UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

NOV 30 2000

Purdue Research Foundation
ATTN: Thomas Wright
1063 Hovde Hall. Purdue University
West Lafayette, IN 47907-1063

Dear Mr. Wright:

SUBJECT: MODIFICATION NO. 9 TO TASK ORDER NO. 2 ENTITLED "MODULARIZATION OF TRAC-P" UNDER CONTRACT NO. NRC-04-97-046

In accordance with Section G.4, Task Order Procedures, of the subject contract, this letter definitizes Task Order No. 2 Modification No. 9. This effort shall be performed in accordance with the enclosed statement of work .

The period of performance for Task Order No. 2 is changed to run September 30, 1997 to November 30. 2001. The total estimated cost for full performance of this task order is increased by $389,357 from $1,697,859 to $2,087,216. $398,000 in incremental funding is hereby allotted to Task Order No 2 This action changes the total cumulative funds obligated for performance of this task order from $1.397,943.60 to $1,795,943.60. The Contractor shall not incur costs for this task order which exceed the cumulative obligated amount of $1,795,943.60. All other terms and conditions of Task Order No. 2 remain unchanged.

Accounting data for Task Order No. 2 mod 9 is as follows:

B&R No.: 16015110135
Job Code: W-6749
BOC Code: 252A
RES ID: RES-C01-316
Appropriation No.: 31X0200
Amount Obligated by This Action: $398,000
FY 97 Obligated Amount:$ 162,000
FY 98 Obligated Amount:$ 300,012
FY 99 Obligated Amount:$ 478,549.60
FY 00 Obligated Amount: $ 457,382
FY 01 Obligated amount:$ 398,000
Total Cumulative Obligations:$1,795,943.60

Please indicate your acceptance of this task order 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. You should retain the third copy for your records. 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: Stephen Pool, Contract Specialist
(301) 415-8168

Sincerely,

Stephen M. Pool, Contracting Officer
Contract Management Branch No. 1
Division of Contracts and Property Management
Office of Administration

ACCEPTED: TASK ORDER NO. 2 Mod 9

By Peter E. Dunn — DEC 8 2000

NAME — DATE

Peter E. Dunn
Assistant Vice President for Research

TITLE

Modification (No.9) to the Statement of Work of Task Order #2, "Modularization of TRAC-P," under Contract # NRC-04-97-046 and Job Code W6749, "Thermal-Hydraulic Research"

Work Requirements (12/1/00 - 11/30/01)

Continue the existing Task 5, and complete the remaining work in the existing Tasks 11, 12, and 16. In addition, add new Tasks 22, 23, and 24.

Task 5. Provide Technical Assistance

This task provides technical assistance to NRC. Examples include technical presentations and tutorial session on the TRAC-M code, conference calls, meetings, and written correspondence to help the NRC staff gain adequate expertise to perform code development and maintenance functions.

Estimated Level of Effort: 2 staff-months (for this performance period)
Estimated Completion Date: November 30, 2001 (new date)

Task 11. 3-D and Plenum Specific Routines

TRAC-M utilizes different sets of subroutines to drive and perform the solution procedure for the one-dimensional components (pipe, valve, tee, etc.), the plenum, and three-dimensional hydraulic (vessel) components. Examples include: subroutines tf1ds and stbme for 1-D, tf3ds and stbme3 for 3-D, and corresponding plenum subroutines tfpln, tfplbk, and stbmpl. This approach shall be modified with the aim of minimizing such a division of functionality while still adhering to the principles of modularity currently followed in the code development activities.

Subtask 11.1: SRD

Prepare an SRD as per the NRC SQA plan. Once reviewed and accepted by the NRC, work on Subtask 11.2 may begin.

Deliverable: a letter report in both text and electronic format

Subtask 11.2: SDID

Prepare an SDID as per the NRC SQA plan. This document will be a living document until the coding work of Subtask 11.4 is finalized. Therefore, the final version of SDID must accurately reflect the coding submitted as the deliverable for Subtask 11.4, Modifications to the SDID must be reported in the monthly progress reports and the corresponding changes must be made to the SDID on a monthly basis. These changes shall be made using red-lining and bolding options of the word processing package, so that these modifications will be highlighted. NRC will then save a clean version of the SDID once these modifications are reviewed.

Deliverable: a letter report in both text and electronic format

Subtask 11.3: Test Plan

Prepare a test plan as per the NRC SQA plan. Once reviewed and accepted by the NRC, work on Subtask 11.4 may begin.

Deliverable: a letter report in both text and electronic format

Subtask 11.4: Code Modification

Modify the code as described in the SDID and ensure its operation by following the test plan developed under Subtask 11.3. Results of the testing shall be summarized in a completion report. The modifications that meet the requirements of the test plan shall be submitted to the NRC in a format that is consistent with the NRC Configuration Control System,.

Deliverables: patch files for code modifications, and a completion letter report in both text and electronic format

Estimated Level of Effort: 2 staff-months (for this performance period)
Estimated Completion Date: August 1, 2001 (new date)

Task 12. Development Error Resolution

Under Task 2, the solution procedure as well as the component communication has been revamped in a more modularized and parallelized manner. During these drastic modifications, a number of long standing code bugs were located and corrected. It is highly probable that some others were introduced in these tasks and a number of other long standing bugs exist in areas not touched by this effort. Given the high level of testing thus far, these two classes of bugs can be expected to be relatively subtle, and careful interpretation of final test results will be necessary to locate and correct such bugs. In addition, the final round of testing can be expected to reveal various modeling deficiencies and coding inefficiencies that should be corrected before final release. Task 12 is dedicated to the detection and resolution of these problems. Submit resolution reports and code modifications to the NRC configuration control as per the currently invoked procedures.

Deliverables: patch files for code modifications, resolution reports, and test plan and results.

Estimated Level of Effort: 1.5 staff-months (for this performance period)
Estimated Completion Date: November 30, 2001 (new date)

Task 16. Higher Order Numerical Methods

Incorporation of the External Component has facilitated coupling the consolidated code to other tools, such as CFD codes. CFD codes utilize higher-order differencing schemes, whereas the consolidated code is limited to a first-order technique. Unfortunately, when coupling two different order numerical schemes, numerically-induced bifurcations may be generated at the location of the coupling if strong gradients are present. Therefore, it may be necessary to incorporate higher-order numerics into the consolidated code.

First-order differencing limits the ability of the code to preserve gradients in physical properties, such as boron concentration and thermal and density fronts. A second-order method would

ameliorate this limitation and improve the code's prediction of boron concentration and physical properties (such as density and temperature) that influence the core power predicted by a coupled kinetics code. These gradients also influence instability predictions, and a less numerically diffusive scheme would improve the code's ability to model these transients. Instability calculations are now performed only with the semi-implicit method, due to the high diffusion of the SETS scheme. However, SETS allows the code to run at larger time steps. It may be possible to run stability cases with SETS if a higher order scheme were used. This would result in a faster running code and would allow the semi-implicit option to be removed from the code, which would reduce the maintenance effort. (Note that RELAP5 currently has a method to sharpen the thermal gradient. This would not be needed if a higher order differencing scheme were implemented, thereby facilitating the RELAP5 consolidation.)

In order to efficiently couple the TRAC code to a CFD code and to minimize numerical diffusion to better represent gradients in physical properties, higher-order numerics should be incorporated into TRAC. This work has been facilitated by the modularization of the hydraulic component to hydraulic component communication in the code as well as the modularization of the solution procedure. Before the optimal means of providing this capability is determined, a pilot study of various approaches should be done so that final incorporation into TRAC is done efficiently and the run-time is not dramatically hindered.

TRAC code will be stripped down to minimize its complexity, leaving just the minimal coding required to run SETS and SEMI-IMPLICIT schemes for a network consisting of both one-dimensional and three-dimensional components. The numerical scheme will be modified to provide a second-order differencing technique, while leaving the first order technique in place. This approach will provide the ability to judge the benefit and detriment of the higher-order technique. Factors should include numerical diffusion, run-time, and numerical stability. Test cases should be devised to test these factors and should be run with both schemes to determine the most advantageous differencing method. Implementation is also a concern and the code architecture should also be studied and discussed to ensure that when incorporated into TRAC, the coding is readable and extendable. Provide a letter report to NRC to summarize the results of this study. All coding must be done in F90 and should be portable across all NRC platforms (SUN, SGI, HP, DEC Alpha, Windows NT, IBM AIX).

Deliverables: a letter report in both text and electronic format, and the pilot code developed during this study in electronic format.

Estimated Level of Effort: 5 staff-months (for this performance period)
Estimated Completion Date: November 30, 2001 (new date)

Task 22. RELAP5 Control System Functionality

The functionality of the RELAP5 control system must be incorporated into TRAC-M. The primary differences between the codes are the interaction of the control system and the system components. This work may involve establishing a new component action table paradigm and cleaning up trip subroutine logic. In RELAP5, any minor edit request can be utilized as a signal variable to control the action of another component or function as input to a control block. Work will be done on putting these values into the TRAC-M database under another contract. It is expected that the current mapping between signal variables and the database can be used.

Deliverables: coding and documentation as per the NRC SQA plan

Estimated Level of Effort: 8 staff-months
Estimated completion date: September 1, 2001

Task 23. Upgrade of the BD Array System Service

Currently, when the BD array data are transferred, the entire array is exchanged even if the values have not changed. The logic developed for the ECI should be used so that the BD transfer will only involve quantities that changed since the last transfer event. This will save some computational time but will mainly clarify the solution procedure. This work will involve elimination of the BE array as well as the BD4 array.

Deliverables: coding and documentation as per the NRC SQA plan

Estimated Level of Effort: 2 staff-months
Estimated completion date: November 1, 2001

Task 24. Robustness

The root cause of cases where decks fail to converge shall be determined and the code shall be modified to enhance robustness.

Deliverables: coding and documentation as per the NRC SQA plan

Estimated Level of Effort: 1.5 staff-months
Estimated completion date: November 30, 2001

Meetings and Travel:

The contractor will attend three meetings at the NRC office in Rockville, Maryland. For planning purpose, each meeting will involve two people and last for two days. Also for planning purpose, the contractor will attend an international meeting involving one person. However, any travel must be approved in advance by the NRC Technical Monitor.