

ORDER FOR SUPPLIES OR SERVICES

PAGE OF PAGES
1 | 27

IMPORTANT: Mark all packages and papers with contract and/or order numbers.

1. DATE OF ORDER 06/22/2016	2. CONTRACT NO. (If any) NRC-HQ-25-14-E-0004	6. SHIP TO:	
3. ORDER NO. NRC-HQ-60-16-T-0001		4. REQUISITION/REFERENCE NO. RES-16-0206	
5. ISSUING OFFICE (Address correspondence to) US NRC - HQ ACQUISITION MANAGEMENT DIVISION MAIL STOP 3WFN-05-C64MP WASHINGTON DC 20555-0001		a. NAME OF CONSIGNEE US NUCLEAR REGULATORY COMMISSION-	
		b. STREET ADDRESS MAIL PROCESSING CENTER 4930 BOILING BROOK PARKWAY	c. CITY ROCKVILLE
		d. STATE MD	e. ZIP CODE 20852

7. TO:		f. SHIP VIA	
a. NAME OF CONTRACTOR NUMARK ASSOCIATES INC		8. TYPE OF ORDER	
b. COMPANY NAME		<input type="checkbox"/> a. PURCHASE	<input checked="" type="checkbox"/> b. DELIVERY
c. STREET ADDRESS 1220 19TH ST NW STE 500		REFERENCE YOUR:	
d. CITY WASHINGTON		Please furnish the following on the terms and conditions specified on both sides of this order and on the attached sheet, if any, including delivery as indicated.	
e. STATE DC	f. ZIP CODE 200362444	Except for billing instructions on the reverse, this delivery order is subject to instructions contained on this side only of this form and is issued subject to the terms and conditions of the above-numbered contract.	

9. ACCOUNTING AND APPROPRIATION DATA See Schedule	10. REQUISITIONING OFFICE OFF OF NUCLEAR REG RESEARCH
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11. BUSINESS CLASSIFICATION (Check appropriate box(es))		12. F.O.B. POINT
<input checked="" type="checkbox"/> a. SMALL <input type="checkbox"/> b. OTHER THAN SMALL <input type="checkbox"/> c. DISADVANTAGED <input type="checkbox"/> d. WOMEN-OWNED <input type="checkbox"/> e. HUBZone <input type="checkbox"/> f. SERVICE-DISABLED VETERAN-OWNED <input type="checkbox"/> g. WOMEN-OWNED SMALL BUSINESS (WOSB) ELIGIBLE UNDER THE WOSB PROGRAM <input type="checkbox"/> h. EDWOSB		

13. PLACE OF		14. GOVERNMENT B/L NO.	15. DELIVER TO F.O.B. POINT ON OR BEFORE (Date) Multiple	16. DISCOUNT TERMS
a. INSPECTION Destination	b. ACCEPTANCE Destination			

17. SCHEDULE (See reverse for Rejections)

ITEM NO. (a)	SUPPLIES OR SERVICES (b)	QUANTITY ORDERED (c)	UNIT (d)	UNIT PRICE (e)	AMOUNT (f)	QUANTITY ACCEPTED (g)
	Numark EWC Unrestricted Task Order No. 5 titled High Density Polyethylene Piping and Joint Structural Integrity Evaluation under Enterprise Wide Contract No. NRC-HQ-25-14-E-0004. Continued ...					

SEE BILLING INSTRUCTIONS ON REVERSE	18. SHIPPING POINT		19. GROSS SHIPPING WEIGHT		20. INVOICE NO.		17(h) TOTAL (Cont. pages)	
	21. MAIL INVOICE TO:							
	a. NAME US NUCLEAR REGULATORY COMMISSION						\$0.00	17(i) GRAND TOTAL
	b. STREET ADDRESS (or P.O. Box) ONE WHITE FLINT NORTH 11555 ROCKVILLE PIKE MAILSTOP 03-E17A						\$985,409.29	
c. CITY ROCKVILLE		d. STATE MD	e. ZIP CODE 20852-2738					

22. UNITED STATES OF AMERICA BY (Signature)	06/22/2016	23. NAME (Typed) MARK THOMPSON TITLE: CONTRACTING/ORDERING OFFICER
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TEMPLATE - ADM001

SUNSI REVIEW COMPLETE

ADM002
JUL - 7 2016

**ORDER FOR SUPPLIES OR SERVICES
SCHEDULE - CONTINUATION**

PAGE NO

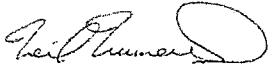
2

IMPORTANT: Mark all packages and papers with contract and/or order numbers.

DATE OF ORDER
06/22/2016

CONTRACT NO.
NRC-HQ-25-14-E-0004

ORDER NO.
NRC-HQ-60-16-T-0001

ITEM NO. (a)	SUPPLIES/SERVICES (b)	QUANTITY ORDERED (c)	UNIT (d)	UNIT PRICE (e)	AMOUNT (f)	QUANTITY ACCEPTED (g)
	<p>Contracting Officers Representative: Patrick Raynaud, Email: Patrick.Raynaud@nrc.gov. Phone: 301-415-1987</p> <p>Contractor POCs: Technical: Martin Bowling. Email: mbowling@numarkassoc.com. Phone: (202) 466-2700. Business: Paul Edelstein. Email: pedelstein@numarkassoc.com. Phone: (202) 466-2700.</p> <p></p> <p align="right">6/21/16 Date</p> <p>Numark Authorized Official</p> <p>Accounting Info: 2016-X0200-FEEBASED-60-60D001-11-6-213-1032- 251A Period of Performance: 06/22/2016 to 05/31/2020</p>					
TOTAL CARRIED FORWARD TO 1ST PAGE (ITEM 17(H))					\$0.00	

NUMARK EWC UNRESTRICTED TASK ORDER 05

SECTION B - SUPPLIES OR SERVICES AND PRICE/COSTS

B.1 PRICE/COST SCHEDULE

CLIN	DESCRIPTION OF SUPPLIES/SERVICES	ESTIMATED COST	FIXED FEE	TOTAL COST PLUS FIXED FEE
00001	Contractor to provide Technical Assistance in accordance with section C: DESCRIPTION/SPECIFICATIONS/ STATEMENT OF WORK	[REDACTED]		[REDACTED]
00002	Fee CLIN		[REDACTED]	
10001	Option CLIN – Continuation of work tasks defined as “Option Tasks” Listed in the SOW below.	[REDACTED]		[REDACTED]
10002	Option Fee CLIN		[REDACTED]	
	Total	[REDACTED]	[REDACTED]	\$985,409.29

NRCB044 CONSIDERATION AND OBLIGATION—INDEFINITE-QUANTITY CONTRACT

(a) The estimated total quantity of this contract for the products/services under this contract is [REDACTED] of which the sum of [REDACTED] represents the estimated reimbursable costs, and of which [REDACTED] represents fixed fee.

(b) The Contracting Officer will obligate funds on each task order issued.

(c) The amount currently obligated by the Government with respect to this contract is [REDACTED] of which the sum of [REDACTED] represents the estimated reimbursable costs, and of which [REDACTED] represents the fixed-fee (the fixed-fee CLIN is now fully-funded).

(d) This is an incrementally-funded contract and FAR 52.232-22 – “Limitation of Funds” applies.

(e) A total estimated cost and fee, if any, will be negotiated for each task order and will be incorporated as a ceiling in the resultant task order. The Contractor shall comply with the provisions of FAR 52.232-20 - Limitation of Cost for fully-funded task orders and FAR 52.232-22 - Limitation of Funds for incrementally-funded task orders, issued hereunder.

FEE HOLDBACK TABLE			
CLIN	TOTAL FEE	LIMIT	(HOLD BACK)
00002			
00004			
TOTAL			

(End of Clause)

SECTION C – DESCRIPTION/SPECIFICATIONS/STATEMENT OF WORK

NRC Requisition Office: Office of Nuclear Regulatory Research (RES)

Fee Recoverable: NO

1. PROJECT TITLE

High-Density Polyethylene Piping and Joint Structural Integrity Evaluation

2. BACKGROUND

Steel and metal alloy piping used in buried systems in the U.S. Nuclear Reactor Fleet are susceptible to fouling, corrosion, tuberculation, microbiological growths, and stress corrosion cracking. These degradation mechanisms are eliminated by replacing steel and metal alloy piping with High-Density Polyethylene (HDPE) piping; however, HDPE is susceptible to creep and slow crack growth (SCG), which recent research has shown to occur at a faster rate in HDPE piping joints than the parent pipe material.

Moreover, structural integrity issues have been raised concerning the HDPE fabrication and examination processes. Industry research indicates that incomplete bonding can occur using the current accepted joint fabrication procedures; however, there is no reliable non-destructive evaluation (NDE) technique in place to determine when incomplete bonding occurs. Further, acceptance criteria for joint quality have not been well-established.

Industry has been developing American Society of Mechanical Engineers (ASME) Code requirements for the use of HDPE piping at the U.S. Nuclear Reactor Fleet. Specifically, Code Case N-755, "Use of Polyethylene (PE) Plastic Pipe, Sections III, Division I and XI has been issued with several revisions. This Section III Code Case and associated revisions (N-755 and N-755-1) are dispositioned as 'unapproved for use' by the U.S. Nuclear Regulatory Commission (NRC) and are listed in Draft Regulatory Guide DG-1298 (proposed Revision 5 of Regulatory Guide 1.193). The NRC has not accepted N-755 because it does not adequately address the flaw tolerance of HDPE piping, fusion procedure qualifications and the volumetric inspection of joints. The ASME Code committees are currently working to incorporate Code Case N-755 into Section III mandatory Appendix XXVI, to be issued in the 2017 edition of the ASME Code. In parallel, the Section XI code committees have created Code Case N-808 to address repair and replacement activities and a Code Case for HDPE pipe flaw evaluation (no number assigned, yet). The NRC has cited several concerns that have not been adequately addressed in research to date. In accordance with 10 CFR 50.55a(z), presently any licensee that chooses to

use HDPE in lieu of metal piping for safety-related piping systems must submit a request proposing an alternative to the requirements of the ASME Code.

Up to this point, all industry and NRC confirmatory research for HDPE piping joint fabrication has been on butt fusion. HDPE piping butt fusion involves cutting and preparing the ends of two pieces of pipe, heating the ends, then pressing them together at a specified pressure and for a specified duration. The process therefore requires that there be an unconstrained end of the piping system so that the two separate pieces can be pulled together. If an HDPE piping system develops a leak or a rupture, there is no NRC-approved fusion technique currently in place for repairing the system.

Electrofusion (EF) couplings, which fit over the ends of the piping and contain integral heating elements, are a possible repair option. Industry has expressed interest in using electrofusion fittings as a repair technique in existing HDPE piping systems and as a joint fabrication technique in future installations. Industry has begun incorporating electrofusion into ASME Code Section III Appendix XXVI, referencing Section IX, Part QF. Proposed uses of electrofusion include full couplings for pipe replacement and saddle fittings for branch piping or for repair of minor gouges that exceed the acceptance requirements in the Code. As guidance, Industry has relied on existing American Society for Testing and Materials (ASTM) specifications, Plastics Pipe Institute (PPI) technical reports, and polyethylene experience when developing ASME Code. However, much of this guidance was developed using older HDPE resins; small-diameter, thin-walled piping and fittings; and operational conditions at lower temperatures and pressures than Class 3 nuclear service water applications. The information on electrofusion presented to the NRC by industry to date is insufficient for the NRC to perform an acceptable analysis of the technique.

Since 2011, the NRC has been conducting independent confirmatory research on using HDPE piping in Class 3 safety systems in the U.S. Nuclear Reactor Fleet, and exchanging research findings on this topic with the Electric Power Research Institute (EPRI) under the auspices of a memorandum of understanding (MOU). This task order will continue support for this HDPE Research Program, and will be focused on confirming the allowable service conditions of HDPE piping parent material and fusion joints through laboratory testing and computational analysis, for butt fusion and electrofusion joints. The HDPE piping electrofusion research has not been performed before, however it is of the same nature as the HDPE piping butt fusion research, but is aimed at studying a different joining technique that can be used for initial fabrication as well as repairs.

3. OBJECTIVE(S)

This Statement of Work for this Task Order falls within the Unrestricted part of NRC IDIQ Enterprise-Wide Contract (EWC) entitled Technical Assistance in Support of Agency Environmental and Reactor Programs, paragraph 3.2 entitled, "LICENSING SUPPORT."

The objective of this research project is to continue performing confirmatory research and analysis of the industry's efforts to install and maintain HDPE piping as a replacement for carbon and steel in Class 3 safety systems in the U.S. Nuclear Reactor Fleet. This shall be achieved through experimental testing on HDPE piping butt fusion joints and electrofusion joints. The objectives of the testing are to establish HDPE piping joint acceptance criteria, to confirm the service life of HDPE piping and joints, and to generate sufficient experimental data to assess the adequacy of electrofusion couplings for use with HDPE piping at the U.S. Nuclear Reactor Fleet.

The Office of Nuclear Reactor Regulation (NRR) and the Office of New Reactors (NRO) intend to use the results from this task order to support regulatory decisions associated with the application of HDPE material in new and replacement Class 3 safety-related piping in the U.S. Nuclear Reactor Fleet. The research will assist NRR and NRO in proactively assessing and identifying the capabilities, effectiveness, reliability and deficiencies of fabrication processes and NDE methods. The findings will also provide technical justification for NRR and NRO regulatory positions.

4. STATEMENT OF WORK TASKS

Task 1: HDPE Piping Butt Fusion Joint Integrity Evaluation

Subtask 1.1: SCG Resistance of HDPE Piping Butt Fusion Joints

The contractor shall review information and data, to be provided by the Contracting Officer's Representative (COR) subsequent to task order award, on tests performed to date on HDPE piping butt fusion joint coupons under the NRC HDPE Research Program. The data will include the NRC Database for SCG resistance of HDPE piping butt fusion joints. The contractor shall develop a test plan to perform the experiments described in the paragraph below. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests to ensure the goals of this project are met. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

The contractor shall perform coupon testing of HDPE piping butt fusion joints to determine SCG resistance, specifically using a combination of Pennsylvania Edge Notch tension (PENT) and Single Edge Notch Tension (SENT) tests. The load, load-line displacement, and time shall be measured to establish failure time. Stress levels and test temperatures shall be chosen to fill holes in the current NRC database for SCG resistance of HDPE piping butt fusion joints, per COR direction.

Subtask 1.2: Whole HDPE Piping Butt Fusion Joint Testing

The contractor shall review information and data to be provided by the COR, subsequent to task order award, on tests performed to date on whole HDPE piping butt fusion joints under the NRC HDPE Research Program. The contractor shall develop a test plan to perform the experiments described in the paragraph below. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests to ensure the goals of this project are met. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

In order to confirm the applicability of the coupon tests performed in Subtask 1.1 to actual full scale HDPE piping butt fusion joints, the contractor shall perform creep testing of whole pipe joints under tensile loading on small pipe diameters (up to 4 inches). The contractor shall also

fabricate and perform tensile testing on large diameter HDPE pipe (up to 12 inches) with butt fusion joints.

Subtask 1.3: Review and Confirmation of Industry HDPE Piping Butt Fusion Joint Integrity Testing

The contractor shall review industry (EPRI) test procedures, test conditions, and results on HDPE piping butt fusion joint integrity testing obtained through the NRC-EPRI MOU. The COR will initiate the information exchange between EPRI and the contractor, and the contractor shall subsequently be responsible for communicating directly with EPRI to obtain EPRI's HDPE testing results as they become available. The contractor shall copy the COR on all written correspondence with EPRI. The contractor shall develop a test plan consist with the test procedures and conditions utilized by EPRI. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests as new EPRI data becomes available. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

The contractor shall perform HPDE piping butt fusion joint integrity testing in accordance with the test procedures and conditions utilized by EPRI to confirm the EPRI results.

Subtask 1.4: Flaw Tolerance Analyses for HDPE Piping Butt Fusion Joints

Based on the data collected in Subtasks 1.1., 1.2, and 1.3 and the data already collected by NRC under the HPDE Research Program, to be provided by the COR subsequent to task order award, the contractor shall perform fracture mechanics analyses to determine the flaw tolerance of HDPE piping butt fusion joints under loading and environmental conditions representative of in-service use in the U.S. Nuclear Reactor Fleet.

Deliverables for Task 1

Test Plan for Subtasks 1.1 through 1.3

The contractor shall prepare and submit a draft test plan in a tabulated format for Subtasks 1.1 through 1.3 that includes test name, test type, specimen type, specimen materials, and test conditions (ex: load, temperature, crack or notch depth, etc., as applicable). The contractor shall prepare and submit a final test plan incorporating any comments from the COR on the draft test plan. If necessary, the contractor shall prepare and submit a revised test plan(s).

Task 1 Draft Technical Letter Report (encompassing Subtasks 1.1 through Subtask 1.4)

The contractor shall prepare and submit a draft technical letter report (TLR) for Task 1 within 6 months after the start of the task. The draft Task 1 TLR shall encompass all work performed to date in Task 1 under Subtasks 1.1, 1.2, 1.3, and 1.4. For Subtasks 1.1 through 1.3, the draft TLR shall describe in detail the test procedures and equipment, the specimens utilized, the test matrices, and the results obtained to date. In addition, the contractor shall submit raw and processed data to the COR upon request. For Subtask 1.4, the analysis methods, assumptions, and results shall be documented by the contractor in the draft TLR. In addition, worksheets

and/or input files used for the analyses shall be submitted to the COR upon request. The contractor shall update the draft Task 1 TLR once every 6 months after the start of Task 1, and incorporate any comments received from the COR in the next draft, until such time as Task 1 is completed.

Task 1 Final Technical Letter Report

The contractor shall prepare and submit a draft final TLR covering all work performed under Subtasks 1.1 through 1.4 within 3 months of completion of Subtasks 1.1 through 1.4. The draft final TLR shall summarize the efforts completed, propose conclusions on the adequacy of HDPE piping with butt fusion joints in Class 3 safety systems in the U.S. Nuclear Reactor Fleet, and identify any remaining gaps in the state of knowledge of HDPE piping butt fusion joint structural integrity for Class 3 safety systems in the U.S. Nuclear Reactor Fleet. The contractor shall prepare a final TLR incorporating any comments from the COR on the draft final TLR. The contractor shall submit to the COR all raw and processed data, and/or analyses (worksheets and/or input files).

Required Equipment and/or Analysis Tools

Items # 1 through 9 from Key Equipment list in Section 11: Special Considerations.

Task 2: HDPE Piping Butt Fusion Joint Quality Assurance

Subtask 2.1: Confirmatory Short Term Testing for Joint Quality Assurance

The contractor shall review the EPRI HDPE Piping Butt Fusion Joint Quality Assurance (QA) Testing Report obtained through the EPRI-NRC MOU on HDPE research to be provided to the contractor by the COR at the start of this subtask. The EPRI report will include a description of EPRI's HDPE piping butt fusion joint QA testing program, the HDPE piping butt fusion joint testing data collected by EPRI, and the conclusions drawn by EPRI regarding HDPE piping butt fusion joint QA.

Based on the review of the EPRI Butt Fusion Joint QA Testing Report and the test data it contains, the contractor shall develop a test plan to perform the experiments described in the paragraph below. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests to ensure the goals of this project are met. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

The contractor shall perform short term HDPE piping butt fusion joint testing to confirm the results of the EPRI HDPE piping butt fusion joint QA test program. The test conditions shall be carefully chosen to encompass the entire range of conditions tested by EPRI with the smallest possible number of tests. Because this testing shall be confirmatory in nature, the contractor shall ensure that the test conditions, specimens, and procedures are as close to the EPRI tests as possible.

Subtask 2.2: Correlation of Essential Variables for Fusion with Joint QA Testing

The contractor shall analyze the testing data from Task 1 and from Subtask 2.1 to correlate the HDPE piping butt fusion joint performance (such as, time to failure for different flaw depths, temperatures, and loads) with the essential variables employed for the butt fusion process. The essential variables for the HDPE piping butt fusion process may include the fusion temperature, the heatup time, and pressure versus time or temperature, among others to be determined upon mutual agreement between the contractor and the COR.

Deliverables for Task 2

Summary Report of EPRI HDPE Piping Butt Fusion Joint QA Testing Report for Subtask 2.1

The contractor shall prepare and submit a draft summary report of the review of the EPRI Butt Fusion Joint QA Testing Report. The draft summary report shall include a description of the testing performed, the key parameters and metrics used in the QA program, the key results from EPRI's test campaign, and EPRI's conclusions about the HDPE piping butt fusion joint QA testing. The contractor shall prepare a final summary report incorporating any comments received from the COR on the draft summary report.

Test Plan for Subtask 2.1

The contractor shall prepare and submit a draft test plan in a tabulated format for Subtask 2.1 that includes test name, test type, specimen type, specimen materials, and test conditions (ex: load, temperature, crack or notch depth, etc., as applicable). The contractor shall prepare and submit a final test plan incorporating any comments from the COR on the draft test plan. If necessary, the contractor shall prepare and submit a revised test plan(s).

Task 2 Draft Technical Letter Report (encompassing Subtasks 2.1 and 2.2)

The contractor shall prepare and submit a draft technical letter report (TLR) for Task 2 within 6 months after the start of the task that encompasses all work performed to date in Task 2 under Subtasks 2.1 and 2.2. For Subtask 2.1, the contractor shall describe in detail in the draft TLR the test procedures and equipment, the specimens utilized, the test matrices, and the results obtained to date. In addition, the contractor shall submit raw and processed data to the COR upon request. For Subtask 2.2, the analysis methods, assumptions, and results shall be documented by the contractor in the draft TLR. In addition, worksheets and/or input files used for the analyses shall be submitted to the COR upon request. The contractor shall update the Task 2 draft TLR every 6 months after the start of Task 2, and incorporate any comments received from the COR in the next draft, until such time as Task 2 is completed.

Task 2 Final Technical Letter Report

The contractor shall prepare and submit a draft final TLR that encompasses all work performed under Subtasks 2.1 and 2.2 within 3 months from completing Subtasks 2.1 and 2.2. The draft final TLR shall summarize the results of the confirmatory testing performed in Subtask 2.1 and describe the efforts performed to assess correlations between fusion essential variables and joint QA testing results. The contractor shall prepare a final TLR incorporating any comments from the COR on the draft final TLR. The contractor shall submit to the COR all raw and processed data and/or analyses (worksheets and/or input files).

Required Equipment and/or Analysis Tools

Items # 1 through 9 from Key Equipment list in Section 11: Special Considerations.

OPTION - Subtask 2.3: Joining Parameter Methodology for Confirming Joint Acceptance

The contractor shall develop Joining Parameter Methodology for Confirming Joint Acceptance. Specifically, the contractor shall develop a quantifiable method based on the calculation of a joining parameter to discriminate between good and bad joints. Good joints are joints that are acceptable for Class 3 safety systems in the U.S. Nuclear Reactor Fleet in accordance with ASME code acceptance criteria. The joining parameter methodology to be developed shall be able to predict the acceptability of a joint based on acceptable ranges for the essential variables used to create that fusion joint, as specified in the Plastics Pipe Institute Technical Report TR-33 (Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe).

Deliverables for OPTION – Subtask 2.3

Subtask 2.3 Draft Technical Letter Report

The contractor shall prepare and submit a draft technical letter report (TLR) for Subtask 2.3 within 6 months after the start of the task. The analysis methods, assumptions, and results shall be documented by the contractor in the draft TLR. In addition, worksheets and/or input files used for the analyses shall be submitted to the COR upon request. The contractor shall update the Subtask 2.3 draft TLR every 6 months after the start of Subtask 2.3, and incorporate any comments received from the COR in the next draft, until such time as Subtask 2.3 is completed.

Subtask 2.3 Final Technical Letter Report

The contractor shall prepare and submit a draft final TLR that encompasses all work performed under Subtask 2.3 within 3 months from completing Subtask 2.3. The draft final TLR shall describe efforts to develop a joint acceptance metric based on a joining parameter. The contractor shall prepare a final TLR incorporating any comments from the COR on the draft final TLR. The contractor shall submit to the COR all raw and processed data and/or analyses (worksheets and/or input files).

Required Equipment and/or Analysis Tools

Item # 9 from Key Equipment list in Section 11: Special Considerations.

OPTION - Task 3: Electrofusion of HPDE Piping Literature Review

Because electrofusion (EF) is a new technology to the Nuclear Industry and the NRC, a literature review is required to compile experience with these joints in service; identify performance issues and potential failure modes; evaluate joint mechanical test methods; and review existing codes, standards, and manufacturer's specifications and recommendations for installation and performance of EF joints.

The contractor shall perform a review of the existing literature on EF of HDPE piping some of which may be provided by the COR. Specifically, the contractor shall research all publically available literature on the following topics:

- Operating experience with EF joints in service:
 - Failure modes in EF joints, including root causes, times to failure, failure prediction models, and flaw tolerance
 - Test methods designed to evaluate short term quality assurance issues and long term structural integrity concerns
 - Existing codes, standards, and manufacturer's specifications and recommendations for installation and performance of EF joints
 - Use of EF for small (<12") versus large (>12") diameter piping, as EF couplings are known to be highly manufacturer dependent, especially for large diameters

- Essential parameters of EF joints to ensure adequate fusion and joint mechanical integrity, including acceptable limits on conditions known to reduce the quality of electrofusion joints, including contamination, overscrape or underscrape of the outer oxidized layer prior to fusion, misalignment, and pipe out-of-roundness or ovality

Deliverables for Task 3

Task 3 Draft Literature Review Technical Letter Report

The contractor shall prepare and submit a draft technical letter report (TLR) for Task 3 within 6 months after the start of the task. The draft Task 3 TLR shall summarize the relevant references reviewed for each of the topic areas listed in the Task 3 description above, and identify gaps in the state of knowledge of EF joint structural integrity for Class 3 safety systems in the U.S. Nuclear Reactor Fleet.

Task 3 Final Literature Review Technical Letter Report

The contractor shall prepare the Task 3 final TLR incorporating any comments from the COR on the Task 3 draft TLR. In addition to the final TLR, the contractor shall submit to the COR a copy of all references used in the Task 3 final TLR, as well as an Excel sheet containing the references and key information (authors, year, title, bibliographic reference) in tabulated format.

OPTION - Task 4: Electrofusion Joint Short-Term Mechanical Testing

Subtask 4.1: Confirmatory Testing for 'Ideal' EF Joints

Based on the literature review performed in Task 3, the contractor shall develop a test plan to perform the experiments described in the paragraph below. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests to ensure the goals of this project are met. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

The contractor shall perform confirmatory testing to compare short-term mechanical test methods for EF couplings produced from ASME Code-compliant PE4710 resins. The confirmatory testing shall include the peel test, crush test, and other methods revealed in the literature review and EPRI research as agreed upon between the COR and the contractor. For all of the testing to be performed under Subtask 4.1, the contractor shall fabricate joints by use of a trained and qualified electrofusion operator who shall fabricate the joints in accordance with the latest ASME Appendix XXVI methodology and manufacturer specifications.

Subtask 4.2: Confirmatory Testing for 'Non-Ideal' EF Joints

Based on the information gathered in Task 3 on potential defects in EF joints, the contractor shall develop a test plan to perform the experiments described in the paragraph below. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests to ensure the goals of this project are met. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

The contractor shall perform confirmatory testing to compare short-term mechanical test methods for EF couplings produced from ASME Code-compliant PE4710 resins. The confirmatory testing shall include the peel test, crush test, and other methods revealed in the literature review and EPRI research as agreed upon between the COR and the contractor. For all the testing to be performed under Subtask 4.2, the contractor shall fabricate joints with (a) intentional voids, (b) over-scrape and under-scrape of the outer oxidized layer of the pipe, and (c) contamination to provide confirmatory research on the effects of such conditions on the mechanical integrity of the joint. Aside from the intentionally introduced defects, the joints shall be fabricated in a manner as close as possible to the latest ASME Appendix XXVI methodology and manufacturer specifications by a trained and qualified electrofusion operator.

Deliverables for OPTION - Task 4

Test Plan for Subtasks 4.1 and 4.2

The contractor shall prepare and submit a draft test plan in a tabulated format for Subtasks 4.1 and 4.2 that includes test name, test type, specimen type, specimen materials, and test conditions (ex: load, temperature, crack or notch depth, etc., as applicable). For Subtask 4.2, the test plan shall also include the type and characteristics of the defect that was intentionally introduced in the EF joint. The contractor shall prepare and submit a final test plan incorporating any comments from the COR on the draft test plan. If necessary, the contractor shall prepare and submit a revised test plan(s).

Task 4 Draft Technical Letter Report (encompassing Subtasks 4.1 and 4.2)

The contractor shall prepare and submit a draft technical letter report (TLR) for Task 4 within 6 months after the start of the task. The Task 4 draft TLR shall encompass all work performed to date in Task 4 under Subtasks 4.1 and 4.2. The draft TLR shall describe in detail the test procedures and equipment, the specimens utilized, the test matrices, and the results obtained to date. In addition, the contractor shall submit raw and processed data to the COR upon request. The contractor shall update the Task 4 draft TLR every 6 months after the start of Task 4, and

incorporate any comments received from the COR in the next draft, until such time as Task 4 is completed.

Task 4 Final Technical Letter Report

The contractor shall prepare and submit a draft final TLR that encompasses all work performed under Subtasks 4.1 and 4.2 within 3 months from completing these two Subtasks. The draft final TLR shall summarize the efforts completed, propose conclusions on the adequacy of short term mechanical testing to assess the adequacy of HDPE piping with electrofusion joints in Class 3 applications, and identify any remaining gaps in the state of knowledge of electrofusion short-term joint structural integrity testing for Class 3 safety systems in the U.S. Nuclear Reactor Fleet. The contractor shall prepare a final TLR incorporating any comments from the COR on the draft final TLR. The contractor shall submit to the COR all raw and processed data.

Required Equipment and/or Analysis Tools

Items # 2, 4, 6, 7, 8, 9 from Key Equipment list in Section 11: Special Considerations.

OPTION - Task 5: Electrofusion (EF) Joints - Long Term Structural Integrity Evaluation

Subtask 5.1: Test Plan and Equipment Modification for EF Joint Testing

In order to assess the long-term structural integrity of EF joints, testing similar to that performed in Task 1 shall be performed on EF joints. Both coupon testing and whole pipe testing shall be performed. In order to develop a test plan that shall encompass the range of conditions expected in Class 3 safety systems in the U.S. Nuclear Reactor Fleet, the contractor shall review EPRI and ASME service life requirements for EF joints.

Based on the review of the EPRI and ASME service life requirements, the contractor shall develop a test plan to perform the experiments for Subtasks 5.2 and 5.3. The test plan shall meet the program requirements while attempting to minimize the number of tests to be run. COR approval of the final test plan is required prior to the contractor performing any tests. The contractor shall update the test plan as needed during the conduct of the tests to ensure the goals of this project are met. COR approval of the revised test plan is required prior to the contractor performing any revised or additional tests.

In order to carry out the Task 5 testing with the equipment used in Task 1, the contractor shall be required to adapt this equipment for EF joint testing. The contractor shall propose a plan to modify the equipment used in Task 1 for HDPE piping butt fusion joint testing to perform the EF joint testing for Task 5. The contractor shall propose modifications that are easily reversible in order to be able to perform additional HDPE piping butt fusion testing, if necessary. COR approval of the modification plan is required prior to the contractor modifying the equipment.

Based on the equipment modification plan approved by the COR, the contractor shall modify the Task 1 test equipment to perform the Task 5 testing.

Subtask 5.2: Coupon Testing of EF Joints

The contractor shall perform coupon testing of HDPE piping EF joints to determine SCG resistance using a combination of Pennsylvania Edge Notch tension (PENT) and Single Edge Notch Tension (SENT) tests. The load, load-line displacement, and time shall be measured to establish failure time. Stress levels and test temperatures shall be chosen to fill holes in the current NRC database for SCG resistance of HDPE EF joints, per COR direction.

Subtask 5.3: Whole Pipe EF Joint Testing

In order to confirm the applicability of the coupon tests performed in Subtask 5.2 to actual full scale HDPE piping EF joints, the contractor shall perform testing of whole pipe joints under tensile loading on small pipe diameters (up to 4 inches). The contractor shall also fabricate and perform tensile testing on large diameter pipe (up to 12 inches) with electrofusion joints.

Deliverables for OPTION - Task 5

Test Plan for Subtasks 5.2 and 5.3

The contractor shall prepare and submit a draft test plan in a tabulated format for Subtasks 5.2 and 5.3 that includes test name, test type, specimen type, specimen materials, and test conditions (ex: load, temperature, crack or notch depth, etc., as applicable). The contractor shall prepare and submit a final test plan incorporating any comments received from the COR on the draft test plan. If necessary, the contractor shall prepare and submit a revised test plan(s).

Equipment Modification Plan

The contractor shall prepare and submit a draft plan to modify the Task 1 equipment to perform the Task 5 EF joint testing. The modification plan shall include a list of the equipment to be modified, detailed descriptions and drawings for the proposed modifications, and a description of how the equipment can be reversed back to initial state for additional HDPE piping butt fusion joint testing, if necessary. COR prior approval of the Equipment Modification Plan is required prior to modification of any equipment.

Task 5 Draft Technical Letter Report (encompassing Subtasks 5.1 through 5.3)

The contractor shall prepare and submit a draft technical letter report (TLR) for Task 5 within 6 months after the start of the task. The Task 5 draft TLR shall encompass all work performed to date in Task 5 under Subtasks 5.1 through 5.3. The draft TLR shall describe in detail the test procedures and equipment, the specimens utilized, the test matrices, equipment modifications, and the results obtained to date. In addition, the contractor shall submit raw and processed data to the COR upon request. The contractor shall update the Task 5 draft TLR every 6 months after the start of Task 5, and incorporate any comments received from the COR in the next draft, until such time as Task 5 is completed.

Task 5 Final Technical Letter Report

The contractor shall prepare and submit a draft final TLR that encompasses all work performed under Subtasks 5.1 through 5.3 within 3 months from completing these Subtasks. The draft final TLR shall summarize the efforts completed, propose conclusions on the adequacy HDPE piping with EF joints in Class 3 safety systems in the U.S. Nuclear Reactor Fleet, and identify

any remaining gaps in the state of knowledge of electrofusion joint structural integrity for class 3 safety systems in the U.S. Nuclear Reactor Fleet. The contractor shall prepare a final TLR incorporating any comments from the COR on the draft final TLR. The contractor shall submit to the COR all raw and processed data.

Required Equipment and/or Analysis Tools

Items # 1 through 9 from Key Equipment list in Section 11: Special Considerations.

Task 6: Related Technical Support

Subtask 6.1: Related Technical and Regulatory Analysis Support

The contractor shall perform technical and regulatory analysis on emerging issues related to HDPE piping integrity in support of NRC licensing regulatory reviews or other NRC nuclear regulatory research. Support shall be provided on an as-needed basis upon the written direction of the COR. Specifically, the contractor shall perform confirmatory calculations for flaw tolerance, service life, fatigue life, or other technical analyses related to HDPE piping integrity. Such analyses shall be performed at the COR's written request, and shall be in support of HDPE piping licensing regulatory reviews, or other related NRC research on HDPE piping.

During the entire period of performance of this task order, the contractor shall communicate with Industry and International Participants in support of this research program, on an as-needed basis, upon the written direction of the COR.

The estimated level of overall effort for this Subtask is up to 160 hours per year.

Deliverable for Subtask 6.1:

Technical and Regulatory Analysis Support Technical Letter Report(s)

For each technical or regulatory analysis support request, the contractor shall prepare and submit a short (e.g. anticipated to be no more than 10 pages) draft TLR that includes analysis results, regulatory conclusions, and/or other information as requested by the COR commensurate with the issue being addressed and the needs of the COR. The contractor shall prepare a final TLR incorporating any comments from the COR on the draft TLR.

Subtask 6.2: Related ASME Code and Standards Support

The contractor shall provide support for ASME Codes & Standards Activities as related to this project, on an as-needed basis, at the written direction of the COR. Support shall include, but is not limited to, participating in the ASME code week meetings once per quarter throughout the period of performance of this task order (3 day domestic trip). The contractor shall prepare briefing materials for the meetings during the ASME code week on an as needed basis, at the written direction of the COR. In addition, after completion of the ASME code week meetings, the contractor shall prepare and submit a written summary of each of the ASME meetings that were attended during the ASME code week.

The contractor shall use participation in the ASME Codes and Standards Activities to stay informed of industry experience with HDPE piping in U.S. and foreign countries, and to identify

emerging issues for existing and new HDPE systems being deployed in the U.S. nuclear reactor fleet.

Deliverables for Subtask 6.2

ASME Meeting Materials and Meeting Summaries

Deliverable 1: The contractor shall prepare and submit any draft materials prepared for the ASME code week meetings. The contractor shall prepare final materials incorporating any COR comments on the draft materials.

Deliverable 2: The contractor shall prepare and submit a short (e.g. anticipated to be no more than 10 pages) meeting summary for each ASME code week meeting attended by the contractor. The summary shall provide any new information obtained related to industry experience with HDPE piping in the U.S. and foreign countries as well as a description of any emerging issues discussed during the meeting related to HDPE piping systems being deployed in the U.S. nuclear reactor fleet.

Subtask 6.3: Kickoff Meeting and Annual Program Review Meetings

Shortly after award, the contractor shall participate in a kickoff meeting at the NRC Headquarters in Rockville, Maryland. Each year of the contract, the contractor shall participate in an annual program review meeting with the COR and other NRC technical staff to discuss work performed during the year. The meetings are expected to be held at NRC Headquarters, in Rockville Maryland.

Deliverable for Subtask 6.3

Kickoff meeting and Annual Program Review Viewgraphs, and Other Supporting Materials

The contractor shall prepare viewgraphs and other support materials, e.g. handouts, for the kickoff meeting and for each annual program review. For the kickoff meeting, the viewgraphs shall go over the scope of the work for all awarded tasks, and provide any insights and suggestions the contractor has to ensure a successful project. For the annual program reviews, the viewgraphs shall summarize the work performed to date under this task order, highlight important test results, provide a snapshot of the project's financial status, highlight any potential problem areas and propose potential solutions, and outline the work to be performed during the following contract year.

Subtask 6.4: Peer-Reviewed Technical Paper

For each year of this task order, the contractor shall prepare a technical paper to be presented at a peer reviewed conference, technical meeting, or to be published in a technical journal. This technical paper shall describe one or more important aspects of the research performed during the year related to this research project. COR written approval of the topics to be addressed in the technical paper is required prior to the contractor starting work on preparing the technical paper. If directed by the COR, the contractor shall present the paper.

Deliverable for Subtask 6.4:

Annual Technical Paper

The contractor shall prepare a draft technical paper and a final technical paper that incorporates COR comments received on the draft technical paper.

Required Equipment and/or Analysis Tools

Items # 9 from Key Equipment list in Section 11: Special Considerations.

OPTION - Task 7: Emerging Research Needs

Upon prior written direction from the COR, the contractor shall provide ad-hoc support to NRC on emerging short and long term HDPE and piping integrity research needs.

Specifically, the work to be performed under this task shall be in one or more of the following categories:

- Fracture mechanics analyses
- Piping integrity analyses
- Mechanical testing on HDPE or other piping specimens using the test equipment developed for the work under this task order, and of the same nature as the testing performed under this task order
- Finite element analyses in support of piping integrity evaluations
- HDPE test specimen manufacturing in support of other NRC programs, using the manufacturing equipment and techniques developed for this research project (such as, pipe joint manufacture, either in ideal conditions, or with intentionally introduced defects)

Deliverables for Task 7

Task 7 Draft Technical Letter Report

The contractor shall prepare and submit a draft technical letter report (TLR) for each emergent request, that encompasses all work performed for that request. For work involving testing, the draft TLR shall describe in detail the test procedures and equipment, the specimens utilized, the test matrices, and the results obtained to date. In addition, the contractor shall submit raw data to the COR in a tabulated format upon request. For work involving analyses, the analysis methods, assumptions, and results shall be documented by the contractor in the draft TLR. In addition, worksheets and/or input files used for the analyses shall be submitted to the COR upon request.

Task 7 Final Technical Letter Report

The contractor shall prepare a final TLR for each emergent request, incorporating any comments from the COR on the draft TLR for that request. The contractor shall submit to the COR all raw and processed data, and/or analyses (worksheet and/or input files) for work performed under Task 7. Any specimens produced under Task 7 in support of other NRC research programs shall be shipped to the location where the other NRC work is being performed, as instructed in writing by the COR.

Required Equipment and/or Analysis Tools

Potentially any of the items from Key Equipment list in Section 11: Special Considerations.

5. APPLICABLE DOCUMENTS AND STANDARDS

ASME Code Section III and Section XI.

Plastic Pipe Institute Technical Report TR-33 (2012).

6. DELIVERABLES/MILESTONE SCHEDULE AND REPORTING REQUIREMENTS

The contractor shall provide the deliverables stated in the table below in electronic format unless otherwise directed by the COR. The electronic format shall be provided using a Microsoft-based product, (e.g., Outlook, Word, Excel, PowerPoint) unless the COR and the contractor specifically agree on another format. All deliverables, with the exception of the Monthly Letter Status Report (MLSR) shall be in the format of draft version, revision version with redline/strikeout with a change-control appendix, and a revised version which shall become the final version. The contractor shall maintain appropriate version control in an electronic format. The contractor shall explicitly state in its submittal(s) that the product provided is the deliverable for Task/Subtask XX, as further described below.

The deliverables below shall be submitted to the task order COR. The COR will review all draft deliverables (and coordinate any internal NRC staff review, if needed) and provide comments back to the contractor. The contractor shall revise the draft deliverable based on the comments provided by the COR and then deliver a revised version of the deliverable, which will then be considered the Final Version. When mutually-agreed upon between the contractor and the COR, the contractor may submit preliminary or partial drafts to help gauge the contractor's understanding of the particular work requirement. More than one round of drafts may be needed if the contractor does not successfully incorporate the COR's comments on the previous draft.

The contractor shall develop (as necessary), maintain, and control data, files, information, and deliverables pursuant to this task order.

DELIVERABLE/MILESTONE SCHEDULE

Task No.	Description	Due Date
1	Draft Test Plan for Subtasks 1.1 through 1.3	2 months after the start of Task 1
1	Final Test Plan for Subtasks 1.1 through 1.3	2 weeks after COR comments are received If applicable, revisions due 1 week after COR request for a revision
1	Draft TLR (encompassing Subtasks 1.1 through Subtask 1.4)	Every 6 months after the start of Task 1
1	Draft Final TLR	3 months after all Task 1 work is completed
1	Final TLR	1 month after COR comments are received
2	Draft Summary Report of EPRI HDPE Piping Butt Fusion Joint QA Testing Report for Subtask 2.1	2 months after start of Task 2

Task No.	Description	Due Date
2	Final Summary Report of EPRI HDPE Piping Butt Fusion Joint QA Testing Report for Subtask 2.1	1 month after COR comments are received
2	Draft Test Plan for Subtask 2.1	3 months after start of Task 2
2	Final Test Plan for Subtask 2.1	2 weeks after COR comments are received If applicable, revisions due 1 week after COR request for a revision
2	Draft TLR (encompassing Subtasks 2.1 through 2.3)	Every 6 months after the start of Task 2
2	Draft Final TLR	3 months after all Task 2 work is completed
2	Final TLR	1 month after COR comments are received
3	Draft Literature Review TLR	6 months after the start of Task 3
3	Final Literature Review TLR Copy of all references used in Literature Review Excel Spreadsheet of References and Key Information from Literature Review	1 month after COR comments are received
4	Draft Test Plan for Subtasks 4.1 and 4.2	2 months after the start of Task 4
4	Final Test Plan for Subtasks 4.1 and 4.2	2 weeks after COR comments are received If applicable, revisions due 1 week after COR request for a revision
4	Draft TLR (encompassing Subtasks 4.1 and 4.2)	Every 6 months after the start of Task 4
4	Draft Final TLR	3 months after all Task 4 work is completed
4	Final TLR	1 month after COR comments are received
5	Draft Test Plan for Subtasks 5.2 and 5.3	2 months after the start of Task 5
5	Final Test Plan for Subtasks 5.2 and 5.3	2 weeks after COR comments are received If applicable, revisions due 1 week after COR request for a revision
5	Draft Equipment Modification Plan	3 months after the start of Task 1
5	Final Equipment Modification Plan	2 weeks after COR comments are received
5	Equipment Modification Completed	3 months after plan approval
5	Draft TLR (encompassing Subtasks 5.1 through 5.3)	Every 6 months after the start of Task 5
5	Draft Final TLR	3 months after all Task 5 work is completed
5	Final TLR	1 month after COR comments are received
6	Draft Technical and Regulatory Analysis Support TLR(s)	1 month after technical assistance request
6	Final Technical and Regulatory Analysis Support TLR(s)	2 weeks after COR comments are received
6	Draft ASME Meeting Materials	2 weeks before each ASME meeting
6	Final ASME Meeting Materials	1 week before each ASME meeting
6	ASME Meeting Summaries	2 weeks after each ASME meeting
6	Kickoff Meeting Viewgraphs and Other Potential Supporting Materials	Day of kickoff meeting
6	Draft Annual Program Review Viewgraphs and Other Supporting Materials	2 weeks before annual program review
6	Final Annual Program Review Viewgraphs and Other Supporting Materials	1 week before annual program review
6	Draft Annual Technical Paper	1 month before deadline for submittal to peer reviewed conference/technical meeting/journal

Task No.	Description	Due Date
6	Final Annual Technical Paper	1 week before submittal to peer reviewed conference/technical meeting/journal
7	Draft TLR(s)	1 draft TLR per emergent request due 3 months after all work is completed for that particular emergent request
7	Final TLR(s)	1 final TLR per emergent request due 1 month after COR comments are received
All	Monthly Letter Status Report (MLSR) per Section F.3 and Attachment 5 of the base contract. Detail the work effort by labor category	20 th calendar day of the following month

The contractor shall submit the raw and processed data and worksheet and/or input files used in testing and analyses with the Draft TLR, upon request by the COR and with the Final TLR, in a tabulated Excel format or other format as directed by the COR.

7. REQUIRED LABOR CATEGORIES/ ESTIMATED LEVEL OF EFFORT (Except for Information Technology Services)

Base tasks

Labor Category	Estimated Labor Hours				
	FY16	FY17	FY18	FY19	FY20
Project Manager (PM)	20	40	40	32	24
Subject Matter Expert (SME)	80	200	180	160	100
Sr. Tech Reviewer (STR)	80	160	120	120	80
Technical Reviewer (TR)	20	60	60	60	40
Administrative Support (ADMIN)	8	16	16	16	8
TOTAL ESTIMATED LOE	208	476	416	388	252

Option tasks

Labor Category	Estimated Labor Hours				
	FY16	FY17	FY18	FY19	FY20
Project Manager (PM)	20	40	40	48	36
Subject Matter Expert (SME)	80	180	200	220	120
Sr. Tech Reviewer (STR)	60	460	200	200	120
Technical Reviewer (TR)	40	80	80	80	40
Administrative Support (ADMIN)	8	16	16	16	16
TOTAL ESTIMATED LOE	208	476	536	564	332

8. GOVERNMENT-FURNISHED PROPERTY

Access to all deliverables from previous NRC HDPE research, as needed for this project per the COR's determination, including all past test data, analyses, and letter reports.

EPRI technical reports and data obtained through the NRC-EPRI Memorandum of Understanding on HDPE research, as needed for this project per the COR's determination.

9. PERIOD OF PERFORMANCE

See SECTION F - Deliveries or Performance, NRCF030A PERIOD OF PERFORMANCE ALTERNATE I

10. PLACE OF PERFORMANCE

The work to be performed under this task order shall be performed at the Contractor's facility except for the travel described in Section 11.1 of this statement of work.

11. SPECIAL CONSIDERATIONS

11.1 TRAVEL/MEETINGS

The following travel may occur under this task order:

Travel Description	Task	Location	Date	Days	Attendees
FY 2016					
Kickoff Meeting	6	Rockville, MD	06/2016	1	11
ASME Code Meeting	6	Washington, DC	08/2016	3	1
Program Review at NRC	6	Rockville, MD	01/2017	2	2
FY 2017					
Program Review at NRC	6	Rockville, MD	06/2017	2	2
ASME Code Meeting	6	Saint Louis, MO	11/2016	3	1
ASME Code Meeting	6	Atlanta, GA	02/2017	3	1
ASME Code Meeting	6	Anchorage, AK	05/2017	3	1
ASME Code Meeting	6	Minneapolis, MN	08/2017	3	1
Technical Conference/Meeting	6	TBD	TBD	4	1
FY 2018					
Program Review at NRC	6	Rockville, MD	06/2018	2	2
ASME Code Meeting	6	Phoenix, AZ	11/2017	3	1
ASME Code Meeting	6	TBD	02/2018	3	1
ASME Code Meeting	6	Dallas, TX	05/2018	3	1
ASME Code Meeting	6	TBD	08/2018	3	1
Technical Conference/Meeting	6	TBD	TBD	4	1
FY 2019					

Program Review at NRC	6	Rockville, MD	06/2019	2	2
ASME Code Meeting	6	Atlanta, GA	11/2018	3	1
ASME Code Meeting	6	TBD	02/2019	3	1
ASME Code Meeting	6	TBD	05/2019	3	1
ASME Code Meeting	6	TBD	08/2019	3	1
Technical Conference/Meeting	6	TBD	TBD	4	1
FY 2020					
Program Review at NRC	6	Rockville, MD	06/2020	2	2
ASME Code Meeting	6	TBD	11/2019	3	1
ASME Code Meeting	6	TBD	02/2020	3	1

Travel Notes

All contractor travel requires prior written approval from the COR.

Number of trips, number of contractor personnel, duration, location, may be modified based on meeting circumstances and COR need for contractor support. Contractor shall implement travel cost-sharing measures (for example sharing rental car) if possible.

At the discretion of the COR, meetings may be conducted via telephone, video conference, or at the contractor site.

All travel conducted pursuant to this task order is billable at Federal per diem rates, in accordance with Federal Travel Regulations.

11.2 SECURITY

The work will be UNCLASSIFIED.

Work on this task order may involve the handling of documents that contain proprietary information. The contractor shall safeguard documents containing proprietary information against unauthorized disclosure. After completion of work, the contractor shall either destroy the documents or return them to the NRC. If they are destroyed, please confirm this in an e mail to the COR with a copy to the CO and include the date and manner in which the documents were destroyed.

11.3 KEY PERSONNEL

See SECTION H - Special Contract Requirements, 2052.215-70 KEY PERSONNEL. (JAN 1993)

11.4 KEY EQUIPEMENT, CERTIFICATIONS, and ANALYSIS TOOLS

The following equipment, certifications, and analysis tools shall be required to perform the research described in this statement of work:

1. PENT Test Equipment: at least 6 instrumented PENT frames with automated data acquisition system to measure load, load line displacement, temperature and time, to be able to determine failure time, crack initiation time and crack growth vs. time.

2. Creep Test Equipment: at least 6 PENT frames along with the above instrumentation, and modified with purpose-built grips to measure creep displacement vs. time curve for HDPE at various stress levels (up to 1200 psi) and temperatures up to 200 F.
3. SENT Test Equipment: at least two large instrumented SENT test frames to measure SCG characteristics for up to 1" x 1" cross section specimens to measure load, load line displacement, temperature and time to be able to determine failure time, crack initiation time and crack growth vs. time.
4. Whole Pipe Test Equipment: purpose-built pipe grips and fixtures for the SENT frames to test whole pipe specimens up to 4" in diameter in tension and up to 800 psi axial stress and 95 C sustained temperature with load, load-line displacement, temperature and time acquired continuously through the tests up to failure (> 10,000 hours) automated with data acquisition system.
5. Hydrostatic Test Equipment: at least two Hydrostatic Baths with complete pressurizers, pumps and servo control system to test pipe specimens up to 12" in diameter under internal hydrostatic pressures up to 200 psi and at 95C until failure (>10,000 hours).
6. Specimen Preparation Equipment: milling cutter to precisely machine specimens with notching techniques needed to prepare PENT, SENT and Whole Pipe specimens. Polishing equipment and procedures to accurately locate the fusion line and melt zone area prior to accurately positioning the razor notch for SCG evaluation of specimens. Special fixtures, as necessary, for razor notching of the PENT and SENT specimens as per ASTM standards and for recording the Load-displacement during the razor notching of specimens.
7. Instrumented Impact Testing Equipment: Dynatup Charpy testing machine with purpose-built fixtures for Charpy specimens to measure load vs. time curves during impact and to determine the energy absorbed in order to discriminate between acceptable and unacceptable joints.
8. Fusion Joint Equipment and Capabilities:
 - a. Instrumentation to determine temperature, pressures, and displacement during the fusion process so as to accurately measure both the melt zone and the molten bead size in order to assess the quality of fused joints and correlate with instrumented impact tests.
 - b. All necessary fixtures to conduct high speed tensile tests (HSTT) and the side bend test per the ASTM standard, which are currently used by industry to assess joint quality.
 - c. Certified technician for fusing and testing plastic pipe specimens.
9. Analysis Capabilities:
 - a. Nonlinear viscoelastic finite element analyses capabilities with specialized user defined subroutines for ABAQUS to model the SCG failure behavior of parent and joint materials.

- b. Multi-physics software package, such as COMSOL, to predict heating times and melt zones during the fusion process.

11.5 LICENSE FEE RECOVERY

All work under this task order is not license fee recoverable.

SECTION F - Deliveries or Performance

NRCF030A PERIOD OF PERFORMANCE ALTERNATE I

The total period of performance for this project is estimated to be June 22, 2016 through May 31, 2020.

The work on this task order is organized into four (4) CLINs.

The Basic Period - Cost (CLIN 00001) is to begin June 22, 2016 and will expire on May 31, 2020.

The Basic Period - Fee (CLIN 00001) is to begin June 22, 2016 and will expire on May 31, 2020.

Option - Cost (CLIN 10001) will begin on October 1, 2018 and will expire on May 31, 2020.

Option - Cost (CLIN 10002) will begin on October 1, 2018 and will expire on May 31, 2020.

(See FAR 52.216-18 - Ordering)

(End of Clause)

Note: The NRC and contractor may opt to exercise Option CLIN 00003 earlier than the time stated above, via an executed bilateral option exercise modification.

SECTION H - Special Contract Requirements

2052.215-70 KEY PERSONNEL. (JAN 1993)

(a) The following individuals are considered to be essential to the successful performance of the work hereunder:

Title	Name
Principal Investigator/ Sr. Vice President	Dr. Prabhat Krishnaswamy
Sr. Technical Reviewer/ Principal Engineer	Dr. Suresh Kalyanam

*The contractor agrees that personnel may not be removed from the contract work or replaced without compliance with paragraphs (b) and (c) of this section.

(b) If one or more of the key personnel, for whatever reason, becomes, or is expected to become, unavailable for work under this contract for a continuous period exceeding 30 work days, or is expected to devote substantially less effort to the work than indicated in the proposal or initially anticipated, the contractor shall immediately notify the contracting officer and shall, subject to the concurrence of the contracting officer, promptly replace the personnel with personnel of at least substantially equal ability and qualifications.

(c) Each request for approval of substitutions must be in writing and contain a detailed explanation of the circumstances necessitating the proposed substitutions. The request must also contain a complete resume for the proposed substitute and other information requested or needed by the contracting officer to evaluate the proposed substitution. The contracting officer and the project officer shall evaluate the contractor's request and the contracting officer shall promptly notify the contractor of his or her decision in writing.

(d) If the contracting officer determines that suitable and timely replacement of key personnel who have been reassigned, terminated, or have otherwise become unavailable for the contract work is not reasonably forthcoming, or that the resultant reduction of productive effort would be so substantial as to impair the successful completion of the contract or the service order, the contract may be terminated by the contracting officer for default or for the convenience of the Government, as appropriate. If the contracting officer finds the contractor at fault for the condition, the contract price or fixed fee may be equitably adjusted downward to compensate the Government for any resultant delay, loss, or damage.

(End of Clause)

* To be incorporated into any resultant contract

2052.215-71 PROJECT OFFICER AUTHORITY. (OCT 1999)

(a) The contracting officer's authorized representative hereinafter referred to as the project officer for this contract is:

Name: Patrick Raynaud,
Address: US NRC
Office of Nuclear Regulatory Research
MS T-10A36
Washington DC 20555
Telephone Number: 301-415-1987
Email: Patrick.Raynaud@nrc.gov

The alternate contracting officer's representative is:

Name: Bruce Lin
Address: US NRC
Office of Nuclear Regulatory Research
MS T-10A36
Washington DC 20555
Telephone Number: 301-415-2446
Email: Bruce.Lin@nrc.gov

(b) Performance of the work under this contract is subject to the technical direction of the NRC project officer. The term technical direction is defined to include the following:

(1) Technical direction to the contractor which shifts work emphasis between areas of work or tasks, authorizes travel which was unanticipated in the Schedule (i.e., travel not contemplated in the Statement of Work or changes to specific travel identified in the Statement of Work), fills in details, or otherwise serves to accomplish the contractual statement of work.

(2) Provide advice and guidance to the contractor in the preparation of drawings, specifications, or technical portions of the work description.

(3) Review and, where required by the contract, approve technical reports, drawings, specifications, and technical information to be delivered by the contractor to the Government under the contract.

(c) Technical direction must be within the general statement of work stated in the contract. The project officer does not have the authority to and may not issue any technical direction which:

(1) Constitutes an assignment of work outside the general scope of the contract.

(2) Constitutes a change as defined in the "Changes" clause of this contract.

(3) In any way causes an increase or decrease in the total estimated contract cost, the fixed fee, if any, or the time required for contract performance.

(4) Changes any of the expressed terms, conditions, or specifications of the contract.

(5) Terminates the contract, settles any claim or dispute arising under the contract, or issues any unilateral directive whatever.

(d) All technical directions must be issued in writing by the project officer or must be confirmed by the project officer in writing within ten (10) working days after verbal issuance. A copy of the written direction must be furnished to the contracting officer. A copy of NRC Form 445, Request for Approval of Official Foreign Travel, which has received final approval from the NRC must be furnished to the contracting officer.

(e) The contractor shall proceed promptly with the performance of technical directions duly issued by the project officer in the manner prescribed by this clause and within the project officer's authority under the provisions of this clause.

(f) If, in the opinion of the contractor, any instruction or direction issued by the project officer is within one of the categories defined in paragraph (c) of this section, the contractor may not proceed but shall notify the contracting officer in writing within five (5) working days after the receipt of any instruction or direction and shall request that contracting officer to modify the contract accordingly. Upon receiving the notification from the contractor, the contracting officer shall issue an appropriate contract modification or advise the contractor in writing that, in the contracting officer's opinion, the technical direction is within the scope of this article and does not constitute a change under the "Changes" clause.

(g) Any unauthorized commitment or direction issued by the project officer may result in an unnecessary delay in the contractor's performance and may even result in the contractor expending funds for unallowable costs under the contract.

(h) A failure of the parties to agree upon the nature of the instruction or direction or upon the contract action to be taken with respect to the instruction or direction is subject to 52.233-1 - Disputes.

(i) In addition to providing technical direction as defined in paragraph (b) of the section, the

project officer shall:

- (1) Monitor the contractor's technical progress, including surveillance and assessment of performance, and recommend to the contracting officer changes in requirements.
- (2) Assist the contractor in the resolution of technical problems encountered during performance.
- (3) Review all costs requested for reimbursement by the contractor and submit to the contracting officer recommendations for approval, disapproval, or suspension of payment for supplies and services required under this contract.

(End of Clause)

SECTION J - List of Documents, Exhibits and Other Attachments

Attachments:

1. Monthly Letter Status Report Template