DCD

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

DEC 07 1999

Purdue Research Foundation
ATTN: Edie Doland
1063 Hovde Hall, Purdue University
West Lafayette, IN 47907-1063

Dear Mr. Doland:

SUBJECT: MODIFICATION NO. 5 TO TASK ORDER NO. 1 ENTITLED "INTERFACIAL AREA TRANSPORT" 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. 1 modification no. 5. This effort shall be performed in accordance with the enclosed Statement of Work.

The period of performance for Task Order No. 1 is changed to run from September 30, 1997 through November 30, 2000. The total estimated cost for full performance of this task order is changed by $299,877 from $894,734 to $1,194,611. Funds obligated for performance of this task order are increased by $299,877 from $894,734 to $1,194,611 to fully fund this task order. The Contractor shall not incur costs for this task order which exceed the cumulative obligated amount of $1,194,611.

Accounting data for Task Order No. 1 Mod 5 is as follows:

B&R No.: 06015110135
Job Code: W-6749
BOC Code: 252A
RES ID: RES-C00-329
Appropriation No.: 31X0200
Obligated Amount This Action: $299,877
FY 97 Obligated Amount:$ 406,734
FY 98 Obligated Amount:$ 208,000
FY 99 Obligated Amount:$ 280,000
FY 00 Obligated Amount:$ 299,877
Total Cumulative Obligations:$1,194,611

DF02

PDR CONTR

DEC 29 1999

The issuance of this task order does not amend any terms or conditions of the subject contract. All other terms and conditions of the task order remain unchanged

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

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.

Sincerely,

Stephen M. Pool, Contracting Officer
Division of Contracts and Property Management

Enclosure:
As stated

ACCEPTED: TASK ORDER NO. 1 Mod 5

P E Dunn — DEC 17 1999

NAME — DATE

Peter E. Dunn
Assistant Vice President for Research

TITLE

Modification (No. 5) to ~~the Statement of Work of~~ Task Order #1, "Interfacial Area Transport," under Contract # NRC-04-97-046 and Job Code W6749, "Thermal-Hydraulic Research"

Additional Work Requirements

Task 10. Enhance Measurement Technique for Churn Turbulent Flow

This task enhances the existing four-sensor conductivity probe measurement technique, which was originally developed to measure interfacial area concentration of single-direction two-phase interface motion as in bubbly or slug flow. The capability of the probe will be enhanced to account for churn turbulent flow for which the interface motion can have two directions - upward or downward in a vertical pipe.

Estimated Completion Date: March 31, 2000
Estimated Level of Effort: 3 staff months

Task 11. Perform Third Stage of Experiments in Vertical Pipes

This task performs third stage of experiments to measure interfacial area concentrations of slug flow and churn turbulent flow in the air-water vertical pipes at various diameters. Two kinds of experiments will be performed in vertical pipes with co-current two-phase flow: (1) experiments in large-diameter pipe at 4" and 6" inside diameter (ID) under flow conditions of bubbly, cap, and churn-turbulent flow, (2) experiments in small-diameter pipes at ID of 0.5" and 2" under flow conditions of bubbly, slug, and churn-turbulent flow. Prepare a letter report in both text and electronic format to summarize the test results.

[Note that the third stage of experiments are complementary to the previously-performed first and second stages of experiments. In the first stage of experiments, data for interfacial area concentrations were obtained in vertical pipes (2" and 4" ID) for bubbly and slug flow and in horizontal pipes (2" and 4" ID) for off-take from a large vessel to horizontal pipes. In the second stage of experiments, data for interfacial area concentrations were obtained in vertical pipes (0.5" and 6" ID) for bubbly and slug flow; data were also obtained in horizontal pipes (2" and 4" ID) to investigate the effects of entrance, elbow, and counter-current flow on interfacial area transport.]

Estimated Completion Date: November 30, 2000
Estimated Level of Effort: 15 staff months

Task 12. Develop One-Dimensional Two-Group Interfacial Area Transport Equation

This task develops one-dimensional two-group interfacial area transport equation to account for both the spherical/distorted bubble group and the cap/slug bubble group as expected in two-phase flow in vertical pipes. (Recall that in the completed Task 9, an one-dimensional one-group interfacial area transport equation was developed for the spherical/distorted bubble group.) Modeling efforts of source/sink terms should include modeling of surface instability of large bubbles, shearing-off of bubbles at the rim of large bubbles, and extension of the existing interaction models. In view of different transport phenomena in large and small pipe flows, the work on theoretical modeling will be divided into two groups accordingly. Evaluation of the transport equation will be performed for each model based on the data obtained in Tasks 4, 8 and 11.

A preliminary one-dimensional two-group interfacial area transport equation will be developed for two-phase flow in large-diameter vertical pipes based on the data to be obtained in 6" pipe under Task 11. A similar equation will also be developed for two-phase flow in small-diameter vertical pipes based on the data to be obtained under Task 11 in 0.5"and 2" pipes. Prepare a letter report in both text and electronic format.

Estimated Completion Date: November 30, 2000
Estimated Level of Effort: 4 staff months

Task 13. Provide Technical Support

Provide technical support to NRC. The work includes making presentations, reviewing technical reports, and providing administrative support regarding fund transfer to the subcontractors under this contract.

Estimated completion date: November 30, 2000
Estimated Level of Effort: 1 staff month

Task 14. Perform Third Stage of Experiments in Horizontal Pipes

This task perform third stage of experiments in 2" (existing) and 4" (to be designed and built) horizontal pipes. The purpose is to produce a database for flow regime transitions from bubbly flow to stratified flow and from stratified flow to slug flow, respectively. Measurements of interfacial parameters will be made to characterize and quantify the development of two-phase flow regimes in horizontal pipes. Data collected will be used to evaluate and improve the one-dimensional interfacial area transport equation.

Subtask 14.1. Design and Construct a 4" Horizontal Test Section

This subtask designs and constructs a 4" horizontal test section and installs it onto the test loop.

Estimated Completion Date: January 31, 2000
Estimated Level of Effort: 4 staff months

Subtask 14.2. Perform Experiments in Horizontal Test Sections

This subtask performs experiments in both 2" and 4" horizontal test sections. Prepare a letter report in both text and electronic format to describe the design of the test loop, data obtained, and phenomena observed. Detailed test data will also be prepared electronically in the NRC databank format.

Estimated Completion Date: November 30, 2000
Estimated Level of Effort: 10 staff months

Task 15. Develop Model for Horizontal Flow Data

This task analyzes the horizontal flow data obtained under Task 14 and develops physical models of the processes that govern the creations and destruction of interfacial area and the constitutive relations to correlate interfacial area. The focus of the task is on those processes

that are quite different from those observed in vertical flow tests. Prepare in both text and electronic format a letter report to summarize the models and correlations developed and the process of development.

Estimated Completion Date: November 30, 2000
Estimated Level of Effort: 8 staff months

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. The contractor will be also allowed to attend a domestic technical meeting sponsored by ANS, ASME, or other national organizations. However, any travel must be approved in advance by the NRC Technical Monitor.