AD-A191 184 WIPP (WAVE INDUCED PARTICLE PRECIPITATION) EXPERIMENT LOGISTIC SUPPORT(U) ELECTROSPACE SYSTEMS INC ARLINGTON VA E A RAY 31 DEC 87 N00014-87-C-0666 1/1

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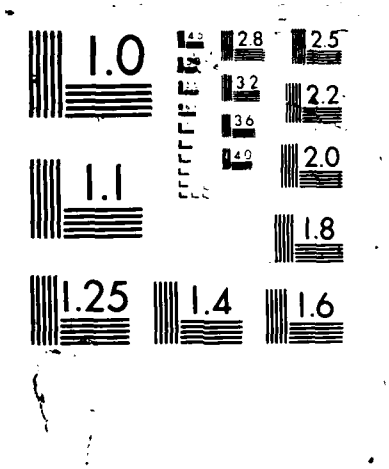
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WIPP EXPERIMENT

LOGISTIC SUPPORT

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FINAL REPORT

31 December 1987

ELECTROSPACE SYSTEMS, INC.
1725 Jefferson Davis Highway
Suite 501
Arlington, VA 22202

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The WIPP (Wave Induced Particle Precipitation) Program required that a series of unique modulation (keying) events be transmitted from the U.S. Navy VLF transmitter at Annapolis, Maryland. The keying events were planned to occur twice daily during the period 15 through 31 July, 1987, and to be of 15 minutes duration each.

Support was provided in assisting the Scientific Officer (ONR Code 1114) in negotiations with the cognizant Navy Broadcast Control Authority, and the Operational Commanders of the facility, for the cooperative use of the Annapolis VLF broadcast transmitter. Additionally, unique keyers, previously developed to support the Stimulated Emission of Energetic Particles (SEEP) experiment, which performed keying events similar to those needed by the WIPP program were tested, and repaired as required, and installed at Annapolis. Finally, Navy personnel at Annapolis were trained in the use of the keyers, and instructed in the provision of support to the WIPP experiment.

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19. ABSTRACT (Continued)

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WIPP EXPERIMENT

LOGISTIC SUPPORT

FINAL REPORT

31 December 1987

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ELECTROSPACE SYSTEMS, INC.

1725 Jefferson Davis Highway

Suite 501

Arlington, VA 22202

ABSTRACT

This report outlines the logistic support efforts performed for the WIPP Program, sponsored by ONR Code 1114, under Contract No. N00014-87-C-0666.

The WIPP (Wave Induced Particle Precipitation) Program required that a series of unique modulation (keying) events be transmitted from the U.S. Navy VLF transmitter at Annapolis, Maryland. The keying events were planned to occur twice daily during the period 15 through 31 July, 1987, and to be of 15 minutes duration each.

Support was provided in assisting the Scientific Officer (ONR Code 1114) in negotiations with the cognizant Navy Broadcast Control Authority, and the Operational Commanders of the facility, for the cooperative use of the Annapolis VLF broadcast transmitter. Additionally, unique keyers, previously developed to support the Stimulated Emission of Energetic Particles (SEEP) experiment, which performed keying events similar to those needed by the WIPP program were tested, and repaired as required, and installed at Annapolis. Finally, Navy personnel at Annapolis were trained in the use of the keyers, and instructed in the provision of support to the WIPP experiment.

Records of the actual event operations, annotated by the Navy operators of the Annapolis VLF, are included as an appendix.

INTRODUCTION

The Wave Induced Particle Precipitation (WIPP) program bears some similarity to the Stimulated Emission of Energetic Particles (SEEP) program, in that both engaged in observation of particle precipitation from the Van Allen Belt occuring as a result of, inter alia, high power radio transmissions from U.S. Navy (and/or other) very low frequency (VLF) broadcast transmitters. Additional information regarding the SEEP, and WIPP programs, is available from the Defense Technical Information Center (DTIC), or the Scientific Officer, ONR Code 1114.

Electrospace Systems, Inc. (ESI) provided support to the Office of Naval Research (ONR) Scientific Officer managing the SEEP program, by assisting in negotiations with the cognizant broadcast control authorities (BCA), and the responsible operational commanders, to obtain cooperative use of the transmitters. Additionally, ESI designed and built preprogrammed keyers specifically to interface with the Navy VLF transmitters and modulation systems. These 'SEEP Keyers' were installed at the Navy VLF transmitter facilities, and the operators were trained in their application and use by ESI.

SEEP keyers were used during 1982 and, briefly, in 1984. ESI assisted again in 1984 by reactivating the keyers, and retraining the operating personnel. The keyers were retained at the transmitter sites.

BACKGROUND

When the ONR Scientific Officer decided to support the WIPP experiment, he was confronted with two problems. First was acquiring the cooperative use of the Navy VLF transmitters to obtain the necessary transmissions. Second was determining the condition of the long unused SEEP keyers. ESI offered to assist in both of these endeavors.

ACTION

Cooperative Use of the Navy VLF Transmitters

ESI accompanied the ONR Scientific Officer to Norfolk, Virginia, to brief the Assistant Chief of Staff, Communications, for the Commander, Submarine Forces, U.S. Atlantic Fleet; some members of his staff; and the Staff Strategic Communications Officer for the Commander in Chief, U.S. Atlantic Fleet on the desired use of the VLF transmitters in support of the WIPP experiment. ESI later assisted the Scientific Officer by providing drafts of messages and/or letters required to consummate the negotiations. Use of the Navy VLF transmitter at Annapolis, Maryland was secured.

ESI provided follow up negotiations with staff members of both of the cognizant Commanders to iron out details of the specific control methods to be employed at Annapolis, and between Annapolis and the BCA. Results of these negotiations were reported, informally, to the ONR Scientific Officer.

Test and Evaluation of the SEEP Keyers

The keyers were recovered from the Navy VLF sites, and evaluated at the ESI Washington Systems Engineering Office, in Arlington, Virginia. Two were operable and required only adjustment and calibration. The third was not operational, and repairs were required. Funding restraints prevented immediate repair of the failed keyer. Since only one keyer was required to support the WIPP program, one of the two operable keyers was installed at Annapolis, the other was held ready to replace it, if that was required. Later, funding limitations were removed, and the third keyer was repaired. Failed parts and residue were discarded as scrap.

All three keyers are presently operational, and have been adjusted, calibrated, and tested at the Annapolis VLF to check out all the interface functions. One is installed at Annapolis, and the two remaining keyers have been retained at ESI Arlington awaiting disposition instructions.

PERFORMANCE

The personnel at Annapolis joined into the performance of tests to support the WIPP program with gusto.

The Annapolis personnel were given notice in advance of the negotiations with the BCA in order to enlist their cooperation, and to avoid conflict with other planned events. After the agreement for cooperative use was secured from the BCA, the sailor - operators were given a detailed briefing of the WIPP program, and the contribution they would be making. Their curiosity was boundless, and the briefing was peppered with appropriate and intelligent questions. Sailors are an inherently curious group, and sailors trained to operate and maintain million-watt radios are more curious than the average. Some of the sailors even planned to watch the rocket launches. (Rocket mounted monitors, launched from Wallops Island Virginia, about 100 miles from the Annapolis transmitter, were part of the WIPP program plans.)

The actual test events were planned to occur twice daily, at 0500 and 0815 GMT, and last for exactly 15 minutes each time. The agreement with the BCA granted control of transmissions to Annapolis two to five minutes before the tests were scheduled to begin, and required restoration of BCA control as quickly after the 15 minute test ended as the operators could manage. The

agreement also provided for denial of a test if the tempo of submarine operations required uninterrupted broadcast. No denials became necessary, and all tests were conducted on schedule.

To reduce the risk of late start of test events, and late return to BCA control, radiated power during the tests were held at about 280kW to obviate the need for retuning. Actual radiated power during the tests can be calculated from the data sheets included as Appendix A. With the elimination of time lost to retuning, the release time and return time was held to two minutes or less, reducing the broadcast time loss to less than twenty minutes each event.

The design characteristics of the SEEP keyer provide for exceptional accuracy in time functions occurring as a result of connection to the cesium beam frequency/time standard located at each VLF transmitter site. The preprogrammed keying sequence selected for the WIPP transmission was 3 seconds on (key closed), followed by 2 seconds off (key open). Keyer control functions require that the operator set the keyer to the test mode anytime during the minute preceeding the desired start time, and keying will begin precisely at the beginning of the next minute.

Unfortunately, the keyer control circuits will cause the test sequence to run for exactly ten minutes and then shut down and audibly notify the operator of the end of testing. This characteristic was based on the requirements of the SEEP program, and neither time nor funds were available to permit alteration of the control circuits prior to the WIPP test schedule. This limitation was

mitigated by causing the 'TEST' switch to be opened and reclosed during the final two seconds (the off period) of the fifth minute, causing the internal clock to restart the 10 minute test exactly on the sixth minute, giving a 15 minute period of transmissions.

The same result could be obtained by resetting the 'TEST' switch during the final two seconds of the tenth minute, and shutting off the keying during the final two seconds of the fifteenth minute. Records do not show whether these techniques, or any other technique, were employed.

The operation of the 'TEST' switch in this manner was not hazardous to the transmitter/antenna system provided it was operated in the two-second off period. Results provide evidence that it was operated safely throughout the 17 days of tests.

Sailors are accustomed to keeping records of operations at transmitter sites, and a formatted record of the WIPP test events was created. The record was entitled "WIPP TEST LOG' and was provided, predated, requiring four entries for each test event. The tests were numbered according to the calendar date. Thus, test 15-1 was the first test conducted on July 15, 1987; and test 31-2 was the second test conducted on July 31st.

Two time entries were required. Since the BCA could deny a test by delaying start time, the first entry required was the time the BCA released the system to local control for WIPP testing. This was followed by the time keying

actually started. The third entry was the antenna current displayed during the test transmission, and the last was the initials of the operator conducting the test. This last entry was required only to provide access to information in the event of test failure or denial.

Review of the records shows that all test transmissions were conducted on schedule without denial, failure, or mishap. Informal information obtained from the Scientific Officer indicates that the Annapolis contribution was the only part of the WIPP program which did perform without a hitch. The Annapolis personnel were most cooperative, and very pleasant to deal with, and their performance was praiseworthy. The Scientific Officer recognized their efforts with a commendatory letter to their Commanding Officer, a copy of which is included as Appendix B of this report.

APPENDIX A

WIPP TEST LOGS

This Appendix contains copies of the actual WIPP TEST LOG records maintained by the operators of the U.S. Navy VLF transmitter at Annapolis, Maryland, throughout the period of the WIPP tests.

Each record sheet shows the time the broadcast was released by the BCA, the time the test actually began, the antenna current during that test, and the record keeper's initials.

Radiated power of the transmissions during the tests may be calculated from the recorded antenna current by operation of the following expression. Radiated power is equal to the square of the antenna current multiplied by the radiation resistance. Radiation resistance for VLF Annapolis at 21.400 kiloHertz is equal to 0.1940 ohms.

WIPP TEST LOG

July 15, 1987

WIPP Test 15-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1153 (A)

Operator (logger) Initials: KDH

WIPP Test 15-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1115 (A)

Operator (logger) Initials: KDH

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 16, 1987

WIPP Test 16-1

Time of COMSUBLANT release for WIPP Test: Ø458 (Z)

Time WIPP keying actually began: Ø500 (Z)

WIPP Test Antenna Current: 1182 (A)

Operator (logger) Initials: CAK

WIPP Test 16-2

Time of COMSUBLANT release for WIPP Test: Ø813 (Z)

Time WIPP keying actually began: Ø815 (Z)

WIPP Test Antenna Current: 1184 (A)

Operator (logger) Initials: CAK

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by EST.

WIPP TEST LOG

July 17, 1987

WIPP Test 17-1

Time of COMSUBLANT release for WIPP Test: Ø458 (Z)

Time WIPP keying actually began: Ø500 (Z)

WIPP Test Antenna Current: 1139 (A)

Operator (logger) Initials: JR

WIPP Test 17-2

Time of COMSUBLANT release for WIPP Test: Ø813 (Z)

Time WIPP keying actually began: Ø815 (Z)

WIPP Test Antenna Current: 1184 (A)

Operator (logger) Initials: JR

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 18, 1987

WIPP Test 18-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1178 (A)

Operator (logger) Initials: [illegible]

WIPP Test 18-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1162 (A)

Operator (logger) Initials: [illegible]

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 19, 1987

WIPP Test 19-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1173 (A)

Operator (logger) Initials: [illegible]

WIPP Test 19-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 08[illegible] (Z)

WIPP Test Antenna Current: 11[illegible] (A)

Operator (logger) Initials: [illegible]

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 20, 1987

WIPP Test 20-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1165 (A)

Operator (logger) Initials: KSO

WIPP Test 20-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1170 (A)

Operator (logger) Initials: KSO

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 21, 1987

WIPP Test 21-1

Time of COMSUBLANT release for WIPP Test: Ø4587 (Z)

Time WIPP keying actually began: Ø5~~00~~ (Z)

WIPP Test Antenna Current: 1179 (A)

Operator (logger) Initials: KLO

WIPP Test 21-2

Time of COMSUBLANT release for WIPP Test: Ø813 (Z)

Time WIPP keying actually began: Ø815 (Z)

WIPP Test Antenna Current: 1177 (A)

Operator (logger) Initials: KLO

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 22, 1987

WIPP Test 22-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1173 (A)

Operator (logger) Initials: BA

WIPP Test 22-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1167 (A)

Operator (logger) Initials: BA

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 23, 1987

WIPP Test 23-1

Time of COMSUBLANT release for WIPP Test: Ø458 (Z)

Time WIPP keying actually began: Ø5ØØ (Z)

WIPP Test Antenna Current: 1152 (A)

Operator (logger) Initials: RAB

WIPP Test 23-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1180 (A)

Operator (logger) Initials: RAB

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 24, 1987

WIPP Test 24-1

Time of COMSUBLANT release for WIPP Test: 0158 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1158 (A)

Operator (logger) Initials: NRC

WIPP Test 24-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1200 (A)

Operator (logger) Initials: NRC

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 25, 1987

WIPP Test 25-1

Time of COMSUBLANT release for WIPP Test: 7458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1200 (A)

Operator (logger) Initials: CAK

WIPP Test 25-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1198 (A)

Operator (logger) Initials: CAK

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 26, 1987

WIPP Test 26-1

Time of COMSUBLANT release for WIPP Test: 04[illegible] (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: [illegible] (A)

Operator (logger) Initials: [illegible]

WIPP Test 26-2

Time of COMSUBLANT release for WIPP Test: 0613 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1198 (A)

Operator (logger) Initials: [illegible]

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 27, 1987

WIPP Test 27-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1184 (A)

Operator (logger) Initials: [illegible]

WIPP Test 27-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1188 (A)

Operator (logger) Initials: [illegible]

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 28, 1987

WIPP Test 28-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1170 (A)

Operator (logger) Initials: KJO

WIPP Test 28-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1185 (A)

Operator (logger) Initials: KJO

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 29, 1987

WIPP Test 29-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500 (Z)

WIPP Test Antenna Current: 1175 (A)

Operator (logger) Initials: MY

WIPP Test 29-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1175 (A)

Operator (logger) Initials: MY

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RMI Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 30, 1987

WIPP Test 30-1

Time of COMSUBLANT release for WIPP Test: Ø448 (Z)

Time WIPP keying actually began: Ø5ØØ (Z)

WIPP Test Antenna Current: 1153 (A)

Operator (logger) Initials: BA

WIPP Test 30-2

Time of COMSUBLANT release for WIPP Test: Ø813 (Z)

Time WIPP keying actually began: Ø815 (Z)

WIPP Test Antenna Current: 1175 (A)

Operator (logger) Initials: BA

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RM1 Cebe daily (Monday morning) who will hold for pickup by ESI.

WIPP TEST LOG

July 31, 1987

WIPP Test 31-1

Time of COMSUBLANT release for WIPP Test: 0458 (Z)

Time WIPP keying actually began: 0500Z (Z)

WIPP Test Antenna Current: 1187 (A)

Operator (logger) Initials: DV

WIPP Test 31-2

Time of COMSUBLANT release for WIPP Test: 0813 (Z)

Time WIPP keying actually began: 0815 (Z)

WIPP Test Antenna Current: 1198 (A)

Operator (logger) Initials: DV

Please enter times for each test event on the spaces allocated. If test is denied by COMSUBLANT, just write "DENIED" across the form, and initial. Operator initials are required only so we know who to talk to about an event if the rocket data is messed up. Please turn completed form in to RM1 Cebe daily (Monday morning) who will hold for pickup by ESI.

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OFFICE OF THE CHIEF OF NAVAL RESEARCH
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IN REPLY REFER TO
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Ser 1114/389
06 Oct 1987

Commanding Officer
Naval Communications Area Master Station,
Atlantic
Norfolk, Virginia 23511

Subj: SUPPORT OF THE ONR WIPP EXPERIMENTS

1. On behalf of the ONR and all of the other participants, I wish to express our thanks and appreciation to you and the personnel in your Command for the CW keying of the NSS transmitter during the Wave-Induced Particle Precipitation (WIPP) Campaign experiments from 15-31 July 1987.

2. The CW keying was conducted precisely on schedule each day. We were able to acquire ground-based data at Wallops during almost every keying period, using subionospheric VLF/LF phase and amplitude sensors, a digital ionosonde, large aperture photometer, riometer and micropulsation detectors. Broadband VLF recordings were also made on the ground, and wave data was acquired on the Dynamics Explorer-1 (DE-1) satellite during one of the keying periods every night. Subionospheric VLF/LF measurements were also carried out at Lake Mistissini, Quebec and at Stanford, California. In addition two high altitude (30 km) balloon flights (equipped with photometer and x-ray detectors) overlapped with the transmitter keying periods. Four rockets were launched as part of the WIPP campaign activities; however, none of these overlapped the 15-min modulation periods.

3. Much of the data from this activity has yet to be analyzed. I am very pleased to report that the WIPP campaign experiments were in general quite successful. We observed signatures of lightning-induced electron precipitation (LEP) events on the ground as well as with the balloon experiments. One of the rockets was launched during a period of prime activity (as determined from ground-based instruments) and also observed a number of LEP events. Detailed analysis of the data from the transmitter keying periods will enable us to assess the relative importance of transmitter-induced electron precipitation as compared to that induced by lightning.

4. Please express a hearty Bravo Zulu to all concerned.

R. Gracen Joiner
Director, Space Physics Program

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