

# ORDER FOR SUPPLIES OR SERVICES

PAGE OF PAGES  
1 2

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

BPA NO.

1. DATE OF ORDER <b>8/18/05</b>		2. CONTRACT NO. (if any) NRC-04-03-055		6. SHIP TO:	
3. ORDER NO. T002		MODIFICATION NO.		4. REQUISITION/REFERENCE NO. RES-C05-038 & RES C05-064	
5. ISSUING OFFICE (Address correspondence to) U.S. Nuclear Regulatory Commission Div. of Contracts Attn: Bhawana Sharma Two White Flint North- Mail Stop T-7-I-2 Rockville MD 20852				a. NAME OF CONSIGNEE U.S. Nuclear Regulatory Commission Office of Nuclear Regulatory Research	
				b. STREET ADDRESS 11555 Rockville Pike Attn: James Han (M/S T10X8)	
				c. CITY Rockville	d. STATE MD
				e. ZIP CODE 20852	
7. TO:				f. SHIP VIA	
a. NAME OF CONTRACTOR PURDUE UNIVERSITY				8. TYPE OF ORDER	
b. COMPANY NAME				<input type="checkbox"/> a. PURCHASE <input checked="" type="checkbox"/> b. DELIVERY Except for billing instructions on the reverse, this delivery/task 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.	
c. STREET ADDRESS SPONSORED PROGRAM SERVICES 302 WOOD ST. (YOUNG HALL)				Reference your 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.	
d. CITY WEST LAFAYETTE		e. STATE IN		f. ZIP CODE 479072108	
8. ACCOUNTING AND APPROPRIATION DATA APPN No.: 31X0200.560 B&R: 56015113107 JOB CODE: Y6769 BOC: 252A Obligated Amount: \$500,000.00 RES-C05-038 and RES C05-064				10. REQUISITIONING OFFICE RES Office of Nuclear Regulatory Research	
11. BUSINESS CLASSIFICATION (Check appropriate box(es))					
<input 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. EMERGING SMALL BUSINESS	
				12. F.O.B. POINT Destination	
13. PLACE OF		14. GOVERNMENT B/L NO.		15. DELIVER TO F.O.B. POINT ON OR BEFORE (Date)	
a. INSPECTION Destination	b. ACCEPTANCE Destination			16. DISCOUNT TERMS Net 30	

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)
	Please see Page 2 of the task order for details.				06025802	

18. SHIPPING POINT		19. GROSS SHIPPING WEIGHT		20. INVOICE NO.	
21. MAIL INVOICE TO:					
a. NAME U.S. Nuclear Regulatory Commission Division of Contracts					
b. STREET ADDRESS (or P.O. Box) Attn: NRC-04-03-055 Task Order No. 2 Mail Stop T7I2					
c. CITY Rockville		d. STATE MD	e. ZIP CODE 20852		\$500,000.00
SEE BILLING INSTRUCTIONS ON REVERSE					17(h) TOTAL (Cont. pages)
					17(i). GRAND TOTAL

22. UNITED STATES OF AMERICA  
BY (Signature)

*Elaine J. Wiggins*

23. NAME (Typed)  
STEPHEN M. POOL  
Contracting Officer  
TITLE: CONTRACTING/ORDERING OFFICER

TEMPLATE ADM001  
ALL INFORMATION CONTAINED HEREIN IS UNCLASSIFIED  
PREVIOUS EDITION NOT USABLE

SISP REVIEW COMPLETE

OP 48 (REV. 3/2005)  
PRESCRIBED BY GSA/FAR 48 CFR 53.213(e)

In accordance with Section G.4, Task Order Procedures, of contract number NRC-04-03-055, this definitizes Task Order No. 002. The effort shall be performed in accordance with the enclosed Statement of Work. Task Order No. 002 shall be in effect from date of the order through December 31, 2006, with a cost ceiling of \$558,134. The amount of \$558,134 represents the total estimated reimbursable costs.

Funds in the amount of \$500,000.00 are being obligated under this task order. The obligated amount shall, at no time, exceed the task order ceiling. When and if the amount(s) paid and payable to the Contractor hereunder shall equal the obligated amount, the Contractor shall not be obligated to continue performance of the work unless and until the Contracting Officer shall increase the amount obligated with respect to this task order. Any work undertaken by the Contractor in excess of the obligated amount specified above is done so at the Contractor's sole risk.

The following individuals have been designated as "Key Personnel" in accordance with Section H.2 Key Personnel [REDACTED]

The Contractor agrees that such personnel shall not be removed from the effort under the task order without compliance with the Contract.

The issuance of this task order does not amend any terms or conditions of the subject contract.

Your contacts during the course of this task order are:

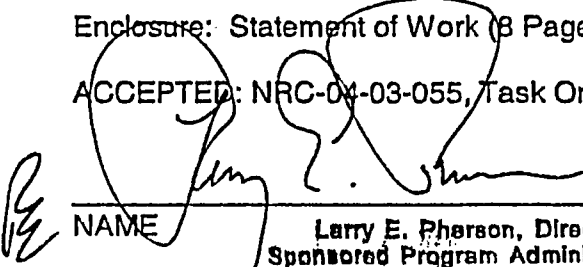
Technical Matters: James Han  
Project Officer  
(301) 415-6773

Contractual Matters: Bhawana Sharma  
Contract Specialist  
(301) 415-5889

Acceptance of Task Order No. 002 should be made by having an official, authorized to bind your organization, execute three copies of this document in the space provided and return two copies to the Contract Specialist at the address below. You should retain the third copy for your records.

Enclosure: Statement of Work (8 Pages)

ACCEPTED: NRC-04-03-055, Task Order No. 002

 NAME Larry E. Pherson, Director  
Sponsored Program Administration

TITLE SEP - 6 2005

DATE

Statement of Work for Task Order No.002, "PUMA Tests,"  
under Contract NRC-04-03-55 and Job Code Y6769

## **I. BACKGROUND**

The Purdue University Multi-Dimensional Integral Test Assembly (PUMA) was originally designed and scaled to produce integral test data relevant to the GE-designed, 2000-MWth Simplified Boiling Water Reactor (SBWR). Three kinds of loss-of-coolant accidents (LOCAs) were conducted at PUMA – main steam line break (MSLB), Gravity-Driven Cooling System (GDSCS) line break (GDLB), and bottom drain line break (BDLB). Test data have been stored in the NRC databank. However, a number of remaining tests, listed in a comprehensive test matrix, were not conducted due to GE's withdrawal of the application for SBWR design certification before completion. As a result, the PUMA data base contains limited LOCA tests in which Isolation Condenser System (ICS) was operational and no single component failure was assumed. Strictly speaking, these LOCA tests do not fall under design basis accidents (DBAs).

In 2002, GE submitted to the NRC a larger and similar reactor design at 4000 MWth, called Economic and Simplified Boiling Water Reactor (ESBWR), for pre-application review. Compared to the SBWR upon which PUMA was designed, the ESBWR design doubled the core power and increased coolant volumes of the reactor pressure vessel (RPV), drywell (DW), and wetwell (WW). In addition, the 4000-MWth ESBWR changed piping configurations: (1) gas space of the GDSCS pools connected to the WW (instead of the DW as in the SBWR design), (2) a loop seal was installed at each GDSCS drain line, and (3) condensed water from the Passive Containment Cooling System (PCCS) was collected in drain tanks (instead of the GDSCS pools as in the SBWR) before draining into the RPV. To make PUMA relevant to the 4000-MWth ESBWR design, piping configurations at PUMA were modified accordingly. The modified piping configurations were designated as Phase 1 modifications.

Subsequently a PUMA scaling analysis was performed (after Phase 1 modifications) and scaling distortions were identified. A few integral LOCA tests were conducted after Phase 1 modifications. But the tests were discontinued, when the NRC was informed by GE that the ESBWR design has been uprated to 4500 MWth and its piping configurations are the same as in the SBWR. In other words, the 4500-MWth ESBWR will have the same piping configurations as in the original PUMA design before Phase 1 modifications. As a result, Phase 1 modifications will be removed from PUMA to restore it to the original design. Furthermore, a scaling analysis for PUMA will be performed to quantify scaling distortions and determine whether PUMA (after removal of Phase 1 modifications) is reasonably scaled to the 4500-MWth ESBWR, for which the design control document will be submitted by GE around June 2005. Otherwise, facility modifications may be needed to make PUMA LOCA data relevant to the 4500-MWth ESBWR.

Furthermore, since the PUMA facility is already 10 years old, a number of the original electronic and mechanical components need to be replaced because of either failure (e.g., oxygen concentration sensors) or unreliability (e.g., data acquisition system (DAS)).

## **II. OBJECTIVES**

1. Restore PUMA to its original design by removing Phase 1 modifications.
2. Refurbish PUMA facility by replacing failed and unreliable components.
3. Perform a PUMA scaling analysis based on the 4500-MWth ESBWR design.
4. Conduct integral LOCA tests and interpret test results.
5. Maintain PUMA facility and design documents .

## **III. SCOPE OF WORK**

Because of a recent design change in ESBWR piping configurations (from the previous 4000-MWth design to the latest 4500-MWth design), Purdue was directed by the NRC Technical Monitor to discontinue the integral LOCA tests listed in Task 3 ("Perform Integral Tests in PUMA") of the SOW for Task Order No. 1. As a result, only Tests (i) and (v) were completed. Similarly, Task 5 ("Assess TRACE against PUMA Integral Test Data") was deleted (no work was ever performed). Other tasks in the SOW either have been completed or will be completed as scheduled.

The following Tasks 9 to 17 are to be performed for this Task Order No. 002. These tasks begin at Task 9 (instead of Task 1) for providing continuity to the SOW for Task Order No. 1, which consists of Tasks 1 to 8.

### **Task 9. Remove Phase 1 Modifications of PUMA**

This task restores PUMA piping configurations to the original design by removing Phase 1 modifications, which were installed according to the previous 4000-MWth ESBWR design. To reflect the current 4500-MWth ESBWR design, gas space of the GDSCS pools of PUMA needs to be reconnected to the drywell (instead of the wetwell gas space as part of Phase 1 modifications), and the condensed water from the PCCS should drain into the GDSCS pools (instead of a drain tank). In addition, the added loop seal to each GDSCS drain line may need to be removed.

Estimated Completion Date: on or about 8/31/05, or the date established by the NRC Technical Monitor.

### **Task 10. Refurbish Facility**

This task will be performed simultaneously with Task 9 to minimize facility downtime. The task replaces those PUMA components that either have failed (e.g., oxygen concentration sensors) or become unreliable (e.g., DAS, flow meters) due to aging. In the last 12 months there have been several failures when running PUMA tests, because of unreliable components. As a result, Purdue had to repeat those tests. It is therefore cost effective to refurbish PUMA before conducting future tests. After the completion of the facility refurbishment, a few integral LOCA tests will be conducted to ensure successful operation of the DAS and instrumentation.

Estimated Completion Date: on or about 8/31/05, on the date established by the NRC Technical Monitor.

**Task 11. Perform a PUMA Scaling Analysis for 4500-MWth ESBWR**

After receiving from GE the design control document for the final 4500-MWth ESBWR (expected in June 2005), Purdue will perform a detailed scaling analysis to evaluate the relevancy of PUMA integral tests for ESBWR LOCAs. Scaling distortions will be determined. Prepare a letter report to delineate the findings in both hard copy and electronic format. (Pending the results of the scaling analysis, the NRC Technical Monitor may convene a peer review panel to decide whether the existing PUMA facility is technically acceptable for investigating ESBWR LOCAs.)

Estimated Completion Date: on or about 9/30/05, or the date established by the NRC Technical Monitor

**Task 12. Propose Facility Modifications to Reduce Scaling Distortions If Needed  
- Optional**

This task will be performed "only if" an independent review of the PUMA scaling analysis from Task 11 (by a peer review panel, for example) concludes that the scaling distortions are too large to be acceptable. The task will propose PUMA modifications (e.g., a larger reactor pressure vessel with higher core power) needed to reduce scaling distortions within acceptable limits. The modifications shall be supported by a scaling analysis. Prepare a letter report in both hard copy and electronic format.

Estimated Completion Date: on or about 11/30/05, or the date established by the NRC Technical Monitor

**Task 13. QA PUMA Design Drawings and Prepare a Report**

After completion of Tasks 9 and 10, this task is to QA PUMA design drawings and make sure that all the dimensions, piping configurations, and instrument and valve locations are accurate. Prepare a letter report to describe the PUMA design in such a detail to allow a TRACE or RELAP5 code user to prepare an input deck for PUMA tests. Also included in the report is a list of instrumentation, and calibrated range/accuracy/location of each instrument. Before publication, the report shall be critically reviewed by a code user to ensure completeness and clarity. Prepare a letter report in both hard copy and electronic format.

Estimated Completion Date: on or about 11/30/05, on the date established by the NRC Technical Monitor.

#### Task 14. Perform Integral Tests in PUMA

If the PUMA facility is judged to be technically acceptable for investigating ESBWR LOCAs, this task will conduct the DBA and beyond-DBA tests listed in the following Table 1.

Table 1. PUMA DBA and beyond DBA Tests

Test No.	Test Description (No ICS in all tests)*	Failure**	Completion Date (est.)
1	GDLB (DBA)	valve on 1 GDCS line	1/06
2	GDLB (beyond DBA)	valve on 1 GDCS line + 1 DPV	2/06
3	GDLB (beyond DBA)	valve on 1 GDCS line + 1 PCC unit	2/06
4	GDLB (beyond DBA)	VB leakage	3/06
5	BDLB (DBA)	valve on 1 GDCS line	4/06
6	BDLB (DBA)	valve on 1 equalizing line	5/06
7	BDLB at a higher initial DW water level than in either Test 5 or Test 6 (whichever is worse)	same as either Test 5 or Test 6	5/06
8	BDLB (beyond DBA)	valves on 1 GDCS line and on 1 equalizing line	6/06
9	BDLB (beyond DBA)	1 PCC unit + valve on 1 GDCS line "or" on 1 equalizing line	6/06
10	MSLB (DBA)	valve on 1 GDCS injection line	7/06
11	MSLB (beyond DBA)	valve on 1 GDCS line + 1 PCC unit	8/06
12	MSLB (beyond DBA)	VB leakage	8/06
13	PANDA counterpart tests to ISP-42 PANDA tests, including Phase A (PCC startup), Phase B (GDCS injection), Phase C (long-term cooling), and Phase D (PCC overload)	None	9/06

\* GDLB = GDCS line break, BDLB = bottom drain line break, MSLB = main steam line break.

\*\* DPV = depressurization valve, VB = vacuum breaker

Prepare a draft NUREG/CR report in both hard copy and electronic format. This report shall be a comprehensive, stand-alone report, which contains: (1) a list of all instruments used in the tests, including identification number, location (e.g., in the DW), and measurement uncertainty of each instrument; (2) isometric drawings showing each instrument location; (3) initial test conditions (including a comparison of the desired values vs. actual values of key parameters such as pressure, temperature, and water level); (4) test results (showing data and instrument ID in a figure) including but not limited to the key parameters (e.g., RPV water level, RPV/drywell/wetwell pressures and temperatures, PCCS condensate flow rate, etc.); (5) a summary of test results for each test; (6) conclusions. Before publication, the report shall be critically reviewed by a TRACE or RELAP5 code user to ensure sufficient information is provided for code assessment.

In addition, a quick-look test report should be prepared within one month after the completion of each test listed in Table 1.

Estimated Completion Date: on, or about, 12/31/06, or the date established by the NRC Technical Monitor.

#### **Task 15. Document Lessons Learned and Problems Encountered in PUMA Testing**

Prepare a letter report to describe lessons learned and problems encountered in conducting PUMA tests, including (1) abnormal, unexpected, or interesting behavior observed in PUMA tests, (2) problems encountered in establishing initial test conditions and the subsequent fixes to resolve the problems, and (3) problems encountered in using either the RELAP5 or TRACE code to calculate initial test conditions.

Estimated Completion Date: on, or about, 12/31/06, or the date established by the NRC Technical Monitor.

#### **Task 16. Maintain Facility and Documents**

Maintain the PUMA facility in operational condition as designed and keep the design drawings and other documents (including instrumentation calibration) up-to-date. The contractor shall: (1) test facility instrumentation periodically to ensure operation as calibrated, (2) perform facility repairs and replace broken components in a timely manner after obtaining NRC's approval, and (3) report to the NRC Technical Monitor any problems regarding the facility. Note that this task is a continuation of Task 7 in the SOW for Task Order No. 1 of the PUMA contract, which ends on 8/22/05.

Estimated Completion Date: on, or about 12/31/06, or the date established by the NRC Technical Monitor.

#### **Task 17. Provide Technical Support to NRC**

The contractor shall provide technical support to NRC, including attending meetings, making presentations, reviewing documents, preparing topical reports (in addition to the reporting requirements listed below), and performing additional PUMA tests and code calculations as requested by the NRC Technical Monitor. Note that this task is a continuation of Task 8 in the SOW for Task Order No. 1 of the PUMA contract, which ends on 8/22/05.

Estimated Completion Date: on, or about 12/31/06, or the date established by the NRC Technical Monitor.

#### **Task 18. Revise NUREG/CR-6727 Report**

This task revises the draft NUREG/CR-6727 report that contains four data reports for PUMA tests conducted in the 1990's. Chapter 2 (PUMA facility description) and Appendixes B and C of each data report shall be revised by fixing the known deficiencies (Ref: E-mails from Dr. James Han of NRC to Profs. Ishii/Revankar/Vierow, "Fixing PUMA Reports - 1st letter," dated 6/1/05; and "Fixing PUMA Reports - 2nd letter," dated 6/22/05). All the dimensions, instrument locations, and facility isometric drawings must be quality assured.

Estimated Completion Date: On or about 10/31/05, or the date established by the NRC Technical Monitor.

### **IV. REPORTING REQUIREMENTS**

In addition to the letter reports required for the above tasks, the contractor shall provide the monthly letter status reports described below.

#### **Monthly Letter Status Report**

A MLSR is to be submitted to the NRC Project Manager by the 20<sup>th</sup> of the month following the month to be reported with copies provided to the following:

Division Management Analyst, (Kim Jones, Mail Stop T-10E32)  
Division of Contracts, Office of Administration (Contracting Officer, Mail Stop T-7-I-2)

The MLSR will identify the title of the project, the job code, the Principal Investigator, the period of performance, the reporting period, summarize each month's technical progress, list monthly spending, total spending to date, and the remaining funds. Any administrative or technical difficulties which may affect the schedule or costs of the project shall be immediately brought to the attention of the NRC project manager.

### **ORGANIZATIONAL CONFLICT OF INTEREST DISCLOSURE**

- A. Provide descriptions of present/planned/past work for other organizations, in the same/similar technical area as the NRC project scope of work, e.g., (included but not



limited to), NRC licensees, vendors, industry groups or research institutes that represent or are substantially comprised of nuclear utilities.

- B. Provide name of organization, dollar value, and period of performance of the work identified in A.

## **V. DELIVERABLES AND DELIVERY SCHEDULE**

Task 11: a letter report by 9/30/05

Task 12: a letter report by 11/30/05 (if this optional task is performed)

Task 13: a letter report by 11/30/05

Task 14: a draft NUREG/CR report by 12/31/06, and a quick-look test report within one month after completion of each test listed in Table 1

Task 15: a letter report by 12/31/06

## **VI. MEETINGS AND TRAVEL REQUIREMENTS**

The contractor should plan to attend an NRC meeting in Rockville, Maryland. For planning purpose, the meeting may be attended by two people for a duration of two days. In addition, the contractor will also attend an ANS/ASME technical conference (for two people) and a meeting (for Prof. Ishii to accompany the NRC Technical Monitor) to visit the PANDA test facility at Paul Scherrer Institut (PSI) in Switzerland for technical information exchange. Prior approval from the NRC Project Manager is needed for any domestic or foreign travel.

## **VII. LEVEL OF EFFORT**

The total level of effort is 75 staff-months to perform the work for the period of performance listed below.

## **VIII. PERIOD OF PERFORMANCE**

The period of performance is from the award date through December 31, 2006.

## **IX. TECHNICAL DIRECTION**

Technical direction is provided by Dr. James T. Han, who is the Technical Monitor as well as the Project Manager of this contract. He can be reached at:

Phone: (301) 415-6773

Fax: (301) 415-5153

Email: JTH1@nrc.gov

## **X. PUBLICATIONS**

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 3.8, "Unclassified Contractor and Grantee Publications in the NUREG Series," 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.