BOUNDARY LAYER INSTRUMENTATION SYSTEM

TASK THREE SEA TRIALS REPORT

A REPORT

from the space science and engineering center
the university of wisconsin-madison
madison, wisconsin

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STAG Contract 2-35116
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Washington, D.C.

April 1973

TASK THREE SEA TRIALS REPORT

A. Introduction

This report prepared under Contract NAS2-35116 covers the period from 1 January 1973 to 1 March 1973 which includes the sea trials. The University of Wisconsin Space Science and Engineering Center (SSEC) was represented by Dr. Stanley G. Burns and James A. Maynard.

Specifically, the objectives of the sea trials were to obtain an engineering evaluation of all elements of the Boundary Layer Instrumentation System (BLIS) and the Surface Meteorological Instrumentation System (SMIS).

B. Scope

This report is organized into the following sections:

I. The development status of each BLIS/SMIS subsystem as of 1 January 1973.

II. Sea Trial Participation.

III. Conclusions and recommendations for the BLIS/SMIS subsystems.

IV. Appendices.

- A. Chronology. A brief summary of the operating log detailing SSEC sea trial participation and equipment performance.
- B. GATE Sea Trials Test Plan
- C. Joint Logistics Planning Document
- D. BLIP Operating Log

I. DEVELOPMENT STATUS AND PREPARATION FOR SEA TRIALS

During November and December, 1972, SSEC was directed to emphasize BLIS development rather than SMIS. This emphasis manifests itself in the time spent during January in preparation for the sea trials.

Quantities and types of instruments were specified by NOAA in telephone conversations and by letter. In particular, it should be noted that many technical details on the handling of SMIS data were open items until well into January.

BLIS

A. Boundary Layer Instrumentation Package (BLIP)

Twelve BLIPs were being prepared for use during the sea trials. There were two each on 420, 435, and 440 MHz, and three each on 425 and 430 MHz. The units were fabricated to meet specifications given in the SSEC document dated 13 August 1971, entitled "Technical Report on a Prototype Boundary Layer Instrumentation System." All units were calibrated so that on-sight engineering unit (EU) evaluations could be made. This calibration has been supplied to NOAA.

In addition, battery packs and spare components were procured and fabricated in accordance with the planned length of the sea trials.

The two-week period leading up to the sea trials was devoted to the final testing and calibration of the BLIPs.

B. Balloon Winch System

1. Winch

An OTIS Engineering Corporation winch Model 6W was used for the sea trials. Figure 1 is a photograph of the winch used. Based on

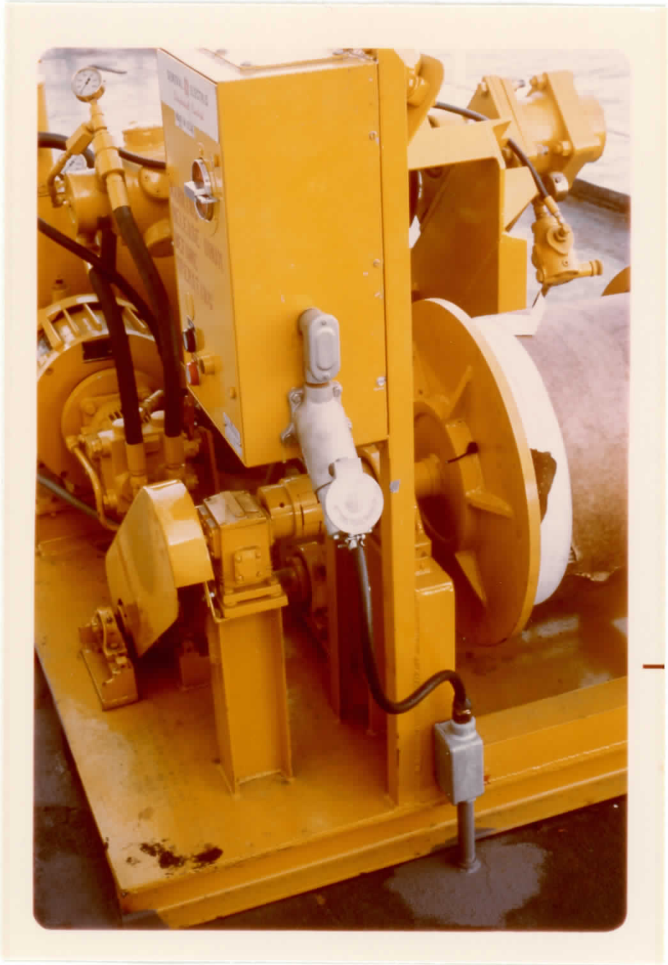


Figure 1

Otis Engineering Model 6W Winch
Mounted on the Deck of the Ship Discoverer

experience obtained during the MTF field tests conducted during August and September 1972, modifications were required.

The winch was received on 6 November 1972 and, in order to ensure its timely installation aboard the ship Discoverer in early January, the winch was shipped from SSEC on 13 December 1972.

The following work was performed:

a. Capstan pulleys and the line counter wheel were acid etched, copper plated and then chrome plated.

b. The line tension pulley was coated with zinc dicromate by OTIS.

c. The control level rate of motion was restricted by the installation of two "SNO-SHOCKS" (Snowmobile shock absorbers).

d. Mechanical stops were added to restrict lever motion.

e. The stationary guide rollers were replaced with light stainless steel rollers with small stainless steel bearings.

f. The Capstan rollers were replaced with light stainless steel rollers with small sealed stainless steel bearings.

g. The line tension pulley was balanced by use of two springs.

h. A drum lock was provided.

i. A warning sign was added to the control box to release drum before operating.

j. A waterproof 440 VAC connector was added.

SSEC was consulted prior to the sea trials as to their recommendations for installing and operating the winch. In addition, an operating and service manual was prepared as part of an overall BLIS documentation package.

2. Fairlead and Pulleys

After receipt of approval to proceed with this work, SSEC personnel designed and fabricated a variable orientation fairlead-- as well as three large radius-of curvature deck mounted pulleys. See Figure 2.

The work was scheduled so that the equipment was available for ship installation on 1 January 1973.

3. Balloon System

Four balloons were to be used during the sea trials. Three balloons were manufactured by Raven Industries, and one balloon by Jalbert Aerology Laboratories. These balloons were identified as:

Balloon 1 — 3500 ft^3, rigid fin tail, Raven Industries. Purchased by SSEC.

Balloon 2 — 2500 ft^3, inflatable tail, Raven Industries. Purchased by SSEC.

Balloon 3 — 2400 ft^3, rigid fin tail, Raven Industries. Purchased by NOAA directly, but handled by SSEC.

Balloon 4 — 3200 ft^3, Jalbert Aerology Labs; rigid tail for this balloon was built by SSEC. Balloon purchased earlier by SSEC for the MTF tests.

The only balloon on hand in early January was Balloon 4. Before being sent to Miami, this balloon was carefully inspected and previous operating damage repaired. In addition, Jalbert Aerology Laboratories forwarded

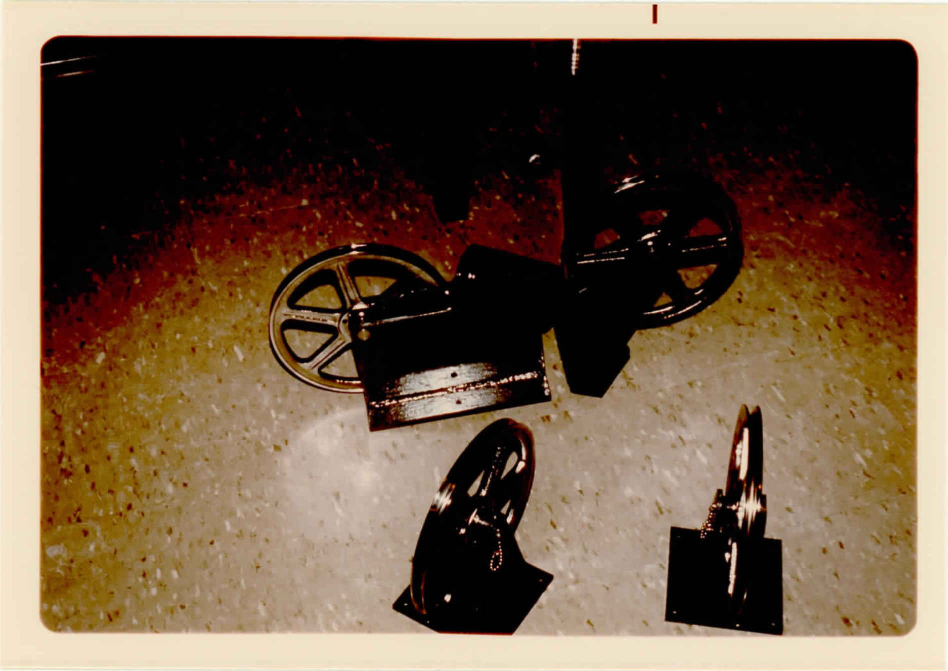


Figure 2

Variable Orientation Fairlead and Deck Mounted Pulleys a set of tail diagrams so that SSEC staff could build a tail assembly. SSEC fabrication was required because of the short lead time given in balloon specification to Jalbert.

The three Raven balloons were assembled at the factory in early January; but as we shall see during the sea trials, they were probably not adequately inspected and tested. Strong pressures placed on Raven to insure their timely delivery probably prevented these tests.

In addition, in a letter from NOAA dated 16 November, SSEC was directed to supply a destruct system modified from the MTF system. In consultation with Raven, this system was developed and adapted to their balloon.

In a letter dated 11 December, SSEC was asked to work on a balloon status telemetry system. The system was undergoing final fabrication and testing just prior to the sea trials.

In our view, the short lead time made it impossible to prepare for the sea trials as completely as really needed.

4. Nolaro Line

All of the NOLARO line used at MTF was returned with the winch on 6 November.

Following a telephone agreement, the entire supply of line was unreeled and carefully inspected and repaired. Four 7000 ft segments of 3/16 inch NOLARO were supplied for the sea trials. One of the lengths was wound on the winch supply drum. As with most of the carrier system, the NOLARO required special handling and preparation to ensure its timely arrival.

SSEC was directed to analyze and improve upon the splicing and line preparation procedure. After considerable testing in the University of Wisconsin Department of Engineering Mechanics Laboratories, a special compact splicing kit was developed and several kits of chemicals were assembled prior to the sea trials. Documentation describing use of the kits was prepared and furnished.

SMIS

During the weeks following the MTF field tests, there was considerable discussion with NOAA as to what would be desirable for a buoy and its sensors as well as other surface instruments. These specifications were then proposed in an SSEC report, November 1972, entitled "Proposed Sea Surface Meteorological Instrumentation System for the U.S. GARP Atlantic Tropical Experiment." This report formed a basis for SMIS work, but no direction to proceed was received until early December. Thus, the proposed instrumentation program had to be greatly reduced in scope. The results are presented below.

A. Instrumented Buoy

On 8 November we received notification to produce a separable instrument package for a PVC spar buoy along the lines of Dr. Sparkman's PVC pipe buoy. To avoid attempting to build separate pieces of the buoy across a difficult special waterproof interface, the entire 30 foot buoy was fabricated at SSEC. It held a thin wall stainless steel tripod mast so that sensors could be held 12 feet above the sea surface. Figure 3 is a photograph of the SSEC buoy. A 16 mm movie, available from SSEC, compares the SSEC configuration with that of Dr. Sparkman's.

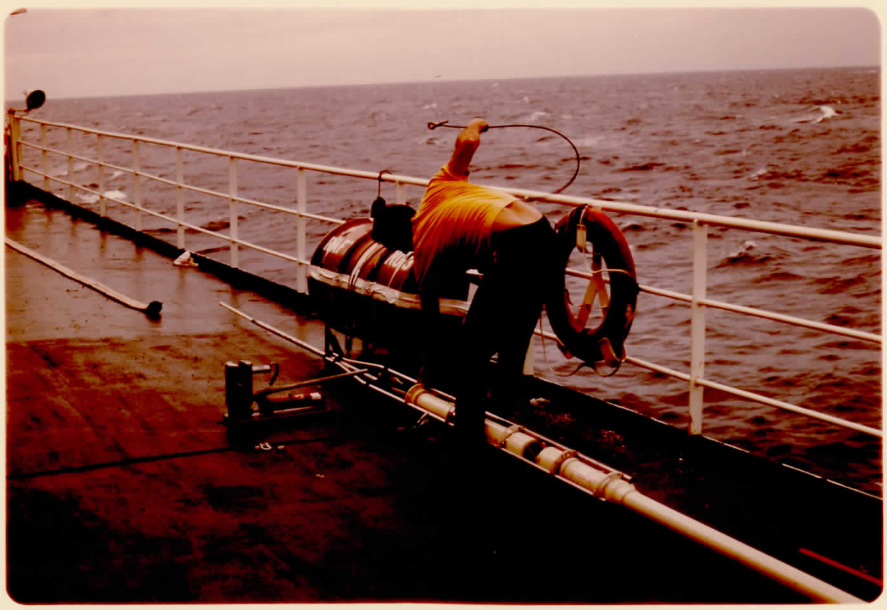


Figure 3

SSEC Buoy

Being Assembled and Rigged Aboard the Ship Discoverer

An instrument package and replaceable rechargeable NiCd battery pack was designed as an integral part of the buoy yielding a cylindrically symmetrical structure. The instrumentation package consisted of a set of BLIP circuit boards modified for a four times faster data rate and a new telemetry frequency of 158.75 MHz. The instrument package was equipped with a thermistor for temperature measuring and an aneroid capacitor for pressure measuring. The other 14 channels had hard wired numbers to simulate typical data points. The buoy package was powered by an ampere hour NiCd battery pack with an operating life in excess of 40 hours. A flexible, yet rugged, antenna was also fabricated.

We were directed on 16 November to be responsible for both ends of the telemetry link. Consequently, a standard commercial receiver was modified to be compatible with the digital data format and PODAS. The entire physical system was tested in Lake Monona at Madison, Wisconsin. Of course, this required launching the buoy through a hole drilled in 18 inches of ice and temperatures of -15°F. See Figure 4.

Another very important design problem required that the buoy could be disassembled so that it could be shipped readily by air and then reassembled on board ship.

B. Gimballed Radiometer System

A Model 8-48 Eppley Black and White Pyronometer (down looking), a Model PSP Eppley Precision Spectral Pyronometer (up-looking), and a Model 622 CSIRO Funk Net Radiometer were mounted on a variably damped gimbal mount for installation on a bow boom. See Figure 5.

Figure 4

Lake Monona (Madison, Wisconsin) Buoy Test

Note Tripod Instrument Platform Flotation Level

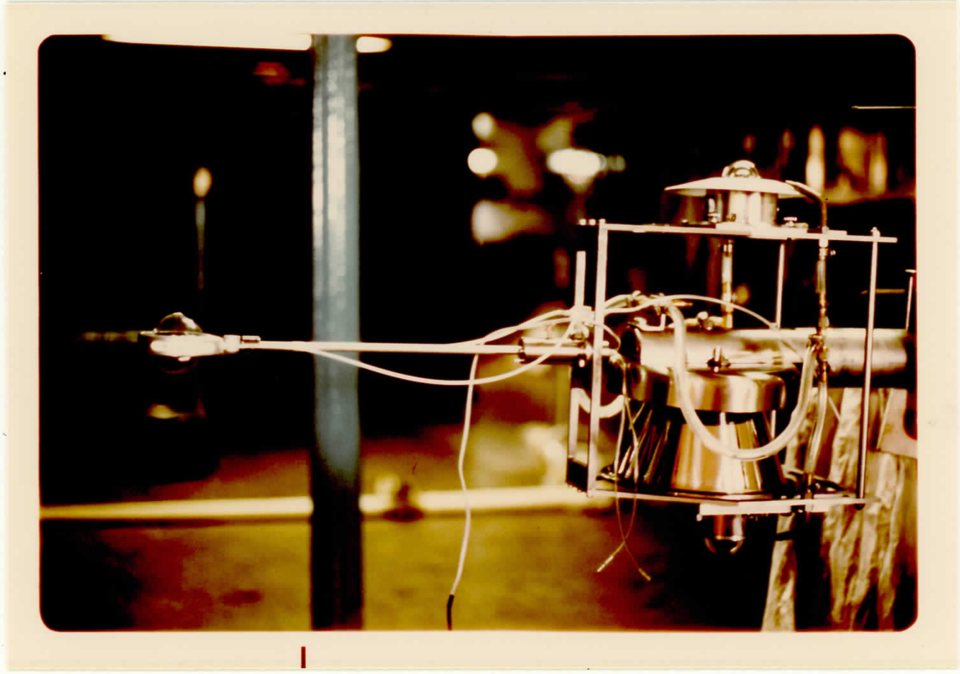


Figure 5

Gimballed Radiometer System Using:

Model 8-48 Eppley Black and White Pyronometer (Down Looking)

Model PSP Eppley Precision Spectral Pyronometer (Up Looking)

Model 622 CSIRO Funk Net Radiometer

The mechanical design of the gimbal is similar to the drawing in Figure 5 of the SMIS Report. Provision was made through an umbilical cable to water rinse the Eppley instruments and pressurize the Funk radiometer housing in addition to relaying electrical signals to a bow-mounted Systems Acquisition Module (SAM).

The electrical interfacing and related calibration techniques were not finalized until several days before the start of the sea trials. Consequently, electrical design had to be flexible to permit easy field interfacing.

C. Humidity Measurement System

As discussed in the SMIS report, a technique to measure the humidity (water vapor) gradient above the sea surface is a requirement to obtain evaporation from the sea surface.

A 20 foot PVC boom with air inlets positioned 135° from the direction of ship movement was built for deployment from the starboard side using the bow crane. Three air inlets, using positive closure valves to avoid sea spray and positioned logarithmically, were equipped with two types of sensors. See Figure 6.

Each radiation shielded inlet had a thermistor for absolute measurement and a thermocouple which was connected in such a way as to obtain directly differential temperature measurements. The air sample was then pulled through equal lengths of tygon tubing by a sealed centrifugal pump. All three air samples were conducted through a sealed heat exchanger where a water bath was kept at a regulated temperature. A set of wet bulb thermistors was then used to obtain the air sample water vapor content.

Figure 6

Humidity Measurement System Air Intake Pipe
Being Rigged Prior to Launch

Tests were performed at SSEC three days prior to the sea trials. It was determined that sensitivities surpassed those described in Table II of the SMIS Report. The entire pump and heat exchanger assembly was mounted on a steel plate suitable for deck welding.

Unfortunately, just prior to shipping, the heat exchanger developed a leak. Since the leak could not be repaired in time to meet schedule, it was decided to try to salvage the experiment by constructing a long-line heat exchanger. This arrangement was bulky, but the operating principle was the same. This arrangement, along with the pump, was then mounted on a wooden platform for shipment. Laboratory tests and calibration were performed on the modified unit. It was anticipated that this last minute problem would complicate deployment and operation; but, hopefully, the HUMS concept could still be evaluated.

Despite the crude appearance of the hastily constructed apparatus, its capability to measure humidity gradients was superb.

D. Sonic Anemometer, Rain Gauge, Upper Sea Surface Temperatures

Beyond some preliminary development work in November and December expanding upon previous experiments and commercial sensors, all work on the sonic anemometer was terminated late in December. This was in agreement with the directive from NOAA, which stated that all emphasis should be placed on BLIS and the sea trials.

The above statement from NOAA also applied to the development of a capacitive rain gauge and an upper sea surface temperature sensor.

II. SEA TRIAL PARTICIPATION

A. Test Organization and Objectives

The GATE Sea Trials Test Plan (Appendix B) was received mid-December. The overall objective of the sea trials was to conduct engineering equipment tests to ensure a successful GATE program. In line with this, the data collected would be readily available for a post sea trial scientific analysis.

Briefly, the role of the SSEC participants (J. A. Maynard and S. G. Burns) was to provide technical support for SSEC experiments and equipment. All scheduling, deployment, coordination and operation of the various experiments were under the direction and disposition of the Chief Scientist, Dr. James Sparkman.

A check-off list supplied by Dr. Sparkman and supplemented by SSEC was used as a logistics planning document for BLIS deployment. This list is included as Appendix C.

B. Equipment Performance Evaluation

1. BLIP Tests

BLIP tests in conjunction with the Portable Data Acquisition System (PODAS) were conducted in three modes:

1) Tethered from the NOAA Ship Base warehouse for 200 yard transmission to the ship. (See Figure 7.)
2) Tethered from deck railings on the Ship Discoverer (See Figures 8 and 8a) and
3) Tethered from balloons.

Of the 465.5 hours of total BLIP operating time, only 62.3 hours were logged during balloon operations. The BLIP Operating Log is included as Appendix D.

Figure 7

BLIP Tests Being Conducted From the
Miami NOAA Ship Base Warehouse
(200 Yards from the PODAS)

(a)

(b)

Figure 8

BLIP Tests (PODAS Stability Runs) Conducted from:

(a) Flying Bridge Deck Railing to G-Deck Port Side

(b) Below Radar Antenna to F-Deck Stern

(Note the Proximity to the Ship's Superstructure)

The BLIPs, as described in Appendix D, were exposed to heavy rainfall and salt spray. Those that received this treatment required some resealing with RTV and related materials. The circuit board spray-on protective coat applied at SSEC prior to the test was subject to failure. Based on these results and the fact that after resealing, the BLIPs worked quite well, a new sealing and packaging technique is being developed.

The wind direction circuit performed well only about half the time. Primary failure mode was from a very low signal level from the μ- metal magnetic concentrator.

The horizontal intensity of the earth's magnetic field at Madison is about .175 gauss, whereas it is .275 gauss in the test area and is about .300 gauss in the GATE area. Thus, the wind direction devices on BLIP should have worked <u>more</u> satisfactorily during the ship trials than they did back in Madison. Unfortunately, the ship tethered tests were assigned to a location where the ship hull and super structure constituted a magnetic short circuit. Unsatisfactory operation under these circumstances should hardly come as a surprise. (The area assigned for BLIP repair and maintenance was deep in the ship's hold--not an ideal place to adjust these sensitive magnetic circuits.)

We have taken steps to increase the sensitivity and stability of the magnetic wind direction circuits, but it must be realized that these instruments will reference the wind direction to the distorted magnetic field near the ship's deck when operated there--and not the direction referenced to magnetic north.

At long distances, the 440 MHz BLIP sondes interfered with the OMEGA radiosonde receiver. This problem has been identified and is being corrected.

As a result of the sea trials, we conclude that as far as the BLIP packages are concerned, a satisfactory engineering test was conducted. The tests indicated satisfactory electrical operation of the BLIS packages under very severe conditions. They also indicated unsatisfactory waterproofing of the BLIP units in some instances and steps are being taken to correct this deficiency.

Unfortunately, we are forced to conclude that the ship trials did not meet the needs of a test of the scientific performance of the BLIP units by a wide margin. For example, we have been unable to obtain any useful data from the PODAS unit to date. Therefore, SSEC has been unable to perform a valid engineering analysis of the meteorological performance during the sea trial experience.

In order to obtain a test of meteorological performance, SSEC has submitted a proposal to NOAA where we would conduct such a test using a TV tower as a means to support the BLIS packages. We consider this test to be very urgent.

It is interesting to note that even though the PODAS receiver preamplifier failed early in the sea trials yielding 20 db less signal gain, data was obtained from the BLIPs over the design distance. Thus, their RF power is more than adequate.

Despite problems with the BLIPs, operational, full-calibrated BLIPs were always available during the sea trials. All problems that occurred were repairable.

2. Winch

Virtually all winch operation was conducted by Drs. Stanley Burns and Jim Sparkman.

There was no difficulty in controlling the rate of inhaul or outhaul. By using the built-in line counter, the amount of line could be accurately controlled. The maximum inhaul and outhaul rate was measured at $\frac{4}{3}$ meters/second. Night operation was satisfactory despite the fact that lighting was poor.

The only difficulties with the winch were directly caused by salt spray induced corrosion, as explained in the following list.

a. The capstan and other plated parts developed a fine patina of rust. By using a wire brush and rustoleum, these parts were protected from future problems. It should be noted that the painting route--while inexpensive--must be repeated every few weeks while the use of all stainless steel parts has an extremely high initial cost. A regular painting schedule is probably the best route to follow.

b. The level wind roller did not at first operate smoothly. This was traced to corrosion on the roller guides. The roller was not greased properly. Again, this was quickly solved by removing the scale and applying a thick coat of marine grease.

3. Fairlead and Pulleys

The fairlead was mounted at the corner of G-deck railing. See Figure 9. The three pulleys were used to guide the NOLARO line from the winch to the fairlead. The fairlead and pulleys worked well. The slight traces of corrosion were abraided off during use.

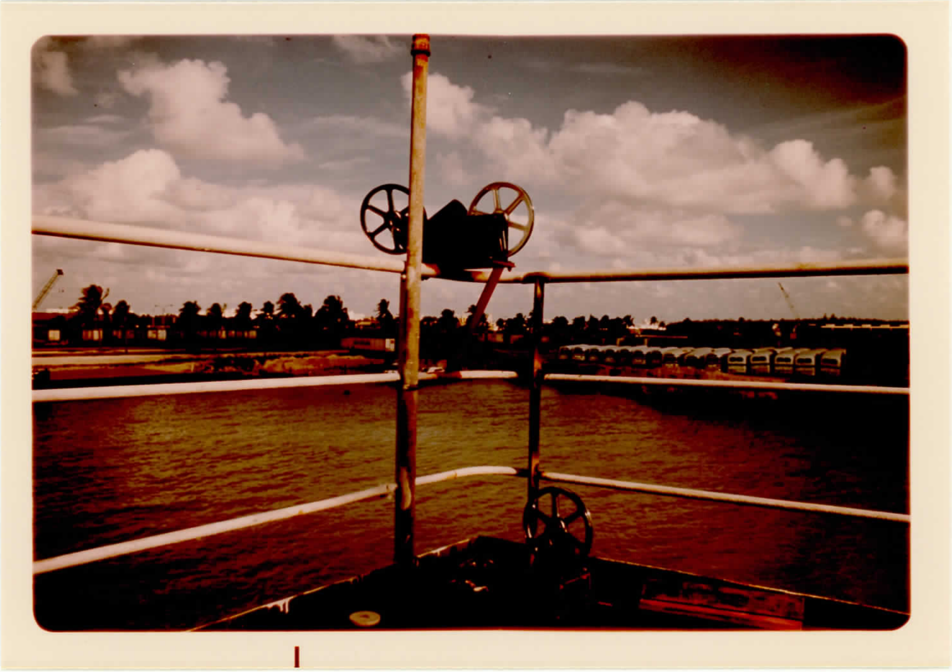


Figure 9

Fairlead Mounting on G-Deck

NOLARO Line Runs Under the Deck Mounted Pulley

and Through the Variable Orientation Fairlead

Future fairleads and pulleys should have a snatch block type of construction so that tether line can be inserted from the side. Stainless steel, rather than chrome plated construction, should also be considered.

4. Balloon

Due primarily to the weather--thus, beyond our control--balloon flying was not attempted until three days before returning to Miami.

Balloon 1 was flown for a total of 23 hours commencing at 1615 EST on 4 February. The balloon was launched in nearly ideal weather. (See Figure 10.) A 16 mm movie of this balloon launch and related activities is available at SSEC. A reviewing of this movie is very instructive. It shows an inexperienced and untrained crew performing a balloon launch which is almost continuously skirting disaster. Training will most certainly improve the situation. Prerigging and the use of tie points will help greatly. The ship's radio antennas are a serious hazard as shown in Figure 11. The antennas should either be relocated--if possible--or a light weight net should be mounted so as to prevent the balloon from making contact with the antennas or other sharp obstructions.

The movie also shows that handling the larger Raven balloon is not much more difficult than the smaller Jalbert balloon. This is illustrated in Figures 12 and 13 respectively. The larger balloon is required if we are to reach heights near 1500 meters.

After the lift-offs required to adjust rigging and ensure minimal interference from the ship's radio antennas, the balloon was launched and tethered at 176 meters. It was decided to operate just one BLIP for an overnight run. This unit was then mounted on the line at the

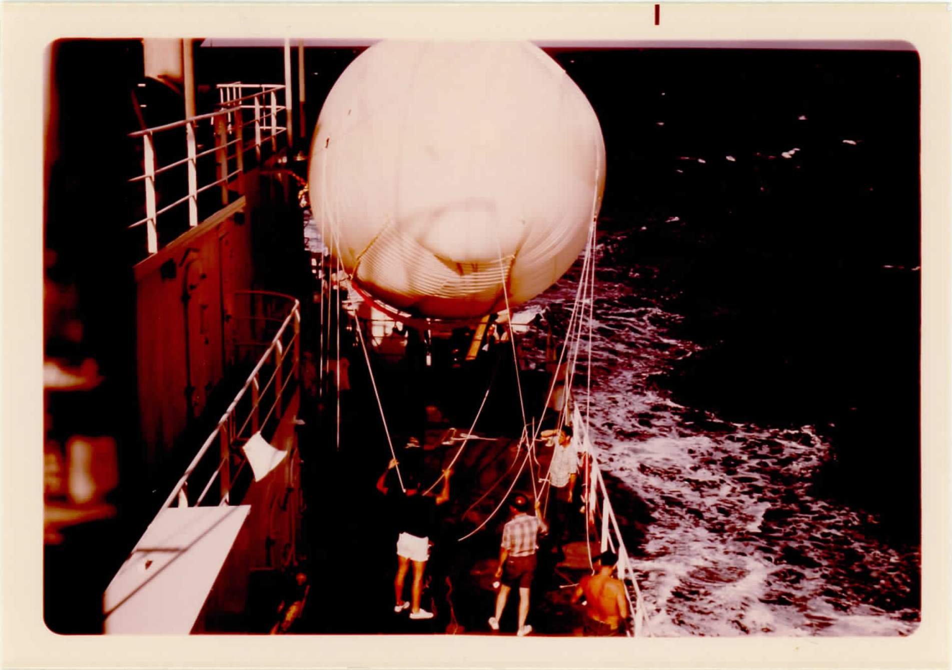


Figure 10

Balloon 1 (Raven 3500 $ft.^3$ with Rigid Tail)

Rigging Being Adjusted Prior to Launch From G-Deck

Port Side (Looking Towards the Stern)

Figure 11

Balloon 1 Striking the Ship's Radio Antennas

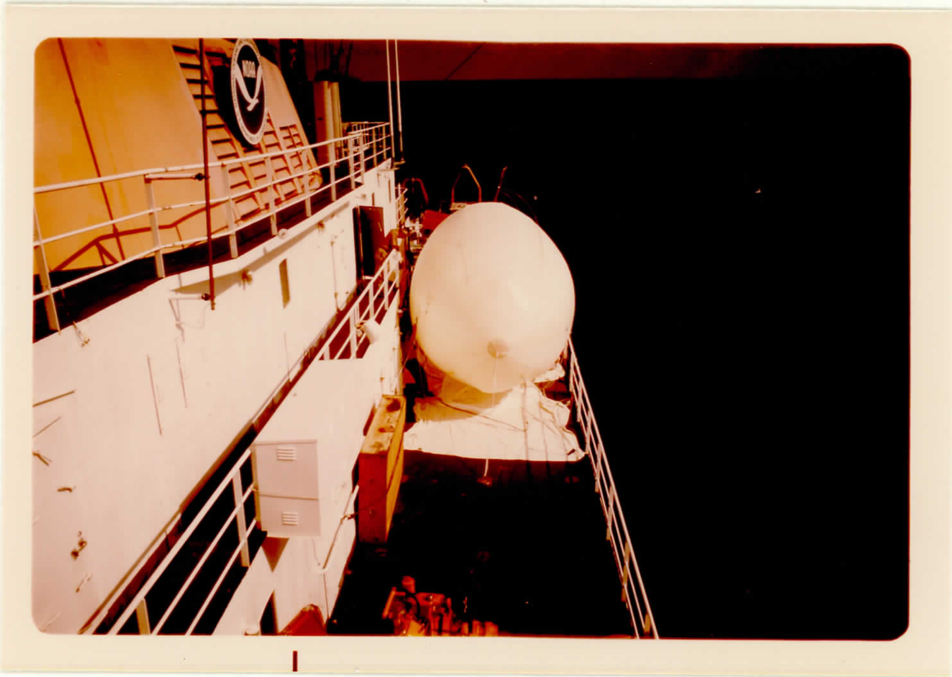


Figure 12

Figure 13

Figures 12 and 13 Comparison Between the Sizes of the Raven Balloon (3500 $ft.^3$) and the Somewhat Lower Volume Jalbert Balloon

Both Photographs from the Same Location--Looking Towards the Stern

176 meter mark and then the balloon was run out to 276 meters. See Figure 14. It remained at this altitude overnight. Since the ship steamed back to station, the balloon experienced a net wind of 30 knots with a resultant line tension peaking at 400 pounds. This value is close to design expectations.

The Raven was outhauled as far as possible. Two thousand three hundred and two (2302) meters of line, the entire drum supply, were outhauled yielding an estimated altitude of 5850 feet. A theodolite altitude check was not made; consequently, a crew member using a sextant obtained a fix so that the altitude could be approximately computed using catenary tables.

The balloon was inhauled and secured at 1530 EST 5 February. At this time, the tail fins were examined. The two lateral fins had fatigue breaks just beyond the damps securing them to the outer ring. Otherwise, the balloon appeared to be in excellent condition with firm aerodynamic shape.

Balloon 2 was unrolled and partially inflated around 1600 EST on 5 February. After the balloon was about half full it was noticed that two of the bridle patches were mounted upside down (2 of the 4 rigging supports). Continuing to fill and fly the balloon would have resulted in large rips at these inverted patches. As a result, the flight was aborted. The errors in fabrication were photographically documented and the balloon was then deflated and secured for storage.

Balloon 3 was not used.

The Jalbert balloon was test flown a total of 9.5 hours, starting at 1000 EST on 6 February and carried four BLIPs spared 200 meters apart. The first one was 70 meters below the balloon.

Figure 14

Placement of a BLIP on the Balloon 1 Tether Line

The balloon was tethered at 1200 meters for most of the day. The weather was again ideal. Around 1530 EST Burns outhauled the balloon to a maximum of 1855 meters of line. This resulted in an estimated maximum altitude of 3700 feet.

The balloon was brought in at approximately 1930 EST on 6 February. This nighttime recovery was difficult because of considerable helium losses through the seams and balloon fabric. The balloon became unstable, and only through extensive handling was it prevented from going into the water.

It is unfortunate that the balloon system, one of the most crucial components of the BLIS program, could not be adequately tested. Despite obvious risks, successful flights probably could have been made in less than ideal weather. After all, GATE experiments will be carried out in all types of weather. However, even with the limited balloon flight experience, it appears that Raven balloons--if equipped with a better tail and prerigged--will be the best available BLIS lifting vehicle.

The destruct packages or the balloon status telemetry system were not used; therefore, no test data were collected on either.

5. NOLARO line

Although no breaks occurred in the tether line, some abrasion of the outer polyethylene jacket did occur.

Abrasion of the polyethylene jacket was caused by: (1) winch level wind balkiness; and (2) the plastic BLIP ball mount abraiding the line.

Rather than using the prepared splicing kit, we were directed to perform the following type repairs for line abrasion: (1) good quality black electrical tape (worked quite well). This procedure is now recommended for minor jacket abrasions. (2) RTV (flaked off, totally unsatisfactory).

Abrasion of the line from the vibrating ball mount was eliminated by winding a layer of glass tape on the line for protection. This technique is not only easy to perform, but yields good results.

It was decided not to use the splicing kit; consequently, eye-splices were made by using lacing cord to tie the parallel section together. This time-consuming procedure was not tested and indeed failed once under a tension test. Fortunately, the second eye-splice held up under use.

During operation, maximum line tension was 400 pounds for a few minutes with the average line tension 80 - 100 pounds.

Due to the limited balloon-flying time, only the NOLARO supplied on the winch drum was used. All other lengths remained in storage.

Salt collected on the line from evaporating sea spray, and was removed by using a damp cloth and wiping the line during inhaul.

SMIS

1. Instrumented Buoy

For most of the sea trials (and before sailing), the entire buoy system was operated while lying on a deck. This mode of operation (over 100 hours) was used to check the telemetry link and to provide signals for analysis in PODAS. Unfortunately, much of this telemetered information was not recorded due to a malfunctioning PODAS DECOM. The only data received by SSEC personnel consisted of a strip chart record of several minutes of reconstructed pulses.

The complete spar buoy was first sea tested on 2 February starting at 1445 EST. The weather was calm with two foot seas. Attached to a nylon tether line with flotation canisters, the assembly was lowered over the stern from F-deck. The buoy was tethered about 50 yards from the ship. Unfortunately, the tether line, floats and associated hardware added too much of the weight near the top which contributed to a 30° from the vertical list. The electronic package worked well despite occasional dunking over the radio antenna. The buoy was brought aboard after 15 minutes to rework the bridle. The heavy hardware and floats were removed. After redeployment, the buoy had improved considerably. The remaining 5° - 10° list occurred because the buoy was top heavy. For stability the center of buoyancy should have been raised. After 30 - 45 minutes of operation, the buoy started to slowly sink. After recovery, it was noticed that water under pressure had started to leak through both O-Ring and PVC cemented joints. The electronic circuit boards were exposed to some salt water damage.

To determine the source of water leakage, a combination of regluing and applying of heavy layers of silicone grease was tried. The buoy was redeployed 3 February, but after several minutes it became obvious that the PVC joints were leaking.

After examination of the buoy and analysis of deployment movies, it is felt that flexing sufficiently weakened the glued joints resulting in slow leaks under pressure.

An important finding is that a small spar buoy does not perform well enough as an instrument platform. Under moderate seas, the mast-mounted sensors would have been repeatedly submerged and probably destroyed.

2. Gimballed Radiometer System

The gimballed radiometer system was disassembled for shipping. The net and down-looking radiometers were hand carried to Miami. While waiting for delivery of the up-looking Eppley instrument, a similar unit was borrowed from SAIL. Interfacing and setup was performed in the warehouse prior to sailing. After shipboard installation, the damping and balancing was given its final adjustment. No difficulties were experienced with the PODAS SAM interface, nor with the mechanical interface. All air, water and electrical lines operated as expected. Refer to Figure 15.

SAIL also installed a rail-mounted up-looking radiometer (see Figure 16) so that a comparison could be made with the gimballed system. The goal was, of course, to remove mechanically the ship's multi-mode oscillatory motion.

Operation of the system was almost continuous, except for a two-day segment--when in removing the assembly from the boom, the entire umbilical system was accidentally severed. This required extensive rework of the air, water and electrical lines. Additionally, even though the radiometers were on line for most of the sea trials, the RFI and other noise problems traced to the SAM and PODAS tape recorder severely limited the amount of recorded data. Only a few strip charts of data were usable.

Real time evaluation of the data via strip charts showed that the passive gimbal did not remove completely the multi-mode ship oscillations. There was no significant improvement between the fixed and gimballed systems.

Figure 15

Bow Mounted Gimballed Radiometer System

Figure 16

Deck Mounted Radiometer

(Eppley PSP Uplooking Precision Pyramometer)

Sea Air Interaction Laboratory

3. Humidity Measurement System

Deployment of HUMS was not attempted until only 18 hours were left in the sea trials. The two objectives in the use of the HUMS system were to determine:

a. What problems occur when the air intake pipe is deployed off the side of the ship.

b. Assuming deployment is satisfactory, whether or not the data meets scientific requirements.

On 2 February we attempted to deploy the HUMS intake pipe, but the pipe broke at a joint and required a minor repair. The second opportunity for deployment occurred the next morning just before arriving in Miami. The air intake system was successfully deployed (see Figure 17); however, the spacing from the ship was too small. Actually the surface float rode on the bow wave, an unsatisfactory spot because of the large amount of spray. We also learned that a rigid system will not stand up under the ship motion. To study these problems and film the results, the ship steamed at speeds up to 10 knots.

There was no opportunity to record sensor data because only two hours remained in the sea trial.

Work Performed 12 February to 28 February

In the period immediately following the Sea Trials, the work effort on BLIS was reduced because of personnel vacation time. The following list itemizes the efforts during this time period.

1. Sea Trials debriefing.
2. Redesign of the wind direction magnetic circuit.
3. Redesign of the wind direction electronics.
4. Experimentation with different packaging techniques and waterproofing.
5. Repair of equipment damaged during the Sea Trials.
6. Analysis of modification required to aid in future mass assembly of BLIPs.

Figure 17

HUMS Air Intake Pipe Deployed

Note the Location in the Bow Wake

III. CONCLUSIONS AND RECOMMENDATIONS

A. Overall Test Results

As far as the boundary layer system was concerned, only of few of the objectives in the GATE Sea Trial Planning Document, Appendix A, were accomplished. Major factors contributing to this poor showing were bad weather, serious problems with the ship's electrical system, and lack of an effective day to day test program which would have improved planning, coordination and direction.

Even though operating BLIS equipment was always ready to support any of the tests originally planned, very little performance data suitable for analysis was received.

B. Boundary Layer Instrumentation System (BLIS)

1. BLIP

Two serious faults in the test instruments were revealed during the sea trials. (1) The packaging of the BLIPS was not sufficiently water tight and in severe wind driven rain conditions, about one quarter of the instruments developed leaks which affected performance. We knew we had to repackage the electronics in any case for the final models, so the sea trial experience was very helpful in pointing out the areas of greatest water ingestion potential. (2) The wind direction sensor and logic system failed to produce good wind direction information about half the time. Most of the problem resulted from trying to use the magnetic circuit in the presence of the large mass of iron in the ship. The BLIS packages had a minimum amount of time on the balloon tether at some distance from the ship. A worst case analysis has shown the design to be too marginal for a practical instrument which must operate in a wide variety of conditions. This design deficiency has been corrected.

It is very unfortunate that the sea trials have not yet produced any data through the PODAS which we can use to analyze BLIP scientific performance.

2. Winch

The winch suffered mild corrosion problems, but a regular program of painting and cleaning appears to be the least cost and operationally acceptable fix. It is felt that except for initial cost, the present winch will serve adequately. It appears that operation can be easily handled by anyone after 10 or 15 minutes of training.

The lighted wind shelter in conjunction with a regular painting and lubrication schedule will allow for reliable operation.

3. Fairleads and Pulleys

A preventative maintenance program for corrosion protection will be required. Otherwise, the fairlead and large radius pulleys worked well. Future designs will include snatch type construction and more versatility in mounting.

4. Balloons

Although there was very limited testing of the balloon system, it appears that a Raven balloon with a 3500 ft^3 volume (Balloon 1) using a Jalbert type tail will adequately satisfy the scientific requirements. Prerigging and adequate crew training, as well as some protection against the ship's radio antennas, will be required to insure success in the program.

The balloon status telemetry package which was not used during the sea trials should be incorporated into the system. A destruct package is also desirable.

5. NOLARO Line

The present line appears to work well. Some additional thought should be given to fast splices and line repairs. Additionally, precautions such as exhibited by SSEC packing, should be applied to line being shipped. All line should be unreeled and inspected prior to use.

C. <u>SMIS</u>

1. Instrumental Buoy

From the limited testing during the sea trials, it is felt that the small spar buoy is totally inadequate to act as an instrument platform for surface measurements.

Consideration will have to be given to using a combination of boom instrumentation or BLIP type devices suspended near the surface (10's of meters) with a smaller balloon.

2. Gimballed Radiometers

Examination of the limited sample of strip chart records indicate that the passive gimbal did not provide any better data than a fixed radiometer system. It appears that to remove all ship motion, an active feedback control system utilizing a gyroscope will be required. The additional expense will probably preclude developing this type of system.

3. Humidity Measurement System

The HUMS concept attempts to measure scientifically important phenomena. Even though the HUMS deployment was unsatisfactory, the method of sensing was very good. It is felt that a workable system could be developed using the experience obtained during the sea trials; however, on direction from NOAA we have stopped all work on HUMS.

IV. APPENDIX INDEX

APPENDIX A

Chronology

The following chronology has been extracted from a log kept by the SSEC participants.

19 January 1973

1. Arrived at the NOAA ship base and inspected the facility. Then, made arrangements for a work area either on the base or aboard ship since none was available. We set up a workbench using a couple of packing crates in a warehouse. The idea was to avoid forklifts, yet have access to electricity.
2. Prepared BLIP packages for operation. Operated four BLIPs in the warehouse and telemetered data 200 yards to the ship to check-out the PODAS. All signals were received well.
3. Considerable time and effort had to be expended to obtain much of our air freighted equipment held at the airport due to a local truck strike.

20 January 1973

1. Set up five BLIPs to continue system testing. Only problem noted was that -40 dB spurious signals from the 7th harmonic of the 440 MHz BLIP oscillator were introducing noise in the OMEGA receiver when the OMEGA sonde was at long range.
2. Made a preliminary setup of the radiometer system, and worked in conjunction with Jim Shull and Monte Poindexter.
3. Preliminary check-out of the entire SMIS buoy telemetry link. After minor adjustments, the telemetry receiver was successfully integrated into the PODAS. Visual inspection of the four times data rate numbers indicated satisfactory operation.

4. After observing the condition of the ship and related support, it was becoming obvious that the 23 January, Tuesday, sailing date would slip.

21 January, Saturday

1. All BLIS and SMIS work relating to PODAS had to be terminated because all electric power was lost from the on-board motor generator (MG) sets.
2. Under the circumstances, we worked independently to organize our equipment and repair some mechanical shipping damage. We did discuss possible solutions of the 440 MHz BLIP interference problem with Jim Shull. It was decided to minimize operation when potential interference with long range OMEGA sondes would exist.

22 January, Monday

1. Using some of the test equipment we supplied, the interference problem was studied to locate its source. Appears to be a combination of low level microwatt spurs and a wide OMEGA receiver and preamplifier bandwidth.
2. Around 10 a.m., the entire shipboard MG electrical system was shut down when it was found to be producing 89 Hz instead of 60 Hz. Also, the voltage regulation was nonexistent. BLIS/SMIS stability runs were indefinitely postponed. PDP-11 computer may have been damaged.
3. Received the SAIL radiometer and proceeded to install and check-out the entire radiometer system. SAM equipment was brought from the ship for this purpose.

4. Consulted with Dr. Sparkman about the availability to 220,3ϕ power on board ship to power the HUMS pump. He said no transformers or power existed and suggested scrubbing the HUMS experiment. Not wanting to give up, purchased a number of light bulbs and sockets which would act as a variable impedance series resistor for the pump motor.
5. Verified request for the SAIL AOML 390 MHz balloon status telemetry receiver we were promised in a letter dated 11 December from NOAA, since it had not been received.
6. Worked with Poindexter on preliminary assembly of the HUMS intake system. Repaired some shipping damage.

23 January, Tuesday

1. Stumbled upon a meeting between NOAA and GE personnel related to sea trial planning. Although not specifically invited, decided to sit in and learn about what was planned.

   The meeting primarily consisted of a technical report by Jim Shull, describing the dockside BLIS and UAM tests. As a summary, Jim Shull remarked, "Nothing yet has bothered BLIS." In addition, he noted that because of the MG failure parts were being flown in which will result in a new sailing time of 1430 EST, 25 January, Thursday.

   Jim Shull recommended, a meeting every evening to serve as a 24 hour in advance planning session. The chief scientist and test conductors should be present. Based on this on the dockside tests he felt that, "fair chance of 80% success for the test objectives."

This turned out to be the first and <u>last</u> meeting concerned with orderly planning or conduct of the sea trials so far as we know.

2. Since ship power was down all day, we continued to work with the radiometer system and its SAM interface. The unit from Eppley purchased by SSEC arrived, and we picked it up at the airport.

<u>24 January, Wednesday</u>

1. Got together with Dr. Sparkman and went over the equipment list (Appendix D) to insure all components of the BLIS system had been accounted for. Except for some minor hardware items NOAA was to supply, all was in good order.
2. Unpacked and inspected two of the three Raven balloons. Rerolled for easy deployment.
3. Started to find and clean some work space aboard ship.
4. Started another stability run with five BLIPs, even though MG set was still not fixed. Shore based power being used. Heavy rainstorm was starting late afternoon.

<u>25 January, Thursday</u>

1. Heavy wind and rain in conjunction with salt spray resulted in three BLIPs damaged to varying degrees. Analyzed and recorded failure mode.
2. Moved aboard the ship and started to set up a lab space.
3. Set up the complete radiometer, gimbal, and umbilical system and operated into the SAM.

26 January, Friday

1. Ship finally sailed at 1500 EST.
2. Started repair on storm damaged BLIPs.

27 January, Saturday

1. Set up the radiometers on the boom. SAM was not yet operational, however.
2. Balloon 1 was laid out in the lab and partially prerigged.
3. Set up five BLIPs for a stability run on a tether line from the flying bridge. Overnight run.
4. Continued repair work on damaged BLIPs.

28 January, Sunday

1. Rumors to the effect that there will be a balloon launch. BLIPs were prepared for a test.
2. Continued with BLIP stability runs.
3. Worked with Monte on SSEC buoy assembly and rigging. Set up buoy telemetry link. However, buoy was not deployed, nor was a balloon launched.
4. Fixed Shull's broken BLIP simulator.
5. Worked on attaching thimbles to NOLARO.
6. PODAS and SAM completely out--resulting in no data from either the BLIPs or radiometers.

29 January, Monday

1. Due to a combination of poor weather and inoperative PODAS, very little testing accomplished.

2. Spent the day repairing BLIPs and studying the SAM RFI problem. Status report at end of day, all BLIPs operating except the unit that was damaged by some person when it was removed from the tether line during the night.

<u>30 January, Tuesday</u>

1. Set up a BLIP and buoy stability run even though the ship's computer is not working and the buoy DECOM is dead.
2. Continued BLIP repairs and failure mode analysis based on stability runs.
3. No work on balloon flying today. All work is independently coordinated among ourselves and Jim Shull.

<u>1 February, Thursday</u>

1. Gene Page, NOAA employee, separated a shoulder--which resulted in a trip into Nassau. Arrived at 1430 EST. The entire NOAA/AOML group also got off since they had apparently completed their work.
2. Buoy and BLIPs still operating from yesterday. Continued stability run.
3. Continued work on the HUMS system. Demonstrated a workable power system for the pump.
4. Buoy umbilical was severed accidentally during handling. Required considerable work to put back into service.

2 February, Friday

1. Another injury, R. Dorsett fell out of his bunk--producing facial lacerations. Steamed close to Miami where a Coast Guard cutter picked him up.
2. Continued BLIP and buoy stability runs.
3. Work on HUMS suspended while we were directed to work on the radiometers and buoy.
4. We were instructed to launch a buoy on 30 minutes notice. There were two launches because the rigging on the first launch was too heavy. After deployment and recovery, work on buoy to improve joint seals.
5. Finished rebuilding and repairing the radiometer system.

3 February, Saturday

1. Worked on aerodynamic pressure balance of the radiometer system.
2. Tested the HUM in the lab.
3. Started to work on bow deck deployment of the HUMS. Working in conjunction with the ship's crew we were able to resolve the power problems for the HUMS.
4. Another buoy test. Sparkman's buoy also deployed.
5. Noise (unknown origin) still invalidated much of the radiometer data. The PDP-11 computer system down time interferes with tests.

4 February, Sunday

1. Continued working with Shull on BLIP stability tests.
2. We were instructed to deploy Balloon 1, and it was launched about 1615 EST. Dr. Sparkman had some question as to whether

or not to fly BLIPs. He decided to fly only one. The destruct package and balloon status telemetry was not used.

3. Some work was done on the winch corrosion to minimize level wind binding.

4. Twenty minute checks with a spotlight were used to verify the balloon status. The one BLIP on the balloon tether was the only unit set up that night for a stability run. Good signals and data were received.

<u>5 February, Monday</u>

1. Worked with Shull in tracing down the reason why weak BLIP signals were being received. Determined the BLIP shelter mounted preamplifier was all but dead.
2. Ran Balloon 1 out to full altitude before bringing it in.
3. Started to work with Balloon 2, but learned that two of the four bridle patches were inverted.
4. Completed HUMS deck wiring.
5. BLIP and radiometer data now being recorded most of the time.

<u>6 February, Tuesday</u>

1. Deployed the Jalbert balloon and four BLIPs thereon. Obtained data for both the BLIPs and altitude information on the Jalbert. Balloon brought in at 1930 EST with considerable difficulty as a result of a loss of stability from loss of helium.

2. Started to deploy the HUMS, but the air intake pipe broke--which was then fixed for an attempted check in the morning.

3. Started packing and securing equipment for movement off the ship.

7 February, Wednesday

1. Deployed the HUMS air intake system. Only photographic studies could be made.
2. Continued to pack equipment.
3. Arrived at Miami at 1215 EST. Rest of day was used in organizing the move off the ship.

8 February, Thursday

1. Working with the crew directly. Unloaded our equipment before noon and succeeded in getting an air freight shipment out by late afternoon.

9 February, Friday

1. Obtained some radiometer strip charts from Monte Poindexter. Discussed the results. Also, he asked for the buoy so he could do some experimentation.
2. Finished packing and obtained a truck pickup for the rest of our materials after obtaining instructions on which equipment goes to SSEC and which goes to NOAA.
3. Left Miami at 1800 EST for Madison.

APPENDIX B

GATE SEA TRIALS

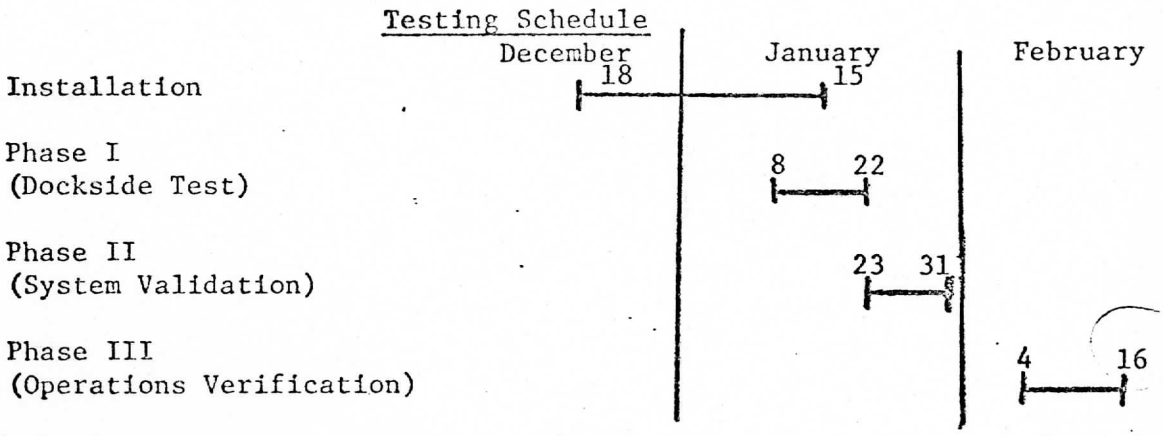
TEST PLAN

GATE Project Office
National Oceanic & Atmospheric Administration
Environmental Monitoring & Prediction
6010 Executive Blvd.
Rockville, Maryland 20852

Table of Contents

PURPOSE & SCOPE

This document presents the overall requirements and schedule for the GATE Sea Trial testing program aboard the NOAA Ship DISCOVERER. It defines the subsystems involved in this test and describes the activities to take place in each test phase.



NASA/MTF will generate detailed test procedures based on the requirements delineated in this document.

Phase II and III of the GATE test program will be conducted concurrently with the EQUAP [Equatorial Atlantic Plate] project. A detailed operations pla for EQUAP is contained in the Project Instructions RP-1-DI-73 EQUAP.

AREAS OF RESPONSIBILITY

NASA/MTF is responsible for installation of all electronic systems, as defined in Exhibit "A" Requirements Document 3 July 1972, for the Portable Data Acquisition System (PODAS). This includes, securing electronic racks to NOAA prepared foundations, all inter and intra rack cabling, all signal cable runs from SAM's to the recording systems, all power cabling from electronic equipment to circuit breaker distribution panels or power recepticles. It is NOAA's responsibility to provide: a precision power source for the PODAS system (25KW Motor-Generator (M-G) Set), all power cabling from the ships service diesel-generator to the M-G Set, cabling to a distribution transformer and distribution panel with suitable circuit breaker protection provided in the line. In addition NOAA will provide ships service power to the PODAS utility outlets.

NOAA will also supply all mechanical foundations for winches, shelters, racks, etc., as required by the system design. For the Below Deck Data Recording & Processing System NOAA will provide all necessary air conditioning ducts and furthermore, NOAA will provide and install, on a non-interference basis, a disk cartridge system for the PDP 11/20 Computer being furnished by NASA. This installation will take place at the Miami ship base during the installation period.

Shipment of the PODAS from MTF to Miami is NOAA's responsibility. By mutual agreement, NASA will arrange for the shipment of PODAS and NOAA will provide the necessary funding. NOAA will provide a staging and ware house facility at its Miami shipbase and will receive the equipment shipped from MTF at this location. NOAA will provide fork-lift and crane service for getting the equipment from the storage facility onto the ship.

The EM Systems Engineering on-site representative will direct the NOAA efforts during the installation phase. Due to the short time period allowed for installation and the uncertainties that preclude precise planning of manpower, space and equipment availability, a detailed installation plan is not practical. The following will be used as a guideline for installation priorities. (In order of priority)

1) Power System
2) Below Deck Data Recording and Processing System
3) BLIS flight equipment
4) UAM and BLIS shelters
5) Towed Sensor Package
6) Surface Meteorological Buoy
7) Subsurface Oceanographic Sub-system w/Rosette Sampler
8) Radiation Boom
9) Ship's System
10) Manual Input Data

Figure I shows the approximate locations of the subsystems aboard the DISCOVERER. The following paragraphs discuss each of the above measurement systems, defines their location aboard ship and establishes their interface into PODAS.

OBSERVED AND RECORDED PARAMETERS

The following is a list by subsystem of observed and recorded parameters for the GATE Sea Trials.

Radiation Boom

- Incident Solar Irradiance - MOD.PSP Eppley Upward Facing Pyranometer (Gimballed)

FIGURE 1

EQUIPMENT CONFIGURATION — SHIP SYSTEM—GATE PROTOTYPE TEST

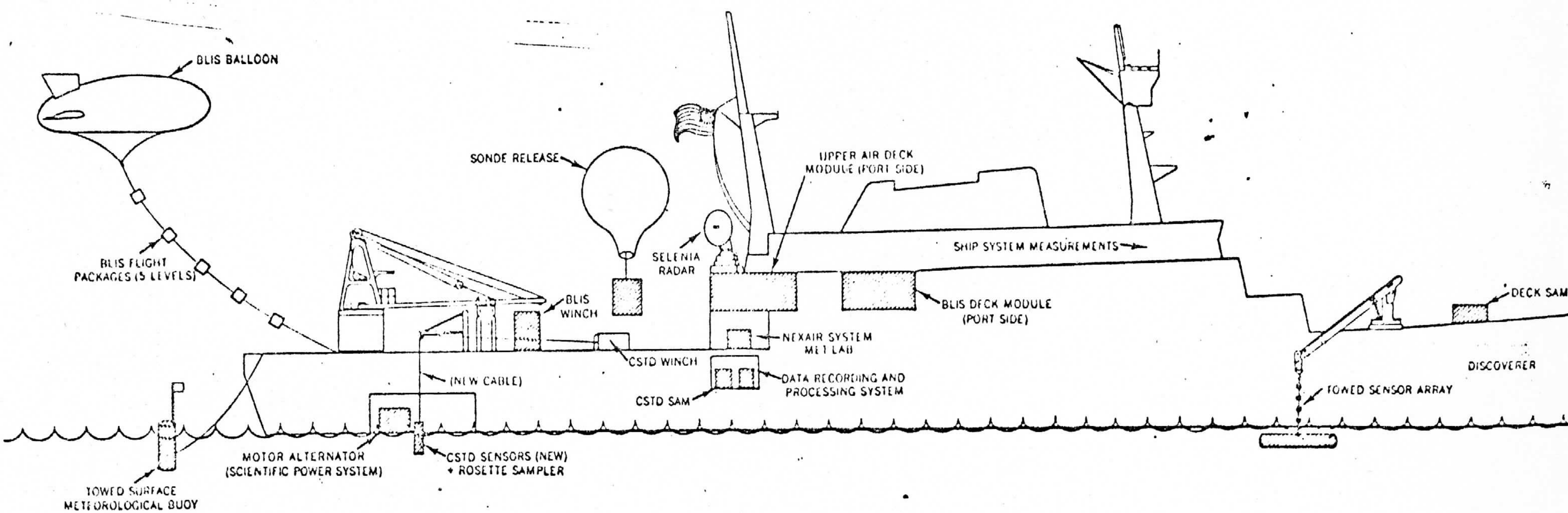
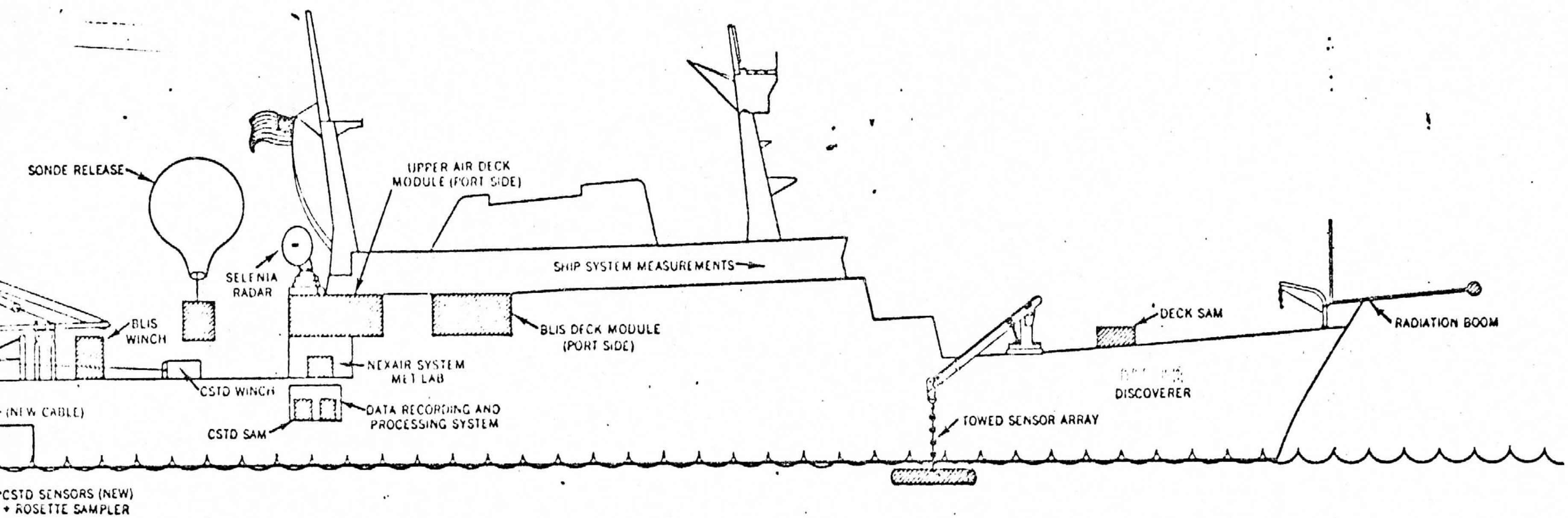


FIGURE 1

EQUIPMENT CONFIGURATION — SHIP SYSTEM—GATE PROTOTYPE TEST



- Reflected Solar Irradiance - MOD.848 Eppley Downward Facing Pyranometer (Gimballed)
- Net Solar and IR Irradiance - Funk Net Radiometer

The Radiation Boom Sensors will interface into the PODAS system at the (Surface Meteorological Subsystem) Deck SAM.

UAM System

- Sonde Retransmitted Omega Position
- Sonde Meteorological Data (Temperature, Humidity, Pressure, Reference)
- Local Omega Signal
- Paper Tape Calibration Data
- Manual Input Data (Thumbwheel Switches)
- Time of day

BLIS System

- 5 levels of BLIS packages each package measuring and transmitting:
  - Package tilt angle
  - Wind direction
  - Wind speed
  - Dry bulb temperature
  - Wet bulb temperature

Package identification word

WINDAV electronic's temperature

Atmospheric pressure

Pressure reference

Pressure electronic's temperature

Synchronization word

Surface Meteorological Buoy

- Wind speed
- Wind direction
- Pressure
- Dry bulb temperature
- Wet bulb temperature
- Sea surface temperature

The buoy will be tethered to the ship and transmit the above data to the ship on a 415MHz RF link. The serial PCM data will be recorded on the UAM PCM Raw Data Recorder.

In the absence of the listed sensors, the buoy will be equipped with fixed resistors to simulate sensor inputs to the buoy telemetry system.

Towed Sensor Package

- 3 levels of wet bulb temperature
- Sea surface temperature

The towed sensor array will be deployed using the hydraulic crane located forward on F deck. The sensor outputs will interface to the PODAS system at the SMS forward deck SAM.

Subsurface Oceanographic Subsystem

• Salinity	Plessy 9040C System
• Conductivity	Plessy 9040C System
• Temperature	Plessy 9040C System
• Depth	Plessy 9040C System
• Rosette trigger signal	General Oceanics
• Rosette bottle number	Rosette Multi-Sampler (12 bottles - 1.7 liters/bottle). Three bottles will be equipped with a resersing thermometers for CSTD temperature verification.)

The subsurface signals interface with the PODAS at the subsurface SAM, which will be located in the computer room.

Ship System Measurements

- Ship's heading
- Ship's speed
- Barometric pressure (Rosemont Sensor)
- Barometric pressure (Kolesman Sensor)

These measurements will interface into PODAS via the manual data input SAM located in the computer room.

Manual Input Data

- Rainfall amount*
- Ship Position
- Sea state
- Ceiling height
- Ship direction
- Ship speed

- Sea surface temperature
- Visibility
- Swell direction & height
- Weather
- Pressure
- Pressure tendency
- Barometric pressure* (Kolesman Sensor)
- Cloud type and amount (middle, low & high)
- Atmospheric temperature
- Dew point
- Wet bulb
- Wind direction
- Wind velocity (indicated gusts)

These measurements will enter the PODAS via the Manual Data Input SAM located in the Computer Room. All measurements except those with a * will be transmitted via ship HF radio per the enclosed communication plan. Transmissions will occur every three hours.

PHASE I TEST PROGRAM

Phase I is the Dockside Test Program and is expected to start as soon as individual systems or sub-systems come on-line after installation. The test period is projected to start approximately 8 January 1973 and continue thru completion on 22 January. The purpose of this testing is to insure end to end system operation by sequentially verifying the operation of discrete system components.

The following items will be validated for each sub-system.

- Mechanical installation and mountings
- Electrical power cabling and connections
- Electronic wire-runs inter-connections and terminations
- Sensor signal cabling and connectors
- Sensor signal simulation and data transmission
- Sensor signal simulation and data recording
- Sensor signal simulation and data processing
- Sensor operation

Power System Dockside Test

A new precision power system will be installed aboard the DISCOVERER for GATE and will provide precision, noise-free power to the scientific equipment. The following procedure will be used to checkout the system operation.

— Validation of Motor Generator foundation, shaft couplings and fly wheel alignment, control location, control cabinet size, location and mounting; and lubrication levels.

- Using figure 2, validate cable runs and connections from the ship's service generators to the M-G Set, the M-G Set to the distribution transformer, and the distribution transformer to the distribution panel.
- Validate M-G startup by following the vendor supplied procedures, which will include a current limiting program so as not to over load ship's service generator. After the M-G Set is brought up to speed provide approximately a 10KW load for the M-G Set to work into. The 10KW test load should be made up of several smaller resistive and inductive loads of approximately 2-3KW each. During tests these loads should be cycled on and off and the resultant voltage/frequency variations should be monitored.
- After M-G start up the strip-chart recorders for voltage and frequency should be verified for accuracy by comparison with suitable test instruments.
- With power applied to the distribution panel each circuit should be checked for presence of power and a check should be made as to presence of high speed transients and other noise on the power line that could be associated with poor electrical connections somewhere in the cable run.
- Operate the power system for at least 24-hours under cycling load conditions before any non-expendable electronics are connected.
- Check for adequate heat dissapation in the room where the M-G Set is located.

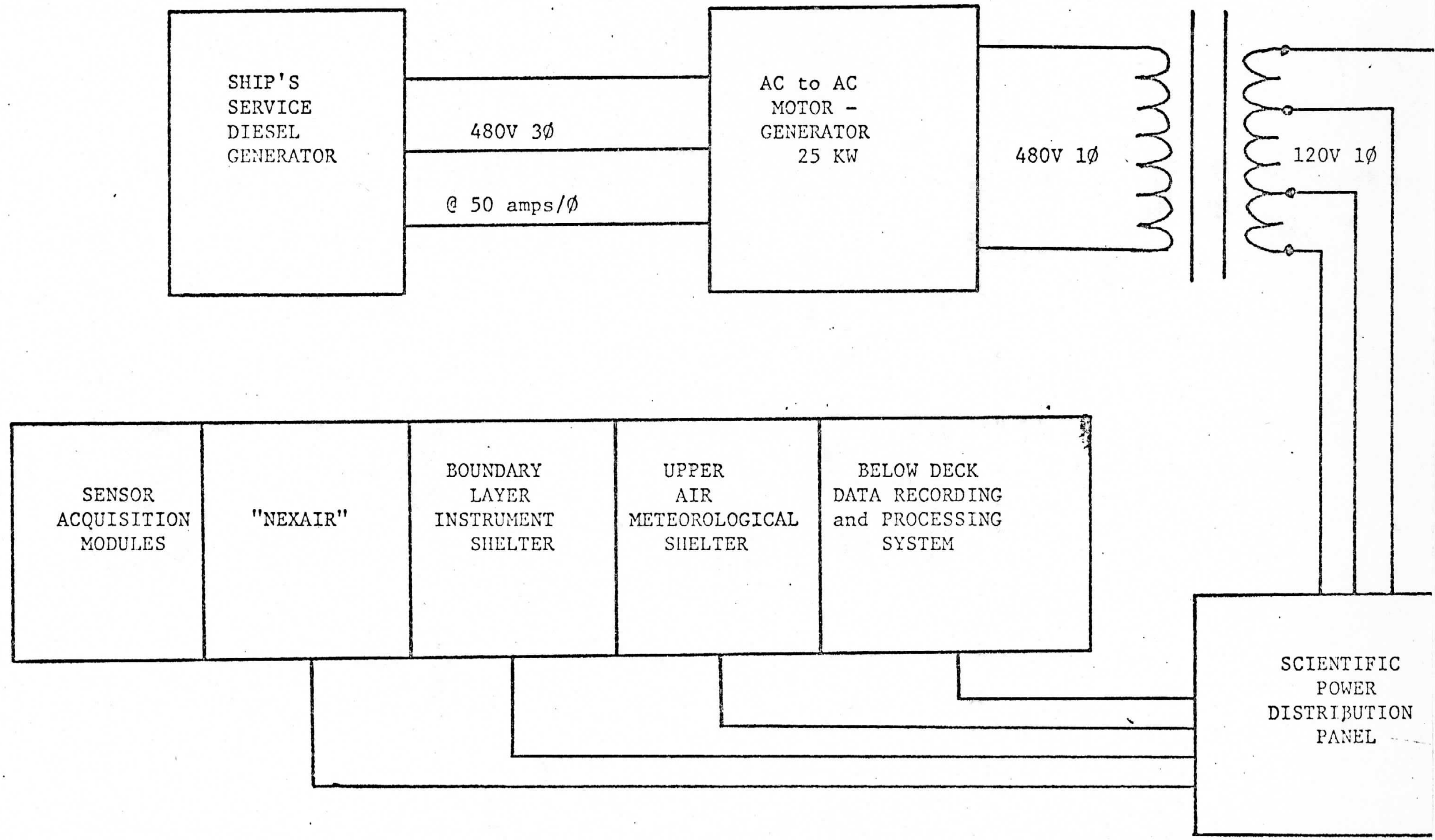


FIGURE 2: SCIENTIFIC POWER SYSTEM FOR NOAA SHIP DISCOVERER (GATE PROJECT CONFIGURATION)

Below Deck Data Recording and Processing System Dockside Test

The Below Deck Data Recording and Processing System provides a central recording and processing facility for the GATE PODAS System. System checkout will be accomplished as follows:

- Validate mechanical installation including shock mounting of the equipment racks on the prepared foundations; verify operation of all front access equipment drawers and draw retainers and validate equipment rack grounding procedures.
- Validate rack power cable run to the distribution panel for connection & circuit breaker protection.
- Validate computer and peripheral equipment cable connections.
- Validate Raw Data Recorder, decom, DR-11A cable connections
- Energize equipment and run Main DEC Diagnostic Programs for the PDP 11/20.
- Upon satisfactory completion of the computer diagostics a Raw Data test tape with known parameter values should be loaded onto the tape deck and played back through the decoms to the quick-look display. Subsequent to this the computer will be required to acquire the decoms and re-record the test tape onto a digital tape. A second digital tape containing the same information as the Raw Data test tape should be provided. The computer will perform a bit by bit comparison of what

should be written on the digital tape, as created by playing the Raw Data tape through the system, versus what was actually written on the Raw Data tape. The Raw Data tape speeds should vary from the real-time rate to a time compression rate of 16:1 real time.

— After validation of the Recording and Processing system hardware and acquisition software, the Below Deck System may be considered operational. At this point signal cables from the SAM's, BLIS & UAM can be connected into the recording system.

BLIS Flight Equipment Dockside Test

The BLIS Flight Equipment Test will validate the following:

— Placement of foundations for the BLIS Winch, snatch block, and fairing lead.
— Power cable runs to the BLIS winch.
— Adequate grounding of the winch structure, including the drum.
— Manifold operation including gas leak check, valve operation, pressure gage operation, and filling line length.
— Establish grounding of helium tanks to the deck by means of a ground strap.

BLIS, Ground Receiving and Processing Equipment

The BLIS Ground Equipment is contained in a 7 ft. x 7 ft. x 7 ft. (inside dimensions) Shelter Module and will be located on "G" deck port side of the DISCOVERER. The equipment receives BLIS signals from the five BLIS Sondes, displays the status of the flight equipment and processes the signals into a serial PCM/FM wave train. The BLIS Ground Equipment Test will validate the following:

- Shelter installation and foundation, as specified in installation drawings.
- That no mechanical damage has occured to the equipment racks or their foundations during shipment.
- Installation of the power cabling for both utility, and scientific power. Inspect the power cable feed-through into the shelter for proper mechanical connections to insure water tight and RFI integrity.
- Inspect the inter-rack wire runs and associated connectors for possible shipping damage and loose connections.
- Validate the signal cable runs from the BLIS shelter to the Below Deck Recording System. Special attention must be paid to shield grounding at the data recording area location.

Testing of the BLIS electronics can begin as soon as the air conditioner has brought both the temperature and humidity in the shelter within acceptable limits. The BLIS electronic test will be conducted on 3-levels:

- Tests using the internal BLIS simulator

- Test using the BLIS flight package simulator
- Test using the BLIS airborne packages.

The BLIS internal simulator provides a simulated BLIS input signal to the time division multiplexer. For the first level test a pre-selected number pattern will be set into the simulator and the time of day must be observed when the number is set into the simulator This predetermined number pattern and time display should be verified on the BLIS status display panel.

The PCM/FM output from the time division multiplexer will next be routed to the data recording sub-system, and the following tests will be run.

- The BLIS flight package simulator will be used to validate operation of the BLIS receivers. A predetermined data pattern will be set into the flight package simulator and transmitted to the BLIS receiver, verified on the display panel, and recorded on the Below Deck Recording system. It is extremely important that the flight package simulator test be conducted with ship communication, navigation, the Selenia Radar and the ship search radar operating as closely as possible to normally expected conditions. Under these simulated conditions the flight package simulator frequency should be slowly veried to ascertain allowable drift rates and high noise regions.
- The first two levels of testing should be performed as soon as it is operationally feasible. The third level of testing with the actual BLIS transmitters should

take place as soon as these transmitters are available. This test would consist of remotely locating the transmitters and again under simulated ship's RF environment, receive the transmitted signals and record them on the Below Deck Recording System. As the data is recorded the Engineering Units (E/U) conversion routines can be utilized by the computer to give a print out in near-real time of the 5 channels of BLIS data. This print out can then be used to compare one BLIS package against the other for reasonable accuracy and verification of the E/U conversion program.

As an additional test each BLIS package will be placed in the Base Line Box and validated for stability and accuracy. The results of this test should be recorded and played into the Data Recording and Processing system as further validation of the computer software for the BLIS system.

Upper Air Meteorological System (UAM) Dockside Test

The UAM Ground Electronics System, is contained in a 7 ft. x 7 ft. x 7 ft. (inside dimensions) shelter module and will be located aboard the ship on "G" deck port side. The system receives Omega and meteorological signals from a sonde, processes and formats the data into a serial PCM/FM signal which may be recorded within the module or cabled to the Below Deck Recording and Processing System. The Dockside Tests will validate the following:

—Shelter installation and foundations, as specified in the installation drawings.

—That no mechanical damage has occured to the equipment racks or their foundations during shipment.

—Power cabling for both utility and scientific power has been correctly installed.

—Inspect power cable feed-through into the shelter for proper mechanical connection to issure water tight & RFI integrity.

—Inspect the inter-rack wire runs and connections for possible shipping damage and loose connections.

—Validate the signal cable run from the UAM shelter to the Below Deck Recording System; special attention should be paid to the shield ground location.

Testing of the electronics can begin as soon as the air conditioner has brought both the temperature and humidity in the shelter within acceptable limits. UAM will be demonstrated using internal simulators,/ direct/OMEGA transmissions, and NOAA furnished meteorological radiosondes which will be equipped for OMEGA retransmissions. UAM/OMEGA Test Configurations 1 through 5 (depicted in Figures 3 thru 7), UAM/MET Test Configurations 1 and 2 (depicted in Figures 8 and 9) and the overall UAM Subsystem Test Configuration (Figure 10) will be run during the UAM Dockside test. For each of the tests, CEDDA will provide a numerical test identification code which will be recorded on the tape using the manual data input; in addition "voice log" will be used as appropriate in the UAM shelters. It is extremely important that throughout the UAM tests the ship's communication, navigation, and search radar equipment, in addition to the Sekebia Radar be operating as closely as possible to normally expected conditions.

UAM/OMEGA Tests

The two Omega channels will be initially demonstrated by using the internal Omega simulators (see Figure 3 ; UAM/Omega Test Configuration 1). The simulators, which are built into each of the Omega preprocessors, have the capability of simulating any two of eight Omega ground transmission stations. The output of the Omega preprocessors can be monitored on front panel displays. In addition, the analog outputs can be displayed on two dual-channel strip-chart recorders and checked for accuracy in this manner. A pre-selected set of simulated input data will be inserted into the preprocessors during the Dockside Tests. This input will be selected to fully exercise a representative number of combinations of two station inputs. The output of the preprocessors, which is a multiplexed PCM/FM signal, will be routed to the Below Deck Recording System.

To further test UAM/OMEGA, the Omega antenna will be located on the ship such that it may receive the 13.6 KHz-Omega signals which are being radiated from the land based Omega transmission stations (see Figures 4 through 6; UAM/OMEGA Test Configurations 2 through 4). The Omega signals will be routed from the antenna through a pre-amp to a 13.6 KHz Omega receiver (which consists of a distribution amplifier and RF amplifiers). In UAM/Omega Test Configuration 2 (Figure 4) a single Omega channel will be utilized. In UAM/Omega Test Configurations 3 and 4 (Figures 5 and 6) the common Omega signals are connected to both channels. In the first case (Figure 5) the Omega signals are routed from the preamplifier through a common distribution amplifier and to the inputs of two separate RF amplifiers. The outputs of the RF amplifiers are routed to the two Omega Preprocessors. In the second case (Figure 6) the Omega signals are routed from the preamplifier through a common distribution amplifier and a common RF amplifier and then to the two Omega Preprocessors.

A minimum one hour data acquisition cycle will be run for each test configuration depicted in Figures 4 through 6 In UAM/Omega Test Configurations 2 through 4, the UAM/Omega subsystem is tracking a fixed target. Data resulting from these test configurations should indicate a zero condition, because of the fixed target, with any registered value reflecting a basic condition indicative of atmospherics, subsystem noise and/or diurnal phase shift. Since identical inputs will be applied to both of the Omega preprocessors in Configuration 4, the output data from each channel can be compared to determine if they are equal with respect to performance. Data acquired from UAM/Omega Test Configuration 3 should reflect the presence or absence of coherent noise radiation.

In UAM/Omega Test Configuration 5 (figure 6) a 13.6 KHz signal from the Omega simulator is inserted into a vacant "station time slot" and routed to a stub antenna. The antenna may be placed in the vicinity of an Omega radiosonde or the 13.6 KHz local Omega receiving antenna. Known, phase shifts can be injected into the 13.6 KHz signal using controls at the Omega simulator panel. The 13.6 KHz signal with known phase shifts will be received and retransmitted by the radiosonde and/or received by the local Omega receiving equipment. Thus a known value will be generated at the input to the UAM/Omega subsystem. The subsystem can be evaluated on an end-to-end basis be comparing the known input to the output (data processing subsystem output). A a minimum one hour data acquisition run with the UAM/Omega connected in Test Configuration 5 will be made as part of the UAM system Dockside test.

With the hardware connected in UAM/Omega Test Configuration 4, a 24 hour stability test will be run. Data will be recorded on the Raw Data Tape Recorder periodically over the 24 hour period to provide the information necessary to assess subsystem stability. Data will be recorded on the strip-chart recorders continuously for the 24 hour period. Values displayed on the Omega Preprocessor front panel Lane Counters will be recorded manually on a periodic basis throughout the 24 hour stability test.

UAM/Meteorological Tests

The meteorological portion of the UAM subsystem will initially be tested using the simulator which is built into the meteorological preprocessor (see Figure 8; UAM/MET Test Configuration 1). The simulator will be used to test the UAM/MET subsystem with and without the RF receiver on line. In the internal operating mode the simulator will provide fixed frequency levels for reference, temperature, pressure and humidity. These fixed levels are routed to the preprocessor and in turn through the MET I/O to a multi-point recorder, a digital printer and the Raw Data Tape Recorder.

In the external operating mode a test oscillator is used to provide an input to the simulator. The reference pressure, humidity, and temperature levels and the PRF can be varied by changing the frequency of the test oscillator. Separate controls which allow each of these parameters to be switched from the internal to the external operating mode are located on the front panel of the simulator.

During the Dockside Tests data will be acquired initially with the simulator operating in the internal mode. The reference will be transferred to the external operating mode while the remaining functions (temperature, humidity, pressure and PRF) remain in the internal mode. The external oscillator frequency will be varied to the upper and lower reference limits to demonstrate that the subsystem will operate over the specified reference range. The reference will then be transferred back to the internal mode and the PRF will be placed in the external mode. The test oscillator will be used to vary the PRF within the acceptable limits to demonstrate that the subsystem will operate over the specified reference range.

With the PRF in the internal mode each of the simulated parameters (i.e., temperature, pressure and humidity) will be transferred one at a time to the external mode. The test oscillator frequency will be varied in discrete steps over the range from zero to full scale for each parameter. Temperature, pressure and humidity will then be operated in the external mode simultaneously while the oscillator frequency is varied over the engineering units range in discrete steps.

The MET data simulator will also be used to modulate an FM signal generator and thus simulate an airborne package (see Figure 9; UAM/MET Test Configuration 2). Known frequency levels for reference, temperature, humidity and pressure are routed to an FM signal generator and used to modulate a 403 MHz carrier. The RF signal generator output will then be routed to the UAM preamplifier and in turn to the 403 MHz UAM receiver. The receiver output will be connected to the meteorological preprocessor.

UAM/MET Configuration 2(Figure 9) will be used to run a stability test on the UAM/MET subsystem. The test will be run for a 24-hour period without any subsystem recalibration or adjustments. The test oscillator will be utilized to provide a fixed frequency level for the external temperature, humidity, from the land-based Omega transmission stations. Data will be processed within the subsystem in the same manner as it would be in the operational configuration in addition the paper tape reader will be used to input meteorological calibration data supplied with the sonde. Omega data will be displayed on the lane counter displays located on the Omega preprocessors and on the strip-chart recorders within the subsystem. Meteorological data will be recorded on the multipoint recorder and the digital printer. Multiplexed data from the two Omega channels and the MET data will be routed to the Raw Data Tape Recorders. The test configuration shown in Figure 10 will be used during the UAM subsystem test with the radiosonde placed at a remote location from the ship.

UAM Data Processing

Data which has been recorded on the Raw Data Tape during the UAM Dockside Tests will subsequently be played back through the PCM decoms and acquired by the computer and its associated peripherals. During this playback operation, selected data will be displayed on an O-graph and a strip-chart recorder provided for data quality validation purposes. The computer and the acquisition software programs will be used to reformat the data and transfer it to digital magnetic tape. The processing software, which is a part of the data processing subsystem, will be utilized to convert the MET data to engineering units. Calibration data that was entered through the paper tape reader will be used in the conversion process. The processing software will also be utilized to compute wind speed and wind direction from the Omega data. The resultant engineering units data will also be stored on digital magnetic tape for further use.

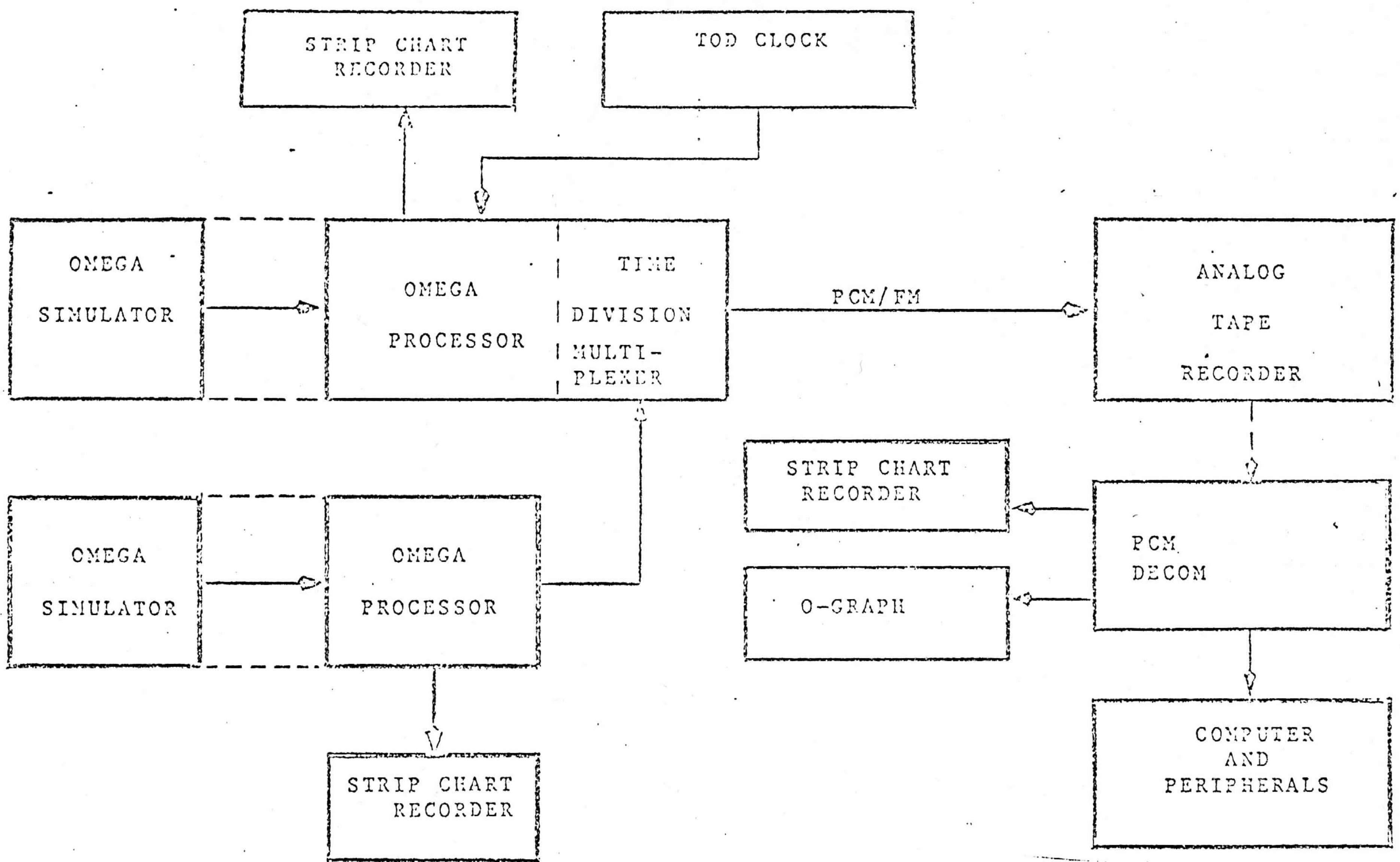


FIGURE 2 UAM/OMEGA TEST CONFIGURATION 1

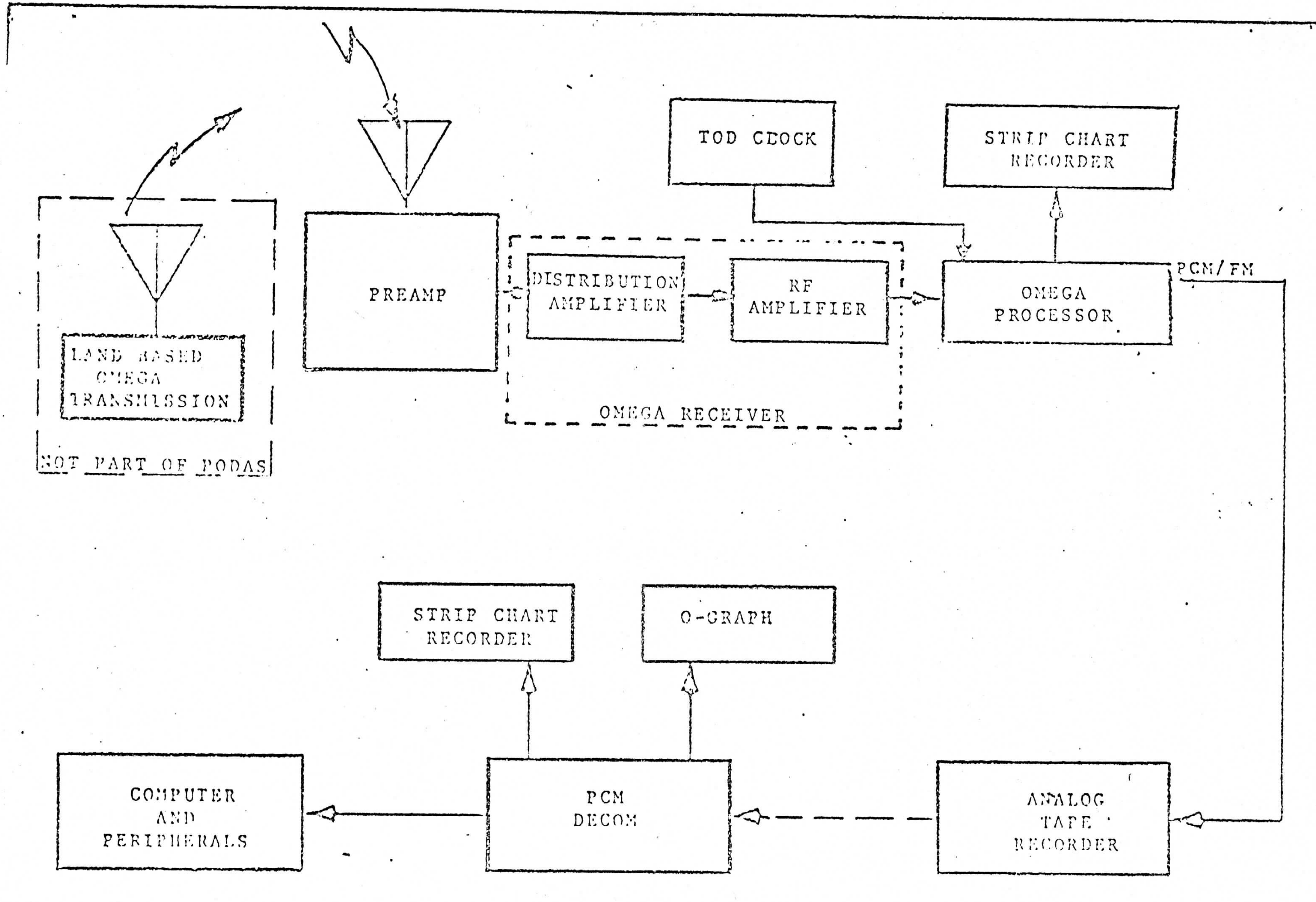


FIGURE 3 UAM/OMEGA TEST CONFIGURATION 2

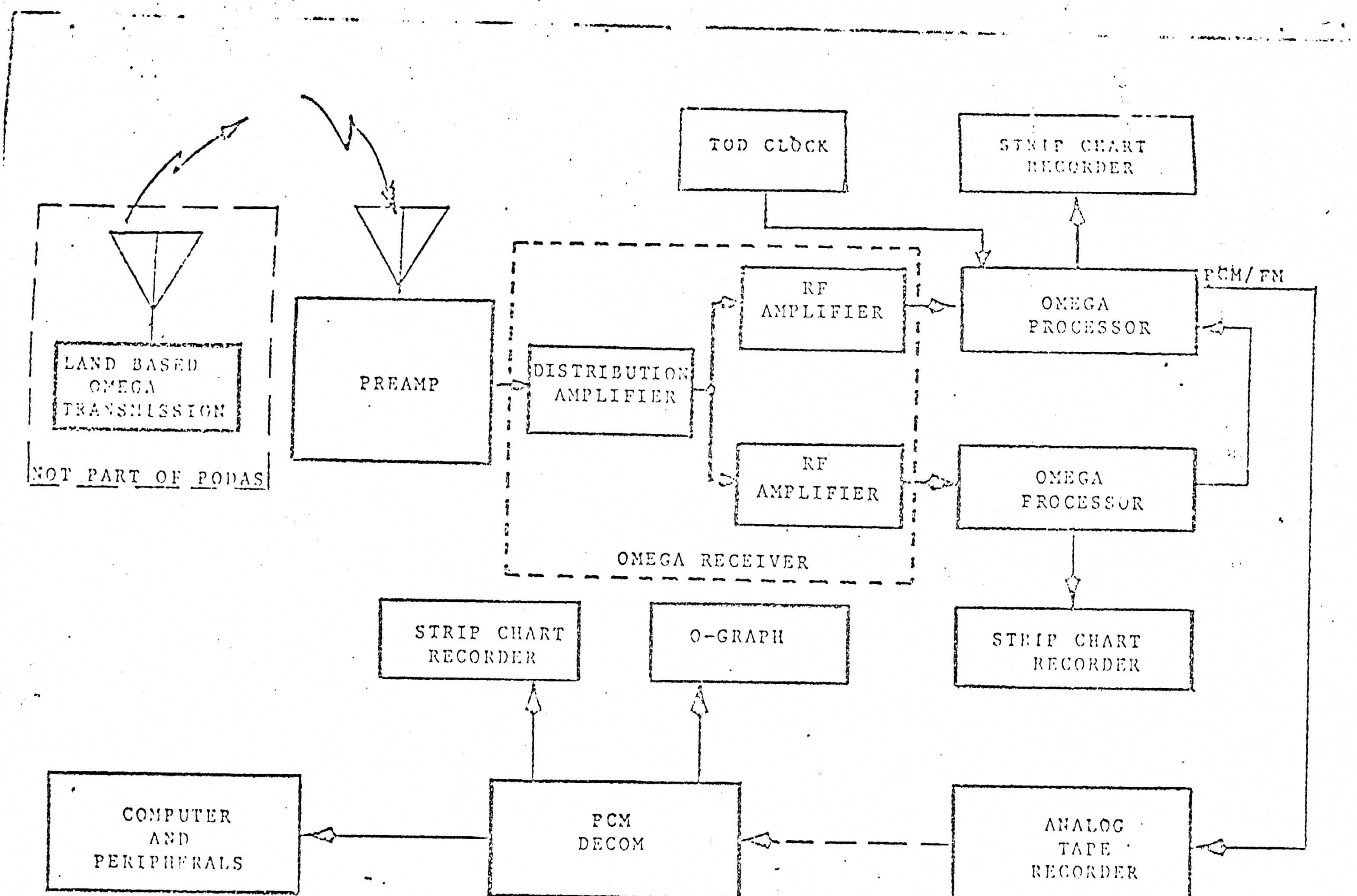


FIGURE 4 UAM/OMEGA TEST CONFIGURATION 3

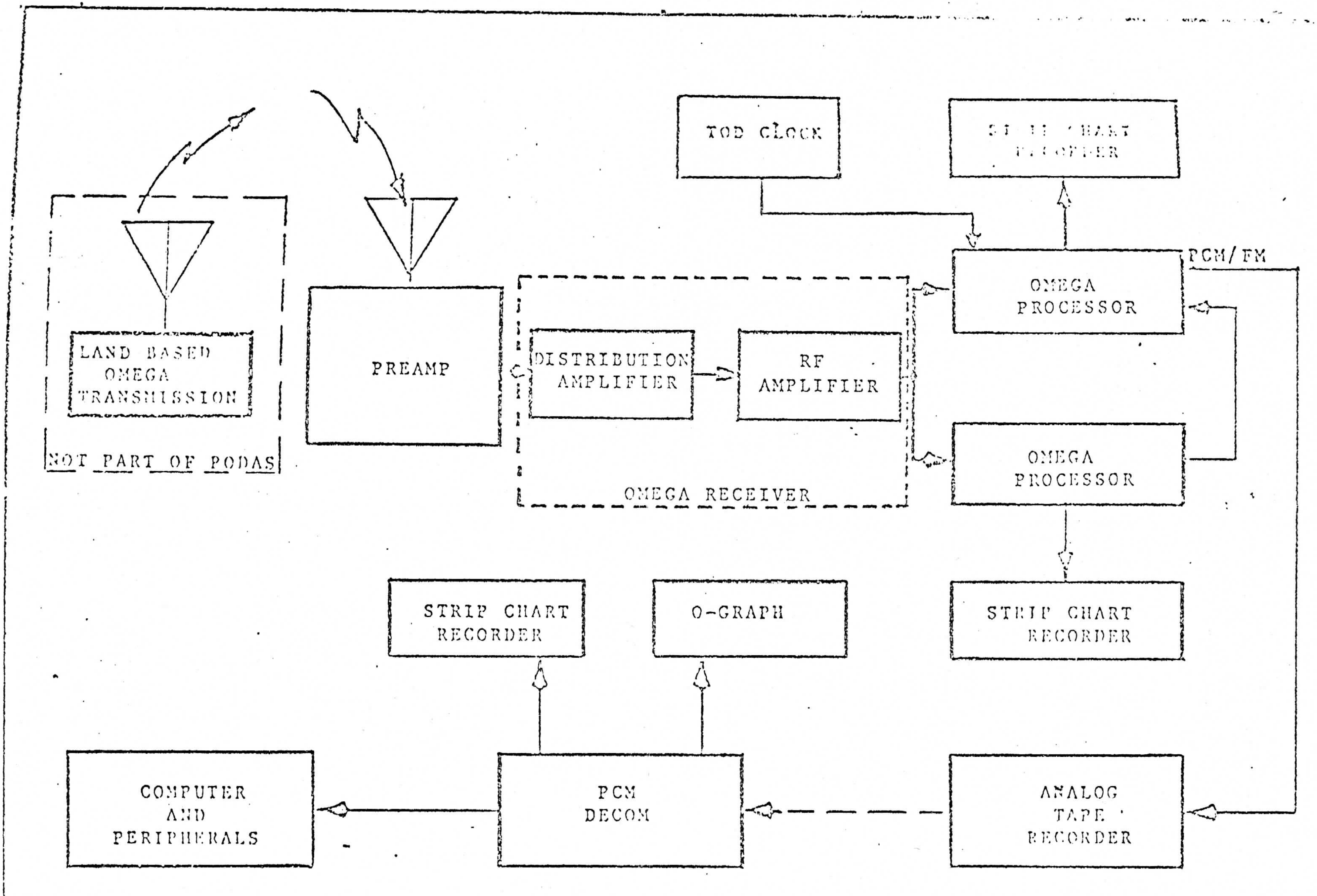


FIGURE 5 UAM/OMEGA TEST CONFIGURATION 4

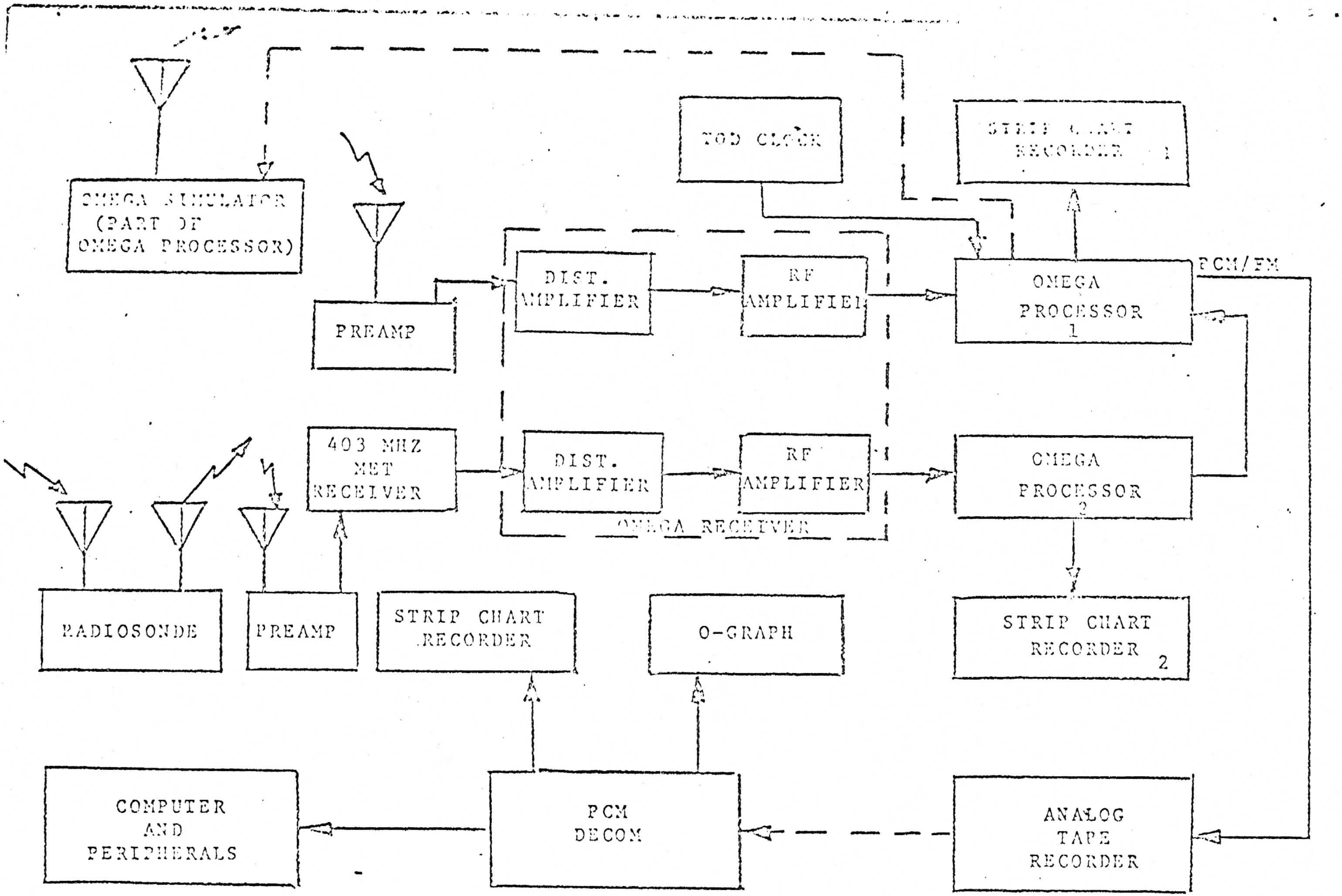


FIGURE 6 UAM/OMEGA TEST CONFIGURATION 5

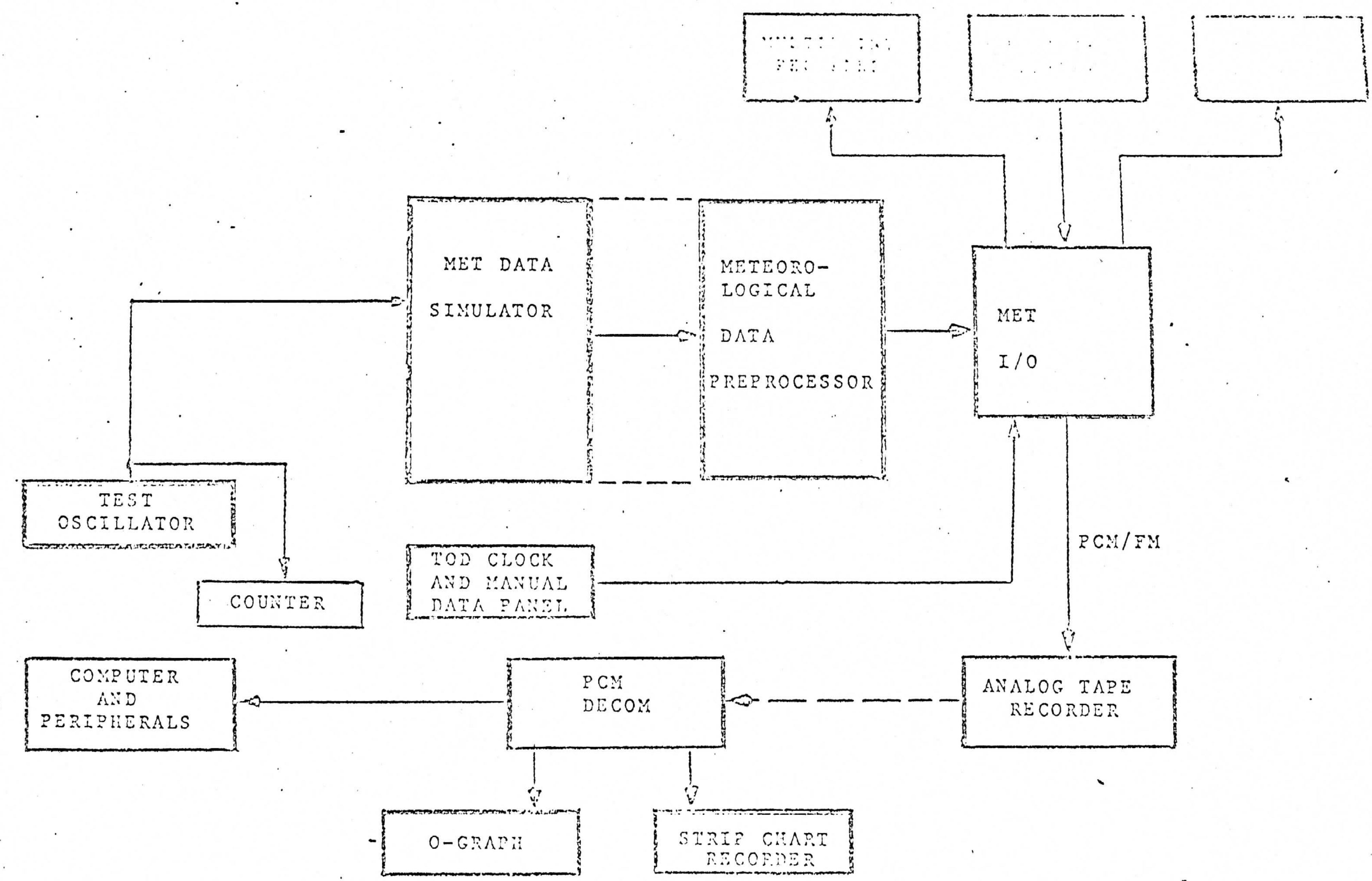


FIGURE 7 UAM/MET TEST CONFIGURATION 1

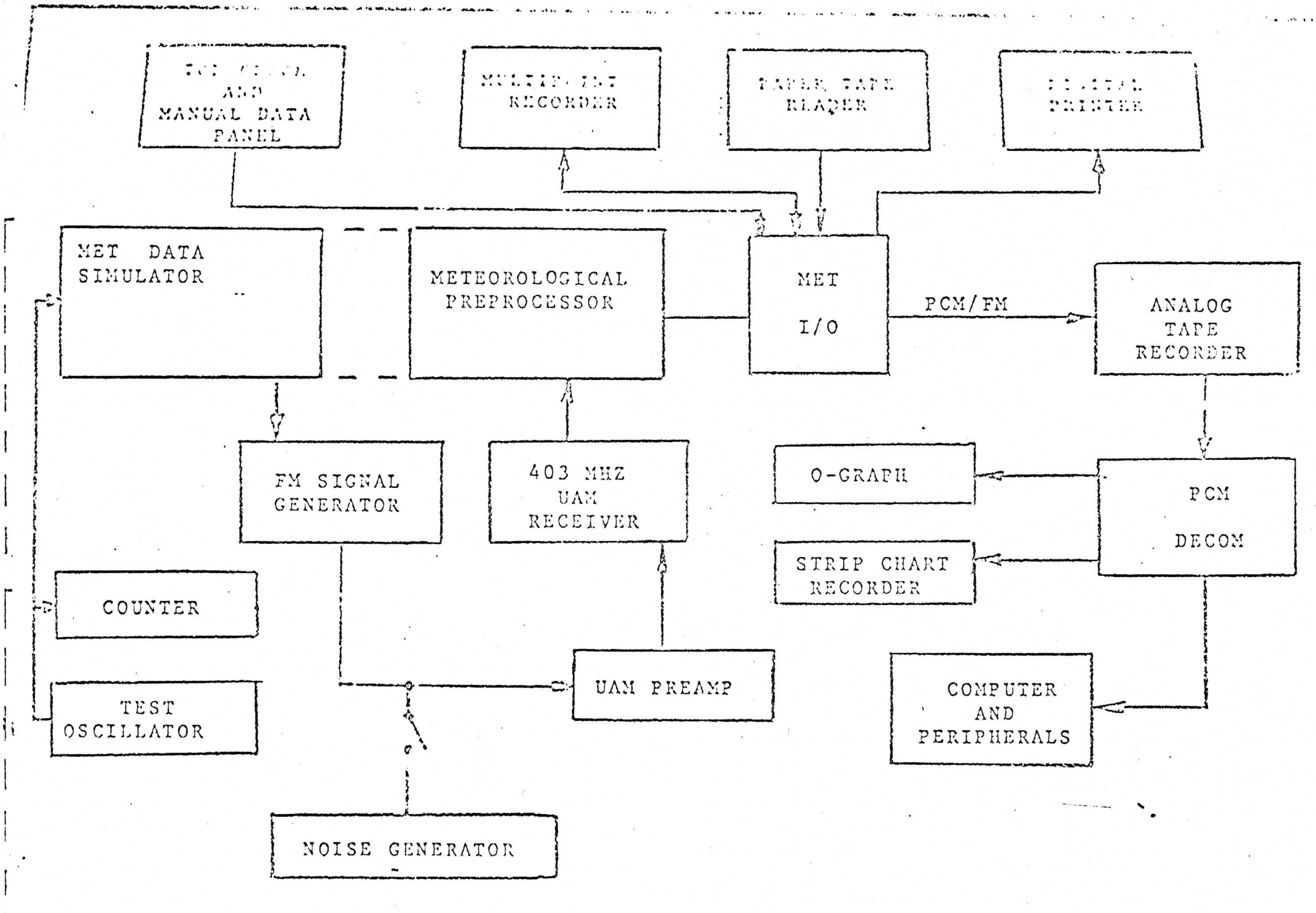
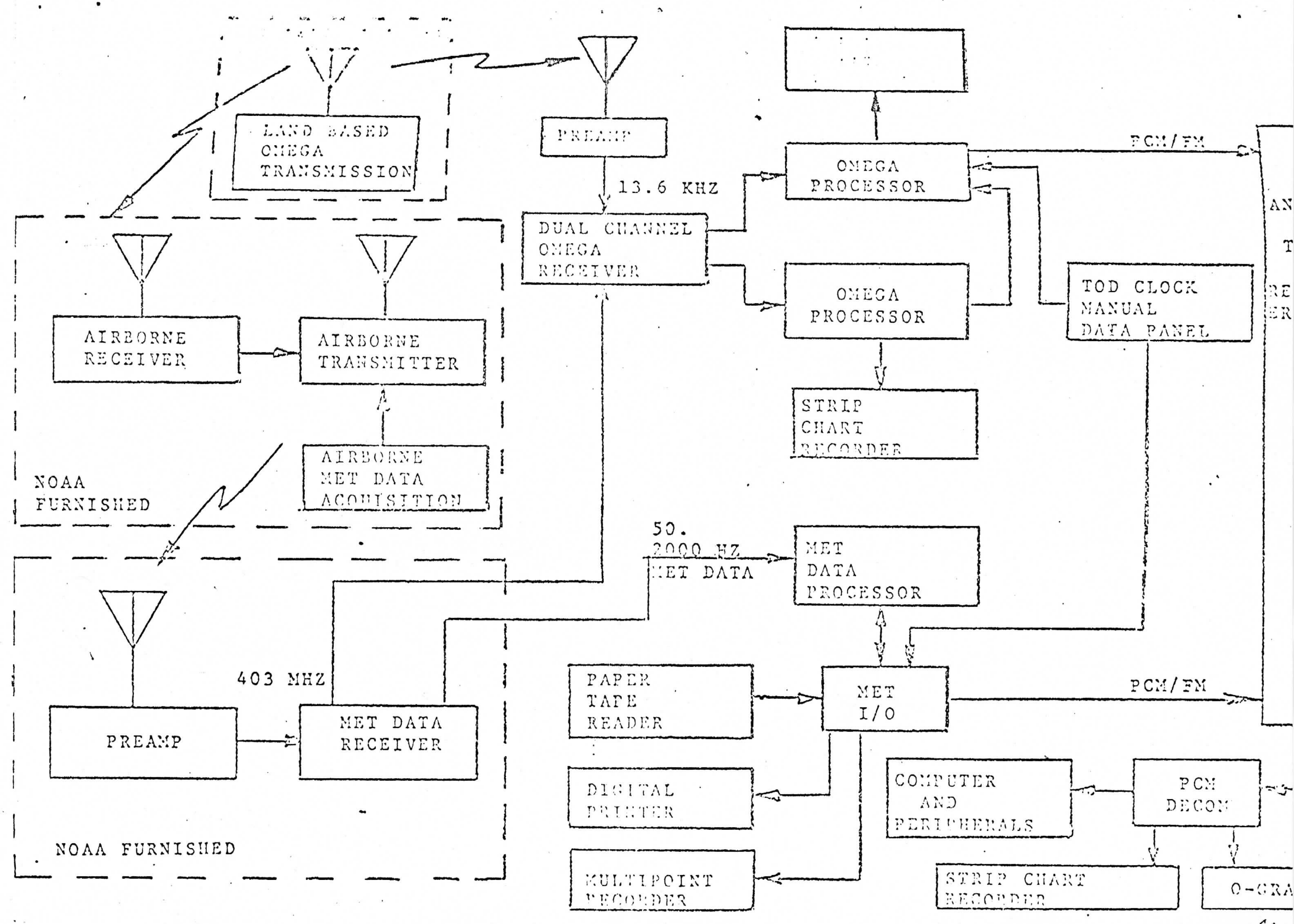


FIGURE 8 UAM/MET TEST CONFIGURATION 2



LAND BASED OMEGA TRANSMISSION
PREAMP
13.6 KHZ
DUAL CHANNEL OMEGA RECEIVER
OMEGA PROCESSOR
OMEGA PROCESSOR
PCM/FM
TOD CLOCK MANUAL DATA PANEL
STRIP CHART RECORDER
AIRBORNE RECEIVER
AIRBORNE TRANSMITTER
AIRBORNE MET DATA ACQUISITION
NOAA FURNISHED
50.
2000 HZ
MET DATA
MET DATA PROCESSOR
403 MHZ
PREAMP
MET DATA RECEIVER
PAPER TAPE READER
MET I/O
PCM/FM
DIGITAL PRINTER
MULTIPOINT RECORDER
COMPUTER AND PERIPHERALS
PCM DECOM
STRIP CHART RECORDER
NOAA FURNISHED

Forward Deck SAM Dockside Test

The Forward Deck SAM will be used to gather signals from the Towed Sensor Package and the Radiation Boom. The dockside test for the Forward Deck SAM will consist of:

- Validation of mechanical mountings for the SAM, the Electronics and Power Module.
- Inspection and validation of the signal and power cable runs from the SAM to the Below Deck Recording System and the power source.
- Using the SAM Verification and Display Module , insure SAM operation by providing a precision-voltage to selected SAM inputs and verifying the results on the display panel.
- At the same time this information is recorded on the Below Deck Recording System, acquisition will be verified on the quick look monitors in the Below Deck Data Recording and Processing System.

After validation of the forward Deck SAM operation, Dockside Testing for the Towed sensor package, and Radiation Boom may begin.

Towed Sensor Package Dockside Test

The Towed Sensor Package consists of a hydrofoil which will be held outboard on either side of the ship by the forward deck crane, with sensors attached to the hydrofoil and the towing line.

The dockside test will consist of validation of crane operation and deployment of the hydrofoil and sensor array; validation of sensor installation and cable run to the forward deck SAM.

Preliminary validation of sensor operation can be made with the SAM verification and display module. Validation of sensor operation and data transmission will be made by recording test data on the below deck data recording system and observing sensor output values on the "Quick-Look" devices of the Below Deck System.

Surface Meteorological Buoy Dockside Test

This test will validate buoy assembly and electronic packaging, ship board antenna location, mountings, and signal couplings. The test will verify the signal cable run from the ship board antenna to the receiver and preprocessor located in the BLIS Shelter and then to the Raw Data Recorder in the UAM Shelter. With the buoy on the deck of the ship, transmission of information via telemetry link can be verified by using the "Quick-Look" equipment associated with the UAM Recording System. At the same time this information will be recorded on the Below Deck Recording System and observed on the "Quick-Look" display devices.

The buoy will then be deployed in near by water and the data link will be validated in the same manner as described above.

Sub-surface Oceanographic Subsystem Dockside Test

This test will validate mechanical installation of the new CSTD cable and drum on the starboard-side oceanographic winch, insure continuity of the signal conductor and shield within the CSTD cable and measure a high impedence between signal conductors and the shield and minimum impedence thru the winch slip rings.

The electronics unit for the CSTD will be located in the computer room. Frequency signals from this unit will enter PODAS via the SAM also located in the Computer Room. Signals from this SAM will then be routed to the Data Recording and Processing System.

The electronics unit for the CSTD will be inspected for proper mechanical installation and the signal cable runs from the winch and the power cable run from the distribution panel will be validated for proper connection.

The CSTD will be energized and placed in a solution of known salinity and temperature. The signals from the CSTD will be observed on the verification and display module for the SAM as well as on the "Quick-Look" equipment of the Data Recording and Processing System. The computer will acquire the data channel on which the CSTD data is being recorded and perform an engineering units conversion which will output to the Varian Printer/Plotter. The digital tape containing the CSTD data will then be used to test the software being provided as part of the sub-surface oceanographic sub-system.

The Rosette multi-sampler must be energized during this test to validate that the noise generated in this procedure is adequately suppressed and to verify that the trip signal and bottle number signal have been recorded correctly, via the CSTD SAM, on the Below Deck Recording System.

Radiation Boom Dockside Test

This test will validate the Radiation Boom mechanical installation and mountings. It will validate mechanical mountings of the Eppley upward and downward facing pyronometers and the Funk Net Radiometer. The signal cable runs from the radiation measurement instruments to the forward deck SAM will be validated and signal transmission will be verified by the SAM verification and display module, using the Below Deck Recording System "Quick-Look" equipment.

Ship's System Dockside Test

The Ship's System parameters of ship's speed and heading will be cabled to the Below Deck SAM. Manual data measurements will also enter the system via this SAM. Ships heading data will come from a synchro to analog converter attached to the gyro-repeater in the computer room. Ship's speed data will come from the EM Log output also in the computer room. The cable runs to the SAM from the synchro to analog converter and the EM Log will be validated by the SAM verification and display module. Data transmission from the SAM to the Data recording system will be verified by the Data System "Quick-Look" displays.

Manual Input Panel Dockside Test

The Manual Input Data Panel will interface to the system at the below deck SAM. All manual data input channels will be verified by the SAM verification and display module. Validation of data transmission and recording will be accomplished thru the Data Recording and Processing system's "Quick-Look" devices.

PHASE II TEST PROGRAM

The Phase II Test Program will start when the ship departs from Miami on 23 January and continue thru 31 January terminating in St. Thomas, V.I. The purpose of this test is an initial shakedown of the equipment at sea. It is not the intent of this test to meet an operational schedule nor simulate a typical "GATE" day, but to test each subsystem to establish its performance at sea.

Phase II - Observation Schedule

Those components of the PODAS system which can be operated with a minimum of manpower and do not conflict with the EQUAP Project should be operated continuously. These would include:

- Ship System Measurement
- Radiation Boom
- Towed Sensor Package
- Manual Data Input
- Below Deck Data Recording & Processing System

The following guidelines are listed for those subsystems which cannot be operated on a sustained basis. This phase will be used to carry out initial tests on all subsystems. Priority in testing should be given to those systems in which failure may require the longest turn around time for remedial action. Subsystems with unproven reliability should, if possible, be tested for sufficiently long time periods to determine the probability of early failure in field use. During portions of the following tests, the Selenia radar, the ship's navigation radar and the ship's communication equipment will be operated to determine

RFI suceptability of the subsystem under test.

The following is a guidleline for deployment of the subsystems during the Phase II test.

— Sub-surface Oceanographic Subsystem

A minimum of 5 casts will be taken to the maximum obtainable depth. Each cast will also test the Rosette multi-sampler and a minimum of three Rosette bottles will be equipped with reversing thermometers.

— BLIS

All four BLIS balloons (3000, 2500, 2000, 1250 ft^3) will be inflated and flown to design altitude. (1500, 1200, 1000, 750M) The Selenia Radar will be used to verify balloon height. Theodolite sighting will also be used to determine balloon height and the shape of the tether line catanary. The BLIS Flight Packages will be deployed after reliability of the flight equipment is established. One or more flight packages will be deployed to establish BLIS antenna performance with varying ship headings, tether line angle, and package height.

Upper Air meteorological System

Limited manpower will restrict exercising the UAM System during Phase II. The objectives will be limited to a shakedown of procedures and assurance that the shipboard equipment is functioning properly. These objectives can be achieved by taking one observation daily at 1200 Z, the run to be tracked as far as possible. If other ship operations make it inconvenient on any given day to release at 1200, release at another time, selected by mutual consent, should be undertaken. The NEXAIR equipment should be on the same balloon train and that equipment operated also. When possible to obtain the necessary ship support, a radar target balloon will be used and the balloon tracked by radar. As a minimum, the radar should be operated in the search mode for the first 30 minutes of the observation, at 1 or 2 degrees elevation, so that susceptability of the equipment to radar interference may be determined. On at least one observation, both radar and ship's HF communications should be exercised during the run, to again to evaluate possible sources of interference. On all observations, strip chart and magnetic tape recording will be made in the normal manner.

Surface Meteorological Buoy

The buoy will be deployed for a total of 24 hrs. during the Phase II test programs. The deployments will occur during EQUAP on-station times. The buoy will be equipped with a sensor package transmitting in the VHF band. The test will include optimization of launch recovery and tethering techniques, estimation of buoy movement under varying sea states, and the effectiveness of vertical motion dampening techniques. The effectiveness of the telemetry link will be evaluated under various buoy conditions of deployment.

Phase II - Data Recording and Processing Requirements

UAM System. Input punch paper tape of calibration data and manual data and record output of OMEGA and meteorological processors on Raw Data Recorder for each sonde flight. Observe, annotate and retain strip chart recording of the flight (both Omega and meteorological), operate printer for selected flight segment. Demonstrate:

(1) Parallel recording with second Raw Data Recorder

(2) On-line computer acquisition

(3) Off-line preparation of a digital tape demonstrating 1 to 16 computer acquisition

(4) Operation of engineering units conversion program (including winds computation)

(5) Printer-Plotter display graphics

BLIS. Record output of BLIP package(s) on Raw Data Recorder when BLIP packages are deployed. When packages are not deployed evaluate balloon performance using the ship Selenia Radar recording slant range and elevation angle to establish balloon altitude. Record length of line payed out from the winch on BLIS manual data panel. This data will be used subsequent to the test to evaluate balloon performance. In addition demonstrate:

- BLIS Status Display Module
- The ability to record manual inputs of BLIS data
- Operability of Data Acquisition and Engineering units conversion and display programs as defined in paragrph's 1 thru 5 in UAM system above,

Subsurface Oceanographic System (SOS)

For each cast record output of CSTD and Rosette multi-sampler on the R Data Recorder. For selected depths, using the Multi-Sampler, trigger reversing thermometers and acquire water sample. Subsequent to the cast, using the ships Oceanographic Laboratory, calculate water temperature, salinity and conductivity, determine and record discrepencies. Demonstrate items 1 thru 5 as defined in UAM data requirements.

Surface Meteorological Buoy

When buoy is deployed record output of sensors (if installed) on Raw Data Recorder. Visually determine motion of the buoy, tilt angle, and sensor package height above the water. Log this data along with estimates of sea state.

Radiation Boom

Demonstrate on-line computer acquisition and off-line 16 to 1 speed up computer acquisition. Quick Look the radiation signals via a decom with a strip chart recorder to establish reasonable signal levels.

Towed Sensor Package

Record data continuously from the Towed Sensor Package for the complete cruise. "Quick-look" the data via a decom with a Strip Chart Recorder. Compare data with manual input readings to establish that the data is within reasonable limits.

Ship System Measurements

Record output of Ship System Measurements on the Raw Data Recorder. "Quick-Look the data via a decom. With a strip chart recorder, compare data with bridge observations and record discrepancies.

PHASE III TEST PROGRAM

The Phase III test program will start when the ship departs from St. Thomas V.I. on 4 February 1973, and continue thru 16 February, terminating in Bridgetown, Barbados. The purpose of this test phase will be to simulate a series of typical GATE Experiment days. Attempts will be made to deploy all systems according to a prescribed schedule and the acquired data will be recorded on the Below Deck and the UAM Recording System. Data will be decommutated, transferred to digital magnetic tape and converted to engineering units. In addition, selective plots of data will be made with the printer-plotter. In as much as the GATE Sea Trial is a prototype test program, strict adherance to a schedule may not be attainable. This will be due to hardware problems, system cabling and RF noise, program debugging and the operating of equipment of this type at sea. The schedule does attempt to bring the systems on line in an ordered way and simulate the operation of a typical "GATE" day during the actual experiment. One other problem which will affect the operating schedule is that the GATE sea trials are piggyback on the DISCOVERER with the EQUAP Program. The planning for the GATE activities has been initially coordinated with EQUAP however, "on station" and underway times may have to be modified to meet the objectives of both programs.

The NEXAIR System will be operated by National Weather Service personnel during the Phase III Test Program. NEXAIR sondes will be flown on selective runs, on the same balloon train, as the GATE Omega sondes. The PHASE III Test Requirements Section presents an initial estimate of the number of flights that will be flown by NEXAIR, however, the exact number will be determined by the onboard Weather Service representative.

Phase III Testing

1. General During this portion of the cruise thorough testing of all components of the system and operating procedures must be accomplished. In addition, there is a requirement to obtain data on short term fluctuations in the upper atmosphere. It is hoped that this requirement can be satisfied by two series of 5 Omegasonde releases at 1 1/2 hour intervals (1 hour of data acquisition from each release.).

   Since the test schedule must be phased with the EQUAP schedule and contingInces that may arise therein, it is essential that minimum test requirements be accomplished as early in the cruise as coordinated activities will allow. Upon completion of these minimum requirements, testing should continue to provide every opportunity for detecting potential problems and refining operational procedures. The EQUAP schedule should provide ample time for GATE minimum test requirements. In general, during the first 5 days in the work area, it calls for 5 hour periods of station keeping with 8 to 10 hours of cruise time between stations. Thereafter, cruise time between stations will be reduced to 1 hour with 5 hours on station during the day and 3 hours at night. In total, it is estimated that about 2/3 of the entire cruise will be spent station keeping. This mode of operation will require repeated deployment and retrieval of over-the-side instrumentation in order to accomplish all system test requirements.

Phase III - Test Requirements

Those components of the data acquisition system that can be operated continuously, without interface with other systems or programs either underway or station keeping should be operated continuously. These would include:

1. Ship System Measurements
2. Radiometer Boom
3. Towed Sensor Package
4. Manual Data Input
5. Below Deck Data Recording & Processing System

The following are minimum test requirements for the Boundary Layer Instrument System (BLIS), Upper Air Measurement System (UAM), Surface Meteorological Buoy (SMB), Subsurface Oceanographic System (SOS) and Radar.

System	Requirement (Total for System)	Remarks
BLIS	240 hours	Possible 3 different size balloons station keeping for filling.
UAM	40 Ascents (30 to 80 mbs)	(30) Ascents at 6 hour intervals, two sets of ascents, of 5 releases each, at 1 1/2 hour intervals.
SMB	65 Hours	Approximately 16 deployments and retrievals
SOS	15 casts	3 casts to 2000M and 12 to 1000M. Ship station keeping.
NEXAIR	15 ascents	Same balloon as UAM

Details of the Phase III Test Schedule must be coorinated with the EQUAP program to insure that all planned shipboard activities are compatable and thereof what follows is an outline of a schedule which will insure that minimum testing will be accomplished.

February 4th

Ship underway from St. Thomas to EQUAP Work Area.

UAM - 2 soundings (first release at first opportunity underway) with second release at 0000Z, 5 Feb. (release every 6 hours thereafter)

BLIS - on board system checkout

SMB - on board system checkout

SOS - on board system checkout

Radar - Operating during Omega ascents

NEXAIR - As determined by NWS representative

February 5th

Ship commences EQUAP Operations (5 hour station keeping periods)

UAM - Continue sounding every 6 hours (00, 06, 12 & 18Z)

BLIS - Commence first test on station (1) BLIS balloon (in-tow aloft between stations)

SMB - Deploy, test and retrieve buoy at each station

SOS - Cast to 1000M at station 1 and to 2000M at station 2. Repeat cast to 2000M at stations 3 and 4. Thereafter all casts will be to 1000M.

NEXAIR - As determined by NWS representative

February 6th thru 9th - Continue above testing

February 10th

Ship commences 5 hour (day) with 3 hour (night) station keeping operation, with-1 hour cruise between stations

UAM - Sounding at 1000Z, 0130Z, 0300Z, 0430Z, and 0600Z with data acquisition for 1 hour only. Next sounding at 1200Z and return to every 6 hour schedule.

BLIS - Continue Testing

SMS - Deploy, test and retrieve at 5 hour (day) stations only

SOS - Continue casts to 1000M until at least 15 casts are completed

Radar - Continue until a total of 10 hours of simulataneous operation with other system is completed

NEXAIR - As determined by NWS representative

February 11th to End of Cruise - Continue above operation until all test requirements are completed. Beginning at 1200Z on February 11 start second series of 5 rapid releases for UAM. Soundings at 1200Z, 1330Z, 1500Z, 1630Z, and 1600Z, again with data acquisition for 1 hour only.

Phase III Data Recording and Processing Requirements

The recording and processing requirement for Phase III are identical to those of Phase II.

DATA FLOW CONTROL & ACCOUNTING

The test conductor, or his designated representative, shall be responsible for assuring proper identification, annotation, logging, storage and accounting of all data collected aboard the ship during all testing phases. All data collected during these tests shall be boxed and packed and delivered to the GATE Ship Systems Analyst, CEDDA, Wisconsin Ave., Washington, D.C. The following types of supporting information will be needed to allow proper interpretation of the data collected:

Magnetic Tapes

Label each tape giving date, time of start and stop, type of tests ...

Instruments

- Identify all instruments used in the sea trial (manufacturer, model number, serial number.
- Provide calibration data for instruments

Recorded data - Strip Charts

- Label each recording giving time, date, type of test.
- Identify each signal and the scale factor for the signal, on each recording
- Identify each test run by a run number and a statement of good/bad test.

Observed data

- Identify instrument used for observation
- Give time of day of observation
- Give ships position and heading at time of observation

° Identify the location on the ship where the observation was made

For each rawinsonde flight, the following items should be collected and placed in a separate envelope marked with ascent number, date scheduled time of launch, and PCM tape number:

Paper strip giving thermistor resistance

Hygristor can lid giving lot number of hygristor

Baroswitch calibration tape

Baroswitch calibration listing

Separate sheet of paper with:

Sonde serial number

Sonde mid-reference resistance valve

Analog strip charts and printed output from the UAM system.

Any other strip charts or o'graphs containing rawinsdone data.

Test Log and Cruise Report

To gain the maximum benefit from the Sea Trials, problems that occur must be corrected in the hardware and software design. Consequently the test conductor is responsible for maintaining an accurate log of the subsystem performance. This log must indicate hardware failures and status of each of the systems on a daily basis, (operating/non-operating). In addition a log of software changes made during sea trial must be maintained giving the problem requiring correction, listing of correction made, and providing a description of what the change would accomplish.

Three weeks after completion of the Sea Trials the Test Conductor is responsible for coordinating the writing of a formal report. This report should summarize the system and subsystem(s) performance during the Sea Trials and make recommendations concerning hardware and software changes considered necessary for the follow-on systems.

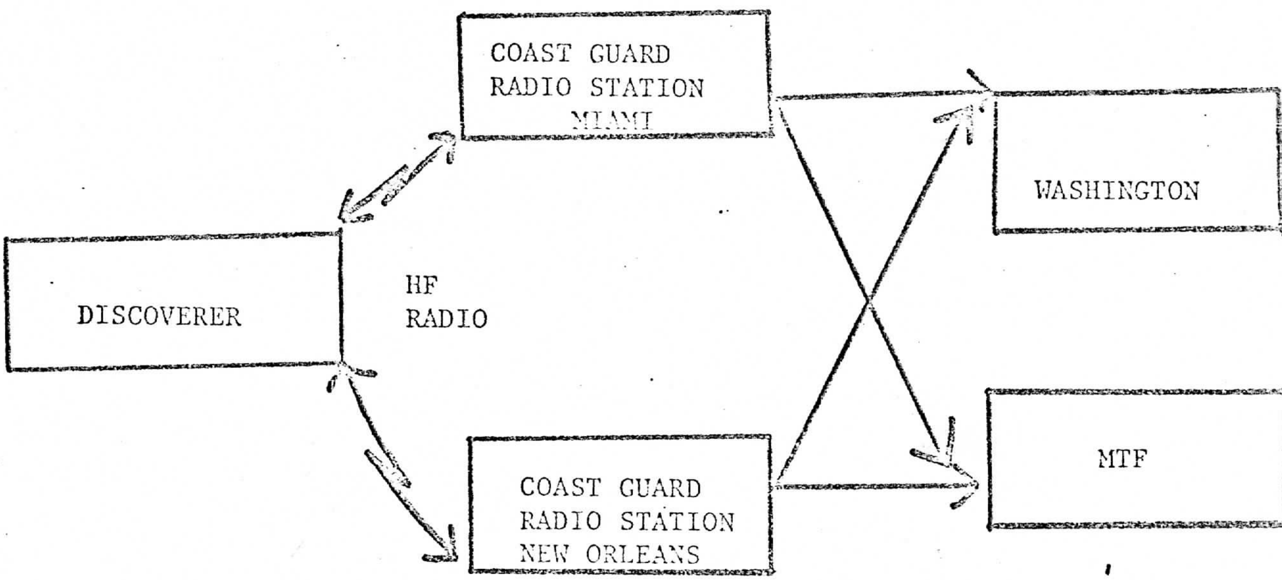
COMMUNICATIONS

During the installation Phase of the GATE Equipment aboard DISCOVERER in Miami personnel envolved in the installation may be contacted directly by calling the ship at the dock in Miami, and asking for the individual to be paged; after hour calls will also be handled from this same telephone number.

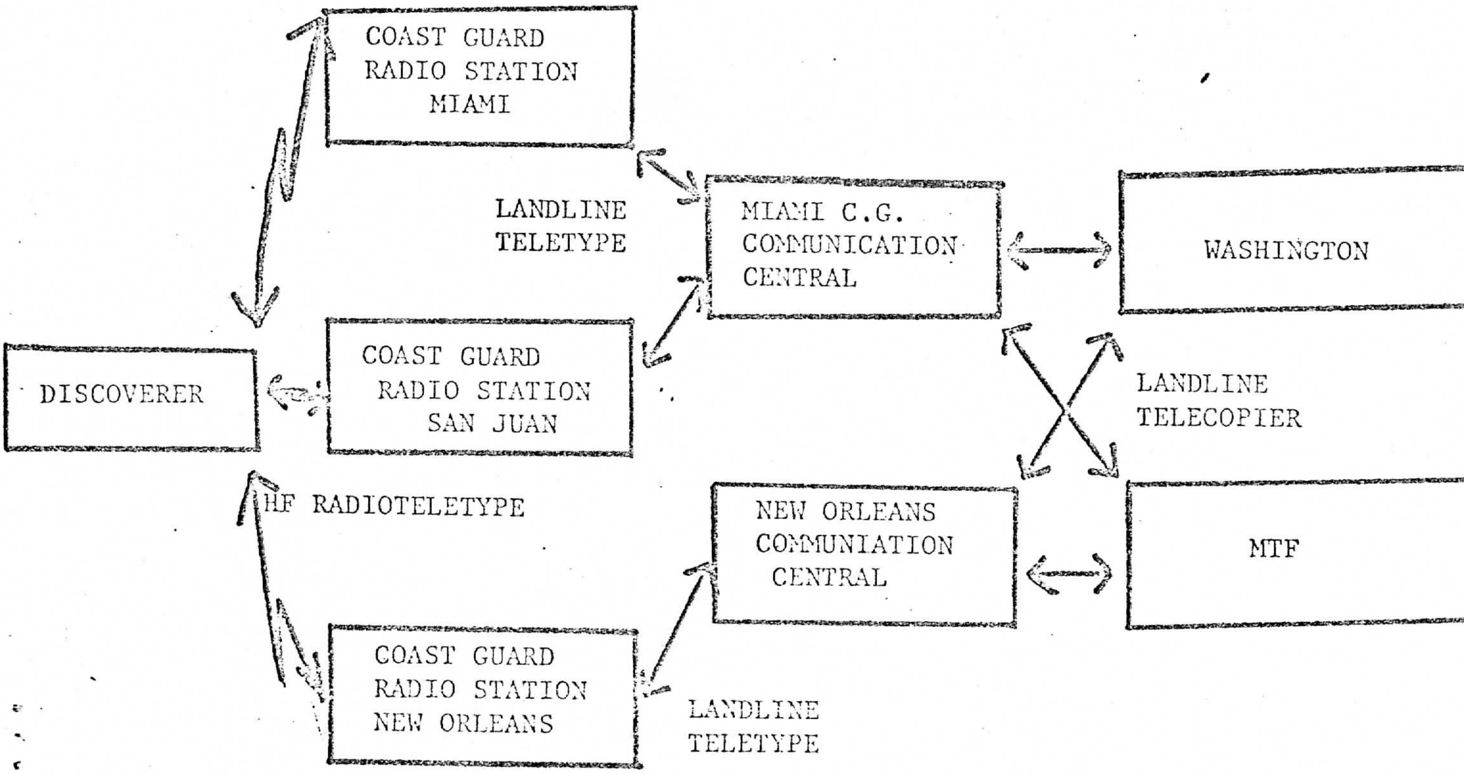
305 - 350 - 4122

During the Phase II and Phase III Sea Trials the following facilities will be used for voice and teletype communication.

Voice



Teletype



Arrangements will be made, prior to the departure of the DISCOVERER, in January, to firm-up detailed plans for utilization of the above facilities.

Points of Contact

Coast Guard Communications Central Miami: Cdr. B.S. Little 305-350-5660

Coast Guard Communications Central New Orleans: LCdr. D.W. Starkweather 504-527-6231

Coast Guard Radio Station Miami: Lt. V. Gaida 305-233-3062

Coast Guard Radio Station New Orleans (co): CWO J.P. Higman 504-527-6854

Coast Guard Radio Station San Juan (co): CWO R.E. Sanders

NOAA Headquarters Manager Field Projects Division W.S. Barney
301-496-8416

Mississippi Test Facility/NASA Manager PODAS John Ivey
601-688-2292

NOS Ship DISCOVERER Capt. Floyd S. Tucker 305-350-4122

Landline Teletype Numbers:

Miami Communications Central: 305-350-5643

New Orleans Communications Central: 504-527-6231/32/80

Mississippi Test Facility Terminal: 601-688-3659

Valid as of 4 January 1973

APPENDIX C

CHECK-OFF LIST FOR BLIP/BLIS DEPLOYMENT

1.0 Balloon, Lift System

1. Gas bag

   SSEC---two balloons to be shipped directly from Raven
   SSEC---one balloon to be repaired and then sent from Madison.
   Sparkman---one balloon to be sent directly from Raven

2. Tail assy

   SSEC---Jalbert tail to be constructed at SSEC from materials supplied by Jalbert.

3. Line for tail harness

   SSEC---120 pound test line recommended by Jalbert for constructing the above mentioned tail. We will supply a minimum of an extra 200 feet.

4. Glass--tape for tail assy

   SSEC---From Madison.

5. Line for hand-lines

   SSEC---two types of line, 500 pound and 1000 pound braided nylon 500 feet of each. From Madison.

6. Plug for major fill tube

   SSEC---This should be supplied by Raven. We will check on this.

7. Plug for top-off tube

   SSEC---Same as 6.

8. Top-off tubing (1/4" id surgical tube)

   Sparkman---per earlier discussions. Also it is my understanding that you will supply 3/4" tubing for the main fill tube.

9. Clamp/petcock for tubing

   Sparkman

10. Patching fabric

    SSEC---Supplied by Jalbert and to be sent from Madison.

11. Glue/sealer, etc.

    10

    SSEC---Same as 9 above.

2.0 Tetherline

1. Reels of tether line of all selected sizes

   SSEC---per your instructions, we are sending our entire NOLARO supply. Four reels. All damaged segments will be repaired.

2. Thimbles

   SSEC---From Madison.

3. Lacing cord

   SSEC---Items three, four, and, five and additional related materials are being supplied in a special line repair kit.

4. Glue or line patching material

   SSEC---see above

5. T

6. Swivels SSEC---From Madison.

7. Shackles (incl. two for shore use) thrubolt
Sparkman.

8. Masking tape
SSEC---see 3,4,and 5 above.

9. Gloves for line handlers
SSEC---see 3,4, and 5 above.

3.0 Winch, Fairlead, etc.

1. Winch SSEC---This has already arrived in Miami. All SSEC modifications have been completed.

2. Power cable if needed
Sparkman---The winch wiring is being taken care of by the ship personnel.

3. Power Plug if needed
SSEC---power connectors were furnished with the winch.

4. "Crank case oil" for winch
SSEC---Hydraulic fluid was supplied with the winch. We will obtain either in Madison or Miami additional fluid.

5. Machinery lube, for winch
SSEC---Lubricating materials will be specified by Otis and supplied by SSEC. The winch was serviced and tested before being shipped

6. Plastic anti-rust paint/spray
Sparkman---"Rustoleum" will be purchased in Miami.

7. Texaco anti-rust spray
Sparkman---See 6 above.

8. Fairlead assy
SSEC---Fairlead assemblies will be shipped from Madison within two or three days.

9. Extra pulleys for shore, etc. (2)
Sparkman

10. Canvas bag (2) for deadweight and weights
Sparkman

11. Line tensiometer
This is still under consideration. We will study specifications of commercially available products. If you find a suitable instrument, let us know so that the procurement responsibility can be resolved.

4.0 Inflation Hardware

All items in this section are allocated as the responsibilit of NOAA (Sparkman)

1. Tanks of gas
2. Manifolds (2)
3. High-pressure gauge
4. Low-pressure gauge
5. Hose/pipe, to deck
6. Valve control at fill
7. Pressure reg. at fill
8. Rubber hose
9. Clamps for rubber hose
10. Plugs for balloons
11. Plug for end of fill hose (when not in use)
12. Balloon--pressure manometer
13. Plastic hose tees, etc.
14. Manifold & hose, etc. for dockside filling

5.0 BLIP Sondes

SSEC---All items in this section will be supplied by SSEC. Item 4 will be purchased in Miami. All other supplies will be sent from Madison.

1. Sondes of proper frequencies
2. Antennas (for flight pkgs.)

3. Batteries

4. Wet bulb water

5. Wet bulb reservoir filler (syringe)

6. Spare thermistors

7. Spare wet bulb wicks

6.0 BLIP Shipboard Station

1. Bendix psychometer

   Sparkman

2. Theodolite

   Sparkman

3. Stopwatch

   Sparkman

4. Large protractor

   Sparkman and SSEC

5. Large graph paper

   Sparkman and SSEC

6. Slide rule

   Personal item supplied by each user.

7. Digital calculator

   Sparkman

8. Trig & log tables

   Sparkman and SSEC.

7.0 Test Equipment and Supplies

All items except 3 and 4 will be supplied by Sparkman. In addition a list of SSEC equipment will be attached.

1. 50 - 0 - 50 μA

2. Small resistance decade box

3. FET multimeter

4. Soldering iron, hand tools

5. Field mill for atmosphere field values

6. Small coax (50 - 75 feet)

7. RCA jacks & plugs

8. Hook up wire for vert. probe

9. Resistor (assorted) box

10. Small capacitors, assorted

11. BNC's & crimpe

12. RG 58U (30 feet)

13. 10 - turn pot, 1 Meg., if available

PRELIMINARY LIST OF SSEC SUPPLIED TEST EQUIPMENT IN GATE SEA TRIAL SUPPORT

1. Tektronix 434 Oscilloscope with probes

2. Tripplet Model 601 FET VTVM and extra batteries

3. BLIP Simulator-no RF link.

4. BLIP Ground Station

5. HP 562 Digital Recorder with extra printer paper.

6. HP 410C VTVM with RF probe.

7. HP Power Meter with 2 (two) 10 dB attenuators.

8. Singer Signal Generator.

9. Spectrum Analyzer-----This will either be supplied by Jim Shull or if this is not possible, SSEC will consider a rental. Sparkman will check to determine if one is available aboard ship.

10. HP 6216 Power Supply

11. HP 5245L and 5253B Frequency Counter and plug-in. This is a piece of rental equipment obtained especially for the sea trials.

15 February 1973

APPENDIX D

SUMMARY

<u>BLIP Performance on the Field Test, 18 January 73 to 7 February 73.</u>

Total operating time for all units: <u>465.5 hours</u>

Six BLIPS returned to SSEC in complete operating condition.
(B2, B4, B6, B8, B9, B12)

Five BLIPS returned to SSEC with all but wind direction operational.
(B1, B3, B7, B10, B11)

B10 has erratic RF output.

B5 Repaired but never checked out before returning to SSEC.
Probably operational.

Approved: Stanley G. Burns
Stanley G. Burns

B 1 425 MHz

Date		Status
19 Jan. 73	OK	3 hours
20 Jan.	OK	6 "
24 Jan.	OK	2 "
31 Jan.	09:35 a.m.	tethered for stability run
1 Feb.	OK	30 hours
4 Feb.	8:40 p.m.	Put on line - had to reglue the Delron ring. Had erratic wind direction and replaced it with B12 at 10:00 p.m. About 1 hour of operation.

Total operating time 42 hours

Status at end of test. no wind direction

B 2 440 MHz

Date		Status
22 Jan. 73	OK	1/2 hour
		Short check to see if it would interfere with the OMEGA radiosonde receiver.
24 Jan.		Set up for an overnight run at 4:30 p.m.
25 Jan.		12 hours
		Rain storm last night -- Still O.K.

Total operating time 12 1/2 hours

Status at end of test O.K.

B 3 435 MHz

Date		Status
24 Jan. 73		Set up for an overnight run at 4:30 p.m.
25 Jan		Rainstorm last night
		Relay clicking -- RF output marginal
26 Jan.		Had water leak --'Gorp' on bottom board made master clock quit.
		Unit was O.K. after cleaning with alcohol
27 Jan.		Reassembled and a coat of RTV on outside of boards. Put on line for overnight test on G Deck. at 8:00 p.m. It didn't have wind direction.
28 Jan.	OK	After 14 hours.
		No wind direction.
		Run a total of 30 hr. before removing from line.
6 Feb.	OK	9 1/2 hours
		10:00 a.m. put on Jalbert--removed at 7:30 p.m.
		No wind direction
Total operating time		41 hours
Status at end of test		no wind direction

B 4 430 MHz

Date		Status
19 Jan.	OK	3 hours
20 Jan.	OK	6 hours
24 Jan.	OK	2 hours
30 Jan.	OK	10 hours on tether line below RADAR
31 Jan.	9:35 a.m.	tethered for stability run
1 Feb.	OK	30 hours
4 Feb.	9:20 a.m.	tether line. Replaced broken antenna. (broken by handling in lab) At 6:00 p.m. we put it on the large RAVEN balloon for the night.
5 Feb.	11:15 p.m.	Brought it back down. Was turned off at 6:20 p.m.
	OK	after 33 hours
6 Feb.	OK	9 1/2 hours operation 10:00 a.m. put on Jalbert. Removed at 7:30 p.m.
Total Operating time		94.5 hours
Status at end of test		OK

B 5 420 MHz

Date	Status
24 Jan.	Set up for an overnight run at 4:30 p.m.
25 Jan.	Rainstorm last night
	Battery pack exploded -- BLIP is dead
27 Jan.	Has severe circuit board damage due to corrosion 3rd lever wiring short to BT from corrosion caused the battery to blow up.
28 Jan.	Logic made to work but no RF output
29 Jan.	RF O.K. after more cleaning and retuning
	Weight was increased by about 50 grams because of extra RTV used.
Total operating time	might be 1 hour
Status at end of test	Not checked into the PODAS after repair. Requires checkout at SSEC.

B 6 430 MHz

Date	Status
27 Jan. 73	Set up for overnight test on G deck at 3:30 p.m.
28 Jan.	After about 13 hours RF O.K. No temperatures. Resistive Osc. is out
29 Jan.	No corrosion inside. Most of the FET's were bad, and the RO op Amp was bad. Works OK now.
Total operating time	30 hours
Status at end of test	OK

B 7 425 MHz

Date		Status
24 Jan. 73		Set up for an overnight run at 4:30 p.m.
25 Jan.		Rainstorm last night
		Relay is clicking but no RF
26 Jan.		Severe localized corrosion. Unit was not circuit coated but doesn't make much difference
27 Jan.		Worked OK after cleaning off the corrosion. Put a coat of RTV on circuit boards
30 Jan.	OK	10 hours on tether below RADAR
31 Jan.		Wind direction is out

Total operating time	11 hours
Status at end of test	No wind direction

B 8 420 MHz

Date		Status
19 Jan. 73	OK	2 hours 15 minutes
20 Jan.	OK	6 hours
24 Jan.	OK	2 hours
27 Jan.	OK	Set up on G deck for overnight test at 3:30 p
28 Jan.	OK	30 hours
30 Jan.	OK	10 hours on tether line below RADAR
31 Jan.		9:35 a.m. hang up for stability run
1 Feb.	OK	30 hours
4 Feb.	OK	Hung on line 8:15 a.m. Had to put RTV on water tank
		Removed from line at 8:15 p.m.
		12 hour operation. Still OK
6 Feb.		10:00 a.m. put on Jalbert--removed at 7:30 p
		9 1/2 hour operation OK
Total operating itme		101.5 hours
Status at end of test		O.K.

B 9 430 MHz

Date	Status
24 Jan. 73	Set up for an overnight run at 4:30 p.m.
25 Jan.	Rain storm last night--Still OK
	12 hours time.
Total operating time	12 hours
Status at end of test	O.K.

B 10 435

Date		Status
19 Jan. 73	OK	3 hours
20 Jan.	OK	6 "
24 Jan.	OK	2 hours
27 Jan.		Set up for overnight test on G deck at 3:30 p.m. Was replaced by B3 because of no wind direction.
28 Jan.		Made operational by pot adjustment.
30 Jan.		10 hours on line below RADAR
		Wind direction is out. Made pot adjustment
31 Jan.		9:35 a.m. hang up for stability run
1 Feb.	OK	26 hours
4 Feb.		Hung on line at 9:40 a.m.
		Removed at 8:15 p.m.
		10 1/2 hour operation
		Wind direction not operating
5 Feb.		Works but SONY Servo loop doesn't seem to function. RF is erratic.
Total operating time		58.5 hours
Status at end of test		No wind direction, RF is erratic

B11 440 MHz

Date		Status
19 Jan. 73	OK	3 hours
20 Jan.	OK	6 "
24 Jan.	OK	2 "
27 Jan.		Had loose B+ wire on battery clip. Soldered it up and it works OK. put on G deck at 3:30 p.m. for over-night test.
28 Jan.		24 hours O.K. but no wind direction Removed from line because of OMEGA inter-ference.
Total operating time		35 hours
Status at end of test		No wind direction

B 12 425 MHz (SSEC Test Unit)

27 Jan. 73	Set up on G deck for overnight test at 3:30 p.m. Had to adjust pot to make wind direction work.
28 Jan.	Found it smashed. Someone bumped into it at night. Unit does not work.
29 Jan.	Replaced Master clock IC. All OK except no wind direction
30 Jan.	Cleaned LED's and phototransistors with alcoho wind direction and speed are now.
31 Jan.	Wind direction is out
4 Feb.	Hung on line at 10:00 a.m. after fixing wind. OK at 8:15 p.m. after 10 hours.
6 Feb.	Put on Jalbert at 10:00 a.m. and removed at 7:30 p.m.
	10 1/2 hours operation O.K.
Total operating time	26.5 hours
Status at end of test	O.K.