SUPPLEMENTAL AGREEMENT
BETWEEN
ARIZONA BOARD OF REGENTS
AND
THE U. S. NUCLEAR REGULATORY COMMISSION

THIS SUPPLEMENTAL AGREEMENT, effective the 1st day of February , 1982, 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 ARIZONA BOARD OF REGENTS
(hereinafter referred to as the "Contractor"),

WITNESSETH THAT:

WHEREAS, the parties desire to modify Contract No. NRC-04-78-275 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, supersedes in its entirety the Appendix A of Modification No. 3 of this contract, and provides for the research to be performed by the Contractor during the contract period specified therein.

2. In Article III Consideration, the sum "$1,476,099.00" is substituted for the sum "$1,092,099.00."

IN WITNESS WHEREOF, the parties have executed this document.

UNITED STATES OF AMERICA

BY: Kellogg V. Morton, Chief
Research Contracts Branch
Division of Contracts
(title)

Nuclear Regulatory Commission

ARIZONA BOARD OF REGENTS

BY: _____

Sherwood E. Carr, Treasurer and
~~Contracting Officer~~
(title)

I, James T. Wheeler (attester), certify that I am the

Assistant Vice President (title) of the Contractor named

under this document; that Sherwood E. Carr (signatory)

who signed this document on behalf of said Contractor was then

Treasurer and Contracting Officer 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)

_____

James T. Wheeler, Assistant Vice President
University of Arizona, Babcock Bldg. Rm. #3313
Tucson, Arizona 85721

Contractor: ARIZONA BOARD OF REGENTS

APPENDIX A

For the contract period June 1, 1980 through May 31, 1984:

Article A-I RESEARCH TO BE PERFORMED BY THE CONTRACTOR:

(a) The unclassified scope of work under this contract entitled, "Field and Theoretical Investigations of Mass and Energy Transport in Subsurface Materials at Waste Disposal Sites" is as follows:

REPORTS

Progress reports shall be submitted semi-annually. An annual topical report shall be submitted at the end of each of the four (4) periods of work. A final report shall be submitted upon completion of the contract performance.

June 1, 1980 through May 31, 1981:

Task One: Field Test Facility:

A field test facility in fractured granite near Tucson, Arizona will be designed and implemented. At the facility high-quality data on ground water flow and solute dispersion in such rocks will be collected. Experiments on hydraulic and solute transport will augment the data base needed to formulate a realistic analysis of the physical and chemical processes involved in mass transport through fractured media.

Certain aspects of the field work will be done in cooperation with the U.S. Geological Survey, in particular through joint use of USGS down-hole television and impression-packer equipment. Other aspects of the field work will be integrated with other NRC-supported projects (Rock Mass Sealing under Dr. Jaak Daemen), in particular through joint use of a number of cored holes.

Task Two: Tracer Selection and Analysis

Work will continue on a) developing a group of non-toxic tracers to be used in analyzing the effects of rock sorption on mass transport, and b) analytical procedures for field injection tests. These tracers will cover a range of sorptive properties.

Task Three: Formulation of Governing Equations

Theoretical work will continue with the goal of formulating governing equations for flow through fractured rock that will be both physically sound and capable of solution. There is reason to doubt the validity of a constant dispersivity value when applied to transport through either natural porous media or through fractured rock. The concept of dispersivity itself rests on questionable physical assumptions.

Sensitivity analyses will be included. The range of values of a given parameter will be used in numerical treatments so as to evaluate the magnitude of change in the solution.

Task Four: Evaluation of Computer Programs

Comparison of the relative merits of existing computer programs for solving mass transport equations will continue.

June 1, 1981 through May 31, 1982:

This year's effort will highlight continued development of the fundamental theory of subsurface mass transport in light of the feedback of results from the field test work. There is a need for firstclass field data on the flow of containments through fractured rock. In consideration of this a major effort will be concentrated in tracer injection tests.

The following additional tasks will be accomplished:

a. Initiate simulation runs of mass transport models.

b. Modify and upgrade field test area based on results obtained in CY80.

c. Perform field sorption studies.

d. Testing of tracers in the laboratory for potential field use using core samples from the test area.

e. Laboratory studies on dispersion through nonhomogeneous materials.

f. Continued cooperation with LLL, LBL, and USGS on field data.

June 1, 1982 through May 31, 1983:

The most important work scheduled for this year is the completion and testing of the fundamental theory of mass transport as developed in this project and elsewhere using the data base generated by the field work in CY 80-82. Replication of field experiments will be done to confirm significant results.

There will be continued experiments with core samples to better establish sorption properties. A continuation and conclusion is projected during this year for transport model evaluation and dispersion studies in nonhomogeneous and fractured media.

June 1, 1983 through May 31, 1984:

The final year of effort for this project will focus on the final development and assessment of models for flow through fractured media utilizing the theoretical and field test results obtained in CY 79-82. Additional tasks include:

a. Closure of field site and preparation of final interpretive reports.

b. Formal arrangements for assessment of the project results by outside experts.

c. Final recommendations from the results of the project as they impact on regulatory criteria.

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

E. S. Simpson and S. P. Neuman: June 1, 1980 through May 31, 1983: 10% of their time for each academic year and summer. June 1, 1983 through May 31, 1984: 5% of their time for the academic year and half summer.

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 $437,400.00

(2) Equipment to be purchased or fabricated by the Contractor $131,700.00

Items in Excess of $1,000:

FY 1980: Graphic Computer System
Interface to Data Computer
Digital Plotter
Remote Terminal (2)
Data Logger
Spectra-Physics Computing Integrator
GAS Chromatograph
ION Chromatograph
Mile Volt meter for Selective ion-electrodes
Recording flowmeter

FY 1981: Fluorometer
Positive Displacement SAMPLING
Pumps (4)

FY 1982: Analytical EQUIPMENT PARTS ($4,000)

FY 1982: Equipment Over $1,000 Each Item

Interface to read field data logger	$1,900.00
Air compressor	1,800.00
Electric water-level sounder. .	1,000.00
High pressure slurry pump . . .	1,700.00
Dual pen chart recorder	1,000.00
Recording integrators (2) . . .	8,000.00
Refrigerator for sample storage	1,000.00
Vacuum oven	1,000.00
Constant temperature bath (2)	2,000.00
Microcentrifuge 15,000 rpm	1,000.00
Power supply regulator	1,500.00
Security chain fence	5,000.00
Security steel shed	5,000.00

FY 1983: None

Items Under $1,000:

FY 1980: Transducers (6)
Compressor
Vacuum Pump

(3) Travel

(i) Domestic $ 33,000.00

(ii) Foreign $ 8,000.00

(4) Other direct costs including staff benefits

(5) Indirect costs based on a predetermined rate of 43 percent applicable to direct costs excluding equipment.

(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$1,476,099.00; 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 A is $1,476,099.00.

The estimated NRC Support Cost is funded as follows:

(a)	Estimated unexpended balance from prior period(s)	$25,000.00
(b)	Funds provided in FY 80	$296,989.00
(c)	Funds provided in FY 81	$442,560.00
(d)	New funds for the current period	$384,000.00
(e)	New funds to be provided in FY 83, subject to their availability	$187,330.00

(f) The new funds being added in A-III(d) constitute the basis for advance payments provided under Article B-X.