TROPICAL WIND, ENERGY CONVERSION, AND REFERENCE LEVEL EXPERIMENT

(TWERLE)

OPERATIONS HANDBOOK

June 1975

TROPICAL WIND, ENERGY CONVERSION, AND REFERENCE LEVEL EXPERIMENT

(TWERLE)

OPERATIONS HANDBOOK

*National Center for Atmospheric Research
Boulder, Colorado

June 1975

*The National Center for Atmospheric Research is operated by the University Corporation for Atmospheric Research and is sponsored by the National Science Foundation.

TABLE OF CONTENTS

I. Introduction

The Nimbus-F meteorological satellite, to be launched by NASA in early 1975 will carry a system designed to locate and retrieve signals from a large number of moving platforms.

The system, a Random Access Measurement System (RAMS), was specifically designed to locate and retrieve information from many drifting constant-level balloons, i.e., superpressure balloons with light, inexpensive electronic packages and their associated sensors. The Tropical Wind, Energy conversion, and Reference Level Experiment (TWERLE), will involve launching, tracking, and retrieving data from about 400 constant-level balloon platforms. An overview of TWERLE is shown in Figure 1.

The TWERL Experiment is a joint effort of a team representing scientists and engineers from the Goddard Space Flight Center (GSFC), the National Center for Atmospheric Research (NCAR) and the University of Wisconsin (UWIS).

The purposes of the TWERL Experiment, closely tied to the objectives of the Global Atmospheric Research Program (GARP), are: (1) to measure winds in tropical regions of the southern hemisphere and mid-latitudes at 150 mb (about 14 kilometers altitude) from the drift of the balloons; (2) to measure the air motion relative to isobaric contours and the conversion of potential to kinetic energy in the atmosphere by comparing pressure and absolute altitude over the ocean; and (3) to provide a direct measurement of temperature, pressure and absolute altitude that can serve as a reference point in adjusting indirect temperature soundings from meteorological satellites.

II. Objectives

A. General

One of the most important and urgent aspects of planning for GARP and a crucial element in the rational design of a global meteorological observing scheme is that of establishing the effectiveness and cost of a number of hypothetical observing systems, differing as to:

1) Variables measured
2) Accuracy of measurement
3) Frequency of measurement

4) Spatial density of measurements made in a fixed interval of time (primarily, density in quasi-horizontal surfaces).

B. Scientific

1. Tropical Wind Measurement Experiment

The tropics are known to be the source region of energy and momentum for the thermo-hydrodynamical atmosphere system. The source of westerly momentum and most of the thermal and latent energy for the atmosphere is near the earth's surface in the tradewind region. From theory and observation we are assured that an overwhelming portion of energy and momentum is transferred horizontally into middle latitudes in the tropical upper troposphere. However, this portion of the atmosphere is poorly described. Sufficient conventional wind and temperature observations are not available to enable us to understand how this transfer takes place. For successful application of numerical modeling of the global circulation, it is imperative that we understand the manner in which energy and momentum are transferred by vertical convection in the upper tropical troposphere and the details of how these quantities are transferred poleward into middle latitudes.

The scientific objectives of the Tropical Wind portion of the experiment are:

- To obtain the wind and temperature fields of circulation systems in the upper tropical troposphere with characteristic zonal scales (in east-west direction) of 2,000 to 10,000 km, and

- To study the interactions between the circulation systems of the tropical upper troposphere and the large-scale circulation systems of middle latitudes.

2. Energy Conversion Experiment

One of the most fundamental questions in meteorology is how the potential energy inherent in the mass distribution of the atmosphere is converted into the kinetic energy of atmospheric motions. The atmosphere is a grossly inefficient thermodynamic engine and the efficiency of conversion of heat into motion does not exceed 5%. A value of 2% probably is more representative. This inefficiency makes it all the more difficult to track the

conversion mechanism in detail. An added difficulty arises because of the wide scale in the spectrum of atmospheric motion. The low efficiency of conversion mentioned above refers to the total energy on all scales.

The scientific objective of this experiment is to determine the process by which the potential energy associated with the mass distribution of the atmosphere is converted into the kinetic energy of atmospheric motions.

3. Reference Level Experiment

In early phases of planning for the First GARP Global Experiment (FGGE), when it was realized that the global temperature fields supplied by polar-orbiting sounders would allow a determination of the mass field, it was considered necessary to tie this determination of the mass field down to some absolute value. Consequently, in discussions of COSPAR Working Group 6, GARP Publication No. 2 and in documents of JOC (GARP Publication No. 3), a "reference level" subsystem was recommended for the southern hemisphere. It was considered that a fleet of constsnt-level balloons carrying pressure and accurate radio altimeters could provide a feasible solution to this need.

The scientific objective of this experiment, therefore, is to provide a pressure field at a known altitude, or in other words, determine the constant of integration that occurs in the mathematics of the inversion process.

C. Operational

In order to attain the scientific objectives described above, it is necessary to know the altitude of the floating balloon above the sea surface, the ambient atmospheric pressure, the ambient air temperature, and the balloon position as a function of time. Several methods have been proposed for balloon location and data telemetry such as the Eole System for the French, the Interrogation and Recording Location System (IRLS) and Omega Position Location Equipment (OPLE) systems in the United States, and more recently the Random Access Measurement System (RAMS) of GSFC, UWIS, and NCAR. The TWERLE has, through field and laboratory experiments, developed a balloon system meeting the requirements of simplicity and low cost.

1. Equipment

Although one of the purposes of performing the complete reference level experiment is to establish accuracy requirements for the reference level, initial or working requirements can be stated as:

- for altitude 20 meters
- for pressure 0.5 millibars
- for temperature $0.5^{o}C$.

The accuracy requirement for wind measurement is one meter per second.

The University of Wisconsin has developed a lightweight, low cost, low power, radio altimeter (Stremler, Levanon and Suomi 1972). This development was stimulated by the need for a reference level for remote temperature soundings of the atmosphere to be used in the global observing system being developed for GARP. A complete evaluation of the absolute accuracy attainable with this instrument has not yet been accomplished. However, tests of the instrumental accuracy have demonstrated a resolution capability of one meter. No difficulty in meeting the initial accuracy requirement stated above with the use of this instrument has been encountered.

The pressure sensor utilizes an aneroid capsule with capacitive coupling. The aneroid capacitor serves as the tuning capacitor of a Clapp oscillator. To allow maximum pre-flight aging at the expected pressure level, the aneroid capsule is mounted inside an evacuated chamber equipped with a relief valve. The relief valve opens at a pressure differential of 60 mb. Hence, it will only open during the balloon ascent, just prior to arrival at the float altitude. The pressure sensor is expected to yield the specified accuracy of 0.5 mb over six months.

The temperature sensor to be used has been selected as a 10-mil coated aluminated bead in a holder developed by NCAR.

2. Participants

The Tropical Wind, Energy conversion, and Reference Level Experiment (TWERLE) represents an effort of unusually great diversity. It draws a large part of its inspiration from the GARP, and therefore involves the gathering of data that are applicable to the improvement of theoretical models of the general circulation. These models will in turn be used to simulate and exploit the proposed data gathering system in order to test

various modes of employment of the balloons. On the engineering side, it involves the development of an elaborate spacecraft hardware and ground processing system, and of a balloon system which requires a specialized integration and deployment effort. The skills needed to accomplish these various tasks do not reside in any single institution.

Participants in the experiment from GSFC, the University of Wisconsin and NCAR work together as members of the TWERLE team. This team has responsibility for the conduct of the experiment, and responsibility for separate aspects of the experiment are clearly assigned to individual members.

The team consists of the following people:

Dr. Paul R. Julian (NCAR) - Team leader
Dr. William W. Kellogg (NCAR)
Mr. Vincent E. Lally (NCAR)
Prof. Verner E. Suomi (UWIS)
Mr. Charles Cote (GSFC).

Mr. William Bandeen (GSFC) has agreed to serve as a continuing ex-officio member to assure the necessary interfacing with other experiments on Nimbus-F. With the responsibility assigned to each participant in the experiment goes the authority to direct the work in his area of responsibility subject only to the Team Leader's overall coordination.

3. Sites

Simulation studies have indicated that adequate balloon density in a 10,000 to 12,000 km longitudinal by 5,500 km latitudinal region can be obtained with 400 balloons. In order to achieve this density, three tropical launch sites have been selected. These include Ascension Island, Tutuila Island in American Samoa and Kotoka International Airport at Accra, Ghana. Although scientific considerations were the primary factor in site selection, political and logistical situations were also considered. A complete description of these stations is included in the appendices of this handbook.

4. Facilities

Launch site facilities required for the program consist of a 2,000 square foot launch assembly building, a self-propelled balloon

launcher and assorted balloon inflation and electronics test equipment.

Figure 2 shows the layout of the launch-assembly building provided at the Ghana and Samoa sites. The facilities on Ascension Island consist of a Quonset hut setup for the electronics check-out and storage areas and the Nimbus building, which was previously used for the Nimbus-4/ IRLS program. This is where the balloon inflation work will be performed and the mobile launcher garaged. The Christchurch site will use the GHOST lab for electronics check-out and a new addition to the building for the balloon inflation work and launcher.

III. Field Program

A. Organization

The organization of the flight crew at each station is outlined in the following paragraphs. The allocation of individuals to specific stations will be done at a later date. Assignment to specific tasks will depend upon the qualifications of the individuals and will be done prior to departure for the field site. Changes in the field necessitated by operational requirements may be made by the site manager. A detailed description of the responsibilities associated with the various functions follows.

1. Site Manager

a. Provides for the health, safety, and welfare of all personnel assigned to one site.

b. Carries out the programmed launches of TWERLE balloons as directed by and at the time specified by the scientific staff of TWERLE.

c. Allocates personnel assigned to the site in such a way as to ensure the maximum effectiveness of the site.

d. Provides transportation, administration, and logistic support for the group assigned to the particular site.

e. Maintains liaison with the cooperating groups of the agency or government controlling the use of the site. In the case of Ghana, the Meteorological Services Department and Civil Aviation Department are the cooperating groups. In some instances, however, the U.S. Embassy is involved

and must be consulted. On Ascension Island, the cooperating agencies are NASA and the USAF operating through their contractors, Bendix, Pan Am and RCA. In Samoa, the Public Works Department of the Government of American Samoa and the airport manager at Tafuna are the cooperating groups.

f. Represents NCAR in all negotiations with contractors and suppliers at the individual sites, to safeguard U.S. and UCAR property and maintain accurate records and control of the program at the respective sites.

g. Administers the UCAR checking account set up in a local bank.

h. Approves or disapproves travel requests initiated by personnel at the site and issues necessary travel authorization. The same authority will apply to purchase requisitions and purchase orders.

2. Electronic Supervisor

a. Responsible for initial site set up with electronic test equipment, launches, etc. and continued check-out of flight instruments and complete system integration and final assembly on launch tray in a "flight ready" configuration.

b. Supervise the electronic technicians assigned to the site to accomplish the above duties and meet all flight schedules. Assist Site Manager and Balloon Supervisor in maintaining a smooth and functional operation.

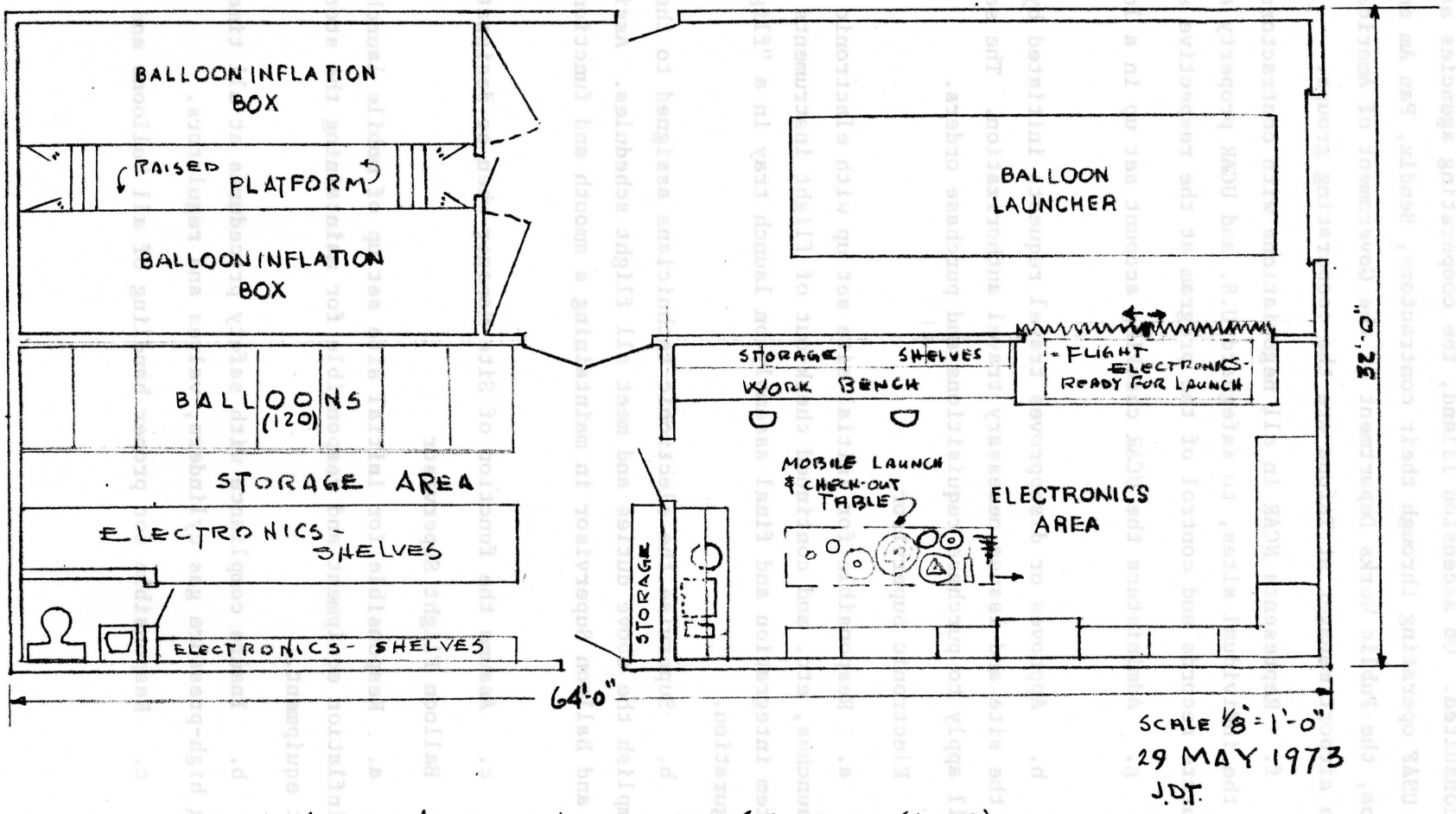
c. Assume the function of Site Manager when so designated.

3. Balloon Flight Supervisor

a. Responsible for initial site set up of mobile launcher and balloon inflation equipment and responsible for maintaining the storage of all flight equipment.

b. Insure compliance with safety procedures at all times when handling high-pressure gas cylinders, valves and regulators.

c. Responsible for proper handling of all balloons and their inflation.



TWERLE LAUNCH-ASSEMBLY SHELTER (LAS)

Figure 2

d. Collect all pre-flight data on each system and complete the flight information folder and originate the telex launch notice for release by the site manager.

e. Assume the functions of site manager when so designated.

4. Site Support Supervisor

a. Supervise communication traffic in accordance with Communications Appendix.

b. Supervise indigenous personnel assigned for security, maintenance and administration.

c. Responsible for procurement of support equipment, materials and supplies as approved by the site manager.

d. Maintain property records of all equipment--scientific, support and recreational.

B. Schedules

The global wind circulation patterns that are monitored by the TWERLE balloons are optimum during the season of June through September. Therefore, the logical timing for the launches to begin from each site is as follows:

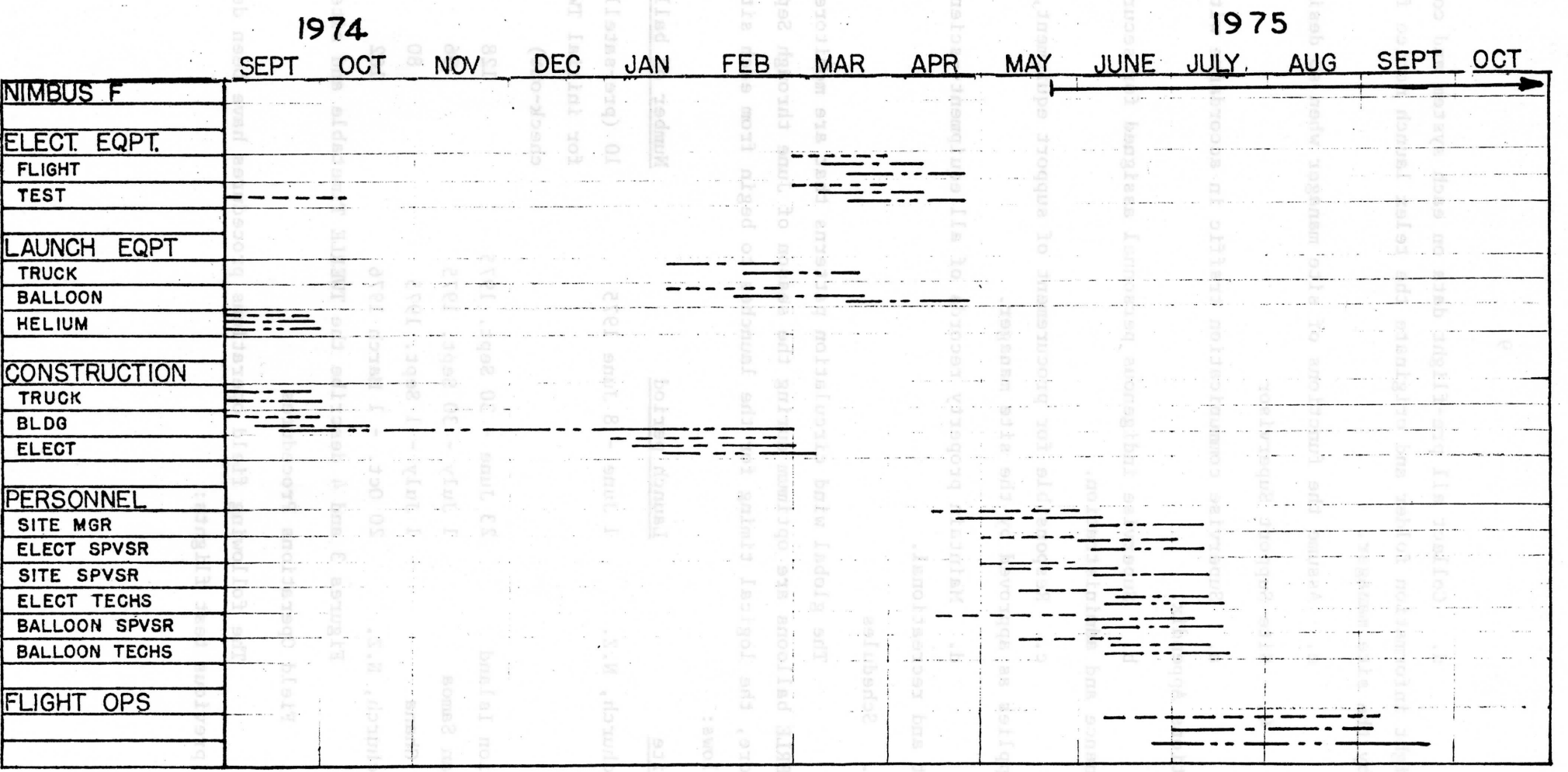
Site	Launch period	Number of balloons
Christchurch, N.Z.	1 June - 8 June 1975	10 (pre-satellite flights for initial TWERLE/RAMS check-out)
Ascension Island	23 June - 30 Sept. 1975	128
American Samoa	1 July - 30 Sept. 1975	96
Accra, Ghana	1 July - 1 Sept. 1975	80
Christchurch, N.Z.	20 Oct. - 1 March 1976	102

Figures 3 and 4 describe the TWERLE Timetable and site schedules.

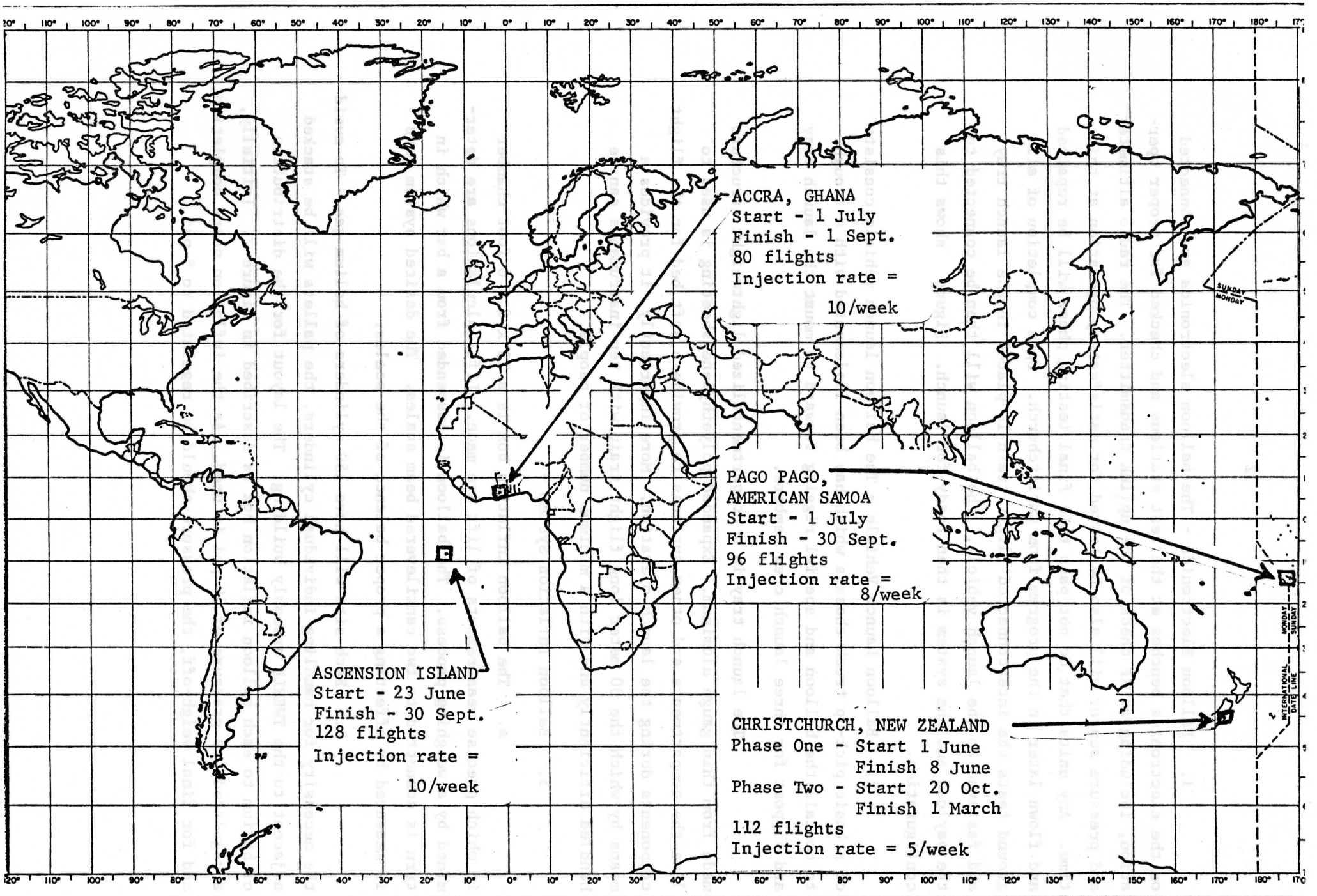
C. Field Operations Procedures

The following field operations procedures have been developed during previous test flights:

TWERLE TIMETABLE



ASCENSION ISLAND ——— 128
ACCRA, GHANA ——— 80
AMERICAN SAMOA ——— 96


ACCRA, GHANA
Start - 1 July
Finish - 1 Sept.
80 flights
Injection rate =
10/week
PAGO PAGO,
AMERICAN SAMOA
Start - 1 July
Finish - 30 Sept.
96 flights
Injection rate =
8/week
ASCENSION ISLAND
Start - 23 June
Finish - 30 Sept.
128 flights
Injection rate =
10/week
CHRISTCHURCH, NEW ZEALAND
Phase One - Start 1 June
Finish 8 June
Phase Two - Start 20 Oct.
Finish 1 March
112 flights
Injection rate = 5/week
SUNDAY
MONDAY
INTERNATIONAL DATE LINE
MONDAY
SUNDAY

1. Balloon Electronics - The balloon electronics are connected on the electronics benches at the test stations and checked for proper operation, including an RF check of the uplink transmitter. The radio altimeter and pressure sensor will also be tested for satisfactory operation at this time. Any units that do not pass this final testing phase will be repaired and flown later in the program from Christchurch. Upon completion of all ground tests the interconnected flight train is placed in the launch tray and fastened to the launch vehicle. The balloon will then be connected to the payload and the system is then ready for launch. Figure shows this configuration.

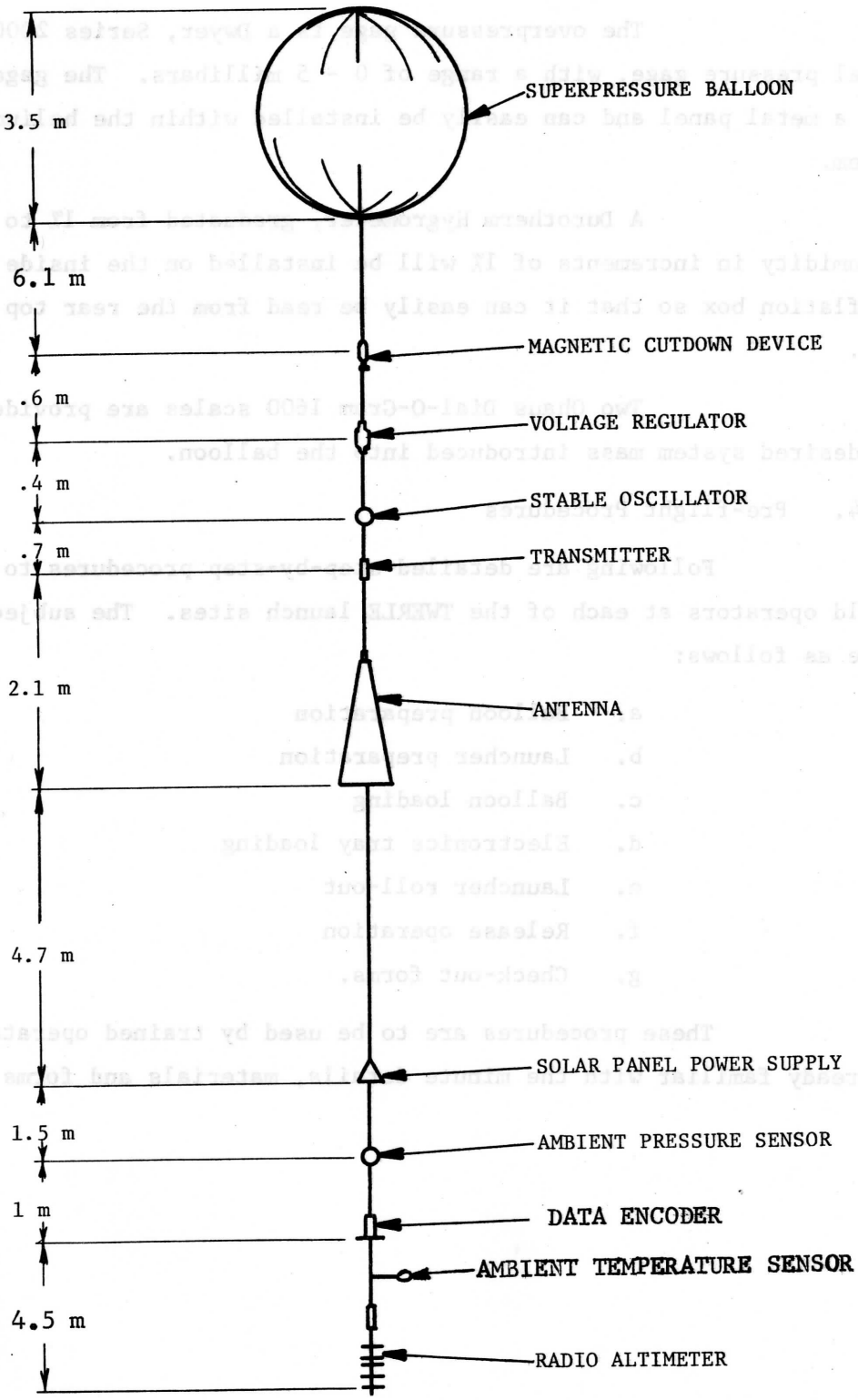
2. Balloon Launch Vehicle - The balloon launch vehicle consists of a basic pick-up truck chassis which has been implemented with a trough to contain the balloon and special rigging forward to mount the launch tray and support for three launch crew members.

The launch tray is a compartmentalized lightweight structure made from thin gauge aluminum. Expanded polyethylene sheeting is used to line the compartments and other surfaces to provide a soft bed for the flight components during the launch operation. More importantly, it provides a means by which the 30 meter long flight train with ten instruments can be handled efficiently and with a minimum number of people.

3. Balloon Inflation System -

a. The balloon inflation box is a 22 x 6 x 6 foot chamber in which precise measurements of lift are made. Lift calculations are determined by a weighing process. The balloon is suspended from a bar which in turn is connected to two cantilevered beam scales. The desired system mass is measured by effecting a proper balance of the scales.

b. Each site will have 150 cylinders of helium gas. To avoid the necessity for handling individual cylinders, the pallets will be stacked adjacent to the TWERLE assembly building. The layout for the distribution of helium to each balloon inflation box is described in Figure 7. Initially, a regulated gas pressure of 10 psi is used. As the inflation nears completion, and for final weigh-off, the pressure should be regulated to 5 psi.



TWERLE BALLOON SYSTEM

12 Feb. 1975

c. Instruments -

The overpressure gage is a Dwyer, Series 2000, differential pressure gage, with a range of 0 - 5 millibars. The gage is mounted in a metal panel and can easily be installed within the helium manifold system.

A Durotherm Hygrometer, graduated from 1% to 100% relative humidity in increments of 1% will be installed on the inside of the balloon inflation box so that it can easily be read from the rear top window of the box.

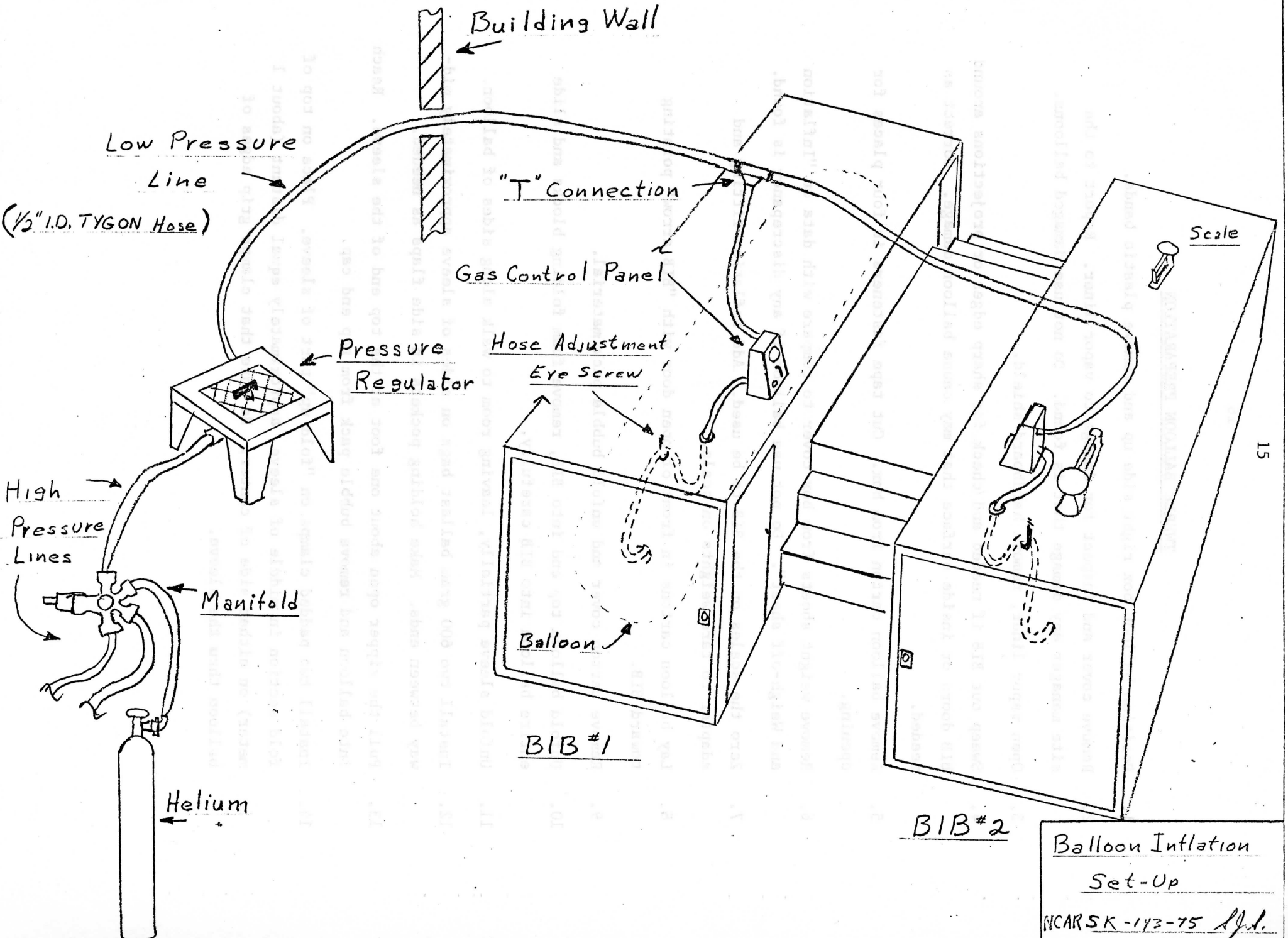
Two Ohaus Dial-O-Gram 1600 scales are provided for measuring desired system mass introduced into the balloon.

4. Pre-flight Procedures

Following are detailed step-by-step procedures to be used by the field operators at each of the TWERLE launch sites. The subjects covered are as follows:

a. Balloon preparation
b. Launcher preparation
c. Balloon loading
d. Electronics tray loading
e. Launcher roll-out
f. Release operation
g. Check-out forms.

These procedures are to be used by trained operators and persons already familiar with the minute details, materials and forms needed.



Balloon Inflation Set-Up

NCAR SK-173-75 RJ.

TWERLE BALLOON PREPARATION

1. Position balloon box right side up and remove plastic bands.
2. Remove cover and inspect for damage to vapor liner. Report to the site manager any damage that is found. Do not use damaged balloons.
3. Open vapor liner, remove hardboard shield.
4. Sweep out BIB if needed and check for sharp edges or projections around BIB doors or inside surface that may cause balloon damage. Correct as needed.
5. Remove balloon carton from box. Cut tape fasteners in four places for opening.
6. Remove weight sheets from box cover to compare with data on "Inflation and Weigh-off sheet". Do not use balloon if any discrepancy is found.
7. Zero the scales on the BIB to be used. Add inflation fitting and adapter to tare weights on scale.
8. Lay balloon cartons in front of open door with "BIB arrow" pointing toward BIB.
9. Remove carton cover and unfold bubble pack material.
10. Unfold balloon top end into BIB, remove foam folding blocks and slide entire balloon into BIB carefully.
11. Unfold sleeve partially, leaving room to walk along sides of balloon.
12. Install two 600 gram ballast bags on sides of sleeve approximately mid-way between ends. Make holding pockets in side flaps as needed.
13. Pull the zipper open about one foot at the top end of the sleeve. Reach into balloon and remove bubble pack from top end cap.
14. Install two padded clamps on "fold up" part of sleeve. Place on top of fold section in middle of sleeve, approximately equal distant (about 1 meter) on either side of center. Be sure that clamps grip edges of balloon thru the sleeve.

15. Cut open red lined arc on base end of sleeve. Use care to avoid cutting balloon.

16. Reach into balloon and remove bubble pack from base cap.

17. Remove inflation fitting cap and quickly insert inflation adaptor (with twist action) to avoid significant air inflow.

18. Begin helium inflation. Lift clamped section to a vertical position to permit uniform deployment of material.*

19. When sleeve is about 90% full, pull both ends of sleeve simultaneously to aid full sleeve deployment.* Also pull both balloon caps within sleeve to aid stretching out full length.

20. Connect string loops on sleeves to the scale hanging bar hooks.

21. Continue inflation to about 1 mb over-pressure.

22. Disconnect large inflation hose and connect one way fitting.

23. Close BIB doors, read relative humidity (RH) and temperature for first weigh-off estimate. Read balance scales after air in BIB has settled to stable condition.

24. Make preliminary calculations and estimate amount of time/gas needed for final weigh-off.

25. Open BIB and install small inflation hose to balloon.

26. Continue adding gas and weighing off until correct amount has been added.

27. Remove inflation adaptor and cap balloon quickly to prevent gas loss.

*Note: Uniform deployment of the balloon within the sleeve is critical to insure fitting into the launch truck later. The sleeve should be a straight cylinder when balloon is correctly deployed. A bent or banana-shaped cylinder will make sleeve fastening difficult.

Launcher Preparation

- Clean trough when needed.
- Check fuel, water, tires, etc. as needed.
- Apply 3M-401 tape to trough edges.
- Unwind winch line from winch and coil near winch. Hand crank should be used for unwinding to prevent tangling of line.
- Inflate 30 gm pibal and insert in pibal container.

Balloon Loading

- Remove green cover of 401 tape except on rear of trough.
- Place balloon in trough. Center balloon to allow sufficient material for good attachment, both front and rear.
- Fasten sleeve flap to 401 tape all around. (Remove green cover on rear of trough.)
- Attach winch line to sleeve "pull tab." Wind excess line on winch making sure winch winds in forward direction with electric power.

Electronics Tray

- Position tray on launcher supports.
- Lock clamps onto hooks on tray.
- Tie flight train to balloon load attachment.
- Load optional tools and material on launcher (such as tape, scissors, knife, volt-ohm meter, etc.)
- Tie pibal line to pibal. Wind line onto spool on tray.

Launcher Roll-out

- Review check list for completion of all tasks.
- Call control tower for runway clearance.
- Operators don personal safety clothing; coveralls, hard hats, gloves, goggles, etc.
- Start engine for brief warm up. Vent fumes outside through exhaust hose.
- Operators assume positions on launcher - make final review of jobs during release.
- Remove exhaust hose, check for door clearance during exit.

Release Operation

- Drive to runway release area.
- Deploy pibal and adjust speed as needed.
- Position on side of runway best suited for cross winds, if any.
- Operate winch to open sleeve.
- Operator who has been holding pibal now releases it entirely so that it will fly away from TWERLE system.
- Deploy flight train, keeping balloon overhead.
- Clear all lines from tray.
- Return launcher to assembly building.

Message

Sent _____

Confirmed _____

TWERLE FLIGHT TRAIN ASSEMBLY FORM

Table No. _____

Launch No.	Jul. day	Time	PS	DE	TS

P.S. Calibration

Ref. Freq.	Aner. Freq.	Ther. Res.

Component		Serial No.	Weight	Check
Magnetic Cutdown	CD			
Voltage Regulator	VR			
Stable Oscillator	SO			
Transmitter	TX			
Antenna	AN			
Solar Panel	SP			
Pressure Sensor	PS			
Data Encoder	DE			
Temperature Sensor	TS			
Radio Altimeter	RA			
Rigging				
Total Weight				
*FTM for balloon no. _____				
Ballast = FTM - Total Weight				

*FTM = Flight train mass (from balloon weigh-off form)

TWERLE BALLOON WEIGH-OFF FORM

Balloon Number

	Cap (1) or no (0)	$f = \frac{\text{Free Lift}}{\text{SYM}} = \begin{matrix}.07 \text{ cap} \\ .13 \text{ no cap}\end{matrix}$
Kg	Balloon mass	
Kg	Sleeve mass	Gross Lift = SYM x (1+f) - HM
m	Diameter (seam)	$\alpha = .98818$
m	Diameter (gore)	
m^3	Volume	$V = \frac{\pi}{6} \alpha \left\{ .9985 \times \frac{Ds + Dg}{2} \right\}^3$
Kg	System mass	SYM = .25 V
Kg	Helium mass	$HM = SYM \times \frac{4.003}{28.966} \times (1+f)$
Kg	Free Lift	FL = f x SYM
Kg	FLIGHT TRAIN MASS	FTM = SYM - HM - BM
g	Weigh-Off Mass	WOM = BM + SLM + 1.2 - GL

(Time of Day)	1 ( )	2 ( )	TRIALS 3 ( )	4 ( )	5 ( )
A WOM (gms)					
B Hum. correction (Temp. °/% RH)	° / %	° / %	° / %	° / %	° / %
C ΔP Correction (ΔP mb)	(mb)	(mb)	(mb)	(mb)	(mb)
D Corrected WOM (A + B + C)					
E Left Scale F Right Scale					
G Total (E + F)					
H Difference (D - G)					

Date _____

FLIGHT TRAIN ASSEMBLY CHECK

Pressure Sensor: #_____ (check Weight tag)

1. Connect to test set and measure

   f reference _____

   f aneroid _____

   Calculate $\frac{fa - fr}{50}$ = N = _____

   Subtract multiple of 256 so result is less than 256.
   Result = _____

2. Connect pressure sensor

   Record (pressure sensor) _____ (should be ±10 counts of above result)

3. Record (pressure temperature) _____ (should be ±5 counts of short circuit pressure temp. reading)

Radio Altimeter: #_____ (check Weight tag)

1. Connect altimeter to data encoder and to test set.

2. Measure frequency at lock

   f1 _____

3. Calculate .16 f1 = N = _____

   Subtract multiples of 256 so result is less than 256

   Result = _____

4. Record (altimeter) _____ (should be ±10 counts of Result above)

Connect to top half of flight train via extension cable.

Power from simulator supply.

Switch data read-out to receiver input and tune receiver.

Record data

ID _____

Mode	Altimeter	Air temp.	Pressure	Pressure temp.

Test solar panel: (check for weight tag)

Current +12 volt _____ mA > 120 mA

Current -12 volt _____ mA > 120 mA

Power flight train from solar panel

ID _____

Mode	Altimeter	Air temp.	Pressure	Pressure temp.

Measure Local Oscillator frequency of ground receiver

LO = _____

Compute transmitter frequency

ft = 11 LO - 5,500,000

ft = _____

Final Assembly

1. Transfer components to launch table - including cutdown.
2. Remove labels and complete weigh-off form.
3. Interconnect components.
4. Check strain relief on all components.
5. Install air temperature thermistor.
6. Measure resistance at test point.
7. Glue connectors.
8. Tie cutdown to 20 ft, 100 lb test line.
9. Check line spins out properly.
10. Check all connections.
11. Re-check all connections.
12. Cover launch table.

RADIO ALTIMETER CHECK-OUT

Test Set #_____

Altimeter S/N _____

Date _____

Weight _____grs.

Weight Label attached o.k. _____

Set attenuator to 40 db

Min freq. _____ < 27 kHz

Max. freq. _____ > 40 kHz

Scanning time _____ sec 10-35 sec

-12 DC current _____mA < 40 mA

+12 DC current _____mA < 40 mA

Attenuator setting

for lock at 27.6 kHz _____ db (101, 104 - > 8)
(102 - > 5)
(103 - > 12)

Exact freq. _____ 27550 - 27650 H_3

Attenuator setting

for lock at 34.2 kHz _____ db (101, 104 - > -3)
(102 - > -8)
(103 - > 1)

Exact freq. _____ 34130 - 34290 H_3

Oscillator Transmitter Check Out

Oscillator Test:

Unit # _____

Weight _____ (add weight label to unit)

50.15 MHz output _____ 1.55V PP

Power from test set with output to oscilloscope with 50 ohm termination

Transmitter Test:

Unit # _____

Power from test set

Drive signal from test set

Oscilloscope on transmitter test point

Transmitter output to wattmeter (50 ohm terminated)

Check acquisition range and slope:

Low oscillator

Test point voltage _____ +3→+10 volts

High oscillator

Test point voltage _____ -5→-10 volts

Check Transmitter Power Out:

Connect matching oscillator

+12 volt DC current _____ < 70 mA

-12 volt DC current _____ < 70 mA

RF power out _____ > 0.6 w

Adjust test point voltage to +2 volts

Match to Antenna:

Connect transmitter to antenna through power meter

RF Power out _____ > 0.6W

Remove power meter and connect transmitter direct to antenna

Test point voltage _____ +1→+3 volts

(if out of range antenna may be defective)

Adjust test point to +2 volts

+12 volt current _____ < 70 mA

-12 volt current _____ < 70 mA

Adjust Modulation:

(Sync scope from modulation output)

(Scope input from detector output)

Adjust +60° and -60° phase modulation

Measure mixer output frequency

fm _____kHz

Repackage Transmitter:

Place clips in end of transmitter

Wrap with snake skin

Weight _____

(add weight label to unit)

CUTDOWN CHECK-OUT

Serial Number	2.50 ± .25 Cutdown point (gauss) x 10	20 < Td Time delay (sec)	WT (gms)	Date

SOLAR PANEL CHECK-OUT

Side A		Side B		Side C		Total Weight		Date
+mA	-mA	+mA	-mA	+mA	-mA	+mA	-mA	
			+mA	-mA	+mA	-mA		

VOLTAGE REGULATOR CHECK-OUT

Serial Number	Regulation Voltage		Date	WT (gms)
	+12 ± .05	-12 ± .05		

DATA ENCODER CHECK-OUT

Weight _____ Date _____

ID _____ (Octal from tag)

ID _____ (Binary compute from octal)

ID _____ (Binary read from test set)
(LSB) (MSB)

Data Out (simulator connected)

Switch Position	Mode	Altimeter	Air Temperature	Pressure	Pressure Temperature
1	10	(199)	(119)		(111)
2	00	(000)	(004)		(008)
3	01	(219)	(200)		(210)

Temperature Sensor #_____ Weight _____

Thermistor Resistance _____ 3K > Rt > 1K

Data Out (Sensor circuit installed)

Sensor input		Air temp.		Pressure Temperature
Open circuit				
100Kn				
Short circuit				

PRESSURE SENSOR CHECK-OUT

Date _____

Serial Number _____

Pre-Check:

+12 V current _____ < 10 mA

-12 V current _____ < 5 mA

fr _____ reference frequency

fa _____ aneroid frequency

Δf _____ fr - fa

Rt _____ thermistor resistance 4K > Rt > 2K

Valve check: Remove plug and install in bell jar

Valve opens _____ (pump to 150 mb)

Valve stays closed _____ (close and pump to 500 mb)

Pressure of valve opening _____ (200 ⟶ 300 mb)

Calibrate sensor: Pump to 150 mb $\pm$ 0.02 mb

fr _____ Hz

fa _____ Hz

Rt _____ ohms (with +12 volts off)

Set up for flight: Increase pressure to 250 mb $\pm$ 5 mb; close valve and increase pressure to surface.

fr _____

fa _____

Δf _____ fr - fa

Install styrofoam plug Weight _____ (attach weight label)

NOTE: If not launched in one day, check Δf. If Δf has changed more than 10 kHz, pump bubble back to 250 mb $\pm$ 5 mb.

Final Assembly

1. Transfer components to launch tray - including cutdown.
2. Remove labels and complete weigh-off form.
3. Interconnect components.
4. Check strain relief on all components.
5. Install air temperature thermistor.
6. Measure resistance at test point.
7. Glue connectors.
8. Tie cutdown to 20 ft, 100 lb test line.
9. Check line spins out properly.
10. Check all connections.
11. Re-check all connections.
12. Cover launch table.

APPENDIX A

ASCENSION ISLAND

GENERAL REMARKS

Ascension Island (7°57'S., 14°22'W.), of volcanic origin, lies in the South Atlantic Ocean about 1200 miles southwest of Accra, Ghana. It has a diameter of seven miles, a circumference of 22 miles, and an area of 34 square miles. The island, which has a very irregular surface, appears rugged and uninviting from seaward.

The island rises to an elevation of 2,817 feet in The Peak, the summit of Green Mountain. This mountain, which takes its name from the color of its top, is surrounded by many other craggy peaks of lesser elevation, which have deep gorges and ravines between them. There are about 40 cones of extinct craters of various heights on the island, and from these cones the courses of the lava streams may be traced to the sea. The only signs of vegetation on the island are on Green Mountain where vegetables are successfully grown. Rains fall more frequently on the mountain than on the lower part of the island. Mist generally obscures the mountain for some part of the day or night. It condenses on the mountain, and the water is piped to covered tanks in Georgetown.

Devils Riding School, about two miles west-southwestward of Green Mountain, is the most prominent and rugged of the craters.

NORTHERN COAST - English Bay, entered immediately westward of North Point, the northern extremity of the island, is about 600 yards wide. A 19-foot patch lies in the entrance of the bay close within the 10-fathom curve. A landing place is on the southern side of the bay. A small buoy for the use of turtle boats is moored off the landing place during the season, January to April, inclusive.

A conspicuous radio mast, marked by an obstruction light, stands about 1 1/3 miles southwestward of North Point. Several other masts stand eastward of the above mast.

Between North Point and North East Point, about three miles southeastward, the coast is bordered by foul ground which extends about 100 yards off the points and over 200 yards in places off the bights between the points. Travellers Hill, 1,174 feet high, stands about 2 1/2 miles southwestward of North East Crater. Several other peaks lie between Travellers Hill and the northeastward coast.

North East Bay is entered about 800 yards westward of North East Point. A landing place is on the eastern side of the bay. A buoy for the use of turtle boats is moored off the landing place during the season. It is said that rollers enter the bay only about six times a year.

Between North East Point and South East Head, about 3 1/4 miles southeastward, the coast is high and inaccessible with deep water close off it. Boatswainbird Islet, 323 feet high, lies about two miles southeastward off North East Point and about 1/4 mile offshore. Boatswainbird Rocks, with depths of less than six feet, lie about 1/3 mile southeastward off Boatswainbird Islet.

South East Head ($7^{o}57'S$, $14^{o}18'W$), the eastern extremity of the island, rises to a height of 479 feet. White Hill, 1,723 feet high, stands about 1 1/3 miles westward of South East Head.

SOUTHERN COAST - Between South East Head and South Point, the southern extremity of the island, about 6 1/2 miles southwestward, the coast continues high and inaccessible. This part of the coast is exposed to the full force of the southeast trade winds, and the sea breaks on it with great violence.

Two conspicuous radar masts were reported (1966) to stand near the coast about 2 3/4 miles southwestward of South East Head.

Several rocks lie close off South Point, and an islet with a rock awash about 100 yards eastward of it lie about 1/2 mile westward of the same point.

South Pyramid is a conspicuous rock, 48 feet high, on the coast about 1/3 mile west-northwestward of South Point.

South West Bay is entered between Portland Point, about 1 3/4 miles northwestward of South Point, and McArthur Point, about 1,800 yards farther northward. The former point is steep-to and the latter is fringed by shoal water extending about 300 yards westward from it. The bay is frequented by turtles during November and June.

The shore of the bay consists of a fine sandy beach backed by a steep lava cliff which rises to a height of 246 feet. Farther inland is a smooth plain. South West Bay Red Hill, 731 feet high, and Saddle Crater, 422 feet high, lie northward and southward, respectively, of this plain and both are conspicuous. An airfield lies in the valley between these two hills. A conspicuous mast stands on the summit of South West Bay Red Hill and South Gannet Hill, about 1/2 mile eastward of Saddle Crater. This latter hill is 749 feet high.

WINDS AND WEATHER

Temperature

The average temperature from June thru September varies from 79°F in June down to 77°F in September. In the same period, average daily maximum temperature is 84°F in June and July and 82°F in August and September. The extreme highest in this period decreases from 90°F in June to 89°F in July and 88°F in August and September. The average daily minimum is 73°F in June and decreases to 72°F for the remainder of the period. The extreme lowest in each of the months in the same period is 65, 67, 65, and 66°F.

Humidity

The humidity increases only slightly from the beginning of the period to the end, rising from 63% to 67%. There is a diurnal range of about 4%, increasing daily between 0900 and 2100.

Cloud Cover

Cloud cover is rather uniform, ranging from three to five oktas in the period from June through September. Diurnal variation is also very slight.

Precipitation

On an annual basis, precipitation is very low. The amount falling annually is only 4.57 inches. In the period of a year, the monthly rainfall ranges from 0.16 inches in January up to 0.59 in March and 1.02 in April.

From June through September it decreased from 0.59 in June to 0.28 in September. In this latter period, the absolute maximum in any one month is 1.6 inches in June and July and less than 0.5 inches in August and September.

Wind

At no time has the mean wind speed been as much as 33 knots. Based on the 0900 observation, 90% of the winds are from the east (33%) and SE (57%). Of the remainder, 7% are northeasterly and 3% are south and southwest.

In June, 69% of the winds are from the southeast; 19% are from 4-10 knots, 40% are 11-21 knots and 10% are 22-33 knots. The remaining 30% are from the east, ranging in speed as follows: 4% are 4-10 knots, 25% are 11-21 knots and only 1% from 22-33 knots.

In July, wind speeds range from 2% at Beaufort Force 2, 23% at Force 3; 44% at Force 4, 19% at Force 4; 9% at Force 5; and 2% at Force 6 (less than 33 knots).

In August, 79% of the winds are from the southeast while wind speeds again do not exceed 33 knots. In September the percentage frequency of southeast winds drops to 68%, but with a slight increase in winds from the east and south and the velocity remains less than 33 knots.

The attached table contains climatological data based on records of 19 to 34 years.

TRANSPORTATION INFORMATION

Reservations

Space on MAC flights to Ascension Island must be booked on scheduled flights through the NASA GNSO office at Kennedy Spaceflight Center (George Tolson). This is done by filling out the MAC travel orders information form, available in the NCAR/TWERLE office.

Official government travel orders are required and issued through this office.

Check-In

All flights depart Patrick Air Force Base Air Terminal, Hangar 800. Passengers must report to the Passenger Service Counter not later than 1 1/2

hours prior to scheduled departure time.

Baggage

Sixty-six pounds is allowed each passenger. Baggage in excess of this amount must be specifically authorized in the official travel orders. Checked luggage cannot exceed 72 inches in one direction or overall dimensions of 100 inches (length plus width plus height) nor exceeding 100 pounds. Intoxicating beverages must be hand-carried but may not exceed one U.S. gallon per person. Consumption of these beverages is not permitted aboard the aircraft. Flammables and other dangerous items will not be packed in checked baggage or carried aboard in hand baggage.

Immunization

The following requirements apply to Ascension Island:

Immunization	Frequency
Smallpox	3 yrs.
Tetanus diptheria	6 yrs.
Typhoid	3 yrs.
Oral polio	Complete

If travel to Liberia and Ghana is likely, yellow fever (10 yrs.) and cholera (6 months) shots are required in those countries.

If medical attention is required, the PAA dispensary is available. Dental work may be obtained from the English dentists at Georgetown.

The Volcano Club provides various types of refreshments (hard and soft--at the bar of package store) and has a snack bar for sandwiches and popcorn.

The Base Exchange has a supply of necessities as well as watches, cameras and film.

Meals are available at the PAA Mess Hall (Air Force cafeteria style).

Transportation is available around the island in the vehicles assigned to the TWERLE program, other drivers going your way, the NASA crew bus to the Devils Ashpit site or the PAA taxi.

There are tennis courts, basketball and skittles on the American base. Soccer, softball and cricket teams are formed during regular seasons. Deep

ASCENSION ISLAND.—Latitude 07°55′ S., longitude 14°24′ W., elevation 55 feet

Weather elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Years of record
SEA LEVEL PRESSURE														
Average (millibars)	1013	1012	1012	1012	1013	1015	1016	1016	1015	1015	1013	1013	1014	20
TEMPERATURE														
Average (° F.)	79	81	82	82	81	79	78	77	77	77	77	78	79	25
Average daily maximum (° F.)	84	88	88	88	88	84	84	82	82	82	82	84	84	25
Average daily minimum (° F.)	73	73	75	75	73	73	72	72	72	72	72	72	73	25
Extreme highest each month (° F.)	89	91	94	95	92	90	89	88	88	88	88	89	95	30
Extreme lowest each month (° F.)	67	67	67	67	67	65	67	65	66	65	66	67	65	30
RELATIVE HUMIDITY														
Average percent (0900)	68	67	67	67	66	63	65	66	67	67	67	67	66	21
Average percent (2100)	72	71	71	70	69	67	69	69	71	69	71	71	70	21
CLOUD COVER														
Average amount (OKTAS) at 0900	4	4	3	3	3	3	4	4	5	5	5	4	4	31
Average amount (OKTAS) at 2100	3	3	3	3	3	3	3	4	4	4	4	3	3	31
PRECIPITATION														
Average amount (inches)	0.16	0.16	0.59	1.02	0.35	0.59	0.47	0.35	0.28	0.28	0.16	0.16	4.57	30
Maximum in 24 hours (inches)	0.2	1.6	1.8	8.3	1.5	1.6	1.6	0.4	0.3	0.2	0.1	0.2	8.3	30
WIND														
Direction (percentage of 0900 obs.):														
North	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Northeast	7	8	5	13	13	13	6	4	7	4	4	5	7	16
East	31	35	29	34	33	33	35	32	33	34	36	35	33	16
Southeast	59	54	59	49	52	48	57	62	59	60	60	59	57	16
South	2	3	5	4	1	3	2	2	1	1	0	1	2	16
Southwest	1	0	2	0	1	2	0	0	0	0	0	0	1	16
West	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Northwest	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Calm	0	0	0	0	0	1	0	0	0	1	0	0	0	16
Mean wind speed (knots)	5	5	5	5	6	5	5	5	5	5	5	5	5	29
34 knots or over (mean number of days)	0	0	0	0	0	0	0	0	0	0	0	0	0	34

sea fishing is available around the island, from the shore rocks or from the PAA rescue boat on weekends. Some fishing rods are available from the dispensary. Lures can be bought at the Base Exchange.

APPENDIX B
INFORMATION REPORT - REPUBLIC OF GHANA

AREA, GEOGRAPHY

Ghana, formerly known as the Gold Coast, is just north of the Equator, and lies entirely within the tropics. It is on the Gulf of Guinea, bounded on the west, north, and east respectively by the Ivory Coast, Upper Volta, and Togo. The country is about 280 miles wide and 440 miles long, with a land area of almost 92,000 square miles--roughly the size of Oregon. The 334-mile coastline is mostly low, sandy shore, backed by plains and scrub-land giving way to lagoons near the mouth of the Volta River. Inland lies an extensive rain forest belt. North of this belt the land rises unevenly from 300 to 1300 feet and is covered by low bush, parkland savannah and grassy plains.

Several rivers and streams intersect the coastal plain, but the principal river system is the Volta, which enters the ocean 70 miles east of Accra. Since the lower reaches of the river are shallow and contain drifting sand-bars, it is navigable for only about 50 miles upstream, by shallow draft boats. Figure 1 shows a map of Ghana and Figure 2 is a sketch map of the city of Accra. Tourist maps of Accra are available at all hotel newsstands.

CLIMATOLOGY - General Remarks

The South Atlantic Ocean and its eastern border, the southwest African coast, are influenced by a variety of climatic regimes. The climate of the South Atlantic islands is quite similar to that of the surrounding seas. The South Atlantic Anticyclone, the heated continental interior, the extratropical storms, and the cool Benguela current are the most influential factors on the climate of this area. Tropical cyclones are not found in these waters. Because of its broad latitudinal extent this is an area of extremes. From the equatorial doldrums to the "roaring 40's" and "whistling 50's", from the soaking monsoonal rains of the Cameroun coast to the arid deserts of South-West Africa, the variety is endless. However, while there is a great deal of variety, its sameness can be just as striking. For example, along the coast, it is just as possible to have several days of rain and drizzle as it is to have

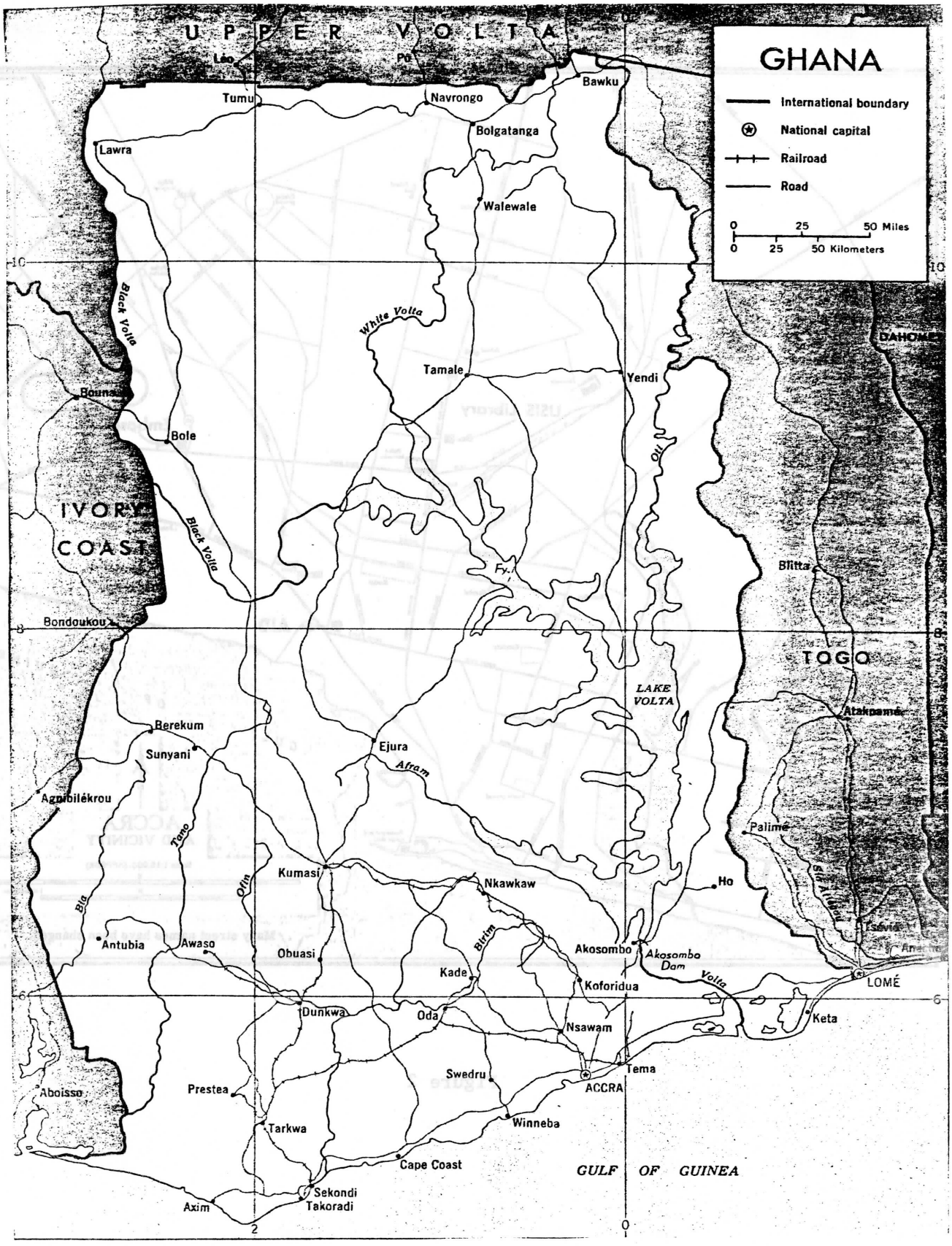

GHANA
International boundary
National capital
Railroad
Road
0 25 50 Miles
0 25 50 Kilometers
UPPER VOLTA
Léo
Po
Tumu
Navrongo
Bawku
Bolgatanga
Lawra
Walewale
Black Volta
White Volta
Tamale
Yendi
Bouna
Bole
DAHOMEY
IVORY COAST
Black Volta
Oti
Fyi
Bondoukou
Blitta
TOGO
LAKE VOLTA
Atakpamé
Berekum
Sunyani
Ejura
Afram
Agnibilékrou
Tano
Palimé
Bia
Kumasi
Nkawkaw
Ho
Ofin
Sio
Antubia
Awaso
Obuasi
Birim
Akosombo
Akosombo Dam
Volta
Kade
Koforidua
LOMÉ
Dunkwa
Oda
Keta
Nsawam
Swedru
Tema
Aboisso
Prestea
ACCRA
Tarkwa
Winneba
Cape Coast
GULF OF GUINEA
Sekondi
Takoradi
Axim
10
8
6
2
0

Figure 1

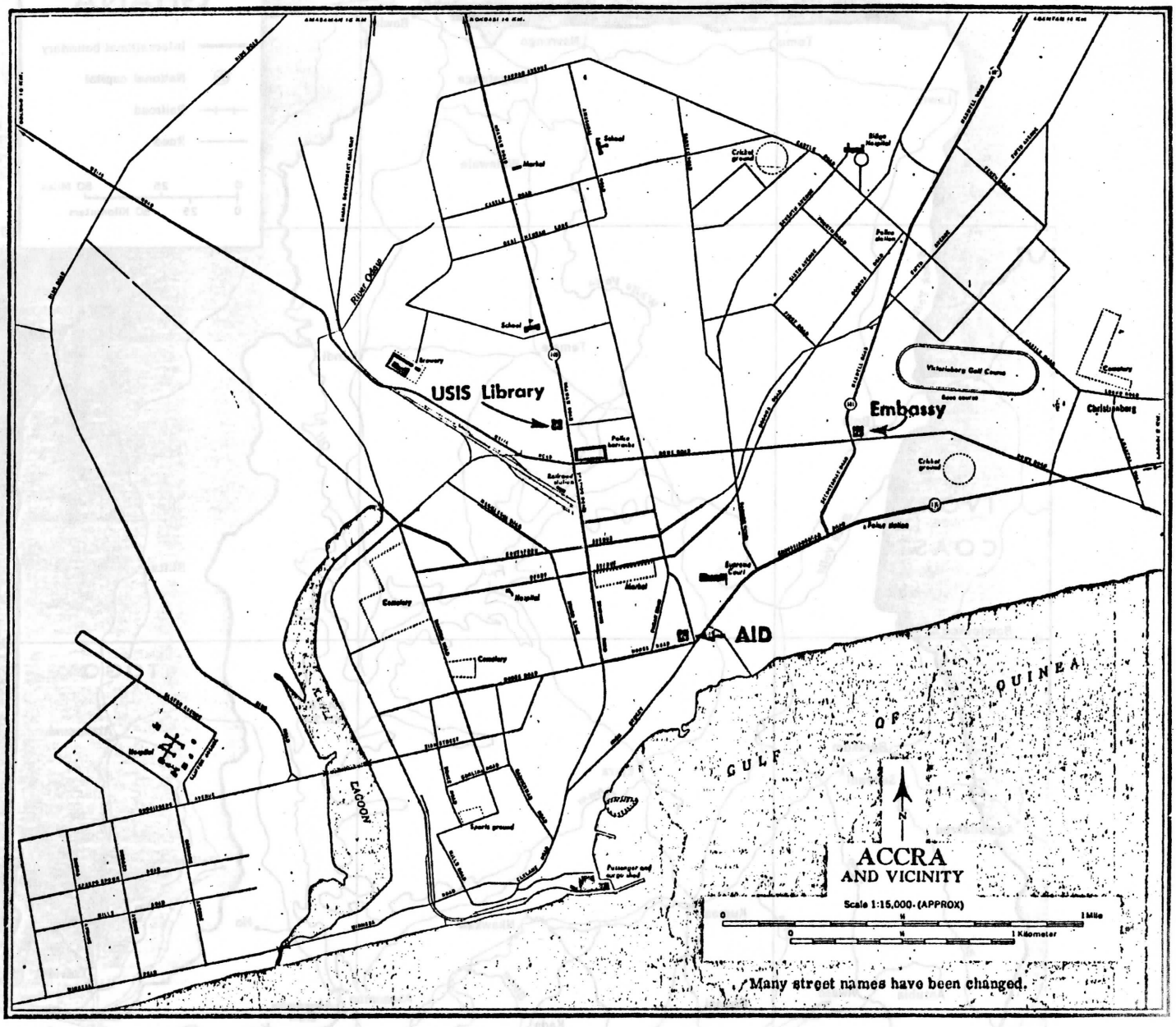

USIS Library
Embassy
AID
River Odaw
KORLE LAGOON
GULF OF GUINEA
ACCRA
AND VICINITY
Scale 1:15,000- (APPROX)
Many street names have been changed.

Figure 2

many days without any clouds. Ironically, coastal South-West Africa, mainly arid desert, has an average relative humidity as high as most equatorial regions.

Pressure

The South Atlantic Anticyclone is the dominant pressure system in this area. Its influence, which varies seasonally, covers a general range of latitudes from 10°S to 35°S. To the north lies the equatorial trough. The southern portion of the area, under the influence of the circumpolar westerlies, is beseiged with extratropical lows which, with associated frontal systems, influence weather as far north as the southern tip of Africa.

The persistence of the South Atlantic Anticyclone is evident in the variation of its average central pressure. It is intense during the southern hemisphere winter (July) when the average central pressure is near 1025 mb. and pressure is high everywhere. In summer (January) the high is weakest as central pressure drops to 1020 mb. and the center shifts about 3° south of its wintertime position. Average pressures are generally four to six mb. lower during the summer, and locally six to eight mb. lower along the coast from Mocamedes to Cape Town. The 1010 mb. isobar replaces the 1015 mb. isobar in the northern portion of the area. This anticyclone is made up of large migratory highs moving under the influence of upper level westerlies. They are not responsible for a large portion of the wind field over the area but associated subsidence is an important factor in rainfall distribution and fog formation.

The equatorial trough, a major factor in the weather of Ghana, is a belt of low pressure lying between the South and North Atlantic Anticyclones. Its most important feature is the ITC (Intertropical Convergence Zone) which represents the area of convergence of the northern hemisphere's northeast trade winds with the southern hemisphere's southeast trade winds. Although the ITC is not found at the surface in the southern hemisphere, its effects are felt well into the area due to its southward slope aloft. Its effect is most evident in the summer (December - March) when the equatorial trough lies just north of the equator. In the winter months (June - September) the equatorial trough moves to near 20°N. and only the portion to the north of the equator is affected.

Winds

Tables 1, 2(a), and 2(b) indicate wind distribution and frequency of winds for Accra.

The most significant of the local wind regimes in the area is the southwest monsoon. This large-scale sea breeze occurs in the northern sections over the Gulf of Guinea and adjacent coasts extending 100 to 200 miles inland. It is strongest during the northern summer (June-August) but it is prevalent year round. The monsoon is a deflection of the southeast trade winds toward the heated continental interior. Its influence is felt to about 10°S. and it acts very much like a land-sea breeze regime. At Douala, for example, while southwest winds are prevalent during the afternoon, their frequency drops to five percent during the early morning hours.

The Harmattan, a wind of continental origin, is a hot, dry wind, from the northeast quadrant, which reaches the shores of the Gulf of Guinea and extends seaward. It is prevalent from December through early March and is usually laden with fine dust which can seriously impair visibility in the form of haze. This may occur at times when other than a northeast wind is blowing since the harmattan may be forced aloft by the southwest monsoon, but the dust will still settle out. The harmattan is found mainly from Cape Palmas to Douala, which includes the area around Accra.

The maximum number of days on which wind speed is 34 knots or greater is three in May and from July through September none have been recorded. On the mean, these winds occur only one day in June. The direction of winds at Accra, based on the 0900 observation, is shown in Table 1. The frequency of various ranges of wind speeds is shown in Tables 2(a) and 2(b).

Precipitation

The west coast of Africa experiences a wide variation in precipitation amounts and is under the influence of several types of rainfall regimes.

The coastline north of the equator is under the influence of an equatorial and a monsoonal regime. In the equatorial type there are usually two rainfall maxima occurring shortly after the equinoxes (spring and fall) while the monsoon regime results in a strong summer maximum. The combination of these two regimes results in an extended rainy season with a summer maximum.

Accra has an annual average of about 31 inches of rain over an average of 54 days. The average monthly maximum of eight inches occurs in June. In that time, the maximum of 24 inches occurs. The daily maximum of 12 inches also takes place in this month. These values are shown for the entire year on a monthly basis in Table 1.

Thunderstorms occur 108 days per year, with a maximum of 16 days in May and 17 days in November.

Cloudiness

Average cloud cover is shown in Table 1, with less than 2/10 average amount occurring only 19 days per year, in the period of November through April. From May through October, the cloud cover is always greater than this. From June through September, about 14 days per month show average cloud cover exceeds 8/10.

Temperature

Atmospheric temperature is principally controlled by the incoming solar radiation and is therefore dependent, to a large degree, upon latitude. It is also influenced by the nature of the earth's surface, the latitude, and the prevailing winds. In the tropical and subtropical regions of this area, average annual temperatures decrease very little with latitude. The average temperature difference between the equator and 30°S. is only about 17°F. as compared to a 36°F difference between Libreville and Cape Town, which is 10°F. in January and 21°F in July. The annual range of temperatures also varies with latitude. Near the equator the range is small, from 4° to 6°F., increasing to 8° to 12°F. from 10°S. to 30°S. South of 30°S. the annual range decreases again reaching a secondary minimum of about 6° to 10°F. near 50°S. This is small when compared with the 40°F. average annual temperature range at 50°N. This secondary minimum is due to the sharp decrease in continental area south of 30°S. At 30°S. about 20 percent of the earth's circumference is covered by land while at 40°S., this drops to four percent. Thus the effect of the

ocean with its smaller annual temperature range is felt more strongly than the influence of increasing latitude which tends to produce a large annual temperature range.

At Accra, the average temperature ranges from 76°F. in July and August to 82°F. from February through April. The absolute maximum ranges from 100°F. in February and March down to 89°F. in August. The monthly distribution of these values is shown in Table 1.

Summary

To summarize these various elements, Accra's climate is warm, humid, and sunny. Mean temperature is 80°F and varies between annual extremes of 73° and 88°F. Relative humidity at Accra is greatest at dawn and falls each day from a mean of 93.5% to 66%. Belongings not kept in air-conditioned rooms may mildew.

Rainy seasons extend from May to July (heavy rains) and from September to November (light rains), but monthly and yearly totals vary greatly; it is quite common for an entire month in the rainy season to pass without appreciable rainfall. Rainstorms are usually intense and brief. Accra's annual rainfall averages 31 inches--quite low for the equatorial coast of West Africa. This accounts for the few cloudy days in Accra during the year.

The coolest months in Accra are May to October. In December the Harmattan, a dry dusty wind from the Sahara usually reaches the city and may persist through January. It reduces relative humidity to 40% and, although daytime temperatures are high, nights are relatively cool. Dust storms may occur during this season causing a constant haze in the sky. This occurs on an average of only 0.3 days per month in August and September. At these times visibility can be reduced to less than 1/2 mile.

A detailed summary of the weather elements by month is shown in Table 1.

POPULATION

Preliminary figures from the 1970 census show that Ghana has about 8.5 million people. The population consists of about 50 tribes which can be

divided into five distinct tribal groups sharing common customs, folkways, and religion. The largest group, the Akan, comprises 43% of the population, followed by the Northern group, 28.8%, the Ewes, 12.5%, and Ga, 3.6%; and Adangbe, 3%.

Although many minor differences exist, the main distinction between groups is language. Major languages are Akan, Dagbani, Ewe, Ga, Hausa, and Nzima. English serves as the lingua franca, especially among the educated.

HISTORY

The history of the Gold Coast (now Ghana) before the last quarter of the 15th century is based primarily on the traditions and memories preserved in tribal stories and folklore. Many of these traditions refer to migrations from the ancient kingdoms of the western Soudan (now the Mauritania-Mali area). The name of Ghana was chosen for the Gold Coast because of speculation that these migrants moved south from the ancient kingdom of Ghana.

The first fully authenticated contact between Europe and the Gold Coast dates from 1470 when a party of Portuguese landed. In 1482 the Portuguese built Elmina Castle as a permanent trading base. The first recorded English trading voyage to the coast was made by Thomas Windham in 1553, and in the course of the next three centuries the English, Danes, Dutch, Germans and Portuguese controlled various parts of the coastal areas at different periods. In 1821 the British Government took over the control of the English private trading company operating the Gold Coast settlement, and in 1844 the Fanti chiefs in the immediate neighborhood approved a pact, or bond, by which they agreed, among other things, to submit cases of murder and other crimes to Queen Victoria's judicial officers sitting with the chiefs.

From 1826 to 1900 the British fought a long series of campaigns against the Ashantis of the interior. Only in 1901 did they succeed in making Ashanti a colony and the Northern Territories a protectorate. The fourth territorial division eventually to form part of the nation, British Togoland, was part of a former German colony, administered by the United Kingdom from Accra as a League of Nations mandate after 1922. In December 1946 British Togoland became a U.N. Trust Territory, and in 1957 following a plebiscite held in 1956, the United Nations agreed that the territory should become a part of Ghana when the Gold Coast achieved independence.

ACCRA, GHANA.—Latitude 05°36′ N., longitude 00°10′ W.

Weather elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Years of record
SEA LEVEL PRESSURE														
Average (millibars)	1011	1010	1010	1010	1012	1013	1014	1014	1013	1012	1011	1011	1012	10
TEMPERATURE														
Average (° F.)	81	82	82	82	81	78	76	76	78	79	81	81	80	20
Average daily maximum (° F.)	87	88	88	88	87	84	81	80	81	85	87	88	86	17
Average daily minimum (° F.)	73	75	76	76	75	75	73	71	73	74	75	75	74	17
Extreme highest each month (° F.)	95	100	100	96	95	92	90	89	91	91	92	94	100	18
Extreme lowest each month (° F.)	59	52	67	60	64	67	64	64	65	67	67	63	59	18
RELATIVE HUMIDITY														
Average percent (0600)	95	96	95	96	96	97	97	97	96	97	97	97	96	9
Average percent (1200)	61	61	63	65	68	74	76	77	72	71	66	64	68	9
CLOUD COVER														
Less than 2/10 average amount (mean number of days)	4	4	1	2	0	0	0	0	0	0	1	7	19	10
More than 8/10 average amount (mean number of days)	9	3	7	5	8	13	12	15	14	7	4	4	101	10
PRECIPITATION														
Average amount (inches)	0.63	1.46	2.87	3.23	5.71	7.60	1.93	0.63	1.58	3.15	1.50	0.71	30.98	30
Greatest amount (inches)	3.50	6.26	8.82	8.84	13.62	23.96	8.89	4.12	8.85	9.22	3.46	3.24	44.90	61
Least amount (inches)	0	0	T	0	0.27	0	0	0	0	0	0	0	10.84	61
Maximum in 24 hours (inches)	3.5	4.2	4.3	5.4	5.9	11.9	4.1	3.7	4.5	5.5	3.7	3.0	11.9	64
0.01 inch or more (mean number of days)	1	2	4	6	9	10	4	3	4	6	3	2	54	46
WIND														
Direction (percentage of 0900 obs.):														
North	10	6	1	2	4	2	3	2	2	2	2	9	4	14
Northeast	9	4	1	2	1	1	0	1	1	1	2	8	3	14
East	3	2	1	1	2	1	0	0	0	1	0	2	1	14
Southeast	1	1	1	1	2	2	2	0	1	3	2	1	1	14
South	0	1	4	4	7	6	8	4	4	3	4	1	3	14
Southwest	30	41	45	53	44	47	57	60	61	57	54	34	49	14
West	20	29	31	24	24	19	23	22	20	20	21	25	25	14
Northwest	19	11	9	7	8	12	9	7	7	8	11	16	10	14
Calm	0	5	7	6	8	10	8	4	4	5	4	4	6	14
34 knots or over (mean number of days)	0.7	1.0	1.0	2.0	3.0	1.0	0	0	0	0.7	0.7	0.3	10.4	3
Mean wind speed (MPH)	5.5	5.5	10.1	5.5	5.5	5.5	5.5	10.1	10.1	5.5	5.5	5.5	6.6	9
VISIBILITY														
Days with visibility less than ½ mile	0	0	0	0	0	0	0	0.3	0.3	0	0	0	0.6	3

Table 1

Constitutional progress was marked by continuous development in the Legislative Council, although until 1946 it was not the legislature for the whole country but only for the coastal area then known as the "Colony". Ashanti, until 1946, and the Northern Territories, until 1951, were administered directly by the British Governor. The constitution of 1951 provided for a greatly enlarged legislature comprised principally of members elected directly or indirectly by popular vote. An Executive Council was responsible for formulating policy, with a majority of African members drawn from the legislature but including three ex-officio members appointed by the Governor.

The constitution, approved on April 29, 1954, established a cabinet composed wholly of African representative ministers drawn from an all-African legislature chosen by direct election. The Convention People's Party (CPP), in the elections which followed, won the majority of the seats in the new Legislative Assembly.

In May 1956 Prime Minister Kwame Nkrumah's Gold Coast Government issued a White Paper containing proposals for Gold Coast independence, including a proposal for changing the name of the country to "Ghana". The British Government, confronted with a serious dispute which had arisen on the issue of a unitary or federal form of government, stated it would agree to a firm date for the granting of Gold Coast independence if a reasonable majority for such a step were obtained in the Gold Coast Legislative Assembly after a general election. The new general elections, held July 12-17, 1956, resulted in the Convention People's Party being returned to power with 71 of the 104 seats in the Legislative Assembly.

Ghana became an independent state on March 6, 1957, when the United Kingdom relinquished its control over the Colony of the Gold Coast and Ashanti, the Northern Territories Protectorate, and British Togoland.

PUBLIC INSTITUTIONS

The Nkrumah regime, which governed Ghana from independence in 1957, was overthrown by a military-police coup in February 1966. The National Liberation Council then governed the country by decree until October 1960, when power was restored to a freely elected civilian government.

On August 22, 1969, the Constituent Assembly promulgated a Constitution for the Second Republic of Ghana. This was followed on August 29 by national elections. The Progress Party (PP), under Dr. K.A. Busia, won 105 out of 140 seats in the National Assembly. The principal opposition party, the National Alliance of Liberals (NAL), under Mr. K.A. Gbedemah, won 29 seats. Prime Minister Busia's government took over formally from the NLC on October 1, 1969. This was followed in 1971 by the National Redemption Council under Col. Aaheompang who, in 1974, is still Chairman of the Council and Head of State.

The Ghanian judiciary, an independent branch of government, is structured like the judicial system in the U.S. Ghana's legal system combines elements of English jurisprudence, common law, and Ghanian customary law.

A number of private social and philanthropic organizations exist in Ghana, including Rotary, Odd Fellows, Boy Scouts, YMCA, YWCA, and the Salvation Army. The government runs a number of charitable institutions, such as the Deaf School, the Blind School, and a leper colony.

COMMERCE AND INDUSTRY

Ghana's economy is mainly agricultural with farmers making up about 60% of the working class. Cocoa is the main cash crop and, with other farm products, accounts for over three-quarters of the country's export earnings and a large part of the government's revenue. Kumasi, the old Ashanti capital, is the center of cocoa production and is also important in the timber industry. In the semiarid savannah of northern Ghana (nearly half the country's land area) raising livestock is the main activity. The humid forest region in the southwest produces rubber and bananas, while the drier southeast produces livestock, poultry, and food crops.

Today Ghana's aim is to emphasize manufacturing based on increased and diversified agricultural production and reduce a heavy dependence on imported foodstuffs. Farmers are encouraged to grow cotton, sugar cane, rubber, tobacco, citrus fruits, corn, and vegetables. The industrial capability, skilled labor, and inexpensive power (produced by the $350 million Volta River hydroelectric project) is largely already available for processing such produce. Even though the station at Akosombo has a generating capacity of about 512,000

killowatts (more than domestic requirements), two new generators will be added shortly.

Pending increased agricultural output and construction of more transmission facilities for Akosombo power, Ghana concerns itself with balancing import requirements and debt service against export earnings. This involves foreign exchange controls. Import licenses are granted according to economic priorities, and as a result, many consumer goods--especially luxury items--are not available.

TRANSPORTATION

The only adequate means of transportation is by private car. Many taxis operate in Accra, but they are hard to find in the residential areas where most Americans live, especially during the rainy seasons. American employees who do not own cars are authorized to use official transportation between residence and office for a small fee each trip. Cars can be rented from several local firms on a daily rate and mileage basis for about $20 per day.

Smaller American and foreign cars are best in Accra. Because lack of street lights and the presence of open drainage ditches make backing up at night hazardous, you should equip your car with back-up lights. As of 14 August 1974, traffic moves on the right and, for some time to come, the risk of accident will be great. Air conditioners are desirable for comfort and for security; closed windows reduce the danger of petty theft while you are stopped in traffic. AM or FM car radios are useless. A stereo tape deck can provide pleasant entertainment. Repair facilities are not very good and spare parts, especially for American cars, are often unavailable. There are no color restrictions on private vehicles.

A number of British and European cars are available from local dealers but the prices include import duty. There is no provision for rebate. The Japanese Toyota, assembled locally, is also available but local excise taxes are levied and these average high, about 100%.

Ghana has about 3500 miles of hard surface roads. Due to poor roads, cars are difficult to operate during the rainy season except in town.

Price for premium gasoline was about 70.5¢, but has now gone up to over $1.00 per imperial gallon (5 U.S. quarts). Personnel on the diplomatic list and employees of A.I.D. can buy gasoline (premium) duty-free at about 27¢ per imperial gallon. All other employees pay full retail price. (This will include NCAR employees.)

Although railroad service exists between Accra and several larger Ghanian towns, Americans rarely use this mode of transportation. For in-country trips other than by car, Ghana Airways has scheduled flights between Accra, Kumasi, and Tamale and Takoradi. Airline service to points outside Ghana is provided by 16 international carriers.

COMMUNICATIONS

Telephone and Telegraph

Radiotelephone service exists between Accra and London. Overseas connections may be made via London for calls to the U.S. and other points. The quality and reliability of these calls is very poor. Telex is the most reliable and goes directly into NCAR. Such calls may be placed between 8:15 a.m. and 6:00 p.m., local time (Accra is on Greenwich Mean Time year round). Cable service is good. Many residences do not have telephones and they are hard to get. In general, telephone service even within Accra is very poor and extremely unreliable.

Mail and Pouch

There are three weekly airmail flights between New York and Accra. Surface mail takes four to 10 weeks, sometimes longer. Nondiplomatic personnel must pay customs duties (prohibitively high on almost all consumer items) on incoming packages through the Ghana mail.

Radio and TV

Only shortwave radios can be used in Ghana. Radio reception is good for Radio Ghana, VOA, and BBC. Nigerian and Ivory Coast stations may also be heard. Sets brought to Accra should be made for tropical conditions. A government-owned TV station broadcasts programs in the evening. Ghana Television uses the European system (625 horizontal lines), which is not compatible with the American system. Sets brought from the U.S. should be adapted before shipment. Radios and TV sets are sold here, but are expensive.

Newspapers, Magazine, and Technical Journals

European editions of "Time", "Life", and "Newsweek" and other American magazines are sold for about 90 pesewas. British magazines and newspapers are also on sale. The USIS library has American magazines and airmail editions of the "Herald Tribune". Three local daily newspapers and several weeklies, monthlies, and quarterlies are published.

HEALTH AND MEDICINE

Medical Facilities

Although a health unit under the direction of an American R.N. is assigned to the U.S. Embassy, the facilities are not regularly available to U.S. citizens in Ghana except those assigned to the Embassy. They have, however, prepared a list of recommended physicians, surgeons and facilities which is attached to this appendix as "Attachment A". Based on information from the health unit, arrangements for NCAR personnel to be admitted to Korle Bu Hospital, if necessary, can be made. A letter from NCAR has already been sent to this hospital in order to facilitate arrangements when operations commence in Ghana.

A letter from NCAR authorizing emergency treatment has also been given to the following general practitioners in Accra:

Dr. J.A. Blankson, Mobil House, Tel. 64921

Dr. K.N. Tamklo, Nyaho Clinic, Airport Road, Tel. 75341.

Limited hospitalization is also available at the Nyaho Clinic.

If you are taking a prescription drug, bring a supply to last several months as renewals may have to come from the U.S. Drugs sold locally are imported from Europe, and selection is small.

A local optometrist can make up prescriptions, but if lenses are for more than minor correction, bring a second pair with you. Any latent medical problem should be investigated before departure for Ghana.

Community Health

Health precautions observed in any overseas area are applicable to Ghana.

Provided your shots are kept current, little danger exists from serious diseases endemic to Ghana (malaria, TB, smallpox, typhoid, hepatitis, and enteric fevers). Stomach upset and diarrhea are common and may be contracted unless care is used in preparation of food. Strict cleanliness in food preparation is important. Staphylococcus infections are prevalent, and you may experience many unidentified infections during your tour. Servants should undergo periodic health examinations.

Preventive Measures

All personnel and dependents should get polio, typhoid, tetanus, gamma globulin, and yellow fever shots before leaving the U.S. Except for yellow fever, all boosters can be obtained from the physicians listed above. Yellow fever boosters are taken at the Public Health Center in Accra.

Malaria suppressives must be taken regularly every week. Obtain an initial supply prior to departure from the States.

It is recommended that malaria suppressives be taken two weeks before arrival at post and continued for a month to six weeks after departure from Accra.

All water, for drinking or ice cubes, should be boiled. Canned, powdered, and reconstituted milk is always available. Raw vegetables are unsafe without treatment with an antiseptic agent (available locally). All meat should be well cooked.

It is not safe to swim in fresh water streams or lagoons due to the prevalence of schistosomiasis.

Persons with respiratory or skin allergies should not be assigned to Accra.

Housing

Rental housing is not readily available for short term lease, but occasionally can be found.

A possible contact for rentals is United Africa Co., Rental Housing Division, Mr. Deppah or Mr. Measah.

A 10% discount can be obtained at the Continental Hotel after the first two weeks to a month of occupancy.

Utilities

Electric current is 230v, 50-cycle, single phase, AC. Power fluctuates and failures are common. Electric fittings are three-prong but U.S. plugs can be used with adapters (available locally). Light fixtures are for British-type bulbs with a bayonet two-pin contact base, but 230v, screw-in type bulbs are also sold for American lamps. Transformers are required with equipment designed for other than 230v and are provided for government-furnished appliances. Radios and record players can deteriorate unless manufactured for tropical climates. Tape recorders and record players must be adapted for 50-cycle current. Individuals who own or plan to buy expensive stereo or similar electrical equipment should bring a voltage regulator. American-made electric clocks cannot be used because of the 50-cycle current.

Food

All essential and some luxury processed, canned, and frozen foodstuffs are imported and are sold at several stores. Many products come from the Sterling area and Eastern Europe. Few American food products are available. The variety and quality of imported foods available on the local market is unpredictable and, at best, quality and selection will be disappointing. Prices are high. The quality of fresh meat and poultry depends on individual taste and choice of butcher. Fresh milk is not available but a local plant produces good reconstituted milk and ice cream. Local beer is good and popular soft drinks such as Coca Cola, Pepsi, and Sprite are available.

In season, local fruits, oranges, pineapple, lemons, limes, and papaya (pawpaw) are excellent and inexpensive. Fresh eggs are easily found.

Clothing

Men. Wash-and-wear suits are very desirable here because of the climate. The "Haspel" type American suit is also a good buy. Wash-and-wear suits are sold in a few local stores but are 40% above U.S. prices. All types of shoes and sandals are worn; bring an adequate supply since locally made shoes may not be satisfactory. Hats are never worn except at the beach and on the golf course to ward off the sun. Bring the lightest weight raincoat available. During the rainy season, lightweight sweaters and sport jackets are comfortable in the evenings. Bring a good supply of sport shirts, underwear, socks

and other clothing items. All of these things are available here but prices are high.

Religious Activities

The Protestant European community generally attends an interdenominational chapel. Other churches in Accra include Roman Catholic, Anglican, Methodist, Christian Science, Baptist, Presbyterian, Seventh Day Adventist, and Lutheran.

Recreation and Social Life

Sports

In Ghana, the Central Organization of Sports is responsible for organization, promotion, and control of all sports. As a result, Ghanians are enthusiastic about sports and sporting clubs. Soccer is the most popular; other favorites are table tennis, cricket, polo, lawn tennis, and field hockey. Horse racing attracts large crowds and turf clubs operate in Accra, Kumasi, and Takoradi.

Recreation facilities around Accra include two 9-hole golf courses, at Achimota on the outskirts of town and at Tema (30-minute drive from Accra), a tennis club, and a polo club. Membership fees are reasonable.

Some private tennis courts (including one at the DCM's residence) are open to Embassy people and NCAR personnel, if arrangements are made personally.

Several attractive beaches for swimming may be found around the city but the undertow is dangerous. The Ambassador Beach Club, five minutes from the Embassy, is a popular spot. Family membership is reasonable. Beverages and lunch are served year-round. The Tesano Club, four miles from Accra, offers movies, tennis, bar, dancing, and swimming pool. Also, two conveniently located clubs, the Acapulco and the Riviera, have olympic-size salt water swimming pools, sheltered areas with beach chairs, wading pools for children, dressing rooms, and snack bars. Membership in either club is reasonable and there is no waiting period for joining.

A softball field is available at the Embassy apartment compound, and a game is played every Saturday, weather permitting.

Boating or sailing is practical only in lagoons or at the Yacht Club in Tema Harbor, about 20 miles from Accra. Water skiing is also done in Tema Harbor.

Bush fowl and duck are hunted a few miles from Accra. Bigger game such as antelope and bush buck are found in the Northern Region some 300 miles away.

Surf fishing and some fishing from boats are done along the coast, expecially off the mouth of the Volta River. A power boat is needed but few exist here. Little sport fishing is done in the rivers.

A small selection of tennis rackets and golf clubs and balls (expensive) are sold here. The usual sports clothes and bathing attire are worn and are available here, though they are more expensive than in the U.S. Tennis and golf shoes are hard to find in American sizes.

Touring and Outdoor Activities

In and around Accra Points of interest in Accra include Black Star Square, Flagstaff House (now Army Headquarters and former residence of Kwame Nkrumah), Christiansborg Castle (now seat of government), the Supreme Court, Parliament, and the State House complex.

Makola and Salaga markets give the flavor and excitement of Ghana today. Hundreds of mammy traders carry on traditional trading in many different items.

The National Museum, National Archives, and National Science Museum are interesting.

The University of Ghana at Legon--one of three university campuses in Ghana--is a 10-minute drive north of the city. Be sure to browse in the University's excellent bookstore and tour some of the residence halls.

Within 30 miles of Accra Of great pride to Ghana is the new industrial seaport of Tema, 20 miles east of Accra. Among the industries here is the VALCO aluminum smelter, largest outside North America. The U.S. Government provided $100 million in loans to the two American companies (Kaiser and Reynolds Aluminum), which then invested an additional $50 million for construction of the plant. The smelter's demand for electric power made the

Akosombo dam on the Volta River feasible. A.I.D. and other U.S. agencies supported construction of the dam with loans totaling one-fifth the cost.

A 40-minute drive north of Accra is Aburi with botanical gardens. Peduasi Lodge (Kwame Nkrumah's weekend lodge), is on the route.

One to Three-Day Trips

Accra-Takoradi (142 miles) - Much of the trip is along the coast where 400 years of Ghanian history is reflected in the forts and castles built by Europeans who came to the Guinea Coast for gold and slaves. Many are well-preserved and provide worthwhile insights into West African history. Fishermen can be seen along the coast with their large canoe-like craft, hewn from large tree trunks. Swimming is good at Winneba, Cape Coast, and Birewa. While at Cape Tarkwa--an hour inland from Takoradi--is the center of the gold mining industry. It is sometimes possible to visit the mines.

Accra-Lome, Togo (120 miles) - This road passes Tema and Pram Pram. A new bridge across the Volta at Sogakofe shortens the trip to under three hours. A more interesting route is via Ada, where you ferry across the Volta through a maze of islands to Anloga, then drive along the penninsula to Keta, a major fishing center.

Accra-Kumasi (175 miles) - There are two roads, one via Koforidua and Aburi, the other via Kibi and Nsawam. In Nsawam you can see the Kente weavers at work. If the trip is made through Aburi, you can stop at the Cocoa Research Institute at Tafo. Kumasi is the capital of the Ashanti Region, site of four Ashanti wars between the British and tribal chiefs of the area. This is Ghana's second largest city and site of the University of Science and Technology. Also of interest here are the Cultural Center, the zoo, and the market.

Near Kumasi is Lake Bosumtwi, Ghana's largest natural lake.

Accra-Ho (105 miles) - An hour and a half along this road is the Volta River dam at Akosombo. The man-made lake behind it covers 3275 square miles, 7.1% of Ghana's land area. There is fresh water swimming, a restaurant, and hotel here. The market at Ho is one of the largest in the Volta Region. Just beyond are the Wli Falls. Not far is Amedzofe, Ghana's highest point, 2900 feet above sea level.

Kumasi-Tamale (main route to Upper Volta, 237 miles) - Here on the northern savannas is a way of life that differs from southern Ghana. The trip includes a ferry ride across the swollen Volta at Yeji, 141 miles north of Kumasi. The slave market at Salaga, on the way to Tamale, recalls Ghana's past. Tamale has a large educational complex and horticultural gardens worth visiting.

Tamale-Navrongo (main route to Upper Volta, 120 miles) - A major stop on the way is Bolgatanga, known for its market, crocodile pond, and Tongo Fetish Tomb. In Navrongo, the Navropio's palace is worth a visit.

Two worthwhile side trips are: to Wa by way of Damongo, where you can see the Moslem influence of northern Ghana and visit a game reserve, and to Yendi to see the Ya-Na's palace.

Travel in Ghana can be stimulating and fun. Ghanians are friendly and hospitable. You should accept opportunities to attend local ceremonies, especially those featuring native dancing and drumming. It is not necessary to drive great distances, or visit only the biggest towns, to have a good time and learn about Ghanian life.

Adequate hotels can be found in Takoradi and Kumasi. Government Catering Rest Houses (serving meals) are in Sunyani, Tamale, Takoradi, Cape Coast, and Koforidua; Government Rest Houses which do not serve food are in many smaller towns. These are open to the public at reasonable prices and most have limited facilities. Few have airconditioning. Privately run hotels or motels exist in places like Discove, Elmina, Akosombo and Kumasi.

Persons interested in photography will find much interesting subject matter here. Camera equipment can rust and mildew. Black and white film is available, and can be developed and printed here although most film is sent to the UK, France, or Germany.

MISCELLANEOUS

Customs and Duties

Shipment of personal effects should be consigned to Meteorological Services Department, marked for individual, Project TWERLE, Kotoka International Airport, Accra, Ghana. Upon receipt of airwaybills, clearance will be arranged

by the Met. Services Dept. (Mr. Larbi, Superintendent of Stores) who will advise you when it can be picked up at the State Supply Commission office at the airport.

Under the terms of the "Memorandum of Understanding" between the Met. Services Dept. of the Government of Ghana and the National Science Foundation of the United States, U.S. personnel will be accorded "First Entry Privileges" and will be free to bring in their personal and household effects (if desired), including one car free of customs duties (but excluding consumable stores and petroleum products). The items may be exported duty-free after completion of the project but any items sold in Ghana will be subject to normal customs duties.

All personnel have a six-month period to receive their duty-free items, but the Ghanian government requires persons, such as those assigned to TWERLE by NCAR, not on the diplomatic list to prove that the items imported were purchased to the entry of the individual into Ghana.

Pets

Although it is doubtful that any NCAR personnel will wish to bring a pet into Ghana for the relatively short period of the project, a Certificate of Health would be required and should state: (1) the pet is in good health and is free of infectuous disease, and (2) that for six months before departure the pet has been in a rabies-free area or has had rabies shots.

Currency

The legal tender in Ghana is the Cedi. One Cedi 15 peswa equals $1. No Ghanian currency may be brought into the country. Violation of this regulation brings a minimum penalty of 25 years imprisonment. There is no limit on the number of dollars, either currency or travelers checks, that may be brought into the country; however, only that foreign currency declared on entry may be exported. Permission must be obtained from the Exchange Control Board to convert Ghanian currency into dollars. Although exchange facilities for authorized personnel are available at the Embassy Annex, NCAR employees will have to utilize the facilities at Barclay's or Ghana Standard Bank on High Street in Accra.

Banking

There are three banks in Accra (Barclays Bank, Standard Bank of West Africa, and Ghana Commercial) at which personnel may open Cedi checking accounts. The banks accept dollar drafts, travelers checks, or currency. There is a 1% commission for changing all foreign currency.

NCAR has opened a checking account at Barclay's since this is a correspondent bank in Ghana for the 1st National Bank of Boulder. Barclay's has also indicated that they will cash personal checks for NCAR personnel if approved by the site manager.

Taxes, Licenses, and Sale of Personal Property

NCAR personnel must pay $30 to $150 for car registration (fee dependent upon vehicle size) and $4 for drivers licenses.

All drivers in Ghana must have a Ghanian drivers license which may be obtained without examination on presentation of a valid U.S. drivers license. You will need three passport-sized photos with the application.

APPENDIX B

ATTACHMENT A

MEDICAL CONSULTANTS

Hospitals

Korle Bu	65401	Ridge	28382
Military	76111	Nyaho Clinic	75341

Name	Home phone	Office	Office phone
Dr. J.B. David (ent)	Ex. 202	Korle Bu	Ex. 6423
Dr. C.O. Quarcoopome	77195	Korle Bu	Ex. 6464
Dr. Chatterjee	Ex. 586	Korle Bu	Ex. 6427
Private Practice			
Dr. Alexander Ababio (Gen. practice)	76377	Behind USSR Trade Rep.	76363
Dr. J.A. Blankson (Gen. practice)	76508	Mobil House	64921
Dr. K.N. Tamaklo (Gen. practice)	76670	Nyaho Clinic Airport Rd.	75341
Dr. K.A. Kwarko (Ob. Gyn)	27482	North Ridge Clinic	27328
Dr. Seth Obeng (Pediatrics)		Obeng' Clinic Cantonments Rd.	75137
Dr. Susan de Graft Johnson (Pediatrics)	26939	Accra Clinic	26667
Dr. Frank A. Abban (Internal Medicine)	23333	St. Francis Clinic	24105
Dr. Janosi (Internal Medicine)	Ex. 6371	Korle Bu	Ex. 6416
Dr. F.F.D. Konotey-Ahulu	Ex. 6262	Korle Bu	Ex. 526
Dr. A.K. Foli	Ex. 585	Korle Bu	Ex. 515
Dr. J.F.O. Mustafah (Neurosurgery)	Ex. 495	Korle Bu	Ex. 6588

	Home phone	Office	Office phone
Dr. Ben Edoo (Neurology)	Ex. 516	Korle Bu	Ex. 527 or 560
Dr. K.G. Korsah (Orthopedics)	Ex. 357	Korle Bu	Ex. 6406
Dr. K.N. Hudson	Ex. 373	Korle Bu & military	Ex. 6550
Dr. K.K. Bentsi-Enchill (Ob-Gyn)	Ex. 493	Korle Bu	Ex. 6359
Dr. K.K. Korsah (Orthopedics)	Ex. 344	Korle Bu	Ex. 6406
Dr. K.N. Hudson (Orthopedics)	Ex. 373	Korle Bu & military	Ex. 6550
Dr. D.A. Ampofo (Ob-Gyn)	Ex. 6292	Korle Bu	Ex. 546
Dr. A.G. Boahene (Pediatrics)	Ex. 6548	Korle Bu	Ex. 6548
Dr. F.K. Nkrumah (Pediatrics)	Ex. 537	Korle Bu	Ex. 6534
Dr. C. Reindorf (Pediatrics)	Ex. 519	Korle Bu	Ex. 6529
Dr. F.F. Christian (Radiology)	77466	Korle Bu	Ex. 488
Col. A.T. Darko (Radiology)		Military	Ex. 465
Dr. E.A. Badoe (Surgery)	Ex. 371	Korle Bu	Ex. 6565
Major E.K. Korley (Surgery)		Military	
Dr. A.A. Akiwumi (Surgery)	25779	Ridge	Ex. 1
Drs. Robert & Sarah Lee (Dentists)	77856	Cantonments Rd. near Texaco	76765
Dr. Kornelia Choitel		Tesano near CFC estate	22685
Dr. W. Wagner (Glasses)		UTC Optical Dept. 2nd floor	64661
Yellow Fever (immunizations)		Adabraka Polyclinic	22490
Ghana Drug House (Pharmacy)			63235
Kingsway Chemist			62440
Dr. F.K. Amarquaye (Psychiatric)		Amarquaye's Clinic, Adabraka	22036

APPENDIX B

ATTACHMENT B

Barclays Bank of Ghana, Ltd. A.C. Fakes		High Street Tel: 64901
COWI Consultant Poul-Ancher Larsen		P. O. Box 3169 Tel: 21174
DEPARTMENT OF CIVIL AVIATION		
E.R.K. Dwemopel Kotoka Airport	Director	Tel: 76171
Kaku A. Kwaw	Dpty. Dir. of Civil Aviation	Tel: 76171, ex. 212 or 77476
Tim K. Pappoe	Sr. Operation Ofcr. Dept. of Civil Aviation	Tel: 76171, ex. 215
S.E. Ampadu	Operations Ofcr. in charge of air traffic control	Tel: 76171, ex. 215
K.A. Buabe	Sr. radio engr.	Tel: 76171, ex. 220 or 75096
B.K. Attuquayefio	Sr. radio officer	Tel: 76171, ex. 221
G.T. Aryee	Sr. radio officer	Tel: 76171, ex. 260
I. Clegg	Electricity	Tel: 76171, ex. 232
G.K. Odoi	Airport Mgr.	Tel: 76171, ex. 228
DEWEGER, GRUTER & PARTNERS		
Hein Gruter Henk Graauwmans	Partner Admin. Mgr.	Tel: 66478
W. Sohne	Assoc. Proj. Eng.	
GHANA GOVERNMENT		
Met. Services Dept. Frank A.A. Acquaah	Director	Legon Tel: 76381-82, ex. 202
Nicholas A. Gbeckor-Kove	Deputy	Tel: 75047 or 76361-82, ex. 203

J.A. Sam	Kotoka Met. Office	Tel: 76171, ex. 242
Mr. Kwaku	"	Tel: 76171, ex. 242
A.T. Dabgovie	"	Tel: 76171, ex. 244
Hertz Kingsway Stores, Ltd.		P. O. Box 1638 Tel: 24590 or 23965
Kotoka Airport Branch		Tel: 76171, ex. 450
Korle Bu Teaching Hospital E.C. Richter	Medical Admin.	Tel: 65401, ex. 326
A. Lang, Ltd. B. Spiess, Technical Mgr.		P. O. Box 605 Tel: 21811
North Atlantic Oil, Ltd. Steven H. Eggers		c/o Hotel Continental Tel: 75361
Pan American World Airways Bob Miller, Mgr.		Pass. Res. Tel: 21151 Cargo tel: 77435 Cocoa House Liberty Avenue
Panorama Hotel		Airport residential area
Riviera Hotel Mr. Salem Eid	Managing Dir.	P. O. Box 4226 Accra Tel: 62400
State Hotels Corp. Mr. F.K. Adu	Gen. Mgr.	P. O. Box 7642 Accra
U.S. Embassy		
Mrs. Shirley Temple Black	U.S. Ambassador to Ghana	76601
Mr. Jonathan Kranz	Third Secretary of the Embassy	

APPENDIX C

INFORMATION REPORT - SAMOA

The Samoa (Navigator) Islands (13°25'S. to 14°30'S.; 168°08W. to 172°46'W.) are composed of two groups, commonly referred to as American Samoa and Western Samoa.

The islands comprising American Samoa are Tutuila, Aunuu, Ofu, Olosega, Tau, and Rose, a very small uninhabited island. The total land area of this group is 76 square miles. Swains Island, about 165 miles north-northeastward of the group, is included under the administration of American Samoa. The population of American Samoa and Swains Island was about 21,000 in 1960. In 1968 it was estimated to be 27,000.

Western Samoa comprises the islands of Upolu, Savaii, and several small islands close by. The population was about 106,000 in 1961.

Administration and Social Conditions

American Samoa

American Samoa is an unincorporated, unorganized territory, the people of which are United States nationals but not citizens. The territory is administered by the United States Department of the Interior, which appoints the governor.

Under the islands' second constitution, adopted in 1966, the Fono (bicameral legislature) is autonomous in its disposition of local revenues. The 21 members of the House of Representatives are elected by universal suffrage; the minimum voting age is 18. The 18 senators are chosen by councils of chiefs, in accordance with Samoan custom. The islands are divided into three administrative districts (each with an appointed district governor), which are subdivided into a total of 14 counties. Chiefs representing each family form village and district councils. Each village has a Samoan magistrate with authority to adjudicate on minor misdemeanors.

The Landscape

Relief Features

Except for the coral atolls, the islands are rocky and were formed by volcanic activity that progressed from east to west within the past 7,000,000 years. The islands of American Samoa are thus the oldest geologically. The main island of Tutuila, 17 miles long and five miles wide, extending NE-SW, covers an area of 53 square miles. Rising steeply above deep inlets, of which the most notable is Pago Pago Harbour, which almost divides the island in two is Tutuila. Its highest peak is Matafao (2,142 feet or 653 meters).

A wooded mountain ridge extends nearly the entire length of the island and is of extremely rugged aspect but more so in the eastern than in the western part. The north coast is bold and precipitous.

Climatology

Since the islands in the Samoa Group are, as a whole, in close proximity to each other, the climatic conditions affecting all of them will be similar. The climate on the islands is mild, equable, and healthy. Although not far from the equator, it is pleasant, even at sea level. The climate varies but little from year to year, because of the great area of water surrounding the group. December is the hottest month, with an average excess of only 2 1/4% over the mean temperature for July, the coldest month.

With regard to rainfall, the year divides itself distinctly, but not sharply, into a dry season, May to October, and a wet season, November to April. There is a wide variation in monthly rainfall from year to year. The wetest month, January, has a range of from five inches to 65 inches. The annual rainfall has varied in the past 21 years from 130.1 inches to 284.4 inches. It also varies with the location. In general it will be less at coastal locations than inland, ranging from 100 inches on the coasts up to 300 inches inland.

In the vicinity of Samoa, the average annual wind velocity is about 11 knots, with the lowest velocities some 8 to 10 knots, occurring as a rule within the period of February to April and the highest, 11 to 14 knots, at varying periods in the northern summer and late fall. At the island stations

there is much greater variability in wind movement. The average annual velocity at Rarotonga is 14 knots, with 11 knots in January and 18 in August, while at Suva, Fiji, it is only about 5 knots, 4 knots in February and March, and 7 knots from September to November. Details of the average wind speeds and directions in Samoa are shown in the attached table for Apia. There will be, of course, variations between Apia and Pago Pago since Apia is located on a north coast while Pago is on the south coast, but is sheltered by mountains.

As another example of local variations, rainfall in Apia averages about 107 inches per year while in Pago Pago it is nearly 200 inches.

Fiji, Samoa, and the Tonga Islands lie in the midst of the eastern part of the South Pacific hurricane area with from about one to five annually, on the average. The majority of these storms occur during January to March, with the next greatest frequency in December. They have been known to occur as early in the season as October, and as late in the season as May. Many originate either north or south of the Samoa Islands, usually between latitudes 10° and 15°S., but rarely between 5° and 10°N., then pass southwestward, affecting the Fijis, thereafter recurving toward the southeast. A fewer number, however, proceed from their place of origin in a general southeasterly direction toward or south of the Cook Islands.

Climatological details are shown in the appended table.

GENERAL

Immigration-Visa Requirements

No visa is required for entry into American Samoa for thirty days or less. A valid passport is necessary. Passports must be stamped before entry into American Samoa and before departure. Those wishing to extend their stay need to apply to the Attorney General or Immigration Office, Government of American Samoa.

Customs

Visitors are required by law to make a written customs declaration. Firearms, ammunition, and explosives of any kind are prohibited by law.

Five quarts of liquor are allowed to persons traveling within the United States. One bottle per person (21 and above) traveling outside of the United States is allowed.

Health

All incoming visitors must possess an International Certificate of Health, showing smallpox vaccination within the last three years.

If you are planning on fishing, note that some of the fish should not be eaten since they are poisonous.

Agriculture

Any species of plants to be brought into American Samoa requires an importation permit from the Department of Agriculture in American Samoa, with a valid Certificate of Health from the country of origin.

Apart from the cultivation of copra on the outlying islands, agriculture is not widely practiced, although family gardens provide subsistence crops to supplement cash wages. Fewer than 200 acres are under commercial cultivation, mostly vegetable gardens for local markets.

Transportation

American Samoa receives several weekly jet flights from Honolulu. Other flights connect Pago Pago with Sydney, Australia; Auckland, New Zealand; Noumea, New Caledonia; Suva, Fiji; and Papeete, Tahiti. Polynesian Airlines makes daily flights between American and Western Samoa. Also, MAC flights go into Tafuna about once a week. Luxury liners visit Pago Pago regularly, and several P & O liners visit Pago Pago each year. Freighter calls are frequent.

For tours around American Samoa, the following travel agencies can make the necessary arrangements:

Samoa Tours & Travel Agency
P. O. Box 727
Pago Pago, American Samoa

Transpac Travel Service
Pago Pago, American Samoa 96799

South Pacific/Pago Pago Tours
P. O. Box 39
Pago Pago, American Samoa 96799.

Communications

Radiogram service to all parts of the world is available continuously through direct teletype connection. Telex calls may be placed to many countries. Overseas telephone service is available 24 hours a day.

Use of FAA communication facilities by NCAR personnel for official business is a possibility and is being investigated.

Money and Banking

United States currency is legal tender in American Samoa. Bank service is provided by the Bank of Hawaii, whose manager will assist in performing services normally provided by stateside banks. Money transfer and trade credit may be arranged with most parts of the world. As American Samoa is a territory of the United States, U.S. dollars spent in this tropical paradise are, in fact, spent in the United States.

A bank account will be set up with the above bank by NCAR for use by the site manager to obtain funds required for the operation and maintenance of the station.

Duty-Free Shopping

Two hundred dollars ($200) in duty-free purchases, plus up to one gallon of liquor per adult, is admitted to the U.S. duty-free from American Samoa.

Hotel Accommodations

A sketch of the airport and its facilities is shown in Figure 1. Although housing and meals are being arranged for the flight crew in the quarters previously used by the USAF personnel, there are hotels in the town of Pago Pago. For your information, the following list will give you some idea of the cost and availability of facilities in Pago Pago:

Pago Pago Americana Hotel - 198 rooms, approximately nine miles from the Pago Pago International Airport, located near the town area, about a minute by taxi and six minutes walking distance. Singles start at $24.00 and doubles at

$26.00. For information contact: General Manager, P. O. Box 996, Pago Pago, American Samoa 96799.

The Malaeimi - 17 rooms now operating with construction of shops and additional rooms to begin soon. Approximately nine miles from town and 1/2 mile from the airport. Singles at $18.00, doubles at $22.00, and triples at $29.50. No service charge. European and long-term plans. For information contact: Manager, P. O. Box 108, Pago Pago, American Samoa 96799.

Both the Pago Pago Americana and the Malaeimi hotels have fresh water swimming pools, restaurants, and cocktail lounges. The Americana has a small private sandy beach. Both hotels have "Fiafia" nights and entertainment.

Herb and Sia's Motel - A privately owned motel located in the heart of town. Singles start at $13.75 without airconditioning and $17.50 with airconditioning. One meal included and no service charge. For information contact: Manager, P. O. Box 430, Pago Pago, American Samoa 96799.

NORMALS, MEANS, AND EXTREMES[ØØ]

Month	Temperature: Normal $ Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal heating degree days (Base 65°)	Precipitation: Normal total $	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets: Mean total	Maximum monthly	Year	Maximum in 24 hrs.	Year	Relative humidity (Local time): Hour 01	Hour 07	Hour 13	Hour 19	Wind & Mean speed	Prevailing direction	Fastest mile: Speed	Direction #	Year	Pct. of possible sunshine	Mean sky cover sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog	Temperatures: Max. 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below	Average daily solar radiation - langleys
(a)	(b)	(b)	(b)	12		12		(b)	(b)	12		12		12		12	12		12		5	5	5	5	5		5	5		5	5	5	5	5	5	5	5	5	12	12	12	12	
J				92	1969	67	1965			17.95	1969	4.65	1968	5.76	1963	0.0	0.0		0.0		90	90	76	82	6.8		48	NW	1969	51	8.0	1	9	21	23	0	5			4	0	0	0	
F				91	1966+	67	1965			32.66	1968	5.91	1966	9.01	1968	0.0	0.0		0.0		90	90	77	84	7.0		56	NW	1968	45	8.7	1	6	21	23	0	3			3	0	0	0	
M				92	1966	67	1965			31.84	1961	4.95	1967	6.10	1961	0.0	0.0		0.0		91	92	77	85	6.6		38	NW	1970	57	7.6	1	13	17	23	0	3			4	0	0	0	
A				92	1966+	68	1968			24.46	1967	4.73	1961	5.27	1969	0.0	0.0		0.0		91	91	78	86	6.6		37	NW	1970	49	7.7	2	10	18	24	0	3			2	0	0	0	
M				90	1970+	67	1963			20.48	1966	4.77	1971	4.40	1966	0.0	0.0		0.0		88	88	76	85	8.6		28	E	1967	45	7.2	2	14	15	20	0	1			*	0	0	0	
J				90	1966	64	1965			12.82	1961	2.71	1968	5.94	1961	0.0	0.0		0.0		87	87	77	84	10.7		30	E	1968	46	6.6	4	14	12	19	0	1			*	0	0	0	
J				89	1961	62	1964			19.39	1962	2.01	1963	8.65	1962	0.0	0.0		0.0		84	85	77	83	11.4		29	SE	1968	56	6.8	3	16	12	20	0	0			0	0	0	0	
A				89	1963	65	1968+			13.02	1967	3.75	1965	6.10	1967	0.0	0.0		0.0		85	85	75	83	11.8		40	SE	1967	53	6.9	3	14	14	19	0	1			0	0	0	0	
S				89	1968+	63	1970			14.92	1964	1.95	1965	8.30	1964	0.0	0.0		0.0		86	86	73	81	10.3		32	E	1966	68	6.2	4	16	10	17	0	1			0	0	0	0	
O				90	1966+	67	1971+			19.67	1965	5.69	1970	7.50	1967	0.0	0.0		0.0		87	86	77	84	9.8		32	E	1967	51	7.2	3	13	15	22	0	3			*	0	0	0	
N				92	1966	67	1964			16.68	1964	1.36	1965	5.35	1964	0.0	0.0		0.0		88	86	75	83	8.1		28	E	1967	54	7.2	3	11	16	20	0	2			1	0	0	0	
D				91	1963+	67	1964			26.30	1970	6.00	1963	8.97	1970	0.0	0.0		0.0		88	87	76	82	6.9		31	E	1967	46	7.8	3	8	20	23	0	3			1	0	0	0	
YR				92	JAN. 1969+	62	JUL. 1964			32.66	FEB. 1968	1.36	NOV. 1965	9.01	FEB. 1968	0.0	0.0		0.0		88	88	76	84	8.7		56	NW	FEB. 1968	52	7.3	30	144	191	253	0	26	0	15	0	0	0	

ØØ Temperature data in this summary are based on daily extremes of hourly values for the period April 1964 through March 1966.

(a) Length of record, years, based on January data. Other months may be for more or fewer years if there have been breaks in the record.
(b) Climatological standard normals (1931-1960).
° Less than one half.
+ Also on earlier dates, months, or years.
T Trace, an amount too small to measure.
Below zero temperatures are preceded by a minus sign. The prevailing direction for wind in the Normals, Means, and Extremes table is from records through 1963.
$ ≥ 70° at Alaskan stations.

Unless otherwise indicated, dimensional units used in this bulletin are: temperature in degrees F.; precipitation, including snowfall, in inches; wind movement in miles per hour; and relative humidity in percent. Heating degree day totals are the sums of negative departures of average daily temperatures from 65° F. Cooling degree day totals are the sums of positive departures of average daily temperatures from 65° F. Sleet was included in snowfall totals beginning with July 1948. The term "Ice pellets" includes solid grains of ice (sleet) and particles consisting of snow pellets encased in a thin layer of ice. Heavy fog reduces visibility to 1/4 mile or less.

Sky cover is expressed in a range of 0 for no clouds or obscuring phenomena to 10 for complete sky cover. The number of clear days is based on average cloudiness 0-3, partly cloudy days 4-7, and cloudy days 8-10 tenths.

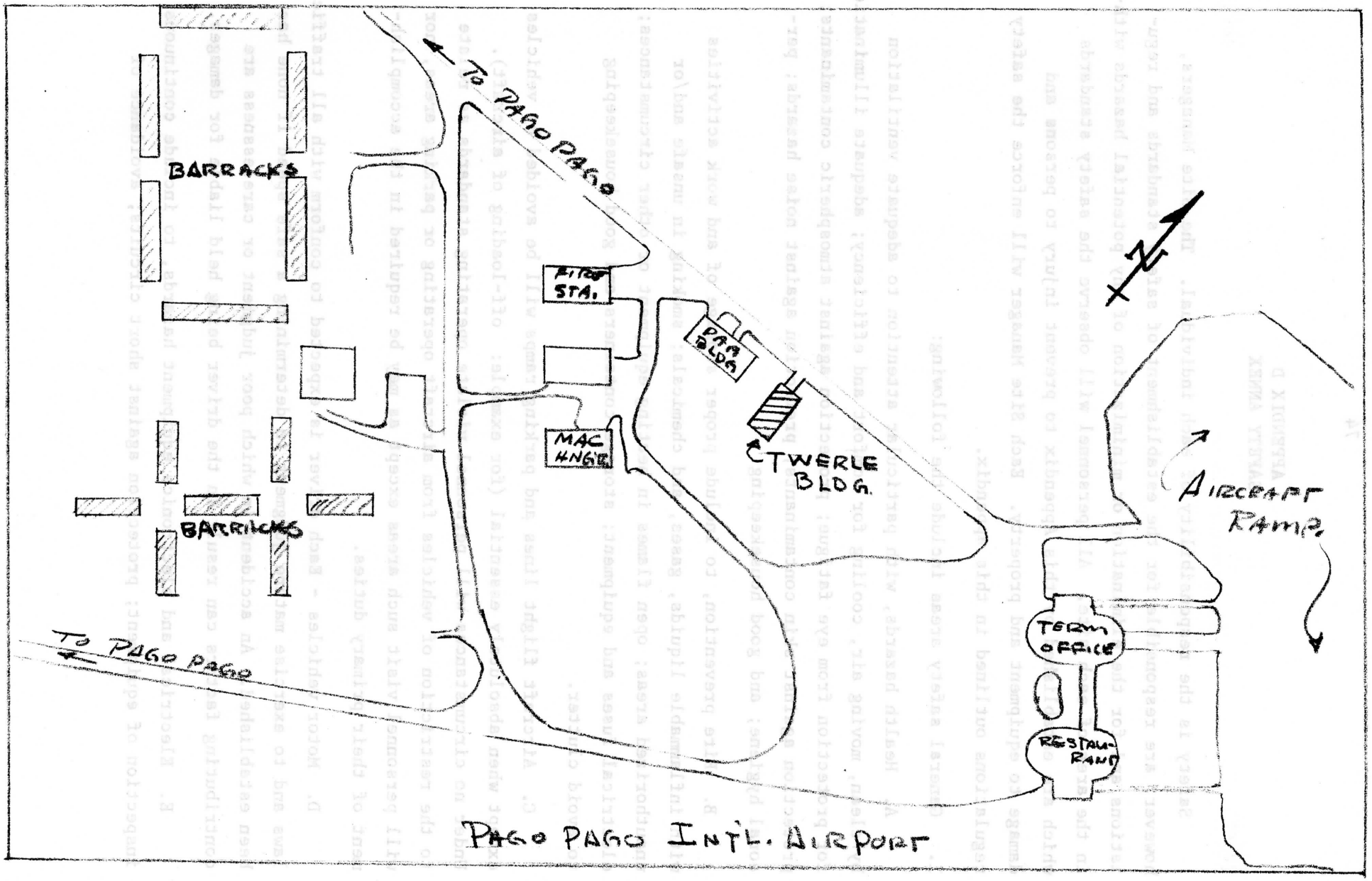
Solar radiation data are the averages of direct and diffuse radiation on a horizontal surface. The langley denotes one gram calorie per square centimeter.

& Figures instead of letters in a direction column indicate direction in tens of degrees from true North; i.e., 09 - East, 18 - South, 27 - West, 36 - North, and 00 - Calm. Resultant wind is the vector sum of wind directions and speeds divided by the number of observations. If figures appear in the direction column under "Fastest mile" the corresponding speeds are fastest observed 1-minute values.

To 8 compass points only.

$ Normals have not been established for this station.

Table 1


BARRACKS
BARRACKS
To PAGO PAGO
FIRE STA.
PAA BLDG.
MAC HNGR.
TWERLE BLDG.
AIRCRAFT RAMP
TERM OFFICE
RESTAU-RANT
To PAGO PAGO
PAGO PAGO INTL. AIRPORT

APPENDIX D
SAFETY ANNEX

Safety is the responsibility of each individual. The Site Managers, however, are responsible for the establishment of safety standards and regulations and for the elimination or minimization of any potential hazards within the area of each site. All personnel will observe the safety standards which are established by this Appendix to prevent injury to persons and damage to equipment and property. Each Site Manager will enforce the safety regulations outlined in this appendix.

I. General safety areas include the following:

A. Health hazards, with particular attention to adequate ventilation by clean, moving air, cooling for comfort and efficiency; adequate illumination for protection from eye fatigue; protection against atmospheric contaminants; protection against skin contaminants; protection against noise hazards; personal hygiene; and good housekeeping.

B. Fire prevention, to include proper storage of and work activities with inflammable liquids, gases, and chemicals; smoking in unsafe and/or unauthorized areas; open flames in heating equipment or other circumstances; electrical fuses and equipment; storage containers and good housekeeping to avoid clutter.

C. Aircraft flight lines and parking ramps will be avoided by vehicles except when absolutely essential (for example: off-loading of aircraft). Under no circumstances will personnel violate operating standards as relate to the restriction of vehicles from aircraft operating or parking areas, nor will personnel visit such areas except as may be required in the accomplishment of their primary duties.

D. Motor vehicles - Each driver is expected to conform with all traffic laws and to exercise mature judgment in determining a safe speed if none has been established. An accident in which poor judgment or carelessness are contributing factors can result in the driver being held liable for damages.

E. Electrical and electronics equipment hazards, to include continuous inspection of equipment; protection against short circuits; avoidance of

loose clothing and jewelry while working with electrical circuits; avoidance of overloading electrical circuits; use of portable devices, heating appliances; plugs and sockets; proper respect for low voltage equipment; adjustment and maintenance of equipment in the presence of high voltage potentials; compliance with operating instructions and other applicable directives when working with equipment; use of insulated tools when working near circuits carrying high voltages; grounding at the exact point of intended repair or adjustment before making actual contact with that area of energized equipment; avoidance of dependence on equipment safety devices; voltage cutoff when working on antennas or antenna transmission lines.

F. Materials handling, to include proper lifting and carrying positions; restriction to 75 pounds for one-man loads; care and operation of mechanical handling and lifting devices; vehicle loading and off-loading; proper storage and crating.

II. In connection with recreational and off-duty activities, the following items must be observed:

A. Skin diving and swimming - Permitted only in designated areas and with at least two persons participating. The hazards are undertow, surf, currents, coral, giant clams, sea urchins, sharks, moray eels, etc.

B. Adequate foot protection - On shore the dangers are cuts and sprains. In the water the principal dangers are cuts and bruises. Any cuts resulting from contact with coral should be given immediate and careful attention, since serious infection usually results from this type of cut or abrasion.

C. Sunburn is the most common health problem - use appropriate lotions and wear adequate clothing.

D. Salt deficiency - The average person doing heavy physical labor will require an augmented salt intake. Salt tablets will be available and should be used as required.

E. Fungus is often a personal health problem - Advise all participants to get help whenever a persistent rash or skin eruption appears.

F. Small boating - Permitted only in authorized areas and with designated personnel in charge. This is a real hazard--coral heads and strong

currents combine to surprise even experienced boat men.

G. Fishing and wading - The particular problems at TWERLE sites are coral and, in some areas, quicksand. The best protection is again a buddy system with the two partners maintaining a separation of no more than 50 feet.

H. Wild life - Biting insects and occasional nesting birds are able to cause minor injuries if pestered long enough. Rats abound at these sites but are harmless although a nuisance in destroying food and equipment (particularly insulation). Very poisonous snakes, including mambas, vipers and cobra are present in Ghana and extreme care must be taken to avoid them. If struck at any time, obtain medical care immediately.

I. Plant life - There are numerous edible berries, coconuts, etc. Except for coconuts, personnel should not sample berries and other wild plant food--severe digestive upsets may result from certain wild foods.

III. Medical plan:

Doctors are available at each site and should be consulted whenever necessary. Information concerning doctors and hospitilization is contained in Appendices A, B, and C. Emergency first aid equipment will also be available at each site and at least one launch crew member will have had emergency first aid instruction. Arrangements have been made at all sites to treat NCAR personnel and to have hospital facilities available if required.

IV. Miscellaneous:

A. Firearms - Firearms will be permitted at the TWERLE sites in the possession of participants in accordance with local regulations.

B. Liquor and Spirits - Local customs and regulations as to purchase and use of alcoholic beverages will apply to all personnel at the TWERLE sites. Excessive use resulting in substandard performance of assigned duties will be sufficient reason to terminate the individual immediately. (hic!)

APPENDIX E

COMMUNICATIONS

Telephone

NCAR - Boulder, Colorado

303/494-5151

Eileen Howe -	ex. 7633
Paul Julian -	ex. 316
Ernie Lichfield -	ex. 788
Jack Tefft -	ex. 735

Telex

NCAR PSRB BDR (Terminal located in rm. 229 - PSRB3 - E. Howe's office)
Telex No. 45-989

NCAR BDR (Terminal located in Receptionist's area - Mesa Lab)
Telex No. 45-694

Mailing Addresses

National Center for Atmospheric Research
P. O. Box 3000
Boulder, Colorado 80303

Name
American Embassy
P. O. Box 194
Accra, Ghana

Name
NCAR/TWERLE Representative
Ascension Island
P. O. Box A
Patrick Air Force Base, Florida 32925

Mailing Addresses - continued

Name
National Weather Service Office
P. O. Box 788
Pago Pago, American Samoa 96799
Attn: TWERLE Project

Name
NCAR/GHOST Flight Station
Christchurch International Airport
P. O. Box 14022
Christchurch, New Zealand

INTERNATIONAL ROAD SIGNS