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FLORIDA UNIV GAINESVILLE DEPT OF ELECTRICAL ENGINEERING  
LIGHTNING PHYSICS (U)  
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April 3, 1981

DEPARTMENT OF ELECTRICAL ENGINEERING

Mr. James Hughes, Code 465  
Atmospheric Sciences Program  
Office of Naval Research  
800 North Quincy Street  
Arlington, VA 22217

Dear Jim:

Please consider this letter a final report on ONR contract N00014-75-C-0146 entitled "Lightning Physics." The contract expired January 31, 1981 after running a period of 6½ years. As you know, we are continuing our lightning research under a new ONR contract.

During the course of the contract we studied a variety of properties of lightning, concentrating, however, on the return stroke, its electric and magnetic fields, and its currents. Three Ph.D. candidates, eleven masters degree candidates and about ten undergraduates have been involved in this research as well as myself and Dr. William Beasley, an Assistant Professor. In lieu of a detailed description of the research, I am listing below the publications resulting from ONR support. In some cases the work was jointly supported by NSF and/or NASA. I believe that you have previously been sent copies of all reviewed publications and all significant unreviewed publications.

Articles in Reviewed Journals

"Progress in Atmospheric Electricity," Reviews of Geophysics and Space Sciences, 13, 760-765, 849-853 (1975), M.A. Uman, G.A. Dawson, and W.A. Hoppel.

"A Gated Wideband Magnetic Direction Finder for Lightning Return Strokes," J. Appl. Meteor., 15, 301-306 (1976), E.P. Krider, R.C. Noggle, and M.A. Uman.

"Tests of a Wideband Magnetic Direction Finder for Lightning Return Strokes," J. Appl. Meteor., 15, 402-405 (1976), B.D. Herrman, M.A. Uman, R.D. Brantley, and E.P. Krider.

"Electric Field Statistics for Close Lightning Return Strokes near Gainesville, Florida," J. Geophys. Res., 81, 4430-4434 (1976), J.A. Tiller, M.A. Uman, Y.T. Lin, R.D. Brantley, and E.P. Krider.

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"Reply to Smyth and Smyth," Am. J. Phys., 45, 582, (1977), M.A. Uman.

"An Unusual Lightning Flash at the NASA Kennedy Space Center," Science, 201, 9-16, (1978), M.A. Uman, W.H. Beasley, J.A. Tiller, Y.T. Lin, E.P. Krider, C.D. Weidmann, P.R. Krehbiel, M. Brook, A.A. Few, J.L. Bohannon, C.L. Lennon, H.A. Poehler, W. Jafferis, J.R. Gulick, and J.R. Nicholson.

"Lightning Location and Lower Ionospheric Height Determination from Two Station Magnetic Field Measurements," J. Geophys. Res., 84, 1727-1734, (1979), T.B. McDonald III, M.A. Uman, J.A. Tiller and W.H. Beasley.

"Criticism of Comments on Detection of Lightning Supertolts," J. Geophys. Res., 83, 5523 (1978).

"The RF Spectra of First and Subsequent Lightning Return Strokes in the 1-200 km Range," Radio Science, 15, 1089-1094, 1980, G.I. Serhan, M.A. Uman, D.G. Childers, and Y.T. Lin.

"Errors in Magnetic Direction Finding due to Non-Vertical Lightning Channels," Radio Science, 15, 35-39, 1980, M.A. Uman, Y.T. Lin, and E.P. Krider.

"Characterization of Lightning Return Stroke Electric and Magnetic Fields from Simultaneous Two-Station Measurements," J. Geophys. Res., 84, 6307-6314, (1979), Y.T. Lin, M.A. Uman, J.A. Tiller, R.D. Brantley, E.P. Krider, and C.D. Weidmann.

"Lightning Source Locations from VHF Radiation Data for a Flash at Kennedy Space Center," J Geophys. Res., 85, 4893-4903, 1980, P.L. Rustan, M.A. Uman, W.H. Beasley, D.G. Childers, and C.E. Lennon.

"Electromagnetic Noise and Radio Wave Propagation below 100 kHz in the Jovian Atmosphere," J. The Equatorial Region, J. Geophys. Res., 84, 5181-5188 (1979), K. Rinnert, L.J. Lanzerotti, E.P. Krider, M.A. Uman, G. Dehmel, R.O. Gliem and W.I. Axford.

Classification For  
ALL INFORMATION CONTAINED  
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"Lightning Return Stroke Models," J. Geophys. Res., 85, 1571-1583, 1980, Y.T. Lin, M.A. Uman, and R.B. Standler.

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"A New Model for Lightning Return-Stroke Current from Simultaneous Two-Station Electric and Magnetic Field Measurements (Abstract)," Trans. Am. Geophys. Union, 57, 924 (1976), Y.T. Lin, M.A. Uman, and E.P. Krider.

"Lightning Strike to the KSC 500 Foot Weather Tower" (Abstract), Trans. Am. Geophys. Union, 57, 924 (1976), M.A. Uman, J.A. Tiller, W.H. Beasley, E.P. Krider, and C.D. Weidmann.

"Correlated Satellite Optical and Ground-Based Electric and Magnetic Field Observations of Lightning" (Abstract), Trans. Am. Geophys. Union, 59, 285 (1978), W.H. Beasley, M.A. Uman, B.C. Edgar, and B.N. Turman.

Review of Lightning, edited by R.H. Golde, M.A. Uman, Science, 200, 647 (1978).

"A Cooperative Study of An Unusual Lightning Flash at Kennedy Space Center During 1976," Conference on Cloud Physics and Atmospheric Electricity, July 31-Aug. 4, 1978, Issaquah, Wash., Published by Am. Meteor. Society, Boston, Mass., with W.H. Beasley, Y.T. Lin, E.P. Krider, C.D. Weidman, P.R. Krihbiel, M. Brook, A.A. Few, J.L. Bohannon, C.L. Lennon, H.A. Poehler, W. Jafferis, J.R. Gubick, J.R. Nicholson, J.A. Tiller.

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"The RF Spectrum of First and Subsequent Lightning Return Strokes in the 1-200 km Range," (Abstract), Trans. Am. Geophys. Union, 60, 270, (1979), G.I. Serhan, M.A. Uman, D.G. Childers, and Y.T. Lin.

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"DOE Project - Lightning Protection of Distribution Systems," IEEE Power Engineering Society, Winter Meeting, submitted to Transmission and Distribution Committee, New York, February 1979, M. Darveniza and M.A. Uman.

"Lightning Studies of Distribution Lines," Proceedings of IEEE/PAS Transmission and Distribution Systems Conference, Atlanta, GA, April 1979, M. Darveniza and M.A. Uman.

"Lightning Studies of Distribution Lines," Proceedings of Annual Southeastern Exchange Conference, Bal Harbor, May 10, 1979, R. Frowd, M. Darveniza, and M.A. Uman.

"Research into Lightning Protection of Distribution Systems - Equipment for Field Tests," IEEE Power Engineering Society Summer Meeting. Vancouver, B.C., July 1979, M. Darveniza and M.A. Uman.

"Properties of Lightning Derived from Multiple Station VHF Radiation Data," (Abstract), Trans. Am. Geophys. Union, 60, 836 (1979), P.L. Rustan, M.A. Uman, D.G. Childers, W.H. Beasley, and C.E. Lennon.

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"Calculations of Lightning Return Stroke Electric and Magnetic Fields Above Ground," Lightning Technology, NASA Conference Publication 2128, FAA-RD-80-30, Conference at Hampton, VA, April 1980, Uman, Lin, Standler, Master, Fisher.

"Lightning Return Stroke Models," 6th International Conference on Atmospheric Electricity, Manchester, England, July, 1980, Uman.

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"Electric Fields Preceding Cloud to Ground Lightning," 6th International Conference on Atmospheric Electricity, Manchester, England, July 1980, Beasley, Uman, Rustan.

"Planetary Lightning and Lightning Measurements on the Galelio Probe to Jupiter's Atmosphere," 6th International Conference on Atmospheric Electricity, Manchester, England, July 1980, Lanzerotti, Rinnert, Krider, Uman, Dehmel, Gliem.

"Lightning Properties Derived from Time Series Analysis of VHF Data," 6th International Conference on Atmospheric Electricity, Manchester, England, July 1980, Rustan, Uman, Beasley, Lennon.

"Charge Distribution in Lightning Flashes," IEEE EMC Meeting, Fall 1980, Rustan and Uman.

"A Comparison of Lightning and Nuclear EMP Environments and Their Interaction with Aircraft," 1980 Nuclear EMP Meeting, August 5-7, 1980, Anaheim, CA, Perala, Uman, Krider.

"Lightning," Encyclopedia of Physics, Addison-Wesley Publishing Company, Reading, MA, 520-521 (1980), M.A. Uman.

"Return Stroke Frequency Spectra from 1 to 20 MHz" (Abstract), Trans. Am. Geophys. Union, 61, 977, 1980, E.P. Krider, C.D. Weidman, and M.A. Uman.

"On the Varieties of Stepped Leader Electric Fields" (Abstract), Trans. Am. Geophys. Union, 61, 977, 1980, W.H. Beasley and M.A. Uman.

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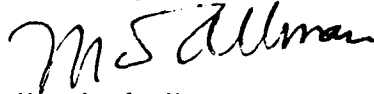
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Attached find 3 copies DD Form 882, Final Report of Inventions and Subcontracts, completed in triplicate.

Please let me know if I can provide any additional information.

Sincerely,



Martin A. Uman

MAU/rc

copies to:

Janet E. Chitty, Grants Coordinator  
B.E. Cherrington, Department Chairman, E.E.  
J. Fitzgerald, Assistant Department Chairman, E.E.  
ACO (1)  
NRL Code 2627 (6)  
DDC (12)

**REPORT OF INVENTIONS AND SUBCONTRACTS**  
(Pursuant to "Patent Rights" Contract Clause)

Form Approved  
Budget Bureau No. 22-R160

**INSTRUCTIONS TO CONTRACTOR**

This form (in triplicate) is for use in submitting INTERIM and FINAL reports to the Contracting Officer.

An INTERIM report shall be submitted at least every twelve months, commencing with the date of the contract, and should include only those inventions and subcontracts for which the information requested below has not previously been reported.

A FINAL report shall be submitted as soon as practicable after the work under the contract is complete and shall include (a) a summary of all inventions required by the contract to be reported, including all inventions previously reported and any inventions since the last INTERIM report; and (b) any required information for subcontracts which has not previously been reported.

1. NAME AND ADDRESS OF CONTRACTOR (Include ZIP Code)  
University of Florida  
Gainesville, Florida 32611

2. CONTRACT NUMBER  
N00014-75-C-0143

3. TYPE OF REPORT (check one)  
 a. INTERIM  b. FINAL

**SECTION I - INVENTIONS** ("Subject Inventions" required to be reported by the "Patent Rights" clause)

4. INVENTION DATA (Listed below are all inventions required to be reported) (if NONE, so state).

(i) NAME OF INVENTOR	(ii) TITLE OF INVENTION	(iii) PATENT APPLICATION SERIAL NUMBER, IF AVAILABLE, OR CONTRACTOR DISCLOSURE IDENTIFICATION NUMBER	(iv) CONTRACTOR HAS FILLED OR WILL FILE U.S. PATENT APPLICATION		(v) CONFIRMATORY LICENSE OR ASSIGNMENT HAS BEEN FORWARDED TO CONTRACTING OFFICER	
			YES	NO	YES	NO
NONE						
<p style="text-align: center;"><i>M. A. Uman</i> M. A. Uman, Principal Investigator</p>						

**SECTION II - SUBCONTRACTS** (Containing a "Patent Rights" clause)

5. LISTED BELOW IS INFORMATION REQUIRED BUT NOT PREVIOUSLY REPORTED FOR SUBCONTRACTS. (If "None" so state.)

(i) NAME AND ADDRESS OF SUBCONTRACTOR (Include ZIP Code)	(ii) SUBCONTRACT NUMBER	(iii) DATE SUBCONTRACT WAS FURNISHED TO CONTRACTING OFFICER	(iv) DATE SUBCONTRACT COMPLETED
NONE			
<p style="text-align: center;"><i>M. A. Uman</i> M. A. Uman, Principal Investigator</p>			

**SECTION III - CERTIFICATE**

CONTRACTOR CERTIFIES THAT THIS REPORT OF INVENTIONS AND SUBCONTRACTS, INCLUDING ANY ATTACHMENTS, IS COMPLETE AND CORRECT TO THE BEST OF THE CONTRACTOR'S KNOWLEDGE AND BELIEF.

DATE: \_\_\_\_\_ NAME AND TITLE OF AUTHORIZED OFFICIAL (Print or Type): Division of Sponsored Research SIGNATURE: \_\_\_\_\_



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