Julian

THE TROPICAL WIND, ENERGY CONVERSION, AND REFERENCE LEVEL EXPERIMENT

(TWERLE)

STATUS REPORT

For Period Ending 31 October 1974

National Center for Atmospheric Research

TROPICAL WIND, ENERGY CONVERSION, REFERENCE LEVEL EXPERIMENT (TWERLE)

Status Report

(For the period ending 31 October 1974)

During the period of 15-25 September, eight test flights were made from Ascension Island. These tests provided training for the launch crew, evaluation of the TWERLE flight electronics, and resolved the problem of high frequency fluctuations in the temperature sensor. Attached are remarks concerning the test flights and a Technical Progress Report for the period of 1 September to 1 November from the University of Wisconsin.

While on Ascension, ten French balloons were launched as part of the TWERLE/GARP program. The first two balloons launched had problems but the balance of eight were a success. Although no tracking had been done from the French stations, Ascension had four successful days of tracking one balloon and one balloon was still being tracked as of 2 October.

Production

All cutdowns have been completed.

Production on all regulators has been completed, with the exception of 26 yet to be tested.

Three hundred and thirty (330) solar panels need to be tested and packaged.

All but 20 temperature sensor circuit boards are completed, but they all need to be glued to the foam cylinder caps.

Transmitters are being tested as some transistors are failing at cold temperatures (-40^{o}C). Preliminary testing has revealed that transmitters with open substrate transistors do not function at cold temperatures; these questionable transistors are also drawing high current at low temperatures, but otherwise perform well. The transistors that are gold-coated function well to -55^{o}C. Transmitters have been sent to the University of Wisconsin for their testing.

Approximately 45 encoders have been recently tested. There are still 100 to assemble before the entire 440 units have been completed. The production rate is six per day.

Launch Sites

The agreement with the Government of Ghana has been signed.

The new building at Ascension works very well for the electronic assembly and check-out of TWERLE packages.

The launch assembly building at Samoa is complete, except for the installation of the air conditioning system which has been partially delivered.

7 October 1974

DEBRIEFING ON SEPTEMBER 1974 TWERLE BALLOON LAUNCHES FROM ASCENSION ISLAND

Balloon

1. Tabs for hanging balloon on scales are off-center so balloon tips toward one wall in BIB - Perhaps better ballast pockets on sides of sleeve would be the answer.

2. BIB's and weigh-off scales worked well.

3. Inflation fitting and check valve need to be modified and standardized. A right-angle fitting should be attached to the end of the high-pressure pig tail hose.

4. One balloon was damaged in the box during shipment by a forklift - added protection is needed around bottom edges of boxes.

5. Helium bottles are stacked poorly, but are usable.

6. Helium regulator in metal brackets worked o.k., but steel grating is starting to rust.

7. Holes from scales to BIB should be larger diameter and the scales should be firmly attached to BIB.

8. Could just use larger inflation hose in BIB; however, weight of large hose is a problem--two hoses are clumsey--problem needs to be worked on.

9. Over-pressure gages will be on all sites--could use another valve instead of clamp and the gage should be vented to atmosphere.

10. Pre-mount the relative humidity gage.

11. A larger container for ballast should be considered--styrene beads work well.

12. Window should be added in BIB door to see if balloon is touching side.

Launch

1. A place is needed to put the back cover from the launch table after it is removed.

2. A smaller ohmeter would be advantageous for final check of thermistor continuity--could be attached to frame in canvas bag or where convenient.

3. Need guide on truck for zip pull, just above winch.

4. Spool on side of table or truck side rail for pibal line.

5. Ends of table should be marked for easy identification.

6. Gloves should be worn only by balloon launcher.

7. Particularly on Ascension, driver should make a run with pibal to determine general direction of cross-winds.

Cutdown

1. Checked out well.

Voltage Regulators

1. Electronics so close to foil could cause a shorting problem--should be protected.

2. Awkward handling in present package. Following procedure should be followed:

Slit one side
Open lid
Tape top and bottom window with glass tape
Close, but don't tape shut.

Flight Train

1. Lengths o.k.

2. Antenna pals were off location - not taut enough on inside line.

3. Antennas should be pre-hung to straighten the hoops.

Transmitter-Oscillator

1. Weights - none are weighed before shipping to launch site.

2. Could put on the new thermal covering and then weigh--but there is danger of forgetting to weigh the package.

3. Each transmitter-oscillator is packaged in 8 x 8 boxes and plastic bags, as received from the manufacturer.

4. We will not weigh them here, but people will have to be extra careful at the sites.

5. Change location of "record weight" on the transmitter check-out sheet.

Solar Array

1. Not pre-weighed or pre-serialized.

2. Put weight label on top.

3. Need double-sided sticky tape, added to back of label.

Pressure Sensor

1. Will have to be re-weighed.

2. Make new labels.

Temperature Sensor Boards

1. Thermistors and wands should be packaged.

2. A final location for the temperature sensor will be made after the flight data is analyzed and after conferring with the University of Wisconsin.

Data Encoder

1. Pal below 3" too short--need to keep cable ties off until field assembly.

2. Radio altimeter connector only needs one cable tie.

3. Shorting plug; reverse connectors or change to 3-wire plug or fill pins.

4. Fasten shorting plug to launch table with short length of nylon line.

5. Strain relief wires on ends--wrap with sticky tape and then thick-dip.

6. When labeling, put I.D. on stickers.

Radio Altimeter

1. Won't be weighed or tested anymore at Boulder.

2. Temperature sensor wire should be attached with cold temperature tape--should be attached on opposite side of antenna boom to co-axial cable, if located below altimeter.

GROUND TEST EQUIPMENT

Radio Altimeter

1. Needs to be on continuously regulated power supply.

2. Antenna wire has to be lengthened.

3. Make adapter to do frequency measurement on final checkout.

4. Rebuild receiver.

Data Encoder

1. A chart recorder to watch line voltage and frequency is suggested and provide AC regulator for all test equipment on site.

Pressure Sensor

1. Check valve so things won't short.

2. Make sure there are adequate lengths of hose supplied to properly connect the test set.

3. Calibration curves for T.I. gage should accompany each gage.

Transmitter

1. Plastic stands for mount.

2. Knobs for magnetometer variac should be added to front panel.

Tracking Antennas

1. The ground-based tracking antennas should be painted, to protect the elements from the salt spray and corrosion.

T W E R L E

TROPICAL WIND, ENERGY CONVERSION,
REFERENCE LEVEL EXPERIMENT

Technical Progress Report

for the period

1 September 1974

to

1 October 1974

Space Science and Engineering Center
The University of Wisconsin
1225 West Dayton Street
Madison, Wisconsin 53706

T W E R L E

Technical Progress Report

1 September to 1 October 1974

1. William Massman and Robert Oehlkers participated in the September Ascension Island Test Flights. Their trip reports are given in Appendix 1 and Appendix 2.

2. On 4-5 September, Juris Afanasjevs visited NCAR, Boulder, to consult with Ernest Lichfield on preliminary design of the proposed TWERLE memory system.

3. Dr. Nadav Levanon has returned to Tel-Aviv University, Israel. His mailing address is:

   Dr. Nadav Levanon
   Environmental Sciences Department
   Tel-Aviv University
   Ramat-Aviv, Tel-Aviv
   Israel

TRIP REPORT ON THE SEPTEMBER 1974 ASCENSION ISLAND TWERLE FLIGHTS

The purpose of the trip to Ascension Island was to assist in training the launch crew on the use of the UW built and designed flight and ground support equipment and to provide technical support for the special balloon flights.

During the pre-launch period of 6 September to 12 September test benches and test equipment were set up, antennas were tested, and the buildings were made ready for launch activities.

The launch period was from 13 September through 25 September. During that period the following flights were flown:

Flight 1 14 September QR	GHOST 2 coder. Purpose was to evaluate the transmitter package temperature.
Flight 2 17 September ID 1114	TWERLE configuration with no radio altimeter and two air temperature sensors. 20 sec. sampling rate. The second air temperature sensor was mounted 20 feet below the encoder and used the pressure sensor temperature data channel. Purpose was to investigate fluctuations in the air temperature sensor.
Flight 3 18 September ID 1406	TWERLE configuration with 20 second data rate and special altimeter. Radio altimeter powered continuously. Solar panel was four-sided for extra power. Purpose was to investigate if pressure data aliasing exists.
Flights 4-8 19 September ID 1212 21 September ID 0524 23 September ID 0330 24 September ID 0036 25 September ID 1700	TWERLE configuration with air temperature sensor 15 feet below radio altimeter antenna. Normal one minute data rate. Purpose was to collect data to investigate gravity waves and for launch crew training.

DATA COLLECTION:

A TWERLE tracking station was set up at the NASA Devils Ash Pit Tracking Site (1700 feet above sea level) using the Texas Instruments printer and recording system. This system, interfaced to the data decoder by NCAR personnel, worked extremely well and automatically printed the data received and recorded the information on a digital cassette for further processing. The NASA crew on Ascension provided support by installing the tracking antenna and, when balloons were launched, helped to locate balloon position using their antenna and spectrum analyzer. With this automatic recording system, over 30 hours of one minute data samples were collected from flight 4-8. Over 10 hours of 20 second samples were collected from flights 2 and 3. Without a doubt these are the most successful TWERLE test flights to date. A sample of the data format as printed is given in Appendix 1A.

RADIO ALTIMETER:

From the first inspection of the data it appears that the radio altimeter functioned well on all but two of the flights.

On flight 7 ID 0036 the radio altimeter did not lock. This malfunction cannot be explained because the altimeter was properly tested before flight and was not marginal in any manner.

On flight 3 ID 1406 having the special radio altimeters which were powered continuously, there exist gaps where the radio altimeter wasn't locked. Since these were specially modified radio altimeters and uncertainties exist in their performance due to radio interference from the transmitter, no known reason other than speculation can account for the non locked operation.

The only other problem encountered with the radio altimeter was with S/N 85. The unit tested normally with the test set, but would not lock when connected to the flight train and powered by the solar panel. Another altimeter was substituted and operated properly and was flown on flight 8. This problem with the malfunctioning radio altimeter was not resolved and further investigation will be undertaken.

TWERLE TRANSMITTER AND STABLE OSCILLATOR:

The TWERLE transmitter and stable oscillator performed as designed. No problems were encountered in the seven TWERLE flights. The transmitter test set also worked well with no malfunctions. During testing one set of transmitter and oscillator exhibited an oscillation which could not be explained since the unit appeared to be locked. These units are being returned to the University of Wisconsin Space Science and Engineering Center for further evaluation.

In general the transmitters built and tested by Ball Brothers Research Corporation required little or no tuning. From our experience on Ascension much confidence has been gained in the operation of the transmitter and oscillators.

TWERLE ANTENNAS:

Before going to Ascension Island there was a concern that the TWERLE antenna could not be properly matched to the transmitter in the Ascension round roofed metal building. In testing the antenna with the transmitter, the concern turned out to be real and a high reflected power existed. To prove that this was a building effect and not fault antennas, a wooden shelter covered with plastic (to get out of the wind) was used to test antennas. All of the antennas tested in this special shelter, with the exception of one, proved to have low SWR. The procedure established with this knowledge was to match the transmitter into the 50 ohm load. No adjustment was then made after the antenna was connected to the transmitter. This procedure proved to be valid and can be used provided the antennas are pre-tested and properly adjusted in a reflection free environment.

PRESSURE SENSOR TEST SET:

The Pressure Sensor Test Set, delivered to Ascension Island, had recently been modified with the rubber hoses being removed and replaced by copper tubing. The problems found when trying to put the system together were that most of the external interconnection hoses were missing and the system leaked badly. With the help of the NASA personnel on Ascension, suitable hoses were found and the leaks were stopped with a refrigeration sealant called "Leak Lock".

The Texas Instrument Pressure Gage arrived in good condition as did the Schwien Absolute Pressure Calibration System. The manuals for both these systems were missing but a calibration was accomplished, excluding the correction for temperature and gravity. It would seem that a shipping check list should be established for each system so that important parts need not be left behind.

PRESSURE SENSORS:

The Pressure Sensors all tested well but a few of the units had leaked down to atmosphere pressure. The importance of maintaining this type of sensor near its operating pressure is exhibited by the adaption data of Serial 001 given below.

Serial number 001 had leaked to atmosphere pressure and was first tested on 20 September 1974.

Date	fref	faner	R Temp	fref -faner
20 SEPT	878350	879920	2868	-1570
21 SEPT	878960	880434	2870	-1474
22 SEPT	881064	882494	3103	-1430

Assuming a 400 Hertz per millibar sensitivity there would be more than a millibar error due to adaption between the first day launch and two days later. This unit was flown on flight 6 ID 0330 September 23, 1974. See Appendix 1B for the Pressure Sensor Calibration correction.

NASA SUPPORT:

Much of the credit for the success of the data collection portion of the program must be given to the NASA - Bendix group on Ascension. They provided us parts that we left at home, fabricated parts, installed antennas, lent us a frequency synthesizer when the TWERLE receiver local oscillator died, and helped track the balloons. Their interest in our program was encouraging and their help was greatly appreciated.

AIR TEMPERATURE FLIGHT (ID 1114):

The TWERLE flight with the two air temperature sensors showed that the lower sensor (20 feet below last package on flight train) had fluctuations of about $\pm$ 0.3°C while the upper sensor near the encoder package had fluctuations of $\pm$ 0.6°C. The upper sensor also ran about 0.7°C warmer. The lower sensor appears to be a better position for the air temperature measurement. The flight trains on flights 3-8 were modified to fly the air temperature sensor below the radio altimeter.

GENERAL COMMENTS:

All of the TWERLE flights were launched from the truck without the slightest bit of problem. The TWERLE antenna, which has always been a worrisome item in the wind, went off effortlessly. The NCAR personnel responsible for this launch technique deserve the praise for preserving the integrity of the fragile electronics without which there would have been no experiment.

The new area in the program was the data recording system. This system recorded on paper and magnetic tape all the data that was received. Without the recording system it would have been difficult to gather as much data as we gathered. With this system it should be no problem to get the first day data on at least one balloon everyday.

4 October 1974

R.A. Oehlkers

1001. THE TWERLE DATA FORMAT ON THIS TAPE IS:
3 DIGITS JULIAN DAYS.
2 DIGITS UNIVERSAL TIME HOURS (0000-2400 HOURS).
2 DIGITS MINUTES
2 DIGITS SECONDS
[illegible]IGITS PLATFORM I.1001. THE TWERLE DATA FORMAT ON THIS TAPE IS:
3 DIGITS JULIAN DAYS.
2 DIGITS UNIVERSAL TIME HOURS (0000-2400 HOURS).
2 DIGITS MINUTES
2 DIGITS SECONDS
4 DIGITS PLATFORM I.D. CODE (NASA OCTAL).
1 DIGIT MODE BITS, (ALTIMETER COURSE DATA).
3 DIGITS #1 DATA CHANNEL (RADIO ALTIMETER).
3 DIGITS #2 DATA CHANNEL (AIR TEMPERATURE).
3 DIGITS #3 DATA CHANNEL (PRESSURE).
3 DIGITS #4 DATA CHANNEL (PRESSURE TEMPERATURE).
EXAMPLE: 367 23 45 14 1777 1 234 156 234 002
RECORDED AT 30 CHARACTERS PER MINUTE

266	12	33	11	0330	1	230	206	242	225
266	12	34	13	0330	3	101	212	242	224
266	12	35	15	0330	3	097	208	242	224
266	12	36	17	0330	3	109	209	242	223
266	12	37	18	0330	3	111	208	242	222
266	12	38	20	0330	3	104	206	242	222
266	12	39	22	0330	3	106	211	242	221
266	12	40	24	0330	3	101	213	241	220
266	12	41	25	0330	3	095	207	241	220
26[illegible]	12	42	27	0330	3	101	213	242	219
2[illegible]	12	43	29	0330	3	104	213	241	219
266	12	44	31	0330	3	106	205	240	218
266	12	45	32	0330	3	106	205	224	217
266	12	47	36	0330	3	065	204	243	217
266	12	48	38	0330	3	107	206	243	216
266	12	49	40	0330	3	098	205	243	215
266	12	50	41	0330	3	110	206	242	215
266	12	51	43	0330	3	100	203	244	214
266	12	52	45	0330	3	112	207	244	214
266	12	53	47	0330	3	106	203	240	213
266	12	54	48	0330	3	095	202	239	212
266	12	55	50	0330	3	112	204	246	211
266	12	56	52	0330	3	102	204	247	210
266	12	57	54	0330	3	109	203	241	209
266	12	58	55	0330	3	104	204	241	209
266	12	59	57	0330	3	099	205	245	207
266	13	00	59	0330	3	116	204	244	207
266	13	02	01	0330	3	111	206	243	205
266	13	03	03	0330	3	107	203	243	204
266	13	04	04	0330	3	103	205	243	204
266	13	05	06	0330	3	110	204	242	203
266	13	06	08	0330	3	108	204	241	202
266	13	07	10	0330	3	103	203	242	202
266	13	08	11	0330	3	109	204	244	201
2[illegible]	13	09	13	0330	3	114	203	243	201
266	13	10	15	0330	3	105	205	238	200
266	13	16	26	0330	3	081	202	242	199
266	13	19	31	0330	3	112	206	243	199
266	13	20	33	0330	3	084	205	241	200
266	13	21	34	0330	3	111	203	240	200
266	13	22	36	0330	3	085	204	241	200

APPENDIX 1A

APPENDIX 1B

PRESSURE CORRECTIONS FOR PRESSURE SENSORS AT 150 MB

FLIGHT	ID	PRESS. SENSOR	AIR TEMP.	fREF	fANER	RTEMP	Δf	CORRECTION
2	1114	060	001/484	896238	897597	2896	-1359	-0.78
3	1406	003	038	885207	885886	2764	- 679	-0.215
4	1212	078	032	851659	852808	3074	-1149	-0.24
5	0524	007	130	885715	887155	2964	-1440	-0.66
6	0330	001	232	881064	882494	3103	-1430	-1.20
7	0036	004	036	871224	872899	3205	-1675	-1.07
8	1700	023	022	870536	871033	3058	- 497	-1.025

Mean pressure correction - 0.74 mb.

APPENDIX 2

TWERLE Test Flights

The purpose of the Ascension Island TWERLE test flights was twofold; to resolve the problem of high frequency fluxuations in the temperature sensor and to gather data on gravity waves. Flight TA101 had two temperature sensors, one in the normal position and one at the bottom of the flight train, with a sampling period of 20 seconds. The upper thermistor showed high frequency noise as well as hot spikes of 1°C - 1.5°C. The lower thermistor was quite steady with variations usually about 2°C. On an average the thermistors agreed but for short term readings the upper thermistor was erratic. Flight TA102 was a normal TWERLE but with a 20 second sampling period. The thermistor was in the usual position in the flight train and again displayed similar variations in readings as the upper temperature sensor on the previous flight. Flights TA103 through TA107 were altered to provide a 60 second sampling period and to test the placement of the temperature sensor at the bottom of the flight train. No thermistor displayed variations larger than about .2°C - .3°C on a short term or any high frequency noise. On the basis of these test flights, it is recommended that the TWERLE flight train be altered with the thermistor at the bottom of the flight train. A preliminary examination of the data indicates that some of the flights may display gravity wave oscillations, but a full reduction of the data will be necessary before any conclusions can be drawn.

4 October 74
W. Massman

T W E R L E

TROPICAL WIND, ENERGY CONVERSION, REFERENCE LEVEL EXPERIMENT

Technical Progress Report

for the period

1 October 1974

to

1 November 1974

Space Science and Engineering Center
The University of Wisconsin
1225 West Dayton Street
Madison, Wisconsin 53706

T W E R L E

Technical Progress Report

1 October to 1 November 1974

1. Temperature testing was done on nine (9) TWERLE transmitters to determine the cause of reported component failures and phase shift at low temperatures. The results of the testing to date are given in Appendix A. Further transmitter work is suggested to determine the cause of modulation phase shift with temperature and to determine the selection of the temperature compensating bias network for the transmitter.

2. Because of the long 1 - 1 1/2 year delay between the manufacture and calibration of the pressure sensors rudimentary plans are being formed to spot check the stored pressure sensors to determine if the plan to use a single calibration point to correct the sensor reading just before launch is still valid. If the one point calibration no longer holds, plans must be made to re-calibrate the pressure sensors at some time before launch.

3. Results of the Ascension flights have shown that the original position of the air temperature sensor is unsatisfactory because of the proximity of the heat producing encoder package. The deployment of the temperature sensor below the altimeter antenna on a 15-20 foot wire gave good temperature measurements but may affect the altimeter antenna pattern and, hence, the directional gain. The problem is being studied to evolve a flight train modification which will give good air temperature data and which will not impair altimeter operation.

4. Analysis of radar data from the Ascension flights is presented by W. Massman in Appendix B.

5. Work on the TWERLE add-on memory has been discontinued at the end of the study phase pending the authorization of further work and funds.

Appendix A

Preliminary Report

TWERLE Transmitter Temperature Test

This report summarizes the preliminary results of the temperature tests on the TWERLE transmitters. During the week of 28 October--1 November, nine (9) TWERLE transmitters were temperature tested. The reason for the temperature tests was to investigate transmitter component failures as reported by Mike Sites of Stanford University. Since the transmitters were constructed and purchased without a power-on temperature test, these tests also provided an opportunity to evaluate the production transmitters.

The test specifications for the transmitters were:

a) Temperature ÷ ambient to -40°C
(measured at amb, -10°C, -10°C, -30°C, & -40°C)

b) Power out: $\geq$0.60 watts with I $\geq$ 70 ma

c) Lock in range: $\pm$ 3 MHz from 401.2 MHz center frequency

d) Phase levels: 60° ±6°, 0°, -60 ± 6°

e) Phase symmetry within 5°

Table I summarizes the results of the initial test. Four out of the nine transmitters tested pass all of the above specifications. The transmitter failures fall into three catagories:

1. Excessive input current with low temperature

2. Decreased positive locking range

3. Phase symmetry >5°.

Excessive Current

This problem is due to the imperfect temperature compensation between the RF transistor and the bias network. A network consisting of a 1K resistor (R2) and a 6.8K sensistor (R3), (a sensistor has a positive temperature coefficient) provides bias current for the RF oscillator. When the temperature is decreased the bias is increased to compensate for transistor gain and bias changes. In five out of the nine transmitters tested the compensation was correct; on the remaining four the bias increase caused the power supply current drawn to be excessive.

A note of caution on the measurement of the power and current at low temperature is necessary. The current and power should be observed within five (5) seconds after turning the carrier on since the transmitter, in normal operation, is on for only one second. The compensation should provide proper oscillator starting conditions and proper power and current for this one second. The drift upward in current after the unit is left turned on is due to the RF transistor heating and not temperature matching the sensistor correctly. It is impractical to physically tie the sensistor to the RF transistor.

The four units which failed this test were run a second time with the bias resistor R2 changed. The results are given in Table 2. For all practical purposes three out of the four units rejected now pass the low temperature test. The remaining unit was re-run with a different value of R2 and now meets the low temperature specifications.

Locking Range

The locking range failure does not appear to be a serious one. Some of the range change can be corrected by readjustment of C29 to compensate for a reduction in the positive range due to temperature reduction. There is some correlation between the choice of the proper bias resistor R2 and maximum locking range. Three of the transmitters had failures in both locking range and excessive current; when the excessive current problem was remedied and the locking range readjusted normally the units passed both tests at the low temperatures.

Phase Symmetry

This is the most difficult of the three failures to correct. The maximum phase dis-symmetry noted in all of the tests performed was 12°. Some correction can be made by adjustment of L2 and L3 in conjunction with the voltage required by the varactor. Further study into this problem is continuing.

Conclusion

No failures due to components were noted in the temperature test performed. By proper choice of the bias resistor and proper adjustment of the RF stage the excessive current and locking range failures can be eliminated. Further work on defining a procedure to select R2 and on the phase symmetry problem is being continued.

R. A. Oehlkers
5 November 74

Production TWERLE Transmitters

1st Temperature Test

Serial No.	Output Power	Input Current	Phase	Locking Range
452				
247				
453				
440		X	X	
441		X	X	X
451			X	X
393		X		
446				
330	X	X		X

TABLE 1

X = Repair or readjustment required

TRANSMITTERS WITH EXCESSIVE CURRENT @ -42°C

	1st Temp Run R2 = 1K		2nd Temp Run R2 = 270Ω		3rd Temp Run R2 = 510Ω	
Serial No.	PO	I	PO	I	PO	I
440	0.60	84	0.64	62		
441	0.61	86	0.57	57		
393	0.57	>100ma	0.45	59	0.60	68
330	0.50	>100ma	0.58	63		

TABLE 2

NOTE: Power loss with longer RF cable = 0.02 watts.

Appendix B

Radar data from Ascension Island of two balloon flights of the TWERLE test program have been analyzed to determine the neutral bouyant frequency of superpressure balloons; N. Levanon, et. al. (1974). Analysis of the radar data of the September 1974 TWERLE test flights show the same 3 to 4 minute period of oscillation. A fast fourier transform spectrum analysis was done on the FPS-16 radar data after the balloon had reached float altitude. The spectrum was then hahned. Only about half an hours worth of data was available and every 30 seconds of data was used.

Figures 1 through 4 give the radar data and hahned spectrum for the flights of September 16, 17, 19 and 24 respectively. The spectrums show periods of 226 seconds, 191 seconds, 216 seconds, and 240 seconds for the four flights above. The other balloon flights were analyzed and show periods in a range from 160 seconds to 277 seconds.

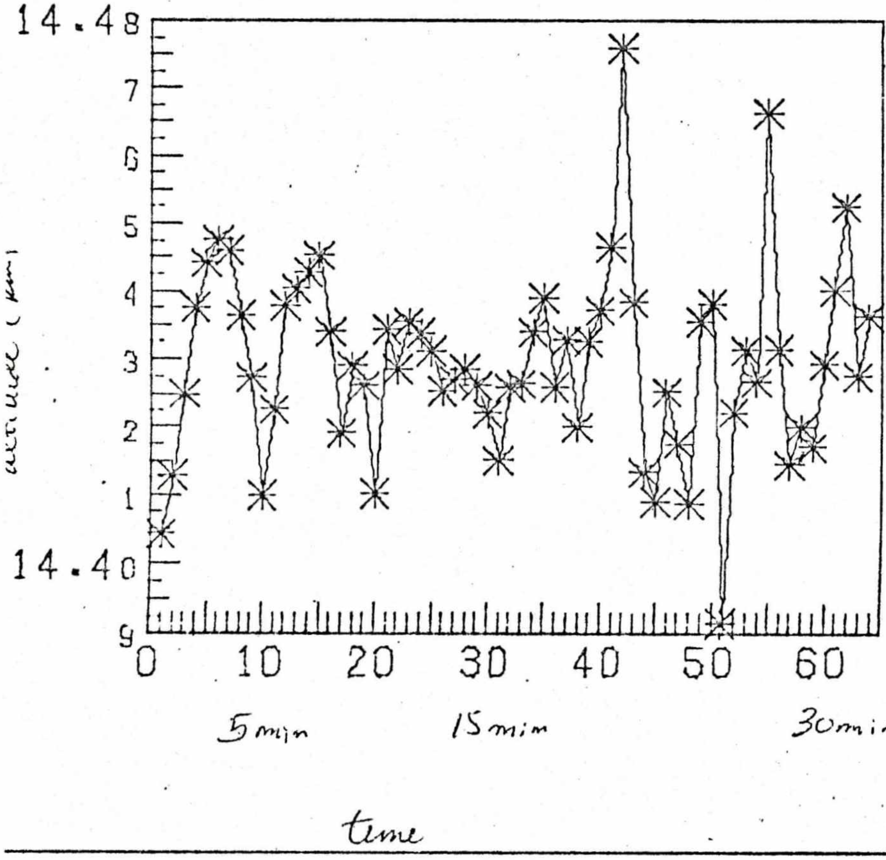
GHOST package (64 pts.)

9/16/74

$\underline{\omega_N}$

$\omega = 2\pi f$
$= \frac{2\pi}{P}$

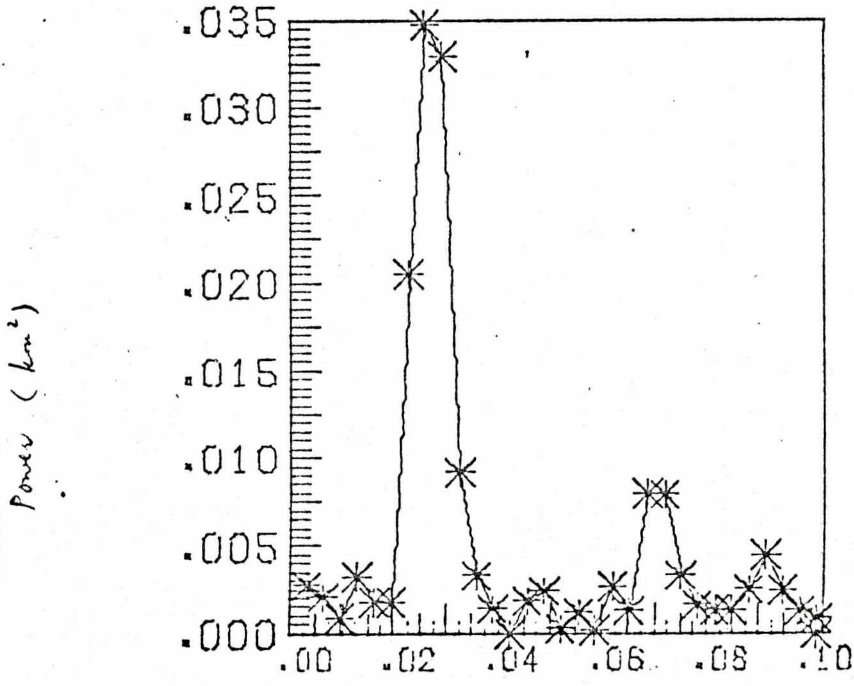
$P = \frac{2\pi}{\omega}$



No. 40-00 PRINTED BY PLEXICRAFT, INC. U.S.A.

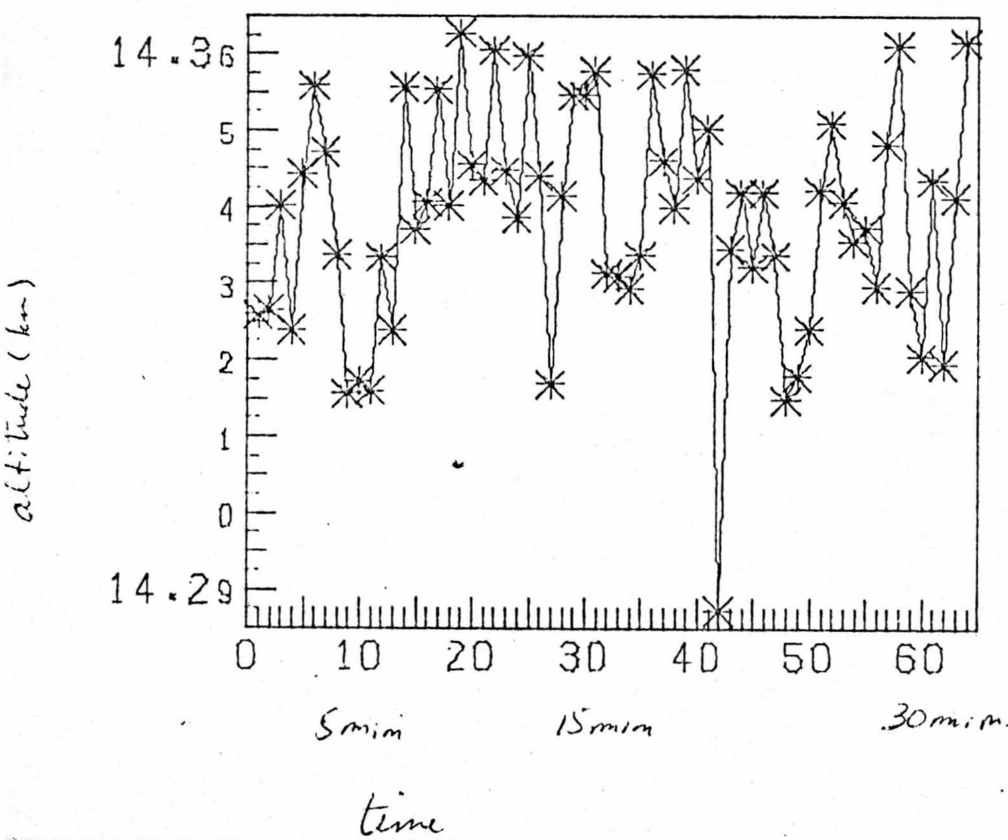
FIGURE 1

$= (27.8)\, 10^{-3}$ /sec $T_N = 226$ sec



TA101 (pts.)
9/17/74

$\omega_N = (32.7)10^{-3}/\text{sec}$ $\quad T_N = 191$ sec



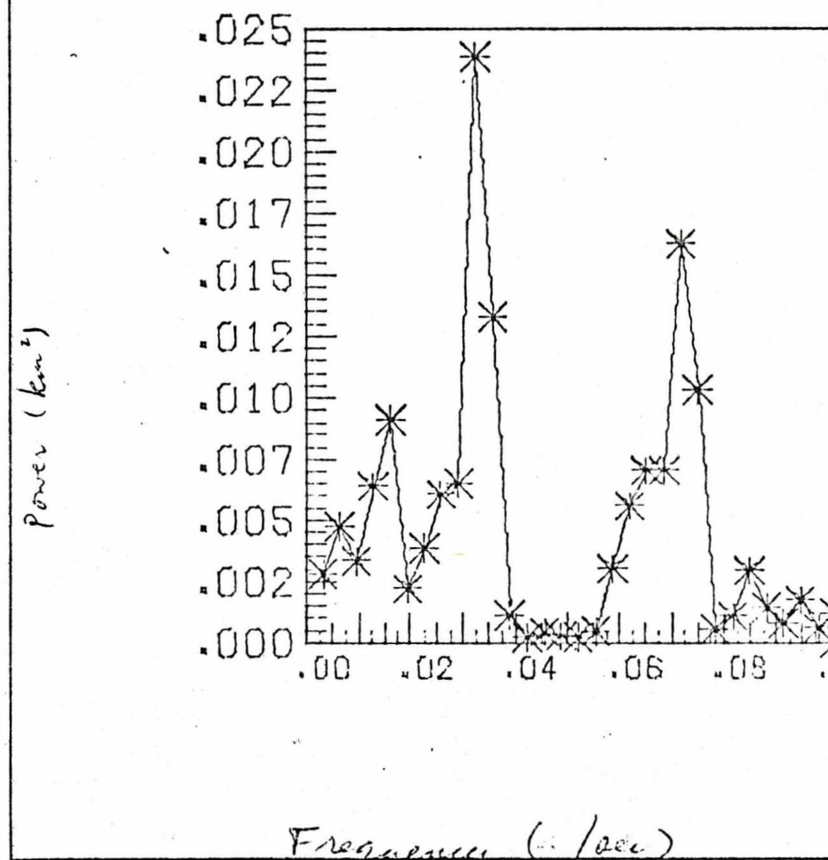
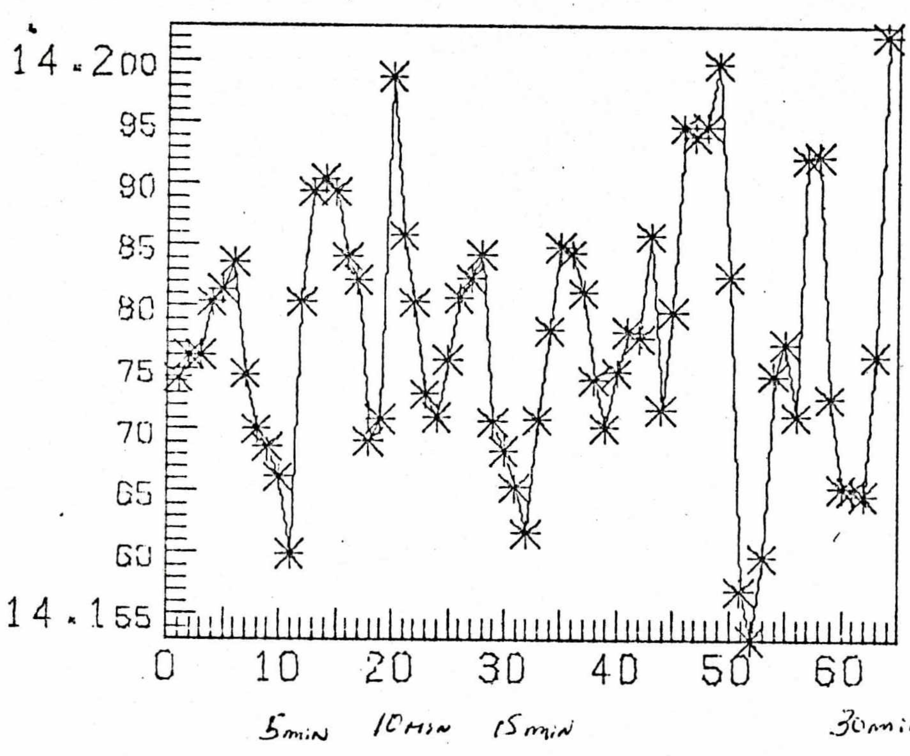


FIGURE 2

TAIO5 (64pts.)

9/19/74

$\nu_N = (29.1)10^{-3}$/sec $T_N = 216$ sec



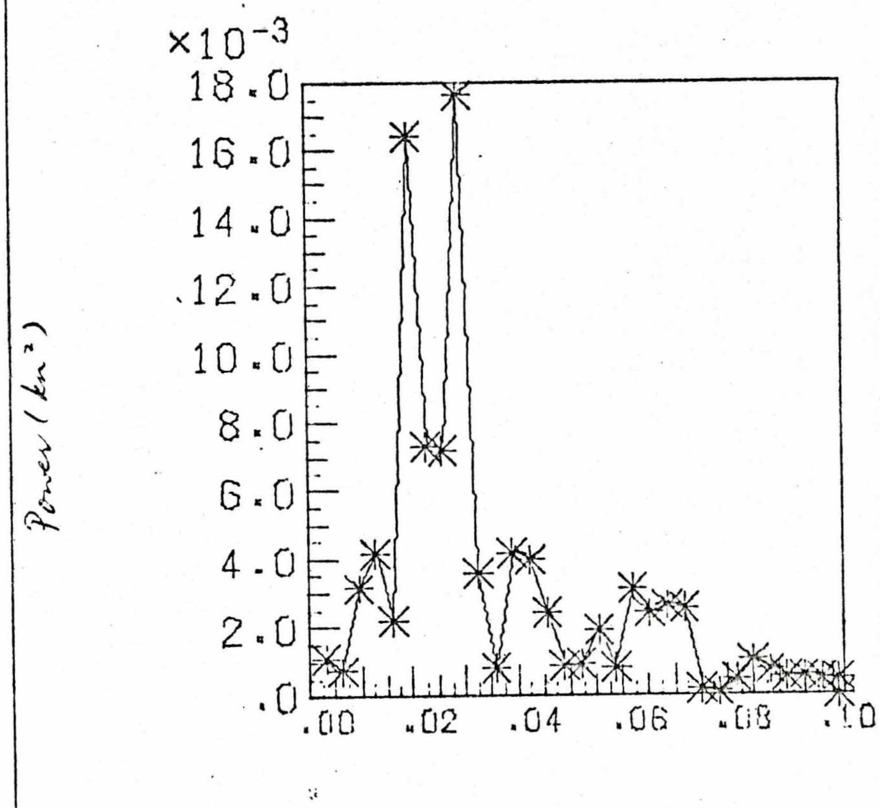


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Figure 3

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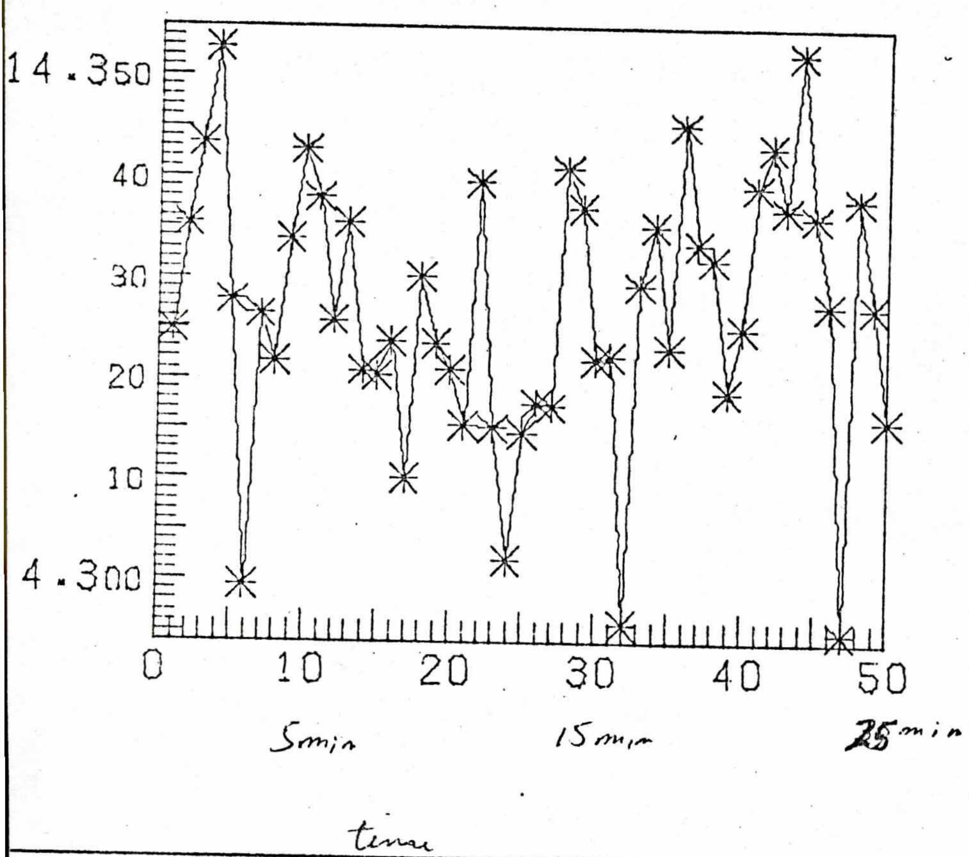
$\omega_N = (26.2)10^{-3}$/sec $T_N = 240$ sec



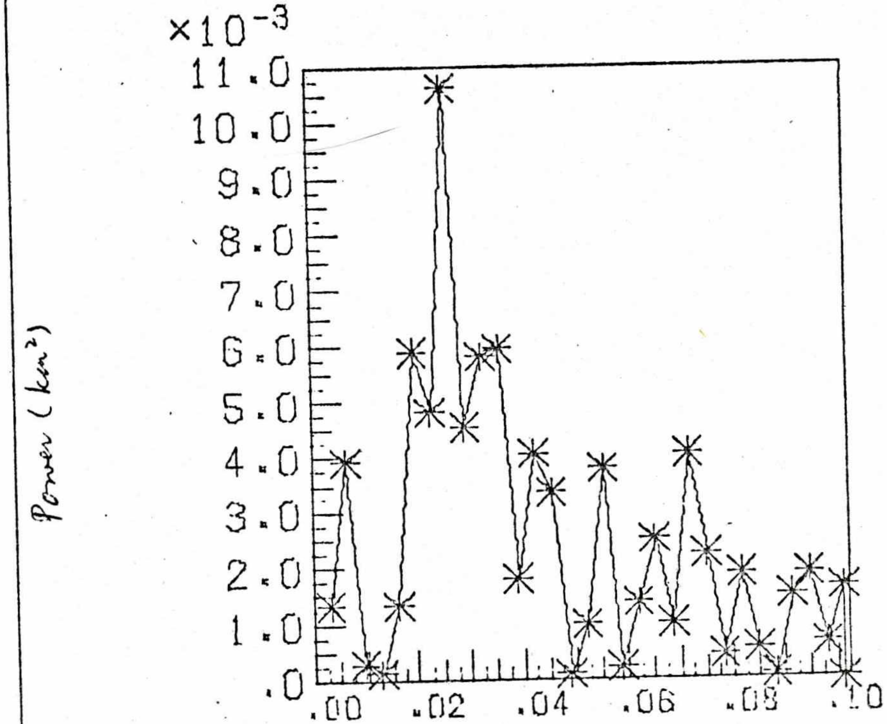


FIGURE 4