CONTRACT BETWEEN

COLUMBIA UNIVERSITY

AND

THE U. S. NUCLEAR REGULATORY COMMISSION

THIS AGREEMENT, effective the 1st day of August, 1981, by and between the UNITED STATES OF AMERICA (hereinafter referred to as the "Government"), as represented by the NUCLEAR REGULATORY COMMISSION (hereinafter referred to as the "Commission"), and COLUMBIA UNIVERSITY existing under the laws of the State of New York with its principal office in Palisades, New York (hereinafter referred to as the "Contractor"),

WITNESSETH THAT:

WHEREAS, the Commission desires to have the Contractor perform certain research work, as hereinafter provided; and

WHEREAS, this 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, the parties hereto agree as follows:

ARTICLE I - THE RESEARCH TO BE PERFORMED

(a) The Contractor shall, to the best of its ability, furnish personnel, facilities, equipment, materials, supplies, and services, except such as are furnished by the Government, necessary for the performance of the research provided for in Appendix A hereto, and shall perform the research and report thereon pursuant to the provisions of this contract. It is understood that Appendix A, a guide to the performance of this contract, may be deviated from by the Contractor subject to the specific requirements of this contract.

(b) This work shall be conducted under the direction of H. J. Simpson or such other member of the Contractor's staff as may be mutually satisfactory to the parties.

ARTICLE II - THE PERIOD OF PERFORMANCE

The period of performance under this contract shall commence on August 1, 1981 and expire on August 15, 1984. Performance may be extended for additional periods by the mutual written agreement of the parties.

ARTICLE III - CONSIDERATION

(a) In full consideration of the Contractor's performance hereunder, the Commission shall furnish the equipment, supplies, materials, and services, if any, listed in Article A-II(b) and pay the Contractor the sum of $274,027.00, hereinafter called the "Support Ceiling" which sum shall be subject to adjustment as hereinafter provided.

(b) Payments to the Contractor shall equal the "Cumulative Support Cost" of the performance of this contract, as the term "Cumulative Support Cost" is defined in Article B-XXVIII, provided, however, and notwithstanding any other provisions of this contract, that the Government's monetary liability under this contract shall not exceed the Support Ceiling specified in (a) above. The Commission shall not pay more than the Support Ceiling or an amount equal to the Cumulative Support Cost, whichever is less. The Contractor shall be obligated to perform under this contract throughout the agreed-upon period of performance, and to bear all costs which the Commission has not agreed to pay, provided, however, that the Contractor shall have the right to cease to perform the research provided for in this contract, upon written notice to the Commission to that effect, at any time when or after the Cumulative Support Cost equals or exceeds the Support Ceiling.

(c) The Support Ceiling specified in (a) above may be increased unilaterally by the Commission by written notice to the Contractor and may be increased or decreased by written agreement of the parties (whether or not by formal modification to this contract). In the event the stated period of contract performance is extended, the Support Ceiling will be revised to reflect any increased Commission support for the extended period or periods.

(d) Upon termination, or expiration of the total period of performance, the Contractor shall promptly refund to the Commission (or make such disposition as the Commission may in writing direct) any sums paid by the Commission to the Contractor under this contract, in excess of the Cumulative Support Cost incurred in performance under this contract.

ARTICLE IV - GOVERNMENT PROPERTY

The following items of property procured or fabricated by the Contractor are hereby listed as "Government property": None

ARTICLE V - APPENDICES

Appendix A, Appendix B - General Provisions and Appendix C - Statement of Costs, are hereby attached to and made a part of this contract.

ARTICLE VI - NONDISCRIMINATION

The Contractor agrees to comply with the Commission's Regulation (Part 4 of Title 10, Chapter 1, Code of Federal Regulations), as amended, effectuating the provisions of Title VI of the Civil Rights Act of 1964, and Title IV of the Energy Reorganization Act of 1974, as amended.

ARTICLE VII - CONFLICT OF INTEREST

The Contractor agrees to adopt policies and procedures, designed to avoid conflict-of-interest situations, which are in substantial conformance with the Joint Statement of the Council of American Association of University Professors and the American Council on Education of December 1964, entitled "On Preventing Conflicts of Interest in Government-Sponsored Research at Universities", which policies and procedures will be in connection with this contract.

ARTICLE VIII - ALTERATIONS

a. Article B-XXII, Priorities, Allocations, and Allotments, of Appendix B is deleted in its entirety.

b. In accordance with FPR Temporary Regulation No. 39, Article B-XXVII, Listings of Employment Openings, of Appendix B is deleted in its entirety and inserted in lieu thereof is the attached Article B-XXVII, Disabled Veterans and Veterans of the Vietnam Era.

c. Article B-XXXII, Employment of the Handicapped, of Appendix B is deleted in its entirety and inserted in lieu thereof is the attached Article B-XXXII, Employment of the Handicapped.

d. The attached Article B-XXXIII, Preference for U. S. Flag Air Carriers. is added to Appendix B.

e. The attached Article B-XXXIV, Clean Air and Water, is added to Appendix B.

IN WITNESS WHEREOF, the parties have executed this document.

UNITED STATES OF AMERICA

BY: _____
Kellogg W. Morton, Chief
Research Contracts Branch
(title)

Nuclear Regulatory Commission

BY: _____
James P. Lewis
Director, Projects and Grants
(title)

I, Marion E. Jemmott (attester), certify that I am the

Secretary (title) of the Contractor named

under this document; that James P. Lewis (signatory)

who signed this document on behalf of said Contractor was then

Director, Office of Projects and Grants (title) 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.

Marion E. Jemmott

(SEAL)

CONTRACTOR: COLUMBIA UNIVERSITY

APPENDIX A

For the Contract period August 1, 1981 through August 15, 1984

Article A-I RESEARCH TO BE PERFORMED BY CONTRACTOR

(a) The unclassified scope of work under this contract entitled, "Field Experiment Determinations of Distribution Coefficients of Actinides Elements in Aquatic Environments" is as follows:

STATEMENT OF WORK

The contractor will conduct field studies of several natural water environments (lakes and ground water) to establish the effective distribution coefficients of a number of radionuclides as a function of the type of chemical environment. The research will attempt to bridge the gap between small-scale laboratory experiments and the real systems of primary interest in waste management, and should provide important constraints on the numerical values of distribution coefficients used in model computations of radionuclide behavior. The experiments conducted by the contractor will test the validity of the results obtained from methodologies generally employed, and will help confirm those results or point out additional factors which may be important to include in future laboratory experiments.

The contractor will help define the numerical values of effective distribution coefficients in natural waters as a function of chemical variables which are likely to be important in causing significant variations in effective K_d values. The contractor will rely heavily on direct measurements of radioisotopes in natural water systems. In addition, they will conduct experiments on large samples of natural waters which offer the potential for defining the chemical and other environmental parameters which are important in determining the distribution of transuranic elements between aqueous and solid phases. The contractor will work initially on a group of lakes which offer unusual opportunities for defining the distribution of radioisotopes including plutonium, americium, uranium, thorium, radium, polonium and others in natural waters that approach "end-member" compositions.

A. Distribution Coefficients in High Carbonate Ion Environments

Mono Lake provides an ideal experimental system for helping establish the effect of high carbonate, high pH environments on the distribution of radioisotopes. The contractor has already measured fallout plutonium in the water column of Mono Lake at activities about two orders of magnitude above those of most other surface waters. They have conducted a number of experiments designed to elucidate the mechanisms which may be esponsible for establishing the effective K_d for plutonium.

The contractor will attempt similar measurements for americium to attempt to determine whether its behavior in high carbonate environments is similar to the behavior of plutonium.

Initial measurements in high carbonate environments primarily involved plutonium in Mono Lake. Walker and Pyramid Lakes in Nevada and Lake Abert in Oregon have received fallout plutonium over the same time period as Mono Lake, but two of them have considerably less carbonate ion than Mono Lake. The relative activities of 239,240Pu, 240Am, 234,232,230,228Th, 238,234U, 228,226Pa, and 210Po in water and sediments of these lakes will be measured to evaluate the variation of effective K_d as a function of carbonate ion concentration. This information will be used for extrapolating observations in lake environments to other environments.

A topical report on Distribution Coefficients of Radionuclides in High Carbonate Environments will be submitted to NRC within 18 months following initiation of the contract.

B. Distribution Coefficients in Sulfate Environments

A second set of experiments will be designed to measure the effective distribution coefficients of transuranic and actinide elements in a natural water system in which the anion balance is dominated by sulfate. The system on which the contractor will work is Green Lake which is situated in a gypsum-rich terrain in central New York State. The effect of sulfate ion, in both oxidizing and reducing conditions, on the partitioning of 241Am, 240,239Pu, 234,232,230,228Th, 238,234U, 228,226Pa and 210Po will be established. The abundant published chemical data on Green Lake as well as additional unpublished data on fission product distributions in the varved sediments of the central lake basin, will be used to facilitate interpretation of transuranic and actinide measurements in terms of the main processes affecting distribution between water and particle phases.

C. Distribution Coefficients in Chloride Environments

The third major class of anionic environments in natural waters is that dominated by chloride ion. There are good possible natural water environments of this t pe in which the contractor may measure the effective distribution coefficients of transuranic elements, but they will firs evaluate preliminary data to give strong indications of the value of the particular system to the task of defining effective distribution coefficients of transuranic elements as a function of chloride concentration. There are a number of good candidates within the Great Basin of the western U.S., including lakes for which the contractor already has some preliminary information. The contractor will provide a research plan for conducting measurements on chloride environments to the NRC project manager for his approval. This plan will be submitted within 18 months of the initiation of the contract. The contractor will conduct the approved research on the effect of chloride complexation.

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

H. J. Simpson: First year - 100% of his time for 2 months
Second year - 100% of his time for 1 1/2 months
Third year - 100% of his time for 1 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 $ 109,212.00

(2) Equipment to be purchased or fabricated by the Contractor $ 8,000.00

Continuous Flow Centrifuge
(CENTRICO - small version)

(3) Travel

(i) Domestic $ 15,069.00

(ii) Foreign $ -0-

(4) Other direct costs including fringe benefits

(5) Indirect costs based on a predetermined rate of percent applicable to modified total direct cost, 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 $274,027.00 ; the Commission will pay 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 $274,027.00 .

The estimated NRC Support Cost is funded as follows:

(a) Estimated unexpended balance from prior period(s) $ -0-

(b) New funds for the current period $ 274,027.00

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