

SUPPLEMENTAL AGREEMENT
BETWEEN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
AND
THE U. S. NUCLEAR REGULATORY COMMISSION

THIS SUPPLEMENTAL AGREEMENT, effective the 1st day of August, 1980, 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 MASSACHUSETTS INSTITUTE OF TECHNOLOGY (hereinafter referred to as the "Contractor"),

WITNESSETH THAT:

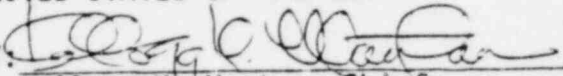
WHEREAS, the parties desire to modify Contract No. NRC- 04-79-181 as hereinafter provided, and this supplemental agreement is authorized by law, including the Energy Reorganization Act of 1974, as amended, and the Atomic Energy Act of 1954, as amended.

NOW, THEREFORE, said contract is hereby modified as follows:


1. Appendix A, attached to this supplemental agreement and made a part hereof, provides for the research to be performed by the Contractor during the contract period specified therein.
2. In Article II - The Period of Performance, the date "July 31, 1981" is substituted for the date "July 31, 1980".
3. In Article III - Consideration, the sum "\$149,977.00" is substituted for the sum "\$54,977.00".

IN WITNESS WHEREOF, the parties have executed this document.

UNITED STATES OF AMERICA

BY: 
Kellogg V. Morton, Chief
Research Contracts Branch
Division of Contracts
U. S. Nuclear Regulatory Commission

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

BY: 
George H. Dummer Director
Office of Sponsored Programs
(title)

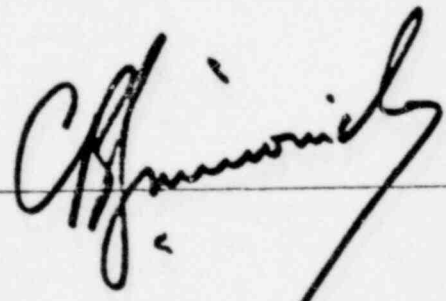
APPROVED 

I, C. B. Simonides, certify that I am the
(attester)
Secretary of the Executive
Committee of the Corporation of the Contractor named under this
(title)

document; that George H. Dummer who signed this
(signatory)
document on behalf of said Contractor was then Director
Office of Sponsored Programs

of said Contractor; that this document was duly signed for and on behalf of
said Contractor by authority of its governing body and is within the scope
of its legal powers.

IN WITNESS WHEREOF, I have hereunto affixed my hand and the seal of said
Contractor.



(SEAL)

CONTRACTOR: MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APPENDIX A

For the Contract period August 1, 1980 through July 31, 1981

Article A-I RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) The scope of work under this contract is unclassified and shall be in accordance with the Contractor's proposal entitled, "Adequacy of Codes, Standards and Safety Evaluation Methods for Reinforced Concrete Nuclear Structures," dated December 14, 1979, as amended June 6, 1980, which is incorporated herein by reference. The contractor shall perform the following:

1. Analytical Simulation of PCA Containment Wall Specimens

Specimens No. 2, 4, 5 and 6 as outlined in PCA proposal of March 1977 (). Specimens 2 and 4 will be loaded to predetermined high biaxial stress levels and subsequently subjected to monotonically increased tangential shear loads. Specimens 5 and 6 are comparable with specimens 2 and 4 respectively, except reversals of shear loading will be applied.

Specimens No. 7 and 8 as described earlier in the experimental part of contractor proposal. In Specimen 7 a lower design biaxial tension of 18ksi will be used and subsequent shear load reversals will be applied. Specimen 8 will simulate a horizontal construction joint in the containment wall.

The analytical simulation of PCA specimens will be a direct continuation of the current research being performed at MIT. In each analysis, the crack stiffness parameters, the cracked shear modulus of the specimen are calculated based on the analytical model developed. Cracking, deformation and stresses are predicted by the analysis. The sensitivity of the response to the cracked shear characteristics is investigated. As the test results are compared with the observed behavior.

2. Investigation of Load Reversals and Cyclic Effects for Application to PCA Tests

Most of the test specimens involved in the proposed experimental program utilize cyclic shear load reversals. Therefore, based on the available test results, a thorough investigation will be made of the behavior of cracked reinforced concrete under reversing cyclic shear effects. The effects of the aggregate interlock and dowel action will be studied and the mechanism by which the material degradation is caused will be investigated. Based on this background information a refined analytical model will be developed and implemented in the computer program for application to the simulation analyses. Basis for such a model has been presented earlier in this Section.

3. Analytical Investigation of the Ductility of the Containment Wall

The ductility of a reinforced concrete structure can be defined as its deformation capacity from yielding of steel to the state when final collapse occurs. The ductility, therefore, may be affected by many factors including yielding of reinforcement, concrete cracking and sliding due to shear. Therefore, generally a detailed analysis of the structure is necessary for a realistic assessment of ductility. The objective, herein, is to perform a three-dimensional analysis of a typical wall specimen to trace the deformation behavior for a full range of loading from start to the ultimate collapse. Such information would serve as a basis to produce most ductil structural response for a given design input.

- (b) The Principal Investigator expects to devote the following approximate amount(s) of time to the contract work:

J. J. Connor - 10% of his time for the academic year and one half of a summer month

ARTICLE A-II WAYS AND MEANS OF PERFORMANCE

- (a) Items for which support will be provided as indicated in A-III, below

(1) Salaries and Wages	\$ 47,480.00
(2) Equipment to be purchased or fabricated by the Contractor	\$ -0-
(3) Travel	
(i) Domestic	\$ 3,000.00
(ii) Foreign	\$ -0-
(4) Other direct costs including fringe benefits	
(5) Indirect costs based on a predetermined rate of 68.3 percent applicable to total salaries and wages plus benefits plus one half graduate research assistants wages. (Graduate research assistants do not earn benefits)	

- (b) Items, if any, significant to the performance of this contract, but excluded from computation of Support Cost and from consideration in proportioning costs:

NONE

- (c) Time or effort of Principal Investigator(s) including indirect costs and fringe benefits contributed by Contractor but excluded from computation of Support Cost and from consideration in proportioning costs:

NONE

Article A-III

The total estimated cost of items under A-II(a) above for the contract period stated in this Appendix A is \$95,000.00 ; the Commission will pay 100 percent of the actual costs of these items incurred during the contract period stated in this Appendix A, subject to the provisions of Article III and Article B-XXVIII. The estimated NRC Support Cost for the contract period stated in this Appendix is \$95,000.00 .

The estimated NRC Support Cost is funded as follows:

- | | |
|---|-------------------------|
| (a) Estimated unexpended balance from prior period(s) | \$ <u> -0-</u> |
| (b) New funds for the current period | \$ <u>95,000.00</u> |
| (c) The new funds being added in A-III(b) constitute the basis for advance payments provided under Article B-X. | |