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Final Report

CALIFORNIA AIR RESOURCES BOARD
CONTRACT # 96-320

SOUTHERN CALIFORNIA OZONE STUDY 1997 NORTH AMERICAN RESEARCH STRATEGIES FOR TROPOSPHERIC OZONE (SCOS97-NARSTO) UPPER-AIR AND ASSOCIATED SURFACE METEOROLOGICAL MEASUREMENTS

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ABSTRACT

The Southern California Ozone Study 97—North American Research Strategies for Tropospheric Ozone (SCOS97-NARSTO) program was an aggressive campaign to collect meteorological and air quality data to help understand the processes that lead to high ozone concentrations in the Southern California region. An extensive network of remote sensing devices measured meteorological conditions above the surface. Six sodars and 28 radar wind profilers (RWP) equipped with radio acoustic sounding systems (RASS) were operated at 32 sites within the study domain. These were supplemented by rawinsondes released at 13 sites. The RWP and RASS instrumentation consisted of 449, 915, and 924 MHz commercial and NOAA-Environmental Technology Laboratory (ETL) systems. Sodars included both commercial and NOAA-ETL research instrumentation. Supplementing the upper-air measurements were surface (10-meter) measurements that provided both transport data as well as quality control information for the operations of the remote sensing instrumentation. This report describes the quality assurance (QA) program for the auditing of the RWP/RASS and sodar stations in this network. Rawinsonde sites were not audited. The program included system audits of 23 sites including the collocated surface meteorological measurement systems. Performance audits were also performed on the surface measurement systems and a selected number of the remote profiling systems. Performance audits of the RWP consisted of comparisons to a collocated mobile audit Doppler sodar and rawinsondes launched at the monitoring sites. RASS performance audits consisted of comparisons with the virtual temperature profiles calculated from the rawinsonde measurements. Sodar performance audits consisted of comparisons with simulated Doppler shifted signals representing known wind speeds. The audit techniques, audit methods and preliminary audit findings are presented in this report.

EXECUTIVE SUMMARY

The Southern California Ozone Study 97—North American Research Strategies for Tropospheric Ozone (SCOS97-NARSTO) program included an aggressive campaign to collect meteorological data aloft to help understand the processes that lead to high ozone concentrations in the southern California region. In addition to rawinsondes and ozone sondes, there were 32 upper-air monitoring stations that used remote sensing technology. This technology included 28 radar wind profilers (RWP) and radio acoustic sounding systems (RASS), and 6 sodars. Supplementing the upper-air measurements were surface (10-meter) measurements that provided both transport data as well as quality control information for the operations of the remote sensing instrumentation.

To help insure the quality of the collected data, a comprehensive quality assurance program was implemented. This program consisted of essentially two phases. First, the Quality Assurance Plan and associated standard operating procedures (SOPs) for these measurement systems where reviewed to ensure that data quality objectives (DQOs) were adequate and realistic for the intended purpose and that the proposed procedures were appropriate for achieving those goals. Second, equipment and operator performance were verified through system and performance audits of each measurement system.

System audits were conducted at 26 sites. System audits documented and commented on the extent to which the DQOs were met by the level of adherence to the applicable SOPs, and recommended changes in site operations, if needed, to achieving those goals. A system audit form/checklist was used to ensure that critical aspects of the operation were checked and to report audit findings. Items checked during the system audit included station and equipment operational procedures, equipment setup, preventive maintenance, and data handling.

Performance audits compared the response of individual measurements to certified standards to determine any deviation from the project DQOs. Performance audits of RWP/RASS systems were conducted 11 sites, and performance audits of sodar systems were conducted at four sites. The sodars were audited using an acoustic pulse transponder (APT), a device which simulates wind speeds along each of the sodar component axes by detecting the sodar's transmit pulse and returning a set of known pulse sequences. Two different methods were used for the auditing of the radar wind profilers. The first involved the collocation of a portable sodar with the RWP while the second used rawinsondes for collection of the wind data. Both of the methods have advantages and drawbacks in conducting performance audits. The sodar allows collection of a longer time series of data, specific to the site and under a variety of meteorological conditions. This is especially useful for sites in regions where significant changes in flow patterns can occur over the diurnal cycle and where site specific influences, such as complex terrain, can cause differences in flow patterns at distances away from the RWP site. Sodars, however, are limited in the altitude coverage and cannot provide data much above 700 to 1,000 meters, a region well covered by rawinsondes. Rawinsondes also provide temperature and moisture profiles that are required for the RASS comparisons.

Problems uncovered during the system audits fell, for the most part, into two categories: system setup and siting. System setup problems included improper RWP and RASS antenna orientation/leveling and inconsistent site-to-site configurations in the RWP and RASS range gate spacing. Siting problems dealt primarily with antenna exposure. With respect to the sodar installations, active noise sources noted included noise from vehicular traffic, water well pumps, an air conditioner, and a rifle range. Passive noise sources that generate false return echoes included buildings, walls, canyon walls and cliffs. For RWP and RASS, active interferences noted by the audits included radio frequencies close to the RWP's operational frequency. Passive interferences included power lines, trees, vertical surfaces such as buildings and walls, hills, and automobiles moving on an elevated roadway. For the surface meteorological systems, set up problems consisted of wind directions sensor misalignment and unsecured towers, while siting problems consisted primarily of poor sensor exposure.

The audit comparisons between the RWP and both the audit sodar and the rawindsonde measurements showed good general agreement, and where differences exceeded the audit criteria the reasons for the differences for the most part were due to limitations in the audit methodology or siting issues. It should be noted that all comparisons were made with the raw data collected in the field. Subsequent to the data collection effort, the RWP data were reprocessed using various screening algorithms. The reprocessed data have not been included in the analyses described in this report. The differences noted may change once the reprocessed data become available and any analyses are performed.

The average differences for the RASS / rawinsonde comparisons were well within the audit criteria for seven of the 11 sites audited and three additional sites came very close to meeting the criteria. Only one site showed relatively large differences during the audit, which were probably the result of difficulties experienced with the rawinsonde system during the audit at this site. The audits of the four sodars using the APT gave comparisons that were within the audit criteria with respect to wind direction at all sites audited and at two of the four sites with respect to wind speed. Two of the sodars audited were found to have calculation errors in the wind speed. These errors were corrected following the audit, and subsequent data were calculated correctly. Performance audit results for the surface meteorological equipment were generally good.

Subsequent to the comparisons made in this report, the EPA has made further recommendations on QA analysis methods for remotely sensed data. Some of the lessons learned and experience gained in this program were used to develop additional analysis methods to be used in evaluation of QA data. These new methods, now in draft form (EPA, 1999), should be used in the evaluation of the audit data collected during the SCOS97 program. The analyses should be performed on the validated data set that, as of the printing of this report, is not yet available.

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Section 1

BACKGROUND

1.1 PROJECT

The Southern California Ozone Study 97—North American Research Strategies for Tropospheric Ozone (SCOS97-NARSTO) program included an aggressive campaign to collect meteorological data aloft to help understand the processes that lead to high ozone concentrations in the southern California region. In addition to rawinsondes and ozone sondes there were 26 upper-air monitoring stations that used remote sensing technology. This technology included 28 radar wind profilers (RWP), radio acoustic sounding systems (RASS), and 6 sodars. The RWP and RASS instrumentation included 449, 915, and 924 MHz commercial, and NOAA Environmental Technology Laboratory (ETL) profilers. Sodars included both commercial and ETL research instrumentation. Supplementing the upper-air measurements were surface (10-meter) measurements that provided both transport data as well as quality control information for the operations of the remote sensing instrumentation.

AeroVironment Environmental Services Inc. (AVES) was the quality assurance (QA) contractor for a portion of these meteorological measurements. They performed these duties under the sponsorship of the California Air Resources Board (ARB), the South Coast Air Quality Management District (SCAQMD), and the San Diego Air Pollution Control District (SDAPCD).

1.2 PROGRAM OBJECTIVES

The objectives of the audit program for upper-air meteorological measurements were to ensure that the established data quality objectives (DQOs) for these measurements were achieved. The approach taken was to first review the DQOs in the Quality Assurance Plan and the applicable standard operating procedures (SOPs) for these measurement systems to ensure that DQOs were adequate and realistic for the intended purpose and that the proposed procedures were appropriate for achieving those goals. The second part of the approach was to test the implementation of the procedures documented in the SOPs by performing system and performance audits of each measurement system. The system audits documented and commented on the extent to which the DQOs were met by the level of adherence to the applicable SOPs, and recommended changes in site operations, if needed, to achieving those goals. The performance audits compared the response of individual measurements to certified standards to determine any deviation from the project DQOs.

1.3 PROGRAM SCOPE AND LIMITATIONS

The QA program performed by AVES addressed most of the remote sensing instruments and the collocated surface meteorological instruments. In order to provide feedback to the operators and provide the opportunity for timely corrections of operations, the performance audits were conducted against the data from each RWP/RASS that was available in near real time. For some sites the final post-processed RWP/RASS data which was not available until much later. This final data has not been evaluated against the audit observations.

Performance audits of the RWP included comparisons to a collocated mobile audit Doppler sodar, and rawinsondes launched at the monitoring sites. RASS performance audits consisted of comparisons to virtual temperature profiles from the launched rawinsondes. Sodar performance audits consisted of comparisons with an Acoustic Pulse Transponder (APT). The APT simulated wind profiles by creating Doppler shifted signals representing known wind speeds at time intervals that corresponded to the sodar range gates. The audit techniques, audit methods, and preliminary audit findings are presented in this report.

Of the 28 RWP/RASS operated at 26 sites, AVES performed system audits at 23 sites and performance audits at 11 sites. The 11 RWP/RASS sites selected for formal performance audits included at least one system operated by each of seven organizations—ARB, National Oceanographic and Atmospheric Administration (NOAA), NOAA-(Environmental Technology Laboratory [ETL]), Ventura County Air Pollution Control District (VCAPCD), SCAQMD, SDAPCD, and Radian Corporation/Sonoma Technology Inc. (STI). SCAQMD and SDAPCD funded the performance audits for each of their RWP/RASS. The performance audits were conducted by comparing the RWP/RASS with rawinsondes and either a collocated project sodar or a portable audit sodar.

Although funding was only available to provide formal performance audits for fewer than half of the RWP/RASS sites, additional observations are available that may be used for comparisons. At Vandenberg AFB three RWP/RASS and a sodar operated in near proximity; these can be checked against each other for consistency but were not otherwise audited. Likewise, the Tustin RWP/RASS was near a project rawinsonde site. In addition, to supplement the performance audits provided by AVES, the ARB and the U.S. Naval Weapons Center, Point Mugu made two rawinsonde releases at each of 12 sites. The collocated project soundings and the 24 supplemental rawinsondes provide a basis for a limited evaluation of all of the RWP/RASS sites that lacked performance audits except for Van Nuys. The U.S. Navy released rawinsondes at Port Hueneme on September 18, 1998; the University of Southern California on September 26, 1997; Santa Catalina Island on September 29, 1997; San Clemente Island on September 29, 1997; Palmdale on October 29, 1997; and Goleta on October 30, 1997. ARB released sondes at Barstow, Hesperia, Riverside, Norton AFB, Thermal, and Imperial Airport (near El Centro). The rawinsonde soundings at these 12 sites have not been compared with the RWP/RASS data under the AVES contract.

Both system and performance audits were conducted by AVES for the three sodars installed by NOAA-ETL, and the one sodar installed by SDAPCD. The existing sodar at

Vandenberg AFB was not audited but may be compared with nearby RWP/RASS and rawinsondes. The two sodars installed later in the program at Twenty-Nine Palms were not audited.

All of the sites that received system audits for RWP/RASS and sodar also received performance audits for the surface measurements of winds, temperature, and humidity.

Section 2

METHODS SECTION

2.1 AUDIT EQUIPMENT

2.1.1 RWP

The RWP were audited using either a portable or a collocated project sodar and rawinsondes. Each of the associated certifications is described below.

2.1.1.1 Portable Audit Sodar

A portable audit sodar was used to perform audits of the RWP systems. The sodar collected independent 15-minute average wind data that was compared to the collocated RWP. The sodar was an AeroVironment Model 2000 three-axis system. The AVES sodar is a self-contained, trailer-mounted unit developed for finer resolution remote measurements of wind speed and direction in the lower atmosphere. The certifications included both the initial checkout and acceptance of the system, and checks prior to each individual audit.

- System Checkout and Acceptance

Prior to field deployment, the portable sodars' operation was verified against a known audit standard. The standard was an Acoustic Pulse Transponder (APT) capable of generating simulated Doppler shifted frequencies and known timing intervals.

To verify the system operation, the sodar was operated in the vertical velocity correcting mode. This was the same mode of operation as the RWP. At least three complete averaging intervals (15-minute) were run using the APT. Anticipated winds included horizontal components in the range of 5-10 m/s and a vertical component of about 0.5 m/s. An antenna rotation angle was used off of the normal north/south or east/west axes. Criteria for acceptable operation were horizontal and vertical components within ±0.2 m/s and vector resultant winds within ±0.5 m/s and ±5°. If the sodar data fell within this accuracy bound, then the sodar was considered suitable for use as an audit device.

To optimize the vertical range of the sodar and minimize the potential influence of reflective sources, the sodar was operated using a 20° zenith angle.

- Sodar Operational Verification Prior to Each Audit

The orientation of the portable audit sodar was determined using a Brunton Pocket Transit Model F5007LM. The transit was tripod-mounted and could be read to an approximate accuracy of ±0.5°. This magnetic alignment was corrected to true north using the local magnetic declination. When possible, and cloud cover allowed, the orientation was verified using the solar azimuth angle and site latitude and longitude.

2.1.1.2 On-Site Sodar

At sites with existing collocated sodars, the sodars were audited to establish their validity as a transfer device to audit the collocated radar profilers. The procedures were divided into system and performance audit procedures and are described below. Sodar audit procedures are presented in Section 3 of this report.

2.1.1.3 Rawinsonde System

For the audits of the RWP upper-range gates, VIZ Model W-9000 rawinsondes were released. Prior to release, the sondes' output was verified against the surface pressure and temperature readings of an audit device. Surface pressure was measured using a Peet Bros. Ultimeter Model 3. This barometer was certified by single-point comparisons to the AVES standard and their field barometers as well as periodic comparisons to airport pressure readings in the field. Temperature was measured using a Brooklyn Thermometers Model 76-mm mercury-in-glass thermometer, which were compared with the AVES NIST-certified standard thermometer.

2.1.2 <u>RASS</u>

The rawinsonde pressure, temperature and relative humidity data were used to calculate virtual temperature profiles for comparison with the RASS virtual temperature profiles. The check of the sondes prior to release is described in Section 1 of this report.

2.1.3 <u>Sodars</u>

The sodars were audited using an acoustic pulse transponder (APT). The APT is a microcomputer-based system that is programmable for the number of pulses, pulse duration, pulse frequency, and timing delays. The system detects the transmit pulse from the sodar antenna and retransmits a preprogrammed pulse sequence. The pulse sequence consists of one or more sequential frequencies at specific timed intervals that represent known frequency offsets from the sodar system. The frequency offsets and timing of the pulses simulate wind speeds along each of the sodar component axes. The APT system consists of three modules, which are described below.

<u>Pulse transponder.</u> The pulse transponder is placed near the sodar antenna and serves two purposes. First, it detects the transmit pulse from the sodar antenna; and second, it provides a speaker that transmits the audio audit frequency back into the sodar antenna. For the three-axis sodar, an individual transponder is placed in each of the three antennas and all components are verified at the same time.

<u>System interface.</u> The system interface provides the link between the pulse transponder and laptop computer. The interface converts the detected pulse into a digital signal that is transmitted to the laptop computer RS-232 port. In addition, the

interface amplifies the audio frequencies generated by the computer that are sent to the transponder.

Laptop computer. The laptop computer detects the transmit pulse in the RS-232 port and initiates the pulse timing sequence. The computer software calculates the retransmission timing and frequency generation based on a preprogrammed configuration that is specific to the sodar being audited. The frequencies generated by the computer are transmitted to the system interface by means of an audio pickup. The system configuration, as well as a record of each retransmitted pulse, is recorded in a documentation file.

There are two variables that require verification in order to have confidence in the APT's ability to accurately simulate wind speeds. These variables include generation of known frequencies, and timing of the returned pulse or change in frequency.

The generation of known frequencies is verified using a Fluke Model 87 true RMS multimeter that measures the APT frequency. This multimeter is, in turn, certified against another traceable standard.

Two types of pulse timing checks are performed to check the timing in the computer software. The first checks the accuracy of the APT in timing the delay after pulse recognition. The second determines the accuracy of the retransmitted pulse length. Both of these timers are verified using a quartz clock.

2.1.4 Surface Meteorological Measurements

The audit standards that the AVES audit team used in the field were certified at the beginning of the audit program in accordance with the procedures recommended in the EPA monitoring guidelines (EPA, 1994a, 1994d). All instruments were certified by the AVES Measurements Standards Laboratory, with the exception of the barometers that are certified by Temperature Standards, Inc. of Monrovia, California. The results of these certifications were documented and added to the existing certification history for each instrument. If the results of a certification showed that an instrument did not meet the EPA-recommended criteria (EPA, 1994a, 1994d), the instrument was repaired and re-certified before it was allowed to be used again.

- **Wind Speed**

  - Anemometer Drive

The R.M. Young Model 18801 anemometer drive is certified quarterly. A photo-tachometer is used to determine the actual rotational speed of the anemometer drive shaft for comparison with the rotational speed indicated by the anemometer drive display. Readings are made at six speeds evenly spaced through the entire operating range of the instrument.

- Torque Disk

The torque disk used to check starting threshold requires no certification.

- **Wind Direction**

- Compass

No certification required.

- Torque Disk

The torque disk used to check starting threshold requires no certification.

- **Ambient Temperature**

- Mercury-in-glass thermometer

The audit mercury-in-glass thermometer was compared to AVES' NIST-traceable standard thermometer when it was purchased. The two thermometers were immersed in water baths of approximately 0, 10, 20, 30, and 40°C. Periodic comparisons with the standard thermometer are not required.

- **Relative Humidity and Dew-point Temperature**

- Psychrometer mercury-in-glass thermometers

When the psychrometer mercury-in-glass thermometers were purchased, they were compared to AVES' NIST-traceable standard thermometer. The two psychrometer thermometers and the standard thermometer were immersed in water baths of approximately 0, 10, 20, 30, and 40°C. Periodic comparisons with the standard thermometer are not required.

- Audit barometer (Ultimeter Model 3)

The audit barometer is compared yearly with a standard barometer by the AVES standards laboratory. The last certification was performed May 2, 1997.

2.2 SYSTEM AUDIT PROCEDURES

The purpose of the system audit is to assess the consistency of measurements with the quality assurance plan and the applicable SOPs. A system audit form/checklist was used to ensure that the pertinent items of the audit were covered and to report the audit findings. The checklist used for SCOS97–NARSTO Upper–air Meteorological Measurements Audit Program can be found in Appendix A.

2.2.1 <u>Sodar System Audit Procedures</u>

The sodar system audit was divided into several tasks. A description of each task is provided below.

An evaluation of the site characteristics was performed. Passive and active noise sources were identified and noted to evaluate their impact on the sodar's ability to separate the return pulses from the background noise. Passive sources are objects that may reflect the pulse and contaminate the return spectra with what appears to be near-zero wind speeds. These sources include buildings, trees, nearby towers, etc. Active sources generate their own noise such as air conditioners, fans and industrial complexes. Low-level active white noise sources are not generally a problem except to reduce the maximum altitude. Active noise sources in the frequency spectrum of the sodar operations may affect the operations. General sound levels were measured using an integrating sound level meter and measuring levels, in dBA, in at least the four cardinal directions.

In addition to the evaluation of the total noise spectrum above, a system check was performed with the system "listening only"; i.e., without transmitting a pulse. The results of this check should produce no measured winds, or winds with very low reliability. If reliable winds are reported at any level, then there is probably an active noise source in the area that is generating frequencies in the operational region of the sodar.

Alignment checks were performed on the sodar systems. The orientation of the antenna array or individual component antennas will directly affect the accuracy of the calculated wind directions. The orientation of the respective antenna arrays was checked using a tripod-mounted Brunton Pocket Transit. The measured orientation was then compared to the software settings in the sodar. The criteria for acceptable orientation are ±2°. During the field audit, the compass alignment to magnetic north was compared against solar observations and the magnetic declination to verify the accuracy of the magnetic measurements.

The level of a phased sodar antenna array directly affects the calculations of the component speeds. The array level was checked using the inclinometer integral to the Brunton Pocket Transit. The criteria for acceptable level in any direction are ±1°.

2.2.2 <u>Radar Profilers and RASS System Audit Procedures</u>

Little guidance exists, regulatory or otherwise, for the quality assurance of remote sensing systems. For this program, *Draft Guidelines for the Quality Assurance and Management of PAMS Upper-Air Meteorological Data* (STI, 1995), which was prepared under funding from the EPA, was used as a starting point for the system and performance audit procedures. The procedures in the guidance are enhanced with experience of the auditor in previous quality assurance programs involving radar profiler and RASS instrumentation.

The system audit of the radar profiler inspected the antenna(s) and controller interface cables for proper connection, set up, and antenna level and alignment.

Antennas and enclosures or clutter fences were inspected for structural integrity. The orientation of the antennas were checked using a magnetic transit and tripod with the observed magnetic readings corrected to true directions using the local magnetic declination. The alignment of the array was checked using flags dropped from the antenna array that were visible from outside the clutter fence. The magnetic orientation measurements were also verified using solar azimuth measurements and latitude and longitude information provided by a geo positioning system (GPS). The level of the antennas was measured using a Pro SMARTLEVEL. Measurements were made in at least two directions on the bottom of the antenna array's support structure.

A vista diagram was prepared that documents the site's surroundings. The diagram identified potential reflective sources for the radar signal, as well as potential active sources that could generate interference. The diagram also provided a description of the view in 30-degree increments around the antenna, including the elevation angle and estimated distance to potential sources.

A scan of frequencies around the central operating frequency of the radar was performed using an RF scanner. This method identifies potential sources of active radio frequency noise that can contaminate the wind and virtual temperature data.

The settings of the controller and data collection devices were checked and noted to ensure that the instrument was operating in the proper mode and that the data being collected were those specified by the SOPs. This included a check of all clocks for accuracy, verifying that they were within ±2 minutes of the standard. The site operator was interviewed to determine his/her knowledge of the system operation, maintenance and proficiency in the performance of quality control checks. Emphasis was placed on verifying that preventive maintenance procedures had been implemented and were adequate. The station logbooks were reviewed for completeness and content.

While no specific audit criteria exist for the orientation and level, we used values consistent with past audits and the EPA-funded document, *Draft Guidelines for the Quality Assurance and Management of PAMS Upper-Air Meteorological Data* (STI, 1995). For orientation we used a value of ±2°. For level we used ±0.5°.

For data use purposes, the orientation of the single antenna, phased-array RWP adds a bias to the wind direction data that is proportional to the orientation offset. For the three component RWPs, operated by NOAA and located at the Alpine, Brown's Field, Carlsbad, Los Alamitos, Palmdale, Port Hueneme, Santa Catalina Island, San Clemente Island, Tustin, USC, and Van Nuys sites, wind direction error is further complicated by having to take into consideration the orientation of the two tilted beam antennas. Depending on the wind speed, the error introduced by misalignment depends on the wind speed and wind direction relative to the antennas. Typically, a 2°

orientation error of one of the antennas will result in a wind direction error of about 1°. If both antennas are offset the same amount in the same direction, the error will be similar to the that of the single antenna, phased-array RWP.

With respect to the level of the RWP antenna(s) both the wind direction and wind speed data are affected. The magnitude of the effect depends on the wind speed and the wind direction relative to the antenna azimuth direction.

For the level of the RASS acoustic sources, the effect on the data of an out-of-level RASS acoustic source is not clear. In the absence of research data, it is felt that the virtual temperature accuracy is not effected, but rather the maximum altitude of the RASS measurements. Additionally, there is evidence that the warmest virtual temperature value reported may be biased to a lower value by RASS acoustic sources that are not illuminating the entire RWP radio beam volume. At this time there is no way to determine this and correct the data.

For siting, the recommendations of the EPA-funded document, *Draft Guidelines for the Quality Assurance and Management of PAMS Upper-Air Meteorological Data* (STI, 1995) were used to augment the recommendation that the radars be set up away from tall buildings, power lines and other obstructions that may be a potential source of interference. Ground clutter is the primary problem; therefore, locations on hilltops away from trees or other tall objects, are desirable.

2.2.3 Surface Meteorological Measurements System Audit Procedures

The system audits of the surface meteorological sensing systems associated with the RWP and RASS consisted of an inspection of the site to assess proper siting of the instrument sensors, a review of the station check logs and other site documentation, as well as an interview with the site operator concerning his or her knowledge of the QAPP and applicable SOP sections. Sensor siting criteria for meteorological sensors are specified in the EPA's *Quality Assurance Handbooks for Air Pollution Measurement Systems, Volume IV* (EPA, 1994d). On-site forms and site logs were reviewed to check that the documentation conformed to the specifications of the plan. The subjects that were addressed by the system audits were:

— Network design and siting

- network size and design
- sensor exposure
- review of station

— Resources and facilities

- instruments and methods
- staff and facilities
- standards and traceability

— Quality assurance and quality control

- status of quality assurance program
- audit participation
- precision and accuracy checks

Additionally, once the system audits of all sites were completed, the auditor checked for possible differences in operation among the various sites.

2.3 PERFORMANCE AUDIT PROCEDURES

2.3.1 Sodar Performance Audit Procedures

The performance audit of the sodar was done by comparison with simulated winds from the APT. The audit criteria for the rawinsonde comparison were the same as for the RWP described in Section 2.3.2, with two flights performed per site. Sodar audit criteria are presented in Table 2-1.

Unlike conventional sensors where known wind speeds and directions can be input directly to the sensor through various rotational methods, the acoustic system relies on the measurement of time and frequency shift of the back scattered acoustic pulse. The only means of truly providing a known input is through the introduction of fixed audio frequencies at known times. The frequency shift will correspond to a Doppler shift introduced by winds to or from an antenna. The timing of the simulated return will represent a known altitude based on the speed of sound.

These simulations of the Doppler shifted signal were performed with the APT as described in Section 2.1.1. As in the evaluation of the portable sodar, at least three sampling intervals were evaluated using simulated wind speed and direction inputs. The audit criteria also followed the criteria set for the portable sodar.

As a final check of the sodar data, data collected during several days prior to the audit were reviewed to establish the internal consistency of the values. As this was a qualitative check, there were no fixed evaluation criteria. The goal was to evaluate the following:

- Data reliability or quality codes for consistency.
- Measured vertical intensity values for detection of potential fixed echoes.
- Vertical profile of the individual wind components for detection of potential fixed echoes and consistency.
- Vertical profile of the calculated vector winds for internal consistency.
- Methods used to create hourly values from sub-hourly intervals.

TABLE 2-1. Audit observables and audit instrumentation – Sodars.

Observable	Audit Device	Audit Device Traceability	Audit Device Precision Accuracy		Audit Criteria (DQOs)	Comments
Orientation	Brunton Pocket Transit model F5007LM	N/A	N/A	±1°	±2°	The accuracy of the orientation measurement is based on the ability to read the compass and avoid magnetic aberrations. When possible solar siting verifications will be obtained.
Level	Pro SMARTLEVEL with inclinometer verification	N/A	0.2°	±0.2°	±0.5°	The SMARTLEVEL is calibrated according to the factory recommendations over the full operating range. The indicated accuracy and precision are conservative estimates. The manufacture claims ±0.1° accuracy.
Wind Speed and Wind Direction	Acoustic Pulse Transponder	Fluke model 87 frequency meter for frequency. Quartz clock timing.	1 Hz 3 ms	±1 Hz ±3 ms	±0.2 m/s component speed. ±0.5 m/s speed. ±5° direction resultant vector. ± one range gate for altitude response.	The audit device precision and accuracy are expressed in simulated Doppler shift frequency and echo delay. The respective response in m/s and altitude depends on the operational parameters of the sodar audited. The audit criteria apply to both the portable sodar & the on-site sodars used to audit the radar profilers.
Exposure	Brunton Pocket Transit model F5007LM and inclinometer	N/A	N/A	N/A	Minimize active & passive sources. Passive sources below 20° in the beam directions.	The evaluation is subjective. More details are provided in the workplan.

2.3.2 RWP Performance Audit Procedures

The new EPA guidance for QA on radar profilers (EPA, 1999) defines a series of system checks inherent to the profiler electronics. Unlike the sodar where instrumentation exists for simulation of winds by introduction of "Doppler shifted frequencies" no such instrumentation exists for the profiler or RASS systems. Thus, to audit the data gathered by these profilers, procedures similar to those used in acceptance testing were implemented. The acceptance test procedures included comparisons to another form of upper-air measurement.

The audit comparisons for RWP systems were made to collocated sodars at each of the sites. For sites without existing collocated sodars, comparisons were made using a portable AeroVironment Model 2000. All comparisons were made over a minimum 24-hour period. The portable sodar collected wind speed and wind direction data at 30-meter height intervals up to 750 meters and 15-minute time intervals. The data were validated and then averaged in both time and vertical space to match the intervals of the radar profilers. The collocated sodar data were collected over at least a 24-hour interval so as to include a variety of stability conditions. Prior to deploying the sodar to the field, its operation was verified using the Acoustic Pulse Transponder, as described above.

Rawinsonde flights were conducted midmorning and mid-afternoon at each site for comparison to the RWP at altitudes above the maximum altitudes reached by the audit sodars.

Audit criteria for RWP (Table 2-2) was consistent with the *Draft PAMS Upper-air Guidance* document (STI, 1995). Overall systematic differences should be within ±1 m/s for wind speed and ±10° for wind direction. The root mean squared difference between the observations, which we will refer to as the "comparability" should be within ±2 m/s for wind speed and ±30° for direction. If the observed differences exceeded these criteria, it did not necessarily mean the RWP failed the audit, but the differences were qualified by the auditor. The reasons for the differences were fully explored before determining that a problem with the RWP existed. Differences between the RWP and the audit comparison device may be a function of the properties of the RWP and the comparison device and thus may not indicate a problem with the RWP. Such properties include the following.

- RWP versus Sodar

The averaging schemes of the two systems differ, which can result in relatively large differences if a wind shift occurs during an averaging period (usually one hour). The RWP averaging uses a consensus technique that looks for maxima in the Doppler shifts for each averaging period and range gate. If a change in the winds occurs during an averaging period, two peaks may occur. The RWP will select the dominant peak for the average wind for each range gate in that period. The audit sodar determines vector

TABLE 2-2. Summary of audit observables and audit instrumentation - Radar Profiler and RASS.

Observable	Audit Device	Audit Device Traceability	Audit Device Precision	Accuracy	Audit Criteria (DQOs)	Comments
Orientation	Brunton Pocket Transit model F5007LM	N/A	N/A	±1°	±2°	The accuracy of the orientation measurement is based on the ability to read the compass and avoid magnetic aberrations. When possible, solar siting verifications were obtained.
Level	Pro SMARTLEVEL with inclinometer verification	N/A	0.2°	±0.2°	±0.5°	The SMARTLEVEL is calibrated according to the factory recommendations over the full operating range. The indicated accuracy and precision are conservative estimates. The manufacture claims ±0.1° accuracy.
Wind Speed and Wind Direction	AVES Model 2000 sodar	Sodar verification with Acoustic Pulse Transponder	0.1 m/s	±0.2 m/s	±1.0 m/s speed ±10° direction for collocated sites.	The audit device precision and accuracy refers to the response of the sodar to the Acoustic Pulse Transponder (APT) on a component-by-component basis. The audit criteria shown are based on the vector resultant comparisons. See sodar below for more on the APT.
Exposure	Brunton Pocket Transit model F5007LM and inclinometer	N/A	N/A	N/A	Minimize active and passive sources. Passive sources below 20° in the beam directions.	The evaluation is subjective.
Virtual Temperature (*Tv*)	Rawin-sonde	Brooklyn 76 mm mercury-in-glass thermometer for temp. Peet Bros. Ultimeter 3 for pressure	0.2° C 1 mb	±0.3°C ±4 mb	*Tv* ±1.0°C	The temperature precision and accuracy refer to the dry bulb thermistors. The devices used for traceability check the sondes before launch. Acceptable launch differences are ± 0.5°C and ±10 mb.

averages from all of the data collected during each averaging period. If a wind shift occurs during an averaging period, the data for that period will be the actual calculated average vector wind speed and wind direction. Additionally, the vector wind speed probably will be lower than the scalar wind speed, which essentially is what the RWP is reporting according to its consensus averaging scheme.

Changes in the height of an inversion or shear layer during an averaging period can result in differences that exceed the criteria. Due the RWP's consensus averaging scheme, the RWP software will pick the dominant peck in the doppler shift spectra for that averaging period which may put the height of a corresponding change in wind direction and wind speed at a higher or lower range gate compared to that indicated by the sodar.

Other factors that can affect the individual differences, the average difference, and comparability are passive and active noise sources that affect the sodar data and RWP data. Active noise sources for the audit sodar can limit the vertical range of the measurements, or bias the data. For the RWP active noise sources can produce erroneous or biased data. Passive noise sources can cause artificially low wind speeds and erroneous wind directions for both systems.

- RWP versus Rawinsonde

  The rawinsonde provides a semi-instantaneous measurement but the RWP provides an hourly averaged observation. If the wind shifts during the hour of the rawinsonde sounding the differences may exceed the criteria for average difference and comparability for wind speed and direction.

  Changes in the height of an inversion or shear layer during an averaging period can also result in differences that exceed the criteria. The RWP's consensus averaging scheme will pick the dominant peak in the Doppler shift spectra for that averaging period. This may put the height of a corresponding change in wind direction and speed at a higher or lower range gate compared to that indicated by the rawinsonde sounding. Wind direction and wind speed can be effected.

As a final part of the audit of the radar profilers, data from several days prior to the audit were reviewed for internal consistency. This review included checking indicated flags for data reliability or quality codes for consistency, individual component intensity values to identify potential reflections, and the vertical profiles of the components and resultant values for internal consistency both in space and time. This was a subjective review which has proved useful in past audits as a "second set of eyes" reviewing the data.

2.3.3 RASS Performance Audit Procedures

The EPA-funded draft *PAMS Upper-air Guidance* document (STI, 1995) recommends that performance auditing of RASS consist of a comparison to independently collected virtual temperature (Tv) profiles. These profiles were collected using a rawinsonde system.

For this study, two rawinsondes were launched at each of the sites for comparison with the RASS over several stability conditions. These balloon-borne sondes collected observations of pressure, temperature, and relative humidity that were used to calculate the virtual temperature profiles (T*v*) for comparison to the RASS-derived T*v* values. The data collected from each launch were volume averaged to match the averaging intervals of the RASS. Audit criteria used for evaluation of the data were systematic differences of ±1.0°C and comparability of ±1.5°C. Experience gained in the LMOS, IMS-95 and NARSTO-Northeast studies showed these criteria are readily achievable. However, differences outside of this criteria do not mean the RASS system has failed. It indicates that the data need further analyses to determine the reasons for the differences.

As in the wind profiles, data from several days prior to the audit were reviewed. The review focused on the internal consistency of the data in both space and time and looked for the reasonableness of the Tv profiles.

2.3.4 Surface Meteorological Measurements Performance Audit Procedures

Performance audit procedures and criteria were those recommended in the U.S. EPA *Handbook for Air Pollution Measurement Systems*, Volume IV (EPA, 1994d). The audit standards used in the audits, audit standard accuracy and precision, as well as the audit criteria, are detailed in Table 2-3.

TABLE 2-3. Tolerance limits for meteorological audit results.

Parameter	Accuracy Tolerance
Wind Speed	± 0.25 m/s, ws = 0 - 5 m/s * ± 5%, ws > 5 m/s
Wind Direction	± 5° *
Ambient Temperature	± 0.5°C **
Relative Humidity	± 1.5°C ***

* Audited by means of an artificial field, which implies simulation of the measured variable by artificial means.
** Audited by means of collocated sensors.
*** Equivalent dew-point temperature.

- Wind Speed

The wind speed audit began with the inspection of the wind speed cups or propeller(s) to ensure that they were intact. The cups were then removed to produce a zero point. Next, the R.M. Young selectable speed anemometer drive was connected to the sensor shaft to simulate wind speeds of approximately 10, 25 and 35 m/s. Actual values depended on the sensor model and were determined by multiplying the motor speed by a cup or propeller transfer coefficient supplied by the manufacturer. The data logger responses were entered into the AVES Audit Software Package (AVASP) and the difference between them and the audit input values were calculated. The calculated difference for each wind speed was then compared with the audit criteria (see Table 2-3).

The sensor bearings were then checked for excessive wear by manually turning the sensor shaft to determine whether there was any bearing drag. Next, the sensor was removed from the crossarm and the R.M. Young torque was disk mounted on the sensor shaft. The starting torque was determined using the manufacturer-recommended procedures.

- Wind Direction

The wind sensor crossarm alignment relative to true north was checked using a tripod-mounted Brunton surveyor compass. The angle of declination was taken into account when performing this check. The wind direction vane was then pointed toward the four cardinal directions and the responses of the data logger were noted. The data logger responses were entered into the AVASP for comparison with the audit input values. The difference calculated for each input wind direction was compared with the criteria (see Table 2-3).

The sensor bearings were then checked for excessive wear, first by manually turning the sensor shaft to determine whether bearing drag was present and then by using an R.M. Young vane bearing torque gauge according to the manufacturer-recommended procedures.

- Ambient Temperature

The temperature-sensing system was audited by immersing the system thermistor and an NIST-traceable mercury-in-glass thermometer in the same water bath and comparing the readings of the thermometer with the data logger and chart recorder outputs at approximately 0, 20, and 40°C. The comparisons were carried out using the AVASP . The difference calculated for each point was compared with the audit criteria (see Table 2-3).

- Relative Humidity and Dew-point Temperature

The wet bulb thermometer's muslin wick of the motorized psychrometer was wetted with distilled water. The motorized psychrometer was then placed in close proximity to the relative humidity or dew point sensor and allowed to run for at least five minutes or until the thermometer readings stabilized. Once the readings stabilized, the audit psychrometer wet and dry bulb temperatures, the audit barometric pressure and the station's relative humidity and ambient temperature or dew-point temperature were read simultaneously. These readings were entered into the AVASP where the audit relative humidity or dew-point temperature was calculated. If relative humidity was present, it was converted to an equivalent dew-point temperature for comparison with the calculated audit dew point temperature. If dew-point temperature was measured directly, the station value was directly compared with the calculated audit value. The difference between the station equivalent or measured dew-point temperature and the calculated audit dew-point temperature was compared with the audit criteria (see Table 2-3).

Section 3

RESULTS SECTION

Appendix B contains the system and performance audit reports for each site audit.

3.1 SYSTEM AUDITS

3.1.1 RWP and RASS

TABLE 3-1. RWP and RASS System Audit Results Summary

Site ID	Site ID	Audit Date	Date Corrected	Audit Tests						
Field-Ops	SCOS 97			RWP Antenna Level *	RWP Antenna Orientation +	RASS Source Level *	Sensor Exposure	Controller Set Ups	Range Gate Set Up	Misc.
BTW	BARM	6/22/97					(1)			
RSD	RIHM	6/17/97	6/17/97				(2)		(3)	
HPA	HESO	6/18/97	6/18/97, except (5)		-5°	1.3°		(4)	(5)	
TML	THRM	6/19/97	6/19/97, except (7)					(6)	(7)	
NTN	NAFB	6/20/97		0.9°			(8)		(9,10)	
TCL	TMCM	6/21/97								
SIM	SVLM	6/23/97						(11,12)		
PHE	HUEN	6/30/97	6/30/97 (13)			3.3°				(13)
PDE	PALD	7/1/97	7/1/97 (15)		5°	1.2°			(14)	(15)
USC	USCZ	7/2/97	7/2/97, except (16)		-19°	1.6°			(16)	
SCE	SCLM	7/3/97	7/3/97, except (17)		3°	2.1°			(17)	
VNS	VNUY	7/10/97	7/10/97, except (18)		6°	1.7°			(18)	
LAX	LAXP	7/11/97	7/11/97		-2°	0.9°				
SCL	CATM	7/11/97	7/11/97, except (21)		-4°	6.2° (19)		(20)	(21)	(22)
LAS#	LOSM	7/16/97	7/16/97, except (23)				(23,24)			
PTL	PTLP	7/17/97	7/19/97		-7°	3.8°	(25)		(26)	
VLC		7/19/97			3°	1.5°	(27)			
BFD	BRWN	7/21/97		0.5°,0.9°		1.4°			(28)	
APE	ALPM	7/23/97		-0.7°,-1.2°	4°, 3°	2.5°, 2.3°, 1.6°, 1.5°			(29)	
TTN	TUST	7/24/97		0.5°, 0.5°	0°, -2°	3.2°			(30)	
CBD	CARL	7/25/97			0°,3°	1.9°			(31)	
EMT	EMAM	7/28/97			-5°	1.5°	(32)		(33)	(34)
ONT	ONTP	11/21/97			-1°	(35)				

* Audit criteria is ± 0.5°

\+ Audit Criteria is ± 2°

\# LAS is listed in both this section and Section 3.1.2 that follows because the instrument was a combination RWP and sodar.

1. Highway 58 is a potential active noise source that appears to produce clutter.
2. Buildings around the site can produce reflections.
3. RASS set to 12 range gates. Changed to 20 range gates following the audit.
4. The RASS temperature range is from 2 to 36°C. The upper boundary should be increased to include temperatures that are normally expected in a desert environment.
5. The RASS height range was increased during the audit from 12 gates (780 m) to 20 gates (1280 m). Consideration should be given to raising it to 1560 meters.
6. The RASS temperature range is from 2 to 36°C. The upper boundary should be increased to include temperatures that are normally expected in a desert environment.
7. The RASS height range was increased during the audit from 12 gates (780 m) to 20 gates (1280 m). Consideration should be given to raising it to 1560 meters.
8. Power lines to the south may produce clutter when it is windy.
9. The RASS is set to collect data at 210-meter intervals starting at 285 meters up to 2185 meters. Collecting RASS in this mode can miss much of the surface stability structure.
10. The high mode winds are set to collect data at 210-meter intervals with a pulse length of 400 meters. Other participants are collecting the high modes winds at 100-meter intervals.
11. The RWP is set to collect 15-minute averages and the RASS makes a sounding every 15 minutes. Most RWP are set to collect hourly wind data.
12. The RWP is set to collect wind data in the low mode of operation only to a maximum altitude of 1988 meters. All other SCOS97 RWP are collecting wind data in the high mode as well as the low mode.
13. At the time of the audit there were two RASS sources not functioning. It was indicated they would be fixed after the audit.
14. The RASS is set for 100-meter spacing. Most of the RASS operating in SCOS97 are set to collect 60-meter data.
15. At the time of the audit, there were two RASS sources not functioning. It was indicated these would be fixed after the audit.
16. The RASS range gate spacing was 106 m instead of the recommended 60 m.
17. The RASS range gate spacing was 105 m instead of the recommended 60 m.
18. The RASS range gate spacing was 106 m instead of the recommended 60 m.
19. Three of the RASS dishes were out of level by 1.8 to 5.4°. In the worst antenna the transducer was out of level by 6.2°. The worst source was re-leveled.
20. The radar profiler time was 7 minutes slow. The time was corrected during the audit. The data logger time was within 1 minute.

21. The RASS range gate spacing was 106 m instead of the recommended 60 m.

22. One of the RASS transducers was not working. A loose connection was found and repaired.

23. There are several sources of noise that could affect the sodar operation. The most significant source is an air conditioner on the adjacent trailer (about 5 meters from the sodar antenna). One sodar beam was toward the air conditioner. The broad band noise in the direction of the air conditioner averaged about 60 dBA, as opposed to 52 to 54 dBA in the other potential beam directions. A sampling of the spectral noise in the direction of the air conditioner showed active noise around the sodar operational frequency (the sodar frequency is 1889 Hz). Most significant was a band at about 1900 Hz. A quick review of the on-site data showed the sodar is seriously affected by the noise in the wind levels above about 250 to 300 meters. Aiming the beam away from the air conditioner may not help the problem because the interference is also seen in the vertical beam. The noise from the air conditioner needs to be minimized in order to achieve reasonable data in the upper ranges of the sodar. Another possibility is to move the operating frequency to about 2400 Hz where the air conditioning frequency spectra was at a minimum. However, the best alternative is to separate the noise source from the sodar. Other active noise sources that could affect the sodar include broad band noise from the aircraft and helicopter operations at the airport and agricultural operations in the adjacent fields. These sources would tend to decrease the altitude capabilities of the sodar.

24. The RWP was just changed from 924 to 915 MHz to move away from interfering frequencies in the 924 MHz band.

25. The cliffs and hills to the north through east side of the site present potential reflective surfaces to the northeast beam. A review of the data showed ground clutter to approximately 500 meters in the northeast antenna data in the low mode of operation. The northeast antenna data in the high mode of operation did not show ground clutter, but the spectral peak for these range gates appeared smoothed and translated toward lower values.

26. The low mode winds are collected at 100-meter intervals instead of 60-meter intervals. The high mode winds are collected at 200-meter intervals instead of 100-meter intervals. The RASS virtual temperature data is collected at 100-meter intervals instead of 60-meter intervals.

27. The surrounding hills and embankments present a potential to interfere with the wind data. Clutter is present in the lowest two to three range gates. This potential will be investigated further when the audit, RWP and RASS data are compared.

28. The RASS range gate spacing was 106 m instead of the recommended 60 m.

29. The RASS range gate spacing was 106 m instead of the recommended 60 m.

30. The RASS range gate spacing was 106 m instead of the recommended 60 m.

31. The RASS range gate spacing was 105 m instead of the recommended 60 m.

32. The movement of automobiles on Lower Azusa Road toward the north to northwest and the trees that line Lower Azusa Road toward the northwest present potential passive noise sources to the RWP measurements.

33. The RASS range gate spacing was 105 m instead of the recommended 60 m.

34. The RASS acoustic temperature and acoustic source ranges were set too low for the expected temperature ranges in the El Monte area. They were adjusted to more suitable ranges following the audit. No further actions are required.

35. The level of the northeast RASS source exceeded the audit criteria of ± 1°.

3.1.2 Sodars

TABLE 3-2. Sodar System Audit Results Summary

Site ID	Site ID	Audit Date	Date Corrected	Audit Tests					
Field-Ops	SCOS 97			Sodar Antenna Level *	Sodar Antenna Orientation +	Sensor Exposure	Controller Set Ups	Range Gate Set Up	Misc.
SCA	CLAR	7/12/97	7/12/97, except (1,2)			(1,2)			
AZS	AZSM	7/13/97			2.5°,4.5°	(3,4)			
LAS#	LOSM	7/16/97	7/16/97, except (5)			(5,6)			
WSP	WSPM	8/8/97 & 9/10/97		(7)		(8)	(9)		

* Audit criteria is ± 0.5°
\+ Audit Criteria is ± 2°
\# LAS is listed in both this section and Section 3.1.1 because the instrument was a combination RWP and sodar.

1. There were several sources of noise. The most significant was background traffic, which tends to decrease the altitude capabilities of the sodar. The antennas were aimed in the direction of two roads that produce significant amounts of noise. The second source of noise was the pumps that were internal to the adjacent building. While the building has been sound-proofed, a sampling of the frequency spectra generated by one of the internal pumps showed broad band active noise generation at frequencies between 1100 and 2000 Hz and again at about 2080, 2460 and 2700 Hz. There are three other pumps in the building in addition to a backup generator.

2. In the direction of the east beam was a building that could produce reflections in the range of about 40 to 100 meters. In the south beam were trees from which reflections could be heard. The data should be reviewed carefully to invalidate data that may be contaminated by these reflections.

3. There were a couple primary sources of noise. The most significant was traffic along the adjacent road. The second source of noise was the loud frequent gun shots from the nearby shooting range. These noise sources will limit the vertical range of the sodar.

4. The site is in a canyon with possible reflections from the canyon walls. During the audit, reflections could be heard from both of the transmit beams. This will contaminate the data and potentially bias the component wind values low.

5. There are several sources of noise that could affect the sodar operation. The most significant source is an air conditioner on the adjacent trailer (about 5 meters from the sodar antenna). One sodar beam was toward the air conditioner. The broad band noise in the direction of the air conditioner averaged about 60 dBA, as opposed to 52 to 54 dBA in the other potential beam directions. A sampling of the

spectral noise in the direction of the air conditioner showed active noise around the sodar operational frequency (the sodar frequency is 1889 Hz). Most significant was a band at about 1900 Hz. A quick review of the on-site data showed the sodar is seriously affected by the noise in the wind levels above about 250 to 300 meters. Aiming the beam away from the air conditioner may not help the problem because the interference is also seen in the vertical beam. The noise from the air conditioner needs to be minimized in order to achieve reasonable data in the upper ranges of the sodar. Another possibility is to move the operating frequency to about 2400 Hz where the air conditioning frequency spectra was at a minimum. However, the best alternative is to separate the noise source from the sodar. Other active noise sources that could affect the sodar include broad band noise from the aircraft and helicopter operations at the airport and agricultural operations in the adjacent fields. These sources would tend to decrease the altitude capabilities of the sodar.

6. The RWP was just changed from 924 to 915 MHz to move away from interfering frequencies in the 924 MHz band.
7. The level of the vertical antenna drive was 1°. The audit criteria is ± 0.5°.
8. Trees surrounded the site and may cause clutter in the lowest range gates.
9. The zenith angles of the horizontal antennas were measured at 17.4° for the north/south antenna and 17.2° for the east/west antenna. The controller setting for these angles was 16°.

3.2 PERFORMANCE AUDITS

3.2.1 RWP Versus Audit Sodar

The results of the RWP versus sodar comparisons are presented here and are summarized in Table 3-3. All high mode data through the first 700 meters were eliminated from the comparisons because pulse coding in the high mode data renders these data invalid. Sodar wind speeds less than 2 m/s were not compared to the RWP due to the variability in the calculated vector winds at low wind speeds. As in the subsequent rawinsonde comparisons, the RWP data are considered raw and values will change with the subsequent post processing. Therefore the results presented here should be considered preliminary.

- Alpine

A comparison of the data collected on 7/23/97 was made with the corresponding RWP wind data in the low operating mode (60 meter range gates). The comparisons were made for the levels between the surface and 558 meters. The wind speeds and wind directions compared fairly well but were at the fringe of the audit criteria. A portion of the observed differences could be attributable to the antenna zenith angle settings of the RWP. Additionally, differences may change once the RWP goes through the final processing. Overall the results looked reasonable.

- Brown's Field

Sodar data collected on 7/21/97 was compared to the corresponding low mode RWP wind data. Reasonable comparisons were obtained for the levels between the surface and 558 meters. While the average differences for wind speed were just above the audit criteria, those differences may change once the RWP data are final processed. The results from the wind direction comparison showed good average differences but with some scatter, as shown in the 38° RMS value. Again, those results may change once the data are final processed.

- Carlsbad

Data collected at the site were limited due to local noise sources. Where data were available, the wind speed and RMS differences were just outside of criteria and average wind directions were well within criteria. The large scatter in the wind direction data, shown by the RMS differences, probably relates to the relatively poor siting and data collection conditions for the sodar. Additionally, comparisons to the final RWP data may show a change in the audit results.

- El Monte

The audit results showed that the RWP and sodar wind speed and wind direction average differences did not agree within the audit criteria. This lack of agreement did not indicate poor performance on the part of the RWP. Instead, the reason for the poor agreement between the audit sodar and the RWP was active and passive noise interference affecting the performance of the audit sodar. The active noise sources were from aircraft and other vehicular traffic at the El Monte Airport, and a main thoroughfare (Santa Anita Avenue) that ran along the east side of the airport, approximately 100 meters from the sodar location. This noise interference limited the height to which the sodar could collect data or prevented the sodar from collecting data at all. The passive noise interference resulted from reflections of the sodar signal off nearby buildings because of limited siting alternatives at the airport that were suitable for sodar operations. This affected both the sodar wind speed and wind direction.

- Los Alamitos

The RWP at this site was to be audited using data from an existing sodar collocated at this site. However, the site's sodar data were never made available for comparison to the RWP. An audit of the site's sodar using simulated winds from a pulse transponder showed an appropriate response to simulated winds. Therefore, once noted problems with noise interference to the site's sodar data are corrected, the site sodar data can be used for comparison with the RWP.

- Los Angeles International Airport

The siting for sodar operations was less than optimal at the airport due to noise and, as a result, data were limited. With the noise contamination considered, the comparison results were reasonable even though they were at, or just above, the edge of the audit criteria. The overall operation and data collected from the RWP looked reasonable.

- Ontario International Airport

All comparisons were within the audit criteria.

- Point Loma

RWP data collected in the low mode appeared to be affected by ground clutter up to about 500 meters in the northeast beam. This created relatively poor comparison results. Results in the high mode showed acceptable agreement. Further comparisons should be made following the final processing of the RWP data to determine if the low mode clutter problem was resolved.

- Simi Valley

Overall comparisons of the sodar and RWP data showed average differences in wind speed and direction to be within the audit criteria. The RMS differences, however, showed more scatter between the two data sets, which indicates one or both of the instruments had relatively "noisy" vertical profiles. It is suspected that reflective sources in the sodar data may have caused several of the levels to be contaminated. Tighter validation criteria for the sodar data would most likely bring the comparisons closer together. Thus, while the RMS differences did exceed criteria, the data from the RWP looks reasonable.

- Temecula

The audit results showed the average results were reasonable, but there was quite a bit of scatter, as shown by the RMS differences. The validation of the sodar data revealed some contamination by noise from pumps operating on the north side of the site. This may account for at least part of the scatter in the data. Additionally, the relatively high wind speeds will produce higher differences as a result of the magnitude of the speeds. And, as with the other sites, final validation of the RWP data my also produce better results. Overall, the results from the comparison showed the RWP data looked reasonable.

- Valley Center

An audit comparison between the RWP and audit sodar winds was not possible. The site is a water pump station. Seven 750 horsepower electric motors, that drive water pumps, operate continuously creating noise that made it impossible to collect data with the audit sodar.

TABLE 3-3. Summary of RWP Versus Sodar Audit Comparison Results.

Site ID Field Ops	Site ID SCOS97	Audit Date	High Mode WS Average Diff./RMS (m/s)	High Mode WD Average Diff./RMS (deg)	Low Mode WS Average Diff./RMS (m/s)	Low Mode WD Average Diff./RMS (deg)
TCL	TMCM	6/21/97	0.6 / 1.4	-3 / 14	-1.7 / 4.8	-1 / 36
SIM	SVLM	6/23/97	(1)	(1)	0.8 / 2.6	-4 / 54
LAX	LAXP	7/11/97	-1.4 / 1.8	-8 / 48	-1.4 / 1.8	7 / 42
LAS	LOSM	7/16/97	(2)	(2)	(2)	(2)
PTL	PTLP	7/17/97	-0.8 / 1.1	-10 / 31	-1.5 / 2.1	-44 / 59 (3)
VLC	ESCM	7/19/97	(2)	(2)	(2)	(2)
BFD	BRWN	7/21/97	(4)	(4)	-1.3 / 2.1	-3 / 38
APE	ALPM	7/23/97	(4)	(4)	-1.1 / 1.5	21/ 33
CBD	CARL	7/25/97	(4)	(4)	-1.5 / 2.2	1 / 67
EMT	EMAM	7/28/97	-4.8 / 7.7 (5)	60 / 106 (5)	-5.6 / 8.2 (5)	35 / 96 (5)
ONT	ONTP	10/23/97	-0.6 / 1.2	1 / 30	-0.4 / 0.9	-2 / 15

Audit criteria:
WS average difference: ± 1.0 m/s
WS comparability (RMS): ± 2.0 m/s
WD Average Difference: ± 10°
WD comparability (RMS): ± 30°
RASS Average Difference: ± 1.0 °C.

1. High mode winds were not measured at site.
2. Audit sodar data were not available.
3. The PTL low mode (60 meter) data was affected by ground clutter to about 500 meters in the northeast beam.
4. A) RWP high mode data not valid below 700 meters because of pulse coding.

B) Final quality controlled RWP data were not available for the audit comparison. The audit comparison was made using preliminary data.

C) The large average difference for the APE low mode wind direction could not be explained. Further, comparisons between the sodar and high mode winds (which are invalid) for all three NOAA sites audited (APE, BFD, and CBD) compared within the audit criteria, which is perplexing.

5. The audit sodar data were contaminated by noise.

3.2.2 RWP and RASS Versus Rawinsonde

The results of the RWP versus rawinsonde comparisons are presented here and are summarized in Table 3-4. All high mode data to the first 800 meter range gate were eliminated from the comparisons because pulse coding that is applied to the high mode data renders these data invalid. Rawinsonde wind speeds less than 2 m/s were not compared to the RWP due to the variability in the calculated vector winds at low wind speeds.

- Alpine

High Mode

Up to 1800 meters the RWP high mode winds and the rawinsonde winds agreed well. Above 1800 meters the rawinsonde showed multiple shear layers that were not reflected in the RWP data. Between 1800 and 2700 meters the RWP data showed a steady increase in wind speed while the RWP and rawinsonde wind directions diverged. This may be due to the RWP consensus averaging.

Low Mode

The average differences exceeded the audit criteria of ±1.0 m/s for wind speed. These differences were due to the winds above 1800 meters and may be a result of the RWP consensus averaging.

- Brown's Field

The RWP appeared to be operating within the design criteria, in spite of relatively large wind direction differences. The differences resulted from a directional shear in the rawinsonde data between 450 and 650 meters, while this shear appears in the RWP data between 550 and 1000 meters. The displacement of the shear layer in the RWP sounding relative to the rawinsonde data and the relatively larger swings in the RWP direction profile were probably due to the RWP consensus averaging.

- Carlsbad

The 7/26/98 1000 hours rawinsonde sounding appeared to have had a problem, so it was not included in the comparison statistics.

Low Mode

The wind speed average differences were within the suggested criteria of ±1.0 m/s but slightly exceeded the ±2.0 m/s criteria for comparability. It should be noted that the rawinsonde wind speeds showed shear at various levels while the RWP wind speeds appears to reflect the average of the rawinsonde wind speed fluctuations.

The wind direction average difference exceeded the suggested criteria of ±10°, and the comparability exceeded the suggested criteria of ±30°. The reason the suggested criteria were exceeded was due to consistent differences noted in the levels from 602 to 1530 meters. These consistent differences suggest that the wind direction in this layer was changing during the hour. The consensus averaged RWP data would be the predominant wind direction during the hour while the rawinsonde data is a quasi-instantaneous measurement or snapshot of the winds at that time. The similarities of the two profiles indicates that the RWP was probably operating within its design parameters.

High Mode

The wind direction average differences and comparability were within the suggested criteria of ±10° and ±30°, respectively.

The wind speed average difference and comparability exceeded the suggested criteria of ±1.0 m/s and ±2.0 m/s, respectively. The differences appeared to be confined to the upper range gates above 2865 meters. Above this altitude the rawinsonde wind speeds increased markedly to greater than 11.0 m/s, but the RWP wind speeds were consistent with the speeds observed below 2865 m. The RWP 3282 meter range gate wind speed (of less than 4 m/s) is suspect. The RWP data below 2865 meters appeared to be reasonable, indicating that the RWP was probably operating within its design parameters. The reason for the large differences above 2865 meters was not apparent from this comparison.

- El Monte

The RWP appeared to be operating within its design criteria in spite of relatively large differences in the low mode wind direction comparisons. These differences were due to ground clutter created by walls, trees, bushes, and low buildings and aircraft hangers that surrounded the site. Additionally, traffic on Lower Azusa Road, that ran along the north side of the site and was elevated approximately eight feet above the site level, probably was an active interference in the lower range gate data.

- Los Alamitos

The audit comparisons showed differences in both the high and low mode range gates that corresponded to the low mode vertical range. This was an indication of ground clutter that was probably caused by the trees that lined the site on the south and west sides. RWP data above 2,500 meters appeared to agree well with the rawinsonde data.

- Los Angeles International Airport

There appeared to have been a problem with the RWP at the time of the audit. The RWP - rawinsonde comparisons were not very good overall. The 6/27/97 0600 RWP high mode data profile was very dissimilar to the rawinsonde profile and the RWP data for all three soundings was mostly missing between approximately 2000 meters and the tops of the soundings. A conversation with Kevin Durkee of South Coast Air Quality Management District revealed that a phase shifter was found to be inoperative a month after the audit. It is not certain that the phase shifter had malfunctioned before the audit date. A careful review of these RWP and RASS data should be performed before using this data in analyses.

- Ontario International Airport

From the three RWP - rawinsonde comparisons conducted on 7/29/97 at 2200 hours, 7/30/97 at 0600 hours, and 7/30/97 at 1000 hours, there is not a clear bias in either the wind direction or wind speed comparisons. More comparisons are recommended to make a clear determination, but based on the present results, the RWP appeared to be operating within its design criteria.

High Mode

The high mode data was within the suggested criteria of ±10° for the average difference and slightly higher than ±30° for the comparability. Relatively large average differences showed up in the 7/29/97 2200 hours comparison, but the RWP and rawinsonde wind direction profiles were similar. The wind speed average difference exceeded the ±1.0 m/s criterion and the corresponding comparability just exceeded the ±2.0 m/s criterion. Theses exceedances were due to the RWP wind speeds underestimating the wind speed between 1890 and 2375 meters of the 7/29/97 2200 hours comparison and between the 1696 and 1987 meter levels of the 7/30/97 1000 hours comparison. These differences were probably due to the difference between the hourly-averaged RWP data and the quasi-instantaneous rawinsonde data.

Low Mode

The low mode wind speed and wind direction average differences both were within the suggested criteria of ±1.0 m/s and ±10°, respectively, although both exceeded the suggested criteria for comparability. The RMS differences that exceeded the comparability criteria were probably influenced by low wind speed values interspersed in the profile. Values less than 2.0 m/s were eliminated from the comparisons but the remaining relatively low speeds (>2.0 m/s) still caused significant differences in the comparison results.

- Point Loma

High Mode

The RWP appeared to operating within the instrument design criteria even though the overall wind speed comparability slightly exceeded the ±2.0 m/s criterion. The individual average differences that exceeded the wind speed and wind direction average difference criteria were due mostly to the orientation of the RWP antenna at the time of the audit. (The beam orientation was changed following the audit). The north beam was pointed toward the ridge behind the site, which produced ground clutter biasing, the data toward lower values.

Low Mode

The low mode overall wind speed average difference exceeded the ±1.0 m/s criteria. The reason for this was the pointing direction of the RWP north beam. As stated above, it was directed toward a ridge that produced ground clutter in range gates within the first 1000 meters. Following the audit the beam pointing directions were changed.

- Simi Valley

The RWP appeared to be operating within the instrument design criteria. This RWP operated in the low mode only. The overall average differences for wind speed and wind direction were within the suggested criteria of ±1.0 m/s and ±10°, respectively. The wind speed comparability was also within the suggested criterion of ±2.0 m/s. Only the wind direction comparability exceeded the suggested criterion of ±30°. The reason for this appeared to be ground clutter, which resulted in wind direction average differences of -167°, -159°, and -152° in the first three range gates.

- Temecula

The RWP appeared to be operating within the instrument design criteria.

High Mode

The overall average difference and comparability for wind speed and wind direction were all within the suggested criteria. Rawinsonde data was not available below 600 meters for the 6/23/97 1300 hours sounding.

Low Mode

Only one comparison point was possible for the low mode of operation. Low mode rawinsonde wind speeds were less than 2.0 m/s for all but one range gates in the 6/24/97 0900 hours sounding.

- Valley Center

The RWP appeared to be operating within the instrument design criteria. For both the high and low mode, the wind speed and wind direction average differences both were essentially within the suggested criteria of ±1.0 m/s and ±10°, respectively. The overall wind speed comparability was also within the suggested criterion of ±2.0 m/s. The wind direction comparability somewhat exceeded the suggested ±30° criterion, probably due to ground clutter from the hilltops that surrounded the site.

TABLE 3-4. Summary of RWP and RASS Versus Rawinsonde Comparison Results.

Site ID Field Ops	Site ID SCOS97	Audit Date	High Mode WS Average Diff./RMS (m/s)	High Mode WD Average Diff./RMS (deg)	Low Mode WS Average Diff./RMS (m/s)	Low Mode WD Average Diff./RMS (deg)	RASS Average Diff/Std. Dev. (°C)
TCL	TMCM	6/21/97	0.6 / 1.4	-3 / 14	(1)	(1)	0.6 / 0.4
SIM	SVLM	6/23/97	(2)	(2)	1.0 / 1.6	-1 / 49	1.2 / 1.2
LAX	LAXP	7/11/97	-2.4 / 4.0 (3)	-9 / 86 (3)	-3.2 / 4.7 (3)	21 / 58 (3)	0.0 / 1.2
LAS	LOSM	7/16/97	0.8 / 2.3	2 / 25	0.7 / 2.3	-17 /47	0.4 / 1.5
PTL	PTLP	7/17/97	-1.2 / 2.5	-1 / 14	-1.5 / 2.2	-2 / 19	0.6 / 1.0
VLC	ESCM	7/19/97	-0.6 / 1.6	4 / 37	-0.9 / 1.5	11 / 46	1.1 / 0.8
BFD	BRWN	7/21/97	0.4 / 3.8 (4)	-5 / 19 (4)	-0.8 / 1.9	-7 / 35	-0.4 / 0.8
APE	ALPM	7/23/97	-9.0 / 11.7 (4)	-17 / 34 (4)	-2.0 / 3.8	-10 / 38	-2.2 / 2.0
CBD	CARL	7/25/97	1.7 / 6.4 (4)	7 / 22 (4)	0.8 / 3.4	17 / 37	1.1 / 3.9
EMT	EMAM	7/28/97	-0.4 / 1.5	5 / 33	-0.3 / 1.2	11 / 41	0.5 / 0.4
ONT	ONTP	10/23/97	-1.7 / 2.3	-1 / 39	-0.2 / 4.0	2 / 45	0.8 / 0.3

Audit criteria:

WS average difference: ± 1.0 m/s
WS comparability (RMS): ± 2.0 m/s
WD Average Difference: ± 10°
WD comparability (RMS): ± 30°
RASS Average Difference: ± 1.0°C

1. Rawinsonde data within the vertical range of the low mode data were not available for the comparisons.
2. High mode winds were not measured at site.
3. Large differences between the rawinsonde and RWP data may be due to the distance between the rawinsonde launch site and the RWP location. The rawinsonde site was close to the east end of runway 25, and the RWP location was at the west end of the runways, a linear distance of more than five miles.
4. A) Results are from comparisons of data collected above 700 meters. RWP high mode data are not valid below 700 meters because of pulse coding.

   B) Final quality controlled RWP data were not available for the audit comparison. The audit comparisons were made using preliminary data.

3.2.3 Sodars

TABLE 3-5. Summary of Sodar Audit Results.

Site ID Field Ops	Site ID SCOS97	Audit Date	Audit Levels	SODAR - APT WS Average Diff./RMS (m/s)	SODAR - APT WD Average Diff./RMS (deg)
SCA	CLAR	7/12/97	1 (160 m)	1.79 (1)	1
			2 (367 m)	1.72 (1)	0
AZS	AZSM	7/13/97	1 (161 m)	-1.69 (2)	0
			2 (354 m)	-3.26 (2)	0
LAS	LOSM	7/16/97	1 (329 m)	0.11	3
			2 (657 m)	-0.01	1
WSP	WSPM	9/10/97	1 (327 m)	-0.99	-2
			2 (686 m)	-0.58	-2

Audit criteria:

WS average difference: ± 0.5 m/s
WD Average Difference: ± 5°

1. Results of the Acoustic Pulse Transponder (APT) audit showed the sodar responded within criteria for the timing and altitude calculations. However, problems were found with the wind speed calculations. The calculation of the horizontal wind speed along the beam direction was found to differ from the audit input by up to 0.7 m/s. When combined into a resultant wind speed, this difference could be over 1 m/s. It is suspected the reason for the difference lies in sodar resolution in measuring the Doppler shift frequency of returned echoes. The current operational mode has a fairly broad bin range that translates into an effective resolution of component speeds of about 0.9 m/s. This provides a resultant resolution of about 1.2 m/s. Consideration should be given to using a finer resolution in the bin spacing for the calculation of the radial speeds.

   The second problem with the sodar was found in the calculation of the U and V wind components from the radial component speeds. Recognizing the identified resolution problem above (~0.9 m/s wind speed gates), the speeds along the radial directions were calculated correctly. However, errors were found in the calculation that takes the radial speeds and converts them to U and V components. In the tests performed, the errors resulted in U and V speeds that differed significantly from the audit speeds, but directions that were accurate. The calculation errors need to be corrected and affected data reprocessed from the radial values. Word was received from NOAA on July 14 that the U and V calculation algorithm was fixed and will be installed at both the Santa Clarita and Azusa sites on July 14.

Given the zenith angle of the sodar at 20°, the horizontal components should be corrected for vertical velocity. Since vertical velocity is not measured with the sodar (it is only a two-axis sodar), there will be inaccuracies in the measured wind data even after the calculations and resolution are resolved with the problem stated above.

2. Similar to the Santa Clarita site above.

3.3 SURFACE METEOROLOGICAL MEASUREMENTS

3.3.1 Surface Wind Direction Summary

TABLE 3-6. Summary of Surface Wind Direction Audit Results.

Site	Audit Date	Date Corrected	Audit Tests					
			Sensor Orientation +	Sensor Height *	Sensor Exposure	Sensor Verticality	Starting Threshold	Misc.
BTW	6/22/97							
RSD	6/17/97				(1)			
HPA	6/18/97				(2)			
TML	6/19/97	6/19/97	5°			(3)		(4)
NTN	6/20/97				(5)			(6)
TCL	6/21/97				(7)			
SIM	6/23/97							
PHE	6/30/97						NP	
PDE	7/1/97	7/1/97	6°				NP	
USC	7/2/97			3 meters	(8)		NP	
SCE	7/3/97	7/3/97 (10)				(9)	NP	(10)
VNS	7/10/97		9°				NP	
LAX	7/11/97	7/11/97	9°	23'				
SCL	7/11/97	7/11/97 (11)	6°				NP	(11)
SCA	7/12/97	7/12/97	5°				NP	
AZS	7/13/97		10°				NP	
LAS	7/16/97		7°				NP	
PTL	NM							
VLC	NM							
BFD	7/21/97		10°	3 meters			NP	
APE	7/23/97		10°				NP	
TTN	7/24/97		10°				NP	
CBD	7/25/97						NP	
EMT	7/28/97		NP		(12)		NP	
WSP	NM							
ONT	NP							

+ Difference from true north if the difference exceeded the criteria of ± 5°.
* Actual height of wind sensors if different from 10 meters.
NP = Not performed.
NM = Measurement not present.

1. The wind direction sensor was mounted on a building. The wake created by the building will influence the wind measurements.
2. The surface wind measurements will not be accurate when winds are from the southeast. The water tank will form an obstruction that exceeds the EPA siting criteria for distance from obstructions.
3. The wind direction sensor was not vertical. This was corrected during the audit.
4. The wind vane was not balanced. The vane was balanced following the audit.

5. Trees to the south of the site presented an obstruction to the wind measurements.
6. The wind vane was bent.
7. The wind measurements were obstructed on the southwest by a building.
8. The meteorological sensor mast was mounted on a building. The wake created by the building will influence the wind measurements.
9. The wind sensor mast was found to be loose and leaning to one side. This was corrected during the audit.
10. The base of the meteorological tower is loose and could pivot. This will cause inaccuracies in the reported wind directions. The base should be secured.
11. The guy lines for the tower were loose allowing the tower base to pivot. This will cause inaccuracies in the reported wind directions. The base was secured during the audit.
12. The wind sensors were obstructed by the retaining wall, bushes, and trees on the east side of the site. The arc of unobstructed flow for these measurements was between 180 and 200°.

3.3.2 Wind Speed Summary

TABLE 3-7. Summary of Surface Wind Speed Audit Results.

Site	Audit Date	Date Corrected	Audit Tests					
			Performance Test +	Sensor Height *	Sensor Exposure	Sensor Verticality	Starting Threshold	Misc.
BTW	6/22/97	6/22/97	(1)					
RSD	6/17/97				(2)			
HPA	6/18/97				(3)			
TML	6/19/97	6/19/97				(4)		
NTN	6/20/97		NP		(5)		NP	
TCL	6/21/97	6/21/97	(6)		(7)			
SIM	6/23/97							
PHE	6/30/97							
PDE	7/1/97							
USC	7/2/97			3 meters	(8)			
SCE	7/3/97	7/3/97 (10)				(9)		(10)
VNS	7/10/97							
LAX	7/11/97			23'				
SCL	7/11/97	7/11/97 (11)						(11)
SCA	7/12/97							
AZS	7/13/97						0.6 m/s	
LAS	7/16/97							
PTL	NM							
VLC	NM							
BFD	7/21/97			3 meters				
APE	7/23/97							
TTN	7/24/97							
CBD	7/25/97							
EMT	7/28/97		NP		(12)		NP	
WSP	NM							
ONT	NP							

\+ WS < 5 m/s; ± 0.25 m/s, WS ≥ 5 m/s: ± 5%.
* Actual height of wind sensors if different from 10 meters.
NP = Not performed.
NM = Measurement not present.

1. The data logger was programmed with the wrong wind speed coefficients resulting in about a 4 to 5% error in reported speeds. The correct coefficients were entered following the audit. No further action is needed.
2. The wind direction sensor was mounted on a building. The wake created by the building will influence the wind measurements.
3. The surface wind measurements will not be accurate when winds are from the southeast. The water tank will form an obstruction that exceeds the EPA siting criteria for distance from obstructions.

4. The wind speed direction sensor was not vertical. This was corrected during the audit.
5. Trees to the south of the site presented an obstruction to the wind measurements.
6. The wind speed sensing system outputs differed from the corresponding audit inputs by more than the EPA-recommended criteria. The transfer coefficients that convert RPM to wind speed may not be correct. The operator should contact the manufacturer (Met One) for the proper coefficients and calibrate the system.
7. The wind measurements were obstructed on the southwest by a building.
8. The meteorological sensor mast was mounted on a building. The wake created by the building will influence the wind measurements.
9. The wind sensor mast was found to be loose and leaning to one side. This was corrected during the audit.
10. The base of the meteorological tower is loose and could pivot. This will cause inaccuracies in the reported wind directions. The base should be secured.
11. The guy lines for the tower were loose allowing the tower base to pivot. This will cause inaccuracies in the reported wind directions. The base was secured during the audit.
12. The wind sensors were obstructed by the retaining wall, bushes, and trees on the east side of the site. The arc of unobstructed flow for these measurements was between 180° and 200° .

3.3.3 Ambient Temperature Summary

TABLE 3-8. Summary of Ambient Temperature Audit Results.

Site	Audit Date	Date Corrected	Audit Tests			
			Performance Test	Sensor Height *	Sensor Exposure	Misc.
BTW	6/22/97					
RSD	6/17/97		-1.3°C		(1)	
HPA	6/18/97					
TML	6/19/97					
NTN	6/20/97					
TCL	6/21/97					
SIM	6/23/97		1.5°C			
PHE	6/30/97					
PDE	7/1/97					
USC	7/2/97					
SCE	7/3/97					
VNS	7/10/97					
LAX	7/11/97					
SCL	7/11/97					
SCA	7/12/97				(2)	
AZS	7/13/97					
LAS	7/16/97					
PTL	NM					
VLC	NM					
BFD	7/21/97					
APE	7/23/97					
TTN	7/24/97					
CBD	7/25/97					
EMT	7/28/97				(3)	
WSP	NM					
ONT	NP					

* Audit criteria = ± 1.0°C.
NP = Not performed.
NM = Measurement not present.

1. Due to the poor siting of the sensors, the surface data from this site should not be used for any purpose other than general QC checks of the profiler data.
2. The temperature and relative humidity sensors are not over representative terrain. Gravel and asphalt surfaces are nearby.
3. The temperature and relative humidity sensors were obstructed and/or influenced by the retaining wall, bushes, and trees on the east side of the site.

3.3.4 Relative Humidity Summary

TABLE 3-9. Summary of Humidity (Dew Point) Audit Results.

Site	Audit Date	Date Corrected	Audit Tests			
			Performance Test *	Sensor Height	Sensor Exposure	Misc.
BTW	6/22/97		-2.6°C			
RSD	6/17/97				(1)	
HPA	6/18/97		4.8°C			
TML	6/19/97		4.7°C			
NTN	6/20/97					
TCL	6/21/97		1.7°C			
SIM	6/23/97					
PHE	6/30/97					
PDE	7/1/97					
USC	7/2/97					
SCE	7/3/97					
VNS	7/10/97		-5.6°C			
LAX	7/11/97					
SCL	7/11/97					
SCA	7/12/97				(2)	
AZS	7/13/97		3.0°C			
LAS	7/16/97					
PTL	NM					
VLC	NM					
BFD	7/21/97					
APE	7/23/97					
TTN	7/24/97					
CBD	7/25/97					
EMT	7/28/97				(3)	
WSP	NM					
ONT	NP					

* Audit criteria based on equivalent dew point temperature of ± 1.5°C.
NP = Not performed.
NM = Measurement not present.

1. Due to the poor siting of the sensors, the surface data from this site should not be used for any purpose other than general QC checks of the profiler data.
2. The temperature and relative humidity sensors were not over representative terrain. Gravel and asphalt surfaces are nearby.
3. The temperature and relative humidity sensors were obstructed and/or influenced by the retaining wall, bushes, and trees on the east side of the site.

Section 4

CONCLUSIONS SECTION

4.1 SYSTEM AUDITS

4.1.1 Radar Profiles, RASS, and Sodars

The systematic problems uncovered by the audits fell, for the most part, into two categories: system set up and siting. The system audit results summarized in Table 3-1 should be consulted by the persons processing and validating these data, as well as the persons performing data analyses that use these data.

- System Set Up

System set up problems also fell into two categories: (1) RWP and sodar antenna, and RASS acoustic source level and orientation, and (2) system configuration.

- Antenna and RASS Source Orientation and Level

The RWP and sodar antenna, and RASS acoustic source orientation and level problems were probably due to training issues with respect to the use of compasses, specifically the application of magnetic deviation corrections, and magnetic interference from underground and above ground metal such as pipes or conduit, fences, etc. Whenever possible, the auditors used sun angles to determine orientation and eliminate the possibility of magnetic interference. Simple pointing devices and a freeware program called Compass are available for this purpose. With respect to RWP and sodar antenna and RASS acoustic source level, a digital electronic level is a must for determining 0.5° tolerances which cannot be determined using a bubble level.

Operators differed regarding the importance of the audit criteria of 0.5° for RASS source level. For the Radian built RWP/RASS, the criteria of 0.5° was specified. For the NOAA RWP/RASS, there was little concern for the RASS source level. RASS source level was found in some cases to vary between 3° and 6°. Assuming that the RASS source is out of level 6° and pointing away from the RWP antenna, at an altitude of 1000 meters the horizontal separation of the RASS source from the RWP antenna would be more than 100 meters. It may be that the level of the RASS sources is not that important and that the 0.5° criteria is too stringent. This issue should be addressed and criteria based on the operational requirements of the RASS systems should be determined.

- System Configuration

With respect to system configuration, differences in radar profiler and RASS range gate spacing were noted among the various agencies and monitoring contractors. These differences resulted from operational requirements for some of the agency units, recommendations from the manufacturer, and the personal experience of some of the operators. To ensure consistency in the measurements of future monitoring programs of this scope, the project management should decide on the maximum altitudes and range gate spacing for the high and low modes of operations. These settings should be based on the data requirements of the study and the individual meteorological characteristics of each site, such as the marine boundary layer at shore sites.

- Siting

Siting problems dealt primarily with antenna exposure.

– Sodars

With respect to the sodar installations, active noise sources noted included noise from vehicular traffic, water well pumps, an air conditioner, and a rifle range. Passive noise sources that generate false return echoes included buildings, walls, canyon walls and cliffs.

– RWP and RASS

For RWP and RASS, active interferences noted by the audits included radio frequencies operating close to the RWP's 915 mHz frequency. Passive interferences included power lines, trees, vertical surfaces such as buildings and walls, hills, and automobiles moving on an elevated roadway.

4.1.2 Surface Meteorological Measurements

As with the RWP/RASS and sodars, the surface meteorological measurement system audit problems fell into two categories, set up, and siting or sensor exposure. The system audit results summarized in Tables 3-5, 3-6, 3-7 and 3-8 should be consulted by the persons processing and validating these data, as well as the persons performing data analyses that use these data.

- System Set Up

– Wind

Set up problems consisted of wind direction sensor misalignment, sensors not vertical, and towers not securely mounted at the base, which allowed the tower to pivot.

Additionally, the height of the wind sensors was 23 feet at one site, and 3 meters at two sites instead of 10 meters as specified by the EPA for large-scale wind measurements. These nonstandard heights must be taken into consideration when using these data in analyses.

- Siting or Sensor Exposure

– Wind

Wind sensor exposure problems were noted at six sites. These problems dealt with sensors mounted on rooftops and obstructions to the wind flows around the site. Wind sensors mounted on rooftops must be one-and-a-half times the height of the building above the building to be out of the wake caused by the building. Obstructions to the wind flows were caused by retaining walls, bushes, trees, and a water tank.

– Temperature and Relative Humidity

Sensor exposure problems consisted of sensors either being mounted over non-representative terrain or being mounted close to radiating surfaces such as walls, bushes, and trees.

4.2 PERFORMANCE AUDITS

4.2.1 Radar Profilers

Two different methods were used for the auditing of the radar wind profilers. The first involved the collocation of a sodar with the RWP while the second used rawinsondes for collection of the wind data. Both of the methods have advantages and drawbacks in conducting performance audits. The sodar allows collection of a longer time series of data, specific to the site and under a variety of meteorological conditions. This is especially useful for sites in regions where significant changes in flow patterns can occur over the diurnal cycle and where site specific influences, such as complex terrain, can cause differences in flow patterns at distances away from the RWP site. Sodars, however, are limited in the altitude coverage and cannot provide data much above 700 to 1,000 meters, a region well covered by rawinsondes. Rawinsondes also provide temperature and moisture profiles that are required for the RASS comparisons.

From the results of this study, and from prior experience, not all soundings taken from a rawinsonde system will provide useful data for wind and temperature comparisons. If the sounding is taken during a transition period or under light and variable winds, the comparisons can be somewhat ambiguous. It is therefore important to have adequate data to perform an analysis. Ideally, when rawinsondes are used for the performance audit, at least 5 sondes should be released over a variety of flow patterns. This will allow for resolution of some of the questionable results.

Subsequent to the comparisons made in this report, the EPA has made further recommendations on QA analysis methods for remotely sensed data. Some of the lessons learned and experience gained in this program were used to develop additional analysis methods to be used in evaluation of QA data. These methods include the component evaluation of the RWP, sodar and rawinsonde information to allow the use of low wind speed comparisons in analyzing the performance of instruments. While it doesn't change the methods of collection of the audit data, it allows different analyses to determine if the systems are working acceptably. These new methods, now in draft form (EPA, 1999), should be used in the evaluation of the audit data collected during the SCOS97 program. The analyses should be performed on the level 1 validated data set that, as of the printing of this report, is not yet available. The conclusions provided below are based on the analyses performed on the original raw data set and do not include the component analyses described in the EPA draft document.

– RWP Versus Audit Sodar

The audit comparisons between the RWP and audit sodar showed good agreement for the most part, and where differences exceeded the audit criteria the reasons for the differences were explained in Section 3. It should be noted that all comparisons were made with the raw data collected in the field. Subsequent to the data collection effort, the RWP data were reprocessed using various screening algorithms. The reprocessed data have not been included in the analyses described in this report. The differences noted may change once the reprocessed data become available and any analyses are performed.

– RWP versus Rawinsonde Winds

The audit comparisons between the RWP and the audit rawinsonde measurements showed good overall agreement. Where differences exceeded the audit criteria the reasons for the differences were explained in Section 3. As noted above, the comparison results may change once the RWP data are finalized.

4.2.2 RASS

The average differences for the RASS, rawinsonde comparisons were well within the audit criteria of ±1.0°C for seven of the 11 sites audited. Of the four sites where the average difference exceeded the criteria, the average differences for three of the sites were 1.1, 1.1, and 1.2°C. The average difference for the fourth site, Alpine, was -2.2°C. This relatively large difference was probably the result of difficulties experienced with the rawinsonde system during the audit at this site.

4.2.3 Sodars

The audits of the sodars using the APT gave comparisons that were within the audit criteria with respect to wind direction at all sites audited and at two of the four sites with respect to wind speed. The differences in the wind speed comparisons at the Santa Clarita (SCA) and Azusa (AZS) sites were determined to be the lack of sufficient resolution in the measurements of the return echo Doppler shifts by these sodars. This lack of resolution can result in errors in the horizontal wind speeds of over 1 m/s, which is in agreement with the results presented in Table 3-5. It is unclear if the lack of resolution will result in a significant degradation in accuracy since the atmosphere does not produce discrete returns, as does the APT used in the audit. The maximum potential error due to this resolution problem will be noticed most during low wind speed conditions. Under these low wind speed conditions there will also be significant wind direction errors. Table 3-5 should be consulted by the persons performing data analyses using these data.

4.2.4 Surface Meteorological Measurements

4.2.4.1 Wind Direction

Where the wind direction sensing system responses did not meet the audit criteria of ±5°, because the sensor was not orientated correctly with respect to true north. In all cases these problems were corrected following the audits. The data processing personnel should consult Table 3-6 during the validation process to correct the affected data.

4.2.4.2 Wind Speed

Where the wind speed sensing system responses did not meet the audit criteria of ±0.25 m/s for winds less than 5 m/s and 5% for winds equal to or greater than 5 m/s, the transfer coefficients were incorrect. The data processing personnel should consult Table 3-7 and the field personnel during the validation process to correct the affected data.

4.2.4.3 Ambient Temperature

At two sites, Riverside (RSD) and Simi Valley (SIM) the temperature sensing system did not agree with the audit temperature to within the EPA recommended criterion of ±0.5°C. The data processing personnel should consult Table 3-8 during the validation process to correct the affected data.

4.2.4.4 Relative Humidity

At six sites—Barstow (BTW), Hesperia (HPA), Thermal (TML), Temecula (TCL), Van Nuys (VNS), and Azusa (AZS)—the site equivalent dew point temperature did not agree with the audit equivalent dew-point temperature to within the EPA-recommended criterion of ± 1.5°C. The data processing personnel should consult Table 3-9 during the validation process to correct the affected data.

Section 5

REFERENCES

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Appendix A

SCOS97–NARSTO Checklist

SCOS97-NARSTO

SITING AND SYSTEM AUDIT FORM

MEASUREMENTS GROUP:

SITE NAME AND LOCATION:

AUDITOR:

DATE:

KEY PERSON:

I. Observables

A. Meteorological

Observable	Method	Manufacturer	Model	Serial #	Range

Comments:

Are there any required variables which are not measured?

Are there any methods and/or equipment that are not in the SOP?

Do any operating ranges differ from those specified in the SOP?

Are there any significant differences between instrumentation on site and the SOP?

Comments:

B. Auxiliary Equipment

Type	Manufacturer	Model	Serial #	Last Calibration Date

Comments:

B. Station Check Equipment

Type	Manufacturer	Model	Serial #	Comments

Comments:

II. Sensor/Probe height and Exposure

Variable	Value	Meet SOP (Yes/No)
1. Orientation		
2. Level		
3. Distance to closest obstruction		
4. Distance to closest active noise source		

Comments:

III. Operation

A. Meteorology

Question		Response (Yes/No)	Meet SOP (Yes/No)
1.	Is all instrumentation operational?		
2.	Are all cables secure?		
3.	Are all cables connected according to SOPs or instrument manuals?		
4.	Are connections clean and rust free?		
5.	Are serial numbers available?		
6.	Do data system times agree with audit times. If not, what is the deviation?		
7.	Is the printer functional?		
8.	Overall, is the site maintenance sufficient to meet the DQOs?		

Comments:

B. Auxiliary Equipment

Question		Response (Yes/No)	Meet SOP (Yes/No)
1.	Is the A/C unit sufficient to maintain temperatures in the range specified in the SOPs?		
2.	Is the site temperature recorded?		
3.	Is the site temperature maintained at 20-30°C?		
4.	Is the site kept clean enough to allow operation of all instruments as specified in the SOP?		
5.	Does the modem work?		
6.	Does the telephone work?		
7.	Is the site secure?		
8.	Overall, is the auxiliary equipment maintenance sufficient to meet the DQOs?		

Comments:

C. Station Check Procedures and Documentation

	Question	Response (Yes/No)	Meet SOP (Yes/No)
1.	Are the station logs present?		
2.	Are the station logs up to date?		
3.	Do station logs contain details as required by the SOPs?		
4.	Are routine checklists used?		
5.	Do the routine checklists contain details as required by the SOPs?		
6.	Are the calibration forms present?		
7.	Do the calibration forms contain details as required by the SOPs?		
8.	Are the SOPs present?		
9.	Are the instrument manuals present?		
10.	Do the SOPs include quality control tests?		
11.	If quality control tests are included then how are the results of the tests documented?		
12.	Has the site technician undergone training as specified in the SOPs?		
13.	Is the site visited twice weekly?		
14.	Does the site technician understand the SOPs?		

Comments:

D. Chain of Custody

1.	Review paper work for chain of custody from field to data processing.	Comments:
2.	How are data stored?	
3.	How often are the data backed up?	

Comments:

V. Preventive Maintenance

Question		Response (Yes/No)	Meet SOP (Yes/No)
1.	Is preventive maintenance discussed in the SOPs?		
2.	Is preventive maintenance being performed?		
3.	Are field operators given special training in preventive maintenance?		
4.	Are tools and spare parts adequate at the site to meet the requirements of the SOPs?		
5.	Are maintenance logs maintained and reviewed?		

Comments:

VI. Overall Comments

Question		Response (Yes/No)	Meet Work Plan (Yes/No)
1.	Overall, is the station maintenance sufficient to meet the DQOs?		
2.	Does the siting meet the program objectives?		
3.	Overall, is the site technician trained as specified in the SOPs?		
4.	Does the QC program appear to be working?		
5.	Overall, does the meteorological data look reasonable?		
6.	Overall, does the data appear to meet the program objectives?		

Comments:

52-16016-5206

Final Report

CALIFORNIA AIR RESOURCES BOARD
CONTRACT # 96-320

SOUTHERN CALIFORNIA OZONE STUDY 1997 NORTH AMERICAN RESEARCH STRATEGIES FOR TROPOSPHERIC OZONE (SCOS97-NARSTO) UPPER-AIR AND ASSOCIATED SURFACE METEOROLOGICAL MEASUREMENTS

APPENDIX B

AVES
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June 1999

Appendix B

SITE SYSTEM AND PERFORMANCE AUDIT REPORTS

ALPINE (APE)

SCOS97-NARSTO AUDIT SUMMARY
RADAR PROFILER/RASS/SODAR/SURFACE METEOROLOGY

Site:	Alpine (APE)
Audit Dates:	July 23 - 25, 1997
Instrumentation Audited:	Radar Profiler, RASS, Surface Meteorology
Key Person(s):	Cat Russell
Auditor:	Alexander N. Barnett

The purpose of this summary is to provide a preliminary report of any significant audit findings. The site is operated by NOAA/ETL. Key elements of the audit are identified below.

AUDIT INSTRUMENTATION

No problems with the audit equipment occurred during the audit.

SITE CHARACTERISTICS

The site is locate on a ranch approximately five miles northeast of the Alpine, California city center. The ranch terrain gently slopes down toward the east. The east-northeast view has a hill that is approximately 200 meters away and 100 meters in height above the RWP and RASS location.

SYSTEM AUDIT NOTES

1. The RWP system clock was set to the atomic clock time but the clock displayed on the spectral data screen lagged the system clock by 1 minute and 20 seconds. This is a problem If the time on the CDN data is the spectral data clock rather than the system clock.

2. The north-south RWP antenna zenith angle was measured to be 14.3° and the east antenna zenith angle was measured as 13.8°. The RWP set up puts these zenith angles at 15°. A calculation of the wind speed and wind direction error attributed to these discrepancies are approximately 6.5% and 2%, respectively. The controller should be reset to compensate for these differences so that the winds are calculated correctly.

3. The levels of all of the RASS acoustic sources (a combination of the level of the suspended drivers and the parabolic dishes) exceeded the EPA PAMS recommended criteria of ± 1.0°, in some cases by more than ± 2.0°. There is a concern that if this angle away from the vertical may affect the vertical range of the RASS measurements.

4. The NOAA/ETL RASS acoustic sources consist of a parabolic dish and a "floating" acoustic driver that is not connected to the dish. There is a question about how the position of the driver with respect to the focus of the parabolic dish may effect the altitude that the RASS acoustic source signals can reach and the vertical range of the RASS measurements.
5. The base of the surface meteorological measurements tower was not securely staked and could rotate slightly within the confines of the guy wires. The movement could affect the wind direction measurements and should be corrected.
6. The temperature and relative humidity sensors are in a non-aspirated radiation shield. The data should therefore not be used in dispersion modeling.
7. There are no signs warning of potential audio or radio frequency radiation. Appropriate signage is recommended.
8. The site is visited approximately once every four weeks. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

POTENTIAL ACTIVE NOISE SOURCES

No RFI was detected from a scan of the frequencies between 914 and 916 mHz, and a listen only check.

POTENTIAL PASSIVE NOISE SOURCES

No passive sources were noted. The north antenna data did not indicate clutter from the hill to the east-northeast of the site.

ANTENNA LEVEL AND ALIGNMENT

1. The zenith angles of he RWP antennas were 14.3° for the south facing antenna, and 13.8° for the east facing antenna. These deviations from the RWP controller settings of 15° introduces errors of approximately 6.5% for wind speed and 2% for wind direction.
2. The level of all of the RASS acoustic source drivers and dishes were outside of the audit criteria of ±1.0°.

RADAR PROFILER PERFORMANCE AUDIT

A comparison of the sodar data collected on 7/23/97 was made with the corresponding RWP wind data in both the low (60 meter range gates) and the high (100 meter range gates) of operation. The comparisons were made for the levels between the surface and 558 meters. The low mode winds compared exceptionally well with the sodar winds, while the high mode winds differed by more than the audit criteria of ± 10° for wind direction and ± 1.0 m/s for wind speed. The NOAA/ETL engineers commented that the high mode wind discrepancies were due to the pulse coding of the high mode winds which produces erroneous readings in the range gates between the surface to approximately 700 meters. The data that NOAA/ETL will submit to the SCOS97-NARSTO data base will use the low mode winds for the surface to 700 meter range gates and the high mode winds for the range gates above approximately 700 meters.

RASS PERFORMANCE AUDIT

The RASS data was compared with virtual temperature data calculated from the temperature, humidity and pressure data collect by on-site rawinsonde soundings. Preliminary results showed good agreement between the two measurement systems, although, the RASS soundings tended to under estimate the thickness and intensities of inversions as compared with the rawinsonde soundings.

RADAR PROFILER DATA INTERNALCONSISTENCY

1. Overall, the data look reasonable. A review of the data collected during the three days prior to the audit, showed the low mode of operation to be collecting data between 1000 meters and the top of the sounding (2,300 meters), while the high mode of operation was collecting data to between 2,400 and the top of the sounding (approximately 4,000 meters).
2. During the period of the audit, the low mode winds were restricted to below 1000 meters and the high mode winds were kept to below 2,400 meters.

RASS DATA INTERNAL CONSISTENCY

1. During the period of the audit revealed that the the vertical extent of the RASS data varied from day to day with the average maximum altitude of approximately 1000 meters. This variation is probably due to atmospheric conditions including strong surface inversion in the early morning hours and dry layers aloft in the afternoon and evening.
2. It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project. The current mode of operation is 106 m. This will remove some of the spatial averaging and provide a much clearer picture of the atmosphere.

SURFACE METEOROLOGY PERFORMANCE AUDIT

1. The 10 meter wind direction sensor orientation was outside of criteria which produced a total error of 10°. The sensor was aligned following the audit and the alignment verified.
2. All sensors are scanned every 10 seconds with five minute averages recorded. Other than the wind direction alignment error, no problems were noted with the performance audit results. However, not all of the variables could be audited completely. A summary of these audits are provided below:
   - The temperature sensor could not be immersed in water and the probe design was not conducive to placement in a water proof sheath while retaining good thermal conductivity. Only one ambient comparison point was therefore audited.
   - Due to the wiring and the method of sensor installation, the wind direction sensor was not removed from the tower to perform the torque test. Future installations should consider an alternate installation that will allow for appropriate sensor evaluation.
   - Wind data recorded include scalar wind speed and resultant vector wind direction.
   - As indicated above, the 10 meter wind direction sensor orientation was outside of criteria which produced a total error of 10°. The sensor was aligned following the audit and the new alignment verified.

SCOS97-NARSTO

SITING AND SYSTEM AUDIT FORM

MEASUREMENTS GROUP:	NOAA/ETL
SITE NAME AND LOCATION:	Alpine (APE)
AUDITOR:	Alexander N. Barnett
DATE:	July 23 - 25, 1997
KEY PERSON:	Cat Russell

I. Observables

A. Meteorological

Observable	Method	Manufacturer	Model	Serial #	Range
Wind Speed/ Wind Direction	Radar Profiler	NOAA/ETL	915 MHz	915-32-6	Lo 152 - 2296 m at 58 m inc. Hi 152 - 3905 m at 102 m inc.
Virtual Temperature	RASS	NOAA/ETL	915 MHz	915-32-6	157 - 1628 m at 105 m inc. (see below)
	Audio amplifier	Crest Audio	NA	NA	NA
10 m Wind Speed	Propeller	RM Young	5103-AQ	20106	0 - 50 m/s
10 m Wind Direction	Vane	RM Young	5103-AQ	20106	0 - 355 degrees
2 m ambient temperature	RTD	Campbell	CS-500	NA	-35 - 50 °C
2 m relative humidity	Solid State	Campbell	CS-500	NA	0 - 100%
Data Logging	Digital	Campbell	21X	NA	NA

Comments: It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project while retaining the altitude coverage.

Are there any required variables which are not measured?	No
Are there any methods and/or equipment that are not in the SOP?	Yes
Do any operating ranges differ from those specified in the SOP?	See Below
Are there any significant differences between instrumentation on site and the SOP?	No

Comments: Station is also monitoring total solar and net radiation and barometric pressure. As indicated above the RASS resolution should be increased to about 60 m.

B. Auxiliary Equipment

Type	Manufacturer	Model	Serial #	Last Calibration Date
Communications computer	SMT	NA	NA	NA
RWP computer	Diversified Technology	NA	NA	NA
RASS amplifier	Crown	460-CSL	121447	NA
Power conditioner	Best	FE1-4kva	FE1-4kv-11444	NA
Jaz Drive	NA	NA	NA	NA

Comments:

B. Station Check Equipment

Type	Manufacturer	Model	Serial #	Comments
NA[1]	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA

Comments:

1. Station check equipment is carried with the NOAA engineers and not left on site.

II. Sensor/Probe height and Exposure

A. Radar Profiler/RASS/Sodar

Variable	Value	Meet SOP (Yes/No)
1. Orientation (three axis radar antenna)	Radar – 4°, 3° 10 m Vane – 6°	No No
2. Level (level and inclination of the horiz ant)	Radar – 13.8° RASS – 2.5°	No No
3. Distance to closest obstruction	Not significant	Yes
4. Distance to closest active noise source	No significant active RF sources	Yes

Comments:

1. The the orientation of the west RWP antenna differs from the audit determined orientation by 4°. The orientation of the north antenna differs from the audit determined orientation by 3°. The 10 meter wind vane orientation was outside orientation criteria by 6°.
2. The south RASS acoustic source transducer and dish were out of level by 1.5° and 2.3°, respectively . The north RASS acoustic source transducer and dish were out of level by 1.6° and 2.5°, respectively. The dishes and transducers were leveled following the audit.
4. A listen only test of the radar revealed no significant RF sources nearby.

B. Surface Meteorology

Variable	Value	Meet SOP (Yes/No)
1. Height of wind sensors above ground	10 m	Yes
2. Distance to nearest obstacle	None	Yes
3. Is separation at least 10x obst. height?	No	No
4. Are instruments on a rooftop?	No	NA
5. Is exposure 1.5x height above roof	NA	NA
6. Arc of unrestricted flow	360°	Yes
7. Height of temp sensor above ground	3 m	Yes
8. Distance of temp sensor from obst.	None	Yes
9. Height of DP/RH sensor above ground	2 m	Yes
10. Distance of DP/RH sensor from obst.	None	Yes
11. Are the distances 4x the obst. height?	Yes	see below
12. Is the sensor shielded or aspirated?	Shielded	Yes
13. Are the T/DP/RH abv representative terrain?	Yes	Yes
14. Are there significant differences between on-site equipment and the monitoring plan?	No	Yes

Comments:

1,2,3. Wind data recorded include scalar wind speed and resultant vector wind direction. All surface sensors are scanned every 10 seconds with five minute averages recorded.

12. The temperature and relative humidity sensors are in a non-aspirated radiation shield. The data should therefore not be used in dispersion modeling.

III. Operation

A. Radar Profiler, RASS and Surface Meteorology

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is all instrumentation operational?	Yes	Yes
2. Are all cables secure?	Yes	Yes
3. Are all cables connected according to SOPs or instrument manuals?	Yes	Yes
4. Are connections clean and rust free?	Yes (see below)	Yes
5. Are serial numbers available?	Yes	Yes
6. Do data system times agree with audit times. If not, what is the deviation?	Yes ~ 30 sec.	Yes
7. Is the printer functional?	NA	NA
8. Overall, is the site maintenance sufficient to meet the DQOs?	See below	Yes

Comments:

8. The site is visited approximately every four weeks for routine maintenance. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

B. Radar Profiler/RASS/Sodar Settings

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Software version	POP 4.1	Yes
2. High mode pulse length	700 ns	Yes
3. Low mode pulse length	400 ns	Yes
4. RASS pulse length	700 ns	Yes
5. RASS acoustic temperature Range?	10 - 40°C	Yes
6. RASS acoustic source range?	10 - 40°C	Yes
7. Time zone	GMT	Yes
8. Wind data consensus	53 min (see below)	Yes
9. RASS consensus	7 min (see below)	Yes

Comments:

8, 9. The configuration was changed to gave a 53 minute wind data consensus and a 7 minute RASS consensus. This was done in response to findings at other NOAA sites where it was found that the polling of the surface data during the first five minutes of the hour only gave about a 3.5 minute RASS consensus.

	Wind Low Mode	Wind High Mode	RASS
First Gate	138 m	138 m	157 m
Last Gate	2282 m	3890 m	1628 m
Spacing	58 m	102 m	105 m
Full Scale Velocity	10.2 m/s	10.2 m/s	409.6 m/s

Comments: It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project while retaining the altitude coverage.

B. Auxiliary Equipment

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is the A/C unit sufficient to maintain temperatures in the range specified in the SOPs?	Yes	Yes
2. Is the site temperature recorded?	No	See below
3. Is the site temperature maintained at 20-30°C?	Yes	See below
4. Is the site kept clean enough to allow operation of all instruments as specified in the SOP?	Yes	Yes
5. Does the modem work?	Yes	Yes
6. Does the telephone work?	Yes	Yes
7. Is the site secure?	Yes (see below)	Yes
8. Overall, is the auxiliary equipment maintenance sufficient to meet the DQOs?	Yes	Yes

Comments: 2. There is no measurement of the shelter temperature. It was indicated that the temperature is not critical for the system operation.

7. Security is good. There are no signs warning of potential audio or radio frequency radiation. Appropriate signage is recommended.

C. Station Check Procedures and Documentation

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Are the station logs present?	Yes	Yes
2. Are the station logs up to date?	Yes	Yes
3. Do station logs contain details as required by the SOPs?	Yes	Yes
4. Are routine checklists used?	Yes	Yes
5. Do the routine checklists contain details as required by the SOPs?	Yes	Yes
6. Are the calibration forms present?	No	See below
7. Do the calibration forms contain details as required by the SOPs?	NA	NA
8. Are the SOPs present?	Yes	Yes
9. Are the instrument manuals present?	No	See below
10. Do the SOPs include quality control tests?	Yes	Yes
11. If quality control tests are included then how are the results of the tests documented?	In site checklist	Yes
12. Has the site technician undergone training as specified in the SOPs?	See Below	Yes
13. Is the site visited twice weekly?	No	See below
14. Does the site technician understand the SOPs?	Yes	Yes (see below)

Comments: 6. Calibration records are maintained at NOAA/ETL

9. Manuals are maintained at NOAA/ETL. If repairs are needed then the engineer brings the manuals to the site.

12. There are no site technicians. During most times there is an engineer in the field that travels from site to site for the checks and needed maintenance.

13, 14. The site is visited approximately every four weeks for routine maintenance. In between the visits the data are polled and reviewed on a regular basis. Data are retrieved hourly and reviewed daily. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

D. Chain of Custody

1. Review paper work for chain of custody from field to data processing.	Comments: The site is inspected every four weeks with all data archived at that time. Paperwork older than about two months is forwarded to NOAA/ETL.
2. How are data stored?	Data are stored locally on the computer hard drive with consensus files and surface data transferred on an hourly basis to the communications computer. The files on the communications computer are downloaded to NOAA/ETL on an hourly basis and then erased.
3. How often are the data backed up?	Files are copied to an optical drive on an hourly basis. These data are recovered on a monthly basis when the engineer visits the site.

Comments: 1. It is recommended a carbonless or similar form be used for the site checklist. In that manner a copy could be left at the site while the original can be sent back to NOAA/ETL.

V. Preventive Maintenance

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is preventive maintenance discussed in the SOPs?	Yes	Yes
2. Is preventive maintenance being performed?	Yes	Yes
3. Are field operators given special training in preventive maintenance?	Yes	Yes
4. Are tools and spare parts adequate at the site to meet the requirements of the SOPs?	See below	Yes
5. Are maintenance logs maintained and reviewed?	Yes	Yes

Comments: 4. Tools and spares are carried with the field engineers. Some spares such as RASS transducers are stored at various sites throughout the NOAA/ETL network.

VI. Overall Comments

Question	Response (Yes/No)	Meet Work Plan (Yes/No)
1. Overall, is the station maintenance sufficient to meet the DQOs?	Yes	Yes
2. Does the siting meet the program objectives?	Yes	Yes
3. Overall, is the site technician trained as specified in the SOPs?	Yes	Yes
4. Does the QC program appear to be working?	Yes	Yes
5. Overall, does the meteorological data look reasonable?	Yes	See below
6. Overall, does the data appear to meet the program objectives?	Yes	Yes

Comments:

5. During the period of the audit the vertical extent of the RASS data varied from 400 meters during the earlier morning hours to 1300 meters during the afternoon. This was probably due to the current meteorological conditions.

   It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project. The current mode of operation is 106 m. The finer resolution will remove some of the spatial averaging and provide a much clearer picture of the atmosphere. When changing the resolution, the height range should be maintained by increasing the number of range gates collected.

SCOS97-NARSTO AUDIT RECORD
VISTA, ORIENTATION AND LEVEL

Site Name:	Alpine	Instrument:	NOAA/ETL
Date:	7/23/97 - 7/25/97	Receiver s/n:	915-32-6
Time:	14:00 PDT	Interface s/n:	915-32-6
Measurements group:	NOAA/ETL	Frimware version:	POP-4
Key contact:	Cat Russell	System rotation angle:	84° , 173°
Audited by:	Alex Barnett	Measured orientation:	80° ,170°
Site longitude:	116° 48.57'W	Orientation difference:	4° , 3°
Site latitude:	32° 51.57'N	Array level (vert):	N-S: 0.1° E-W: 0.4°
Site elevation:	463 meters	Beam zenith angle:	N: 14.3°, W: 13.8°
Magnetic declination:		Beam directions:	North and West

Mag. Az. Angle (deg)	True Az. Angle (deg)	Terrain El. Angle (deg)	Features and Distances
NA	0	10	Hill at 200 meters.
NA	30	20	Hill at 200 meters.
NA	60	30	Hill at 200 meters.
NA	90	20	Hill at 200 meters.
NA	120	20	Hill at 100 meters.
NA	150	20	Hill at 100 meters
NA	180	5	Easy up slope at 100 meters.
NA	210	5	Easy down slope, hill at 300 meters.
NA	240	5	Easy down slope, hill at 300 meters.
NA	270	5	Hill at more than ½ mile.
NA	300	<2	Hill at more than ½ mile
NA	330	<2	Hill at more than ½ mile.

Comments:

SCOS97-NARSTO AUDIT RECORD
HORIZONTAL WIND SPEED

Date:	July 23, 1997	Site name:	Alpine
Start:	17:00	Project:	SCOS97-NARSTO
Finish:	17:20	Operator:	NOAA
Auditor:	Alex Barnett	Site Operator:	Cat Russell

Sensor Mfg:	R.M.Young	Model:	05103
Sensor s/n:	20106	Sensor Ht.:	10 meters
K factor:	1.4	Starting torque:	0.3 gm-cm
Range:	0 - 50 m/s	Starting Threshold:	0.46 m/s
Logger:	Campbell CR-10X		
Logger s/n:	XXXXX		
Prop s/n:	46427		

Cal. Factors

	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Last calibration date: XXXX

WS Calibration Point	M/S Input	M/S Chart	M/S Diff. Chart	M/S DAS	M/S Diff. DAS	% Diff. DAS
1	0.0	#N/A	#N/A	0.0	0.0	#N/A
2	2.5	#N/A	#N/A	2.5	0.0	#N/A
3	4.9	#N/A	#N/A	4.9	0.0	0.0
4	14.7	#N/A	#N/A	14.7	0.0	0.0
5	24.5	#N/A	#N/A	24.5	0.0	0.0
6	34.3	#N/A	#N/A	34.3	0.0	0.0

Pass/Fail Criteria: +/-.25 m/s; ws <= 5 m/s
+/- 5%; ws > 5 m/s

Comments: Okay.

SCOS97-NARSTO AUDIT RECORD
HORIZONTAL WIND DIRECTION

Date: July 23, 1997
Start: 17:20 PDT
Finish: 17:50 PDT
Auditor: Alex Barnett

Site name: Alpine
Project: SCOS97-NARSTO
Operator: NOAA
Site Operator: Cat Russell

Sensor Mfg: R.M.Young
Serial No.: 22039
K Factor: 29.8
Range: 0 - 355 deg
Logger: Campbell CR-10X
Logger s/n: XXXXX

Model: 05103
Sensor Ht.: 10 meters
Starting torque: 5.0 gm-cm
Starting threshold: 0.41 M/S

Last calibration date: XXXX

Crossarm: 0 deg true

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

WD Audit Point	Degrees Reference	Corrected Degrees Reference	Degrees Chart	Diff. Chart Deg.	Degrees DAS	Linearity	Total Diff DAS Deg.
Orientation	0.0				3.0		3.0
1	9	9.0	#N/A	#N/A	16.0	1.8	7.0
2	70	70.0	#N/A	#N/A	76.0	0.8	6.0
3	184	184.0	#N/A	#N/A	190.0	0.8	6.0
4	257	257.0	#N/A	#N/A	259.0	-3.3	2.0
5							
6							
7							
8							
9							
10							
11							
				Avg difference:			5.3
				Maximum difference:		-3.3	7.0

Criteria: Orientation: +/- 2 degrees
Linearity: +/- 3 degrees
Maximum Difference: +/- 5 degrees

Comments: Did not meet audit criteria. Sensor orientation adjusted after audit.

SCOS97-NARSTO AUDIT RECORD
AMBIENT TEMPERATURE

Date: July 23, 1997
Start: 16:32
Finish: 16:42
Auditor: Alex Barnett

Site name: Alpine
Project: SCOS97-NARSTO
Operator: NOAA
Site Operator: Cat Russell

Campbell
Serial No.: NA
Range: -50 to 50 Deg C

Model: CS-500
Sensor Ht.: 3 meters

Logger: Campbell CR-10X
Logger s/n: XXXXX

Last calibration date: XXXX

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Temperature Audit Point	Deg C Input	Deg C Chart	Deg C Diff. Chart	Deg C DAS	Deg C Diff. DAS
1	27.9	#N/A	#N/A	27.5	-0.4

Criteria: +/- 0.5 degree Celsius

Comments: Okay.

SCOS97-NARSTO AUDIT RECORD
RELATIVE HUMIDITY (DEW POINT TEMPERATURE)

Date: July 23, 1997
Start: 16:32
Finish: 16:42
Auditor: Alex Barnett

Site name: Alpine
Project: SCOS97-NARSTO
Operator: NOAA
Site Operator: Cat Russell

Sensor Mfg: Campbell
Serial No.: NA
Range: 0 - 100 Percent

Model: CS-500
Sensor Ht.: 3 meters

Logger: Campbell CR-10X
Logger s/n: XXXXX

Last calibration date: XXXX

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

RH/DP Audit Point	%RH Input	Deg C Input	% RH Chart	Deg C Chart	Deg C Diff. Chart	%RH DAS	Deg C DAS	Deg C Diff. DAS
1	63.6	17.6	#N/A	#N/A	#N/A	58.0	16.8	-0.8

Criteria: +/- 1.5 degree Celsius

Comments: Okay.

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Alpine
Date: July 23 - 25, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

High Mode of Operations

Overall Difference Radar Profiler - Sodar	Wind Dir. (deg)
Average:	10
Maximum:	112
Minimum:	-71
Standard Deviation:	27
Root Mean Square (RMS):	29

		Wind Dir. Difference (deg, Radar Profiler - Sodar) Level (m)					
Date	Hour	152	253	354	455	556	657
07/23/97	14:15	2.0	20.3	39.4		41.8	27.7
	15:15	-28.2	7.0	21.4	43.2	31.2	
	16:15	-38.8	-7.2	9.3	-7.1		
	17:15	6.1	26.2				
	18:15	14.3	7.2	14.2			
	19:15						
	20:15			4.2			
	21:15		-5.6				
	22:15		25.4				
	23:15	-2.1	5.5		1.9		
07/24/97	0:15	11.6	96.7				
	1:15						
	2:15		35.6				
	3:15		14.0				
	4:15	-26.4	-23.1	-22.9			
	5:15	-12.8	-10.8	-11.3	12.7		
	6:15						
	7:15	-55.1					
	8:15						
	9:15						
	10:15	26.7	3.9	40.1			
	11:15		-30.7	-11.0	34.5		
	12:15	22.0	-7.7	3.4			
	13:15	-14.3	8.8	15.1	18.8	16.6	
	14:15		22.1				
	15:15	18.0	28.5	32.9			
	16:15		46.2	47.4			
	17:15	24.9	39.4	51.3			
	18:15	28.6	20.8				
	19:15			-11.4			
	20:15		-15.3	-8.2			
	21:15		-8.3	0.9			
	22:15		-33.9	-10.8			
	23:15						
25-Jul	0:15		18.1	41.7	-2.4		
	1:15		7.5	13.9	5.4		
	2:15		1.6	15.1			
	3:15		3.0	-8.3	11.3		
	4:15		5.3	-4.8	9.6		
	5:15			-8.5			
	6:15				111.8		
	7:15		36.6	37.3	-71.4		
	8:15	28.5	16.6	2.3			
	Average:	0	11	11	14	30	28
	Std Dev:	26	25	22	42	13	#DIV/0!
	RMS:	25	27	24	42	32	28
	Maximum:	29	97	51	112	42	28
	Minimum:	-55	-34	-23	-71	17	28

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Alpine
Date: July 23 - 25, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

High Mode of Operations

Overall Difference Radar Profiler - Sodar	Wind Speed (m/s)
Average:	-0.8
Maximum:	2.6
Minimum:	-4.3
Standard Deviation:	1.1
Root Mean Square (RMS):	1.4

		Wind Speed Difference (m/s, Radar Profiler - Sodar) Level (m)					
Date	Hour	152	253	354	455	556	657
07/23/97	14:15	0.1	-2.3	-2.2		-3.0	-1.5
	15:15	1.9	-0.3	-2.1	-1.3	0.0	
	16:15	0.1	-1.1	-1.2	-2.0		
	17:15	1.5	-0.4				
	18:15	-0.6	-2.0	-1.4			
	19:15						
	20:15			-1.3			
	21:15		-0.9				
	22:15		-0.8				
	23:15	-0.7	-1.1		-2.2		
07/24/97	0:15	-1.1	-2.5				
	1:15						
	2:15		-0.4				
	3:15		-1.6				
	4:15	0.6	-1.9	-1.2			
	5:15	0.0	-1.3	-1.1	-1.4		
	6:15						
	7:15	0.1					
	8:15						
	9:15		-1.3				
	10:15	0.5	-2.0	-0.6			
	11:15		-1.1	-0.9	-1.4		
	12:15	-0.6	-2.9	-1.7			
	13:15	0.1	-1.5	-2.1	-0.5	0.0	
	14:15		0.2				
	15:15	2.6	1.3	1.9			
	16:15		0.8	1.2			
	17:15	-0.9	-4.3	-1.6			
	18:15	-0.3	-1.9				
	19:15			-1.1			
	20:15		-1.3	-1.0			
	21:15		-0.5	-0.4			
	22:15		-0.6	-0.9			
	23:15						
25-Jul	0:15		-0.4	-0.5	-0.7		
	1:15		-0.6	-0.7	-0.6		
	2:15		-0.6	-1.0			
	3:15		-0.4	-1.1	-0.7		
	4:15		-0.7	-0.9	-0.8		
	5:15			-0.8			
	6:15				-1.1		
	7:15		-0.1	-2.2	-1.7		
	8:15	-0.7	-1.0	-1.2			
	Average:	0.2	-1.1	-1.0	-1.2	-1.0	-1.5
	Std Dev:	1.0	1.1	0.9	0.6	1.7	#DIV/0!
	RMS:	1.0	1.5	1.3	1.3	1.7	1.5
	Maximum:	2.6	1.3	1.9	-0.5	0.0	-1.5
	Minimum:	-1.1	-4.3	-2.2	-2.2	-3.0	-1.5

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Alpine
Date: July 23 - 25, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

Low Mode of Operation

Overall Difference Radar Profiler - Sodar	Wind Dir. (deg)
Average:	21
Maximum:	77
Minimum:	-104
Standard Deviation:	26
Root Mean Square (RMS):	33

		Wind Dir. Difference (deg, Radar Profiler - Sodar) Level (m)								
Date	Hour	152	210	268	326	384	442	500	558	616
7/23/98	14:15:00	17	-1	22	23	43		58	39	20
	15:15:00	47	33	67	77	61	76	72	69	
	16:15:00	15	7	39	37	39	19			
	17:15:00	26	27	33						
	18:15:00	32	34	23	16	5				
	19:15:00	14								
	20:15:00				21	8				
	21:15:00			13						
	22:15:00			22						
	23:15:00		-2	28			49			
	0:15:00	11	10	45						
	1:15:00									
	2:15:00			7		32				
	3:15:00		-23	-25						
	4:15:00	-15	-5	3	31					
	5:15:00	28	22	24	29	52	62			
	6:15:00									
	7:15:00	-38								
	8:15:00									
	9:15:00	26								
	10:15:00	50	41	16	12					
	11:15:00	50	42	-9	-13		11			
	12:15:00	43	32	25	9					
	13:15:00	36	24	46	57	66	53	37		
	14:15:00	15	17	15						
	15:15:00	-5	-25	15	24					
	16:15:00	22	29	48	57					
	17:15:00	12	30	36	31	38				
	18:15:00	30	37	30						
	19:15:00			11	2	10				
	20:15:00		3	3	7	-6				
	21:15:00		34	19	7					
	22:15:00			-2	-1	-18				
	23:15:00									
	0:15:00			18	22	58	33			
	1:15:00			8	32	5	5			
	2:15:00			-5	21					
	3:15:00		-18	8	0		-5			
	4:15:00		-4	-7	-6	19	13			
	5:15:00				28	23	-18			
	6:15:00					15	57			
	7:15:00			26	40	21	-104			
	8:15:00	-18	-12	-45	52	42				
	Average:	19	14	17	24	27	19	56	54	20
	Std Dev:	23	21	22	21	24	47	18	21	
	RMS:	29	25	27	32	35	49	58	56	20
	Maximum:	50	42	67	77	66	76	72	69	20
	Minimum:	-38	-25	-45	-13	-18	-104	37	39	20

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

7 hours difference between doppler and rwp data

Site: Alpine
Date: July 23 - 25, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

Low Mode of Operation

Overall Difference Radar Profiler - Sodar	Wind Speed (m/s)
Average:	-1.1
Maximum:	1.1
Minimum:	-5.6
Standard Deviation:	1.0
Root Mean Square (RMS):	1.5

		Wind Speed Difference (m/s, Radar Profiler - Sodar) Level (m)								
Date	Hour	152	210	268	326	384	442	500	558	616
7/23/98	14:15:00	-3.9	-2.8	-3.0	-3.6	-2.6		-3.3	-2.6	-2.1
	15:15:00	-1.3	-1.7	1.0	0.1	-2.8	-2.4	-1.5	-0.2	
	16:15:00	-2.1	-0.4	0.1	-0.4	-0.5	-1.8			
	17:15:00	-0.8	-0.1	-0.1						
	18:15:00	-2.7	-1.6	-1.1	-0.9	-0.9				
	19:15:00	-1.4								
	20:15:00				-1.6	-1.3				
	21:15:00			-1.3						
	22:15:00			-0.8						
	23:15:00		-1.0	-0.1			-1.3			
	0:15:00	0.1	-0.9	-1.5						
7/24/98	1:15:00									
7/24/98	2:15:00			-0.5		-0.9				
	3:15:00		-0.2	-0.4						
	4:15:00	0.2	-0.5	-1.4	-0.9					
	5:15:00	0.2	-1.1	-0.4	-0.8	-0.3	-0.2			
	6:15:00									
	7:15:00	-1.3								
	8:15:00									
	9:15:00	-1.1								
	10:15:00	-2.8	-2.1	-1.7	-0.9					
	11:15:00	-1.5	-0.4	-1.8	-0.4		-1.6			
	12:15:00	-2.5	-2.2	-1.9	-0.7					
	13:15:00	0.3	0.9	-0.1	-0.5	0.0	-0.3	-1.2		
	14:15:00	-1.2	-0.5	-1.1						
	15:15:00	-1.2	-1.2	-1.0	-0.4					
	16:15:00	0.3	1.1	1.0	0.4					
	17:15:00	-5.6	-4.4	-2.9	-1.0	-0.6				
	18:15:00	-2.2	-1.6	-1.0						
	19:15:00			-1.5	-2.0	-1.0				
	20:15:00		-1.4	-1.3	-0.6	-0.9				
	21:15:00		-0.4	-0.5	-0.6					
	22:15:00			-1.1	-1.1	0.5				
	23:15:00									
	0:15:00			-0.4	-1.1	-0.4	-0.5			
	1:15:00			-0.4	-0.5	-1.2	-0.8			
7/25/98	2:15:00			-0.8	-0.9					
	3:15:00		-0.7	-0.7	-0.8		-1.5			
	4:15:00		-0.7	-0.8	-0.9	-0.6	-0.7			
	5:15:00				-1.1	-0.7	-0.6			
	6:15:00					-0.5	-1.0			
	7:15:00			-1.2	-2.2	-2.9	-1.4			
	8:15:00	-1.1	-0.9	-1.8	-0.8	-1.1				
	Average:	-1.5	-1.0	-0.9	-0.9	-1.0	-1.1	-2.0	-1.4	-2.1
	Std Dev:	1.5	1.1	0.9	0.8	0.9	0.7	1.1	1.7	
	RMS:	2.1	1.5	1.3	1.2	1.3	1.3	2.2	1.8	2.1
	Maximum:	0.3	1.1	1.0	0.4	0.5	-0.2	-1.2	-0.2	-2.1
	Minimum:	-5.6	-4.4	-3.0	-3.6	-2.9	-2.4	-3.3	-2.6	-2.1

SCOS97-NARSTO Audit Report
Radar Profiler - Rawinsonde Wind Comparison

Site: Alpine
Date: July 23-25, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Rawinsonde: VIZ Model W-9000

High Mode Overall Difference RWP - Rawinsonde	Wind Speed (m/s)
Average:	-9.0
Maximum:	0.9
Minimum:	-21.3
Standard Deviation:	7.6
Root Mean Square:	11.7

WS Difference (m/s)		
	7/24/97	
Altitude	1200	
138		
239		
340		
441		
542		
643	1.5	
744	1.4	
845		
946	0.9	
1047	0.5	
1148		
1249		
1350		
1451		
1552	-0.1	
1653	-0.2	
1754	-1.7	
1855	-1.4	
1956	-5.1	
2057	-5.1	
2158	-6.5	
2259	-10.3	
2360	-15.7	
2461	-19.3	
2562	-19.6	
2663	-19.7	
2764	-6.4	
2865	-2.5	
2966	-3.4	
3067	-8.2	
3168	-8.6	
3269	-9.8	
3370	-7.8	
3471	-14.9	
3572	-18.4	
3673	-21.3	
3774	-21.0	
Average:	-8.3	
Maximum:	1.5	
Minimum:	-21.3	
Std Dev:	7.8	
RMS:	11.2	

Comments:

High Mode Overall Difference RWP - Rawinsonde	Wind Direction (deg)
Average:	-17
Maximum:	47
Minimum:	-85
Standard Deviation:	30
Root Mean Square:	34

WD Difference (deg)		
	7/24/97	
Altitude	1200	
138		
239		
340		
441		
542		
643	23	
744	19	
845		
946	12	
1047	47	
1148		
1249		
1350		
1451		
1552	1	
1653	-2	
1754	-4	
1855	-31	
1956	-44	
2057	-50	
2158	-45	
2259	-31	
2360	-38	
2461	-71	
2562	-85	
2663	-62	
2764	-9	
2865	4	
2966	8	
3067	-1	
3168	-30	
3269	0	
3370	7	
3471	5	
3572	2	
3673	-13	
3774	-4	
Average:	-15	
Maximum:	47	
Minimum:	-85	
Std Dev:	31	
RMS:	34	

Low Mode Overall Difference RWP - Rawinsonde	Wind Speed (m/s)
Average:	-2.0
Maximum:	1.4
Minimum:	-8.3
Standard Deviation:	3.3
Root Mean Square:	3.8

WS Difference (m/s)		
	7/24/97	
Altitude	1200	
138	1.4	
196		
254	0.1	
312	0.0	
370		
428		
486		
544		
602	1.2	
660	1.1	
718	1.3	
776	0.6	
834		
892		
950	0.4	
1008	0.1	
1066	-0.7	
1124		
1182		
1240		
1298		
1356		
1414		
1472		
1530		
1588	-1.2	
1646		
1704		
1762	-0.7	
1820	-2.1	
1878	-3.5	
1936	-5.8	
1994	-8.3	
2052	-7.4	
2110	-5.9	
2168	-6.9	
2226	-4.2	
Average:	-2.0	
Maximum:	1.4	
Minimum:	-8.3	
Std Dev:	3.3	
RMS:	3.8	

Comments:

Low Mode Overall Difference RWP - Rawinsonde	Wind Direction (deg)
Average:	-10
Maximum:	93
Minimum:	-55
Standard Deviation:	38
Root Mean Square:	38

WD Difference (deg)		
	7/24/97	
Altitude	1200	
138	93	
196		
254	41	
312	21	
370		
428		
486		
544		
602	40	
660	4	
718	29	
776	6	
834		
892		
950	-24	
1008	-20	
1066	-29	
1124		
1182		
1240		
1298		
1356		
1414		
1472		
1530		
1588	-23	
1646		
1704		
1762	-19	
1820	-40	
1878	-39	
1936	-45	
1994	-55	
2052	-48	
2110	-36	
2168	-29	
2226	-21	
Average:	-10	
Maximum:	93	
Minimum:	-55	
Std Dev:	38	
RMS:	38	

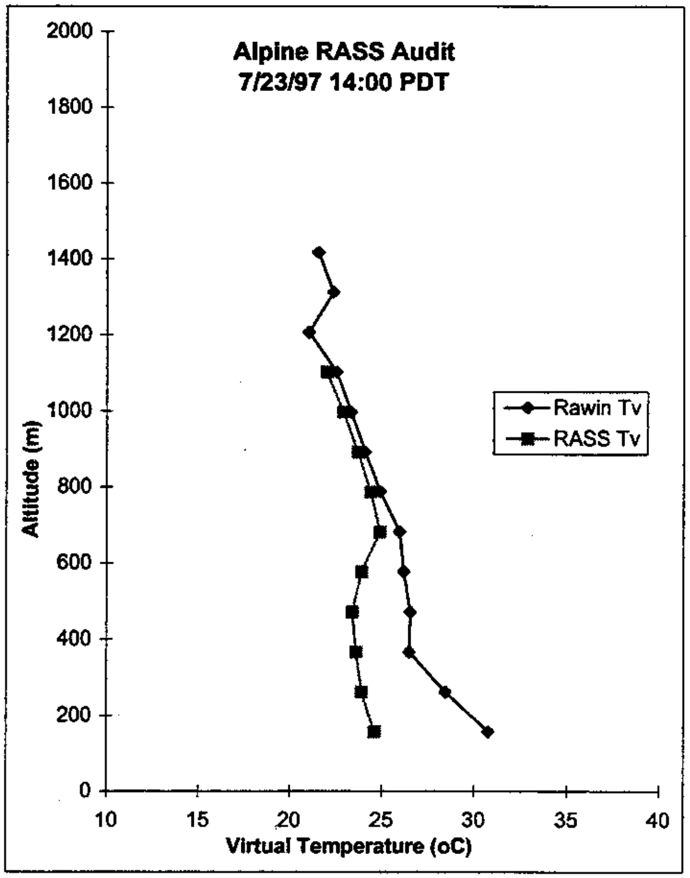
AeroVironment Environmental Services inc.
Audit Report
RASS Summary

Date: 7/23/97
Start: 14:01 PDT
End: 14:26 PDT
Key Person: Cat Russell
Auditor: Alex Barnett

Instrument: ETL 915-32-6

Site Name: Alpine
Project: Upper-Air Audits
Measurement Org.: NOAA

RASS Alt (m)	RASS Tv (oC)	Airsonde Tv (oC)	Diff. (oC)
1417	9999	21.6	NA
1312	9999	22.4	NA
1207	9999	21.0	NA
1102	22.0	22.5	-0.5
997	22.9	23.3	-0.4
892	23.7	24.1	-0.4
787	24.4	24.9	-0.5
682	24.9	26.0	-1.1
577	23.9	26.2	-2.3
472	23.4	26.5	-3.1
367	23.6	26.5	-2.9
262	23.9	28.5	-4.6
157	24.6	30.8	-6.2



Results Summary

Min. Diff. :	-6.2
Max Diff. :	-0.4
Ave. Diff. :	-2.2
Std. Dev. :	2.0

Audit Criteria: +/- 1oC

Audit Sonde Data

Sonde Serial # :	2000644
Td offset (oC):	-1.1
RH offset (%)	-5.0
Sonde Pressure (mb):	962.2
Ref Pressure (mb):	961.9
Difference (mb):	0.3

Comments: The sonde data was vertically averaged to match the RASS levels.
The sonde Td and Tw offsets were included in the Tv calculations.

AZUSA (AZU)

SCOS97-NARSTO AUDIT SUMMARY
RADAR PROFILER/RASS/SODAR/SURFACE METEOROLOGY

Site:	Azusa (AZS)
Audit Dates:	July 13, 1997
Instrumentation Audited:	Sodar, Surface Meteorology
Key Person(s):	Scott Abbott
Auditor:	Robert A. Baxter RAB

The purpose of this summary is to provide a preliminary report of any significant audit findings. The site is operated by NOAA/ETL. Key elements of the audit are identified below.

AUDIT INSTRUMENTATION

No problems were encountered with the audit instrumentation.

SITE CHARACTERISTICS

The site is located at the mouth of the San Gabriel Canyon with the exposure primarily showing the up/down canyon flow. The site is noisy for operation of a sodar with the adjacent road and a shooting range nearby.

SYSTEM AUDIT NOTES

1. The temperature and relative humidity sensors are in a non-aspirated radiation shield. The data should therefore not be used in dispersion modeling.
2. There are no signs warning of potential audio frequency radiation. Appropriate signage is recommended.
3. The overall site is not secure. While there is a "lock" on the gate entering the property, it can be easily removed or people may walk in. Cables, the sodar antennas and the data logger and meteorological system are open to vandalism. A fence around the tower and the sodar antennas is recommended.
4. The site is visited approximately once every four weeks. There is a potential for problems to occur such as propeller failure or vandalism that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

5. The site UPS was activating frequently with the cycling of the air conditioner. While this helps to protect the equipment at the site, the frequent cycling of the UPS batteries may tend to degrade them. The condition of the batteries should be monitored to assure the system does not go down. The reason for the cycling of the UPS should also be explored and corrected.

POTENTIAL ACTIVE NOISE SOURCES

There are a couple primary sources of noise. The most significant is traffic along the adjacent road. The second source of noise is the loud frequent gun shots from the nearby shooting range. These noise sources will limit the vertical range of the sodar.

POTENTIAL PASSIVE NOISE SOURCES

The site is in a canyon with possible reflections from the canyon walls. During the audit, reflections could be heard from both of the transmit beams. This will contaminate the data and potentially bias the component wind values low.

ANTENNA LEVEL AND ALIGNMENT

The orientation of both of the antenna beams were found to be outside the audit criteria of ±2°. The audit orientation was verified by the site operator and the system settings corrected.

SODAR PERFORMANCE AUDIT (APT)

Similar to the Santa Clarita audit, results of the Acoustic Pulse Transponder (APT) audit showed the sodar responded within criteria for the timing and altitude calculations. However, problems were found with the wind speed calculations. The calculation of the horizontal wind speed along the beam direction was found to differ from the audit input by up to 0.5 m/s. When combined into a resultant wind speed, this difference could be over 0.7 m/s. It is suspected the reason for the difference lies in sodar resolution in measuring the Doppler shift frequency of returned echoes. The current operational mode has a fairly broad bin range that translates into an effective resolution of component speeds of about 0.9 m/s. This provides a resultant resolution of about 1.2 m/s. Consideration should be given to using a finer resolution in the bin spacing for the calculation of the radial speeds.

The second problem with the sodar was found in the calculation of the U and V wind components from the radial component speeds. Recognizing the identified resolution problem above (~0.9 m/s wind speed gates), the speeds along the radial directions were calculated correctly. However, errors were found in the calculation that takes the radial speeds and converts them to U and V components. In the tests performed, the errors resulted in U and V speeds that differed significantly from the audit speeds, but directions that were accurate. The calculation errors need to be corrected and affected data reprocessed from the radial values. Word was received from NOAA on July 14 that the U and V calculation algorithm was fixed and will be installed at both the Santa Clarita and Azusa sites on July 14.

Given the zenith angle of the sodar at 19°, the horizontal components should be corrected for vertical velocity. Since vertical velocity is not measured with the sodar (it is only a two-axis sodar), there will be inaccuracies in the measured wind data even after the above problems with the calculations and resolution are resolved.

RASS PERFORMANCE AUDIT

Not applicable (no RASS at site).

SODAR DATA INTERNAL CONSISTENCY

The sodar data over a several day period were reviewed. Serious reflections could be seen in both beams from about 100 to 300 meters. This is shown by depressions in the component values to near zero speeds, while above and below this range much higher values were observed. Much of the data show the reflections with the primary time periods affected during the nighttime hours. Additional side lobe beam suppression or appropriate clutter rejection algorithms need to be implemented. In the interim it is recommended the spectral data be saved so that there is some possibility of later reprocessing of the data in an attempt to reject the reflected signals.

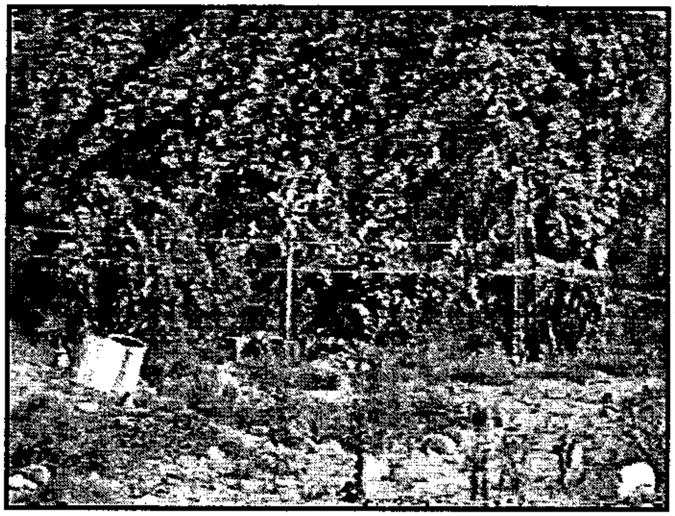
SURFACE METEOROLOGY PERFORMANCE AUDIT

All sensors are scanned every 10 seconds with five minute averages recorded. A summary of significant audit findings is provided below:

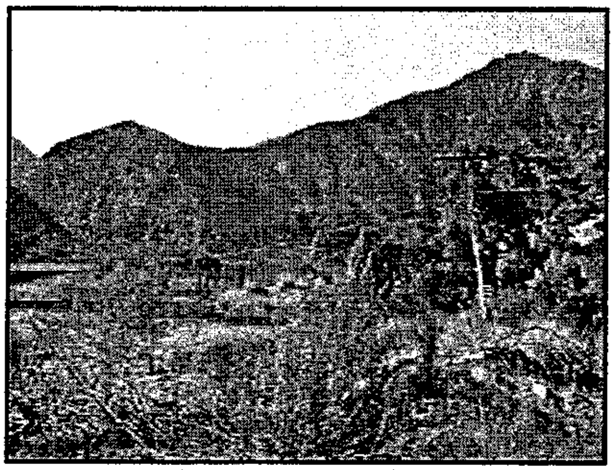
1. Due to the wiring and the method of sensor installation, the wind direction sensor was not removed from the system to perform the torque tests.
2. Wind data recorded include scalar wind speed and resultant vector wind direction.
3. The wind direction vane orientation was found to be outside criteria causing directions to read about 10° high. The orientation was corrected during the audit.
4. The relative humidity sensor equivalent dew point value differed from the audit value by 3.0° C, which is outside the audit criteria of 1.5° C. The difference was verified through an additional comparison. The sensor should be repaired or replaced.

5. The wind speed sensor failed the starting threshold criteria of 0.5 m/s. Replacement of the bearings should be considered.

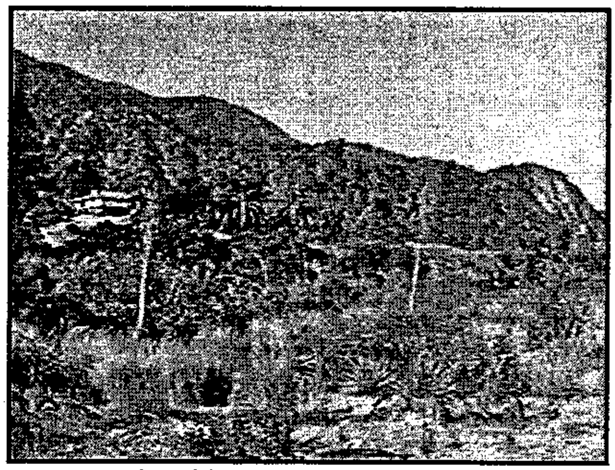
Azusa Site
Photographs



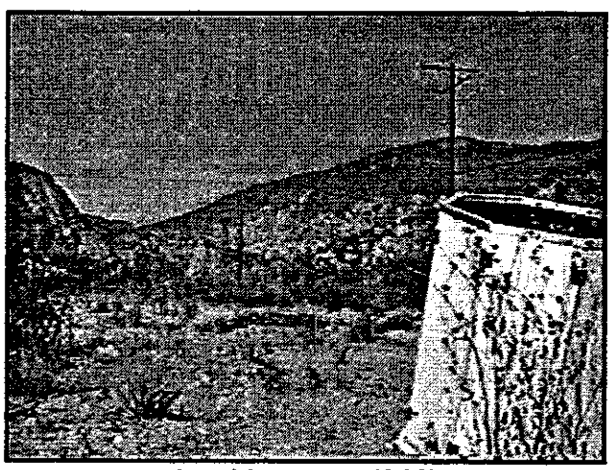
View of Site



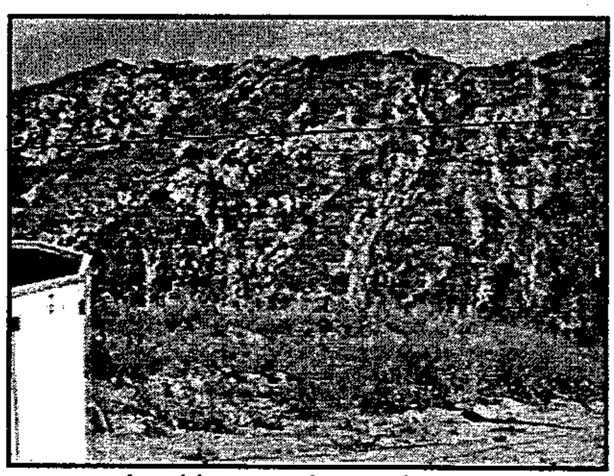
Looking north (0°)



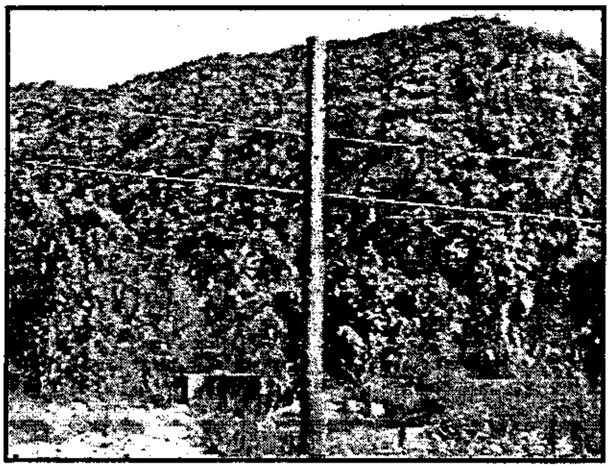
Looking northeast (45°)



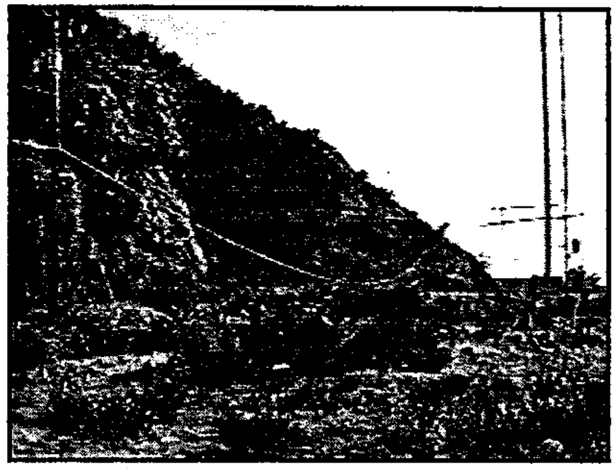
Looking east (90°)



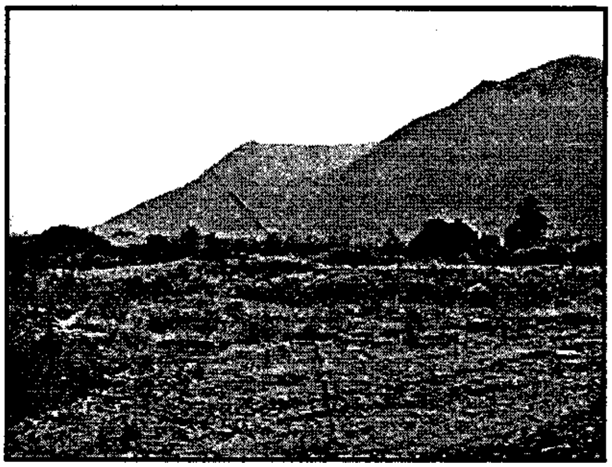
Looking southeast (135°)



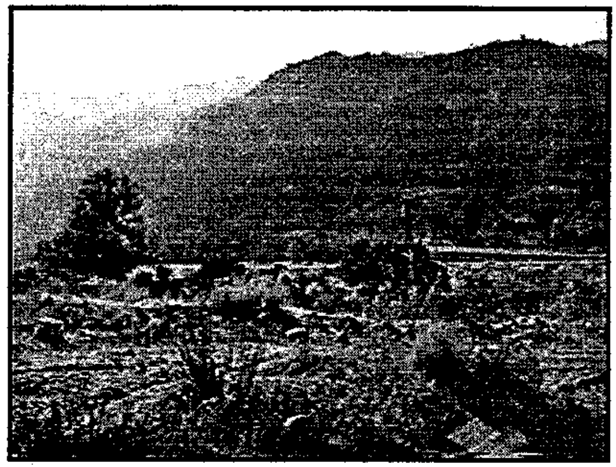
Looking south (180°)



Looking southwest (225°)



Looking west (270°)



Looking northwest (315°)

SCOS97-NARSTO

SITING AND SYSTEM AUDIT FORM

MEASUREMENTS GROUP:	NOAA/ETL
SITE NAME AND LOCATION:	Azusa (AZS)
AUDITOR:	Robert A. Baxter
DATE:	July 13, 1997
KEY PERSON:	Scott Abbott

I. Observables

A. Meteorological

Observable	Method	Manufacturer	Model	Serial #	Range
Wind Speed/ Wind Direction	Sodar	NOAA/ETL	NA	96343316	15 - 395 m in 20 m inc.
	Audio amplifier	Crown	460 CSL	NA	NA
10 m Wind Speed	Propeller	RM Young	Wind Monitor	442502	0 - 50 m/s
10 m Wind Direction	Vane	RM Young	Wind Monitor	442502	0 - 355 degrees
2 m ambient temperature	RTD	CSI	207	3147	-35 - 50 °C
2 m relative humidity	Solid State	CSI	207	3147	0 - 100%
Data Logging	Digital	CSI	CR10	NA	NA

Comments:

Are there any required variables which are not measured?	No
Are there any methods and/or equipment that are not in the SOP?	Yes
Do any operating ranges differ from those specified in the SOP?	See Below
Are there any significant differences between instrumentation on site and the SOP?	No

Comments: Station has solar and net radiation in addition to pressure being monitored.

B. Auxiliary Equipment

Type	Manufacturer	Model	Serial #	Last Calibration Date
Communications computer	NOAA	NA	NA	NA
Jaz drive	NA	NA	NA	NA

Comments: The site UPS was activating frequently with the cycling of the air conditioner. While this helps to protect the equipment at the site, the frequent cycling of the UPS batteries may tend to degrade them. The condition of the batteries should be monitored to assure the system does not go down. The reason for the cycling of the UPS should also be explored and corrected.

B. Station Check Equipment

Type	Manufacturer	Model	Serial #	Comments
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA

Comments: Station check equipment is carried with the NOAA engineers and not left on site.

II. Sensor/Probe height and Exposure

A. Radar Profiler/RASS/Sodar

Variable	Value	Meet SOP (Yes/No)
1. Orientation (two axis sodar)	Sodar – 2.5°, 4.5° 10 m Vane – 10°	No No
2. Level (level and inclination of the horiz ant)	SW trans. – 0.4° SW dish – 0.5° NW trans – 0.3° NW dish – 0.2°	Yes
3. Distance to closest obstruction	See below	See below
4. Distance to closest active noise source	See below	See below

Comments: 1. The orientation of both sodar antennas and the wind vane were outside of audit criteria. The orientations were corrected during the audit.

3. There are numerous objects that cause reflections in the sodar data. See the vista report for more details.

4. There is several sources of noise. The most significant is background traffic which will tend to decrease the altitude capabilities of the sodar. Other sources include the adjacent shooting range in the direction of one of the antennas. See the noise report for more details.

B. Surface Meteorology

Variable	Value	Meet SOP (Yes/No)
1. Height of wind sensors above ground	10 m	Yes
2. Distance to nearest obstacle	20 m	see below
3. Is separation at least 10x obst. height?	No	Yes
4. Are instruments on a rooftop?	No	NA
5. Is exposure 1.5x height above roof	NA	NA
6. Arc of unrestricted flow	355°	Yes
7. Height of temp sensor above ground	2 m	Yes
8. Distance of temp sensor from obst.	NA	Yes
9. Height of DP/RH sensor above ground	2 m	Yes
10. Distance of DP/RH sensor from obst.	NA	Yes
11. Are the distances 4x the obst. height?	Yes	Yes
12. Is the sensor shielded or aspirated?	Shielded	Yes
13. Are the T/DP/RH abv representative terrain?	Yes	Yes
14. Are there significant differences between on-site equipment and the monitoring plan?	No	Yes

Comments: Wind data recorded include scalar wind speed and resultant vector wind direction. All surface sensors are scanned every 10 seconds with five minute averages recorded. The base of the meteorological tower is loose and can pivot. This will cause inaccuracies in the reported wind directions.

2, 3. A tree to the south provides a minimal blockage to the flow. The height of the tree is about 10 meters. The site is in a canyon that will channel the flow – southwest during the day and northeast (drainage flow) during the night.

12. The temperature and relative humidity sensors are in a non-aspirated radiation shield. The data should therefore not be used in dispersion modeling.

III. Operation

A. Radar Profiler, RASS and Surface Meteorology

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is all instrumentation operational?	Yes	Yes
2. Are all cables secure?	Yes	Yes
3. Are all cables connected according to SOPs or instrument manuals?	Yes	Yes
4. Are connections clean and rust free?	Yes	Yes
5. Are serial numbers available?	Yes	NA
6. Do data system times agree with audit times. If not, what is the deviation?	Yes	Yes
7. Is the printer functional?	No	Not used
8. Overall, is the site maintenance sufficient to meet the DQOs?	See below	Yes

Comments: 8. The site is visited approximately every four weeks for routine maintenance. There is a potential for problems to occur such as propeller failure or sodar antenna movement that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

B. Radar Profiler/RASS/Sodar Settings

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Software version	DOPSPD10	Yes
2. Pulse length	70 ms	Yes
3. Time zone	GMT	Yes
4. Wind data consensus	58 min	Yes

Comments:

	Horizontal Wind
First Gate	15 m
Last Gate	395 m
Spacing	20 m

Comments:

B. Auxiliary Equipment

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is the A/C unit sufficient to maintain temperatures in the range specified in the SOPs?	Yes	Yes
2. Is the site temperature recorded?	No	See below
3. Is the site temperature maintained at 20-30°C?	Yes	Yes
4. Is the site kept clean enough to allow operation of all instruments as specified in the SOP?	Yes	Yes
5. Does the modem work?	Yes	Yes
6. Does the telephone work?	Yes	Yes
7. Is the site secure?	No	See below
8. Overall, is the auxiliary equipment maintenance sufficient to meet the DQOs?	Yes	Yes

Comments: 2. There is no measurement of the shelter temperature. It was indicated that the temperature is not critical for the system operation.

7. The overall site is not secure. While there is a "lock" on the gate entering the property, it can be easily removed or people may walk in. Cables, the sodar antennas and the data logger and meteorological system are open to vandalism. A fence around the tower and the sodar antennas is recommended. Additionally, there are no signs warning of potential audio frequency radiation. Appropriate signage is recommended.

C. Station Check Procedures and Documentation

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Are the station logs present?	Yes	Yes
2. Are the station logs up to date?	Yes	Yes
3. Do station logs contain details as required by the SOPs?	Yes	Yes
4. Are routine checklists used?	Yes	Yes
5. Do the routine checklists contain details as required by the SOPs?	Yes	Yes
6. Are the calibration forms present?	No	See below
7. Do the calibration forms contain details as required by the SOPs?	NA	NA
8. Are the SOPs present?	Yes	Yes
9. Are the instrument manuals present?	No	See below
10. Do the SOPs include quality control tests?	Yes	Yes
11. If quality control tests are included then how are the results of the tests documented?	In site checklist	Yes
12. Has the site technician undergone training as specified in the SOPs?	See Below	Yes
13. Is the site visited twice weekly?	No	See below
14. Does the site technician understand the SOPs?	Yes	Yes (see below)

Comments: 6. Calibration records are maintained at NOAA/ETL

9. Manuals are maintained at NOAA/ETL. If repairs are needed then the engineer brings the manuals to the site.

12. There are no site technicians. During most times there is an engineer in the field that travels from site to site for the checks and needed maintenance.

13, 14. The site is visited approximately every four weeks for routine maintenance. In between the visits the data are polled and reviewed on a regular basis. Data are retrieved hourly and reviewed daily. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

D. Chain of Custody

1. Review paper work for chain of custody from field to data processing.	Comments: The site is inspected every four weeks with all data archived at that time. Paperwork older than about two months is forwarded to NOAA/ETL.
2. How are data stored?	Data are stored locally on the computer hard drive with consensus files and surface data transferred on an hourly basis to the communications computer. The files on the communications computer are downloaded to NOAA/ETL on an hourly basis and then erased. Moments data are not stored.
3. How often are the data backed up?	Files are copied to an optical drive on an hourly basis. These data are recovered on a monthly basis when the engineer visits the site.

Comments: 1. It is recommended a carbonless or similar form be used for the site checklist. In that manner a copy could be left at the site while the original can be sent back to NOAA/ETL.

V. Preventive Maintenance

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is preventive maintenance discussed in the SOPs?	Yes	Yes
2. Is preventive maintenance being performed?	Yes	Yes
3. Are field operators given special training in preventive maintenance?	Yes	Yes
4. Are tools and spare parts adequate at the site to meet the requirements of the SOPs?	See below	Yes
5. Are maintenance logs maintained and reviewed?	Yes	Yes

Comments: 4. Tools and spares are carried with the field engineers. Some spares such as RASS transducers are stored at various sites throughout the NOAA/ETL network.

VI. Overall Comments

Question	Response (Yes/No)	Meet Work Plan (Yes/No)
1. Overall, is the station maintenance sufficient to meet the DQOs?	Yes	Yes
2. Does the siting meet the program objectives?	Yes	Yes
3. Overall, is the site technician trained as specified in the SOPs?	Yes	Yes
4. Does the QC program appear to be working?	Yes	Yes
5. Overall, does the meteorological data look reasonable?	Yes	See below
6. Overall, does the data appear to meet the program objectives?	Yes	Yes

Comments: 5. The sodar data over a several day period were reviewed. Serious reflections could be seen in both beams from about 100 to 300 meters. This is shown by depressions in the component values to near zero speeds, while above and below this range much higher values were observed. Much of the data show the reflections with the primary time periods affected during the nighttime hours. Additional side lobe beam suppression or appropriate clutter rejection algorithms need to be implemented. In the interim it is recommended the spectral data be saved so that there is some possibility of later reprocessing of the data in an attempt to reject the reflected signals.

SCOS97-NARSTO AUDIT RECORD
VISTA, ORIENTATION AND LEVEL

Site Name:	Azusa	Instrument:	NOAA ETL Sodar
Date:	July 13, 1997	Sodar Computer:	96343316
Time:	1500 PDT	Interface s/n:	NA
Measurements group:	NOAA/ETL	Software version:	DOPSOD10
Key contact:	Scott Abbott	System antenna angles:	232°, 307°
Audited by:	Bob Baxter	Measured orientation:	229.5°, 302.5°
Site longitude:	117° 54.34' W	Orientation difference:	2.5°, 4.5°
Site latitude:	34° 09.65' N	Antenna inclination diff.:	SW trans – 0.4° SW dish – 0.5° NW trans – 0.3° NW dish – 0.2°
Site elevation:	NA	Horizontal beam angle:	19° ind.
Magnetic declination:	15° (appx)	Beam directions:	232°, 307° ind.

Mag. Az. Angle (deg)	True Az. Angle (deg)	Terrain El. Angle (deg)	Features and Distances
0	15	20	House at ~350 m, mountains at ~800 m.
30	45	16	Mountains at ~1 to 1.5 km.
60	75	26	Electrical pole at ~20 m, mountains at ~800 m.
90	105	45	Adjacent power lines, mountains and roadway at ~400 m. The 45° refers to the angle to the power lines.
120	135	45	Adjacent power lines, trees at ~50 m, mountains at ~350 m. The 45° refers to the angle to the power lines.
150	165	45	Adjacent power lines, trees at ~50 m, mountains at ~300 m. The 45° refers to the angle to the power lines.
180	195	32	Adjacent power lines, trees at ~50 m, mountains at ~300 m.
210	225	20	Pole at ~6 m, electrical pole at ~10 m, mountains at > 2km.
240	255	25	Meteorological tower (25°), mountains at ~2 km.
270	285	14	Tree at ~75 m, mountains at ~1 km. The 14° refers to the mountains, the tree is at 8°.
300	315	18	Palm tree at ~ 75 m, mountains at ~800 m.
330	345	15	Water tank at ~100 m, mountains at ~1 km.

Comments: The site is located at the mouth of the San Gabriel Canyon with the exposure primarily showing the up/down canyon flow. The site is noisy for operation of a sodar with the adjacent road and a shooting range nearby. Echoes can be heard throughout the canyon.

SCOS97-NARSTO AUDIT RECORD
AMBIENT NOISE

Site Name:	Azusa	Meter Manufacturer:	Realistic
Date:	July 13, 1997	Model Number:	33-2055
Time:	1320 PDT	Averaging:	Slow
Measurements group:	NOAA/ETL	Weighting Scale:	A
Key contact:	Scott Abbott	Time Averaging (sec):	60
Audited by:	Bob Baxter	Meter Range (dB)	50 - 70

Mag. Az. Angle (deg)	True Az. Angle (deg)	Noise Min (dB)	Noise Max (dB)	Noise Avg (dB)	Comments
NA	0	<50	65	<50	Hear shots from range and traffic noise
NA	90	<50	>70	52	Hear wind in trees and road noise
NA	180	<50	>70	53	
NA	270	<50	>70	54	Some shots but not as many as usual. This is in the direction of the shooting range.

"Listen Only" Results: Response showed no active noise sources in sodar spectrum during the one hour period of the "listen only" test.

Comments: There is significant noise in the direction of the antenna beams. The noise comes from the shooting range and the adjacent road.

SCOS97-NARSTO AUDIT RECORD
HORIZONTAL WIND SPEED

Date: July 13, 1997	Site name: Azusa (AZS)
Start: 1510 PDT	Project: SCOS97-NARSTO
Finish: 1600 PDT	Operator: NOAA/ETL
Auditor: Bob Baxter	Site Operator: Scott Abbott

Sensor Mfg: R.M. Young	Model: Wind Monitor
Sensor s/n: 442502	Sensor Ht.: 10 m
K factor: 2.4	Starting torque: 0.8 gm-cm
Range: 0 - 50 m/s	Starting Threshold: 0.58 m/s
Logger: CR10	
Logger s/n: NA	
Prop s/n: 47644	

Last calibration date: unknown

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

WS Calibration Point	M/S Input	M/S Chart	M/S Diff. Chart	M/S DAS	M/S Diff. DAS	% Diff. DAS
1	0.0	#N/A	#N/A	0.0	0.0	#N/A
2	2.5	#N/A	#N/A	2.5	0.0	#N/A
3	7.4	#N/A	#N/A	7.4	0.0	0.0
4	12.3	#N/A	#N/A	12.3	0.0	0.0
5	22.1	#N/A	#N/A	22.1	0.0	0.0
6	34.3	#N/A	#N/A	34.3	0.0	0.0

Pass/Fail Criteria: +/-.25 m/s; ws <= 5 m/s
+/- 5%; ws > 5 m/s

Comments: Sensor passed speed criteria.
Sensor failed the starting threshold criteria. The wind speed bearings need replacement.

SCOS97-NARSTO AUDIT RECORD
HORIZONTAL WIND DIRECTION

Date: July 13, 1997
Start: 1345 PDT
Finish: 1545 PDT
Auditor: Bob Baxter

Site name: Azusa (AZS)
Project: SCOS97-NARSTO
Operator: NOAA/ETL
Site Operator: Scott Abbott

Sensor Mfg: R.M. Young
Serial No.: 442502
K Factor: NA
Range: 0 - 355 deg
Logger: CR10
Logger s/n: NA

Model: Wind Monitor
Sensor Ht.: 10 m
Starting torque: NA gm-cm
Starting threshold: #DIV/0! M/S

Last calibration date: unknown

Crossarm: 176.5 deg true

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

WD Audit Point	Degrees Reference	Corrected Degrees Reference	Degrees Chart	Diff. Chart Deg.	Degrees DAS	Linearity	Total Diff DAS Deg.
Orientation	176.5				186.4		9.9
1	45	37.9	#N/A	#N/A	49.8	1.2	11.9
2	90	82.9	#N/A	#N/A	94.0	0.4	11.1
3	135	127.9	#N/A	#N/A	140.3	1.7	12.4
4	180	172.9	#N/A	#N/A	182.8	-0.8	9.9
5	225	217.9	#N/A	#N/A	227.8	-0.8	9.9
6	270	262.9	#N/A	#N/A	272.5	-1.1	9.6
7	315	307.9	#N/A	#N/A	317.8	-0.8	9.9
Avg difference:							10.7
Maximum difference:						1.7	12.4

Criteria: Orientation: +/- 2 degrees
Linearity: +/- 3 degrees
Maximum Difference: +/- 5 degrees

Comments: Sensor passed linearity test but failed orientation criteria. The wind direction threshold could not be checked without removing the sensor from the tower. Due to the method of installation it was decided not to remove the sensor.
Note the "Corrected Degrees Reference" includes the offset for the arbitrary markings on the sensor shaft.
The sensor orientation was corrected following the audit.

SCOS97-NARSTO AUDIT RECORD
AMBIENT TEMPERATURE

Date: July 13, 1997
Start: 1235 PDT
Finish: 1259 PDT
Auditor: Bob Baxter

Site name: Azusa (AZS)
Project: SCOS97-NARSTO
Operator: NOAA/ETL
Site Operator: Scott Abbott

Sensor Mfg: CSI
Serial No.: 3147
Range: -35 - 50 Deg C

Model: 207
Sensor Ht.: 2 m

Logger: CR10
Logger s/n: NA

Last calibration date: unknown

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Temperature Audit Point	Deg C Input	Deg C Chart	Deg C Diff. Chart	Deg C DAS	Deg C Diff. DAS
1	3.2	#N/A	#N/A	3.4	0.2
2	21.5	#N/A	#N/A	21.7	0.2
3	40.4	#N/A	#N/A	40.9	0.5

Criteria: +/- 0.5 degree Celsius

Comments: The sensor was immersed in a waterproof sheath.
Sensor passed criteria.
Note the sensor is in a naturally aspirated shield.

SCOS97-NARSTO AUDIT RECORD
RELATIVE HUMIDITY (DEW POINT TEMPERATURE)

Date: July 13, 1997
Start: 1200 PDT
Finish: 1212 PDT
Auditor: Bob Baxter

Site name: Azusa (AZS)
Project: SCOS97-NARSTO
Operator: NOAA/ETL
Site Operator: Scott Abbott

Sensor Mfg: CSI
Serial No.: 3147
Range: 0 - 100 Percent

Model: 207
Sensor Ht.: 2 m

Logger: CR10
Logger s/n: NA

Last calibration date: unknown

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

RH/DP Audit Point	%RH Input	Deg C Input	% RH Chart	Deg C Chart	Deg C Diff. Chart	%RH DAS	Deg C DAS	Deg C Diff. DAS
1	54.0	15.4	#N/A	#N/A	#N/A	65.3	18.4	3.0

Criteria: +/- 1.5 degree Celsius

Comments: Sensor failed criteria.
Retest was performed at 1230 PDT with similar results.
Sensor is in a naturally aspirated shield.

SCOS97-NARSTO AUDIT RECORD
APT -- DOPPLER SODAR

Date: 7/13/97
Start: 1115 PDT
Finish: 1300 PDT
Auditor: Bob Baxter

Site name: Azusa
Project: SCOS97-NARSTO
Operator: NOAA/ETL
Site Operator: Scott Abbott

Sensor Mfg: NOAA/ETL
Serial No.: 96343316
Sodar software ver.: DOPSOD10
Range: 15 - 395 m
Avg. Int.: 60 minute
Antenna angles: 232°, 307°
Transp. mode: Continuous tone, two frequency wind shear
APT software ver.: 1.06

Model: NA
Frequency: 1710 Hz
Measured antenna angles: 229.5°, 302.5°
Zenith angle: 19°, 19°
Mag. Declination: NA
Last cal. date: NA
APT File: 07131116.APT
Antenna level: SW -- +0.4°
NW -- +0.3°

		Horizontal												Vertical		
		APT Input		Sodar Output		Radial Diff.		APT Res In		Sodar Res Out		Result. Diff.		Audit	Sodar	
Time (PDT)	Level	SW (m/s)	NW (m/s)	SW (m/s)	NW (m/s)	SW (m/s)	NW (m/s)	Speed (m/s)	Dir (deg)	Speed (m/s)	Dir (deg)	Speed (m/s)	Dir (deg)	Input (m/s)	Output (m/s)	Diff (m/s)
1116 to 1200	1	-5.95	-5.95	-6.15	-6.15	-0.20	-0.20	9.44	270	7.75	270	-1.69	0	NA	NA	NA
	2	11.82	11.82	12.29	12.29	0.47	0.47	18.75	90	15.49	90	-3.26	0	NA	NA	NA
1200 to 1300	1	-5.95	-5.95	-6.15	-6.15	-0.20	-0.20	9.44	270	7.75	270	-1.69	0	NA	NA	NA
	2	11.82	11.82	12.29	12.29	0.47	0.47	18.75	90	15.49	90	-3.26	0	NA	NA	NA
Avg Difference (level 1)						-0.20	-0.20					-1.69	0			0.00
Avg Difference (level 2)						0.47	0.47					-3.26	0			0.00
Max Difference (level 1)						-0.20	-0.20					-1.69	0			0.00
Max Difference (level 2)						0.47	0.47					-3.26	0			0.00

Audit Criteria (component): ±0.2 m/s
Audit Criteria (resultant): ±0.5 m/s, ±5°
Audit Criteria (alt. transition): ±1 range gate (20 m)

APT information

Transponding pulse length (ms):	Cont.
Transponder delay from pulse detection (ms):	0
Number of reporting altitudes:	2
Anticipated horiz. reporting alt. for transition level 1 (m):	161
Anticipated horiz. reporting alt. for transition level 2 (m):	354
Sodar transmit frequency (Hz):	1710
Assumed speed of sound (m/s):	340

APT Frequency Delay (ms)	APT Frequency (Hz)	Analysis Levels (m)	Measured Transition (m)
1000	1729.5	35 - 155	175
2200	1671.3	255 - 355	355

Comments

The SW and NW radial values from the sodar were compared to the APT inputs.
The response used six frequencies to gradually transition through the simulated wind shear. This transition occurred over a period of 300 ms.

Results of the performance audit showed the sodar responded within criteria for the timing and altitude calculations. However, problems were found with the wind speed calculations. The calculation of the horizontal wind speed along the beam direction was found to differ from the audit input by up to 0.5 m/s. When combined into a resultant wind speed, this difference could be over 0.7 m/s. It is suspected the reason for the difference lies in the sodar resolution in measuring the Doppler shift frequency of returned echoes. The current operational mode has a fairly broad bin range that translates into an effective resolution of component speeds of about 0.9 m/s. This provides a resultant resolution of about 1.2 m/s. Consideration should be given to using a finer resolution in the bin spacing for the calculation of the radial speeds.

A second problem with the sodar was found in the calculation of the U and V wind components from the radial component speeds. Recognizing the identified resolution problem above (~0.9 m/s wind speed gates), the speeds along the radial directions were calculated correctly. However, errors were found in the calculation that takes the radial speeds and converts them to U and V components. In the tests performed, the errors resulted in U and V speeds that differed significantly from the audit speeds, but directions that were accurate. The calculation errors need to be corrected and affected data reprocessed from the radial values. Word was received from NOAA on July 14 that the U and V calculation algorithm was fixed and was installed at both the Santa Clarita and Azusa sites.

Given the zenith angle of the sodar at 19°, the horizontal components should be corrected for vertical velocity. Since vertical velocity is not measured with the sodar (it is only a two-axis sodar), there will be inaccuracies in the measured wind data even after the problems with the calculations and resolution are resolved.

BARSTOW (BTW)

SCOS97-NARSTO AUDIT SUMMARY
RADAR PROFILER/RASS/SODAR/SURFACE METEOROLOGY

Site:	Barstow (BTW)
Audit Dates:	June 17, 1997
Instrumentation Audited:	Radar Profiler, RASS, Surface Meteorology
Key Person(s):	Tim Dye, Scott Ray, Gabe Lovato
Auditor:	Robert A. Baxter RAB

The purpose of this summary is to provide a preliminary report of any significant audit findings. The audit was performed immediately following the STI training of the site technician. While there were a few items missed by the technician during the observation of the site check, the individual appeared to take an interest in doing a good job and will probably work out well. Key elements of the audit are identified below.

AUDIT INSTRUMENTATION

No problems were encountered with the audit instrumentation.

SITE CHARACTERISTICS

The site is in a flat and open area with good exposure to the southwest and southeast. To the north is highway 58 with significant traffic. No changes in the site characteristics were noted since the candidate site review performed on April 8, 1997. The site review provided the vista information, therefore, this audit did not repeat those measurements. The results in the audit form reflect the previously noted characteristics.

SYSTEM AUDIT NOTES

1. The guy lines for the RASS sources were loose. It is recommended turnbuckles be put on the lines to allow easier tightening of the guys. This site is frequented by high winds.
2. The level of the profiler antenna and RASS sources should be checked during each site visit. This was inadvertently missed by the site technician during the observed check.

3. There was no specific place in the site checklist to document the QC checks performed by the technician (reasonableness checks of wind speed, wind direction and temperature). It was agreed to place those observations in the regular site log.
4. Upon arrival at the site the instruments were operating on Pacific Daylight Time. It was subsequently changed to Pacific Standard Time.

POTENTIAL ACTIVE NOISE SOURCES

Significant traffic on highway 58 north of the site appears to produce some clutter.

POTENTIAL PASSIVE NOISE SOURCES

No problems noted

ANTENNA LEVEL AND ALIGNMENT

No problems noted.

RADAR PROFILER PERFORMANCE AUDIT

Not applicable (no performance audit performed).

RASS PERFORMANCE AUDIT

Not applicable (no performance audit performed).

RADAR PROFILER DATA INTERNAL CONSISTENCY

Review of the low and high mode data showed the nighttime data recovery appears to be limited to about 1 to 1.5 km with frequent gaps above 500 meters in the data during the afternoon and evening hours. Data reviewed included June 13 through June 16. The reason for the limited height coverage should be explored.

RASS DATA INTERNAL CONSISTENCY

1. The RASS appears to be having trouble obtaining data during the afternoon hours. Frequent gaps appear. On June 13 there were significant gaps in the data for most of the day. Data reviewed included June 13 through June 16. The reason for the gaps should be explored.
2. The RASS is operating with only 12 range gates. With 60 meter gates the altitude coverage is only up to 780 meters. The limited height capability should be corrected.

SURFACE METEOROLOGY PERFORMANCE AUDIT

1. The data logger was programmed with the wrong wind speed coefficients resulting in about a 4 to 5% error in reported speeds. The correct coefficients were entered following the audit. No further action is needed.

2. While the site relative humidity sensor was within 3% of the audit, the equivalent dew point temperature was different by -2.6°C. This is outside of the ±1.5°C criteria. The sensor is not aspirated which may or may not account for at least part of the difference. The reason for the difference should be explored and corrected.

SCOS97-NARSTO

SITING AND SYSTEM AUDIT FORM

MEASUREMENTS GROUP:	Sonoma Technology, Inc./Radian
SITE NAME AND LOCATION:	Barstow (BTW)
AUDITOR:	Robert A. Baxter
DATE:	June 17, 1997
KEY PERSON:	Tim Dye/Gabe Lovato

I. Observables

A. Meteorological

Observable	Method	Manufacturer	Model	Serial #	Range
Wind Speed/ Wind Direction	Radar Profiler	Radian Corp.	LAP-3000 Interface Receiver/ Modulator Profiler Monitor Antennas	NA	Lo 124 - 1443 m at 55 m inc. Hi 254 - 3525 m at 96 m inc.
Virtual Temperature	RASS	Radian Corp.	LAP-3000	NA	120 - 780 m at 60 m inc.
	Audio amplifier	Peavey	CS-800	NA	NA
10 m Wind Speed/Wind Direction	Propeller/Vane	R.M. Young	AQ	22211	0 - 40 m/s 0 - 355 degrees
2 m ambient temperature	RTD	Climatronics	p/n 100093-3	NA	-30 - 50 °C
2 m relative humidity	Solid State	Vaisala	HMP35	NA	0 - 100%
Data Logging	Digital	CSI	CR10	NA	NA

Comments:

Are there any required variables which are not measured?	No
Are there any methods and/or equipment that are not in the SOP?	Yes
Do any operating ranges differ from those specified in the SOP?	See Below
Are there any significant differences between instrumentation on site and the SOP?	No

Comments: Also measured, but not part of the study database, is solar radiation and precipitation. The relative humidity sensor is not aspirated. The operating range of the RASS should be increased.

B. Auxiliary Equipment

Type	Manufacturer	Model	Serial #	Last Calibration Date
Uninteruptable Power Supply	NA	NA	NA	NA
Modem	NA	NA	NA	NA
Gateway Computer and Monitor	NA	NA	NA	NA
Zip drive	Iomega	Parallel	NA	NA

Comments:

B. Station Check Equipment

Type	Manufacturer	Model	Serial #	Comments
Clock	NA	Analog	NA	NA
Level	NA	NA	NA	NA
Ladder	NA	NA	NA	NA
Hearing Protection	NA	NA	NA	NA
Tool Kit	NA	NA	NA	NA
Shovel	NA	NA	NA	NA

Comments:

II. Sensor/Probe height and Exposure

A. Radar Profiler/RASS/Sodar

Variable	Value	Meet SOP (Yes/No)
1. Orientation	Radar -- -2° 10 m Vane -- +1°	Yes
2. Level	Radar -- <0.4°	Yes
3. Distance to closest obstruction	see vista record	Yes
4. Distance to closest active noise source	No significant active RF sources	Yes

Comments:

B. Surface Meteorology

Variable	Value	Meet SOP (Yes/No)
1. Height of wind sensors above ground	10 m	Yes
2. Distance to nearest obstacle	~100 m	Yes
3. Is separation at least 10x obst. height?	Yes	Yes
4. Are instruments on a rooftop?	No	NA
5. Is exposure 1.5x height above roof	NA	NA
6. Arc of unrestricted flow	360°	Yes
7. Height of temp sensor above ground	2 m	Yes
8. Distance of temp sensor from obst.	see below	Yes
9. Height of DP/RH sensor above ground	2 m	Yes
10. Distance of DP/RH sensor from obst.	see below	Yes
11. Are the distances 4x the obst. height?	Yes	Yes
12. Is the sensor shielded or aspirated?	see below	Yes
13. Are the T/DP/RH abv representative terrain?	Yes	Yes
14. Are there significant differences between on-site equipment and the monitoring plan?	No	Yes

Comments: 8, 10. There are oil line heaters about 100 meters to the east.

12. The temperature is force aspirated, the RH is naturally aspirated.

III. Operation

A. Radar Profiler, RASS and Surface Meteorology

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is all instrumentation operational?	Yes	Yes
2. Are all cables secure?	Yes	Yes
3. Are all cables connected according to SOPs or instrument manuals?	Yes	Yes
4. Are connections clean and rust free?	Yes	Yes
5. Are serial numbers available?	See below	NA
6. Do data system times agree with audit times. If not, what is the deviation?	Yes	See below
7. Is the printer functional?	No	Not used
8. Overall, is the site maintenance sufficient to meet the DQOs?	Yes	Yes

Comments: 5. Did not want to move profiling equipment to get serial numbers.

6. Upon arrival at the site the instruments were operating on Pacific Daylight Time. It was subsequently changed to Pacific Standard Time.

B. Radar Profiler/RASS/Sodar Settings

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Software version	POP 4	Yes
2. High mode pulse length	96 m	Yes
3. Low mode pulse length	54 m	Yes
4. RASS pulse length	59 m	Yes
5. Time zone	PST (see below)	Yes
6. Wind data consensus	55 min	Yes
7. RASS consensus	5 min	Yes

Comments: 4. Site was on PDT upon arrival. It was changed to PST during audit.

	Wind Low Mode	Wind High Mode	RASS
First Gate	124 m	254 m	120 m
Last Gate	1443 m	3525 m	780 m
Spacing	54 m	96 m	59 m
Full Scale Velocity	10.2	10.2	NA

Comments: Recommend operating RASS to a higher altitude.

B. Auxiliary Equipment

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is the A/C unit sufficient to maintain temperatures in the range specified in the SOPs?	Yes	Yes
2. Is the site temperature recorded?	No	See below
3. Is the site temperature maintained at 20-30°C?	Yes	See below
4. Is the site kept clean enough to allow operation of all instruments as specified in the SOP?	Yes	Yes
5. Does the modem work?	Yes	Yes
6. Does the telephone work?	Yes	Yes
7. Is the site secure?	Yes	Yes
8. Overall, is the auxiliary equipment maintenance sufficient to meet the DQOs?	Yes	Yes

Comments: There is no measurement of the shelter temperature. It was indicated that the temperature is not critical for the system operation. Site security is good.

C. Station Check Procedures and Documentation

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Are the station logs present?	Yes	Yes
2. Are the station logs up to date?	Yes	Yes
3. Do station logs contain details as required by the SOPs?	Yes	Yes
4. Are routine checklists used?	Yes	Yes
5. Do the routine checklists contain details as required by the SOPs?	Yes	Yes
6. Are the calibration forms present?	No	See below
7. Do the calibration forms contain details as required by the SOPs?	NA	NA
8. Are the SOPs present?	Yes	Yes
9. Are the instrument manuals present?	No	See below
10. Do the SOPs include quality control tests?	Yes	Yes
11. If quality control tests are included then how are the results of the tests documented?	Yes	See below
12. Has the site technician undergone training as specified in the SOPs?	Yes	Yes
13. Is the site visited twice weekly?	No	See below
14. Does the site technician understand the SOPs?	Yes	Yes

Comments: 6. Calibration records are maintained at STI and Radian.

9. Manuals are maintained at STI and Radian. If repairs are needed then the technician brings the manuals to the site.

11. Documentation of the QC test results were not specifically addressed. The QC test results should be placed in the maintenance checklist log.

13. The site is visited every two weeks for routine maintenance. In between the visits the data are polled and reviewed daily.

D. Chain of Custody

1. Review paper work for chain of custody from field to data processing.	Comments: The site is inspected every two weeks with all data archived and paperwork forwarded to STI in pre addressed envelopes.
2. How are data stored?	Data are stored locally on the computer hard drives with CDF files downloaded on a daily basis.
3. How often are the data backed up?	All data (CDF, moments) are copied to Zip disks every two weeks and shipped to STI.

Comments:

V. Preventive Maintenance

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is preventive maintenance discussed in the SOPs?	Yes	Yes
2. Is preventive maintenance being performed?	Yes	See below
3. Are field operators given special training in preventive maintenance?	Yes	Yes
4. Are tools and spare parts adequate at the site to meet the requirements of the SOPs?	Yes	Yes
5. Are maintenance logs maintained and reviewed?	Yes	Yes

Comments: 2. The guy lines for the RASS sources were loose. It is recommended turnbuckles be put on the lines to allow easier tightening of the guys. This site is frequented by high winds.

The level of the profiler antenna and RASS sources should be checked during each site visit. This was inadvertently missed by the site technician during the observed check.

VI. Overall Comments

Question	Response (Yes/No)	Meet Work Plan (Yes/No)
1. Overall, is the station maintenance sufficient to meet the DQOs?	Yes	Yes
2. Does the siting meet the program objectives?	Yes	Yes
3. Overall, is the site technician trained as specified in the SOPs?	Yes	Yes
4. Does the QC program appear to be working?	See below	NA
5. Overall, does the meteorological data look reasonable?	Yes	Yes
6. Overall, does the data appear to meet the program objectives?	See below	See below

Comments: 4. The procedures are in place for an appropriate QC program. However, the technician was just trained and a history of operation is not yet available.

6. Review of the low and high mode wind data showed the nighttime data recovery appears to be limited to about 1 to 1.5 km with frequent gaps above 500 meters in the data during the afternoon and evening hours. Data reviewed included June 13 through June 16. The reason for the limited height coverage should be explored.

The RASS appears to be having trouble obtaining data during the afternoon hours. Frequent gaps appear. On June 13 there were significant gaps in the data for most of the day. Data reviewed included June 13 through June 16. The reason for the gaps should be explored.

The RASS is operating with only 12 range gates. With 60 meter gates the altitude coverage is only up to 780 meters. The limited height capability should be corrected.

SCOS97-NARSTO AUDIT RECORD
VISTA, ORIENTATION AND LEVEL

Site Name:	Barstow	Instrument:	Radian LAP 3000
Date:	June 17, 1997	Receiver s/n:	NA
Time:	1400 PDT	Interface s/n:	NA
Measurements group:	STI	Firmware version:	POP 4
Key contact:	Tim Dye, Scott Ray	System rotation angle:	214°
Audited by:	Bob Baxter	Measured orientation:	216°
Site longitude:	117° 18.44'	Orientation difference:	-2°
Site latitude:	34° 55.36'	Array level:	< 0.4°
Site elevation:	NA	Beam zenith angle:	23.6°
Magnetic declination:	NA	Beam directions:	124°, 214° ind.

Mag. Az. Angle (deg)	True Az. Angle (deg)	Terrain El. Angle (deg)	Features and Distances
NA	0	7	Power pole, road at ~150 m.
NA	30	7	Light pole, road at ~200 m.
NA	60	4	Structures with lights, road at ~300 m.
NA	90	<2	Brush
NA	120	<2	Brush
NA	150	<2	Brush
NA	180	<2	Brush
NA	210	<2	Brush
NA	240	<2	Brush
NA	270	<2	Brush
NA	300	<2	Road at ~300 m.
NA	330	<2	Road at ~200 m.

Comments: Vista taken from the April 8, 1997 survey. The vantage point for the vista was outside of the fence, about 10 to 15 meters to the west of the antenna.

SCOS97-NARSTO AUDIT RECORD
HORIZONTAL WIND SPEED

Date: June 17, 1997
Start: 0930 PDT
Finish: 1045 PDT
Auditor: Bob Baxter

Site name: Barstow (BTW)
Project: SCOS97-NARSTO
Operator: Radian/STI
Site Operator: T. Dye/S. Ray

Sensor Mfg: R.M. Young
Sensor s/n: 22211
K factor: 5.0
Range: 0 - 40 m/s
Logger: CR10
Logger s/n: 56702
Prop s/n: 56702

Model: 05305 (AQ)
Sensor Ht.: 10 m
Starting torque: 0.2 gm-cm
Starting Threshold: 0.20 m/s

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Last calibration date: 06/01/97

WS Calibration Point	M/S Input	M/S Chart	M/S Diff. Chart	M/S DAS	M/S Diff. DAS	% Diff. DAS
1	0.0	#N/A	#N/A	0.0	0.0	#N/A
2	2.6	#N/A	#N/A	2.5	-0.2	#N/A
3	7.7	#N/A	#N/A	7.4	-0.4	-4.5
4	15.4	#N/A	#N/A	14.7	-0.7	-4.6
5	23.0	#N/A	#N/A	22.1	-0.9	-4.1
6	38.4	#N/A	#N/A	36.7	-1.7	-4.3

Pass/Fail Criteria: +/-.25 m/s; ws <= 5 m/s
+/- 5%; ws > 5 m/s

Comments: Site operated on PDT. Using coefficients for older propeller. Newer coefficients should be programmed into data logger.

SCOS97-NARSTO AUDIT RECORD
HORIZONTAL WIND DIRECTION

Date: June 17, 1997
Start: 0930 PDT
Finish: 1045 PDT
Auditor: Bob Baxter

Site name: Barstow (BTW)
Project: SCOS97-NARSTO
Operator: Radian/STI
Site Operator: T. Dye/S. Ray

Sensor Mfg: R.M. Young
Serial No.: 22211
K Factor: 37
Range: 0 - 355°
Logger: CR10
Logger s/n: 56702

Model: 05305 (AQ)
Sensor Ht.: 10 m
Starting torque: 6.0 gm-cm
Starting threshold: 0.40 M/S

Last calibration date: 06/01/97

Crossarm: 178 deg true

	Cal. Factors Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

WD Audit Point	Degrees Reference	Corrected Degrees Reference	Degrees Chart	Diff. hart Deg	Degrees DAS	Linearity	Total Diff DAS Deg.
Orientation	178.0				178.6		0.6
1	30	29.4	#N/A	#N/A	30.0	0.7	0.6
2	60	59.4	#N/A	#N/A	60.2	0.9	0.8
3	90	89.4	#N/A	#N/A	90.2	0.9	0.8
4	120	119.4	#N/A	#N/A	120.1	0.8	0.7
5	150	149.4	#N/A	#N/A	149.7	0.4	0.3
6	180	179.4	#N/A	#N/A	180.1	0.8	0.7
7	210	209.4	#N/A	#N/A	209.0	-0.3	-0.4
8	240	239.4	#N/A	#N/A	238.9	-0.4	-0.5
9	270	269.4	#N/A	#N/A	268.0	-1.3	-1.4
10	300	299.4	#N/A	#N/A	298.1	-1.2	-1.3
11	330	329.4	#N/A	#N/A	328.1	-1.2	-1.3
				Avg difference:			-0.1
				Maximum difference:		-1.3	-1.4

Criteria: Orientation: +/- 2 degrees
Linearity: +/- 3 degrees
Maximum Difference: +/- 5 degrees

Comments: Sensor passed.

SCOS97-NARSTO AUDIT RECORD
AMBIENT TEMPERATURE

Date:	June 17, 1997	Site name:	Barstow (BTW)
Start:	1045 PDT	Project:	SCOS97-NARSTO
Finish:	1100 PDT	Operator:	Radian/STI
Auditor:	Bob Baxter	Site Operator:	T. Dye/S. Ray

Sensor Mfg:	Climatronics	Model:	p/n 100093-3
Serial No.:	n/a	Sensor Ht.:	2 m
Range:	-30 - 50 Deg C		

Logger: CR10
Logger s/n: 56702

Last calibration date: 6/1/97

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Temperature Audit Point	Deg C Input	Deg C Chart	Deg C Diff. Chart	Deg C DAS	Deg C Diff. DAS
1	0.3	#N/A	#N/A	0.3	0.0
2	25.1	#N/A	#N/A	25.5	0.4
3	41.9	#N/A	#N/A	41.8	-0.1

Criteria: +/- 0.5 degree Celsius

Comments: Used A. Barnett Hg in glass thermometer readings. Sensor passed.

SCOS97-NARSTO AUDIT RECORD
RELATIVE HUMIDITY (DEW POINT TEMPERATURE)

Date: June 17, 1997
Start: 1115 PDT
Finish: 1140 PDT
Auditor: Bob Baxter

Site name: Barstow (BTW)
Project: SCOS97-NARSTO
Operator: Radian/STI
Site Operator: T. Dye/S. Ray

Sensor Mfg: Vaisala
Serial No.: n/a
Range: 0 - 100 Percent

Model: HMP35
Sensor Ht.: 2 m

Logger: CR10
Logger s/n: 56702

Last calibration date: 6/1/97

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

RH/DP Audit Point	%RH Input	Deg C Input	% RH Chart	Deg C Chart	Deg C Diff. Chart	%RH DAS	Deg C DAS	Deg C Diff. DAS
1	15.5	6.6	#N/A	#N/A	#N/A	12.9	4.0	-2.6

Criteria: +/- 1.5 degree Celsius

Comments: Equivalent dew point temperature is outside of criteria. The relative humidity sensor is not aspirated.

BROWN'S FIELD (BFD)

SCOS97-NARSTO AUDIT SUMMARY
RADAR PROFILER/RASS/SODAR/SURFACE METEOROLOGY

Site:	Brown Field (BFD)
Audit Dates:	July 21, 1997
Instrumentation Audited:	Radar Profiler, RASS, Surface Meteorology
Key Person(s):	Cat Russell
Auditor:	Alexander N. Barnett

The purpose of this summary is to provide a preliminary report of any significant audit findings. The site is operated by NOAA/ETL. Key elements of the audit are identified below.

AUDIT INSTRUMENTATION

The sodar data from 08:00 to 12:00 hours PDT on both Tuesday the 24th and Wednesday the 25th were contaminated by a jet engine test cell that was operating on the opposite side of the runway. The data collected during this period was invalidated and not included in the comparisons with the RWP wind data.

SITE CHARACTERISTICS

The site is on the south side of the Brown Field main runway, approximately 400 meters from the west end of the runway in a field at the end of the hanger road. The pointing direction of the oblique antennas are north and west.

SYSTEM AUDIT NOTES

1. The zenith angles of the oblique RWP antennas were 14.5° for the north antenna and 14.1° for the west antenna. The controller set up was 15.0° for these angles. A calculation of the wind speed and wind direction error attributed to these discrepancies are approximately 4.5% and 2%, respectively. The controller should be reset to compensate for these differences so that the winds are calculated correctly.
2. The temperature and relative humidity sensors are in a non-aspirated radiation shield. The data should therefore not be used in dispersion modeling.
3. There are no signs warning of potential audio or radio frequency radiation. Appropriate signage is recommended.

4. The radar transmitter main module was resting on a board under the vertical antenna. It is recommended they be mounted off the ground to prevent moisture entry or other problems with it on the ground.
5. The site is visited approximately once every four weeks. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

POTENTIAL ACTIVE NOISE SOURCES

No RFI was detected by a scan of the frequencies between 914 and 916 mHz, and a review of the spectral data while the system was in the listen only mode.

POTENTIAL PASSIVE NOISE SOURCES

No passive sources were noted.

ANTENNA LEVEL AND ALIGNMENT

The level of the south and east RASS acoustic source drivers or dishes were outside of the audit criteria of ±1.0°.

RADAR PROFILER PERFORMANCE AUDIT

– <u>**RWP – AUDIT SODAR COMPARISON**</u>

The results of the comparison between the audit sodar wind data with the radar profiler winds were as follows:

	Low Mode		High Mode	
	Wind Direction (deg)	Wind Speed (m/s)	Wind Direction (deg)	Wind Speed (m/s)
Average Difference	-3	-1.3	7	-1.4
Root Mean Squared	38	2.1	39	2.0

Criteria: ± 10° - wind direction
± 1.0 m/s - wind speed.

– **RWP – RAWINSONDE COMPARISON**

The results of the comparison between the audit rawinsonde wind data with the radar profiler winds were as follows:

	Low Mode		High Mode	
	Wind Direction (deg)	Wind Speed (m/s)	Wind Direction (deg)	Wind Speed (m/s)
Average Difference	-7	-0.8	6	-0.3
Root Mean Squared	35	1.9	47	3.7

Criteria: ± 10° - wind direction
± 1.0 m/s - wind speed.

RASS PERFORMANCE AUDIT

The RASS data was compared with virtual temperature data calculated from the temperature, humidity and pressure data collect by on-site rawinsonde soundings. Preliminary results showed good agreement between the two measurement systems, however, the RASS soundings tended to under estimate the thickness and intensities of inversions as compared with the rawinsonde soundings.

RADAR PROFILER DATA INTERNALCONSISTENCY

1. Overall, the data look reasonable. A review of the data collected during the three days prior to the audit, showed the low mode of operation to collect data between 1000 meters and the top of the sounding (2,300 meters), while the high mode of operation collected data between 2,400 and the top of the sounding (approximately 4,000 meters).
2. During the period of the audit the low mode winds were restricted to below 1000 meters and the high mode winds were kept to below 2,400 meters. From the rawinsonde soundings, conducted as part of the audit, dry layers were noted between 930 and 1600 meters and 2200 to 2800 meters which could be the reason for the lack of data in these regions.

RASS DATA INTERNAL CONSISTENCY

1. During the period of the audit the vertical extent of the RASS data was limited to about 1000 meters. A review of the RASS data collected during the 3 days prior to the audit showed a capability to about 900 meters, on the average. It is probable that the RASS data was limited to below this level by the dry layer noted by the audit rawinsonde soundings between 930 and 1600 meters.
2. It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project. The current mode of operation is 106 m. This will remove some of the spatial averaging and provide a much clearer picture of the atmosphere. When changing the resolution, the height range should be maintained by increasing the number of range gates collected.

SURFACE METEOROLOGY PERFORMANCE AUDIT

1. The wind sensors were mounted on a 3 meter mast instead of a 10 meter mast as is the usual height for large scale surface wind measurements. The wind measurements should be at 10 meters to be comparable with the other surface meteorological measurements being made for the study.

2. The 10 meter wind direction sensor orientation was outside of criteria which produced a total error of 10°. The sensor was aligned following the audit and the alignment verified.

3. All sensors are scanned every 10 seconds with five minute averages recorded. Other than the wind direction alignment error, no problems were noted with the performance audit results. However, not all of the variables could be audited completely. A summary of these audits are provided below:

   - The temperature sensor could not be immersed in water and the probe design was not conducive to placement in a water proof sheath while retaining good thermal conductivity. Only one ambient comparison point was therefore audited.
   - Due to the wiring and the method of sensor installation, the wind direction sensor was not removed from the tower to perform the torque test. Future installations should consider an alternate installation that will allow for appropriate sensor evaluation.
   - Wind data recorded include scalar wind speed and resultant vector wind direction.
   - As indicated above, the 10 meter wind direction sensor orientation was outside of criteria which produced a total error of 10°. The sensor was aligned following the audit and the new alignment verified.

SCOS97-NARSTO

SITING AND SYSTEM AUDIT FORM

MEASUREMENTS GROUP:	NOAA/ETL
SITE NAME AND LOCATION:	Brown Field (BFD)
AUDITOR:	Alexander N. Barnett
DATE:	July 21 - 23, 1997
KEY PERSON:	Cat Russell

I. Observables

A. Meteorological

Observable	Method	Manufacturer	Model	Serial #	Range
Wind Speed/ Wind Direction	Radar Profiler	NOAA/ETL	915 MHz	915-32-5	Lo 152 - 2296 m at 58 m inc. Hi 152 - 3905 m at 102 m inc.
Virtual Temperature	RASS	NOAA/ETL	915 MHz	915-32-5	157 - 1628 m at 105 m inc. (see below)
	Audio amplifier	Crest Audio	NA	NA	NA
10 m Wind Speed	Propeller	RM Young	5103-AQ	22039	0 - 50 m/s
10 m Wind Direction	Vane	RM Young	5103-AQ	22039	0 - 355 degrees
2 m ambient temperature	RTD	Campbell	CS-500	NA	-35 - 50 °C
2 m relative humidity	Solid State	Campbell	CS-500	NA	0 - 100%
Data Logging	Digital	Campbell	21X	7505	NA

Comments: It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project while retaining the altitude coverage.

Are there any required variables which are not measured?	No
Are there any methods and/or equipment that are not in the SOP?	Yes
Do any operating ranges differ from those specified in the SOP?	See Below
Are there any significant differences between instrumentation on site and the SOP?	No

Comments: Station is also monitoring total solar and net radiation and barometric pressure. As indicated above the RASS resolution should be increased to about 60 m.

B. Auxiliary Equipment

Type	Manufacturer	Model	Serial #	Last Calibration Date
Communications computer	SMT	NA	NA	NA
RWP computer	Industrial Computer Source	NA	NA	NA
RASS amplifier	Crest	CA-4	NA	NA
Power conditioner	Best	FE1-4kva	FE1-4k07467	NA
Optical WORM drive	NA	NA	NA	NA

Comments:

B. Station Check Equipment

Type	Manufacturer	Model	Serial #	Comments
NA[1]	NA	NA	NA	NA
NA	NA	NA	NA	NA
NA	NA	NA	NA	NA

Comments:

1. Station check equipment is carried with the NOAA engineers and not left on site.

II. Sensor/Probe height and Exposure

A. Radar Profiler/RASS/Sodar

Variable	Value	Meet SOP (Yes/No)
1. Orientation (three axis radar antenna)	Radar – 0°, 0° 10 m Vane – 10°	Yes No
2. Level (level and inclination of the horiz ant)	Radar -- 0.5° RASS – 1.4°	Yes No
3. Distance to closest obstruction	Not significant	Yes
4. Distance to closest active noise source	No significant active RF sources	Yes

Comments:

1. The 10 meter wind vane orientation was outside orientation criteria by 10°.
2. The south RASS acoustic source transducer was out of level by 1.4°.

4. A listen only test of the radar revealed no significant RF sources nearby.

B. Surface Meteorology

Variable	Value	Meet SOP (Yes/No)
1. Height of wind sensors above ground	3 m	No
2. Distance to nearest obstacle	30 m	see below
3. Is separation at least 10x obst. height?	No	No
4. Are instruments on a rooftop?	No	NA
5. Is exposure 1.5x height above roof	NA	NA
6. Arc of unrestricted flow	300°	see below
7. Height of temp sensor above ground	2 m	Yes
8. Distance of temp sensor from obst.	Okay	Yes
9. Height of DP/RH sensor above ground	2 m	Yes
10. Distance of DP/RH sensor from obst.	Okay	Yes
11. Are the distances 4x the obst. height?	Yes	see below
12. Is the sensor shielded or aspirated?	Shielded	Yes
13. Are the T/DP/RH abv representative terrain?	Yes	Yes
14. Are there significant differences between on-site equipment and the monitoring plan?	No	Yes

Comments:

1. The wind sensors are on a three meter mast. They should be at 10 meters to measure the large scale wind flows.

2, 3, 6. Hangers to the east of the site are an obstruction to the flow.

Wind data recorded include scalar wind speed and resultant vector wind direction. All surface sensors are scanned every 10 seconds with five minute averages recorded.

12. The temperature and relative humidity sensors are in a non-aspirated radiation shield. The data should therefore not be used in dispersion modeling.

III. Operation

A. Radar Profiler, RASS and Surface Meteorology

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is all instrumentation operational?	Yes	Yes
2. Are all cables secure?	Yes	Yes
3. Are all cables connected according to SOPs or instrument manuals?	Yes	Yes
4. Are connections clean and rust free?	Yes (see below)	Yes
5. Are serial numbers available?	Yes	Yes
6. Do data system times agree with audit times. If not, what is the deviation?	Yes ~ 30 sec.	Yes
7. Is the printer functional?	NA	NA
8. Overall, is the site maintenance sufficient to meet the DQOs?	See below	Yes

Comments:

4. The main radar transmitter module was resting on a board under the vertical antenna. It is recommended it be mounted off the ground to prevent moisture entry or grounding.

5. Did not want to move equipment to get serial numbers.

8. The site is visited approximately every four weeks for routine maintenance. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

B. Radar Profiler/RASS/Sodar Settings

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Software version	POP 4.1	Yes
2. High mode pulse length	700 ns	Yes
3. Low mode pulse length	400 ns	Yes
4. RASS pulse length	700 ns	Yes
5. RASS acoustic temperature Range?	10 - 40°C	Yes
6. RASS acoustic source range?	10 - 40°C	Yes
7. Time zone	GMT	Yes
8. Wind data consensus	53 min (see below)	Yes
9. RASS consensus	7 min (see below)	Yes

Comments:

8, 9. The configuration was changed to gave a 53 minute wind data consensus and a 7 minute RASS consensus. This was done in response to findings at other NOAA sites where it was found that the polling of the surface data during the first five minutes of the hour only gave about a 3.5 minute RASS consensus.

	Wind Low Mode	Wind High Mode	RASS
First Gate	152 m	152 m	157 m
Last Gate	2296 m	3905 m	1628 m
Spacing	58 m	102 m	105 m
Full Scale Velocity	10.2 m/s	10.2 m/s	409.6 m/s

Comments: It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project while retaining the altitude coverage.

B. Auxiliary Equipment

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is the A/C unit sufficient to maintain temperatures in the range specified in the SOPs?	Yes	Yes
2. Is the site temperature recorded?	No	See below
3. Is the site temperature maintained at 20-30°C?	Yes	See below
4. Is the site kept clean enough to allow operation of all instruments as specified in the SOP?	Yes	Yes
5. Does the modem work?	Yes	Yes
6. Does the telephone work?	Yes	Yes
7. Is the site secure?	Yes (see below)	Yes
8. Overall, is the auxiliary equipment maintenance sufficient to meet the DQOs?	Yes	Yes

Comments: 2. There is no measurement of the shelter temperature. It was indicated that the temperature is not critical for the system operation.

7. Security is good. There are no signs warning of potential audio or radio frequency radiation. Appropriate signage is recommended.

C. Station Check Procedures and Documentation

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Are the station logs present?	Yes	Yes
2. Are the station logs up to date?	Yes	Yes
3. Do station logs contain details as required by the SOPs?	Yes	Yes
4. Are routine checklists used?	Yes	Yes
5. Do the routine checklists contain details as required by the SOPs?	Yes	Yes
6. Are the calibration forms present?	No	See below
7. Do the calibration forms contain details as required by the SOPs?	NA	NA
8. Are the SOPs present?	Yes	Yes
9. Are the instrument manuals present?	No	See below
10. Do the SOPs include quality control tests?	Yes	Yes
11. If quality control tests are included then how are the results of the tests documented?	In site checklist	Yes
12. Has the site technician undergone training as specified in the SOPs?	See Below	Yes
13. Is the site visited twice weekly?	No	See below
14. Does the site technician understand the SOPs?	Yes	Yes (see below)

Comments: 6. Calibration records are maintained at NOAA/ETL

9. Manuals are maintained at NOAA/ETL. If repairs are needed then the engineer brings the manuals to the site.

12. There are no site technicians. During most times there is an engineer in the field that travels from site to site for the checks and needed maintenance.

13, 14. The site is visited approximately every four weeks for routine maintenance. In between the visits the data are polled and reviewed on a regular basis. Data are retrieved hourly and reviewed daily. There is a potential for problems to occur such as propeller failure or RASS source failure that would go unnoticed for up to four weeks. If a key Intensive Operational Period (IOP) is forecast, it is recommended the site be visited prior to the start of the IOP.

D. Chain of Custody

1. Review paper work for chain of custody from field to data processing.	Comments: The site is inspected every four weeks with all data archived at that time. Paperwork older than about two months is forwarded to NOAA/ETL.
2. How are data stored?	Data are stored locally on the computer hard drive with consensus files and surface data transferred on an hourly basis to the communications computer. The files on the communications computer are downloaded to NOAA/ETL on an hourly basis and then erased.
3. How often are the data backed up?	Files are copied to an optical drive on an hourly basis. These data are recovered on a monthly basis when the engineer visits the site.

Comments: 1. It is recommended a carbonless or similar form be used for the site checklist. In that manner a copy could be left at the site while the original can be sent back to NOAA/ETL.

V. Preventive Maintenance

Question	Response (Yes/No)	Meet SOP (Yes/No)
1. Is preventive maintenance discussed in the SOPs?	Yes	Yes
2. Is preventive maintenance being performed?	Yes	Yes
3. Are field operators given special training in preventive maintenance?	Yes	Yes
4. Are tools and spare parts adequate at the site to meet the requirements of the SOPs?	See below	Yes
5. Are maintenance logs maintained and reviewed?	Yes	Yes

Comments: 4. Tools and spares are carried with the field engineers. Some spares such as RASS transducers are stored at various sites throughout the NOAA/ETL network.

VI. Overall Comments

Question	Response (Yes/No)	Meet Work Plan (Yes/No)
1. Overall, is the station maintenance sufficient to meet the DQOs?	Yes	Yes
2. Does the siting meet the program objectives?	Yes	Yes
3. Overall, is the site technician trained as specified in the SOPs?	Yes	Yes
4. Does the QC program appear to be working?	Yes	Yes
5. Overall, does the meteorological data look reasonable?	Yes	See below
6. Overall, does the data appear to meet the program objectives?	Yes	Yes

Comments: 5. During the period of the audit the vertical extent of the RASS data looked limited. This was probably due to the current meteorological conditions. A review of RASS data collected over the last 3 days showed a capability to about 1000 meters, on the average. It is recommended the RASS be operated at a finer resolution (about 60 m), such as other systems in the project. The current mode of operation is 106 m. The finer resolution will remove some of the spatial averaging and provide a much clearer picture of the atmosphere. When changing the resolution, the height range should be maintained by increasing the number of range gates collected.

SCOS97-NARSTO AUDIT RECORD
VISTA, ORIENTATION AND LEVEL

Site Name:	Brown Field	Instrument:	NOAA/ETL
Date:	7/21/97 - 7/23/97	Receiver s/n:	
Time:	14:00 PDT	Interface s/n:	
Measurements group:	NOAA/ETL	Frimware version:	POP-4
Key contact:	Cat Russell	System rotation angle:	284° True
Audited by:	Alex Barnett	Measured orientation:	284° True
Site longitude:	116o 59.64'W	Orientation difference:	0°
Site latitude:	32o 34.25'N	Array level (vert):	N-S: 0.4° E-W: 0.3°
Site elevation:	158 meters	Beam zenith angle:	N: 14.5°, W: 14.1°
Magnetic declination:		Beam directions:	North and West

Mag. Az. Angle (deg)	True Az. Angle (deg)	Terrain El. Angle (deg)	Features and Distances
NA	0	<2	Open, airport runway ~300 m.
NA	30	10	Single story hangers ~200 m.
NA	60	10	Single story hangers ~150 m.
NA	90	20	Single story hangers ~100 m.
NA	120	40	Power pole and trees ~150 m.
NA	150	10	Truck bodies ~30 m. Trees ~100 m.
NA	180	20	Tree ~100 m.
NA	210	<2	Open.
NA	240	5	Gasoline loading terminal platforms ~100 m.
NA	270	15	Single light pole ~50 m.
NA	300	<2	Open, airport runway ~300 m.
NA	330	<2	Open, airport runway ~300 m.

Comments:

AeroVironment Environmental Services Inc.
HORIZONTAL WIND SPEED

Date: 07/21/97
Start: 14:30 PDT
Finish: 14:45 PDT
Audited By: Alex Barnett
Witness: Cat Russell

Site Name: Brown's Field
Operator: NOAA-ETL
Project: NOAA-ETL

Manufacturer: R.M.Young
Serial No.: 22039
K factor: 1.4
Range: 50 m/s

Model: 05103
Sensor Ht.: 3 Meters
Starting torque: 0.2 gm cm
Starting threshold: 0.38 m/s

Cal. Factors	Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Last calibration date:

WS Audit Point	m/s Input	m/s Chart	m/s Diff. Chart	m/s DAS	m/s Diff. DAS
1	0.00	#N/A	#N/A	0.00	0.00
2	2.50	#N/A	#N/A	2.50	0.00

Audit Criteria: +/-.25 m/s; ws <= 5 m/s

Audit Point	m/s Input	m/s Chart	% Diff. Chart	m/s DAS	% Diff. DAS
3	14.70	#N/A	#N/A	14.70	0.0
4	34.30	#N/A	#N/A	34.30	0.0

Audit Criteria: +/- 5%; ws > 5 m/s

Comments: None

AeroVironment Environmental Services Inc.
HORIZONTAL WIND DIRECTION

Date: 07/21/97
Start: 14:45 PDT
Finish: 15:08 PDT
Audited By: Alex Barnett
Witness: Cat Russell

Site Name: Brown's Field
Operator: NOAA-ETL
Project: NOAA-ETL

Manufacturer: R.M.Young
Serial No.: 22039
K factor: 29.8
Range: 355 Deg
Crossarm: 2 Deg true

Model: 05103
Sensor Ht.: 3 Meters
Starting torque: 5 gm cm
Starting threshold: 0.41 m/s

Last calibration date:

	Chart	DAS
Slope:	1.000	1.000
Int.:	0.0	0.0

WD Audit Point	Degrees Reference	Degrees Chart	Diff. Chart	Degrees DAS	Diff. DAS
1	24	#N/A	#N/A	38	14
2	120	#N/A	#N/A	131	11
3	221	#N/A	#N/A	222	1
4	295	#N/A	#N/A	303	8

Audit Criteria: +/- 5 degrees

Comments: None

AeroVironment Environmental Services Inc.
AMBIENT TEMPERATURE

Date: 07/21/97
Start: 15:43 PDT
Finish: 15:53 PDT
Audited By: Alex Barnett
Witness: Cat Russell

Site Name: Brown's Field
Operator: NOAA-ETL
Project: NOAA-ETL

Manufacturer: Campbell
Serial No.: NA
Lower Range: -50 Deg C
Upper Range: 50 Deg C

Model: CS-500
Sensor Ht.: 2 Meters

Last calibration date:

	Cal. Factors Chart	DAS
Slope:	1.000	1.000
Int.:	0.000	0.000

Temperature Audit Point	Deg C Input	Deg C Chart	Deg C Diff. Chart	Deg C DAS	Deg C Diff. DAS
1	25.0	#N/A	#N/A	24.3	-0.7
2	25.4	#N/A	#N/A	25.0	-0.4
3	39.6	#N/A	#N/A	39.0	-0.6

Audit Criteria: +/- 1.0 degree Celsius

Comments: None

AeroVironment Environmental Services Inc.
RELATIVE HUMIDITY

Date: 07/21/97
Start: 15:43 PDT
Finish: 15:53 PDT
Audited By: Alex Barnett
Witness: Cat Russell

Site Name: Brown's Field
Operator: NOAA-ETL
Project: NOAA-ETL

Manufacturer: Campbell
Serial No.: NA

Model: CS-500
Sensor Ht.: 2 Meters

Psychro. Units:Deg C

Last calibration date:

	Cal. Factors Chart	DAS
Slope:	1.000	1.000
Int.:	0.00	0.00

R.H. Audit Point	R.H. Input	R.H. Chart	R.H. Diff. Chart	R.H. DAS	R.H. Diff. DAS
1	56.6	30.0	-26.6	59.7	3.1

Audit Criteria: N/A

Equivalent Dew Point	Deg C Input	Deg C Chart	Deg C Diff. Chart	Deg C DAS	Deg C Diff. DAS
1	15.8	6.2	-9.6	16.6	0.8

Audit Criteria: +/- 1.5 degrees Celsius

Comments: None

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Brown's Field
Date: July 21 - 23, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

High Mode of Operations

Overall Difference Radar Profiler - Sodar	Wind Dir. (deg)
Average:	7
Maximum:	176
Minimum:	-134
Standard Deviation:	38
Root Mean Square (RMS):	39

Date	Hour	Wind Dir. Difference (deg, Radar Profiler - Sodar) Level (m)					
		152	253	354	455	556	657
07/21/97	12:15	-28	-44	-75			
	13:15						
	14:15	-40	-43				8
	15:15	13	-10				
	16:15	-2	6				
	17:15	-33	-35	-46	76		
	18:15	8	23	38	42		
	19:15	2	7	30			
	20:15	2	17	0	1		
	21:15		31	7	12	-16	
	22:15		20	11	9	23	31
	23:15		4	5	5		47
7/22/97	0:15		13	-4	-2	-27	44
	1:15			-6	-13		
	2:15					176	
	3:15		13		-134		
	4:15		42			84	
	5:15	38					
	6:15						
	7:15						
	8:15						
	9:15						
	10:15						
	11:15	40	34				
	12:15	38	46	34	18		
	13:15	52	43	21	-21		
	14:15	57	43	27	-19		
	15:15	4	21	15	1		
	16:15	49	35	-2	-43		
	17:15	47	27	28	-20		
	18:15	40	40	31	-23		
	19:15	43	33	2	-11		
	20:15	25	17	-10	-34	-95	
	21:15			-43	-19		
	22:15		16	-26	-54		
	23:15			-45	-78		
7/23/97	0:15						
	1:15		-1	-36			
	2:15		10	-8	-5		
	3:15			-22	-15	32	
	4:15	22	-5	-3	-16	10	
	5:15				-3		
	6:15						
	7:15						
	8:15					79	
	9:15						
	Average:	19	14	-3	-14	29	32
	Std Dev:	29	25	29	39	78	18
	RMS:	34	28	28	41	79	36
	Maximum:	57	46	38	76	176	47
	Minimum:	-40	-44	-75	-134	-95	8

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Brown's Field
Date: July 21 - 23, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

High Mode of Operations

Overall Difference Radar Profiler - Sodar	Wind Speed (m/s)
Average:	-1.4
Maximum:	3.4
Minimum:	-5.0
Standard Deviation:	1.3
Root Mean Square (RMS):	2.0

		Wind Speed Difference (m/s, Radar Profiler - Sodar) Level (m)					
Date	Hour	152	253	354	455	556	657
07/21/97	12:15	-5.0	-3.3	-4.4			
	13:15						
	14:15	-4.0	-3.5				0.0
	15:15	-3.8	-4.4				
	16:15	-1.2	0.6				
	17:15	-1.0	-0.5	-2.0	-1.2		
	18:15	-3.2	-1.7	-2.3	-1.9		
	19:15	-1.0	-1.5	-3.1			
	20:15	-0.9	-2.4	-1.5	-2.1		
	21:15		-0.3	-1.1	-1.7	-1.1	
	22:15		-1.5	-2.0	-1.4	-1.9	-1.5
	23:15		-1.0	-0.3	-1.4		0.4
7/22/97	0:15		-0.7	-1.2	-1.4	-1.6	-1.7
	1:15			-1.6	-1.7		
	2:15					3.1	
	3:15		3.4		0.3		
	4:15		-0.8			-0.5	
	5:15	0.4					
	6:15						
	7:15						
	8:15						
	9:15						
	10:15						
	11:15	-2.0	-1.3				
	12:15	-3.1	-1.9	-0.4	0.9		
	13:15	-2.5	-1.2	0.5	-0.3		
	14:15	-3.6	-1.4	-0.1	-1.3		
	15:15	-4.2	-2.5	-1.4	-0.7		
	16:15	-1.8	-0.3	1.5	-0.3		
	17:15	-2.7	-2.0	0.2	-0.9		
	18:15	-1.8	-0.6	-0.5	-1.5		
	19:15	-0.6	-1.9	-2.6	-1.5		
	20:15	0.6	-1.5	-2.4	-2.0	-2.6	
	21:15			-1.3	-2.7		
	22:15		-2.3	-1.6	-2.0		
	23:15			-1.8	-1.2		
7/23/97	0:15						
	1:15		-1.1	-0.9			
	2:15		-0.9	-2.0	-2.6		
	3:15			-1.8	-1.5	-2.2	
	4:15	0.2	-0.6	-2.0	-1.6	-3.2	
	5:15				-0.8		
	6:15						
	7:15						
	8:15					0.3	
	9:15						
	Average:	-2.1	-1.3	-1.4	-1.3	-1.1	-0.7
	Std Dev:	1.6	1.4	1.2	0.8	1.9	1.1
	RMS:	2.6	1.9	1.8	1.5	2.1	1.2
	Maximum:	0.6	3.4	1.5	0.9	3.1	0.4
	Minimum:	-5.0	-4.4	-4.4	-2.7	-3.2	-1.7

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Brown's Field
Date: July 21 - 23, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

Low Mode of Operation

Overall Difference Radar Profiler - Sodar	Wind Dir. (deg)
Average:	-3
Maximum:	135
Minimum:	-164
Standard Deviation:	38
Root Mean Square (RMS):	38

		Wind Dir. Difference (deg, Radar Profiler - Sodar) Level (m)									
Date	Hour	152	210	268	326	384	442	500	558	616	674
7/21/98	12:15:00	-6	-37	-61	-101						
	13:15:00	29	33	40	62						
	14:15:00	0	-12	-17	6					-65	
	15:15:00	31	49	30							
	16:15:00										
	17:15:00	8	21	11	-14	-20	135				
	18:15:00	-25	-25	-9	33	61	109				
	19:15:00	-10	-18	-1	-2						
	20:15:00	15	21	-5	20	-11	1				
	21:15:00	-9	11	-3	2	-6	2		-19	-15	
	22:15:00	-20	-9	0	6	-4	0	-15	-24	-19	
	23:15:00	-19	-13	-2	-5		-11				36
	0:15:00	-26	-9	1	-2	-13	-30	-12	8	-33	
	1:15:00				-52	-79	-108	-139	77		
	2:15:00							-164			
	3:15:00		23	7				-159			
	4:15:00	-22	-20	-31	-47				123		
	5:15:00	-7									
	6:15:00										
	7:15:00										
	8:15:00										
	9:15:00										
	10:15:00										
	11:15:00	12	47	19							
	12:15:00	4	47	25	41	22	-5				
	13:15:00	27	40	13	35	9	-21				
	14:15:00	41	69	29	13	14	0				
	15:15:00	-3	-3	3	2	6	-32				
	16:15:00	28	38	21	18	-15	-41				
	17:15:00	15	16	-29	36	13	2				
	18:15:00	-22	-11	-15	24	13	-34				
	19:15:00	-12		8	23	-5	-27	1			
	20:15:00	9	7	-1	-7	-38	-33	-24			
	21:15:00	-7			-11	-42	-19				
	22:15:00	-7		-16	-13	-34	-12	-35			
	23:15:00			-16	27	-14	48	-51			
	0:15:00								-57		
	1:15:00	-1	-5	0	3	-47					
	2:15:00	31	5	7	-9	-25	-23				
	3:15:00					-20	-12	-15	14		
	4:15:00	-5	-19	-37	1	27	-15	-13	-2		
	5:15:00							-12			
	6:15:00										
	7:15:00										
	8:15:00								110		
	9:15:00										
	Average:	2	9	-1	3	-9	-5	-53	26	-33	36
	Std Dev:	19	28	22	32	29	49	62	63	22	#DIV/0!
	RMS:	19	29	21	31	30	48	80	65	38	36
	Maximum:	41	69	40	62	61	135	1	123	-15	36
	Minimum:	-26	-37	-61	-101	-79	-108	-164	-57	-65	36

SCOS97-NARSTO Audit Report
Radar Profiler - Sodar Wind Speed Comparison

Site: Brown's Field
Date: July 21 - 23, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Sodar: AeroVironment Model 2000

Low Mode of Operation

Overall Difference Radar Profiler - Sodar	Wind Speed (m/s)
Average:	-1.3
Maximum:	6.1
Minimum:	-5.4
Standard Deviation:	1.6
Root Mean Square (RMS):	2.1

Date	Hour	Wind Speed Difference (m/s, Radar Profiler - Sodar) Level (m) 152	210	268	326	384	442	500	558	616	674
7/21/98	12:15:00	-3.8	-3.9	-1.7	-1.5						
	13:15:00	-2.6	-1.0	-0.4	-0.3						
	14:15:00	-2.5	-3.0	-1.8	-3.1					0.3	
	15:15:00	-3.6	-4.2	-2.0							
	16:15:00										
	17:15:00	-0.9	0.4	1.1	-0.8	-1.7	-2.1				
	18:15:00	-3.4	-3.0	-1.1	-2.0	-2.6	-0.8				
	19:15:00	-2.1	-1.9	0.0	-2.4						
	20:15:00	-1.4	-2.2	-1.4	-1.3	-1.4	-2.3				
	21:15:00	-0.7	-1.3	-1.0	-0.2	-0.9	-1.5		-0.2	-1.1	
	22:15:00	-0.5	-1.1	-2.1	-1.3	-1.6	-1.6	-1.2	-0.9	-1.5	
7/21/98	23:15:00	-0.4	-1.1	-0.5	0.5		-1.0				-0.8
7/22/98	0:15:00	-0.1	-0.9	-0.5	-0.9	-1.6	-0.4	-1.3	-1.8	0.7	
	1:15:00				-0.7	-1.7	-2.1	-2.2	-0.9		
	2:15:00							4.0			
	3:15:00		6.1	5.1				3.4			
	4:15:00	-0.4	-0.9	-0.4	1.2				-0.2		
	5:15:00	-0.4									
	6:15:00										
	7:15:00										
	8:15:00										
	9:15:00										
	10:15:00										
	11:15:00	-3.0	-3.2	-1.2							
	12:15:00	-3.5	-4.8	-4.3	-2.3	0.7	3.0				
	13:15:00	-4.3	-4.4	-3.1	-2.5	0.9	1.5				
	14:15:00	-5.4	-4.6	-3.7	-3.2	-2.3	-1.4				
	15:15:00	-1.5	-1.5	-1.8	-0.8	1.1	1.7				
	16:15:00	-1.6	-1.6	-1.8	-1.8	0.3	-0.9				
	17:15:00	-3.8	-4.4	-3.8	-3.4	-0.9	-1.3				
	18:15:00	-3.3	-2.9	-2.1	-1.6	-0.3	0.0				
	19:15:00	-1.6		-1.1	-2.3	-2.9	-1.8	-1.2			
	20:15:00	-1.5	-1.2	-0.8	-2.2	-1.2	-1.9	-1.7			
	21:15:00	-1.7			-2.2	-1.5	-1.3				
	22:15:00	-0.8		-1.8	-1.9	-1.6	-1.8	-1.9			
	23:15:00			-1.2	-1.8	-1.9	-0.4	-0.8			
7/23/98	0:15:00								0.3		
	1:15:00	0.2	-0.5	-1.4	-2.0	-0.2					
	2:15:00	-0.1	0.3	0.5	-1.7	-0.4	1.0				
	3:15:00					-1.6	-1.2	-1.5	-1.7		
	4:15:00	-0.8	-1.1	0.5	-1.0	-2.6	-1.2	-1.9	-3.1		
	5:15:00							-0.3			
	6:15:00										
	7:15:00										
	8:15:00								0.8		
	9:15:00										
	Average:	-1.9	-1.8	-1.2	-1.6	-1.1	-0.8	-0.5	-0.9	-0.4	-0.8
	Std Dev:	1.5	2.2	1.7	1.1	1.1	1.4	2.0	1.2	1.0	#DIV/0!
	RMS:	2.4	2.9	2.1	1.9	1.6	1.5	2.0	1.4	1.0	0.8
	Maximum:	0.2	6.1	5.1	1.2	1.1	3.0	4.0	0.8	0.7	-0.8
	Minimum:	-5.4	-4.8	-4.3	-3.4	-2.9	-2.3	-2.2	-3.1	-1.5	-0.8

7 hours difference between doppler and rwp data

SCOS97-NARSTO Audit Report
Radar Profiler - Rawinsonde Wind Comparison

Site: Brownsfield
Date: July 21-22, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Rawinsonde: VIZ Model W-9000

High Mode Overall Difference RWP - Rawinsonde	Wind Speed (m/s)
Average:	0.4
Maximum:	11.6
Minimum:	-4.3
Standard Deviation:	3.9
Root Mean Square:	3.8

High Mode Overall Difference RWP - Rawinsonde	Wind Direction (deg)
Average:	-5
Maximum:	89
Minimum:	-31
Standard Deviation:	19
Root Mean Square:	19

WS Difference (m/s)		
Altitude	7/21/97 1500	7/22/97 1100
152		
254		
356		
458		
560		-0.3
662	0.7	-0.8
764	-0.5	-2.9
866	-1.2	-3.4
968	-0.7	-2.8
1070	-0.8	-2.0
1172	-2.6	1.4
1274	-4.2	
1376	-3.6	
1478	-4.1	2.3
1580	-4.2	1.6
1682	-4.1	0.0
1784	-4.3	-1.5
1886	-2.9	-1.8
1988	-3.0	-1.6
2090	-3.0	0.4
2192	0.1	0.9
2294	-1.0	0.8
2396	0.9	
2498	1.5	
2600	2.6	
2702	3.9	
2804	6.6	1.5
2906	5.4	-0.3
3008	11.1	0.7
3110	11.6	-1.9
3212	10.8	-0.2
3314	1.8	1.4
3416	2.9	
3518	1.7	
3620		
3722		
3824		
Average:	0.7	-0.4
Maximum:	11.6	2.3
Minimum:	-4.3	-3.4
Std Dev:	4.7	1.6
RMS:	4.6	1.6

WD Difference (deg)		
Altitude	7/21/97 1500	7/22/97 1100
152		
254		
356		
458		
560		27
662	184	157
764	189	-17
866	89	-20
968	22	-14
1070	12	28
1172	-6	-14
1274	-7	
1376	-23	
1478	-27	6
1580	-11	1
1682	2	3
1784	4	6
1886	-3	-8
1988	-16	-4
2090	-10	-2
2192	5	0
2294	10	3
2396	-14	
2498	-18	
2600	-17	
2702	-18	
2804	-12	9
2906	-7	-1
3008	-5	-4
3110	-13	-1
3212	-27	-13
3314	-22	-14
3416	-31	
3518	-30	
3620		
3722		
3824		
Average:	7	6
Maximum:	189	157
Minimum:	-31	-20
Std Dev:	55	36
RMS:	54	36

Comments:

SCOS97-NARSTO Audit Report
Radar Profiler - Rawinsonde Wind Comparison

Site: Brownsfield
Date: July 21-22, 1997
Measurements Group: NOAA-ETL
Radar Profiler: NOAA-ETL
Audit Rawinsonde: VIZ Model W-9000

Low Mode Overall Difference RWP - Rawinsonde	Wind Speed (m/s)
Average:	-0.8
Maximum:	3.3
Minimum:	-7.1
Standard Deviation:	1.8
Root Mean Square:	1.9

Low Mode Overall Difference RWP - Rawinsonde	Wind Direction (deg)
Average:	-7
Maximum:	108
Minimum:	-115
Standard Deviation:	34
Root Mean Square:	35

WS Difference (m/s)		
Altitude	7/21/97 1500	7/22/97 1100
152	-7.1	-1.4
210	-4.7	-0.4
268	-2.8	
326	-1.3	
384	-1.4	
442		
500	0.4	
558		-1.3
616		-1.6
674	0.7	-0.8
732	0.1	-1.9
790	-0.6	-2.3
848	-1.0	-2.3
906	-1.6	-2.2
964	-1.4	-2.1
1022	-1.4	-0.9
1080	-1.7	-0.2
1138	-1.6	1.2
1196	-1.8	3.3
1254	-1.7	3.3
1312	-2.0	
1370	-2.5	
1428	-2.5	3.2
1486	-1.7	2.8
1544	-1.6	2.6
1602	-1.3	1.2
1660	-0.8	1.0
1718	-1.4	0.2
1776	-1.1	-0.9
1834	-1.8	-1.5
1892	-0.3	-1.3
1950	-2.0	-1.4
2008	-0.8	-1.0
2066	0.1	0.1
2124	0.6	1.6
2182	0.4	0.7
2240	0.6	-1.0
Average:	-1.4	-0.1
Maximum:	0.7	3.3
Minimum:	-7.1	-2.3
Std Dev:	1.5	1.8
RMS:	2.0	1.8

WD Difference (deg)		
Altitude	7/21/97 1500	7/22/97 1100
152	-31	82
210	4	108
268	-32	
326	1	
384	-19	
442		
500	-53	
558		6
616		14
674	-109	0
732	-97	-31
790	-115	-19
848	-79	-17
906	-33	-19
964	-13	-17
1022	5	-16
1080	10	-12
1138	-5	-22
1196	-11	-23
1254	-15	-26
1312	-19	
1370	-16	
1428	-17	3
1486	-14	7
1544	-7	7
1602	0	-1
1660	10	0
1718	20	-6
1776	21	-7
1834	25	2
1892	25	0
1950	22	-3
2008	22	2
2066	18	-6
2124	14	-4
2182	5	-3
2240	6	22
Average:	-14	1
Maximum:	25	108
Minimum:	-115	-31
Std Dev:	37	28
RMS:	39	28

Comments:

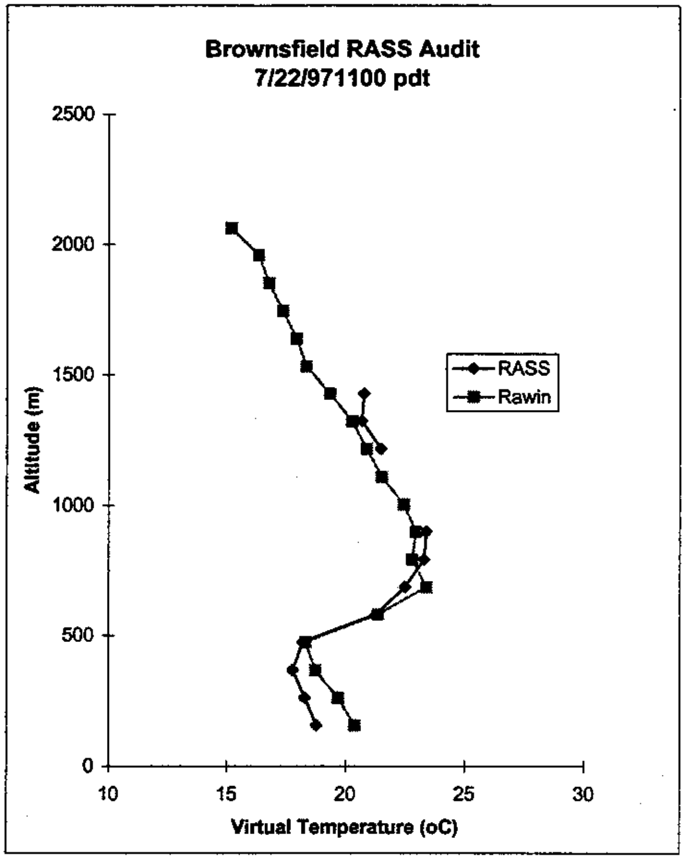
AeroVironment Environmental Services Inc.
Audit Report
RASS Summary

Date: 7/22/97
Start: 11:00 PDT
End: 11:26 PDT
Key Person: Cat Russell
Auditor: Alex Barnett

Site Name: Brownsfield
Project: Upper-Air Audits
Measurement Org.: NOAA

Instrument: ETL 915-32-5

RASS Alt (m)	RASS Tv (oC)	Airsonde Tv (oC)	Diff. (oC)
2065	9999	15.2	NA
1959	9999	16.3	NA
1853	9999	16.8	NA
1747	9999	17.4	NA
1641	9999	17.9	NA
1535	9999	18.4	NA
1429	20.8	19.4	1.5
1323	20.7	20.3	0.4
1217	21.5	20.9	0.6
1111	9999	21.5	NA
1005	9999	22.4	NA
899	23.4	23.0	0.4
793	23.3	22.8	0.5
687	22.5	23.4	-0.9
581	21.3	21.4	-0.1
475	18.2	18.3	-0.1
369	17.8	18.8	-0.9
263	18.3	19.7	-1.4
157	18.8	20.4	-1.6



<u>Results Summary</u>

Min. Diff. : -0.9
Max Diff. : 1.5
Ave. Diff. : 0.4
Std. Dev. : 0.8

Audit Criteria: +/- 1oC

<u>Audit Sonde Data</u>

Sonde Serial # : 2000741

Td offset (oC): -2.4
RH offset (%) 0.0

Sonde Pressure (mb): 997.5
Ref Pressure (mb): 997.6
Difference (mb): -0.1

Comments: The sonde data was vertically averaged to match the RASS levels.
The sonde Td and Tw offsets were included in the Tv calculations.

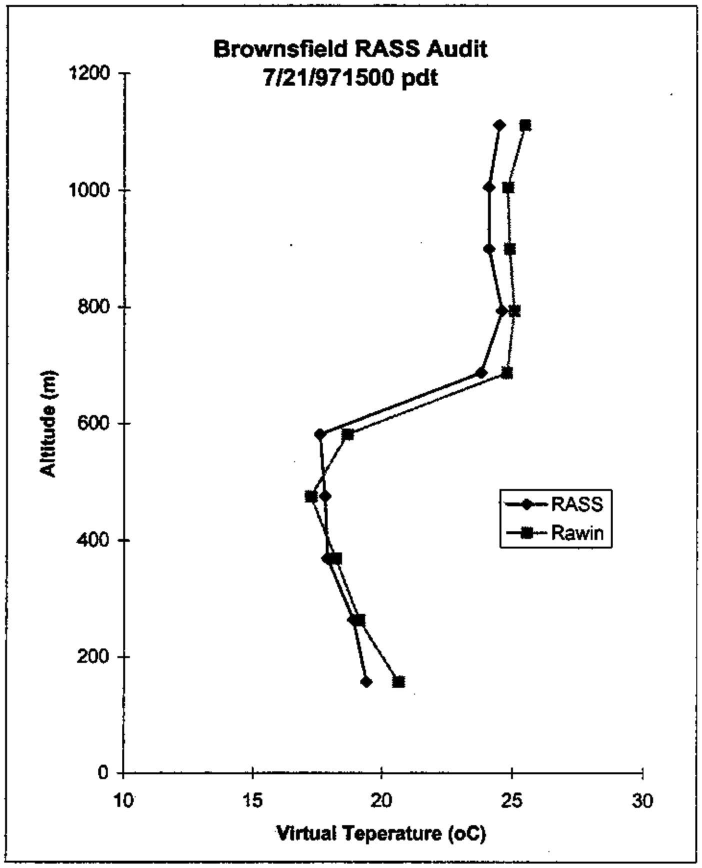
AeroVironment Environmental Services Inc.
Audit Report
RASS Summary

Date: 7/21/97
Start: 15:00 PDT
End: 15:35 PDT
Key Person: Cat Russell
Auditor: Alex Barnett

Site Name: Brownsfield
Project: Upper-Air Audit
Measurement Org.: NOAA

Instrument: ETL 915-32-5

RASS Alt (m)	RASS Tv (oC)	Airsonde Tv (oC)	Diff. (oC)
1111	24.5	25.5	-1.0
1005	24.1	24.8	-0.7
899	24.1	24.9	-0.8
793	24.6	25.1	-0.5
687	23.8	24.8	-1.0
581	17.6	18.6	-1.0
475	17.8	17.3	0.6
369	17.9	18.2	-0.3
263	18.9	19.1	-0.2
157	19.4	20.6	-1.2



Results Summary

Min. Diff. :	-1.2
Max Diff. :	0.6
Ave. Diff. :	-0.6
Std. Dev. :	0.5

Audit Criteria: +/- 1oC

Audit Sonde Data

Sonde Serial # :	2000604
Td offset (oC):	2.7
RH offset (%)	5.0
Sonde Pressure (mb):	996.6
Ref Pressure (mb):	996.6
Difference (mb):	0.0

Comments: The sonde data was vertically averaged to match the RASS levels.
The sonde Td and Tw offsets were included in the Tv calculations.