P. Julian

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

Status Report (for Period Ending 31 December 1973)

During the period of 1 October 1973 thru 31 December 1973, the TWERLE program concentrated its efforts on assembly and testing of subsystems and further development of launch sites.

1. SUBSYSTEM STATUS - SUMMARIES

Balloon (TBN-100)

A purchase order was issued to Ball Brothers Research Corporation in October for a cold chamber to destructive-test the balloons received from G.T. Schjeldahl Co.

Sig Stenlund visited Schjeldahl in October and noted the following:

1) New sealing machine does a good job but is not consistent
2) End caps look good
3) There are handling problems in the final seam.
4) The present scale will not meet the specifications of ± 1 gram--now get ± 5 grams. Schjeldahl is considering purchasing a new scale, which would increase the contract cost.
5) One balloon has been sent to Christchurch for testing.
6) Schjeldahl's Quality Control and Manufacturing departments still have problems, which Sig is going to try to straighten out.

At the end of October, test balloons were received from Schjeldahl and launched from the NCAR parking lot. In mid-November, 220 TWERLE balloons were completed by Schjeldahl. They were leak-tested in the Northfield, Minnesota Armory.

Solar Panel (TSP-200)

A tester for the TWERLE Solar Panel was designed with a cooling fan at the top of the panel.

The solar panel test flight was reported south of 70° from June to October. The last date it was heard was the 24th of October, 1973.

A week-end test flight of the solar panel in November showed the TSP giving 50% more output than was planned, which was probably a result of the earth's radiation.

Antenna (TAN-300)

It was estimated that approximately 2-3 man-hours are required for the assembly of one antenna. This estimate was given after the foam core problems had been solved in early October. The cores are now cut from foam blocks in the TWERLE antenna lab. Production schedules show that between 25-40 antennas will be completed by 1 December 1973.

Cutdown (TCD-400)

All cutdown packages were received in early October.

Data Encoder (TDE-500)

During test flights in November, it was speculated that the data encoder picked up moisture from the air because it was not coated, thus affecting its performance. Further tests with the encoder will be performed to see if this is true.

As of mid-November, production had not been started on the encoder.

Transmitter (TTX-600)

Much development of a source for dewars has occurred, as the Viz company can no longer produce them. The gentleman who was making the dewars for Viz died, and no one has been able to successfully produce satisfactory dewars since. However, we are working with a local source, R.H. Allen Company. An internal heater was built to test the dewars received from Allen, which have progressively improved.

Test flights with the transmitter were performed in mid-November. The possibility of holding the transmitter "on" for the first few minutes was explored, using the radio altimeter channel. However, this would not work if the data encoder should fail.

Temperature Sensor (TTS-700)

Results of test flights in October showed the temperature sensor is not sensitive to voltage changes.

As of mid-November, 230 temperature sensors had been completed and tested.

Pressure Sensor (TPS-800)

A pressure sensor test flight was launched in early November. Bob Rader traveled to Dodge City, Kansas for down-range tracking. (Dodge City is 1320 miles S.E. of Boulder.) Rader picked up the balloon at approximately 1230 CST; there was a strong signal between 1300 and 1330 hrs., and good data was received until 1600 hrs., when the signal was lost. The plus (+) and minus (-) currents were tracking each other. Three hundred minutes of continuous data was received from the test flight.

Radio Altimeter (TRA-900)

Two hundred and twenty-five radio altimeters have now been received from Meeda. This order should be completed by April 1974.

Voltage Regulator

The TWERLE voltage regulator was modified to handle 250 mA instead of 200 mA as maximum.

2. TWERLE FLIGHT OPERATIONS (TFO)

Launch Sites:

Further development of the launch sites at Pago Pago, American Samoa; Ascension Island; and Accra, Ghana was achieved during this period. Stran-Steel Corporation has been contracted to make the launch assembly shelters for Pago Pago and Accra. These buildings will be ready for shipment in early January.

Site A - Accra, Ghana

As a new date of August 1974 has been given by NASA for the launch of Nimbus-F, there is a chance that Accra will not be used as a TWERLE launch site, as conditions are not favorable for launch after September 1974. However, all plans are proceeding according to schedule and will continue to do so until it should become apparent that Ghana will not be used as a site.

Deweger, Gruter and Partners, Architects and Engineers, have been contracted to supervise the erection of the launch assembly shelter. As the schedule now stands, the building will arrive in Ghana in mid-February via Black Star or Delta shipping lines. After the arrival of the building, Deweger predicts it will take 120 days to complete the erection of the building. CFAO will supply the air conditioning for the building.

The subcontract for construction of the launch assembly shelter was awarded to A. Lang Limited on 22 November 1973. Mr. C.L. Hitchins, Quantity Surveyor, is Lang's representative.

James Walker, 2nd Secretary at the American Embassy in Ghana, has advised that there would probably be no problem in obtaining commissary privileges as other government contractors are now authorized. He suggested that the National Science Foundation send a letter to Mr. Grover's attention, asking him to present it to the Commissary Board.

Accra does not have satisfactory commercial telex communications, so it will be necessary to establish radio communications between the site and Boulder in the near future. Harry Kakalikian, Regional Communication Director of the Diplomatic Communication Service, advised that NCAR radios will need Ghana call letters and commercial licenses. He also advised that there is no RF Communications Inc. equipment in Ghana, so there would be no local maintenance capability.

We will employ two watchmen and one janitor (maintenance) man. The watchmen will be paid 33 Cedis per month each, and the janitor will be paid 25 Cedis per month.

Mr. Frank A.A. Acquaah, Director of the Meteorological Services Department, is cooperating in helping us obtain duty-free certificates from the customs people in Accra.

Helium for the Accra site will be supplied from Air Force stores and shipped to Ghana.

Site B - Ascension Island, S.A.

By early October, drawings on modifications to the mess hall had been sent to PAA for a cost estimate. These modifications include interior partitioning and other minor modifications.

Helium for Ascension will be supplied from Air Force stores. This will save transportation costs from Amarillo to Patrick Air Force Base and return, as well as the monthly demurrage charge of twenty-five cents per cylinder.

Site C - Pago Pago, American Samoa

As was stated previously, Stran-Steel Corporation has been awarded the contract for fabrication of the Pago Pago launch assembly shelter. The shelter is due to be in Pago Pago in early February 1974.

Bids for erection of the launch assembly shelter are due to be received by Lee Crowthers on 15 January 1974. Landis Parsons and Marcel Verstraete will attend the bid opening and sign the contracts shortly thereafter. Lee hopes to receive two or three bids from local contractors.

Site D - Christchurch, New Zealand

As of yet, it has not been decided which contractor will be awarded the contract for construction of the addition to the GHOST building in Christchurch. Due to the good summer weather and the required construction for the Commonwealth Games in January, no interested bidders had picked up our plans and specifications by 4 p.m. on Friday, 7 December. Completion of the addition is now scheduled for April 1974.

Any time after 10 February 1974 would be suitable for test launches, as accommodations will then be easy to find. The inflation and weigh-off will take place in the Balloon Test Chamber. The launcher can be backed up to the door and the balloon put in place. The electronics will have to be checked out and assembled inside the lab, as it is planned to be done during the flight operations.

Mobile Launcher (MOL-200)

The first launcher has been modified somewhat and the second launcher is in the NCAR shop. GMC is not guaranteeing the delivery of the third launcher as they have closed down their production line.

3. CONCLUSION

Progress reports from the University of Wisconsin are attached.

APPENDIX A

T W E R L E

TROPICAL WIND, ENERGY CONVERSION, REFERENCE LEVEL EXPERIMENT

Technical Progress Report

for the period

1 October 1973

to

1 November 1973

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

TWERLE

Technical Progress Report

1. Nine (9) prototype TWERLE crystals were received from Bliley Electric and were tested. These were not as good as the first 5 prototypes which were received previously. Of the 9 units tested, 5 were acceptable, 3 were marginal and one was out of spec. If the production units are similar, we can probably expect an 88% yield. This implies that each crystal has to be screened before mounting in the stable oscillator. Bliley will deliver 250 crystals on about 15 November with the remaining crystals to follow in two weeks. (McCoy plans to deliver its 500 units about 15 November).

2. Two prototype crystals were received from CTS Knights. They were tested and were found to be marginal.

3. Twelve (12) Bliley crystals (all prototypes) were sent to Ball Brothers on 12 October for assembly into the pre-production units.

4. Dr. N. Levanon was recalled to active duty in Israel on 10 October 1973. He is expected back sometime in November.

5. As a result of the Middle-East War, there is a chance that the delivery on radio altimeters may be delayed. A contingency plan has been formulated to manufacture the altimeters in the U.S. in case the war is prolonged and delivery is impaired. The latest communication from Dr. Levanon (31 October) assures that Meeda plans to deliver the altimeters on schedule.

6. Two (2) complete pressure sensor test systems were sent to NCAR on 30 October 1973. The remaining completed system is being kept at U.W. as a test fixture. Operation manuals for the pressure test systems, to be used at the launch sites, will be completed as time permits. C. Wolfe has been fully instructed as to the use of the pressure sensor test systems in the pressure sensor manufacturing process.

7. One (1) stable oscillator, two (2) transmitters and two (2) pressure sensors were sent to NCAR on 26 October 1973 for flight tests.

8. A transmitter test system prototype unit has been finished and has been tested. Construction of the launch site units is in progress. A test system will be provided to Ball Brothers at the earliest possible time to aid in production testing of the TWERLE transmitters.

9. Ten (10) samples of the circle seal pressure relief valves have been tested for differential opening pressure. The differential opening pressure is of the right magnitude and is reasonably consistent from unit to unit. Leakage tests are still in progress. Problems have arisen with the sealing integrity of the valves at temperatures below -30°C (see attached report). The testing procedures are being reviewed to see if the low temperature problem can be circumvented.

10. A. McLellan and W. Massman went to NCAR on 24 October to 26 October 1973 for a TWERLE data management meeting. A trip report is enclosed.

Evaluation of the Circle Seal Relief Valves

A. <u>Test Performed</u>

1. Ten production type Circle Seal Relief valves were received from NCAR for evaluation. All valves were checked for opening differential pressure at ambient temperatures. The results of the tests are shown in Table I.

2. Four of the valves were checked at 0°C and -30°C for opening differential pressure. The results of the test are shown in Table II.

3. Two valves were oiled with Convoil 20 oil to reduce the leakage. These valves were then checked at 0°C and -30°C with the results shown in Table 3.

4. After Chuck Wolfe from Boulder Scientific Research Development Lab (BSRDL) noted a problem with the valves at low temperatures, two valves were tested at temperatures below -30°C.

B. <u>Conclusions of Tests</u>

1. In general the valves without the addition of oil meet the design goals. The opening differential pressures are consistent throughout the sample batch and the valves operate satisfactory to -30°C. The valves, with the addition of oil, proved unsatisfactory because the valves tended to stick at low temperatures and would not operate reliably.

2. The low temperature operation (below -30°C) proved unsatisfactory. The valves leaked severely. Fortunately, the failure mode is in the proper direction for the flight application. That is, if a valve fails to open the leak rate after the first night cycle would place the capsule at the proper operating pressure. It appears that the valves would then stay open.

3. While the low temperature failures should not prove detrimental to the flights, the failures do complicate the testing procedure. It is now evident that the bubbles cannot be used as pressure containers as configured, for performing the temperature cycling and capsule adaptation.

C. <u>Disposition of Valves and Future Testing</u>

1. Two of the tested valves have been installed in the TWERLE pressure sensors sent to NCAR for the November flight tests.

2. Four valves will be installed into complete pressure sensors for system leakage evaluation and long term evaluation of sensors.

3. Two valves will be installed into bubbles to evaluate the leakage component due to the valves. After this evaluation is complete, these valves will be installed in complete TWERLE pressure sensor to be tested with the four above.

4. The two valves which were oiled with the Convoil oil will not be used.

TABLE I

Opening Differential Pressures at Ambient Temperatures for Circle Seal Relief Valves. Bubbles at 150 mb.

Valve Number	Opening Pressure - mb	Pressure Differential - mb
2	215	65
3	241	91
4	229	79
5	222	72
6	231	81
7	241	91
8	235	85
9	222	72
10	225	75

TABLE II

Opening Differential Pressures at 0°C and -30°C for Circle Seal Relief Valves

Valve Number	Opening Differential Pressure mb 0°C	-30°C
3	82	65
4	75	60
7	110	95
8	60	40

TABLE III

Opening Differential Pressures at 0°C and -30°C for Circle Seal Relief Valve Oiled with Convoil 20 Oil.

Valve Number	Opening Differential Pressure mb 0°C	-30°C
7	45	*
8	0	*

*Valve did not open after soak over night at -30°C.

Dr. Alden McLellan

Trip Report

DATA MANAGEMENT to NCAR

24 October--26 October

Alden McLellan and Bill Massman visited the NCAR TWERLE facilities to establish the data levels that will be transmitted to SSEC for the TWERLE experiment. We met first with the theoretical group and then we spent a day with the instrumentation group.

The Theoretical Data Acquisition Meeting

The data that NCAR will provide SSEC is to be in a usable meteorological form. That is, the raw data from Goddard Space Flight Center will be converted into a serial array of pressure, temperature, position, winds, and altitude. The winds will be calculated at NCAR. The serial array implies that the data will be in a format separate for each satellite orbit. This is a good way to archive the data, but it is somewhat difficult to access the data for meteorological calculations. For this reason NCAR will rearrange the data into platform formats. This means that all the data from one platform (balloon) will be together. However, in order for SSEC to receive the data at reasonable intervals, say on the order of every two weeks during the experiment, it is necessary for SSEC to perform some data reformatting.

The primary data handling problem for us to work on in the next few weeks is to determine how to arrive at analytical formulas for the pressure sensor calibrations so that the raw pressure data can be computer corrected.

T W E R L E

TROPICAL WIND, ENERGY CONVERSION, REFERENCE LEVEL EXPERIMENT

Technical Progress Report

for the period

1 November 1973

to

5 December 1973

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

TWERLE

Technical Progress Report

1. On November 12, 13, 14, Juris Afanasjevs and Bob Oehlkers visited Boulder. They met with NCAR and Boulder Scientific Research Development Lab (BSRDL) personnel to review the progress of the manufacturing of pressure sensors and to agree upon a revised test procedure. (The need for the test revision was due to the excessive low temperature leakage of the relief valve.) After the revision to the test procedure was agreed upon, C. Wolfe from BSRDL was instructed to advise UCAR of the price and schedule impact.

The manufacturing of the pressure sensor is progressing well except for the leakage problem of the relief valve. The leakage is on the order of 4-5 mb per day. Various methods are being considered to reduce the leakage while the units are being stored after calibration.

2. The pre-production phase of the pressure sensor manufacturing has been completed and BSRDL has delivered the ten (10) units to NCAR. We have received four (4) of those units for evaluation. Our evaluation included a pressure calibration at room temperature. The results of the calibration shows a shift of the calibration curve of about 1 mb from that measured by the manufacturer. The remaining six (6) units have been requested from NCAR, so they too can be measured to see if a trend exists.

3. From the above discovery in the shift of the calibration curve, the need for an absolute pressure standard to check on the Texas Instrument Gage at the launch site is evident. Research into such a standard is being started and one possibility is a single pressure point piston gage built by Schwien Engineering. One system would be used and would travel from site to site to check the accuracy of the measurement system.

4. Juris and Bob also visited with Ball Brothers Research Corporation (13, 14 November) to evaluate the progress of the manufacturing of the transmitters and oscillators. A report is enclosed.

Due to the poor performance by Ball, a trip to Boulder was made by Nadav Levanon and Bob Oehlkers on 28, 29 November. Ball personnel were instructed in the testing of the oscillators and transmitters. A slotted line and auxiliary test equipment was loaned to Ball by U.W. to help facilitate the testing of the transmitters. Until Ball Brothers satisfactorily completes the building and testing of the pre-production units they will not be given the approval to build production units. The U.W. TWERLE team will closely monitor the Ball Brothers Progress.

5. McCoy has delivered 437 crystals and Bliley has delivered 59 crystals. Temperature plots are being made of all crystals. About 95% of the McCoy's meet the temperature and frequency tolerance. The McCoy crystals have higher activity (lower series R) than the Blileys. We have observed the first McCoy's shipped to be better than the last shipped. A quantity of 50 tested crystals were shipped on 5 December to Ball Brothers Research Corporation.

6. Work is continuing on the Transmitter Test Box and the Radio Altimeter Test Box.

7. Programming of the pre-production pressure sensor calibration data has begun by Dr. Alden McLellan and Dennis Phillips.

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

THE UNIVERSITY OF WISCONSIN

20 November 1973

Mr. David Waltman
National Center for Atmospheric Research
P.O. Box 1470
Boulder, CO 80302

Subject: Visit to Ball Brothers Res. Corp. for a Technical Evaluation of Performance of Contract NCAR 1-74.

Dear Dave:

A visit to Ball Brothers Research Corporation (BBRC) was made by Dr. Juris Afanasjevs and myself on 13 November 1973. The following are our comments:

1. In general, with one major exception, the workmanship (soldering and appearance) of the assemblies was good. Two mistakes on the parts list and one mistake on the assembly drawing were found and corrected by BBRC. They are to be commended for their diligence.
2. All of the wound coils are poorly made. Improvement in this area is mandatory.
3. The most disturbing area of contract execution was the testing of the oscillator and transmitter. To begin with, the test station for the transmitter did not have the proper test equipment necessary to test the transmitter. Secondly, the adapters necessary for interconnecting the transmitter to the test equipment were not available. Thirdly, the thermal chamber for testing the oscillator was much too small for the quantity of units to be tested. The test plan in general appears to have been given little serious consideration.

<u>Action and Recommendation</u>

We received from BBRC, three (3) complete transmitter assemblies. (Each assembly includes a transmitter, an oscillator, a buffer, and an oven temperature control--less foam parts.) These units will be electrically and mechanically inspected here at the U.W. Space Science and Engineering Center and detailed results will be available shortly. We feel, however, that our testing should not relieve BBRC from fulfilling their contractual obligation of properly testing pre-production units. Therefore, we recommend that no work on production units be authorized until the pre-production testing is satisfactorily completed.

When BBRC has the proper test equipment (or agreed upon substitutions) available along with the appropriate adapters, we will be available to assist in and observe the pre-production testing.

Respectfully,

Robert A. Oehlkers

Robert A. Oehlkers

RAO:wbl

xc: W. Kellogg, NCAR
E. Lichfield, NCAR
J. Tefft, NCAR
J. Happs, BBRC
C. Wood, BBRC

T W E R L E

TROPICAL WIND, ENERGY CONVERSION, REFERENCE LEVEL EXPERIMENT

Technical Progress Report
for the period
5 December 1973
to
5 January 1974

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

TWERLE

Technical Progress Report

1. Crystal testing is still in progress. To date, 250 crystals have been shipped to BBRC. All but 33 McCoy crystals have been received. Only 130 Bliley crystals have been received to date. Due to large temperature slopes and low activity, the fallout rate is about 10% for the units tested.

2. Ten (10) pre-production transmitter prototypes have been received from BBRC and have been evaluated. Eight (8) stable oscillator pre-production prototypes have been received from BBRC and have been evaluated. The details of the evaluation are available in the enclosed 21 December letter from Dr. Levanon to Jack Tefft. In general, the testing of the pre-production prototypes by BBRC was not deemed satisfactory. A recommendation has been made to NCAR to allow the electronic assembly of transmitters and oscillators. Permission for final testing of transmitters and oscillators and packaging of oscillators should be withheld pending the evaluation of five (5) additional properly adjusted stable oscillator and transmitter pre-production units.

3. Assembly of four (4) altimeter test sets for launch site use have been completed.

4. One (1) TWERLE transmitter test set for use at launch sites has been completed. The assembly schedule has been delayed on these units because of noise problems encountered in the finalized version of the test set.

5. Bob Rader from NCAR visited U.W. on December 10 and 11. He was instructed on the adjustment and testing of the TWERLE transmitters.

6. The pressure sensor test system manuals and the altimeter test set and transmitter test set manuals are still in the process of being written.

7. Data analysis--Software on pressure sensor data reduction is now under preparation. Simulation studies using EOLE data are being tried.

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T W E R L E

Transmitter--Preproduction Units

Evaluation

1. General

   a. None of the 10 transmitters met all specs as shown in Table 1.

   b. We found that most of the transmitters did not meet the locking range specs because of poor adjustment of R24.

   c. Many of the transmitters were not even close to the specs with regard to the phase modulation levels. Optional resistor R43 had to be added to units 001, 006, and 007.

   d. Only units 005 and 006 met the input and output power specifications.

   e. After readjustment at our laboratory, 9 out of the 10 transmitters met all the specifications. This indicates that the problem at Ball Brothers is not in assembly but in adjustment and final test.

2. Specific Problems

   a. Transmitter #7--Did not lock on crystal oscillator. Found the leads (3-4) reversed on transformer T1.

   b. Transmitter #8--Very limited locking range. Found the leads on T_1 (3-4) reversed.

   c. Transmitter #5--No modulation. Found D9 marked incorrectly by Motorola--effectively the diode was connected backwards. The diode was replaced. It is beyond us how the final test sheet on this transmitter can indicate proper phase modulation.

   d. Transmitter #9--Correct power output could not be obtained even in our lab, due to poor etching of the RF board.

3. Conclusions and Recommendations

   a. Assembly of the transmitter subassemably is acceptable and the company can proceed with assembly of the transmitter TTX 610, TTX 620, and TTX 630.

   b. Adjustment and final testing is totally unacceptable and Ball Brothers must drastically improve its effort in this area. This part of the effort is understaffed, lacks proper instrumentation, and is performed under insufficient supervision. In simple words, one technician can not do all the adjustment and testing by himself!!

   The company may not proceed with adjustment. We require that 5 more units, adjusted properly, will be sent to the University of Wisconsin for approval, before the company gets permission for adjustment and final testing.

Preproduction TWERLE Transmitters

Serial No.	Locking Range	Phase	Output Power	Remarks
001		X	X	
002	X	X	X	
003	X	X	X	
004	X	X	X	
005		X		No Modulation
006		X		
007	X	X	X	
008	X	X	X	
009	X	X	X	
010	X		X	

TABLE 1

X = Repair or readjustment required

T W E R L E

STABLE OSCILLATOR--PRE-PRODUCTION UNIT EVALUATION

1. General

Eight (8) units were received. According to the data sheets, all units were rejected by Ball Brothers because of the -12v currents at cold temperatures. In addition, three units: #001, #002, and #005 did not attain the 1.5v ptp RF output. Since the current reading recorded on all of the data sheets seemed abnormal, while the frequency change versus temperature was normal, we suspect that the current measuring system in Ball Brothers' environmental chamber is malfunctioning.

2. Current Check

Table 2 summerizes currents measured on unit 003 at our lab and at Ball Brothers. Our measurements reflect the normal difference between the + and - currents (about 8 mA = 12 mA oscillator consumption from + only, -4 mA oven control IC current, from -12v only). They also reflect the decrease in heater power as the ambient is warmed from -45°C to -15°C. We have no doubt that Ball Brothers readings are of something else.

The fact that our readings are slightly above specs may be due to variations in Dewar flasks and excessive losses in the packaging (the cork in the Dewar flask, and the gaps in the foam box); however they should not be a cause for rejection. We have decided to relax the current specs on the oscillator to allow for some component (Dewar flask, packaging, etc.) variations. The new maximum allowable values are given in Table 3. These maximum values should be the exception rather than the rule.

3. Output Voltage

a. The output voltages measured on arrival were, in general, lower than those reported on the data sheets. Upon opening the boxes almost all of the core in the buffer were loose. When tightening the core with the core lock it is necessary to check from the other side of the coil to see whether the core is really locked tightly in place.

b. Table 4 summarizes the output voltages before and after corrections.

The corrections included replacement of a MOSFET and/or addition of 4 pf in parallel with C38. After the corrections, only 1 out of 8 units did not reach the minimum of 1.5v ptp. Mainly because the crystals used in this pre-production series were not taken out of the production quantity, we cannot yet determine if we have an output voltage problem, and whether the 4 pf is the solution.

4. Packaging

a. The soft foam plastic cork is not satisfactory. The cork should be of cylinderical shape with a diameter only slightly larger than the inner diameter of the Dewar flask, so that it will fit in without being squeezed too much (excessive compression of the foam reduces the trapped air volume). The length of the cork should be only slightly less than the gap remaining between the circuitry and the open end of the flask. When inserted, the cork should be level with the end of the flask.

b. The styrofoam inner package had huge air gaps between the sides. There is a 3/16" gap between the outer shell and the inner assembly where the buffer and the oven control fit in. This gap is excessive and should be plugged with styrofoam wedges.

c. The channel cut for the terminal strip is too deep. Instead of cutting a complete channel it is better to make 4 slots for the three feedthrus and the RF connector. Appendix 1 describes the modification.

d. The foil flap which has two narrow side flaps should go on last, so that the cut edges of the other flaps are covered.

e. In reference to the inner assembly, the RF wire (white wire) from the oscillator to the buffer should be trimmed to minimum after the other wires have been soldered and routed.

5. Conclusions and Recommendations

a. Assembly of the oscillator board TTX 641, buffer board TTX 642, and oven control board TTX 651 are acceptable and Ball Brothers may proceed with the assembly of the above three boards. We require, however, that the bonding of the crystals to the board be delayed until after the adjustments on the oscillator are completed.

b. The packaging of the oscillator assembly is unsatisfactory.

c. Adjustment and final testing are not satisfactory.

d. The company may not proceed with adjustment and packaging until five (5) more units, adjusted and packaged properly, are sent to the University of Wisconsin for approval. These oscillators do not have to be put inside the sphere.

Temp	Power Supply	U.W. Current	Ball Brothers Current	Maximum Current Specification
-45°C	+ 12v	18.5 mA	13.6	17 mA
	- 12v	11 mA	13.7	10 mA
-15°C	+12v	15.3 mA	13.67	----
	-12v	7.8 mA	13.87	----

TABLE 2

Comparison between current measurements at Ball Brothers and at University of Wisconsin (Unit #003)

Ambient Temp.	+ 12v Max. Current	- 12v Max. Current
-45°C	21 mA	14 mA
-15°C	19 mA	12 mA

TABLE 3

New (relaxed) current specifications

Output Voltage

		Vout PTP		
Serial #	Ball Bros.	U.W. On arrival	U.W. After correction	Type of Correction
1	1v	0.8v	1.0v	Core adjusted
			1.8v	Mosfet replaced
			2.2v	4 pf added para-llel to C38
2	1v	0.8v	1.7v	Mosfet replaced & 4 pf added paral-lel to C38
3	1.5v	0.5v	1.8v	Core adjusted
4	1.5v	1.5v		
5	1v	0.5v	1.25v	Core adjusted
			1.5v	4 pf added paral-lel to C38
6	1.45v	1.7v		
7	1.75v	0.8v	1.8v	Resolder C37 and adjust core
			2.2v	Add 4 pf paral-lel to C38
10	1.58	No Output	1.4	Resolder broken voltage line

TABLE 4

APPENDIX 1

Modification for Mounting the Oscillator Terminal Strip.

The scheme presently used to mount the oscillator terminal strip is awkward to implement and produces a weak mounting structure. The scheme presented below produces a sturdy mounting with little or no additional effort. Briefly, the new scheme uses slots melted in with a miniature soldering iron to mount the terminal strip. The slots are located on the buffer side of the virgin end of the inner styrofoam block (see attached drawings).

The slots for the RF connector and the power terminals are melted into the foam using the jig to be provided and a miniature soldering iron (we use a 15-watt ANTEX iron). The wire channel for the coax is melted in with the iron also. The whole process of slot melting and wire channel forming takes only a few seconds.

The terminal strip, with wires and coax attached is positioned so that the terminals and RF connector fit into the slots. When the outer styrofoam shell is assembled, the terminal strip sits flush with the styrofoam edge of the box and has excellent support.

After the foil is folded over the styrofoam (use scotch tape to fasten down flaps), the RF ground connection is made at the RF connector by tightening the RF connector nut and star washer onto the foil, thus clamping the foil to the phosphor bronze strip below. The foil, at the power terminals, is kept from shifting by taping down with pieces of scotch tape which have holes punched out to clear the solder post of the terminals. Shrink tubing should be used on the soldered terminals so that the connection has protection from the environment and so that the power supply wires are strain relieved.

Glue such as RTV, Lochtite, etc., should be used liberally to secure the RF connector. The steep pitch of the thread makes these connectors prone to loosening by vibration.

APPENDIX 1

Modification for Mounting the Oscillator Terminal Strip.

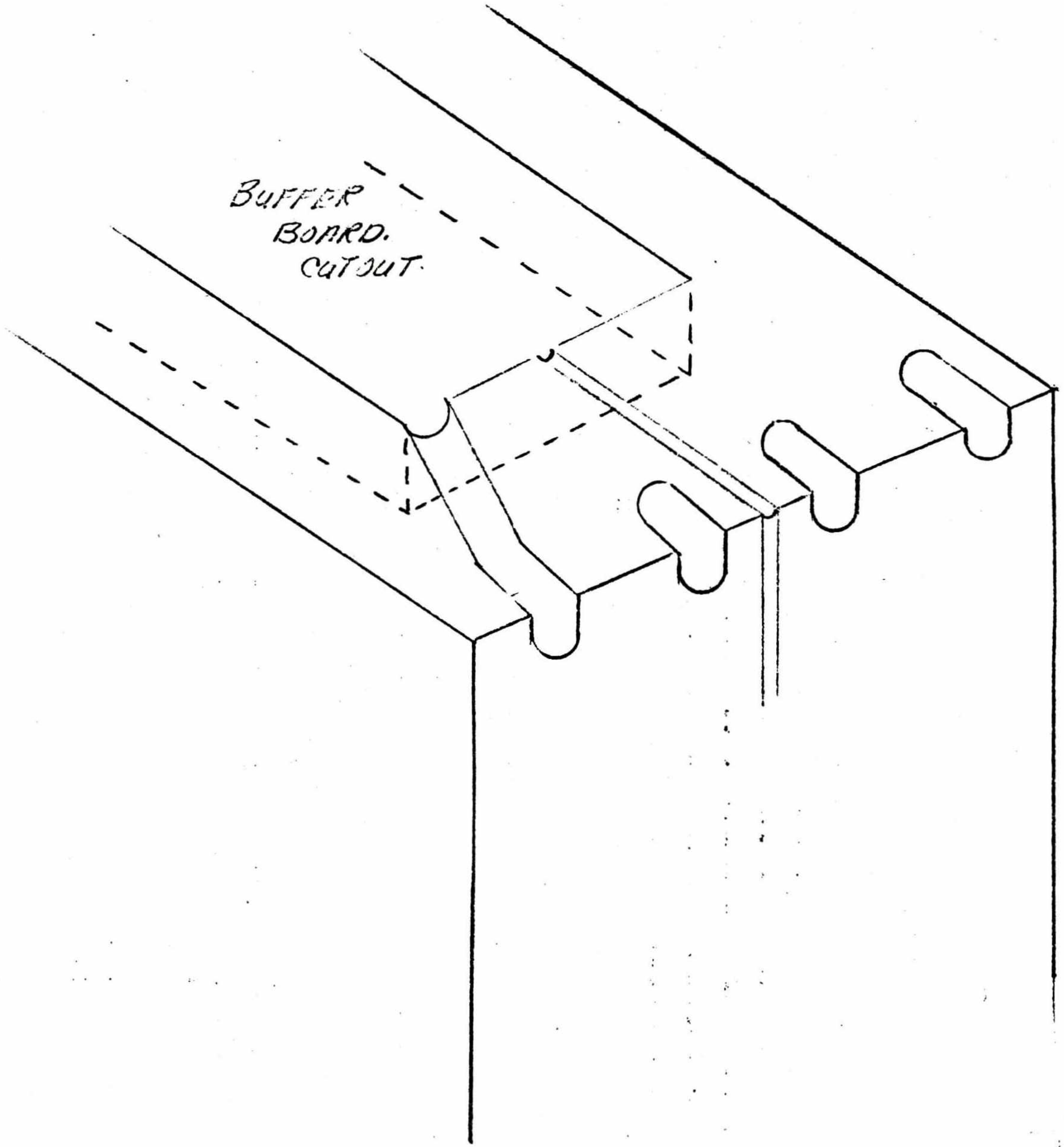
The scheme presently used to mount the oscillator terminal strip is awkward to implement and produces a weak mounting structure. The scheme presented below produces a sturdy mounting with little or no additional effort. Briefly, the new scheme uses slots melted in with a miniature soldering iron to mount the terminal strip. The slots are located on the buffer side of the virgin end of the inner styrofoam block (see attached drawings).

The slots for the RF connector and the power terminals are melted into the foam using the jig to be provided and a miniature soldering iron (we use a 15-watt ANTEX iron). The wire channel for the coax is melted in with the iron also. The whole process of slot melting and wire channel forming takes only a few seconds.

The terminal strip, with wires and coax attached is positioned so that the terminals and RF connector fit into the slots. When the outer styrofoam shell is assembled, the terminal strip sits flush with the styrofoam edge of the box and has excellent support.

After the foil is folded over the styrofoam (use scotch tape to fasten down flaps), the RF ground connection is made at the RF connector by tightening the RF connector nut and star washer onto the foil, thus clamping the foil to the phosphor bronze strip below. The foil, at the power terminals, is kept from shifting by taping down with pieces of scotch tape which have holes punched out to clear the solder post of the terminals. Shrink tubing should be used on the soldered terminals so that the connection has protection from the environment and so that the power supply wires are strain relieved.

Glue such as RTV, Lochtite, etc., should be used liberally to secure the RF connector. The steep pitch of the thread makes these connectors prone to loosening by vibration.



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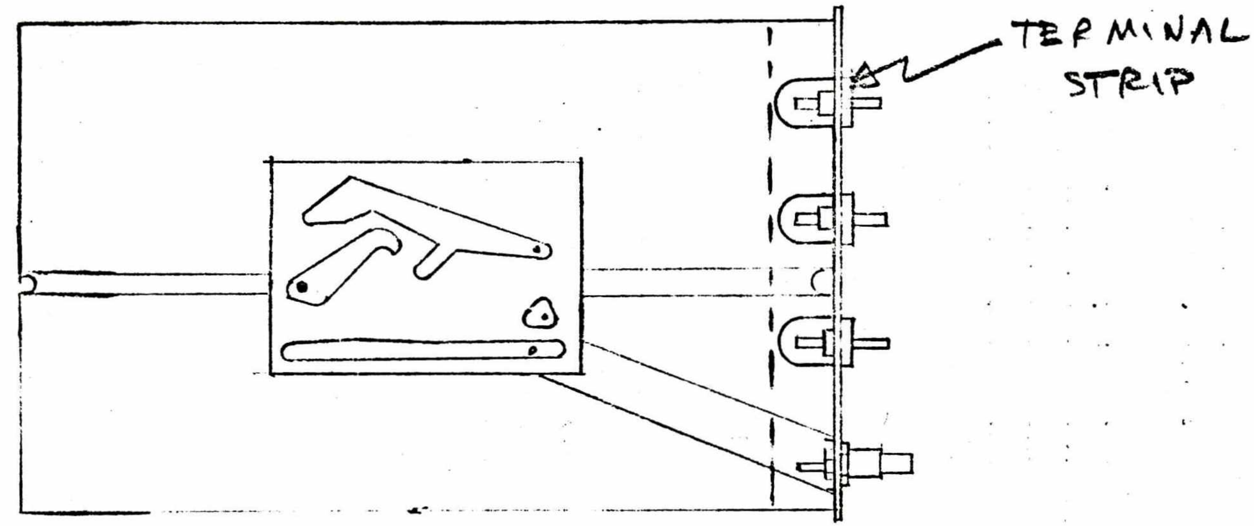
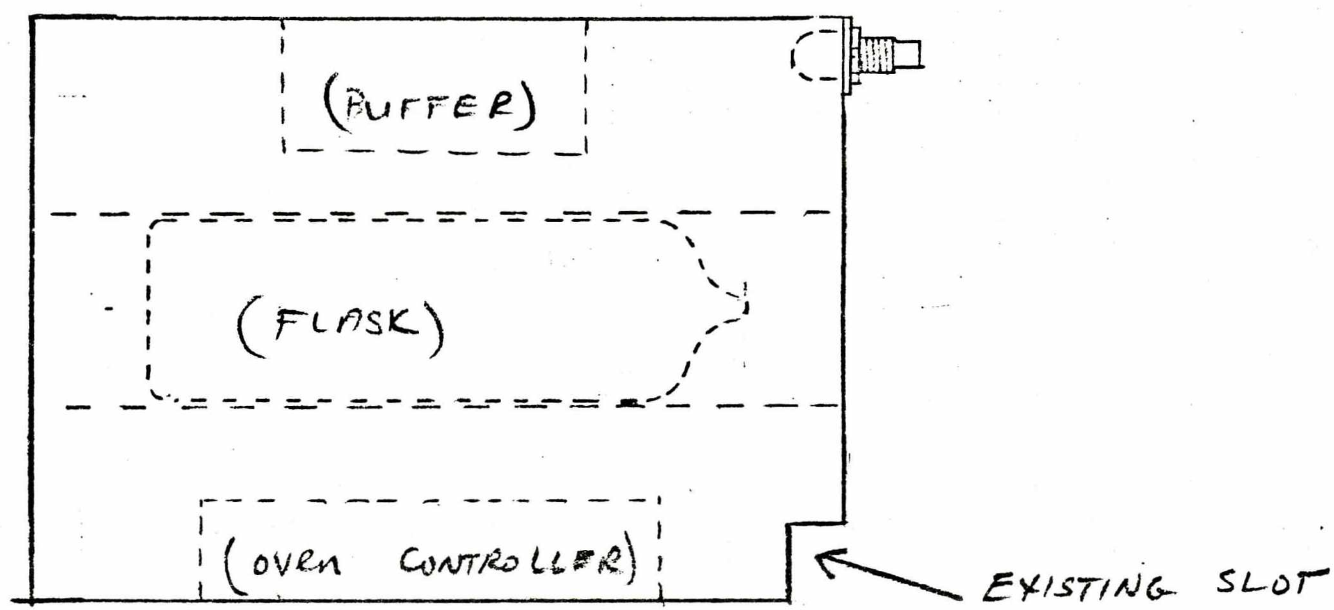
TOP VIEW



SIDE VIEW



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