

SUPPLEMENTAL AGREEMENT
BETWEEN
GENERAL ELECTRIC COMPANY
AND
ELECTRIC POWER RESEARCH INSTITUTE, INC.
AND
THE U.S. NUCLEAR REGULATORY COMMISSION

This SUPPLEMENTAL AGREEMENT, effective the 17th day of April, 1981, by and between the UNITED STATES OF AMERICA (hereinafter referred to as the "Government"), as represented by the UNITED STATES NUCLEAR REGULATORY COMMISSION (hereinafter referred to as the "Commission"), and GENERAL ELECTRIC COMPANY, a corporation duly organized and existing under the laws of the State of New York with its principal office in Fairfield, Connecticut (hereinafter referred to as the "Contractor"), and ELECTRIC POWER RESEARCH INSTITUTE, INCORPORATED, a not-for-profit corporation duly organized and existing under the laws of the District of Columbia, with its principal office in Palo Alto, California (hereinafter referred to as the "Institute"),

WITNESSETH THAT:

WHEREAS, the Contractor has been performing work under Contract No. NRC-04-76-215;

WHEREAS, the parties desire to modify Contract No. NRC-04-76-215 as hereinafter provided, and this supplemental Agreement is authorized by law, including the Federal Property and Administrative Services Act of 1949, as amended, the Atomic Energy Act of 1959, as amended, and the Energy Reorganization Act of 1974, as amended:

NOW THEREFORE, said Contract, as amended, is hereby further amended as follows:

1. Regarding ARTICLE II - STATEMENT OF WORK

The objectives set forth in the original work scope have been accomplished as stated in Appendix A to this Modification 11. However, with the insight gained from the TMI incident and the results of this TLTA program, it is now necessary to redirect the efforts in order to fully accomplish the objectives of the TLTA program. Therefore, the redirected effort, to be referred as "BWR FULL INTEGRAL SIMULATION TEST (FIST) PROGRAM" is hereby incorporated by the addition of the following new paragraph 4.

"4. BWR FULL INTEGRAL SIMULATION TEST (FIST) PROGRAM

The contractor shall perform the following Tasks to achieve the objective stated for each task.

OVERALL PURPOSE

The purposes of the EPRI/NRC/GE BWR FIST test program are to:

1. Implement the major modification to build the ^{BWR}FIST Facility capable of simulating a spectrum of BWR loss-of-inventory and limited operation transients (e.g., natural circulation).

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2. Obtain and evaluate basic data from the test system configuration which has calculated performance characteristics similar to a BWR with 8x8 fuel bundles during hypothetical loss-of-inventory and limited operation transients.
3. Provide phenomenological understanding and data to assess available best estimate models for BWR system and fuel bundles and, as necessary, recommend model improvement needs.

TASK 1 - PROGRAM PLANNING AND ADMINISTRATION

OBJECTIVE: Provide the overall planning, personnel supervision and program management for the BWR FIST Program.

- 1.1 Prepare a detailed test plan which describes both the facility shakedown and performance tests as well as the complete integral simulation tests. The test plan shall include the test objectives, test description, test matrix, parameter ranges and reasons for selection, test execution plan, planned utilization of the data and the planned schedule for completion of the BWR FIST Program.
- 1.2 Following PMG review, modify the test plan, as required, and prepare the document as approved by the PMG for publication (see Task 2.2).
- 1.3 Provide the supervisory and program management functions for this program. Prepare the required periodic technical and administrative status reports.
- 1.4 Provide technical representatives to the PMG and other programmatic meetings, and as approved by the PMG, attend pertinent technical society meetings.

TASK 2 - FACILITY DESIGN, PROCUREMENT AND FABRICATION

OBJECTIVE: Design and build the BWR FIST Facility test section with improved feedwater system which has appropriate scaling to allow full integral simulation tests in a single-bundle BWR system configuration.

- 2.1 Perform scaling and design analyses for the ^{BWR}FIST configuration to evaluate the reactor simulation accuracy. Particular attention shall be given to attaining a real time simulation of calculated BWR system and fuel bundle thermal-hydraulic response. Apply appropriate analytical methods including TRAC and/or other non-proprietary codes used for BWR performance analyses to obtain best estimate performance predictions of the BWR reference plants and the test system configuration. Differences in anticipated dynamic response of the test apparatus as compared to a BWR shall be identified by appropriate analysis. Measurement requirements and an instrumentation plan shall be developed to meet the program objectives.

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- 2.2 Prepare a facility description report which presents the scaling and technical basis for the BWR FIST Facility and documents the results of Task 2.1. Following PMG review, modify the description document, as required, and prepare the document as approved by the PMG for publication. The PMG has the option to combine this report with the test plan report in Task 1.
- 2.3 Design the hardware and develop the software necessary for the data acquisition and measurement systems.
- 2.4 Provide the data reduction program to calculate the measured and derived quantities in engineering units for the BWR FIST configuration and measurement system.
- 2.5 Dismantle the existing TLTA test section and salvage reusable components for use in ^{the BWR} FIST Facility. MMK
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- 2.6 Complete the detailed design, procurement and assembly of components for the BWR FIST facility. Assemble the components and prepare the facility for conducting shakedown tests.

TASK 3 - FACILITY SHAKEDOWN AND PERFORMANCE TESTING

OBJECTIVE: Verify the design capability of the BWR FIST Facility hardware and instrumentation for conducting full integral simulation tests and establish the system operational characteristics.

- 3.1 Prepare the facility and auxiliary equipment for system hardware and instrumentation checkout and shakedown tests.
- 3.2 Perform the system hardware checkout and shakedown tests, including the adequacy of the heated feedwater system and BWR FIST heater bundle design. Verify the operation of the process instrumentation and controls and the test instrumentation.
- 3.3 Perform the system performance tests per the approved test plan. These performance tests shall include hydrostatic tests, flow calibration tests, transient startup tests and other system operational characteristic tests. These tests are expected to determine heat loss, flow vs. pressure drop characteristics, instrumentation capability and performance characteristics to provide the basis for interpretation of the BWR FIST results.
- 3.4 Provide data from the facility shakedown and performance tests as an informal data report.

TASK 4 - TESTING

OBJECTIVE: Obtain experimental data from the BWR FIST Facility.

- 4.1 Prepare the facility and instrumentation and perform the simulation tests per the approved test plan (Task 1), including acquisition of the appropriate pre- and post-test measurement calibration data.

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- 4.2 Reduce the data, as appropriate, to obtain:
- a. system effluent (break and steam line) flow rates and enthalpies,
 - b. feedwater and ECC flows and enthalpies,
 - c. regional (lower plenum guide tube, core, core bypass, upper plenum, steam dome, and downcomer) fluid pressures, fluid temperatures and two-phase mixture levels,
 - d. differential pressure distributions within the regions and associated masses, density and void distributions and (where possible) internal flow rates between the regions, and
 - e. heater rod temperatures and surface heat transfer coefficients.
- 4.3 Verify the test data as specified in the approved test plan to ensure quality and consistency.
- 4.4 Process and store the measured and derived data on computer tape, and make available through the INEL Data Bank System.

TASK 5 - DATA ANALYSIS AND REPORTING

OBJECTIVE: Evaluate the data to interpret the phenomena governing the system performance and bundle heat transfer behavior and use the data to assess available best estimate BWR transient thermal hydraulic methods.

- 5.1 Evaluate the test apparatus design for meeting program objectives on the basis of system performance tests and, as appropriate, recommend any adjustments to the test facility.
- 5.2 Analyze and evaluate the experimental data to determine the governing phenomena for each test. Document the results of each test in data reports, in accordance with the approved test plan (Task 1.2).
- 5.3 Provide the experimental data base for the assessment of available best estimate BWR transient thermal-hydraulic methods. The assessment includes pre-test predictions, comparisons with the data, and post-test analyses for the types of tests specified by the PMG in accordance with the approved test plan. The results of the assessment should identify areas in which the models can be improved for BWR performance evaluations.
- 5.4 Prepare an interim report, as directed by the PMG, covering the progress on the BWR FIST Program.
- 5.5 Prepare a topical (Final) report covering BWR FIST Program."

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2. Regarding ARTICLE III - PERIOD OF PERFORMANCE

The period of performance under this contract was extended by modification No. 10 through June 15, 1981. Contract costs from the effective date of this modification No. 11 through June 15, 1981 shall not exceed \$205,000.00. The total contract cost of \$10,980,733.00 remains unchanged. HAK
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3. Regarding ARTICLE IV - ESTIMATE OF COST, OBLIGATION OF FUNDS, AND FIXED FEE

In accordance with Article IV, Part 9, Parts 10, and 11 are hereby added as set forth below. Parts 1 through 9 hereof remain unchanged.

"10. Cost Ceiling for Period of April 17, 1981 through June 15, 1981

Over the period of April 17, 1981 through June 15, 1981, the contractor shall not incur costs in excess of \$205,000.00. The costs incurred over this period shall be shared by the parties hereto in accordance with ARTICLE IV, Part 1."

"11. TASK COST LIMITATIONS

The following estimated costs are assigned by the PMG to each of the Tasks listed below:

<u>Task (BWR FIST PROGRAM)</u>	<u>Estimated Cost</u>
1. Program Planning and Administration	\$ 406,120.00
2. Facility Design, Procurement and Fabrication	2,312,098.00
3. Facility Shakedown and Performance Testing	272,243.00
4. Testing	572,183.00
5. Data Analysis and Reporting	465,402.00
Total	\$4,028,046.00

The above estimated costs are to be regarded as ceilings which may not be exceeded without prior approval by the Contracting Officer and the Authorized Representative of the Institute as coordinated with the PMG. Such approval, if granted, shall be effected by a contract modification changing the above estimated costs.

If at any time the Contractor has reason to believe that the costs expected to be incurred in the performance of any task will exceed the ceiling amount then assigned to that task, the Contractor shall verbally notify the PMG, the Contracting Officer and the Authorized Representative of the Institute to that effect. This notification shall be confirmed in writing. The notice shall state the estimated amount of additional funds required to complete performance of the task and the manner in which those funds will be expended by cost element. The Commission and the Institute shall not be obligated in excess of the ceiling amounts, without the above indicated approval, for each task set forth above, nor shall the Contractor be obligated to perform beyond those ceiling amounts.

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The above provisions are in addition to the requirements of
ARTICLE IV, Part 5, hereof and other provisions of the contract."

4. Regarding ARTICLE VIII - REPORTS

Part a. is hereby divided into parts a.1. and a.2., with the original
part a. language constituting part a.1. Part a.2. is added to
incorporate "BWR-FIST DOCUMENTATION" reporting requirements as follows:

"a.2. Reporting Schedule and Requirements for BWR-FIST PROGRAM

The following reporting requirements apply to technical, administrative
and financial reports, and are in addition to any other applicable
provisions of this contract with regard to reports and reporting
requirements.

2.1 Reports

a. Monthly Progress Reports

The Contractor shall prepare and distribute an informal letter
progress report each month. These reports will cover technical
and administrative matters and indicate the status of program
activities by active Task. Preliminary test results may be
included, if available.

b. Monthly Financial Reports

The Contractor shall furnish to EPRI and NRC monthly financial
reports that include current year information for active program
tasks and the total program. For each active program, task
graphs will be provided that include current year cumulative
cost to date, projected costs to current year completion and
budget monthly costs for the current year.

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In addition, the Contractor shall furnish by program task
current year and current month cost information by cost
element (direct labor, overhead, materials and equipment,
services performed by outside sources, graphics and computer,
travel and living, other direct costs and other allowable
expenses).

The Contractor shall separately provide to EPRI and NRC
monthly information regarding projected versus actual progress
(including milestones) for the work. This fiscal information
shall be provided in the cost tracking format and set forth
in the EPRI Monthly Contractor Cost Performance Report
(177-11/76). In addition thereto, the fiscal planning form
"Contractor Forecast Input Form" is to be completed and
submitted to EPRI and NRC within thirty (30) calendar days
after award of contract (only NRC and EPRI cost sharing
portion of the forecast for required funds is to be shown,
respectively).

Providing the above information shall not preclude the Contractor from providing reports on financial matters pertinent to the contract as reasonably requested by EPRI and/or NRC which are not addressed in the reporting identified above.

c. Informal Data Reports

These reports will document measured and derived test data and pertinent associated information. Distribution will be made on a timely basis prior to completing data analysis and evaluation, and preparation of the associated Topical Report.

Note:

The Test Plan, Facility Description, Interim and Topical reports are subject to the following conditions:

1. The Contractor shall submit to the PMG, detailed outlines of report contents at times agreed to by the PMG. Simultaneously, the Contractor will provide information to the PMG on any revision of program schedule and costs deemed necessary to complete these reports.
2. The PMG members shall review the recommendations supplied above by the Contractor, modify those recommendations as deemed necessary, and mutually establish for each report (a) the content outline, (b) the date for submission of the draft, and (c) that the report preparation cost estimates are consistent with the approved program funding levels.

The technical reports listed above are to be reviewed and approved by the Commission and the Institute in draft form. Comments shall be provided by the Institute and/or the Commission to the Contractor within thirty (30) calendar days of the receipt of each draft report. These comments shall be considered by the Contractor, and any disagreements related thereto shall be referred to the PMG for resolution within a sixty (60) calendar day period following original receipt of each draft report by the Commission and the Institute. Upon resolution of the comments, the Contractor shall provide camera-ready copies of the reports to the Commission and the Institute within a forty-five (45) calendar day period. If comments are not supplied to the Contractor by the Commission or the Institute within thirty (30) calendar days from receipt of the draft reports, then the reports will be deemed approved by the sponsors. The periods stated above for review and comment, resolution of comments, and/or publication of reports may be changed for specific reports by the mutual agreement of the PMG members without further amendment to this contract.

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d. Test Plan Report

The contractor shall prepare a Test Plan Report for the ^{zur}FIST Phase of the program. This report will formally document the approved plan and address those items listed in paragraph 1.1 of Task 1.

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e. Facility Description Report

This report will formally document those aspects of the test facility and its operation, pertinent to the technical interpretation and modeling of tests by independent users of the data. The contents for this report are described in paragraph 2.1 of Task 2.

f. Interim Reports

This report will cover the program progress and will be prepared as directed by the PMG.

g. Topical (Final) Report

This report will formally document the results and pertinent associated information for the ^{zur}FIST Phase.

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h. Test Data Storage and Delivery

Engineering data obtained from tests conducted under the contract shall be stored on magnetic tapes or other forms suitable for access, and shall be retained by the Contractor during the contract period. Upon completion of the contract, or upon request of either or both the Commission and the Institute, a copy of the stored data shall be furnished to the Commission and the Institute.

2.2 Report Schedule

- a. Monthly Progress Reports - due 15 days after end of period.
- b. Monthly Financial Reports - due 30 days after end of period.
- c. Informal Data Reports - due 90 days after completion of tests unless otherwise directed by the PMG.
- d. Test Plan Report - due six months after commencement of work.
- e. Facility Description Report - due seven months after commencement of work.
- f. Interim Reports - as directed by the PMG.
- g. Topical (Final) Report - due upon completion of the contract. A draft of this report shall be submitted to the PMG members within 120 days of completion of testing.

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The specific objectives as stated in the original work scope of the BD/ECC Program are shown in Table A1. Objectives 2 (7x7 CCFL Flooding Characteristics), 3 (8x8 BDHT Tests), and 8 (Model Development) have been met and documented in References 1 through 6. Objectives 1 (Scaling Analysis), 7 (Reporting of Data), and 9 (Application of Data) are generic for each test phase and are included in these same references. As described in the Program Plan (Reference 7), objectives 4 (BD/ECC Interaction Tests) and 5 (Alternate Power Shape BD/ECC) were to be met in a series of test phases using two test system and heater bundle configurations. Objective 6 (Non-Jet Pump Plant BD/ECC) was to be met using a further modified test system configuration.

Following the TMI incident and with new insight as provided by the TLTA experimental results (including very low cladding temperatures and relative importance of the various scaling compromises, particularly as they affect small break simulation), the PMG recommended that objectives 5 and 6 be eliminated and that the residual of objective 4 be met using the FIST Facility. Furthermore, the PMG recommended that the original large break focus be changed to emphasize other loss-of-inventory transients including small breaks, natural circulation and degraded conditions.

Table A2 compares the original cost estimate, as updated in March, 1979, with the latest projections. The present estimate for the BD/ECC Interaction Phase represents expenditure through 1980 (\$5,111K) and planned expenditure to complete the documentation of the BD/ECC 1A Phase (large break, small break and "boiloff" test topical reports). The expenditures through 1981 include the BD/ECC 1A effort as well as the preliminary planning and design efforts for the proposed FIST Facility.

Table A1. Specific Objectives of BD/ECC Program

1. **Scaling Analysis:** evaluate and document the scaling basis of the TLTA in the configurations selected for BD/ECC interaction tests as compared to reference BWR designs.
2. **7x7 Counter-Current-Flow-Limited (CCFL) Flooding Characteristics:** conduct CCFL flooding characteristic tests of the present TLTA bundle geometry to establish the need, or lack thereof, to modify the present test apparatus design for the initial BD/ECC interaction experiments.
3. **6x6 Blowdown Heat Transfer Tests:** conduct 6x6 BDHT tests for comparison with 7x7 BDHT data and to serve as a BDHT baseline for BD/ECC interaction experiments.
4. **BD/ECC Interaction Tests:** evaluate system response and heat transfer, and evaluate effectiveness of ECC during the blowdown period, and the period extending well beyond the initial flow coastdown and lower plenum "flashing" periods of the calculated BWR-LOCA in one or more system configurations.
5. **Alternate Power Shape BD/ECC:** determine the effects of axial power shape on the system response and bundle heat transfer behavior during the calculated BWR LOCA.
6. **Non-Jet Pump Plant BD/ECC:** investigate the ECC interaction with the system during blowdown in a representative non-jet pump test system configuration.
7. **Reporting of Data:** report all data (including pertinent error bands) in conventional parametric form suitable for correlation by others.
8. **Model Development:** develop, verify, and document an improved bundle thermal-hydraulic model that can be incorporated into analyses of BWR LOCA's.
9. **Application of Data:** specify how General Electric intends to use the data to qualify the degree of conservativeness of BWR LOCA evaluation models.

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Table A2. Cost Comparisons

<u>Test Phase</u>	<u>March 1979 Estimate</u>	<u>Present Estimate</u>	
7x7 CCFL & BHDT (Objectives 2 & 3)	2,326	2,326	
BD/ECC Interaction Including Alternate Power Shape (Objectives 4 & 5)	6,789	5,174	
Non-Jet Pump BD/ECC (Objective 6)	1,860 ⁶	0	ANK BBR CC
BWR FIST Phase	---	4,028	ANK BBR CC
	<u>\$10,987K</u>	<u>\$11,528K</u>	

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As indicated in Table A2, the contract cost limit must be increased from the current value of \$10,981K to \$11,528K to complete the modified program work. This \$547K difference is comprised of \$4,028K for the ^{BWR}FIST Phase and \$63K to complete the BD/ECC 1A documentation.

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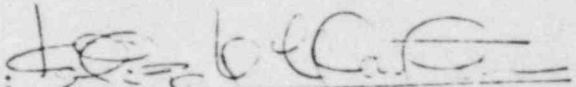
References

1. Dougherty, J.P. and Muzzy, R.J., BWR 8x8 Fuel Rod Simulation Using Electrical Heaters, GEAP-21207 Informal, March 1976.
2. Walker, J.P., 64-Rod Bundle BDHT Test Plan, GEAP-21333 Topical Report, September 1976.
3. Jones, D.D., TLTA Components CCFL Tests, NEDG-NUREG-23732, December 1977.
4. Letzring, W.J., Editor, BWR Blowdown/Emergency Core Cooling Program Preliminary Facility Description Report for the BD/ECC-1A Phase, GEAP-23592, December 1977.
5. Wood, J.C. and Morrison, A.F., BWR Blowdown/Emergency Core Cooling Program 64-Rod Bundle Core Spray Interaction (BD/ECC1A) Test Plan, GEAP-NUREG-21638A, February 1978.
6. 64-Rod Bundle Blowdown Heat Transfer (8x8) Final Report, GEAP-NUREG-23977, September 1978.
7. Muzzy, R.J., Preliminary BWR Blowdown/Emergency Core Cooling Program Plan, GEAP-21255 Topical Report, June 1976.

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IN WITNESS WHEREOF, the parties have executed this document.

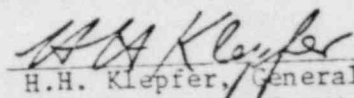
UNITED STATES OF AMERICA

BY: 
Kellogg V. Morton, Chief
Research Contracts Branch
(Name and Title)

DATE: 5-28-81

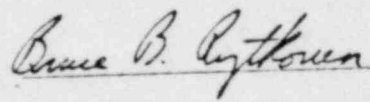
U. S. NUCLEAR REGULATORY COMMISSION

GENERAL ELECTRIC COMPANY

BY: 
H.H. Klepfer, General Manager
Nuclear Fuel & Services Engrg Dept
(Name and Title)

DATE: 4/29/81

ELECTRIC POWER RESEARCH INSTITUTE

BY: 
(Name and Title)

DATE: May 14, 1981