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

JUL 12 2002

Purdue Research Foundation
ATTN: Thomas B. Wright
1021 Hovde Hall, Purdue University
West Lafayette, IN 47907-1021

Dear Mr. Wright:

SUBJECT: MODIFICATION NO. 13 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. 13. This effort shall be performed in accordance with the enclosed Statement of Work.

The period of performance for Task Order No. 2 remains from September 30, 1997 to November 30, 2002. The total estimated cost for full performance of this task order is increased by $10,956 from $2,356,427 to $2,367,383. $10,956 in funding is hereby allotted to Task Order No. 2. This action changes the total cumulative funds obligated for performance of this task order from $1,984,216.60 to $1,995,172.60. The Contractor shall not incur costs for this task order which exceed the cumulative obligated amount of $1,995,172.60. All other terms and conditions of Task Order No. 2 remain unchanged.

Accounting data for Task Order No. 2 mod 13 is as follows:

B&R No.:26015110205
Job Code: W-6749
BOC Code: 252A
RES ID: RES-C02-445
Appropriation No.: 31X0200
Amount Obligated by This Action: $10,956

TEMPLATE-ADM001

ADM02

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 Center No. 1
Division of Contracts
Office of Administration

Modification (No.13) 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"

Additional Work Requirements (7/8/02 - 11/30/02)

Modify Tasks 12 and 16 by moving 4 staff-months from Task 16 to Task 12. New item is added to Task 12 (in the first paragraph), while the work in Task 16 (in the last paragraph of the task) is reduced accordingly. New Tasks 12 and 16 are listed below to replace the previous ones. Additional funding of $11,200 is provided for the two foreign trips listed.

Task 12. Development Error Resolution

Fix two problems in the TRAC-M choked flow model. First, the current model exhibits a dependence on the fluid conditions downstream of the choking plane. This behavior is unphysical and can cause the choked flow rate to be sensitive to the noding downstream of the choking plane. Second, the choked flow model has a discontinuity at a choking cell L/D ratio of 1.5. This discontinuity needs to be resolved.

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: 6 staff-months
Estimated Completion Date: November 30, 2002

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 spatial difference method that is at least second-order accurate, 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. Provide a letter report to NRC to summarize the results of the initial implementation. 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: 4 staff-months
Estimated Completion Date: November 30, 2002

Meetings and Travel:

The contractor will attend two foreign meetings. The first meeting is the GAMA meeting in September 2002, London, England. The second meeting is the OECD/NEA meeting on the use of CFD for reactor safety analysis, which will take place in November 2002, Pisa, Italy. Both meetings will be attended by one person only. Furthermore, each trip must be approved in advance by the NRC Technical Monitor.