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Tropical Western Pacific

Site Science Mission Plan

July – December 2000

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CONTENTS

PREFACE

The purpose of the Tropical Western Pacific Site Science Mission Plan is to provide information for the planning of scientific activities in the TWP locale. It will update the status of the locale at six-month intervals with a projection for the next six months, as well as longer-term views when appropriate. All acronyms used are defined in the Acronym Section.

INTRODUCTION

The Department of Energy's (DOE) Atmospheric Radiation Measurement (ARM) Program was created in 1989 as part of the U.S. Global Change Research Program to improve the treatment of atmospheric radiative and cloud processes in computer models used to predict climate change. The overall goal of the ARM program is to develop and test parameterizations of important atmospheric processes, particularly cloud and radiative processes, for use in atmospheric models. This goal is being achieved through a combination of field measurements and modeling studies.

Three primary locales were chosen for extensive field measurement facilities. These are the Southern Great Plains (SGP) of the United States, the Tropical Western Pacific (TWP), and the North Slope of Alaska and Adjacent Arctic Ocean (NSA/AAO), as shown in Figure 1. This Site Science Mission Plan describes the ARM program in the Tropical Western Pacific locale.

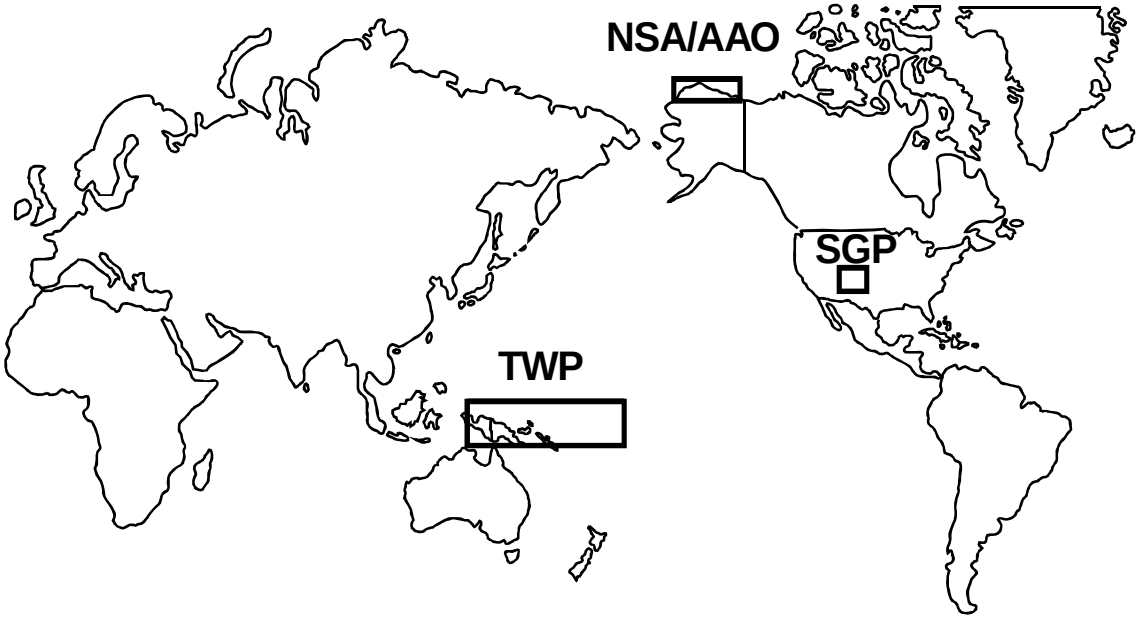


Fig.1. Locations of the three primary ARM Climate Research Facilities.

The TWP locale is the second site to be instrumented by the ARM program. The locale, shown in Fig. 1, encompasses the area from 10°N to 10°S of the equator and from Indonesia to east of the international dateline. The locale was selected[1] because of the existence of the Pacific warm pool, the resulting cloud formations, and its influence on weather and climate throughout the planet. The purpose of the TWP program is to collect long-term data to better understand the effect of tropical clouds on the Earth's

[1] U.S. Department of Energy (DOE), 1991. Identification, Recommendation, and Justification of Potential Locales for ARM Sites. DOE/ER-0495T, National Technical Information Service, Springfield, Virginia.

energy budget. The overall science objectives and measurement strategy for the TWP are given in the ARM Science Plan[2].

Currently TWP program is operating two island-based sites in the TWP locale (Fig. 2). Each site is equipped with an Atmospheric Radiation and Cloud Stations (ARCS). The possibility of implementing a third site is under consideration by ARM management. In addition the TWP program is pursuing ways of obtaining data over the open ocean in the locale with instrumented buoys and ship studies. These data, along with satellite data will constitute the basic ARM TWP data set. Intensive operational periods (IOP), research campaigns, and collaborations with other studies in the locale will occur as the site matures.

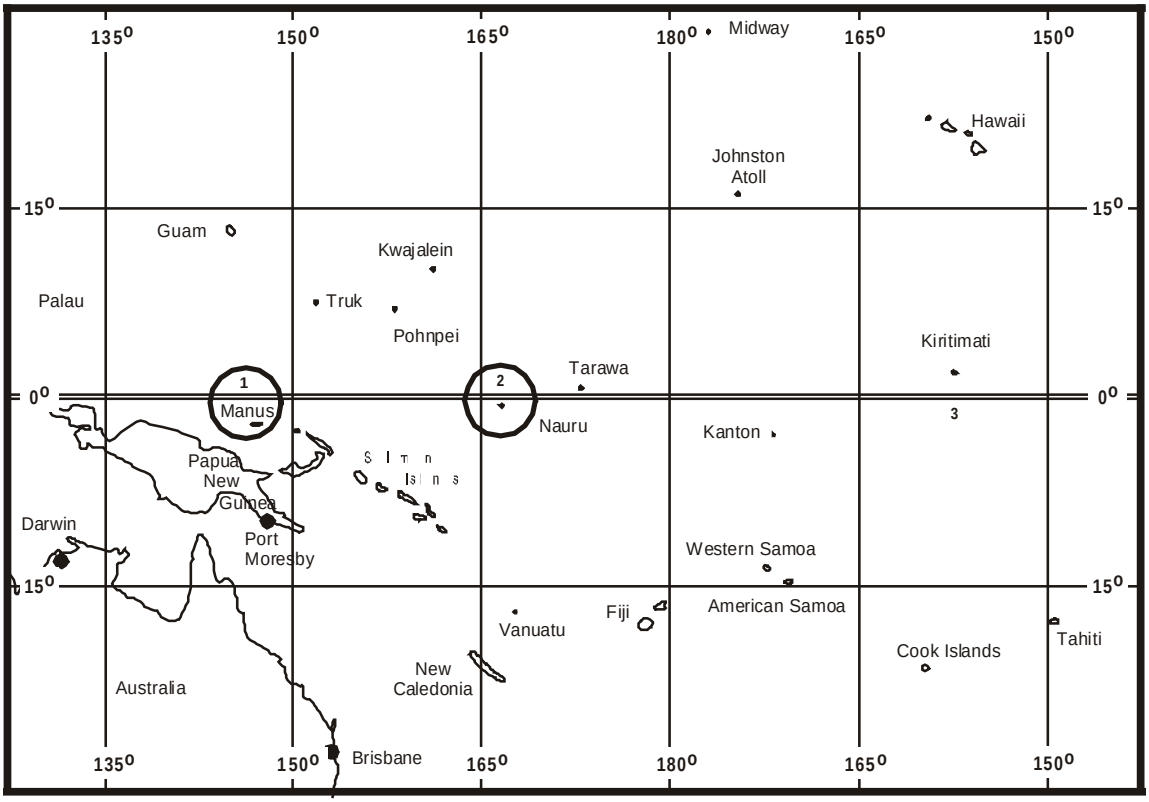


Fig. 2. Equatorial Western Pacific region showing TWP locale (dashed area) and ARM sites at Manus and Nauru (circles).

[2] U.S. Department of Energy (DOE), 1996. Science Plan for the Atmospheric Radiation Measurement Program (ARM). DOE/ER-670T, National Technical Information Service.

SCIENCE GOALS

The Tropical Western Pacific component of the ARM program has four basic science goals:

1. Determine the magnitude of the surface radiation budget terms and determine their spatial and temporal variability.
2. Identify bulk and optical properties of clouds in the TWP and how these properties affect the radiation budget.
3. Understand the linkages among sea surface temperature, ocean-atmosphere coupling, surface radiation budget, and tropical convection.
4. Determine vertical transports of water vapor, energy, and momentum in convective cloud systems.

These goals represent a sequence of increasing complexity of knowledge, as well as increasing complexity of measurement. The first is fundamental. We have relatively incomplete knowledge of the surface radiation budget in the TWP, particularly over periods of time longer than a month or a few months. Similarly, high-resolution measurements of bulk cloud properties in the TWP have only been made for short periods of times during campaigns or research vessel cruises. Further, data sets to establish the effect of clouds on the radiation budget do not exist. The third goal seeks to understand the processes in the TWP that connect surface fluxes, sea surface temperature, and convection. These connections are at the heart of meteorology in the TWP and must be well understood for both short-range and long-range climate modeling. The fourth goal represents the linkage between cloud systems and the larger circulation patterns of the region. In addition, it encapsulates cloud feedback processes as they impact the surface radiation budget and sea surface temperature.

The TWP area of interest to ARM is very large, mostly ocean, logistically remote, and operationally costly. Consequently, ARM operations in the TWP will be more limited in scope than in some other locations. Achieving the scientific goals will require a careful blending of long-term, surface remote sensing observations with field campaigns and satellite observations. The Atmospheric Radiation and Cloud Station (ARCS) currently operating at Manus Island, PNG, and on Nauru Island are the first step in the acquisition of long-term data on surface radiation budget and cloud properties. The planned deployment of an additional ARCS on the Kiritimati Island will further enhance this acquisition.

The ARM TWP team carefully selected the ARCS instrumentation to address the issues raised by the first two goals. A list of ARCS measurements and instruments is given in Table 1. Detailed information on ARM instruments is available on the ARM homepage: www.arm.gov and specific information on TWP instruments can be found at http://www.arm.gov/docs/sites/twp/twp_inst.html..

Table 1. ARCS Measurements and Instruments

Measurement	Instrument
Surface Radiation Balance	• Up- and down-looking pyranometers and pyrgeometers • Sun-shaded pyranometer and pyrgeometer using solar tracker • Normal incidence pyrheliometer • Up- and down-looking 9-11μm narrow-field-of-view radiometers • UV-B hemispheric radiometer • Broadband (solar and infrared) net radiometer
Surface Meteorology	• Temperature and relative humidity sensor • Barometer • Optical rain gauge • Propeller vane anemometer • Sea surface temperature measurement [2]
Cloud Properties	• Cloud lidar (523 nm) • Ceilometer (7.5 km maximum range) • 35 GHz cloud radar • Whole Sky Imager (WSI)
Aerosol Optical Depth	• Multi-filter rotating shadow band radiometer (total, direct, and diffuse irradiance in six 10-nm channels)
Column Water	• Dual channel (23.8 and 31.4 GHz) microwave radiometer
Vertical Structure of Atmosphere	• Rawinsonde • 915-MHz wind profiler with RASS [1]
Atmospheric Emitted Radiation	• Atmospheric Emitted Radiance Interferometer (AERI) [2]

[1] Operated in cooperation with NOAA's Aeronomy Lab
[2] Nauru site only

SITING STRATEGY

An important property of the climate in the tropical Pacific is a strong east to west gradient in various climate parameters including sea surface temperature, water vapor column, and frequency of convection. High sea-surface temperatures and frequent, deep convection characterize the western Pacific. Toward the eastern Pacific, there is a steady decline in sea-surface temperature and a corresponding decrease in the frequency of convection. Because of this longitudinal structure and its variability it would be difficult to characterize the climate of the tropical Pacific with a single site. The original plan for ARM in the TWP was to deploy an ARCS at three sites to sample the structure in this region. Currently, two sites are operational at the locations indicted in Fig. 2 and Table 2. Implementation of the third site is on hold pending budgetary and scientific considerations.

In all aspects of siting, operations, public awareness, and educational outreach the ARM program in the TWP works closely with the South Pacific Regional Environment Programme (SPREP).

Table 2. TWP ARM Sites in the Tropical Western Pacific

Site	Latitude	Longitude	Elevation	Start Date
Manus	2.060°S	147.425°E	4.0 m MSL	8 October 1996
Nauru	0.521°S	166.916°E	7.1 m MSL	21 November 1998

1.0 MANUS SITE (ARCS-1), PAPUA NEW GUINEA

The first TWP site is in Manus Province, Papua New Guinea (PNG). This site was chosen because of its location within the heart of the Pacific warm pool, the existence of a NOAA Integrated Sounding System (ISS), and the support of the PNG National Weather Service (NWS). The site is located at the NWS station at the Momote airport on Los Negros Island at 2.060^{o}S, 147.425^{o}E (Fig. 3).

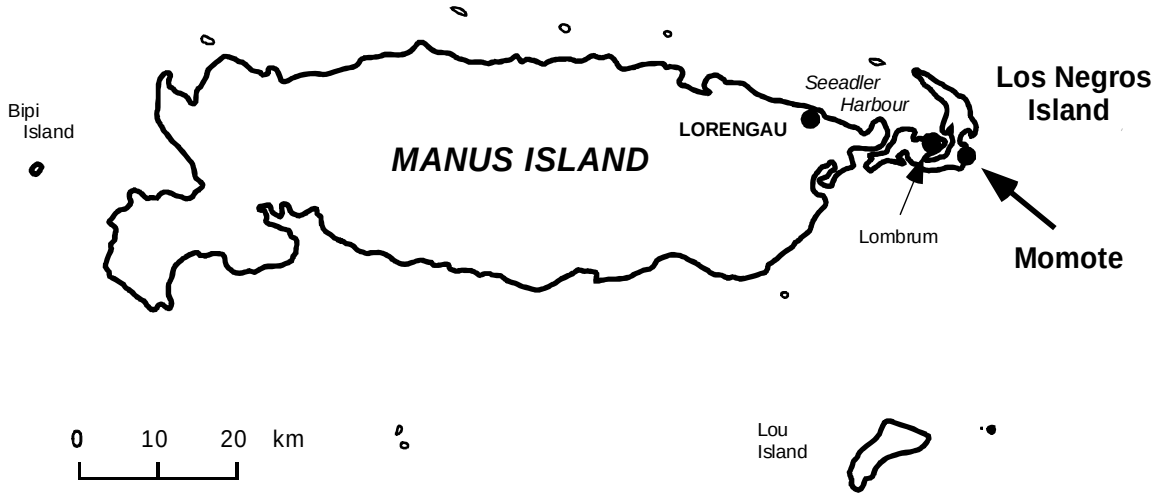


Fig. 3. Manus Province, Papua New Guinea. The ARCS is located at the National Weather Service station at the Momote airport on Los Negros Island.

The site is 4 meters above sea level. The highest point on Manus Island is 702 meters, but most of the island has an elevation of less than 200 meters. The highest point on Los Negros Island is 121 meters, but within 3 kilometers of the site the elevation is less than 20 meters. All equipment is located within the National Weather Service compound at Momote (Fig. 4). Appendix A shows the Manus site layout of instruments and facilities. The operation of the Momote site is collaboration between ARM-TWP and the PNG National Weather Service.

Fig. 4. ARM research station site is located at National Weather Service station at Momote airport, Manus Province, PNG.

1.1 Manus Operations

The ARM Manus site (also known as ARCS-1) was installed at Momote during August and September 1996. It was shipped from Long Beach, California, on 22 May, and all components were on site by 07 August. The installation began on 24 August and took six weeks and 435 man-days of work for completion. The site was formally commissioned on 12 September and routine operations began on 8 October. PNG NWS staff is in charge of the daily operations of the site. Assistance in performing these duties and in troubleshooting problems is provided by the TWP Operations Center in the US. Communication between the site and the Operations Center is conducted by phone, fax, and satellite. A REgional SErvice Team (RESET) visits the site periodically to perform maintenance and calibration. These routine visits are nominally scheduled at six -month intervals. Additional visits are made when required. Appendix A shows the Manus site layout of instruments and facilities.

Operation of the Manus site is managed out of the TWP Operations Center at Los Alamos National Laboratory in collaboration with the Papua New Guinea National Weather Service.

1.1.1 Manus Operations Status

The ARM Manus site has been operating since 8 October 1996, with all planned instrumentation installed and operating. Hydrogen is being generated on site and used as the lift gas for the once-per-day balloon borne sounding at 00Z (1000 Mountain Standard time). Health and status data are transmitted hourly from the site to the ARM Experiment Center via the GOES satellite system. All data are returned on tape every two weeks by courier service. Locally, normally three PNG NWS personnel operate the site.

RESET Visits:

A REgional SErvice Team (RESET) visit consists of two or more TWP technicians and is classified as either “routine” or “non-routine” visits. Routine visits are primarily aimed at instrument calibration, observer training, and semi-annual maintenance. They are scheduled at 12-month intervals. Non-routine visits are for special retrofits or emergency repairs and can be initiated at any time.

During July 1999 through June 2000, TWPPO conducted four RESET trips to the Manus site as summarized below.

RESET-7M: (August 1999, 1 weeks, 2 people). This was a non-routine visit with major tasks of MPL-HR installation and Telcom Phone improvements at Manus and HRPT diagnostics and repair at Port Moresby.

RESET-8M: (October 1999, 1 week, 10 people phased). This was a non-routine visit with major tasks of complete ADaM hardware/software changeout with Y2K upgrades, WSI repair, and H2 Generator Maintenance.

RESET-9M: (January 2000, 1 week, 2 people). This was a non-routine visit with major tasks of general Y2K repairs including the MMCR Y2K upgrades and the MPL Y2K upgrade.

RESET-10M: (March 2000, 2 weeks, 3 people). This was a non-routine with major tasks of instrument changeout, instrument comparison, instrument calibration, repair of EVE, the repair of MACS/COMS, and lightning protection upgrade.

Significant Events

Below are significant operational events that occurred during the January – June 2000 period. The sequential labels (MAS-SE-N) indicate the Manus (MAS) Significant Event (SE) and number (N).

MAS-SE-26: MPL-HR installed on Manus:

During RESET-7M a new MPL HR was installed on 13Aug99.

MAS-SE-27: ADaM data collection system replaced:
During RESET-8M the entire ADaM data collection system and the associated instrument ingests were changed. The entire operation was completed on 23Oct99.

MAS-SE-28: Site System Y2K upgrades installed:
During RESET-8M Y2K upgrades were attempted on Zeno Loggers, the Brusag tracker and other site systems by 27Oct99.

MAS-SE-29: MACS/COMS stops reporting:
On 01Jan0012 the MACS/COMS system stopped reporting due to Y2K problems.

MAS-SE-30: MMCR Y2K upgrade installed:
During RESET-9M the MMCR Y2K upgrade was installed on 24Jan00.

MAS-SE-31: Calibration of Manus Instruments:
During RESET-10M Bill Porch coordinated the calibration, comparison testing and changeout of instruments at Manus from 26Mar through 07Apr00.

MAS-SE-32: Lightning protection upgrade:
During RESET-10M the Manus site's lightning protection system was upgraded on 30Mar00.

MAS-SE-33: MACS/COMS repaired:
During RESET-10M the Manus MACS/COMS system was repaired on 31Mar00.

MAS-SE-34: Anuma receives TWP Award:
During SET-3 Francis Anuma, ARM Manus site OIC, received the first TWP Outstanding Service Award on 19Apr00.

1.1.2 Manus Operations Projection

During the July – December 2000 period, there will be two scheduled RESET visit to perform installations, upgrades and repairs as follows:

RESET-11M Visit (combination 2-Site visit)

This is a non-routine visit to do the following:

- BBSS DCP installation
- Laptop upgrades, changeouts with Core configuration
- MPL Laser diode replacement
- Hook Observer PC to network
- Connect new phone lines and redo phone manager

- Seacon connector upgrade (impulse) and label clearly with color coding
- DC power mods
- Terminal Server expand Flash and Ram memory
- H2 Generator maintenance (Aust BOM)
- Emergency Generator mods
- Grnrad stand Lighting rod installation
- Routine Maintenance Tasks (see list)
- Fix Sparce Station at ECOM HS

RESET-12M Visit (combination 2-Site visit)
This is a non-routine visit to do the following:

- ACCESS upgrade
- Replace copper with fiber data lines
- H2 Generator routine maintenance (BOM)
- Routine maintenance (see list)
- Zeno logger Y2K upgrade

1.2 Manus Data Quality

The TWP Site Scientist Office has been unable recently to continue the data quality assurance efforts usually performed in the past on the high-resolution (1-minute) data. There are several reasons for this difficulty: 1) the implementation and subsequent activities related to the Nauru99 experiment have required a significant amount or resources; 2) Jim Mather, former TWP associate site scientist, left the program; 3) the rest of the TWP Site Scientist Office personnel have relocated to Pacific Northwest National Laboratory in Richland, Washington; and 4) the entire ARM Program has been undergoing reorganization which has required our input and participation.

To improve the current data quality assurance efforts, an ARM Data Quality Manager position has been established, which is to take over all data quality assurance efforts for the ARM program as a whole. In this area, efforts are currently underway to port all the TWP Site Scientist Office codes and programs developed for quality assurance to the new Data Quality Manager, along with interactive training on their use and interpretation of the results. While this task in effect means that current data quality checking is at a standstill, it is envisioned that the long-term benefits to the entire program outweighs the short-term delay.

In the mean time, TWP data is being released through the ARM Archive Center without delay, with the caveat that (as with all other ARM data) these data have only been subjected to standard min/max/delta testing.

1.2.1 Manus Data Quality Status

1.2.2 Manus Data Quality Projection

2.0 NAURU SITE (ARCS-2), REPUBLIC OF NAURU

The second ARM site is located on Nauru Island in the central Pacific (Fig. 2). The Nauru site was chosen because of its location on the eastern edge of the warm pool under La Niña condition and its variable climate associated with ENSO events. Also its small size and isolation suggest that its climate should be strongly oceanic. The site is located in the Denigomodu District near the General Hospital on the west side of the island at 0.522 °S, 166.913 °E, 7m MSL (Fig. 5).

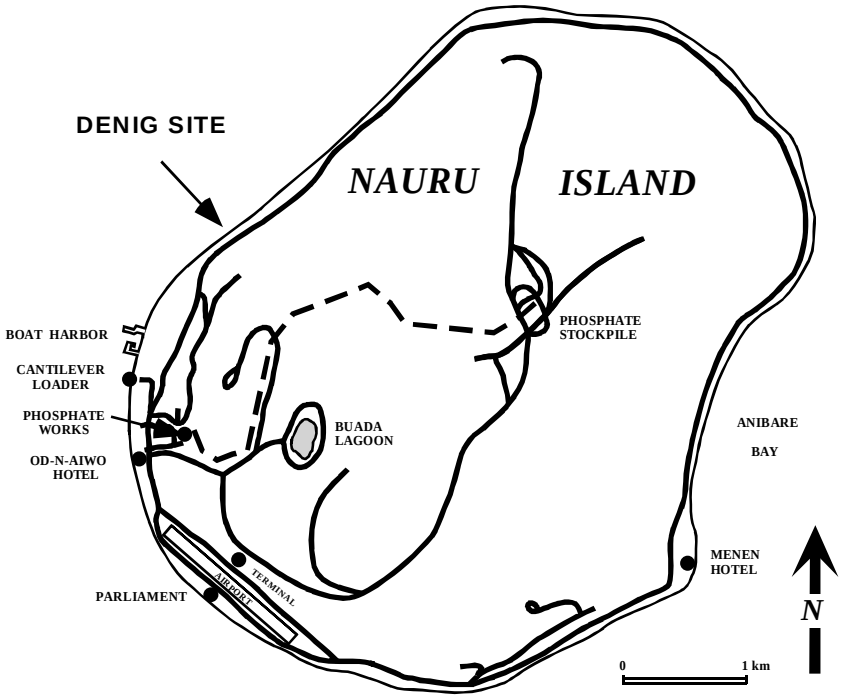


Fig. 5. ARM Nauru station is located in Denigomodu District on the western shore of the island.

The ARCS-2 was installed at this location during October and November 1998. In addition to the standard set of ARCS instruments, the Nauru site has an Atmospheric Emitted Radiance Interferometer (AERI), a hydrogen generator to produce lift gas for the balloon soundings, and a remote balloon launcher. Figures 6 and 7 show panoramic views of the site.

Formal operations of the Nauru site began on 21 November 1998, after official opening ceremony on the island on 20 October. The operations are a joint effort of the ARM Tropical Western Pacific (TWP) Program Office and the Nauru Department of Industry and Economic Development (IED).

Fig. 6. Panoramic view of site looking northeast to southeast (left to right).

Fig. 7. Panoramic view of site looking southeast to northwest (left to right).

2.1 Nauru Operations

The ARM Nauru site (also known as ARCS-2) was installed at Nauru during October and November of 1998. Its components were shipped from Long Beach, California, in July, arriving in Nauru by September. The installation began on 06 October and took 7 weeks to complete. The site was formally commissioned on 20 November and routine operations began on 23 November. The Nauru IED staff is in charge of the daily operations of the site. Assistance in performing these duties and in troubleshooting problems is provided by the TWP Operations Center in the United States. Communication between the site and the Operations Center is conducted by phone, fax, and satellite. A REgional SErvice Team (RESET) visits the site periodically to perform maintenance and calibration. These routine visits are nominally scheduled at six -month intervals. Additional visits are made when required. Appendix A shows the Nauru site layout of instruments and facilities.

Operation of the Nauru site is managed out of the TWP Operations Center at the U.S. DOE's Los Alamos National Laboratory in collaboration with the Nauru Department of Industry and Economic Development.

2.1.1 Nauru Operations Status

The ARM Nauru site has been operating since 23 November 1998, with all planned instrumentation installed and operating. Hydrogen is being used as the lift gas for the twice-per-day balloon borne sounding at 00Z and 1200Z (1000 and 1300 Mountain Standard time, respectively). Health and status data are transmitted hourly from the site to the ARM Experiment Center via the GOES satellite system. All data are returned on tape monthly by courier service. Locally, four Nauru IDI personnel rotate shifts to operate the site.

RESET Visits:

A Regional Service Team (RESET) visit consists of two or more TWP technicians and is classified as either "routine" or "non-routine" visits. Routine visits are primarily aimed at instrument calibration, observer training, and semi-annual maintenance. They are scheduled at 12-month intervals. Non-routine visits are for special retrofits or emergency repairs and can be initiated at any time.

During January 1999 through June 2000, TWPPO conducted four RESET trips to the Nauru site.

RESET-7N: (August 1999, 2 weeks, 2 people). This was a routine visit with main tasks of calibration of all instruments, instrument changeout, and Brusag Solar Tracker Y2K upgrade.

RESET-8N: (October 1999, 1 week, 10 people phased). This was a non-routine visit with major tasks of complete ADaM hardware/software changeout with Y2K upgrades, WSI repair, and H2 Generator Maintenance.

RESET-9N: (January 2000, 1 week, 2 people). This was a non-routine visit with major tasks of General Y2K repairs including the MMCR Y2K upgrades and the MPL Y2K upgrade.

RESET-10N: (April 2000, 1 week, 2 people). This was a non-routine visit with the major tasks of WSI arc drive repair, CIMEL head replacement, and stress testing and trouble shooting the UPS system.

Significant Events

Below are significant operational events that occurred during the July 1999 – June 2000 period. The sequential labels (INU-SE-N) indicate the Nauru (INU) Significant Event (SE) and number (N).

INU-SE-4: Calibration of Nauru Instruments:
During RESET7N Bill Porch coordinated the calibration, comparison testing and changeout of instruments at Manus from 02Aug through 13Aug00 as a check for the just completed Nauru99.

INU-SE-5: Brusag Tracker stops operating:
During RESET-7N while trying to install the Brusag Tracker Y2K upgrade, it broke and stopped operating on 06Aug99.

INU-SE-6: ADaM data collection system replaced:
During RESET-8N the entire ADaM data collection system and the associated instrument ingests were changed. The entire operation was completed on 18Oct99.

INU-SE-7: Site System Y2K upgrades installed:
During RESET-8N Y2K upgrades were attempted on Zeno Loggers, the Brusag tracker and other site systems by 20Oct99

INU-SE-8: Brusag Tracker installed:
During RESET-8N another Brusag tracker was installed without the Y2K upgrade and it seems to work fine on 15Oct.

INU-SE-9: MPL HR Laser Diode replaced:
During RESET-9N the MPL-HR Laser diode was replaced along with the installation of Y2K upgrades. It was discovered that the detector was bad on 18Jan00.

INU-SE-10: WSI stops operating:
The WSI stopped operating on 18Feb00. It turned out to be a bad Arc drive.

INU-SE-11: WSI arc drive replaced:
During RESET-10N the WSI Arc drive was replaced, and the WSI began reporting again on 10Apr00.

2.1.2 Nauru Operations Projection

During the July – December 2000 period there will be two scheduled RESET visits to perform installations, upgrades and repairs as follows:

RESET-11N Visit (combination 2-Site visit)
This is a routine visit to with major tasks of:

- Instrument calibration, comparison and changeout
- Observer training on MTI
- BBSS DCP installation
- Repair Brusag Tracker
- Changeout of LyncSys switch
- Upgrade Ceilometer CPU
- Terminal Server expand Flash and Ram memory upgrade
- H2 Generator maintenance, repair (Australian BOM)
- AERI Hatch hardware upgrades
- Laptop upgrades, changeouts with Core
- Replace MWR window, power cable
- Phone “manager” installation
- Anemometer cable upgrade
- EVE-2 fix from Wilcox
- Routine Maintenance Tasks (see list)

RESET-12N Visit (combination 2-Site visit)
This is a non-routine visit to do the following:

- H2 Generator routine maintenance(BOM)
- Routine maintenance (see list)
- Communications upgrade
- Zeno logger Y2K upgrade
- Replace the broken MPL-HR

2.2 Nauru Data Quality

The TWP Site Scientist Office has been unable recently to continue the data quality assurance efforts usually performed in the past on the high-resolution (1-minute) data. There are several reasons for this difficulty: 1) the implementation and subsequent activities related to the Nauru99 experiment have required a significant amount or resources; 2) Jim Mather, former TWP associate site scientist, left the program; 3) the rest of the TWP Site Scientist Office personnel have relocated to Pacific Northwest National Laboratory in Richland, Washington; and 4) the entire ARM Program has been undergoing reorganization which has required our input and participation.

To improve the current data quality assurance efforts, an ARM Data Quality Manager position has been established, which is to take over all data quality assurance efforts for the ARM program as a whole. In this area, efforts are currently underway to port all the TWP Site Scientist Office codes and programs developed for quality assurance to the new Data Quality Manager, along with interactive training on their use and interpretation of the results. While this task in effect means that current data quality checking is at a standstill, it is envisioned that the long-term benefits to the entire program outweighs the short-term delay.

In the mean time, TWP data is being released through the ARM Archive Center without delay, with the caveat that (as with all other ARM data) these data have only been subjected to standard min/max/delta testing.

2.2.1 Nauru Data Quality Status

2.2.2 Nauru Data Quality Projection

3.0 SITE 3

Implementation of the third site is on hold pending budgetary and scientific considerations.

4.0 IOPs, CAMPAIGNS, AND OTHER COLLABORTIONS

IOPs and Campaigns

None planned

Analysis of the Nauru99 campaign continues. A second workshop is planned for early August in Honolulu, Hawaii. The Nauru Science and Implementation Plan can be found at www.etl.noaa.gov/nauru99 under Expeditions.

Nauru99 Island Effect Study: Following initial evaluations of the data from Nauru99 research campaign, an Engineering Change Request (ECR) was submitted on 19 July 2000 proposing a study on island effect on Nauru Island. Following is an excerpt from the ECR:

> In specific, what is proposed is a one-year deployment of a moderately sophisticated instrument package on the windward side of the island, with the expectation that there will thereafter be a permanent installation of a far less sophisticated and low-maintenance set of instrumentation. Thus this ECR includes both an extended IOP-type deployment, and a request for permanent added instrumentation on Nauru. It is important to note that

the intent of the 1-year study is to quantify the island effect in our ARCS2 measurements. As such, it is imperative that the same instruments (make and model) be deployed to windward as we have at the ARCS2 to eliminate instrument-type differences and record only island effect differences in the measurements. This naturally includes the need that the same instrument maintenance practices be performed as well (i.e., daily dome cleaning, etc.). The specific instruments for the one-year study are as follows:

1. Upward facing broadband radiometers:
   - Unshaded Licor pyranometer
   - Shaded, ventilated pyranometer
   - Unshaded, ventilated pyranometer
   - Shaded, ventilated PIR
   - NIP
   - Tracker
   - Unshaded Licor pyranometer
2. Upward facing IRT
3. Met package (T, P, RH, Wspd, Wdir)
4. Ceilometer
5. 2 ea. - TSI-880 sky imagers, one in the windward package, one at the ARCS2 site
6. MFRSR

For the permanent installation, it is anticipated that only the Met package and the upward facing Licor pyranometer will be needed. This, however, depends on the exact results derived from the 1-year study. We expect that after about six months of data, we will be able to determine the specific need, and adjust our planning accordingly for the permanent installation.

During the recent DOE/ARM Nauru99 Workshop held at Pacific Northwest National Laboratory, various results were presented that indicated there indeed is an island effect on the measurements being made at the Nauru ARCS2 site. Detection of an island effect was shown in many ways, including comparisons between ship and ARCS data, comparison of top side and ARCS measurements, and even satellite images. The cause of this "island effect" is due to the ARCS2 site being located on the leeward side of the island, a siting that proved necessary given the limited available siting choices on Nauru. Of the results presented at the Workshop, some measurements, such as moisture amounts and wind speeds, do not appear to be significantly affected. Some measurements, such as wind direction and downwelling longwave, appear to be slightly but consistently affected. Other measurements, such as downwelling shortwave, cloud base height statistics, and cloud amounts appear to be significantly, though only periodically, affected.

An Island Effects Workgroup convened during the Nauru99 Workshop to discuss these results and propose strategies to address the issue. Our discussion approach was based on two questions:

1. Is it enough to identify the occurrence?
2. Or must we "correct" for the effect using statistical and/or modeling approaches?

Results presented by Jason Cole show that the occurrence of significant island effect can be detected by comparison of ARCS2 site measurements with corresponding measurements made on the windward side of the island. Windward measurements are also needed to further study and quantify the island effect as it relates to specific measurements. To this end, the Island Effect Workgroup produced two initial recommendations that were presented during the summary session of the Nauru99 Workshop:

1. Install a permanent "top side met stand" on the windward side of the island
2. Propose an extended "IOP" of more sophisticated instruments on the windward side of the island

The first recommendation addresses the detection of significant occurrences of an island effect, and will allow the long-term study of affects on basic measurements. The permanent installation would be a rather simple collection of instrumentation including standard met measurements, downwelling shortwave irradiance (from perhaps a Licor), and possibly a few others depending on initial results of the second recommendation. The idea is to have a self-contained, low maintenance package that uses radio broadcast of the collected data to the ARCS2 site.

The second recommendation, a call for a more temporary installation of more sophisticated instrumentation, is necessary to quantify the more important island effects shown so far on cloud amount and cloud base height frequency and surface radiation. In addition, these measurements can be used to relate these effects to the more simple measurements made by the permanent instrument package with an aim of possibly "correcting", or at least actively quantifying, what the island effects are in the data record on a continuing basis. The "IOP" instrumentation would include a ceilometer, since the island effect on clouds is restricted to the lower atmosphere given the distance from the windward shore and the ARCS site. Other suggested instruments include a Whole Sky Imager (WSI), an Infrared Thermometer, a quality pyranometer and a pyrgeometer.

Collaborations

We are working with Savannah River Technology Center to supply ground truth information at the Nauru site for the satellite based Multispectral Thermal Imager (MTI). Information on the MTI can be found at http://www.sandia.gov/media/NewsRel/NR1999/MTIprep.htm.

5.0 SITE MANAGEMENT

SET-3

During April we conducted our third Site Evaluation Trip (SET-3). The purposes of these biannual trips are to enhance local management, train observers, negotiate local arrangements, tend to financial arrangements and accounting, and promote public awareness. In our experience establishing a regular schedule of SETs keeps the sites running smoothly and prevents emergency visits. Larry Jones and Colin Schulz (SPREP Consultant) conducted this SET to Nauru (Jones only), Port Moresby, and Manus. The SET-3 Report can be found at http://www.twppo.lanl.gov/docs/set3_rpt.html. SET-4 is being planned for November 2000.

New TWP Contract Coordinator for Papua New Guinea

Mr. Kevin Luana, Assistant Director of the Papua New Guinea National Weather Service, is the new TWP PNG Contract Coordinator. Mr. Luana replaces Mr. Ken Zorika who served in this capacity since the beginning of our operations in PNG. Mr. Zorika is retiring from the NWS.

New Observers at Manus Site

Mr. Hymson Waffi and Mr. James Pepa have joined the Papua New Guinea National Weather Service staff on Manus. They along with Mr. Francis Anuma (OIC) and Ms. Mary John operate the TWP ARM site on Manus in Papua New Guinea.

6.0 EDUCATIONAL OUTREACH AND PUBLIC RELATIONS

Plan Overview

DOE mandates that its programs have some form of educational outreach program. From the first days of ARM, developing the education outreach program has been assigned to each CART site. A small but consistent funding base has been allocated for the development of the education program, and the Site Scientist and/or the Site Program Manager usually administer it. The content of the site education program, while at the discretion of each site, must be relevant to the communities around each CART site.

The TWP presented us with unique problems for developing an education plan. The three TWP sites are spread out over a huge geographic area, and each site is in a different country with a unique language and culture. More importantly, the local schools generally lack advanced technology, such as Internet capabilities. Many do not have TV, video, or film resources and some are lacking the material, infrastructure and educational resources that are considered to be standard in the US. Our goal has been

to identify the various educational needs in the communities close to each site, and to attempt to deliver enrichment opportunities to satisfy some of those needs.

The overall vision for the TWP education outreach plan is to enrich primary, secondary and college science programs in the TWP region with a focus on basic science, climate, climate change and effects relevant to the region. The TWP educational outreach plan must have a broad scope to address local, national and regional issues and needs, and be flexible to stay current and relevant over the potential 10-year operating period of the TWP locale. The program must include both technical training for on-site staff, and public education and outreach for local communities, as well as addressing the needs of the more formal education systems of communities.

Plan Goals

- **Needs Assessment:** Meet with local and regional educators to determine the ways we can support educational needs for communities and the region. Needs assessment must be an ongoing task.

- **Curriculum Development:** Develop a regional curriculum for enriching science curricula in the secondary schools in collaboration with SPREP and other organizations.

- **Curriculum Implementation:** Develop and implement workshops to assist education departments using the curriculum. We will focus first on the communities and education departments close to the TWP sites, but will also participate in regional implementation efforts**.**

- **SPaRCE (Schools of the Pacific Rainfall Climate Experiment):** Support the SPaRCE program through assisting in the enrollment of schools in the program, support for development of automated school weather stations and advanced equipment, and also in participation in and joint sponsorship of in-service training.

- **Newsletters:** Develop quarterly newsletters for schools and for public information. These newsletters will have information on ARM and TWP progress, information on climate issues with a regional focus (e.g. El Niño, La Niña) as well as a Q&A section for readers to submit issues and concerns.

- **Material Support:** Support the improvement of material and equipment as needed and as funds available in the schools close to the ARCS sites. This material support may include books, video resources, computer usage, and simple automated weather stations and equipment.

- **Teacher Training:** Support enrichment for teachers as needed and as funds are available including attendance at meetings, and other in-service training.

- **ARM Resources:** Support tours of the ARCS, access to TWP and ARM data, and help with data analysis. TWP scientists and technicians will visit schools and give presentations to faculty and classes on the ARM program; we will assist on occasion with local needs for computer support or equipment issues.

- **Public Relations:** Develop a public relations plan in conjunction with on-site colleagues in the relevant government departments. Activities may include town meetings, local events, site tours, radio or TV interviews. The TWP program goal is to be responsible and communicative about ARM activities, and to assist with building local capacity for addressing climate and other environmental issues.

- **Technical Training:** Develop a technical training plan in conjunction with the on-site staff, the staff supervisors or employers, and the TWP program office. Build on existing technical skills, and offer opportunities for training that might not normally be available to the technical and management staff assisting with the day-to-day operations of the ARCS. Initially, observers will be trained to operate the equipment at the site. The initial equipment training will be followed by side-by-side working and training with TWP technicians, engineers and scientists; it could include formal training given by another provider depending on funding.

Significant Events

Workshop Evaluation Study:

In January and February, TWPPO conducted a one-year evaluation survey of the first Nauru Curriculum Implementation Workshop. Aiming to assess the impact of the workshop, which was held in November 1998, the survey used a 16-item, self-administered questionnaire to gather information about behavioral change among the 38 teachers and education officials who participated in the workshop. The results showed that the workshop encouraged the Nauru teachers to spend more classroom time on science, particularly on weather and climate change. In late April 2000, the results were presented at the Pacific Islands Climate Change Conference in Rarotonga, Cook Islands. TWPPO plans to conduct a similar evaluation study for workshops held in Manus and Port Moresby, Papua New Guinea.

School Visit:

During RESET 10 (26 March – 21 April 2000) and RESET 11 (26 June – 21 July 2000), ARM-TWP technicians visited local schools in Manus and Nauru for technical demonstrations and talks. As part of an ongoing effort to help enrich science education in the local schools, the visit featured a lecture and demonstration of Balloon-Borne Sounding System (BBSS), presentation of classroom activities, and a question-and-answer session. TWPPO plans to visit a local school in every RESET visit.

Newsletters:

In April 2000, TWPPO published the second issues of two newsletters, *TWP Update* and *Tropical Winds*. The third issues will be released in early October 2000.

Media Relations:
In April 2000, TWP project manager Bill Clements and then-deputy-project-manager Fairley Barnes appeared on Los Alamos Public Access Channel 8 (PAC 8) for an interview. Clements and Barnes discussed the ARM program as well as its significance contribution in climate change research. Clements also recorded a segment to introduce two video programs: *Atmospheric Radiation Measurement Program*, a promotional video sponsored and produced by the ARM program office; and *Clouds of Change*, a promotional video showcasing the TWP operation of the ARM program, sponsored and produced by South Pacific Regional Environment Programme (SPREP). Following more than a dozen showing on PAC 8, the videos have been aired on surrounding communities such as Santa Fe, Taos, and Albuquerque, New Mexico.

7.0 DISTRIBUTION OF DATA

Specific information on data availability by instrument and day can be found at: www.dmf.arm.gov.

Available data can be obtained from the ARM Experiment Center by contacting:

Ms. Robin Perez, Manager
ARM Experiment Center
robin.perez@arm.gov

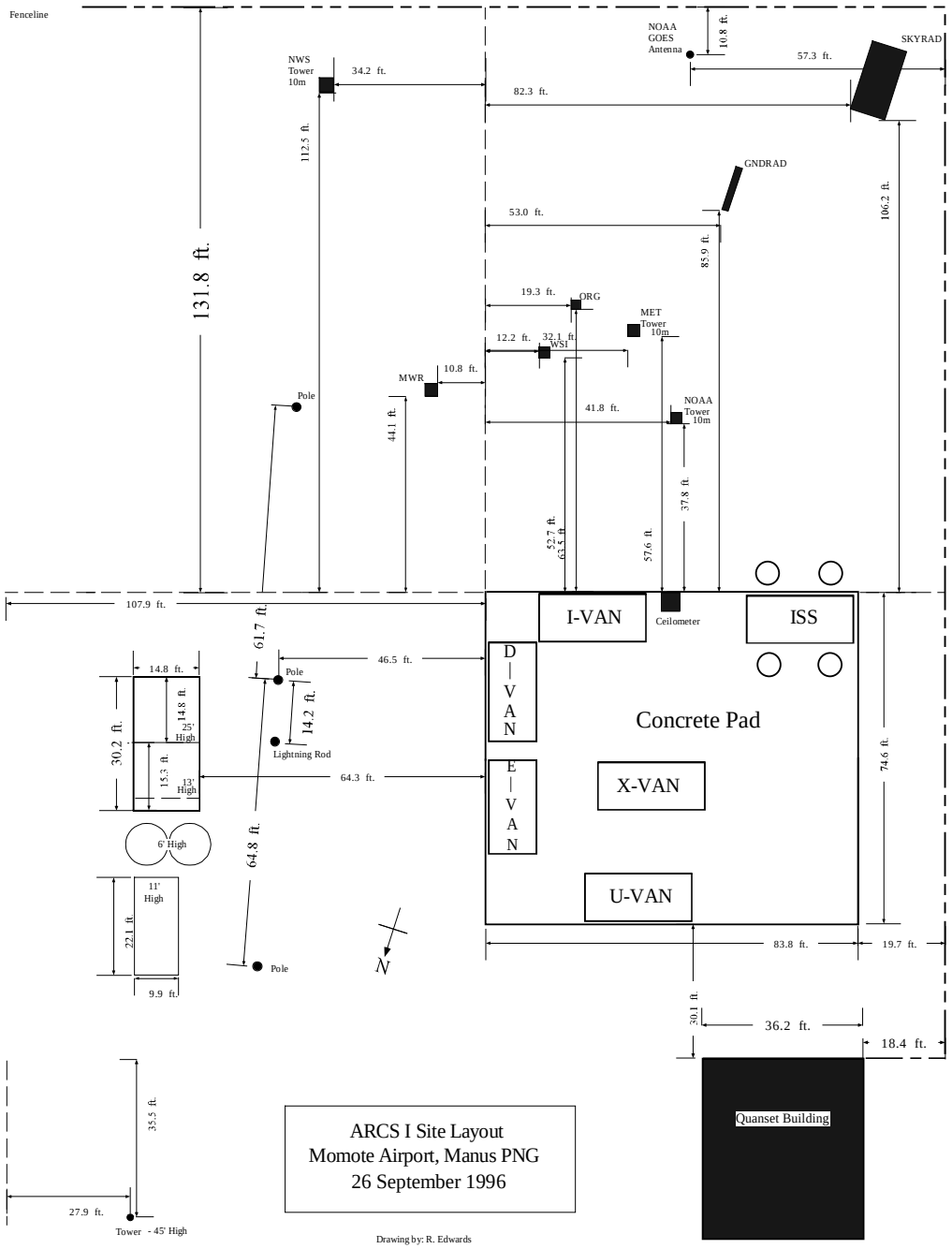
ACRONYMS

ACCESS	Automated Communication Control and Environmental Supervision System
ADaM	ARCS Data and Management System
AERI	Atmospheric Emitted Radiance Interferometer
ARCS	Atmospheric Radiation and Cloud Station
ARM	Atmospheric Radiation Measurement
ATLAS	Atmospheric Laboratory for Applications and Science
AVHRR	Advanced Very High Resolution Radiometer
AWOG	ARM Ocean Working Group
BBSS	Balloon Borne Sounding System
BNL	Brookhaven National Laboratory
CLASS	Cross-Chain LORAN Atmospheric Sounding System
CSP	Combined Sensor Program
DOE	U.S. Department of Energy
ECMWF	European Centre for Medium-Range Weather Forecasts
ENSO	El Niño Southern Oscillation
GNDRAD	Groundward Looking Radiometer Stand
GOES	Geostationary Operational Environmental Satellite
HRPT	High Resolution Picture Transmission
INU	Nauru
IOP	Intensive Operational Period
IRT	Infrared Radiometer
ISS	Integrated Sounding System
JAMSTEC	Japanese Marine Science and Technology Center
MAS	Manus
MFRSR	Multi-Filter Rotating Shadowband Radiometer
MPL	Micro-Pulse Lidar
MWR	Microwave Radiometer
N	Number
NCAR	National Center for Atmospheric Research
NIP	Normal Incidence Pyreheliometer
NOAA	National Oceanic and Atmospheric Administration
NSA/AAO	North Slope of Alaska and Adjacent Arctic Ocean
NTS	National Tidal Facility
NWS	National Weather Service
PIR	Precision Infrared Radiometer
PMEL	Pacific Marine Environmental Laboratory
PNG	Papua New Guinea
PSP	Precision Spectral Radiometer
RACE	Remote Accessibility Communication Equipment (ACCESS)
RASS	Radio-Acoustic Sounding System
RESET	REgional SErvice Team
SAM	Supervision and Management (ACCESS system)
SE	Significant Event

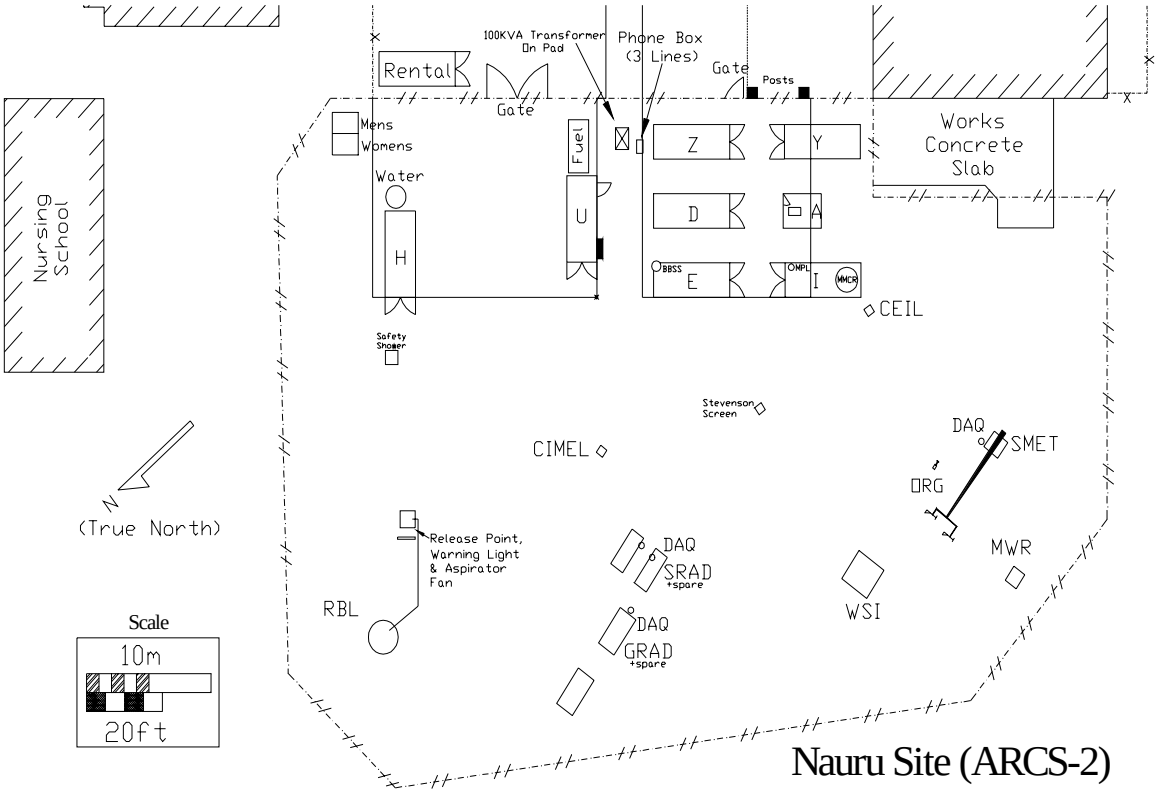
SGP	Southern Great Plains
SKYRAD	Skyward Looking Radiometer Stand
SPaRCE	Schools of the Pacific Rainfall Climate Experiment
SPREP	South Pacific Regional Environment Program
SST	Sea-Surface Temperature
TAO	Tropical Atmosphere-Ocean
TOCS	Tropical Ocean Climate Study
TOGA	Tropical Ocean and Global Atmosphere
TOGA COARE	Tropical Ocean Global Atmosphere Coupled Ocean-Atmosphere Response Experiment
TRITON	Triangle Trans-Ocean Buoy Network
TWP	Tropical Western Pacific
VCEIL	Vaisala Ceilometer
VISSR	Visible and IR Spin Scan Radiometer
VOS	Volunteer Observing Ship
VSOS	Volunteer Ship Observing System
WMO	World Meteorological Organization

APPENDICES

A. Manus Site Layout



B. Nauru Site Layout



Nauru Site (ARCS-2)