

**ORDER FOR SUPPLIES OR SERVICES**

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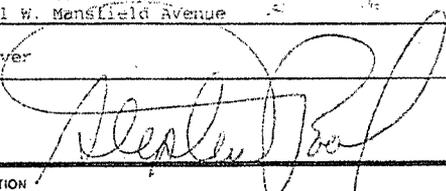
IMPORTANT: Mark all packages and papers with contract and/or order numbers.

BPA NO. NRC-DE-04-08-147

1. DATE OF ORDER <b>AUG 20 2009</b>		12. CONTRACT NO. (if any) G010F01457		6. SHIP TO:	
3. ORDER NO. NRC-T004		4. REQUISITION REFERENCE NO. 04-08-147T004		a. NAME OF CONSIGNEE U.S. Nuclear Regulatory Commission	
5. ISSUING OFFICE (Address correspondence to) U.S. Nuclear Regulatory Commission Div. of Contracts Attn: Adalis M Rodriguez, 301-492-3623 Mail Stop: TMB-01-B10M Washington, DC 20555		b. STREET ADDRESS Mail Stop: C-C67N ATTN: Eric Fochs		c. CITY Washington	
7. TO:		d. STATE DC		14. ZIP CODE 20555	
3. NAME OF CONTRACTOR ENGINEERING MECHANICS CORPORATION OF COLUMBUS EMC2		4. SHIP VIA		8. TYPE OF ORDER	
b. COMPANY NAME		<input type="checkbox"/> a. PURCHASE		<input checked="" type="checkbox"/> b. DELIVERY	
a. STREET ADDRESS 3315 RIVERSIDE DR STE 202		REFERENCE YOUR Please furnish the following on the terms and conditions specified on both sides of this order and on the attached contract, if any, including delivery as indicated		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.	
d. CITY COLUMBUS		e. STATE OH		1. ZIP CODE 432211735	
3. ACCOUNTING AND APPROPRIATION DATA Obligatee \$25,000.00 B&R:960-15-111-123 JOB:N5637 HOC: 252A 31X9200.960 FFS: RES-C09-595 DUNS: 014083161		10. REQUISITIONING OFFICE EES		12. F.O.B. POINT Destination	
11. BUSINESS CLASSIFICATION (Check appropriate box(es))		c. DISADVANTAGED		g. SERVICE-DISABLED VETERAN-OWNED	
<input checked="" type="checkbox"/> a. SMALL		<input type="checkbox"/> b. OTHER THAN SMALL		<input type="checkbox"/> d. EMERGING SMALL BUSINESS	
<input type="checkbox"/> d. WOMEN-OWNED		<input type="checkbox"/> e. HUBZone		13. PLACE OF	
a. INSPECTION Destination		b. ACCEPTANCE Destination		14. GOVERNMENT B/L NO.	
				15. DELIVER TO F.O.B. POINT ON OR BEFORE (Date)	
				16. DISCOUNT TERMS	

17. SCHEDULE (See reverse for Regulations)

ITEM NO. (a)	SUPPLIES OR SERVICES (b)	QUANTITY ORDERED (c)	UNIT (d)	UNIT PRICE (e)	AMOUNT (f)	QUANTITY ACCEPTED (g)
	The contractor shall perform the services as described in the attached statement of work in accordance with the price schedule in section A.1 and the terms and conditions of BPA NRC-DE-04-08-147.  Order Type: Labor Hour Period of Performance: Award date- 8/19/2011 Total Order Ceiling: \$117,326 Total Obligated Amount: \$25,000.00  Accepted:  8/20/09 Date					

18. SHIPPING POINT		19. GROSS SHIPPING WEIGHT		20. INVOICE NO.	
21. MAIL INVOICE TO:					
a. NAME Department of Interior / NRC NRCpayments@nrc.gov					
b. STREET ADDRESS (or P.O. Box) Attn: Fiscal Services Branch - 02770 7301 W. Mansfield Avenue					
c. CITY Denver		d. STATE CO		e. ZIP CODE 80235-2330	
22. UNITED STATES OF AMERICA By (Signature) 				23. NAME (Typed) Stephen Pool Contracting Officer TITLE: CONTRACTING/ORDERING OFFICER	

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OPTIONAL FORM 347 (REV. 4/2006)  
PRESCRIBED BY GSA/FAR 48 CFR 53.213(f)

**TEMPLATE - ADM001**

**SUNSI REVIEW COMPLETE**

AUG 21 2009

**ADM002**

**TASK ORDER TERMS AND CONDITIONS**

**A.1 PRICE SCHEDULE**

<b>Labor Category</b>	<b>Labor Rate</b>	<b>Est. Hours</b>	<b>Total</b>
President	[REDACTED]	0	\$0.00
Vice-President	[REDACTED]	0	\$0.00
Senior Program Manager	[REDACTED]	0	\$0.00
Senior Regulatory Advisor	[REDACTED]	0	\$0.00
Senior Research Leader	[REDACTED]	200	\$40,300.00
Research Leader	[REDACTED]	0	\$0.00
Principal Engineer	[REDACTED]	550	\$72,039.00
Research Engineer	[REDACTED]	0	\$0.00
Engineer	[REDACTED]	0	\$0.00
Master Technician	[REDACTED]	0	\$0.00
Electronics Specialist	[REDACTED]	50	\$4,987.00
Administrative assist.	[REDACTED]	0	\$0.00
ODC – Cost reimbursement. No G&A or Materials and handling charges are applicable.			\$0
Travel - Cost reimbursement. No G&A or Materials and handling charges are applicable.			\$0
<b>Total</b>			<b>\$117,326.00</b>

**A.2 CONSIDERATION AND OBLIGATION - LABOR HOUR ORDER**

- (a) The total not to exceed cost to the Government for full performance of this contract is \$117,326.00.
- (b) The amount currently obligated by the Government with respect to this contract is \$25,000. The contractor shall not exceed this obligated amount at any time.

STATEMENT OF WORK  
FOR CONTRACTOR TO PROVIDE  
PRESSURE BOUNDARY INTEGRITY ANALYSES AND SUPPORT:  
CHARACTERIZATION AND MODELING OF HDPE VISCOELASTIC PROPERTIES

I. BACKGROUND

Boundary integrity analyses are required to conduct safety assessments of nuclear reactor coolant pressure boundary (RCPB) components, including the reactor pressure vessel (RPV), and to develop technical bases for regulatory positions. Polyethylene (PE) piping is being considered as a replacement for carbon steel piping in safety-related nuclear applications. Analyses and confirmatory research are required to establish a regulatory position regarding the service life of PE piping, including joints.

In October 2006, Duke Power (Duke) submitted a relief request to use PE piping as a replacement for carbon steel piping for the emergency diesel generator jacket water coolers and other Class 3 safety-related buried piping. Carbon steel piping installed at Catawba experienced aqueous corrosion and microbiologically induced corrosion (MIC) that resulted in operational inefficiencies and replacement expenses. PE piping is immune to both forms of corrosion and has been used by Duke for raw service water applications (non-safety related) for about 10 years with no reported problems associated with corrosion or MIC. Also, in August 2007, Union Electric Company submitted a relief request to use PE as a replacement for carbon steel piping for the essential service water system at its Callaway plant. Both requests are in review by the NRC.

The industry efforts associated with PE piping have been coordinated through the ASME Special Working Group on Polyethylene Piping (SWG-PP) over the past few years. The SWG-PP prepared Code Case N-755 to establish the design requirements for using PE piping in safety-related nuclear applications. Code Case N-755 covers several aspects critical to specifying the design requirements for PE piping, but the first draft put to a vote neglected to adequately address the flaw tolerance of PE and the volumetric inspection of joints. Based on these issues, the NRC voted negative on the first version of N-755. In response, the SWG-PP limited the service conditions to a maximum stress, service temperature and life of PE piping to 430 psi, 140 °F and 10 years, respectively. The original intention was to specify a 50-year service life at 140 °F. Flaws are limited to 10% of the wall thickness deep. The SWG-PP has recently identified circumferential flaws in butt joints to be a critical piping integrity issue since research has shown that butt joints may exhibit lower flaw tolerance than the parent material. However, data is needed on the more modern resins being evaluated to establish long-life service allowables. Specifically, slow crack growth (SCG) rate testing on the newest high density PE (HDPE) resins, piping and joints is required to calibrate and confirm SCG models that were developed for earlier HDPE resins. Among other properties, the molecular structure of PE has a significant effect on SCG resistance. It has been shown that the bimodal molecular weight distributions exhibited by more recently developed resins tends to help improve SCG resistance over resins with unimodal molecular weight distributions. The predictive capabilities of SCG models needs to be re-established for the newer resins.

In a memorandum dated March 18, 2006, NRR provided a user need request (NRR-2006-007) to RES to assist NRR in the development of a technical basis to support the staff's review of the

Task 4

proposed use of polyethylene piping for low pressure safety-related piping systems at nuclear power plants.

Overall, the deliverables from this project will provide the NRC staff with information needed to enhance the evaluation of industry generic assessments and plant-specific activities and to support long term regulatory actions that provide reasonable assurance of public health and safety in the area of boundary integrity analysis

II. OBJECTIVE

The objective of this task is to perform testing and analyses to model the viscoelastic properties of HDPE in order to more accurately predict the slow crack growth behavior and the material's response to high strains at stress concentrations as a function of stress, strain, temperature and time.

III. SCOPE OF WORK

The contractor shall perform work related to the characterization and modeling of HDPE Viscoelastic properties to include creep testing of HDPE and the development of a constitutive model for HDPE.

IV. REQUIREMENTS

The work to be performed under this task order consists of the following:

**Task 4 Characterization and Modeling of HDPE Viscoelastic Properties**

Task 4a Creep Testing of HDPE – Sustained load testing shall be performed on HDPE resins/pipes at various temperatures to establish the viscoelastic response.

Task 4b Develop of Constitutive Model for HDPE – A numerical model incorporating the viscoelastic (and possibly viscoplastic) behavior of HDPE shall be developed using finite element methods. The purpose of the model shall be to help predict the slow crack growth behavior of HDPE and the time-temperature-stress-strain response of HDPE at stress concentrations. The following shall also be performed related to the model: analysis of uncertainties, sensitivity study, and validation and verification (V&V) of the model. Case studies shall be performed to demonstrate the applicability of the model.

Deliverable schedule

All reports shall be submitted electronically as a Microsoft Word or PDF file to the Project Officer and Contracting Officer. In addition to the monthly letter status reports, the following deliverables are required:

Task 4a Letter report on testing and results. Date TBD. The report shall include background information on creep testing of PE, experimental procedures used, the results obtained, discussion of the results and conclusions.

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Task 4b Letter report on the development of the constitutive model for HDPE and an executable version of the code if possible. The report shall include the background information necessary to establish the basis for incorporating viscoelastic properties into HDPE constitutive models, the assumptions made regarding model inputs and results, results of the case studies, analysis of uncertainties, sensitivity studies and V&V. Due date TBD.

V. PERIOD OF PERFORMANCE

The period of performance of this task order is from award date to August 19, 2011.

VI. MEETINGS AND TRAVEL

Biweekly phone progress reports shall be conducted with the NRC Project Officer for approximately one-hour in duration throughout the period of performance. The frequency and duration of the phone progress reports will be adjusted according to the needs of the program to ensure progress is maintained.

VII. RESEARCH QUALITY

The quality of NRC research programs are assessed each year by the Advisory Committee on Reactor Safeguards. Within the context of their reviews of RES programs, the definition of quality research is based upon several major characteristics:

Results meet the objectives (75% of overall score)  
Justification of major assumptions (12%)  
Soundness of technical approach and results (52%)  
Uncertainties and sensitivities addressed (11%)

Documentation of research results and methods is adequate (25% of overall score)  
Clarity of presentation (16%)  
Identification of major assumptions (9%)

It is the responsibility of the contractor to ensure that these quality criteria are adequately addressed throughout the course of the research that is performed. The NRC project manager and technical monitor will review all research products with these criteria in mind.

VIII. TECHNICAL AND OTHER SPECIAL QUALIFICATIONS REQUIRED

The program manager, key personnel, and any other senior technical staff performing work under this contract shall have expertise, experience, and/or education in the following key areas:

- a) Expertise in finite element analyses;
- b) Expertise in mechanical properties testing and measurement techniques
- c) Expertise in developing fracture mechanics codes;
- d) Expertise in slow crack growth testing and analysis of polymeric materials;

- e) Expertise in polymeric materials and life prediction using rate process modeling techniques.

#### IX. PUBLICATIONS NOTE

RES encourages the publication of the scientific results from RES sponsored programs in refereed scientific and engineering journals as appropriate. If the laboratory proposes to publish in the open literature or present the information at meeting in addition to submitting the required technical reports, approval of the proposed article or presentation should be obtained from the NRC Project Manager. The RES Project Manager shall either approve the material as submitted, approve it subject to NRC suggested revisions, or disapprove it. In any event, the RES Project Manager may disapprove or delay presentation or publication of papers on information that is subject to Commission approval that has not been ruled upon or which has been disapproved. Additional information regarding the publication of NRC sponsored research is contained in NRC Management Directives 3.7, "NUREG Series Publications," and 3.9, "NRC Staff and Contractor Speeches, Papers, and Journal Articles on Regulatory and Technical Subjects."

If the presentation or paper is in addition to the required technical reports and the RES Project Manager determines that it will benefit the RES project, the Project Manager may authorize payment of travel and publishing costs, if any, from the project funds. If the Project Manager determines that the article or presentation would not benefit the RES project, the costs associated with the preparation, presentation, or publication will be borne by the contractor. For any publication or presentations falling into this category, the NRC reserves the right to require that such presentation or publication will not identify the NRC's sponsorship of the work.

#### X. NEW STANDARDS FOR CONTRACTORS WHO PREPARE NUREG-SERIES MANUSCRIPTS

The U.S. Nuclear Regulatory Commission (NRC) began to capture most of its official records electronically on January 1, 2000. The NRC will capture each final NUREG-series publication in its native application. Therefore, please submit your final manuscript that has been approved by your NRC Project Manager in both electronic and camera-ready copy.

All format guidance, as specified in NUREG-0650, Revision 2, will remain the same with one exception. You will no longer be required to include the NUREG-series designator on the bottom of each page of the manuscript. The NRC will assign this designator when we send the camera-ready copy to the printer and will place the designator on the cover, title page, and spine. The designator for each report will no longer be assigned when the decision to prepare a publication is made. The NRC's Publishing Services Branch will inform the NRC Project Manager for the publication of the assigned designator when the final manuscript is sent to the printer.

For the electronic manuscript, the Contractor shall prepare the text in Microsoft Word, and use any of the following file types for charts, spreadsheets, and the like.

File Types to be Used for NUREG-Series Publications	
File Type	File Extension
Microsoft®Word®	.doc
Microsoft® PowerPoint®	.ppt
Microsoft®Excel	.xls
Microsoft®Access	.mdb
Portable Document Format	.pdf

This list is subject to change if new software packages come into common use at NRC or by our licensees or other stakeholders that participate in the electronic submission process. If a portion of your manuscript is from another source and you cannot obtain an acceptable electronic file type for this portion (e.g., an appendix from an old publication), the NRC can, if necessary, create a tagged image file format (file extension.tif) for that portion of your report. Note that you should continue to submit original photographs, which will be scanned, since digitized photographs do not print well.

If you choose to publish a compact disk (CD) of your publication, place on the CD copies of the manuscript in both (1) a portable document format (PDF); (2) a Microsoft Word file format, and (3) an Adobe Acrobat Reader, or, alternatively, print instructions for obtaining a free copy of Adobe Acrobat Reader on the back cover insert of the jewel box.

XI. NRC-FURNISHED MATERIAL

None.