) 9A. AMENDMENT OF SOLICITATION NO.

9B. DATED *(SEE ITEM 11)*

x 10A. MODIFICATION OF CONTRACT/ORDER NO.
31310018D0001
31310019F0034

10B. DATED *(SEE ITEM 13)*
06/10/2019

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended , by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted ; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted , such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*
2020-X0200-FEEBASED-50-50D007-1061-33-7-184-255B-33-7-184-1061 Net Increase: $50,000.00

13. THIS ITEM ONLY APPLIES TO MODIFICATION OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

CHECK ONE	
	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
X	D. OTHER *(Specify type of modification and authority)* Mutual Agreement of the Parties; FAR 43.103(a) Bilateral Modification & FAR 52.232-22 Limitation of Funds

E. IMPORTANT: Contractor ☐ is not. ☒ is required to sign this document and return 1 copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

PLEASE SEE PAGE 2 FOR MODIFICATION DESCRIPTION TO 1) INCREASE THE TASK ORDER CEILING; 2) PROVIDE INCREMENTAL FUNDING; 3) REVISE THE COST AND PRICE SCHEDULE; AND 4) REVISE THE STATEMENT OF WORK.

Task Order Base and All Options: $1,035,321.00 (Changed)
Task Order Exercised Amount: [redacted] (Changed)
Task Order Obligated Amount: [redacted] (Changed)
Period of Performance: 06/10/2019 to 06/09/2020

Except as provided herein, all terms and conditions of the document referenced in Item 9 A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)* JENNIFER A. DUDEK TEL: 301-415-2257 EMAIL: Jennifer.Dudek@nrc.gov	
15B. CONTRACTOR/OFFEROR *(Signature of person authorized to sign)*	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA [redacted] *(Signature of Contracting Officer)*	16C. DATE SIGNED 03/25/2020

The purpose of this task order modification is to: 1) increase the task order ceiling by [redacted] from [redacted] to [redacted]; 2) provide incremental funding in the amount of [redacted], thereby increasing the obligated amount from [redacted] to [redacted]; 3) revise the cost and price schedule and; 4) revise the Statement of Work to include the additional level-of-effort required. Accordingly, the task order is hereby modified:

1) **Section B.2 CONSIDERATION AND OBLIGATION— TASK ORDERS (AUG 2011)** is deleted in its entirety and replaced with the following:

"(a) The total ceiling of this contract for the products/services under this contract is [redacted]. The amount will increase upon exercise of Option Periods and/or Optional Tasks as shown in Section B.3.

(b) This order is subject to the minimum and maximum ordering requirements set forth in the contract.

(c) The amount presently obligated with respect to this order is [redacted] of which [redacted]. The obligated amount shall, at no time, exceed the order ceiling as specified in paragraph (a) above. When and if the amount(s) paid and payable to the Contractor hereunder shall equal the obligated amount, the Contractor shall not be obligated to continue performance of the work unless and until the Contracting Officer shall increase the amount obligated with respect to this order, in accordance with FAR Part 43 - Modifications. Any work undertaken by the Contractor in excess of the obligated amount specified above is done so at the Contractor's sole risk and may not be reimbursed by the Government.

(d) The Contractor shall comply with the provisions of FAR 52.232-22 - Limitation of Funds, for incrementally-funded delivery orders or task orders.

(e) In accordance with FAR 52.216-8 - Fixed Fee, it is the policy of the NRC to withhold payment of fee after payment of 85 percent of the fee has been paid in order to protect the Government's interest. The amount of fixed-fee withheld from the contractor will not exceed 15 percent of the total fee or $100,000, whichever is less. Accordingly, the maximum amount of fixed-fee that may be held in reserve is [redacted].

(End Clause)"

2) **B.3 PRICE/COST SCHEDULE** is deleted in its entirety and replaced with the following:

CLIN	Description	Est Cost	Fixed Fee	Total Cost Plus Fixed Fee
0001	[redacted]	[redacted]	[redacted]	[redacted]
0002	[redacted]	[redacted]	[redacted]	[redacted]
10001	[redacted]	[redacted]	[redacted]	[redacted]
20001	[redacted]	[redacted]	[redacted]	[redacted]
30001	[redacted]	[redacted]	[redacted]	[redacted]
Total		[redacted]	[redacted]	**$1,035,321**

Total Estimated Cost and Fixed-Fee breakdown by cost element per base and option task is presented below.

DESCRIPTION	Estimated Amount Base Period	Estimated Amount Option Period 1	Estimated Amount Option Period 2	Estimated Amount Option Period 3	Total Estimated Costs Inclusive of Option Periods
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	**$1,035,321**

3) **SECTION C-Descriptions/Specifications/Statement of Work** is deleted in its entirety and replaced with Attachment 1.

All other terms and conditions of this task order remain unchanged.

PROJECT TITLE: INTERNATIONAL PROGRAMS AND ACTIVITIES RELATED TO GEOLOGICAL DISPOSAL OF SPENT NUCLEAR FUEL AND HIGH-LEVEL WASTE

CONTRACT NO.:	31310018D0001
TASK ORDER NUMBER:	31310019F0034
NRC ISSUING OFFICE:	Office of Nuclear Material and Safety Safeguards (NMSS)
NRC CONTRACTING OFFICER'S REPRESENTATIVE (COR):	Jack Gwo [redacted]
FEE RECOVERABLE:	No
PERIOD OF PERFORMANCE:	Base Year: June 10, 2019 – June 9, 2020 Option Year 1: June 10, 2020 – June 9, 2021 Option Year 2: June 10, 2021 – June 9, 2022 Option Year 3: June 10, 2022 – June 9, 2023

1.0 BACKGROUND

Since the publication of the final recommendation of the Blue Ribbon Commission on America's Nuclear Future in January 2012, national spent nuclear fuel (SNF) and high-level waste (HLW) geological disposal programs in countries such as Sweden, Finland, Japan, Canada, and France have continued to advance. Internationally, technical and regulatory progresses also result in the accumulation of a large amount of knowledge in design, development, implementation and regulation of deep geological repositories (DGR). In the United States, the Department of Energy (DOE) released a new waste management strategy in 2013, which endorses a system containing a pilot interim storage facility; a larger, full-scale interim storage facility; and a geologic repository. In 2015, DOE also noted its intent to pursue separate defense and commercial HLW disposal facilities. To this date, DOE continues its generic research and development programs for a potential DGR in the future. To remain positioned to support national policy changes in areas associated with its regulatory purview, NRC staff also identified and has continued to analyze key regulatory and technical issues associated with HLW and SNF disposal in a variety of potential repository designs and geologic media.

The U.S. Nuclear Regulatory Commission (NRC) has identified actions from regulatory, environmental, and technical perspectives that will improve the ability of the Agency to quickly adapt to changes in national policy. Because all plausible alternative scenarios for the back end of the nuclear fuel cycle produce residual waste, it is assumed that geological isolation will be a component of any new national policy. Regardless of the direction of national policy, it is imperative that NRC staff continue to stay abreast with technical and regulatory advances and with emerging issues both domestically and internationally. An awareness of international programs with similar aims in foreign countries is thus critical to support the Agency's mission under a range of potential policy outcomes.

The overarching goal of this work is to support NRC's preparations to address ongoing revisions to the U.S. national strategy for regulating and managing nuclear wastes through the collection and analysis of technical and regulatory information produced by international programs and activities, which will then be assimilated with information obtained independently by NRC staff. A secondary goal is to use the information to continue to support NRC's development and maintenance of in-house DGR performance assessment capability to align the staff's activity to NRC's risk-informed, performance-based regulatory approach.
This task order will build on the work completed in this area in FY12 through FY19 (Task Orders 7 and 9 under contract NRC-HQ-12-C-02-0089, and Task Order 31310018F0061 under contract 31310018D0001).

2.0 OBJECTIVE

The objective of this task order is to obtain technical assistance with the identification and analysis of technical and regulatory information and strategic insights obtained from international nuclear waste disposal programs and international research and development (R&D) activities related to the management and disposal of SNF and HLW. A secondary objective is to apply key insights obtained from international SNF and HLW disposal programs and R&D to update NRC's performance assessment knowledge base, supplemented by R&D results on alternative disposal concepts from the Department of Energy.

3.0 SCOPE OF WORK

3.1 TASK 1: DEGRADATION OF CANDIDATE WASTE PACKAGE MATERIALS

3.1.1. Base Period

The HLW disposal programs from countries such as Canada, Sweden, Finland, France, Germany, and Japan, in addition to the U.S., have accumulated a large amount of technical data in waste package material degradation, through laboratory experiments, field tests, analysis of natural analogues, or theoretical predictions. The NRC staff, in collaboration with the Center for Nuclear Waste Regulatory Analysis (CNWRA), has independently obtained a large amount of laboratory results on copper, carbon steel, and titanium corrosion. Utilizing this data, the contractor shall analyze and compare copper, carbon steel, and titanium corrosion rates under various nuclear waste disposal environments from different DGR designs.

The expected outcomes of this task are the quantification of: (1) environmental variables affecting waste package material corrosion, including the effects of the fate and transport of chemical species in the near field of a repository; (2) controlling mechanisms, e.g., electrochemical versus chemical dissolution, affecting waste package material degradation; and (3) uncertainty of measured/theoretical corrosion rates with respect to repository environmental variables. The results will be used to update the NRC's performance assessment knowledge base, including the in-house Scoping of Options and Analysis of Risk (SOAR) model.

Deliverable: The contractor shall develop a technical report that documents the pertinent findings. The technical report shall include summary tables of the obtained information and data in such a format as to facilitate its potential incorporation into the SOAR model.

3.1.2 Option Year 1

The contractor shall collect and analyze data from the most recent results from international HLW disposal programs and related R&D activities. The contractor shall compare these results from those produced by the R&D programs for alternative disposal concepts sponsored by DOE. The contractor shall review the existing implementation of waste package degradation module in the SOAR model and implement necessary updates to the module as approved by the COR.

Deliverable: The contractor shall develop a technical report that updates the knowledge base from the base year. The shall technical report shall document pertinent findings and include summary tables of the obtained information and data in such a format as to facilitate its incorporation into the SOAR model.

3.1.3 Option Year 2

The contractor shall update the knowledge base collected and analyzed in Option Year 1 with the most recent results from international nuclear waste disposal programs and related R&D activities. The

contractor shall compare these results from those produced by the R&D programs for alternative disposal concepts sponsored by DOE. The contractor shall review the existing implementation of waste package degradation module in the SOAR model and implement necessary updates to the module as approved by the COR.

Deliverable: The contractor shall develop a technical report that updates the knowledge base from Option Year 1. The technical report shall document pertinent findings and include summary tables of the obtained information and data in such a format as to facilitate its incorporation into the SOAR model.

3.1.4 Option Year 3

The contractor shall update the knowledge base collected and analyzed in Option Year 2 with the most recent results from international nuclear waste disposal programs and related R&D activities. The contractor shall compare these results from those produced by the R&D programs for alternative disposal concepts sponsored by DOE. The contractor shall review the existing implementation of waste package degradation module in the SOAR model and implement necessary updates to the module as approved by the COR.

Deliverable: The contractor shall develop a technical report that updates the knowledge base from Option Year 2. The technical report shall document pertinent findings and include summary tables of the obtained information and data in such a format as to facilitate its incorporation into the SOAR model.

3.2 TASK 2: DISSOLUTION OF SPENT NUCLEAR FUEL AND HLW GLASS

3.2.1. Base Period

The HLW disposal programs from countries such as Canada, Germany, Korea, France, and Japan, in addition to the U.S., have accumulated a large amount of data in this regard, through laboratory experiments or theoretical predictions. Additionally, there is a significant inventory of HLW glass worldwide, particularly France, Japan, and the U.S. The NRC staff, in collaboration with the CNWRA, has independently obtained a large amount of data regarding SIMFUEL dissolution from laboratory tests under oxic and anoxic conditions. Utilizing this data, the contractor shall analyze and compare HLW and SNF, including SIMFUEL, dissolution rates obtained from deep geologic disposal environments in various DGR programs.

The expected outcomes of this task are the quantification of: (1) environmental variable affecting SNF dissolution, including the effects of fate and transport of chemical species in the near field of a repository; (2) controlling mechanisms, e.g., electrochemical versus chemical dissolution, affecting HLW and SNF dissolution; and (3) uncertainty of measured/theoretical dissolution rates with respect to repository environmental variables. The results will be used to update the NRC's performance assessment knowledge base, including the NRC Scoping of Options and Analyzing Risk (SOAR) model.

Deliverable: The contractor shall develop a technical report that documents the pertinent findings. The technical report shall include summary tables of the information in such a format as to facilitate its potential incorporation into the SOAR model.

3.2.2 Option Year 1

The contractor shall update the knowledge base collected and analyzed in the Base Year with the most recent results from international nuclear waste disposal programs and related R&D activities. The contractor shall compare these results from those produced by the R&D programs for alternative disposal concepts sponsored by DOE. The contractor shall review the existing implementation of SNF and HLW degradation module in the SOAR model and implement necessary update to the module.

Deliverable: The contractor shall develop a technical report that documents the pertinent findings. The technical report shall include summary tables of the information in such a format as to facilitate its potential incorporation into the SOAR model.

3.2.3 Option Year 2

The contractor shall update the knowledge base collected and analyzed in Option Year 1 with the most recent results from international nuclear waste disposal programs and related R&D activities. The contractor shall compare these results from those produced by the R&D programs for alternative disposal concepts sponsored by DOE. The contractor shall review the existing implementation of SNF and HLW degradation module in the SOAR model and implement necessary updates to the module as approved by the COR.

Deliverable: The contractor shall develop a technical report that documents the pertinent findings. The technical report shall include summary tables of the information in such a format as to facilitate its potential incorporation into the SOAR model.

3.2.4 Option Year 3

The contractor shall update the knowledge base collected and analyzed in Option Year 2 with the most recent results from international nuclear waste disposal programs and related R&D activities. The contractor shall compare these results from those produced by the R&D programs for alternative disposal concepts sponsored by DOE. The contractor shall review the existing implementation of SNF and HLW degradation module in the SOAR model and implement necessary updates to the module as approved by the COR.

Deliverable: The contractor shall develop a technical report that documents the pertinent findings. The technical report shall include summary tables of the information in such a format as to facilitate its potential incorporation into the SOAR model.

3.3 TASK 3: MODEL AND DATA TO ASSESS THE PERFORMANCE OF NEAR FIELD BUFFER AND BACKFILL MATERIALS

3.3.1(a) Base Period – xFlo-FLAC Model Updates

The xFlo-FLAC model is a numerical computer code that simulates the coupled hydrological-thermal-mechanical processes of subsurface and geological media. It was used to model laboratory and field experiments during the NRC and CNWRA staff's participation of the DECOVALEX-2015 project. During the subsequent years since 2015, the CNWRA staff continued to improve the physics and the capability of the coupled model and to broaden the applicability of the model to near surface nuclear waste disposal facilities, owing to similar physical processes that are applicable to a range of subsurface and geological materials.

The contractor shall update the coupled-processes model xFlo-FLAC and document the databases

obtained during NRC and CNWRA's participation of the DECOVALEX-2015 international project. The contractor shall capture improvements and experience to date with the xFlo-FLAC model in order to maintain NRC's in-house DGR performance assessment capability.

Deliverables: The contractor shall deliver a computational package containing the xFlo-FLAC coupled model, the supporting documents, including but not limited to the user guide of xFlo and its interface with FLAC (a commercial computer code), and documented database of the DECOVALEX-2015 experimental results and input files to the xFlo-FLAC model.

3.3.1(b) Base Period – xFLO-FLAC Model Workshop

The contractor shall conduct a workshop for NRC and CNWRA staff on the use of the XFLO-FLAC model. The one-day workshop will be held at NRC Headquarters in Rockville, Maryland and is anticipated be participated by up to 25 NRC and CNWRA staff members, including those participating remotely. The contractor shall organize, prepare for, and conduct the workshop. Workshop presentations shall be streamed live over the internet with the ability to obtain real-time response to presentations from remote workshop participants. Potential workshop topics include: the DECOVALEX project; modeling of coupled processes; application of xFlo-FLAC to the near-field of alternative SNF and HLW disposal concepts; and application of xFlo-FLAC to near surface or intermediate depth disposal of nuclear wastes. Final workshop topics are subject to COR approval.

Deliverable: The contractor shall prepare a summary report of the workshop with all workshop presentation materials (e.g. presentation slides and handouts) attached as an appendix.

3.3.2 Option Year 1

The contractor shall apply the fully coupled xFlo-FLAC model to study the effects of coupled thermal-hydrological-mechancial processes on near field components of alternative HLW and SNF disposal concepts. The near field design shall focus on copper waste packages and bentonite buffer in crystalline host rocks similar to those of Sweden and Finland. The contractor shall utilize and apply the data and models collected and developed in the base year, particularly those related to the disposal concepts of Sweden and Finland. The contractor shall identify potential knowledge gaps with regard to disposal of high-temperature SNF and HLW in such disposal concepts and update the xFlo-FLAC model accordingly.

Deliverables: The contractor shall deliver an updated computational package containing the xFlo-FLAC coupled model, and the supporting documents, including but not limited to the userguide of xFlo and its interface with FLAC. The contractor shall also deliver a technical report documenting the near-field model and modeling results of high-temperature SNF and HLW disposal in a crystalline host rock.

3.3.3 Option Year 2

The contractor shall apply the fully coupled xFlo-FLAC model to study the effects of coupled thermal-hydrological-mechancial processes on near field components of alternative HLW and SNF disposal concepts. The near field design shall focus on carbon steel canister and bentonite buffer and/or bentonite plug in clay host rocks similar to those proposed in France and Switzerland. The contractor shall utilize and apply the data and models collected and developed in the base year, particularly those related to the disposal concepts of France and Switzerland. The contractor shall identify potential knowledge gaps with regard to disposal of high-temperature SNF and HLW in such disposal concepts and update the xFlo-FLAC model accordingly.

Deliverables: The contractor shall deliver an updated computational package containing the xFlo-FLAC coupled model, and the supporting documents, including but not limited to the userguide of xFlo and its interface with FLAC. The contractor shall also deliver a technical report documenting the near-field model and modeling results of high-temperature SNF and HLW disposal in a clay host rock.

3.3.4 Option Year 3

The contractor shall apply the fully coupled xFlo-FLAC model to study the effects of coupled thermal-hydrological-mechancial processes on near field components of alternative HLW and SNF disposal concepts. The near field design shall focus on titanium canister in salt host rocks similar to those proposed in Germany. The contractor shall utilize and apply the data and models developed previously by CNWRA staff, particularly those related to the experiments and models for the Waste Isolation Pilot Plant. The contractor shall identify potential knowledge gaps with regard to disposal of high-temperature SNF and HLW in such disposal concepts and update the xFlo-FLAC model accordingly.

Deliverables: The contractor shall deliver an updated computational package containing the xFlo-FLAC coupled model, and the supporting documents, including but not limited to the userguide of xFlo and its interface with FLAC. The contractor shall also deliver a technical report documenting the near-field model and modeling results of high-temperature SNF and HLW disposal in a salt host rock.

3.4 TASK 4: CEMENTITIOUS MATERIAL DEGRADATION

3.4.1. Base Period

The contractor shall collect and analyze available cementitious material degradation data from various international DGR programs. Cementitious materials, such as concrete and grouts, have been used for various international HLW and SNF disposal programs for various purposes. For example, concrete containers were proposed to support waste package emplacement in soft clay host rocks in Belgium. Grouts and shotcrete are routinely used to provide structural support of DGR access tunnels. The degradation of these cementitious materials and its byproducts may affect barrier performance in the near field of a DGR in various ways. The NRC staff, in collaboration with the CNWRA, has accumulated a large amount of information regarding cementitious material degradation in various DGR environments.

The expected outcomes of this task is a technical report that documents: (1) the state-of-the-art understanding of effects of cementitious material degradation on performance of DGR engineered barriers (e.g., high pH effects); (2) uncertainty associated with the effects; (3) gaps in understanding of the effects, including degradation mechanisms and the uncertainty; and (4) the state-of-the art practices in cementitious barrier performance analysis, including modeling approaches and technologies.

The results of this research and analysis will be used to update the NRC's performance assessment knowledge base and to help assessing gaps in the current performance assessment approach.

Deliverable: The contractor shall develop a technical report analyzing the collected information and documenting any pertinent findings. In the report, the contractor shall identify knowledge gaps with respect to the degradation of cementitious materials and the effect on barrier performance in various DGR concepts. The contractor shall also discuss potential approaches to integrate the collected knowledge into the NRC SOAR model.

3.4.2 Option Year 1

On the basis of the information gathered in the Base Year and those previously in the Task Order 31310018F0061, the contractor shall conduct a feasibility study of developing SOAR model components that may be applied to SNF and HLW disposal concepts similar to those proposed in Belgium, namely the super-container concept in soft clay host rock. The contractor shall identify potential knowledge gaps that may require further R&D, development of knowledge base, or modification of the SOAR model.

Deliverable: The contractor shall deliver a technical report documenting the outcome of the feasibility study and any pertinent findings.

3.4.3 Option Year 2

On the basis of the information gathered in the Base Year and Option Year 1, the contractor shall either develop a SOAR model component prototype that may be applied to SNF and HLW disposal concepts similar to those proposed in Belgium or conduct further analyses of international performance assessment (PA) results with respect to use of cementitious materials in DGR settings as directed by the COR. The contractor shall identify potential knowledge gaps that may require further R&D, development of knowledge base, or modification of the SOAR model.

Deliverable: The contractor shall either deliver a SOAR model component prototype or a technical report documenting the outcome of the analyses of international PA results and any pertinent findings.

3.4.4 Option Year 3

On the basis of the information gathered in the Base Year and Option Years 1 and 2, the contractor shall either develop a SOAR model component that may be applied to SNF and HLW disposal concepts similar to those proposed in Belgium or conduct further analyses of international performance assessment (PA) results with respect to use of cementitious materials in DGR settings as directed by the COR. The contractor shall identify potential knowledge gaps that may require further R&D, development of knowledge base, or modification of the SOAR model.

Deliverable: The contractor shall deliver either a SOAR model component or a technical report documenting the update to the analyses of international PA results in Option Year 2 and any pertinent findings.

4.0 REPORTING REQUIREMENTS

All technical reports are to be developed in the contractor (CNWRA) SharePoint system. Submittals for all task deliverables shall be submitted via electronic mail with electronic attachments consistent with the word processor in use at the NRC or in portable document format (*i.e.*, *.pdf), as appropriate to the COR and the relevant NRC technical staff. Reports by the contractor shall be in letter report form. The deliverables shall attribute work to both NRC and CNWRA when the outcome is a result of joint effort between NRC and CNWRA.

For all draft and final technical reports under this task order, the contractor shall assure that an independent review of numerical computations, mathematical equations, and derivations is performed by qualified technical contractor staff other than the original author(s) of the technical reports and other than the person who performed the original calculation. If the contractor proposes to check less than 100 percent of all computations, mathematical equations, and derivations in the technical report(s) (such as may be the case when there is many routine, repetitive calculations), the contractor must first obtain written approval from the

COR. In addition, the contractor must review all technical reports, including those which do not contain numerical analyses for consistency and readability in accordance with the procedures outlined in the CNWRA Quality Assurance Manual (QAM, transmitted to NRC on September 27, 2018, for Contract No. 31310018D001, Task Order 31310018F0053, or subsequent updated version of the QAM). Informal submittals/deliverables must be reviewed and forwarded from at least the Project Manager level.

5.0 DELIVERABLES AND DELIVERY SCHEDULE

Project deliverables are listed in the table below.

TASK/SUBTASK	DELIVERABLE	DUE DATE
3.1.1 (Base Year)	Technical Report: International research, activities, and key findings on waste package material degradation	November 28, 2019
3.1.2 (Option Year 1)	Technical Report: Update on International research, activities, and key findings on waste package material degradation	November 27, 2020
3.1.3 (Option Year 2)	Technical Report: Update on International research, activities, and key findings on waste package material degradation	November 26, 2021
3.1.4 (Option Year 3)	Technical Report: Update on International research, activities, and key findings on waste package material degradation	November 25, 2022
3.2,1 (Base Year)	Technical Report: International research, activities, and key findings on HLW and SNF degradation	October 31, 2019
3.2.1 (Option Year 1)	Technical Report: Update on International research, activities, and key findings on HLW and SNF degradation	October 30, 2020
3.2.3 (Option Year 2)	Technical Report: Update on International research, activities, and key findings on HLW and SNF degradation	October 29, 2021
3.2.4(Option Year 3)	Technical Report: Update on International research, activities, and key findings on HLW and SNF degradation	October 28, 2022
3.3.1a (Base Year)	xFlo-FLAC computational package and documentation and documented DECOVALEX-2015 database and input files	May 15, 2020
3.3.1b (Base Year)	xFlo-FLAC Workshop Summary Report	April 17, 2020
3.3.2 (Option Year 1)	Updated xFlo-FLAC computational package and documentation	December 14, 2020
3.3.2 (Option Year 1)	Technical Report: Modeling the near-field environment of a DGR in a crystalline host rock	December 14, 2020
3.3.3 (Option Year 2)	Updated xFlo-FLAC computational package and documentation	December 13, 2021

TASK/SUBTASK	DELIVERABLE	DUE DATE
3.3.3 (Option Year 2)	Technical Report: Modeling the near-field environment of a DGR in a clay host rock	December 13, 2021
3.3.4 (Option Year 3)	xFlo-FLAC computational package and documentation	December 16, 2022
3.3.4 (Option Year 3)	Technical Report: Modeling the near-field environment of a DGR in a salt host rock	December 16, 2022
3.4.1 (Base Year)	Technical Report: Degradation of cementitious materials and its effect on barrier performance	May 10, 2020
3.4.2 (Option Year 1)	Technical Report: Feasibility study of implementing cementitious material degradation components in SOAR	January 22, 2021
3.4.3(Option Year 2)	SOAR model component prototype or a technical report on international performance assessment activities	January 24, 2022
3.4.4 (Option Year 3)	SOAR model component or a technical report with updates on international performance assessment activities	January 23, 2023
All	*Monthly Letter Status Report (MLSR) per Section F.2 of the Base Contract	20th day of the following month

After comments from NRC staff are provided to the contractor for the above technical reports, the contractor shall deliver a revised technical report incorporating the comments within 15 business days.

*If no work was performed during the prior month, the contractor shall not prepare and submit an MLSR.

#Option year deliverable, applicable only if the option year exercised by NRC.

6.0 QUALITY ASSURANCE

The contractor shall identify and describe in the task order proposal any applicable quality assurance (QA) program, using as the basis the CNWRA Quality Assurance Manual (QAM, transmitted to NRC on September 27, 2018, for Contract No. 31310018D001, Task Order 31310018F0053, or subsequent updated version of the QAM). For, this task order, the QA program shall address the criteria of 10 CFR Part 63, Subpart G. Quality assurance comprises of all those planned and systematic actions necessary to provide adequate confidence that the assessments have been satisfactory performed. Quality assurance shall include verification for completeness, accuracy, consistency, and sufficient documentation to assure the reproducibility of the results of all calculations, laboratory experiments (if any), or modeling.

7.0 PERSONNEL QUALIFICATIONS

Professional staff proposed for the effort shall possess technical expertise in the following disciplines: geology; seismology and volcanology; hydrology, including coupled thermal-hydrology-geochemical processes; materials science and corrosion; geochemistry;
engineered barrier systems, including cementitious materials; mechanical or mining engineering familiarity with

a variety of disposal media and depths, including salt and deep boreholes; nuclear engineering; waste form; source term (thermal loads, inventory as function of different waste streams, burn-ups, and storage times); radionuclide release; radionuclide transport; performance assessment, and health physics. Expertise in preclosure safety analysis expertise is needed to address specific aspects of operational safety issues associated with very long-term storage and deferred transportation of fuel that could be handled in different potential waste disposal systems.

The Contractor shall provide a Program Manager who shall be responsible for the performance of work identified in this SOW. The Program Manager shall have experience with generic nuclear waste disposal.

Contractor is requested to identify designated key personnel for the task order, particularly the leading personnel that will conduct the research and development for the 4 Tasks identified in Sections 3.1 to 3.4.

8.0 TRAVEL

The following travel is anticipated under this task order:

Base Year, FY 20, one (1) trip to NRC Headquarters in Rockville MD, for a one-day workshop, for one contractor staff members.

The contractor shall be authorized travel expenses consistent with the Federal Travel Regulation (FTR) and the limitation of funds for this task order. All travel requires prior written COR approval.

To enhance integration and support the collaborative effort expected between the staffs of the NRC and the contractor (Center) on this task, the NRC staff may participate in staff exchanges with the Center, subject to prior approval by the NRC Division Director of Spent Fuel Management and the Director of the Center.

9.0 SECURITY

Work performed under this task order will be unclassified and unsensitive. This task order does not involve contractor contact with or production of any of the following types of information: Classified Information; Safeguards Information; Sensitive Unclassified Information (SUNSI); Export Control Information (SCI); Controlled Unclassified Information (CUI).

10.0 LICENSE FEE RECOVERABLE

All the tasks listed in Section 3 of this SOW are NOT license fee recoverable.

11.0 NRC FURNISHED MATERIAL

The COR will provide the necessary information to conduct the activities for each topic to the pertinent, identified, Center staff.

12.0 CONTRACTOR ACQUIRED MATERIAL

No materials are expected to be acquired.