STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AG

RADIAN LOWER ATMOSPHERIC PROFILING RADAR
(LAP-3000)

MONITORING AND LABORATORY DIVISION

NOVEMBER 1997

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APPENDIX AG.1

STATION OPERATOR'S PROCEDURES
FOR
RADIAN LOWER ATMOSPHERE PROFILING RADAR
(LAP-3000)

MONITORING AND LABORATORY DIVISION

NOVEMBER 1997

AG.1.0 GENERAL INFORMATION

AG.1.0.1 THEORY OF OPERATION

The Radian Lower Atmosphere Profiling Radar (Figure AG.1.0.1) is a remote sensing doppler radar that uses electromagnetic (EM) energy to sense turbulent fluctuations in the atmosphere. The radar emits pulses of high frequency EM energy which travel through the atmosphere. The speed of the EM energy changes as the index of refraction changes, which is a function of air density. When the energy pulses encounter spatial variations in the index of refraction, small portions of the pulses are scattered and received by the radar. The radar energy is transmitted in orthogonal beams with north-south, east-west and vertical orientations from which corresponding components of the wind vector may be obtained.

AG.1.0.2 SYSTEM DESCRIPTION

Lower **A**tmospheric **P**rofiling Radar (LAP-3000)

The LAP-3000 system (hence referred to as profiler) consists of the following:

1. Receiver/Modulator Unit - The receiver/modulator receives the EM energy returned to the profiler. The receiver is composed of an input blanker, an intermediate frequency (IF) amplifier/filter, a quadrature detector, switchable Bessel filters matched to the transmitted length and a local oscillator and modulator. The intermediate frequency is 60 MHz. The modulator is composed of a 60 MHz oscillator, an amplitude modulator and a phase modulator.

2. Interface Unit - The interface provides the power supply voltages for the final amplifier/preamplifier and the interface control signals for the receiver/modulator and the antenna phase shifter. The interface control board has buffered digital outputs for the control signals and a pair of 10-bit A-to-D converters for the receiver output. The interface displays the status of the antenna control outputs and the supply current for the final amplifier/preamplifier.

3. Radar Processor Unit (Radar computer)- The radar computer is responsible for overall radar operation and data analysis. Each of the ARB radar computers are 486 DX PC’s with 8 MB RAM and 350 MB hard drives.

4. Communications Unit (Gateway computer) - The gateway computer is used to remotely supervise and control the profiler, assign levels of quality control on the data, change the format of the data, and create a variety of graphic presentations. Like the radar computers, the gateway computers are 486 DX PC's with 8 MB RAM and 350 MB hard drives. An ethernet card is installed in the gateway computer to network it to the radar computer.

5. Antenna system - The antenna system consists of a steerable micro-patch phased array planar antenna (Figure AG.1.0.2). To prevent contamination of the radar signal, the profiler is surrounded by a sidelobe fence (clutter screen). The antenna points vertically, with electrically switched delays introduced pointing it 23 degrees off vertical, in planes that are 90 degrees from each other. The antenna has a beamwidth of 10 degrees by 10 degrees and 26 decibels (dB) of gain.

6. Final Amplifier/Preamplifier Unit - The final amplifier/preamplifier is mounted beneath the antenna. It consists of a final Radio Frequency (RF) amplifier, a transmitter/receiver (T/R) switch, a low noise preamplifier, an oscillator, and IF conversion components. The final amplifier/preamplifier unit is involved in signal processing of both the transmitted and received signals.

7. Peripherals (Uninterrupted Power Supply (UPS), printer, surge protection strip and modem) - The ARB profiler sites use Hayes 14.4 Optima modems. It allows serial asynchronous data transfer between the gateway computer and a host computer. Although the modems are rated at 14.4 bytes per second (bps), the type of phone lines used will be the limiting data transmission factor. Typically, 4800 bps is the maximum transmission rate when using cellular phones.

The profiler ideally provides vertical profiles of the horizontal wind speed and direction and vertical wind velocity from 120 meters to 3000 meters (m). The profiler transmits at 915 MHz and then receives returned echoes that bounce off the refractive turbulence in the atmosphere. The profiler can operate using one of four vertical resolution modes 60m, 100m, 200m and 400m. The system is limited to a maximum number of range gates (distance between measurements). Thus, there is a trade-off between range resolution and altitude measured.

Radio Acoustic Sounding System (RASS)

The RASS consists of an acoustic amplifier and four acoustic drivers (Figure AG.1.0.3). During RASS operation, an acoustic pulse followed by an EM pulse is transmitted vertically. The EM pulse travels faster than the acoustic pulse. The EM pulse intercepts the acoustic pulse and the returned EM pulse is analyzed to determine the speed of the acoustic signal. Because the acoustic pulse travels at the speed of sound, the Doppler shifted EM pulse can be used to derive an estimated virtual temperature profile. RASS ideally provides the profiler with the capability to produce virtual temperature profiles from approximately 120 meters to 2000 meters. Virtual temperature is a temperature measurement uncorrected for pressure or humidity.

AG.1.0.3 TYPES OF DATA

The profiler produces four types of data files: spectral, moments, consensus, and common data format files (Figure AG.1.0.1).

The spectral data files are binary files, which contain the rawest form of the radar output. Spectral files are produced and stored by the radar computer. They contain the spectral values (amplitude with respect to frequency) for each spectral bin for every range gate as well as the derived moments data. Spectral files are very large (25 MB per day), thus, are typically not stored by the radar computer.

The moments data files are binary files that include the Doppler velocity, the spectral width, the signal-to-noise ratio of the peak and the noise level. Moment files are also produced and stored by the radar computer. These files can be used to reprocess consensus averages with different averaging times or consensus criteria.

The consensus data files are moment data that have been averaged using a wind consensus-averaging algorithm. The consensus average files are ASCII format files that contain the averaged wind and virtual temperature data. Typically, one-hour averages are calculated but shorter averaging periods are possible.

The common data format (CDF) files are consensus data files that have been formatted by the data formatting program located on the gateway computer. Files must be in the CDF format to be viewed using the graphics or quality control programs.

AG.1.0.4 SYSTEM DATA PROCESSING

Each of the five radar beams is sampled sequentially for approximately 30 seconds each. At the end of each cycle, the spacial and temporal raw data are separated into their North-South (N-S) and East-West (E-W) components. The Doppler shifts of the N-S and E-W components are used to compute the horizontal and vertical wind velocities (consensus data).

After an operating period of usually 50 minutes, a consensus average is performed using the individual consensus values. For an acceptable consensus average, a minimum percentage (typically 60%) of samples for each wind component must agree within a specified range (typically $\pm$ 2 m/s for wind speed and 10 degrees for wind direction). This effectively removes significantly outlying data from the average, while preventing an average from being created from too little data. This ultimately produces the average wind speed and direction. The raw and consensus data files are stored on the radar computer. Once an hour, the gateway computer runs a data format program that creates common data format (CDF) files that may be telemetered and archived.

The RASS samples for typically a 10-minute period. For an acceptable consensus average, a minimum percentage (typically 60 percent) of the virtual temperature samples must agree within a specified range (typically $\pm$ 2 degrees Celsius).

AG.1.0.5 PROFILER SOFTWARE

The profiler uses various software packages to process, format, quality control (QC), display, and download data files.

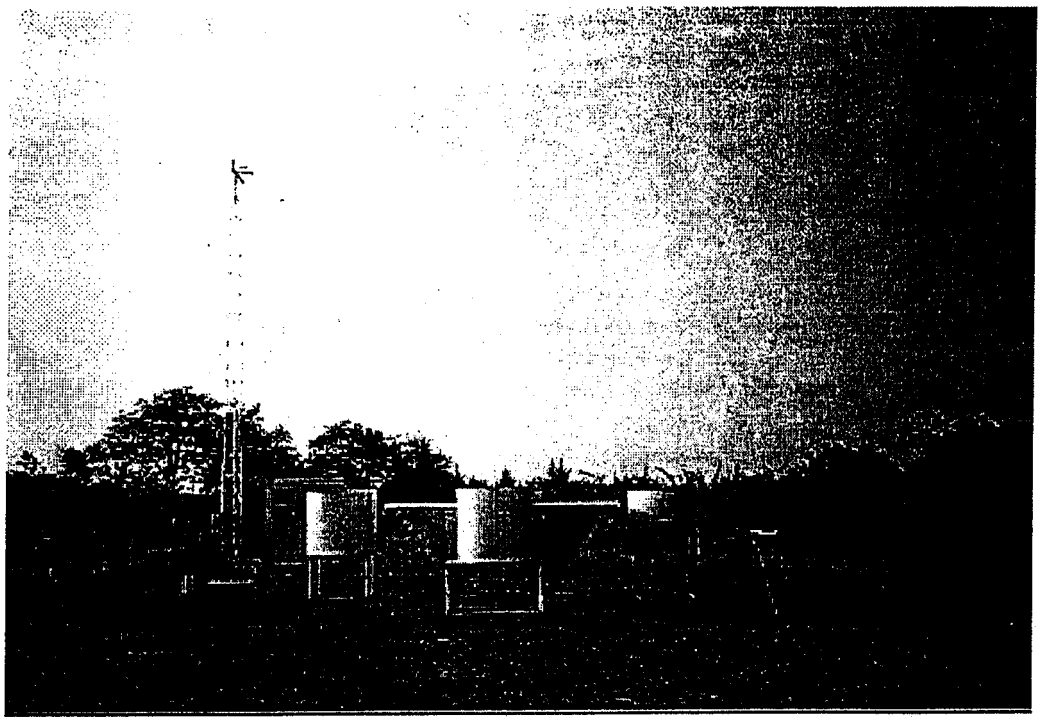
1. Profiler Online Program (POP) - The POP resides on the radar computer and controls the operation of the radar. The POP is used to specify specific site, wind processing, RASS, and Input/Output (I/O) parameters.

2. Gateway Data Formatting Module - The data formatting software (LAPCDF) converts profiler wind and virtual temperature consensus data into an ASCII file that uses a standardized file format called the Common Data Format (CDF).

3. Lower Atmospheric Profiler Quality Control (LAPQC) - The LAPQC software can be used to screen all data files located on the gateway computer. Typically, data files are screened after being downloaded by the host computer. Files that have been screened by the LAPQC program will have a “b” at the end of their filenames. The QC parameters used by the LAPQC are specified in the Quality Control Configuration (QCCFG) file.

4. Gateway Graphics Module (GCM) - The GCM provides screen and hard copy displays of the profiler wind and temperature data (Figures AG.1.0.4 and AG.1.0.5). Winds are viewed in time-height cross-sections using standard wind barb convention or color contours. Wind vector components and signal-to-noise ratios may also be presented as time-height color contours. Temperatures may be displayed as vertical profiles or as time-height color contours.

5. Communications Software – The ARB gateway computers use PROCOMM Plus for Windows as their communication software. A program using PROCOMM's Aspect Script Language is used to automatically download data files. WCRON, a windows scheduler, is used to initiate the download process and runs the LAPQ program.



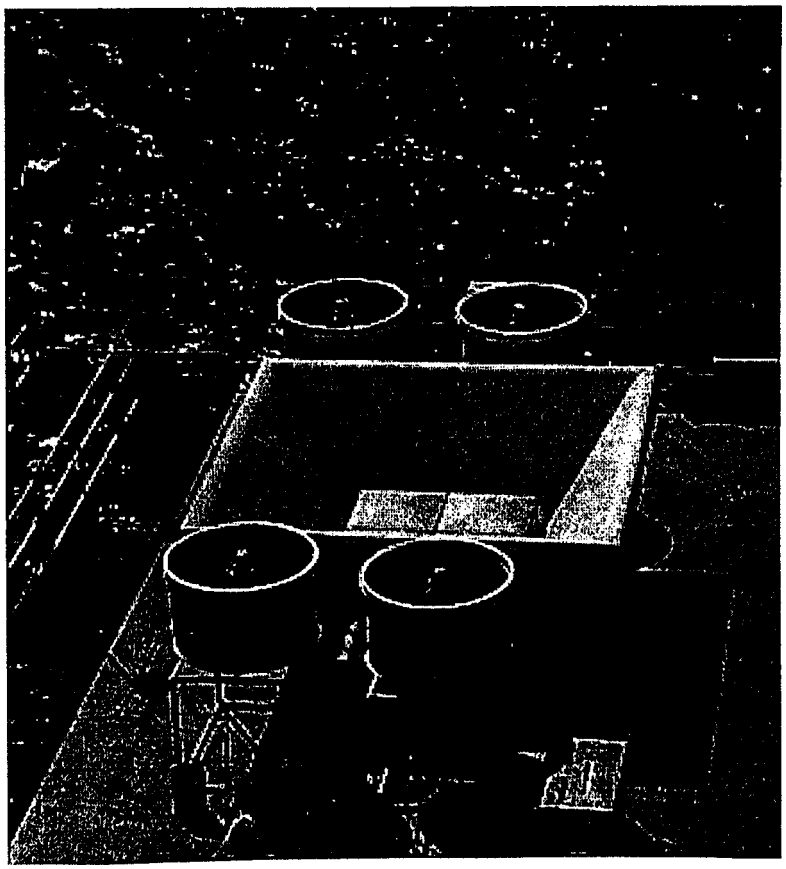


Figure AG 1.0.1
Photographs of 915MHz Radar Wind Profiler and RASS

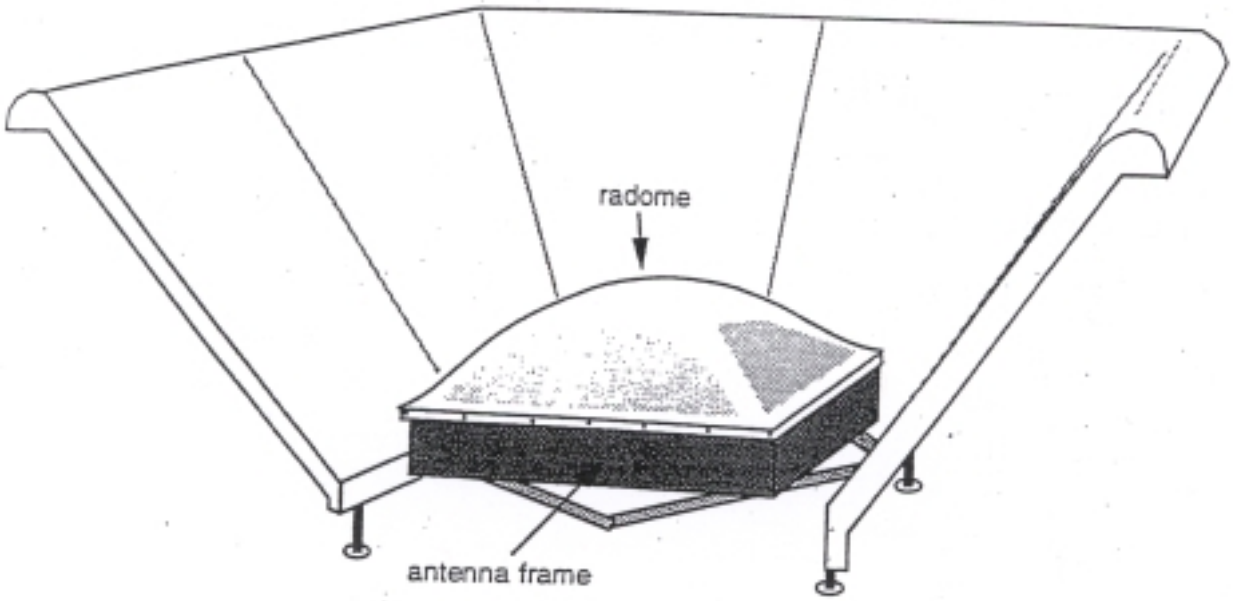


Figure AG.1.0.2
One Side of Clutter Screen Assembly Removed to Show
Radome Covering the Antenna Panels

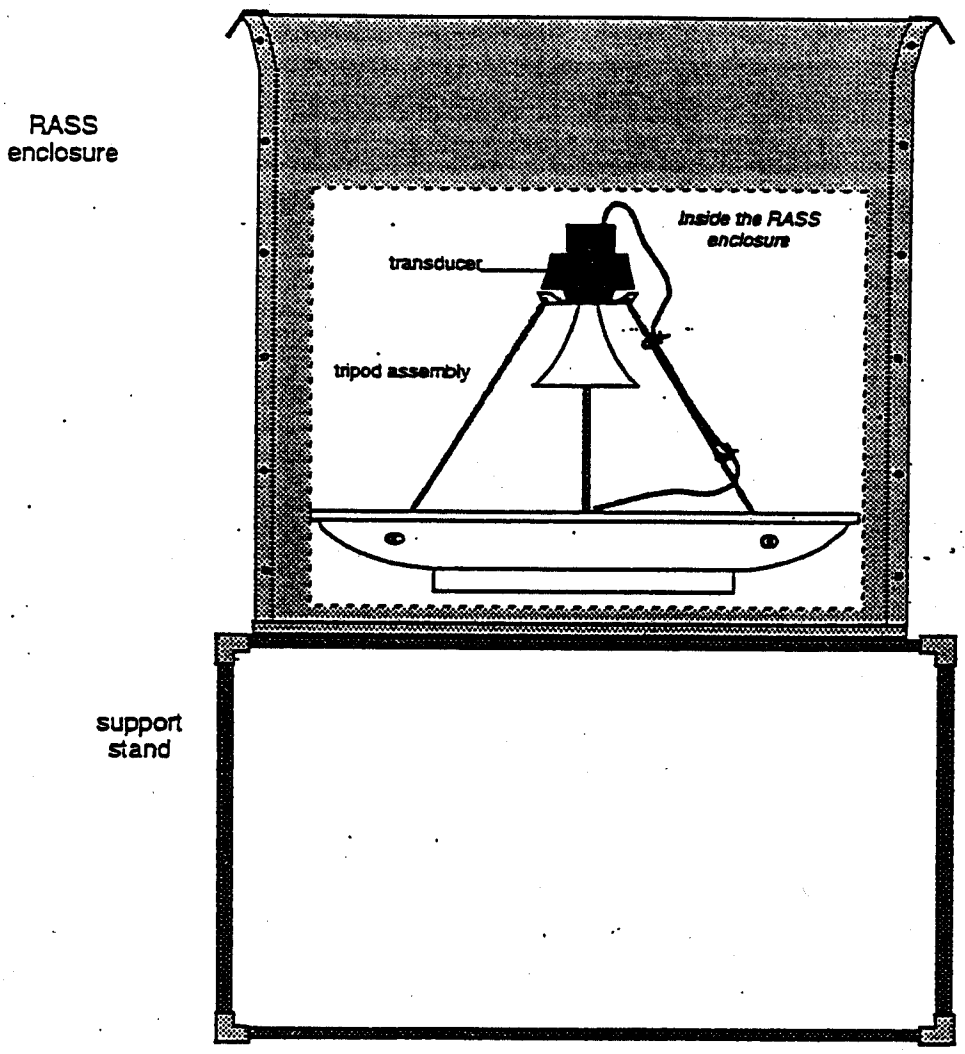


Figure AG.1.0.3
Radio Acoustic Sounding System (RASS)

Table AG.1.0.1

TYPES OF LAP-3000 DATA

Data Type	Data Format	Filename Format	Location	Parameter Archived Variables		Approx. File Size (megabytes/day)
Spectral	Binary	DyyjjjA.SPC HyyjjjA.SPC	Radar Computer c:\radar\data	Winds & Virtual temp.	PSD, RV, SW, SNR, N	24
Moments	Binary	DyyjjjA.MOM HyyjjjA.MOM	Radar Computer c:\radar.data	Winds & Virtual temp.	RV, SW, SNR, N	1.5
Consensus	ASCII	Wyyjjj.CNS Tyyjjj.CNS	Gateway Computer c:\gateway\data	Winds & Virtual temp.	Z, WS, WD, RV, CN, SNR Z, Tv, CN	0.2
Common Data Format	ASCII	iiiymmdd.WmA iiiymmdd.TmA	Gateway Computer c:\gateway\data\ daily	Winds & Virtual temp.	Z, WS, WD, u, v, w, CN, SNR, QC flag, Z, Tv, CN, QC flag	0.2

yy = year
y = last digit of the year
jjj = Julian day
iii = three-letter site identifier
mm = month
dd = day
m = sampling mode number (1-4)

Z = Height
PSD = Power Spectral Density (average power versus FFT bin)
WS = Wind Speed
WD = Wind Direction
Tv = Virtual Temperature
RV = Radial Velocity
SW = Spectrum Width
SNR = Signal-to-noise ratio
CN = Number of profiles in consensus average

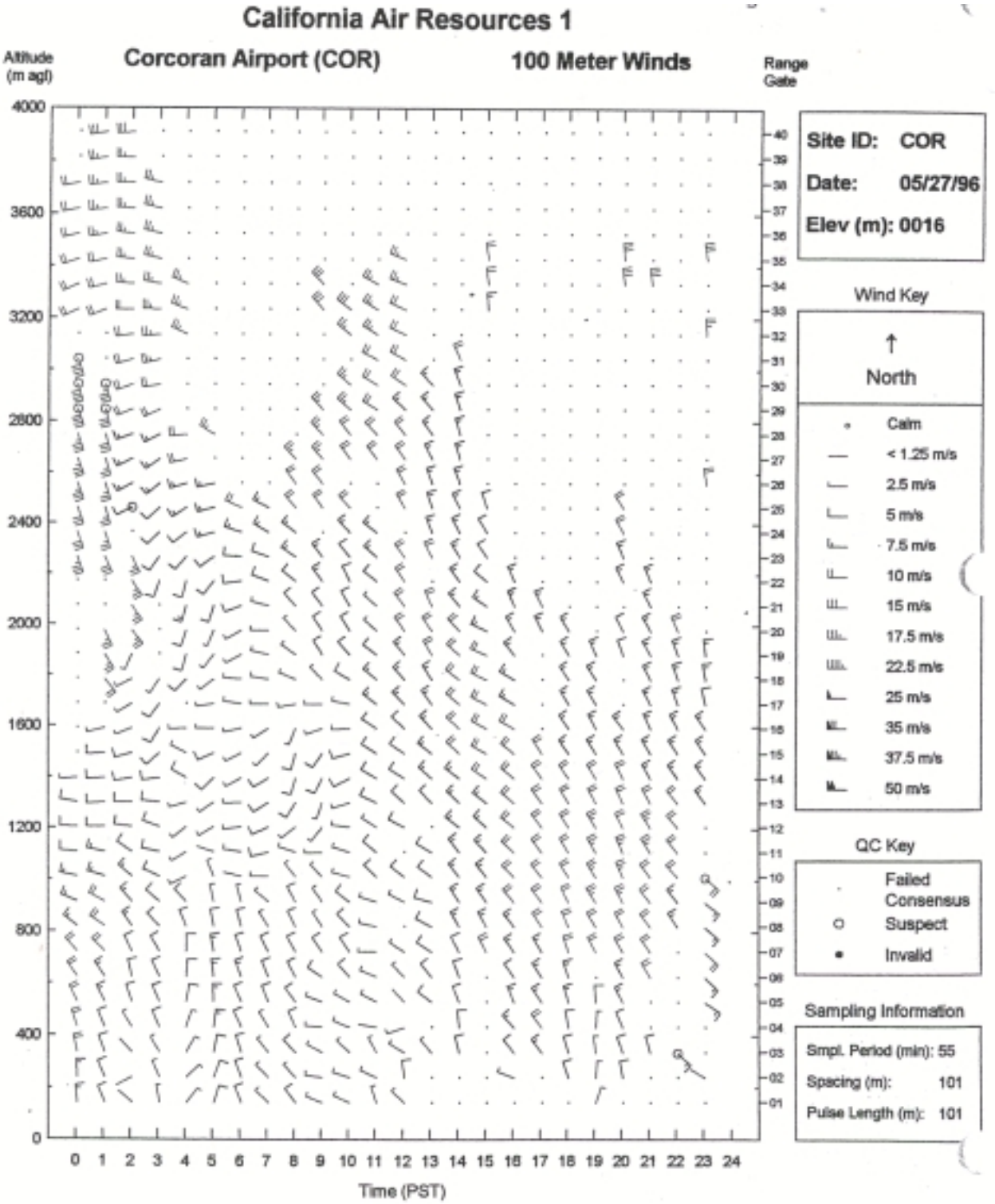


Figure AG.1.0.4
Display of Profiler Wind Data

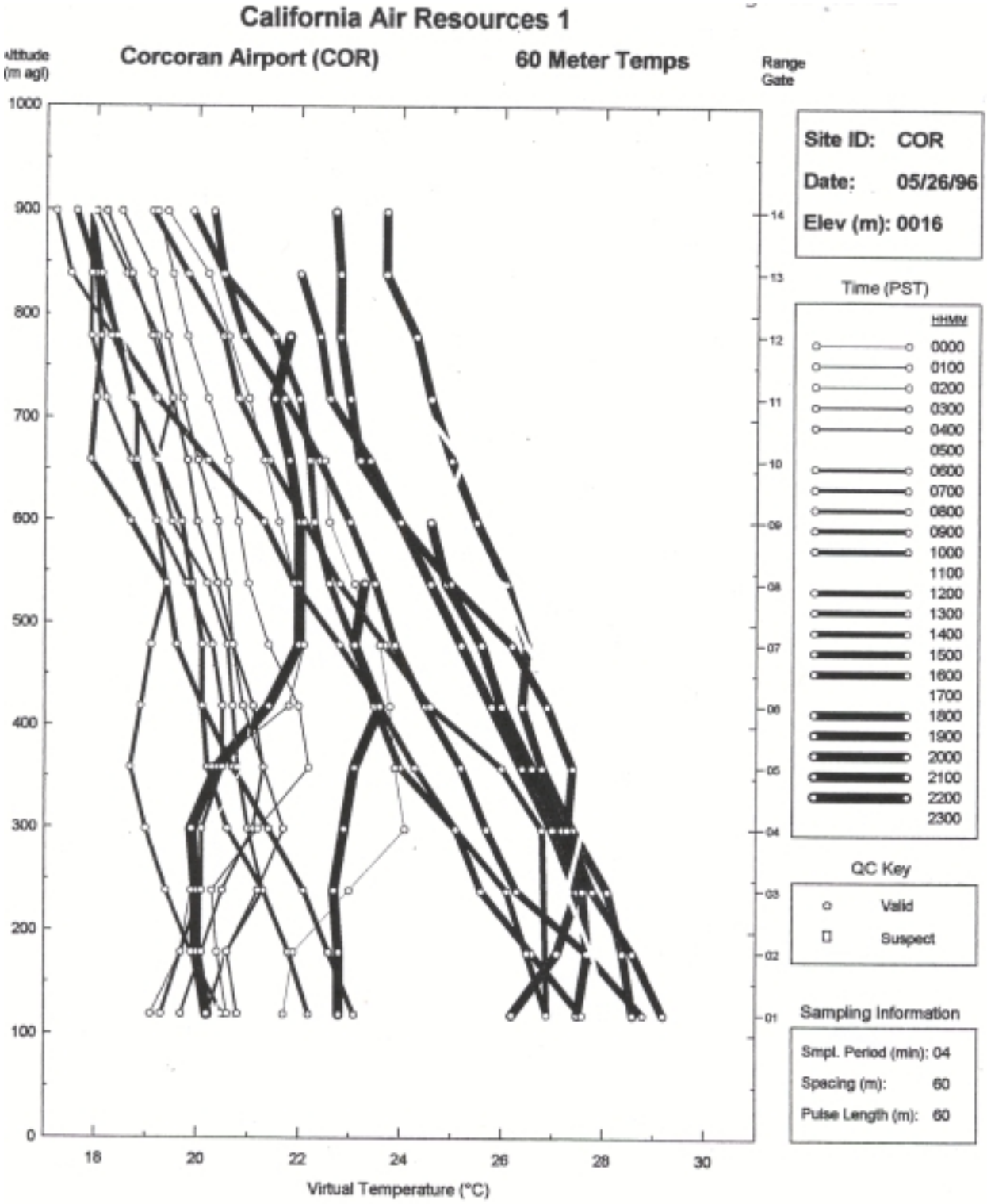


Figure AG.1.0.5
Display of Profiler Temperature Data

AG.1.1 SITING/INSTALLATION CRITERIA

AG.1.1.1 GENERAL SITING INFORMATION

The U.S. Environmental Protection Agency (U.S. EPA) has developed guidelines for ground-based meteorological remote sensing devices. These guidelines are published in the Quality Assurance (QA) Handbook for Air Pollution Measurement Systems: Volume IV, Meteorological Measurements. The U.S. EPA guidance should be followed as closely as possible; however, a site should be selected that meets the requirements of a case study, modeling needs, or objectives of monitoring. Due to meteorological differences in various areas, a meteorologist or person knowledgeable of terrain features and geographical weather patterns should assist in the siting process.

AG.1.1.2 SITING REQUIREMENTS

1. Site preparation - Site preparation can be a timely process; therefore, once a site is selected, preparation should begin at once. A site must have access to power and telephone service. Optimal power service should consist of 220 VAC, 50 Amp service. The site should have at least two telephone lines. Landlines are optimal. In extremely remote or short studies, cellular phone service is acceptable.

2. Space requirements - A site should be located in a relatively clear area approximately 130 feet by 75 feet (70 feet by 45 feet minimum) and have a concrete pad or similar firm surface which to place the profiler and RASS. The site should also be accessible by vehicle and provide adequate drainage.

3. Clutter interference - The site should be located in an area that is free of passive Radio Frequency (RF) interference sources. Obstructions that swing or vibrate in the wind (trees, overhead power lines, towers etc.) may be sources of passive interference. Due to the profiler processing techniques, frequent bird traffic areas and busy highways, overpasses should be avoided. Best performance is achieved if clutter sources are at or below 5 degrees below the profiler horizon.

4. RF interference - RF sources operating at 915 MHz may cause active interference. Possible active RF sources are telemetry lines and microwave towers. A site should be located away from these sources to the maximum extent possible. If possible, test the site using an RF analyzer to determine if an interference exist.

5. Noise - The RASS emits acoustic energy at 2000 Hz and can be a nuisance. Sites should be located 3/4 to one mile minimum from residential or noise-sensitive areas.

6. Safety - While operating the profiler and RASS, operators should be aware of possible RF and noise hazards. While working around the profiler, operators should turn stop radar from transmitting. The RASS operates on a regular schedule. Operators should be aware of the RASS operating schedule and not work near RASS when the sound source is active.

   The site should be enclosed by a security fence and cables should be either buried or placed inside conduit.

7. Permits - The profiler transmits RF energy at 915 MHz. This radio frequency lies in the Ultra High Frequency (UHF) range, and is regulated by the Federal Communication Commission (FCC). A valid FCC frequency allocation authorization permit is required before operating the profiler.

   An FCC Form 442 should be completed and mailed to the FCC approximately 12 weeks prior to estimated operation date.

   If the site is located at or near an airport, Federal Aviation Administration (FAA) approval may be required.

AG.1.1.3 SOFTWARE INSTALLATION/SET-UP

Software included with the profiler should consist of radar processing and communications software. The profiler radar system normally is delivered with software installed. The manufacturer's Gateway Software Operators Manual discusses the day-to-day software operations and should be read prior to operating the profiler. Site name, latitude and longitude, site elevation and sampling parameters must be determined before operating the profiler.

AG.1.2 OPERATING PROCEDURES

AG.1.2.1 GENERAL INFORMATION

The profiler is an automated system and requires little operator interaction. The profiler's operating manuals discuss control of the radar and software operation. Most profiler operations can be performed remotely, via modem, as well as on site. While all electronics are operating, the profiler should be checked routinely for proper operation.

During each site visit, operators should make an entry in the station log. The station log should document everything that happens at the site. At a minimum, operators should record the date, name and reason for the site visit (i.e., routine maintenance).

AG.1.2.2 WEEKLY CHECKS

The profiler site should be checked once a week when initial operations begin. Once an operator is comfortable with site operation, site checks may be completed at bi-weekly intervals. Operators should check the site for problems that may affect site operation. The profiler's operation manual contains information regarding site maintenance and should be read before operating the profiler.

AG.1.2.3 MONTHLY CHECKS

Operators should complete the LAP-3000 Monthly Maintenance Sheet (Figure AG.1.2.1) once a month. The maintenance sheet consists of two parts: 1) the monthly maintenance checks, and 2) the diagnostics checks. Operators should complete all items on the maintenance sheet. Once completed, the maintenance sheet should be forwarded to the supervisor and then filed in the station document folder.

The monthly maintenance section consists of two portions: inside and outside maintenance.

Inside maintenance should include the following:

1. Clean the air filters on the interface, receiver/modulator, and back of computers. A can of compressed air should be used to complete this task.

2. Remove dust from the electronic components with compressed air.

3. Check to verify that all cables are connected and undamaged.

4. If printer is connected, check the condition of the printer ribbon and the paper supply.

5. Turn on monitors. Press radar computer (RC) F8 key to verify the profiler is taking data. A countdown will appear in the lower left corner of the RC. Data will not be displayed until countdown is finished.

6. Archive the data from RC and gateway computer (GC). Press Alt Q key on the RC and then press F1 key to stop radar from transmitting. This will prevent the RC from processing and transmitting data, simultaneously. The moments (or spectral), consensus, common data format, gateway.log and wcron.log files will need to be archived. The GC uses a Colorado Tape back-up system to back archive data. Operators should know how the tape back-up operates.

The outside checks should consist of the following:

NOTE: Ensure radar computer, gateway computer and profiler are off (i.e., not transmitting) before working outside. Turning the power supply off at the Uninterrupted Power Supply (UPS) will shut down power to all systems.

1. Inspect the shelter, security fence, clutter screens, the antenna panel, RASS support stands, cables, guy wires and anchors for wear and or damage. Note the position of the clutter screen support legs. If any leg has moved more than 1 inch, adjustments to radar alignment may be required.

2. Lubricate the hinges, turnbuckles, and leveling screws of the clutter screen base. A lubricant such as WD-40 should be used to accomplish this task.

3. Verify the antenna is level to $\pm$ 0.5 degrees. Operators will need an electronic level for this task. Verify the X+ axis of the antenna panel is within $\pm$ 2 degrees of the value specified on the site-specific parameters screen of the POP.

Diagnostic checks are completed to evaluate the operation of the electronics inside the shelter.

NOTE: Operators will need to restart the profiler before completing the diagnostic checks.

Diagnostic checks should consist of the following:

1. Check to see that lights appear on all the electronic components.

2. Verify the final amp current display on the interface is within 0.02 for each of the directions for one parameter set.

3. Verify that the antenna position display of the interface is changing at the end of each spectral cycle. This will not happen when RASS is operating.

4. Verify that data from each antenna direction is different.

5. Check to see that the range resolution and/or filter values displayed on receiver change if the operational sequence uses different pulse lengths.

6. Listen to each RASS cuff to verify each one is operating. If RASS is not scheduled to sample, operator will need to turn it on via the POP. Do not stand near RASS for extended periods of time without ear protection.

7. Check the RC and GC date and time for accuracy. Time should be within $\pm$1 minutes of time standard used. Time standard should be in Pacific Standard Time (PST).

AG.1.2.4 SEMI-ANNUAL CHECK

The profiler should be audited by an independent agency once every six months. The audit should consist of a system and performance audit and be completed using a system comparable to the profilers spacial and temporal sampling.

AG.1.2.5 MAINTENANCE

The profiler requires very little maintenance. Site maintenance should be completed in accordance with the profiler operator's manual and the LAP-3000 Monthly Maintenance Checksheet (Figure AG.1.2.1).

AG.1.2.6 DATA MANAGEMENT

The data not downloaded daily is stored on the radar and gateway computers. The computers have the capability to store approximately three months of data. Data not downloaded daily should be archived monthly to reduce the potential loss of data.

The profiler data should be routinely reviewed by a meteorologist or operator knowledgeable with profiler operation. The data should be reviewed for unrealistic data values in the graphical presentations of the data.

The time-height cross-sections of the wind and temperature are automatically run through the LAPQC program once downloaded. The LAPQC program is based on the Weber-Wurtz algorithm which screens all data for outliers and consistency as determined by ranges specified in the QC parameter file.

When profiler data is to be used for case studies or model inputs, operators should perform a more rigorous review of the data. Outliers and other suspect data should be flagged and/or left out of the analysis. This process is time consuming and should be conducted daily when possible.

The Aerometric Information Retrieval System (AIRS) format used by the U.S. EPA to store surface air quality and meteorological data was judged to be unsuitable for storing profiler data because it is difficult to archive three-dimensional data in the AIRS format. A standardized format for archiving profiler data is currently being studied. CARB currently archives its profiler data on tape.

California Air Resources Board
LAP-3000 Monthly Maintenance Sheet

Site Name_____ **Date/Time**_____
Operator_____ **Julian Date**_____

Monthly Maintenance

Inside

_____Clean the air filters on the side of the interface and back of computer.
_____Remove the dust from the electronic components.
_____Check to see that all cables are still connected and undamaged.
_____Check the condition of the printer ribbon and the paper supply.
_____Turn on monitor, press RC F8 key, verify profiler is taking and displaying data.
_____Archive data from the hard disk on radar (RC) and gateway computers (GC). Press the RC ALT Q key, then press the F1 key to stop transmitting.
Files to archive: From _____to_____
*Moments (.mom) or Spectural (.spc)
*Consensus (.cns)
Common Data Format (.w and .t*)
*Gateway.log
*Wcron.log

Outside **Ensure RC, GC and Profiler are off before working outside!**

_____Inspect the shelter, the security fence, the clutter screens, the antenna panels, RASS support stand, the cables, the guy wires, and anchors for wear and/or damage.
_____Lubricate the hinges, turnbuckles, and leveling screws of the clutter screen base.
_____Verify antenna is level (+0.5deg.) and properly oriented (+2.0deg.).

Diagnostic Checks

_____Restart the Prolifer
_____Check to see that lights appear on all the electronic components.
_____Verify the Final Amp Current display is within 0.02 for each of the directions for one parameter set.
_____Verify that the Antenna Position display of the interface is changing at the end ofeach spectral cycle. (This will not happen when RASS is operating).
_____Look at the data for each antenna direction. The data should differ.
_____Check to see that the Range Resolution and/or Filter values displayed on receivechange if the operational sequence uses different pulse lengths.
_____Listen to each RASS cuff to verify each one is operating correctly.
_____Check the radar and gateway computer's date and time for accuracy(PST+/-1min.).

Comments:

Figure AG.1.2.1
Monthly Maintenance Sheet

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AG.2

ACCEPTANCE TEST PROCEDURE

FOR

RADIAN LOWER ATMOSPHERE PROFILING RADAR (LAP-3000)

MONITORING AND LABORATORY DIVISION

NOVEMBER 1997

AG.2.0 ACCEPTANCE TEST PROCEDURE

AG.2.0.1 GENERAL INFORMATION

Acceptance testing should be designed to determine if newly purchased or installed equipment is performing according to the manufacturer's specifications. An acceptance test should include comparison of profiler data with data from an acceptable in-situ sensor on a tower, tethersonde, a mini-sodar, kite, National Weather Service (NWS) rawinsonde or similar systems. The U.S. EPA QA Handbook for Air Pollution Measurement Systems: Volume IV: Meteorological Measurements discusses acceptance test procedures for ground-based meteorological radar systems.

AG.2.0.2 ACCEPTANCE TESTING

The operating parameters of the profiler should meet or exceed the following specifications:

	PROFILER	RASS
Minimum Height Measurement:	120 m	100 m
Maximum Height Measurement:	3000 m	2000 m
Minimum Vertical Resolution:	60 m	60 m
Wind Speed Accuracy:	< 1 m/s	--------
Wind Direction Accuracy:	< 10 deg	--------
Virtual Temp. Accuracy:	--------	1 deg. C

New profiler systems should demonstrate the above operating capabilities before they are accepted. A performance report should be received from the system manufacturer to verify that new systems have met these requirements.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

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APPENDIX AG.3

CALIBRATION PROCEDURE

FOR

RADIAN LOWER ATMOSPHERE PROFILING RADAR (LAP-3000)

MONITORING AND LABORATORY DIVISION

NOVEMBER 1997

AG.3.0 CALIBRATION PROCEDURE

AG.3.0.1 GENERAL INFORMATION

The U.S. EPA QA Handbook for Air Pollution Measurement Systems: Volume IV: Meteorological Measurements, contains information regarding calibration and performance audit methods. This document discusses the problems associated with calibrating profilers. The comparisons of radar systems with rawinsondes, tethered balloons, and tall towers, while useful, are not adequate because of the difficulty in comparing point estimates with large volume estimates, as well as temporal and spacial variations.

If the instrumentation is set up properly and all electronics are operating correctly, the precision of the data should be good to $\pm$1 meter/second for wind speed, $\pm$10 degrees for wind direction, and $\pm$1 degrees Celsius for virtual temperature. A diagnostic check of all electronic components should be completed monthly.

AG.3.0.2 CALIBRATION/AUDIT PROCEDURES

The calibration/audit of the profilers should consist of two parts: 1) a system calibration/audit; and 2) a performance calibration/audit. The system calibration should assess the profiler operations for overall compliance with the standard operating procedures. The performance calibration should compare data collected by the profiler to a sodar or system capable of making similar measurements to the profiler.

System Calibration - The system calibration is accomplished to determine if the profiler is set up properly and is operating according to the SOP's. At a minimum, the system calibration should check for the following:

- All cables are inspected for proper connection.
- The orientation of the antenna array should be aligned within $\pm$ 2 degrees.
- The level and inclination angles of the antenna should be within $\pm$ 0.5 degrees.
- A scan of frequencies near the operating frequency of the radar should be performed using an RF scanner.
- Site should be screened for possible active and passive interference sources.

- Antennas and enclosures should be inspected for structural integrity.

- Instrument time clocks should be checked.

- Data processing methods should be checked.

- Data over a several-day period should be checked for reasonableness and consistency.

- Station logs and checklist should be reviewed for completeness.

Performance Calibration/Audit - The performance calibration/audit is completed to determine the accuracy of data collected by the profiler. This check should be accomplished using a sodar or similar system. The test should include the comparison of data at a minimum of three levels. All output generated by the profiler should be included in the comparison.