AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

BPA NO.	1. CONTRACT ID CODE	PAGE	OF PAG
		1	2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. (If applicable)
M006	SEP 29 2006		

6. ISSUED BY — CODE 3100

U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn:
Mail Stop T-7-I-2
Washington, DC 20555

7. ADMINISTERED BY (If other than Item 6) — CODE 3100

U.S. Nuclear Regulatory Commission
Div. of Contracts
Mail Stop T-7-I-2

Washington, DC 20555

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

UNIVERSITY OF MARYLAND

3112 LEE BLDG

COLLEGE PARK MD 207425100

CODE 790934285 FACILITY CODE

(X)	
	9A. AMENDMENT OF SOLICITATION NO.
	9B. DATED (SEE ITEM 11)
	10A. MODIFICATION OF CONTRACT/ORDER NO. NRC-04-04-064
X	10B. DATED (SEE ITEM 13) 11-20-2003

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 ACKNOWLEDGMENT 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)
66015111195, Y6591, 252A, 31X0200 Obligate $78,083.00
FFS No. RES-C06-647

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

(X)	
	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).
X	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF: Mutual Agreement of the Parties
	D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor ☐ is not, ☒ is required to sign this document and return 2 copies to the issuing office.

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

Refer to page 2

Except as provided herein, all terms and conditions of the document referenced in Item 9A 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)
Monique Anderson, Asst. Director	Donald A. King
15B. CONTRACTOR/OFFEROR: Monique Anderson (Signature of person authorized to sign)	15C. DATE SIGNED: 9/29/06
16B. UNITED STATES OF AMERICA BY: Donald A. King (Signature of Contracting Officer)	16C. DATE SIGNED: 9/28/06

STANDARD FORM 30 (REV. 10-83)

TEMPLATE - ADM001

SUNSI REVIEW COMPLETE

ADM002

Confirming the verbal authorization of $15,800 provided to the University of Maryland on 09/07/06, the purpose of this bilateral modification is to: (1) Increase the estimated ceiling amount of this contract by $78,083, from $553,819 to $631,902, (2) increase the obligated amount by $78,083.00 from $553,819 to $631,902 (3) extend the period of performance through April 30, 2007, incorporating the attached revised Statement of Work. Accordingly, the contract is hereby modified as follows:

1. Section B.3, Consideration and Obligation-Cost Reimbursement (JUN 1988) Alternate I (JUN 1988) paragraph (a) is deleted in its entirety and the following paragraph is substituted in lieu thereof:

   "The total estimated cost to the Government for full performance under this contract is $631,902."

2. Section B.3, Consideration and Obligation-Cost Reimbursement (JUN 1988) Alternate I (JUN 1988) paragraph (b) is deleted in its entirety and the following paragraph is substituted in lieu thereof:

   "b. The amount presently obligated by the Government with respect to this contract is is $631,902 which fully funds this contract."

3. Section F.6 Duration of Contract Period (MAR 1987) is deleted in its entirety and the following sentence is substituted in lieu thereof:

   "This contract shall commence on the award date and will expire on April 30, 2007."

All other terms and conditions of the contract remain unchanged.

A summary of obligations for this contract from the date of award through the date of this action is provided below:

Total FY04 Obligation Amount:	$230,244
Total FY05 Obligation Amount:	$226,000
Total FY06 Obligation Amount	$175,658
Cumulative Total of NRC Obligations	$631,902

This modification obligates fiscal year 2006 funds in the amount of $78,083.

STATEMENT OF WORK
MODIFICATION #6

TITLE: Large Scale Validation of a Methodology for Assessing Software Quality

I. BACKGROUND

NUREG-0800, "Standard Review Plan," (SRP) Appendix 7.0-A, addresses safety system software, and Branch Technical Position HICB-14 (BTP-14), "Guidance on Software Reviews for Digital Computer-Based Instrumentation and Control Systems," further clarifies the staff's position on safety system software quality requirements. BTP-14 provides guidelines for evaluating software life cycle processes for digital computer-based instrumentation and controls (I&C) systems, and presents specific acceptance criteria for the elements of software reviews. In Section 3.1 of BTP-14, acceptance criteria are divided into three sets: management characteristics; implementation characteristics; and resource characteristics. Each of these is further divided into specific characteristics. One implementation characteristics is "measurement," defined as a set of indicators used to determine the success or failure of the activities and tasks specified in applicable software project planning documents. Many of the planning documents identified in BTP-14 have measurement as a necessary characteristic to ensure life cycle activities are meeting project goals/requirements.

NRC reviews of safety system software are carried out by a combination of inspection and analysis of documents. Regulatory Guide 1.168, "Verification, Validation, Reviews, and Audits for Digital Computer Software Used in Safety Systems of Nuclear Power Plants," endorses IEEE Std 1012-1998, "IEEE Standard for Software Verification and Validation." IEEE Std 1012-1998 states that management of software development is performed in all phases of the software life cycle and that the use of metrics and other qualitative and quantitative measures can identify trends and possible risk issues that should be addressed by developers to effect timely resolution. For safety system software specifically, IEEE Std 7-4.3.2-2003 (endorsed in Regulatory Guide 1.152, "Criteria for Digital Computers in Safety Systems of Nuclear Power Plants") states that software quality metrics shall be considered throughout the software life cycle to assess whether software quality requirements are being met. Both IEEE Std 1012-1998 and 7-4.3.2-2003 reference IEEE Std 1061-1998(R2004), "IEEE Standard for a Software Quality Metrics Methodology," a IEEE standard not endorsed by the NRC.

In the late 1990s research was funded by the Nuclear Regulatory Commission to develop methods that would be able to provide quantitative measures of software quality, one result of which was a method developed at the University of Maryland, NUREG/GR-0019, "Software Engineering Measures for Predicting Software Reliability in Safety Critical Digital Systems." This research identified and systematically ranked 40 software engineering measures with respect to their ability to predict software reliability using expert opinion elicitation. The report describes a structural classification, termed a Reliability Prediction System (RePS), for assessing quality of software-based digital systems. The technique involves using the top-ranked software measures categorized into families at each software development phase to quantitatively assess software quality.

If the RePS methodology developed at the University of Maryland can be validated by applying it to large-scale software development projects for safety-critical systems, it could serve as the technical basis for endorsement of IEEE Std 1061-1998(R2004) and subsequent licensee software quality metrics programs necessary to comply with Appendix B to 10 CFR Part 50.

The reason for this is because the RePS methodology does not rely on a specific set of software measures, but rather the methodology allows the use of any available measures in the software development process. Licensees could continue using their current software development process, and NRC staff, using the RePS methodology, could then tailor safety software reviews according to the "quality" of measures (where the quality of a measure is determined by the family to which it belongs) used in the licensee's safety system software development process. Such a technology-neutral method comports with the Commission's move towards a performance-based regulatory framework.

II. OBJECTIVES

The objective of this research is to perform a large scale validation of the methodology in NRC report NUREG/GR-0019, "Software Engineering Measures for Predicting Software Reliability in Safety Critical Digital Systems." The validation will help determine the predictive ability as well as practical applicability of the methodology to the nuclear power plant industry. Potentially the methodology will serve as the technical basis for regulatory guide endorsement of IEEE Std 1061-1998(R2004), "IEEE Standard for a Software Quality Metrics Methodology," and subsequent licensee software quality metrics programs for complying with Appendix B to 10 CFR Part 50.

III. SCOPE OF WORK

CONTRACT MODIFICATION #6 TASK

SUBTASK 1. COMPLETE THE ASSESSMENT OF SELECTED MEASURES

Contractor shall complete the assessment of the selected measures in the context of the RePS methodology:

A. Defect Density - investigate the relationship between the inspector efficiency and fault exposure probability.

B. Test Coverage - investigate errors introduced by defect repair/retest activities.

The Contractor shall incorporate the results of these assessments into the draft report deliverable for review and comment by the expert panel (see SUBTASK 2 below) and the NRC. See Section VI, *Deliverables and Delivery Schedule* for additional information.

According to the RePS methodology, the selected measures belong to families that contain similar measures. Draft Report #1 shall provide detailed discussion of the associated families of the selected measures used to predict quality, and address the issues listed in Section VI, *Deliverables and Delivery Schedule.*

SUBTASK 2. EXPERT PEER-REVIEW PANEL

The Contractor shall request a panel of experts to review the results and analysis, and provide an opinion on the method's predicting capability and usability. The panel of experts shall be the same or have qualifications similar to those identified in NUREG/GR-0019. Any alternate or additional experts must be approved by the NRC Project Manager.

The Contractor shall work with the NRC Project Manager to develop a questionnaire for the experts to complete. The questionnaire shall be approved by the NRC Project Manager. The Contractor shall contact the expert panel members, provide them with necessary technical references (e.g., draft report, other supporting documentation as necessary) so they can complete their assessment and render their opinions. The Contractor shall also assist the panel members with travel arrangements to and from the panel meeting location at NRC headquarters. Final travel arrangements shall be approved by the NRC Project Manager prior to booking tickets and hotels.

The Contractor shall review the responses to the questionnaire from the expert panel and produce a summary compilation for the NRC prior to the expert panel meeting. The Contractor shall incorporate the experts' comments from the questionnaire and/or panel meeting, as appropriate, into the draft report. Refer to Section VI, *Deliverables and Delivery Schedule,* for the quality standards of required report documents. See Section VII, *Meetings and Travel,* for additional information on travel requirements for NRC Contractors.

V. REPORTING REQUIREMENTS

1. Technical Progress Report.

The contractor shall provide a monthly Technical Progress Report to the following individuals:

Project Manager: Roman A. Shaffer, Mail Stop (M/S) T-10D20
Program Analyst: Sandra R. Nesmith, M/S T-10D20
Branch Chief: William E. Kemper, II, M/S T-10D20 - **hard copy only**
Division Director: Mark A. Cunningham, M/S T-10D20
Contracting Officer, Division of Contracts/Office of Administration: Donald A. King, M/S T-7I2 - **an electronic copy only to Joyce Fields, email address jaf1@nrc.gov and to Beverly Anker, email address bfa@nrc.gov If the Contractor cannot comply with the request for electronic transfer to the Division of Contracts, please provide a hard copy addressed to Ms. Fields at the above mail stop.**

VI. DELIVERABLES AND DELIVERY SCHEDULE

All deliverables shall meet the requirements of Attachment 2, *New Standards for Contractors Who Prepare NUREG-series Manuscripts.*

The Contractor shall provide the NRC Project Officer the following[1]:

3. Draft Report #1, four (4) weeks after initiating Contract Modification #6 Task;

4. Expert Panel Questionnaire, one (1) week after initiating Contract Modification #6 Task;

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[1]The Contractor should consider utilizing a technical writer for this effort to ensure high quality of all submissions to the NRC. To ensure the highest quality standards are maintained throughout the project, Contractor management shall review each draft letter report prior to its submission. The content of technical reports should follow generally accepted writing practices, see NUREG-650, Revision 1, "Publishing Documents in the NUREG Series."

5. Presentation materials for expert peer-review panel meeting (including summary of responses to questionnaire from expert panel members), one week prior to meeting;

6. Draft Report #2, experts' comments addressed, eleven (11) weeks after initiating Contract Modification #6;

7. Final Report, twenty-four (24) weeks after award of contract.

Draft Report #1 shall discuss in detail the work performed and results obtained. The discussion shall include a detailed, step-by-step explanation of all calculations performed, associated uncertainties, problems encountered, and how the problems were resolved. The measured data shall also be included. A sufficient amount of information shall be provided so that a separate reviewer can obtain similar results after performing the calculation procedure using the measured data.

Further, Draft Report #1 shall explain why the applicable families used to predict quality were selected over the remaining families. Attention will be given to each family, specified in Section III, *Scope of Work,* with regard to:

(a) what each family measures;

(b) their units of measure;

(c) theoretical differences between families (correlations);

(d) in practice, why one family is a better predictor of quality versus another family;

(e) explanation of any discrepancies between predicted relevance to quality and actual relevance.

The Principal Investigator shall explain the benefits and shortcomings of the methodology, its usability, and how to improve the methodology-both in its assessing capability and usability.

Contractor shall incorporate comments from the expert peer-review panel into Draft Report #1, and submit the revised report as Draft Report #2.

The NRC Project Officer will provide comments on Draft Report #2 to the Contractor within sixty days of receiving the report. Contractor shall incorporate NRC comments into Draft Report #2 and submit it as the Final Report.

See Table 1 for the delivery schedule during the period of performance (POP). For Level of Effort the units are *number of person-weeks*, and for Delivery Schedule the units are *number of weeks after initiating Contract Modification #6.* Dates shown under Delivery Schedule are based on an expected Contract Modification #6 start date of August 1, 2006.

SUBTASK 1 and development of the questionnaire (in SUBTASK 2) will be performed in parallel. Other activities could be performed in parallel (see Table 1). Also, there is a sixty-day comment period for the NRC Project Manager to generate comments for incorporation into the final report. The POP ends April 30, 2007.

VII. MEETINGS AND TRAVEL

1 trip, 2 days, 3 persons, for the expert peer-review panel members to attend the panel meeting at NRC Headquarters. The Contractor shall assist the expert panel members with their travel arrangements, and obtain NRC Project Manager approval prior to booking flights and hotels.

1 international trip, 4 days, 1 person, for the expert peer-review panel member to attend the panel meeting at NRC Headquarters. The Contractor shall assist the expert panel member with travel arrangements, and obtain NRC Project Manager approval prior to booking the flight and hotels.

1 trip, 4 days, 2 persons, to attend an appropriate professional meeting at completion of the required effort in order to present results to the software engineering community.

VIII. LEVEL OF EFFORT

The level of effort required to complete the effort is anticipated to total 1050 staff hours.

TABLE 1. Delivery Schedule

ACTIVITY	LEVEL OF EFFORT[a]	DELIVERY SCHEDULE[b]
Initiate CONTRACT MODIFICATION #6 TASK	N/A	Start of Task
Kick-off meeting	1 day	1
CONTRACT MODIFICATION #6		
SUBTASK 1[d]		
Draft NUREG Report #1	12	4
MLSR[f]	N/A	monthly
SUBTASK 3		
Questionnaire[d]	2	1
Summary of Responses[e]	2	6
Presentation Materials and Meeting Logistics[e]	4	6
MLSR[f]	N/A	monthly
Draft NUREG #2	16	11
Final NUREG	8	24
End of POP		

[a]Number of person-weeks, unless specified otherwise.
[b]Unit of measure is *number of weeks after initiating Contract Modification #6 Task.*
[c]Assumes task start date of October 1, 2006; if not, adjustments will be made accordingly.
[d]The tasks will be performed in parallel.
[e]The tasks could be performed in parallel.
[f]Task output is required to be included in both the draft and the final NUREG-series report deliverables; however, monthly updates on these tasks shall be included in the Monthly Letter Status Reports, as required in the section on REPORTING REQUIREMENTS.

IX. PERIOD OF PERFORMANCE

The period of performance of Contract Modification #6 task is the six-month (30-week) period from October 1, 2006, to April 30, 2007.

XIII. REFERENCES

IEEE Std 1061, *IEEE Standard for a Software Quality Metrics Methodology.*