

CONTRACT BETWEEN  
THE UNIVERSITY OF CHICAGO  
AND  
THE U. S. NUCLEAR REGULATORY COMMISSION

THIS AGREEMENT, effective the 1st day of August, 1982, 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 THE UNIVERSITY OF CHICAGO existing under the laws of the State of Illinois with its principal office in Chicago (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 Professor T. Theodore Fujita 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, 1982 and expire on July 31, 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 \$245,000.00, 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 dated June, 1982 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 Conflict of Interest in Government-Sponsored Research at Universities", which policies and procedures will be in connection with this contract.

THE REMAINDER OF THIS PAGE INTENTIONALLY LEFT BLANK.

IN WITNESS WHEREOF, the parties have executed this document.

UNITED STATES OF AMERICA

BY: [Signature]  
Kellogg V. Morton, Chief  
Research Contracts Branch  
(title)

Nuclear Regulatory Commission

BY: [Signature]  
Donald S. Sigal, Director  
Office of Sponsored Programs  
(title)

I, F. Gregory Campbell, certify that I am the  
(attester)

Secretary of the Board of Trustees of the Contractor named  
(title)

under this document; that Donald S Sigal  
(signatory)

who signed this document on behalf of said Contractor was then  
Director, Office of Sponsored Programs of said Contractor; that  
(title)

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.

[Signature]  
F. Gregory Campbell

(SEAL)

CONTRACTOR: THE UNIVERSITY OF CHICAGO

## APPENDIX A

For the contract period August 1, 1982 through July 31, 1984 for Tasks 1 through 8 and August 1, 1982 through July 31, 1983 for Tasks 9.a. and 9.b.

### Article A-I(a)

The unclassified scope of work, report requirements, meetings and travel under this contract shall be as follows:

#### SCOPE OF WORK

- Task 1. Collect and maintain tornado data in a form suitable for efficient tornado hazard probability calculations; a consistent set of Fujita scale tornado intensity ratings should be used to rate all known tornadoes according to their severity. The tornado data record shall begin with 1916 and be updated each year by incorporating each reported tornado. The tornado data shall include, as a minimum, path length, path width, area, location (latitude and longitude), time of occurrence (year, day, hour), Fujita scale rating. Reconcile differences, if any, between the existing data at NSSFC and the University of Chicago. Identify uncertainties inherent in the composite data set. Recommend procedures for resolving differences and minimizing uncertainties.
- Task 2. Review existing tornado hazard probability models (windspeed as a function of probability or recurrence interval) and refine or develop a model to reduce the uncertainties as more data become available; if possible, 5/95% confidence-limits should be determined as a minimum. The relative significance of the variables in the tornado hazard probability model should be identified and quantified; as a minimum, sensitivity analyses should be conducted for tornado occurrence, path area, intensity, damage gradation, time period of record, topography, and correlations of these parameters.
- Task 3. Regionalize the tornado hazard probability for the contiguous United States using the knowledge gained from past tornado damage surveys, tornado hazard probability models, topographical variations, and differing meteorological regimes that may induce or inhibit tornado formation. Site specific calculations should be performed where uncertainties are great or refinements are needed. Maps should be prepared on which are drawn isopleths of windspeeds corresponding to probabilities of  $1 \times 10^{-6}$ ,  $10^{-7}$ , and  $10^{-8}$  per year.
- Task 4. Conduct detailed tornado and high wind damage surveys using the state-of-the-art aerial and ground survey techniques to ascertain the characteristics of the tornado, i.e., windspeed, pressure deficit, size, translation speed; document the gradations of damage as a function of the Fujita tornado intensity scale. Damage surveys shall be conducted for all potential violent tornadoes (F 4 and F 5 on the Fujita tornado intensity scale). Identification of the potentially violent tornadoes shall be based on initial reports received by the contractor from the National Severe Storms Forecast Center (Kansas City), the University of Chicago, and the



communications media. Consultation is required between the contractor and the cognizant NRC technical contract monitor prior to each survey. As a minimum, the damage surveys should accurately document the tornado path length, path width, F-scale rating, the areas (location and size) of each F-scale intensity damage, the time of occurrence, date, location (including latitude and longitude), and any other information found to be significant during the damage survey.

- Task 5. Conduct detailed photogrammetric analyses of available tornado motion picture footage of sufficient quality to resolve dust and debris aggregates into velocities; identify the uncertainties in the calculational procedures and results. Relate the speeds thus measured to actual tornado windspeeds. Compile an atlas of photogrammetric analyses documenting windspeed determinations and identifying and quantifying uncertainties in results. These photogrammetric analyses should all be performed using a consistent methodology and the relevance of the portion of the tornado used for analyses should be related to the lifecycle of each tornado.
- Task 6. Review existing tornado vortex models for possible application to engineering problems; develop or refine a tornado vortex model for particular engineering applications. Applications should include, as a minimum, wind load distributions (laterally and vertically) and tornado missile generation and trajectory determinations.
- Task 7. Develop or revise a workbook on available tornado knowledge applicable to engineering concerns, wind loads and missiles. As a minimum, workbook should include tornado formation mechanisms, geographic variations, topographical variabilities, tornado vortex model, tornado statistics arising from completion of Task (2), an assessment of windspeed determination methods (identifying the advantages and disadvantages of each), and tornado hazard probability model recommended.
- Task 8. Coordination with existing NRC tornado research contractors shall be effected and maintained to assure efficiency and effectiveness in attaining mutual NRC objectives.
- Task 9.a. Review the document entitled "Palo Verde Nuclear Generating Station, Probabilistic Risk Assessment of Tornado Missile Damage to the Station Ultimate Heat Sink, Bechtel Study Number 13-NS-108." Prepare an evaluation of the validity and conservatisms of the mathematical approach, assumptions and data employed in assessing the probability of tornado missile damage to the spray pond components. Include an assessment of the correctness of the results obtained.

- Task 9.b. Review the document entitled "Tornado Missile Simulation and Design Methodology, EPRI NP-2005." Prepare an evaluation of the validity and assumptions of the mathematical approach and provide an assessment of the applicability of this model for use in assessing tornado missile efforts. Compare this approach with that used by the Pa'ó Verde applicant (Task 9.a. above) and provide comments on the appropriateness of each."

#### REPORT REQUIREMENTS

1. Two separate QUARTERLY LETTER PROGRESS REPORTS - one for Tasks 1 through 8 and one for Tasks 9.a. and 9.b., in one (1) copy of each report to the Contracting Officer's Project Officer (PO) and one (1) copy of each report to the Contracting Officer, will be submitted by the 15th day of each quarter and will include as a minimum:

##### Report for Tasks 1 through 8:

- a. a technical report of progress describing findings to date, problems incurred and solutions proposed, and plans for the ensuing quarter
- b. a report of costs incurred each quarter and cumulative costs at the end of each quarter as follows:

Salaries and Wages  
Fringe Benefits  
Indirect Costs  
Travel  
Other Direct Costs  
Reproduction Costs  
Percent that Costs Expended Bear to  
Authorized Costs

##### Report for Tasks 9.a. and 9.b.

- a. a technical report of progress describing:
  1. A listing of the efforts completed during the period; milestones reached, or if missed, an explanation provided.
  2. Any problems or delays encountered or anticipated and recommendations for resolution.
  3. A summary of progress to date (this may be expressed in terms of percentage completion for Task 9).
  4. Plans for the next reporting period.

- b. a separate report of costs incurred for Tasks 9a and 9b each quarter and cumulative costs at the end of each quarter. (Use the same cost categories for the cost report for Tasks 1 through 8).
2. Two separate TOPICAL REPORTS - one for Tasks 1 through 8 and one for Tasks 9.a. and 9.b. in one (1) copy of each report to the Contracting Officer's Project Officer (PO) and one (1) copy of each report to the Contracting Officer.

Report for Tasks 1 through 8:

Will be submitted by the 15th day after

- a. Tasks 2, 3, 5, 6 and 7
- b. Each tornado and high wind damage survey performed for Task 4.

Report for Tasks 9.a. and 9.b.:

Describe the results of

- a. The Bechtel Study Number 13-NS-108 document review (Task 9a), due on or before November 1, 1982.
- b. The EPRI NP-2005 document review (Task 9b), due on or before March 1, 1983.

3. Trip Reports (for Tasks 1 through 8)

The contractor shall furnish in one (1) copy to the Contracting Officer's Project Officer (PO) and one (1) copy to the Contracting Officer, a trip report elaborating the results of each contract related trip funded in whole or part by the NRC. Trip reports are due by the 15th day after completion of each trip.

4. Meetings and Travel

For Tasks 1 through 8:

- a. The contractor shall participate in approximately two (2) four day meetings per year at the regional and national specialist conferences upon the request of the Project Officer.
- b. The contractor shall participate in meetings with the NRC staff at Silver Spring, Maryland as requested by the Project Officer. The contractor shall participate in meetings with other NRC sponsored contractors as requested by the Project Officer.



For Tasks 9.a. and 9.b.

- a. The contractor shall participate in meetings with the NRC staff at Silver Spring, Maryland prior to initiating performance of work on Tasks 9.a. and 9.b.
- b. The contractor shall participate in meetings with the NRC staff at the contractor's office on or about September 1, 1982 to assess work progress on Tasks 9.a. and 9.b.

Article A-I(b)

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

T. T. Fujita: 16% - 1982-1983/100% 1 summer month  
 5% - 1983-1984/100% 1 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 \$107,766.00
- (2) Equipment to be purchased or fabricated by the Contractor \$ None
- (3) Travel
  - (i) Domestic \$ 14,300.00
  - (ii) Foreign \$ None
- (4) Other direct costs including fringe benefits
- (5) Indirect costs based on a fixed rate of 69 percent applicable to total direct costs, less student research assistant tuition remission expense, central computer charges and subcontracts over \$25,000 each; physical sciences division, central shop charges.

(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 \$365,000.00; 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 A is \$365,000.00.

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>\$245,000.00</u> |
| (c) Funds to be provided subject to their availability in FY-1983.  | <u>\$120,000.00</u> |
| (d) The new funds being added in A-III(b) constitute the basis for advance payments provided under Article B-X. |                     |