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The Data Collection Component of the Hanford Meteorology Monitoring Program

C. S. Glantz
M. M. Islam

September 1988

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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From C. S. Glantz

Subject Errata for PNL Document 6684

Three errors have been detected in the 1988 PNL report The Data Collection Component of the Hanford Meteorology Monitoring Program by C. S. Glantz and M. M. Islam.

1) The longitude of the Rattlesnake Mountain Monitoring Site (RTMN - Site 20) provided on page 41 is incorrect. Please delete the erroneous value (119° 24' 40") and replace it with 119° 35' 37" W.

2) The 100F Monitoring Site (100F) is inadvertently referred to as Site 22 on page 18. The 100F site is Site 23.

3) The Pasco Airport Monitoring Site (PASC) is inadvertently referred to as Site 23 on page 42. The PASC site is Site 22

If you detect any additional errors, please contact me and I will issue another errata sheet to inform other users of the document. Thank you for your cooperation.

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THE DATA COLLECTION COMPONENT OF THE HANFORD METEOROLOGY MONITORING PROGRAM

C. S. Glantz
M. M. Islam

September 1988

Prepared for
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Pacific Northwest Laboratory
Richland, Washington 99352

PREFACE

In this document we have elected to use "English" units (e.g, ft, mi, mph, °F) when presenting information on quantities such as distance, speed, and temperature. The metric equivalent (e.g., m, km, m/s, °C) is typically provided in parenthesis following an English unit value. The decision to follow this convention was based on several factors. First, most measurements made by the Hanford Meteorology Monitoring Program (e.g., wind speed, temperature) are recorded in English units. Second, the heights of the instrument towers and the tower levels at which instruments are deployed were generally selected using English units. Finally, when providing instructions on how to reach a monitoring site, the distance to travel on local roads is best provided in miles, because this is the unit of distance displayed on most automobile odometers.

An exception to the rule of providing both English and metric values is made when referring to the towers. There are four sizes of instrumented towers used in the Hanford Meteorology Monitoring Program: 410 ft (125 m), 200 ft (60 m), 40 ft (12 m), and 30 ft (9 m). After the first reference to a tower in a particular size category, towers of that size are referred to by their height in english units (e.g., 410-ft tower) without repeating their metric equivalent.

The figures cited in this report are presented together before the presentation of the references. The figures are grouped this way to allow the reader to more easily examine and compare the photographs of the various monitoring sites. This method of presenting the figures also maintains continuity of the text.

SUMMARY

An intensive program of meteorological monitoring is in place at the U.S. Department of Energy's Hanford Site. The Hanford Meteorology Monitoring Program involves the measurement, observation, and storage of various meteorological data; continuous monitoring of regional weather conditions by a staff of professional meteorologists; and around-the-clock forecasting of weather conditions for the Hanford Site. The objective of this report is to document the data collection component of the program.

In this report, each meteorological monitoring site is discussed in detail. Each site's location and instrumentation are described and photographs are presented. The methods for processing and communicating data to the Hanford Meteorology Station are also discussed. Finally, the procedures followed to maintain and calibrate these instruments are presented.

ACKNOWLEDGMENTS

The senior author would like to thank Owen Abbey for his contributions to this project. Owen took the senior author to each of the meteorology monitoring sites discussed in this document, provided background information on the sites, and used a theodolite to measure the position of each site in relationship to known landmarks. Without Owen's friendly assistance, the senior author might still be driving on the backroads north of Pasco looking for monitoring sites.

The authors wish to thank Rob Rheinschmidt and Dennis Knight at the Hanford Meteorology Station for their cooperation in obtaining information on the instruments that are in the Hanford Meteorology Monitoring Program, the calibration and maintenance procedures, the manner in which analog signals are converted to data averages, and the methods by which data are transmitted to the Hanford Meteorology Station for analysis and storage.

The authors also wish to thank the meteorologists at the Hanford Meteorology Station for answering scores of questions on their role in collecting and interpreting data. Finally, the authors would like to thank Melissa Fairchild, Carol Hayes, Connie Parker, and Darla Sharp for their roles in preparing this document for publication.

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INTRODUCTION

An intensive meteorological monitoring program is in place at the U.S. Department of Energy's (DOE's) Hanford Site in south-central Washington State. The mission of the Hanford Meteorology Monitoring Program is to meet the meteorological and climatological needs of DOE and its contractors for the Hanford Site. In particular, the program calls for the measurement, observation, and storage of various meteorological data; continuous monitoring of regional weather conditions by a staff of professional meteorologists; and around-the-clock forecasting of weather conditions for the Hanford Site. The purpose of this report is to document the data collection component of the program, which includes reporting on the location and types of monitoring equipment being used, the procedures followed to maintain and calibrate these instruments, and the methods for processing and communicating data to the Hanford Meteorology Station (HMS).

The heart of the Hanford Meteorology Monitoring Program is the HMS. The HMS is centrally located on the Hanford Site between the 200 West and 200 East operating areas. Meteorological parameters measured or observed at the station include air temperature, relative humidity, precipitation, atmospheric pressure, solar radiation, cloud cover, and subsurface temperatures. Wind directions, speeds, and air temperatures are measured at multiple levels on a 410-ft (125-m) tower. Winds and atmospheric mixing depth are also measured by a doppler acoustic sounder. At least one professional meteorologist is on duty at the station at any given time. The duty meteorologist makes meteorological observations, analyzes data, prepares weather forecasts, disseminates information, and oversees the automatic components of the meteorological monitoring program.

In addition to the monitoring at the HMS, measurements of winds and air temperatures are made at 24 other locations on the Hanford Site and in the surrounding area (Figure 1 and Table 1). These measurements are made at automated monitoring stations that transmit their data to the HMS via UHF radio transmission. All meteorological measurements and observations are processed and stored at the station on a VAX 11/750 minicomputer. Data can

TABLE 1. Site Identification Numbers, Names, and 4-Character Codes for the Hanford Meteorological Monitoring Sites.

Site Number	Site Name	Site Code
1	Prosser Barricade	PROS
2	Emergency Operations Center	EOCC
3	Army Loop Road	ARMY
4	Rattlesnake Springs	RSPG
5	Edna	EDNA
6	200 East	200E
7	200 West	200W
8	Wahluke	WAHL
9	Fast Flux Test Facility	FFTF
10	Yakima Barricade	YAKB
11	300 Area	300A
12	Wye Barricade	WYEB
13	100-N	100N
14	WNP-2	WPPS
15	Franklin County	FRNK
16	Gable Mountain	GABL
17	Ringold	RING
18	Richland	RICH
19	Sagehill	SAGE
20	Rattlesnake Mountain	RMTN
21	Hanford Meteorology Station	HMSS
22	Pasco	PASC
23	100-F	100F
24	Gable West	GABW
25	Vernita Bridge	VERN

be easily retrieved and transferred to other Hanford Site computers from this system.

In the Background Information section of this report, the rationale for the meteorological monitoring program, location of the Hanford Site, climate of the region, and a brief history of meteorological monitoring in the Hanford area are discussed. In the section on the Meteorological Monitoring Sites, the locations of the various monitoring sites, the parameters monitored, and the instruments deployed at the sites are discussed. In the Instrumentation section, the instruments used in the monitoring program are discussed in detail and their technical specifications are presented. In the section on Data Processing and Transmission, descriptions of how signals from the meteorological sensors are converted to meaningful data and how processed data are communicated to the computer at the HMS are presented. In the section on Maintenance and Calibration Procedures, the formal and informal procedures followed to maintain and calibrate the program's instruments are discussed.

BACKGROUND INFORMATION

In this section, background information on the Hanford Meteorology Monitoring Program is provided. The rationale for the monitoring program, a description of the location of the Hanford Site, a discussion of the climate of the region, and the history of meteorological measurements at Hanford are discussed.

RATIONALE FOR THE HANFORD METEOROLOGY MONITORING PROGRAM

There are several reasons for the existence of the Hanford Meteorology Monitoring Program. First, detailed, real-time, meteorological data are needed in the event of a release of hazardous material to the atmosphere from one of the Hanford Site's facilities. These data would be used to model atmospheric dispersion and estimate the environmental impacts of the release. Second, meteorological data are needed to expand the Hanford Site's climatological database. This database is used in environmental studies, environmental impact reports, facility design, and planning operations. The database is used not only in meteorological analyses but also in ground-water, surface-water, and ecological studies. Third, meteorological data are used to evaluate atmospheric dispersion conditions for scheduling routine atmospheric releases from Hanford facilities. Fourth, meteorological data are used to evaluate weather conditions and prepare forecasts that are used in scheduling Hanford operations and activities.

LOCATION OF THE HANFORD SITE

The Hanford Site is located on approximately 560 mi^2 (1450 km^2) of land in south-central Washington State (Figure 1). A variety of terrain is found on the Hanford Site, including: ridge, lower slope, valley, and river (Figure 2). Ridge terrain is found in the extreme southwest and west portion of the Hanford Site; lower slope terrain in the southwest, west, and northern portions of the Hanford Site; valley terrain in the central and eastern portion of the Hanford Site; and river terrain associated with the Columbia River.

The northern boundary of the Hanford Site lies along the lower slope of the Saddle Mountains. These east-west running mountains rise to an elevation of more than 2000 ft (600 m) above mean sea level. Northwest of the Site, the Columbia River flows south through a gap in the Saddle Mountains. Near Priest Rapids Dam, the river turns toward the east and flows into the northern portion of the Hanford Site. The river flows east and northeast for about 18 mi (29 km) before turning toward the southeast. About 22 mi (35 km) further downstream, the river turns south and forms the southern half of the eastern boundary of the Hanford Site. The elevation of the terrain to the east of the Hanford Site ranges from 340 ft to 900 ft (100 m to 270 m) above sea level. In places, the bluffs along the eastern shore of the Columbia River rise over 500 ft (150 m) above the surface of the river. In total, the Columbia River drops about 70 ft (20 m) along its path through the Hanford Site, from 400 ft (122 m) above sea level when it enters the Hanford Site to 330 ft (100 m) above sea level as it exits the Hanford Site.

The southwestern border of the Hanford Site is marked by the summit ridge of Rattlesnake Mountain. This mountain dominates the local terrain with an elevation that reaches 3581 ft (1091 m) above sea level. Rattlesnake Mountain and its associated hills extend to the northwest to also form the western border of the Hanford Site.

CLIMATE OF THE HANFORD SITE

The climate of the Hanford Site can be classified as mid-latitude semiarid (DOE 1982) or mid-latitude desert depending on the climatological classification scheme being used. Summers are warm and dry with abundant sunshine. Large diurnal temperature variations are common during this season resulting from intense solar heating and radiational cooling at night. Daytime high temperatures in June, July, and August periodically exceed 100°F (38°C). Winters, on the other hand, are cool with occasional precipitation. Outbreaks of cold air associated with modified arctic air masses can reach the area and cause temperatures to drop below 0°F (-18°C). Overcast skies and fog occur periodically in this season.

Topographic features have a significant impact on the climate of the Hanford Site. All air masses that reach the region undergo some modification resulting from their passage over the complex topography of the Pacific Northwest (DOE 1982). The climate of the region is strongly influenced by the Pacific Ocean and the Cascade Range to the west. The relatively low annual average rainfall of 6.3 in. (16.1 cm) at the HMS is, in large part, due to the rain shadow created by the Cascade Range. These mountains limit much of the maritime influence of the Pacific Ocean, resulting in a more continental-type climate than would exist if the mountains were not present. Maritime influences are experienced in the region during the passage of strong synoptic-scale systems[a]. Maritime air also penetrates into the region through gaps in the Cascade Range (such as the Columbia River Gorge).

The Rocky Mountains to the east and the north are also an important influence on the climate of the region. These mountains play a key role in protecting the region from the more severe winter storms and the extremely low temperatures associated with the modified arctic air masses that move southward through Canada.

Locally the climate of the Hanford Site is influenced by the Yakima Ridge and the Rattlesnake Hills to the west, the Horse Heaven Hills to the south, the Saddle Mountains to the north, and the Columbia River.

THE HISTORY OF METEOROLOGICAL MEASUREMENTS AT HANFORD

The HMS was established in 1945 to provide a facility for the collection of meteorological data, analysis of meteorological conditions, and preparation

(a) Synoptic-scale systems have horizontal dimensions of several hundred to over a thousand kilometers.

of weather forecasts. Some meteorological data for the period prior to the operation of the station are available. The earliest official meteorological observations within what was to become the Hanford Site were made in 1912 at the Hanford Townsite by cooperative observers for the U.S. Weather Bureau (now the National Weather Service). These observations were continued until March 31, 1943, when the evacuation of the townspeople of Hanford for the Manhattan Project ended the local measurement program. From March 1943 until May 1944, the meteorological observations for Hanford were made by the U.S. Weather Bureau in Richland (near the southern border of the Hanford Site).

Continuous observations of hourly meteorological conditions began at the HMS on December 7, 1944, and have continued at the same location through the present date. Initially, meteorological observations at the station consisted of wind and temperature data collected at the surface and on the 410-ft tower; however, by the end of 1946 the measurement program was expanded to include all of the standard "surface observations" specified by the Weather Bureau. Today, operations at the HMS are equivalent to those at a National Weather Service station; data from the station are included in the National Weather Service's automated field station reporting network.

METEOROLOGICAL MONITORING SITES

Meteorological monitoring is conducted at the HMS and at 24 automated monitoring sites. These automated monitoring sites consist of three 200-ft (60-m) towers with doppler sodars, two 40-ft (12-m) towers with wind sensors mounted at the 30 ft (9 m) level, fourteen 30-ft (9-m) towers with AC powered instruments, two 30-ft towers with battery powered instruments, a pole-mounted site on the crest of Rattlesnake Mountain, and two sites on the roof of airport control towers. The approximate locations of the meteorological monitoring sites are provided in Figure 1.

METEOROLOGICAL MONITORING AT THE HANFORD METEOROLOGY STATION (HMSS - SITE 21)

Meteorological monitoring at the HMS is conducted on the station's 410-ft instrumented tower, at surface locations, and by a doppler sodar. The station is located between the 200 West and 200 East operating areas about 0.6 mi (1 km) north of the east gate to the 200 West Area and about 300 ft (90 m) east of the local highway. The HMS is positioned near the center of the Hanford Site at 46° 33' 47" N latitude and 119° 35' 54" W longitude. The elevation of the station is 733 ft (223 m) above sea level.

The HMS is housed within the 622 R Building (Figure 3). The building is surrounded by irrigated lawns, trees, and other vegetation. Surface level measurements are made at several locations within several hundred feet of the 622 R Building. The 410-ft tower is located about 1600 ft (500 m) to the east (Figure 4). The tower sits on a large, flat, circular, paved area with several small buildings near its base. Vegetation near the tower is dominated by desert grasses and sagebrush.

The HMS is on the 200 Area Plateau at a higher elevation than most of the Hanford Site. The elevation of the terrain near the station gradually slopes downward to the north decreasing to an elevation of about 600 ft (180 m) above sea level at a point about 1.3 mi (2.1 km) north of the station.

The station can be reached from the east gate of the 200 West Area by proceeding north on Hanford Route 3 for just over 0.6 mi (1 km). Turn right (east) onto the road that leads to the base of the 410-ft instrumented tower. The 622 R Building is located on the north side of the road about 300 ft (90 m) from the highway. The station can be found on the Gable Butte Quadrangle (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 300860 m E, Y = 5151680 m N.

Standard 110 volt, 60-Hz AC power is used at the HMS to power all of the site's electrical instruments, monitoring, data processing, and communication equipment.

<u>410-ft Instrumented Tower</u>

The 410-ft instrumented tower has been in operation since 1945. Wind measurements are made at 6 levels on the tower: 30 ft (9 m), 50 ft (15 m), 100 ft (30 m), 200 ft (60 m), 300 ft (91 m), and 400 ft (122-m) (Figures 5-7). Two sets of measurements are made at the 50-ft (15-m) level on the tower. At the near-surface monitoring site, about 75 ft (23 m) northwest of the tower, wind measurements at made at 7 ft (2 m) above the ground (Figure 8). Data from this monitor are processed and stored with the data from the 410-ft tower.

Wind directions are measured using Weathertronics Model 2020 Micro Response Vanes. Wind speeds are measured using Weathertronics Model 2030 Micro Response Anemometers. The wind sensors are mounted on 48-in. (122-cm) Model 2023 Crossarms. The crossarms are positioned away from the tower on 7-ft (2-m) booms. The booms are oriented towards the northwest. At the 50-ft (15-m) level, a second set of wind measurements are made on a second boom that is oriented toward the southeast. To prevent instrument malfunction in freezing weather, the wind sensors are heated using standard heat tape. The Weathertronics wind sensors were installed in 1982 replacing Bendix Model 120 Aerovane Wind Transmitters.

Air temperatures are measured at 7 levels on the tower: 30 ft (9 m), 50 ft (15 m), 100 ft (30 m), 200 ft (60 m), 250 ft (76 m), 300 ft (91 m), and 400 ft (122 m). Weathertronics Platinum Temperature Probes are used to measure temperatures. These temperature probes are housed in motor aspirated shields.

Surface Monitoring and Observations

A variety of instruments monitor meteorological parameters at or near surface level at the HMS monitoring site. A wide variety of observations are also routinely made by the station's duty meteorologist. Where appropriate, all observational procedures are governed by National Weather Service procedures for surface observations (Standard Aviation Observations). In the following discussions, surface monitoring equipment and observational procedures will be discussed.

Surface Temperature

At the near-surface monitoring site, air temperature is measured at 5 ft (1.5 m) above the ground. As on the 410-ft tower, Weathertronics Platinum Temperature Probes are used to measure temperatures. The temperature probe is housed in a motor-aspirated shield. As a backup, in case of a power failure or another type of failure of the electronic instruments or data communication system, temperature data can be obtained from two mercury-type thermometers that are housed in a shelter located just east of the HMS.

Subsurface Temperatures

At the near-surface monitoring site, subsurface soil temperatures are measured at depths of 0.5 in. (1.3 cm), 15 in. (38 cm), and 36 in. (91 cm) using Weathertronics Model 4470A Platinum Temperature Probes. The sensors are installed in the natural soil of the area with the vegetation cover removed (Stone et al. 1983). The soil is sandy and is mixed with some large gravel. The Weathertronics temperature probes replaced the Leeds & Northrup copper thermohms that were used prior to early 1987.

Dew Point Temperature

A Hygrothermometer System Model H083 is used to measure the dew point temperature near the 410-ft tower at a height of 5.5 ft (1.7 m) above the ground. This instrument was developed by the Technical Services Laboratory for the National Weather Service and is currently the service's standard dew point sensor. This instrument replaced a Humicap Relative Humidity Probe - Model 5120 in 1986. The Humicap replaced the dewcel-based Foxboro Dew Point Measuring System in 1981. Sling psychrometers are also used periodically by HMS personnel to check dew point readings.

Atmospheric Pressure

A Fortin-type mercury barometer and a Bendix Model 790 Microbarograph are used to measure atmospheric pressure. Hourly readings are obtained by the duty meteorologist from the microbarograph. Readings are also obtained from the mercury barometer once every 3 hours. The instruments are located in Room 111 of the HMS.

Precipitation

A standard National Weather Service 8-in. (20-cm) rain gage and a Bendix Model 405 automatic tipping rain gage are used to measure precipitation. During a precipitation event, the rainfall accumulated in the 8-in. rain gage is checked hourly. If the precipitation is in the form of snow, the hourly precipitation sample is brought into the weather station and melted by adding a known quantity of warm water. The liquid water content of the hourly precipitation is then determined. Frozen precipitation entering the automatic tipping rain gage is melted by the unit's heater and the liquid water content of the precipitation is automatically recorded.

The amount of accumulated snowfall on the ground is measured in a cleared area to the south of the HMS that is reserved for this purpose. During windy conditions, when snow may drift, a series of measurements are made to determine the average snow depth.

Solar Radiation

Solar radiation is monitored using two instruments produced by the Eppley Company. One instrument monitors direct solar radiation and the other instrument monitors indirect solar radiation. The instruments are deployed south of the HMS, on the south side of the service road. Data from the instruments are recorded on a strip chart in Room 111 of the HMS.

Visibility

Visibility is measured by the duty meteorologist every hour. Visibility is determined subjectively by attempting to discern landmarks of known distance in various directions. At night, lighted landmarks are used. Under conditions of low visibility, estimates are made by counting the number of telephone poles that can be discerned from the HMS to the 410-ft tower, and north and south of the station along Hanford Route 3.

Cloud Cover

Several cloud parameters are observed by meteorologists on an hourly basis. First, the types of clouds visible from the surface are identified (e.g., altocirrus, cumulo congestus) by comparing their shapes and properties with known forms. Next, the altitude of the clouds are roughly estimated. This estimation is often based on the known altitude ranges of certain types of clouds. Also, aviation reports are used to approximate the elevation of cloud bases. For low clouds, the height of the cloud base is estimated by the amount of Rattlesnake Mountain that is obscured. At night, low clouds are observed from the reflection of lights in the 200 Areas off of the cloud bases. Also at night, a ceiling projector and clinometer can be used to estimate cloud bases. The ceiling projector is installed between the HMS and the 410-ft tower. It projects a narrow vertical beam of light, illuminating the base of any cloud directly over the projector. Using the clinometer, the meteorologist at the HMS can measure the elevation angle to the illuminated cloud base. Knowing the elevation angle and the baseline distance from the HMS to the ceiling projector, the height of the cloud base can be calculated. This device is generally useful for clouds with bases below 4000 ft (1200 m), although under optimal conditions this instrument may be useful up to a height of 10,000 ft (3000 m). Finally, the percent cloud cover is observed and recorded.

Pilot Balloon (Pi-Bal)

To estimate wind direction and speed at heights greater than can be monitored by other HMS equipment, a pilot balloon is launched from near the HMS twice a day, between 0:00 - 1:00 and 12:00 - 13:00 Pacific Standard Time. The balloon rises at an initial rate of about 700 ft (220 m) per minute. Ten minutes after launch the balloon is approximately 6000 ft (1800 m) above the surface and its rate of rise has slowed to about 590 ft (180 m) per minute. To allow the balloon to be tracked at night, it is fitted with a battery powered light. After releasing the balloon, the duty meteorologist records its position with a theodolite. After computing the balloon's altitude, and measuring its azimuth and elevation angles, the duty meteorologist can estimate the wind direction and speed at various altitudes. During conditions of good visibility, cloud cover permitting, the balloon is usually tracked to a height of over 6000 ft (1800 m) before observations are terminated. Under optimal conditions, the balloon has been tracked to a height of over 26,000 ft (8000 m).

Doppler Sodar Monitoring

Four Remtech Doppler Sodars are deployed as part of the meteorological monitoring program. One of these sodars is located a short distance east of the HMS; the other sodars are deployed near the 200-ft instrumented towers.

A doppler sodar uses sound waves to measure three-dimensional winds, turbulence indicators, and the thermal structure of the lower atmosphere.

The sodar functions like a pulse radar, but instead of emitting an electromagnetic wave, it emits an acoustic wave at a frequency of 1600 Hz (or 2400 Hz). The sodar uses the phase difference in its outgoing and incoming acoustic signals to compute the horizontal wind speed, the direction theta of the horizontal wind, the vertical wind speed (w), the standard deviation of w, and the standard deviation of theta at a number of elevations between the surface and 2000 ft (600 m) above ground level. Data from the HMS doppler sodar are displayed on a computer screen in Room 110 of the HMS for analysis by the duty meteorologist.

200-FT INSTRUMENTED TOWER MONITORING SITES

Three 200-ft instrumented towers are deployed as part of the Hanford meteorological monitoring network. These towers are located near the 300 Area, Fast Flux Test Facility, and 100-N Area. Located within several hundred feet of the base of each of the towers are the antennas for the monitoring site's Remtech doppler sodar. Each tower has a climate-controlled instrument shed to house the data processing and transmission equipment for the tower's instrumentation and the doppler sodar. Standard 110 volt, 60-Hz AC power is available at each site and is used to power the site's instruments.

Wind directions and speeds are measured at 3 levels on the towers: 30 ft (9 m), 82 ft (25 m), and 200 ft (60 m). Winds are measured using Climatronics' F460 Wind Sensors. The wind direction sensors (P/N 100076) are counterbalanced, lightweight vanes. The wind speed sensors (P/N 100075) are three cup anemometers. The wind sensors are mounted on a 44-in. (112-cm) crossarm (P/N 100487) and connected to the tower by a 5-ft (1.5-m) boom. To prevent the wind sensors from failing in freezing weather, the sensors are heated using a Climatronics external heater (P/N 100589).

Air temperatures are measured at 3 levels on the tower: 5 ft (1.5 m), 30 ft (9 m), and 200 ft (60 m). The temperature sensor used is a resistance thermistor housed in a forced ventilation chamber. The dew point temperature is also measured at the 5-ft (1.5-m) level.

The following is a description of each monitoring site. The site's location and surroundings will be described. Photographs of the site are provided as figures. The site's full name, four-character code name, and identification number are provided in the section heading.

<u>300 Area Monitoring Site (300A - Site 11)</u>

The 300 Area monitoring site is located about 1300 ft (400 m) southwest of the southwestern corner of the 300 Area. The tower is about 800 ft (250 m) west of Hanford Route 4S (Stevens Drive) and about 500 ft (150 m) west of the railroad tracks that parallel Route 4S. The site is at 46° 21' 50" N latitude and 119° 17' 08" W longitude. The elevation of the base of the tower is 390 ft (120 m) above sea level.

The 200-ft tower is situated on a gravel pad at the top of partially stabilized sand dune. The dune appears to be one of several dunes in the area that are oriented along a southwest-northeast axis. The dune is about 150 ft (45 m) wide and over 300 ft (90 m) long. The base of the tower is situated at the top of the dune at a height of 10 to 20 ft (3 to 6 m) above the surrounding terrain. Desert grasses appear to be the dominant stabilizing vegetation on the dune. Several small "blow-outs" (i.e., unstable areas of the dune with little or no vegetation) are located on the dune. The antennas for the doppler sodar are deployed a short distance southwest of the 200-ft tower. A climate-controlled instrument shed is located between the tower and the sodar antennas. Photographs of the site are presented in Figures 9-12.

The site is reached from Route 4S by turning west onto the gravel road located across from the north fence of the 300 Area [about 0.6 mi (1 km) north of the 200-ft tower]. Turn left (south) immediately after crossing the railroad tracks, and follow this gravel road south to the base of the tower. The 300 Area monitoring site can be found on the Richland Quadrangle - Washington (1978 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 324190 m E, Y = 5136820 m N.

Prior to 1983, meteorological measurements at this site were made on a 30-ft instrumented tower. The old 30-ft tower was located within 100 ft (30 m) of the present tower.

Fast Flux Test Facility Monitoring Site (FFTF - Site 9)

The Fast Flux Test Facility (FFTF) monitoring site is located about 1000 ft (300 m) south of the FFTF fenceline almost due south of the reactor dome. The site is at 46° 25' 49" N latitude and 119° 21' 31" W longitude. The elevation of the base of the tower is 570 ft (170 m) above sea level.

The 200-ft tower is situated on a large gravel pad on a stabilized sand dune at a slightly higher elevation than the surrounding terrain. The local topography is dominated by a series of low, stabilized sand dunes that are oriented along a southwest-northeast axis. An active sand dune (of the "blow-out" form) is located just to the northeast of the tower. The stabilizing vegetation in the area near the tower appears to be dominated by desert grasses. The doppler sodar is deployed a short distance to the south of the 200-ft tower. A climate-controlled instrument shed is located between the tower and the sodar antennas. Photographs of the site are presented in Figures 13-16.

The elevation of the local terrain changes dramatically along a lengthy north-south running slope that approaches within 2000 ft (600 m) to the east of the monitoring site. At the bottom of this slope the terrain elevation is more than 100 ft (30 m) lower than at the base of 200-ft tower.

To reach the monitoring site from Hanford Route 4S, take the FFTF exit and proceed 1 mi (1.6 km) down the road toward the reactor complex. Turn left (south), before reaching the FFTF's south parking lot, onto the paved service road. Proceed on this road for 0.6 mi (1 km). Turn left (south) onto the gravel road that leads directly to the base of the tower. The FFTF tower can be found on the Wooded Island Sectional (1978 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 318760 m E, Y = 5144340 m N.

Prior to 1983, a 30-ft tower was operated at a location about 0.8 mi (1.3 km) to the north-northeast of the 200-ft tower. Use of the 30-ft tower was discontinued before the 200-ft tower became operational. The old monitoring site was located outside the FFTF fenceline at a location northeast of the reactor building (approximately at UTM coordinates: X = 319200 m E, Y = 5145150 m N).

<u>100-N Monitoring Site (100A - Site 13)</u>

The 100-N monitoring site is located between the 100-N and 100-D areas, just over 1300 ft (400 m) to the southwest of the Columbia River. The site is located at 46° 41' 16" N latitude and 119° 32' 58" W longitude. The elevation of the station is 460 ft (140 m) above sea level.

The 100-N monitoring site is closer to the 100-D Area [0.5 mi (0.8 km) from the reactor buildings] than to the 100-N Area [1.5 mi (2.4 km) away]. Only the very tops of some 100-N facilities are visible from this location. Most of the 100-N facilities are hidden from view by a series of rounded mounds (a natural formation) that lie between the 100-N Area and the monitoring site.

The tower is situated on a large gravel pad surrounded by relatively flat terrain. The vegetation in the region is dominated by desert grasses. The doppler sodar is deployed a short distance to the east-northeast of the 200-ft tower. A climate-controlled instrument shed is located close to the base of the tower between the tower and the sodar antennas. Photographs of the site are presented in Figures 17 and 20.

To reach the monitoring site from the intersection of Hanford Route 4N and Hanford Route 1, proceed north on Route 4N for about 0.1 mi (160 m), toward the 100-D reactor, and turn left (west). Proceed straight ahead on this service road following it as it turns right (to the north). Turn left (west) onto the first gravel road; this road leads to the base of the tower. The FFTF monitoring site can be found on the Coyote Rapids Quadrangle - Washington

(1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 305050 m E, Y = 5173420 m N.

Prior to 1983, a 30-ft tower was operated at a location much closer to the 100-N Area. This tower was on a rise about 0.3 mi (0.5 km) east of the reactor building, at a point about 500 ft (150 m) northeast of the 100-N Area's main access road (at approximately UTM coordinates: X = 304000 m E, Y = 5171900 m N).

40-FT INSTRUMENTED TOWER MONITORING SITES

The 40-ft instrumented meteorological towers are deployed at the 100-F and Gable West monitoring sites. The towers' wind sensors are deployed at approximately 30 ft (9 m) above ground level. Winds are measured using Climatronics F460 Wind Sensors. The wind direction sensors (P/N 100076) are counterbalanced, lightweight vanes. The wind speed sensors (P/N 100075) are three cup anemometers. The wind sensors are mounted on a 44-in. (112-cm) crossarm (P/N 100487) and connected to the tower by a short boom. Temperatures are measured at 5.5 ft (1.7 m) above the ground using a Climatronics Fast Response Air Temperature Sensor - Model 100093-3. A Climatronics naturally aspirated shield protects the thermistor from direct and scattered sunlight. Standard 110 volt, 60-Hz AC power is available at each site and is used to power the site's instruments.

The following is a description of the two monitoring sites. Each site's locations and surroundings will be described. Photographs of the site are provided. The site's full name, four-character code name, and identification number are provided in the section heading.

100-F Monitoring Site (100F - Site ~~22~~ 23)

The 100-F monitoring site is located about 1.5 mi (2.4 km) south of the 100-F Area, slightly southwest of the junction of Hanford Route 1 and Hanford Route 2N, and east of the local railroad tracks. The monitoring site is also about 1.5 mi (2.4 km) west of the Columbia River. The site is at 46° 38' 6" N latitude and 119° 27' 4" W longitude. The elevation of the site is 410 ft (125 m) above sea level.

The 40-ft tower is situated on a small gravel pad in an area of relatively flat topography. The vegetation in the region appears to be dominated by desert grasses. Tumble weeds were growing within the gravel pad around the base of the tower. Photographs of the site are presented in Figures 21 and 23.

To reach the 100-F monitoring site from Hanford Route 1, near the intersection of Route 1 and Route 4N, turn south onto the gravel service road located between the railroad tracks and Route I. The site is located between Route 4 (to the east) and the railroad tracks (to the west). Proceed south on the gravel road for about 300 ft (90 m) to reach the base of tower. The exact location of the 100-F monitoring site can be found on the Locke Island Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 312380 m E, Y = 5167300 m N.

Gable West Monitoring Site (GABW - Site 24)

The Gable West monitoring site is located about 0.4 mi (0.6 km) west of the western edge of Gable Mountain at a point less than 230 ft (70 m) west of Hanford Route 4N. The site is 2.2 mi (3.5 km) north of the intersection of Hanford Route 4N and Route 1I-A and about 1.6 mi (2.5 km) south of the intersection of Hanford Route 4N and Route 1. The site is at 46° 36' 35" N latitude and 119° 33' 23" W longitude. The elevation of the station is 490 ft (150 m) above sea level.

The 40-ft tower is situated on a small gravel pad in a local area with relatively flat topography. The site is approximately 0.6 mi (1 km) north of the 200 Area Plateau. The vegetation in the region appears to consist mostly of desert grasses and a significant population of shrubs. A few tumble weeds were growing within the gravel pad around the base of the tower. Photographs of the site are presented in Figures 24-26.

To reach the Gable West tower from the intersection of Hanford Route 4N and Route 11-A, travel north on Route 4N for about 2.2 mi (3.5 km) and turn southwest onto the gravel service road that begins about 300 ft (90 m) north of the tower. This road leads to the base of the tower. The exact location of the Gable West monitoring site can be found on the Gable Butte Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 304220 m E, Y = 5164760 m N.

30-FT INSTRUMENTED TOWER MONITORING SITES WITH AC POWER

The 30-ft instrumented meteorological towers that operate on 110 volt, 60-Hz AC power are deployed at: 200 West, Rattlesnake Springs, Army Loop Road, 200 East, Gable Mountain, Yakima Barricade, Edna, Wye Barricade, Emergency Operations Center, Wahluke, WNP-2, Prosser Barricade, Sagehill, Franklin County, and Ringold monitoring sites. The wind sensors on each tower are deployed at 30 ft (9 m) above ground level. The wind sensors used on these towers are in the process of being changed from Weather Measure to Climatronics equipment. The transition to the Climatronics equipment began in early 1988, and the last tower should be converted prior to October, 1988. The Weather Measure wind sensors that have been used are the Model W103 Cup Anemometer and Model W104-SC Lightweight Vane with sin-cos potentiometers. These instruments have been mounted on a 37-in. (94-cm) crossarm - Model W1034. Heat tape has been used at some sites to prevent the instruments from failing in moist, freezing weather.

The new sensors that are being deployed are Climatronics' F460 Wind Sensors. The wind direction sensors (P/N 100076) are counterbalanced, lightweight vanes. The wind speed sensors (P/N 100075) are three cup anemometers. The wind sensors are mounted on a 44-in. (112-cm) crossarm (P/N 100487) and connected to the tower by a short boom. At present, Climatronics external sensor heaters (P/N 100589) have not been deployed on these towers.

Temperatures are measured at 5.5 ft (1.7 m) above the ground using a Climatronics Fast Response Air Temperature Sensor - Model 100093-3. The thermistors are protected from direct and scattered sunlight by a naturally aspirated shield.

The following is a description of the monitoring sites. Each site's location and surroundings will be described. Photographs of the site are provided. The site's full name, four-character code name, and identification number are provided in the section heading.

Prosser Barricade Monitoring Site (PROS - Site 1)

The Prosser Barricade monitoring site is near the location of the old Prosser Barricade on Hanford Route 10 (near the southern boundary of the Hanford Site). The Prosser Barricade guardhouse is no longer present on Route 10, but its former location is roughly indicated by a parking area on the west side of road. The monitoring site is located at 46° 23' 31" N latitude and 119° 24' 40" W longitude. The elevation of the site is 480 ft (146 m) above sea level.

The 30-ft instrumented tower is situated on a slight rise (a stabilized sand dune) about 160 ft (50 m) west of parking area. An automatic air quality sampler is operated near the base of the tower. Vegetation in the area is dominated by desert grasses. Most of the local shrubs appear to have been burned off by a brush fire that occurred several years ago. Photographs of the site are presented in Figures 27-29.

The topography near the Prosser Barricade is composed of low, rolling mounds and stabilized sand dunes. Slightly higher terrain is found to the west, north, and east of the site.

To reach the monitoring site from Washington State Highway 240, turn north onto Route 10 or turn northeast onto Horn Rapids Road. Horn Rapids Road and Hanford Route 10 merge at about the halfway point between Highway 240 and the Prosser Barricade. The monitoring site is located to the west of the southern edge of the parking area about 0.9 mi (1.5 km) up the road from Highway 240. The exact location of the Prosser Barricade monitoring site can be found on the Horn Rapids Dam Quadrangle - Washington (1977 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 314630 m E, Y = 5140220 m N.

<u>Emergency Operations Center Monitoring Site (EOCC - Site 2)</u>

The Emergency Operations Center (EOC) monitoring site is located in the old Ecology Reserve compound within the boundaries of the Arid Lands Ecology (ALE) Project. The compound is on the east slope of Rattlesnake Mountain, downhill and to the east of the Rattlesnake Mountain Observatory. The monitoring site is at 46° 23' 33" N latitude and 119° 32' 10" W longitude. The elevation of the site is 1240 ft (380 m) above sea level.

The monitoring site is situated in the northwest corner of the Ecology Reserve compound approximately 300 ft (90 m) from a series of one-story buildings located in this portion of the compound and about 1300 ft (400 m) from the EOC. The tower is located at the edge of a large gravel parking lot only several meters from the compound's fenceline. The vegetation past the edge of the parking lot is dominated by desert grasses and sagebrush. Photographs of the site are presented in Figures 30-32.

The elevation of the local topography decreases smoothly to the east-northeast, as the terrain slopes downward with a 5% grade. The EOC is located well to the east of the 30-ft tower near the entrance to the ecology reserve compound.

Unlike most of the 30-ft towers, this site is not surrounded by vegetation-covered ground. The large size of the gravel parking lot to the south and east of the tower may affect temperature readings by the site's shielded (but not ventilated) thermistors. Therefore, care must be taken when using temperature data from this site.

Access to ALE lands, including the EOC monitoring site, is restricted by fences and locked gates. A gate key is required to enter the ALE reservation and visit the EOC site. To reach the site from State Highway 240, proceed west on Horn Rapids Road for about 1.5 mi (2.4 km) and then turn right (north) onto the ALE reservation and Rattlesnake Mountain access road. Very shortly after turning onto the access road, a locked access control gate will be encountered. Unlock the gate, drive through and re-lock the gate; then proceed west and north for about 4.3 mi (7 km) [bypassing the turnoff to the Rattlesnake Mountain Observatory at 3 mi (5 km)] and turn left (west-southwest) at the road for the EOC and the ecology reserve compound. Proceed straight on this road to the west fence marking the end of the ecology reserve compound and turn right (north). The monitoring site is straight ahead at the northwest corner of the compound. The exact location of the monitoring site can be found on the Iowa Flats Quadrangle - Washington (1974 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 305020 m E, Y = 5140570 m N.

A substantial number of animal bones litter the ground near the base of the 30-ft tower. We have been assured that these bones are not the remains of visiting instrument technicians or meteorologists but of elk that expired of natural causes on the ALE reservation (the bones were collected for study by ALE scientists and later deposited at the corner of the compound).

Franklin County Monitoring Site (FRNK - Site 15)

The Franklin County monitoring site is located outside of the Hanford Site on the east side of the Columbia River. The site is located just over 4 mi (6 km) north-northeast of the 300 Area and about 1.2 mi (2 km) east of the Columbia River. The monitoring site is at 46° 25' 3" N latitude and 119° 14' 12" W longitude. The elevation of the terrain on the east side of the Columbia River is significantly higher than on the west side of the river; the elevation of the monitoring site is 875 ft (267 m) above sea level.

The Franklin County monitoring site is situated in an agricultural area of alfalfa fields and orchards. The 30-ft tower is located several feet north of a gravel road that runs east-west from a county road (Cottonwood Drive) to a farm house. A short dirt road that parallels the gravel road is several feet north of the 30-ft tower. Apple orchards border the roads; the closest trees are about 30 to 65 ft (10 to 20 m) from the tower. The rows of apple trees are perpendicular to the roads. On the south side of the gravel road, there are about four trees per row. The rows on the north side of the dirt road have substantially more trees. The trees are currently about 9 to 13 ft (3 to 4 m) tall. The trees should have some impact on the meteorological parameters measured on the tower. This impact should be greatest during the warm season when leaves are on the trees and should become more significant as the trees increase in size. Photographs of the site are presented in Figures 33-35.

The topography near the site is flat, although the elevation of the terrain increases slightly to the west. Rankin Canyon is located about 0.3 mi (0.5 km) to the west of the site, but the steep slope of the canyon's walls cannot be seen from the base of the 30-ft tower. Sparse grass grows up through the sandy soil at the base of the tower. Some agricultural equipment (e.g., irrigation pipes, tractor accessories, chemicals) were stored near the tower during our inspection of the site.

Exit at Road 68 to reach the monitoring site from Highway 182 in west Pasco. Proceed north on Road 68 for just over 3 mi (5 km) to the intersection of Taylor Flats Road. Proceed north on Taylor Flats Road for just over 8 mi (13 km), then turn left (west) onto Dogwood Road. Proceed west for about 1.6 mi (2.6 km) until the road ends at the intersection with Cottonwood Drive. On the west side of Cottonwood Drive, just north of the intersection with Dogwood Road, a gravel road continues to the west (after briefly turning south to cross an irrigation canal). Take this road west for about 0.3 mi (0.5 km) to reach the 30-ft tower. The exact location of the Franklin County monitoring site can be found on the Mathews Corner Quadrangle - Washington (1975 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 328090 m E, Y = 5142650 m N.

Ringold Monitoring Site (RING - Site 17)

The Ringold monitoring site is outside of the Hanford Site on the east side of the Columbia River. The site is located at the intersection of Rickert Road and Ranger Drive about 2.2 mi (3.5 km) east of the Columbia River and 2.5 mi (4 km) north-northeast of the Ringold fish hatchery. The monitoring site is at 46° 32' 42" N latitude and 119° 14' 13" W longitude. The site is located in a northeast-southwest oriented valley at an elevation of 620 ft (190 m) above sea level. The elevation of the terrain on the northwestern rim of the valley, 0.7 mi (1.2 km) from the site, exceeds 900 ft (270 m) above sea level. The elevation of the terrain on the southeastern rim of the valley, 1.5 mi (2.4 km) from the site, exceeds 850 ft (260 m) above sea level.

The Ringold monitoring site is situated in an agricultural area, on sandy soil, near the intersection of two roads. An irrigation canal passes a short distance from the tower. Several automatic air quality samplers are operated near the base of the tower. Cultivated fields are located to the east across Rickert Road. Other fields are located to the west of the site with tall vegetation growing in the summer between these fields and the 30-ft tower (fed by irrigation water from the fields and the irrigation canal). The vegetation on the dry soil near the base of the tower consists of desert grasses. Photographs of the site are presented in Figures 36-38.

About 230 ft (70 m) to the north-northwest of the site is located a "V-shaped" line of about 65 ft (20 m) tall Poplar trees. These trees form a wind break for a farm house and may, under some conditions, impact the winds measured on the 30-ft tower. The varying vegetative cover of the agricultural lands around this site should also have some impact on the meteorological measurements.

The local topography increases in elevation to the northeast (up-valley) and northwest (toward the valley rim). To the southwest, a hill in the middle of the valley splits the valley in half before it reaches the Columbia River. There are a few small-scale undulations in terrain height within the valley;

however, changes in elevation are so gradual and uniform that the valley floor appears flat.

To reach the monitoring site from the intersection of Taylor F'ats Road and Ringold Road [just over 16 mi (25 km) north of Highway 182 (in west Pasco) on Road 68 and Taylor Flats Road], proceed west on Ringold Road for just over 0.4 mi (0.6 km) and turn northwest onto Eltopia Road. Follow Eltopia Road down into the Ringold Valley, where the road turns into Rickert Road, for about 5 mi (8 km). The monitoring site will be visible near the left (west) side of the road just south of the intersection with Ranger Drive. The exact location of the Ringold monitoring site can be found on the Basin City Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 328560 m E, Y = 5156830 m N.

Sagehill Monitoring Site (SAGE - Site 19)

The Sagehill monitoring site is outside of the Hanford Site on the east side of the Columbia River. The monitoring site is on Mountain Vista Road, near an electrical substation, at a point about 7 mi (11 km) east of the 100-F reactor. The site is at 46° 39' 21" N latitude and 119° 17' 58" W longitude. The site is located on the Sagehill Plateau at an elevation of 990 ft (300 m) above sea level.

The Sagehill monitoring site is situated in an agricultural area, on sandy soil, between Mountain View Road and the local electrical substation. The substation is surrounded by a chain link fence that should have a negligible impact on meteorological monitoring at this site. An automatic air quality sampler is operated about 30 ft (9 m) from the base of the tower toward the substation.

The vegetation near the base of the tower consists of desert grasses and short brush. Cultivated fields are located several hundred meters to the south and west of the 30-ft tower. Less than 650 ft (200 m) west of the monitoring site, a stand of trees provides a windbreak and shade for a farm house. About 1000 ft (300 m) west of the site is a lengthy row of mature poplar trees. Under selected meteorological conditions, this line of trees might have a slight impact on wind measurements at the monitoring site. Photographs of the site are presented in Figures 39-41.

The terrain in the immediate vicinity of the site is flat. The nearest significant change in elevation begins at a point 0.4 mi (0.6 km) north of the site where the north slope of the Sagehill Plateau begins a 200 ft (60 m) descent. The western slope of the Sagehill Plateau begins its descent about 0.6 mi (1 km) west of the site. There are no significant terrain features within several kilometers to the east or south of the site.

To reach the monitoring site from the intersection of Sagehill Road and Basin Hill Road[a], proceed north for 2 mi (3.2 km) on Sagehill Road. Turn left (west) on Hollingsworth Road and proceed west for 2 mi (3.2 km) to the end of the road. Turn left (south) onto Wahluke Slope Road and proceed for 1 mi (1.6 km). Turn right (west) onto Hollingsworth Road (which resumes at this point) and proceed west for 4 mi (6.4 km) to the end of the road. Turn right (north) onto Mountain Vista Road and proceed north for about 3.5 mi (5.6 km). The 30-ft tower is located approximately 50 ft (15 m) east of the road near the electric substation. The exact location of the Sagehill monitoring site can be found on the Hanford NE Quadrangle - Washington (1986 edition) of the USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 324070 m E, Y = 5169270 m N.

WNP-2 Monitoring Site (WPPS - Site 14)

The Washington Nuclear Power Plant 2 (WNP-2) monitoring site is located about 0.4 mi (0.6 km) west of the WNP-2 reactor building. The 30-ft tower at this site is located about 120 ft (35 m) west of WNP's 200-ft instrumented tower, which is not part of the Hanford Meteorology Monitoring Program. The

(a) This intersection is located just over 1 mi (1.6 km) west of Basin City. Basin City can be reached by several different routes from the Pasco area. Basin City is located 7 mi (11 km) west of Mesa on Route 170 (Basin Hill Road).

monitoring site is at 46° 28' 12" N latitude and 119° 20' 34" W longitude. The elevation of the site is 450 ft (140 m) above sea level.

The 30-ft tower is located on sandy soil about 50 ft (15 m) from the end of the gravel service road for the 200-ft tower. The topography in the immediate vicinity of the monitoring site is flat, but stabilized sand dunes are located within several hundred meters of the site. The vegetation in the area is dominated by desert grasses. Photographs of the site are presented in Figures 42-44.

To reach the monitoring site from the Hanford Route 4S, take the exit for WNP-2 and proceed northeast for about 1.3 mi (2 km). Turn left (west) at the gravel access road that leads to the 200-ft and 30-ft towers. The exact location of the WNP-2 monitoring site can be found on the Wooded Island Quadrangle - Washington (1978 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 320150 m E, Y = 5148710 m N.

Wye Barricade Monitoring Site (WYEB - Site 12)

The Wye Barricade monitoring site is located just west of the Wye Barricade guardhouse on Hanford Route 4S. The monitoring site is at 46° 28' 56" N latitude and 119° 23' 34" W longitude. The elevation of the site is 550 ft (170 m) above sea level.

The 30-ft tower is located about 260 ft (80 m) west of the guardhouse on the top of a stabilized sand dune. Several automatic air quality samplers are operated near the base of the tower. A gravel road that parallels the highway lies between the monitoring site and the guardhouse. Because of its position on top of a sand dune, the base of the 30-ft tower is about 10 to 13 ft (3 to 4 m) above the level of the gravel road and the highway. There are no significant terrain features in the vicinity of this monitoring site; however, low, stabilized sand dunes characterize the terrain to the southwest of the site.

The vegetation in the area consists predominately of desert grasses and brush. The vegetation near the base of the 30-ft tower is less dense than at most of the other sites; there are areas on the sand dune that have no vegetation. Blow-out formations are present on the southwestern flank of the sand dune. Photographs of the site are presented in Figures 45-47.

To reach the monitoring site from Hanford Route 4S, check in at the Wye Barricade guardhouse and pull off to the west side of the road. Extreme care should be taken if one chooses to drive up the side of the sand dune to the base of the tower. A vehicle not equipped with four-wheel drive is best left on the nearby gravel road. The exact location of the Wye Barricade monitoring site can be found on the Horn Rapids Dam Quadrangle - Washington (1977 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 316390 m E, Y = 5150170 m N.

Gable Mountain Monitoring Site (GABL - Site 16)

The Gable Mountain monitoring site is located at the eastern summit of Gable Mountain. The site is located at 46° 35' 53" N latitude and 119° 27' 36" W longitude. The elevation of the site is 1085 ft (331 m) above sea level.

The summit is "littered" with various types of towers and power poles. The 30-ft instrumented meteorological tower is located about 30 ft (9 m) to the west of the small [approximately 13 ft by 20 ft (4 m by 6 m)], short [10 ft (3 m)], cinderblock building at the summit. A tall utility-type pole with a diameter of about 2 ft (0.6 m), is located near the southwest corner of the building. The soil at the summit of Gable Mountain is rocky. Sparse grasses and small shrubs grow on the summit of the mountain. Photographs of the site are presented in Figures 48-50.

To reach the monitoring site from the Wye Barricade, proceed north on Hanford Route 2S for about 6.5 mi (10.5 km). At this point, take the left fork in the road as it splits into westbound Hanford Route 11-A and northbound

Route 2N. Proceed west on Highway 11-A for about 3.3 mi (5.3 km) and turn right (north) onto the gravel road that heads straight toward the mountain. Proceed on the gravel road for 2.1 mi (3.4 km) as it approaches the mountain and winds its way up to the summit. The exact location of the Gable Mountain monitoring site can be found on the Hanford Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 311590 m E, Y = 5163230 m N.

Edna Monitoring Site (EDNA - Site 5)

The Edna monitoring site is located just east of Highway 2N about 0.5 mi (0.8 km) west of the remains of the Hanford townsite's old school. The name of the monitoring site is taken from the "Edna" railroad crossing, which is located about 0.6 mi (1 km) west of the site. The site is at 46° 35' 15" N latitude and 119° 23' 50" W longitude. The elevation of the site is 410 ft (125 m) above sea level.

The 30-ft tower is located near the remains of the foundation of a small building and about 30 ft (9 m) from a line of gravel mounds that have a maximum height of about 6 ft (2 m). The mounds flank an abandoned gravel pit. The topography of the area is flat. The base of the tower is on a surface of compacted sand and rock. Vegetation in the area is dominated by desert grasses with some shrubs. To the east and south, scattered trees mark the location of the old Hanford townsite. Photographs of the monitoring site are presented in Figures 51-53.

To reach the monitoring site from the intersection of Hanford Route 11-A and Route 2N, proceed north on Route 2N for about 0.7 mi (1.1 km). Turn right (east) onto the road that heads toward the remains of the old Hanford townsite school. About 300 ft (90 m) east of Route 2N, turn right (south) and head toward the 30-ft tower. The exact location of the Edna monitoring site can be found on the Hanford Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 316350 m E, Y = 5161910 m N.

Wahluke Monitoring Site (WAHL - Site 8)

The Wahluke monitoring site is northwest of the Hanford Site about 3.8 mi (6.1 km) east of the Mattawa turnoff from Highway 243 and 3 mi (4.8 km) east of the town of Mattawa. The site is at 46° 44' 7" N latitude and 119° 50' 11" W longitude near the southern slope of the Saddle Mountains at an elevation of 855 ft (260 m) above sea level.

The Wahluke site is situated in an agricultural area of fields and orchards. The 30-ft tower was erected about 0.1 mi (0.2 km) south of the main road on the south side of a storage building. The building is about 23 ft (7 m) tall, 30 ft (9 m) wide, and 100 ft (30 m) long. The site's anemometers are mounted about 7 ft (2 m) above the peak of the building's roof. The temperature sensor is positioned about 2 ft (0.6 m) away from the south wall of the metal building. The base of the tower sits on a gravel driveway. About 200 ft (60 m) to the east of the tower, a line of trees extends to the north and south. These trees, planted as a wind break for the farm house and supply buildings at the site, are approaching about 50 ft (15 m) in height. To the south of the monitoring site is a large irrigation pond. Photographs of the site are presented in Figures 54-56.

The topography in the area around the site is flat. The base of the south slope of the Saddle Mountains begins about 1.2 mi (2 km) to the north of the site. Less significant changes in elevation are further away in all other directions.

For sites not on U. S. government property, the permission of the property owner is required to erect a meteorological tower and hook up to the owner's electrical power. Because of this constraint, great difficulty was experienced in finding a suitable location for the Wahluke monitoring site. The location finally selected was not optimal from a meteorological standpoint. As a result, extreme care must be taken when using the data collected from this site. The winds measured on the tower are frequently impacted by the large storage building adjacent to the tower. In addition, winds are impacted, especially during the warm seasons, by the dense windbreak planted a short distance to the east. Temperature readings at this site are also impacted by the proximity of the temperature sensor to the south wall of the metal building and by the gravel surface of the driveway (as opposed to the sandy soil and desert grasses at most other sites) at the base of the tower.

To reach the monitoring site from Highway 243, take the Mattawa exit. Proceed east for 3.8 mi (6 km) through the town of Mattawa and into the agricultural area to the east. Turn right (south) onto the gravel road (to the east of the irrigation canal) that leads down the line of poplar trees toward the monitoring site. The site is hidden from view as one drives the 0.1 mi (0.2 km) down this road to the south side of the metal storage building. The exact location of the Wahluke monitoring site can be found on the Priest Rapids NE Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 283290 m E, Y = 5179430 m N.

Rattlesnake Springs Monitoring Site (RSPG - Site 4)

The Rattlesnake Springs monitoring site is east of Highway 240 on the Hanford Site's ALE Reservation. The site is located 0.4 mi (0.6 km) east of the eastern edge of the Yakima Ridge and 1.6 mi (2.6 km) southwest of gate 218 on Highway 240. The site is at 46° 30' 22" N latitude and 119° 41' 56" W longitude. The elevation of the site is 680 ft (207 m) above sea level.

In addition to the standard wind and temperature measurements made at the monitoring sites, precipitation is also measured at this site. A Weather Measure P501-I automatic tipping rain gage is situated 3 ft (1 m) from the base of the tower. A rain collector that does not have an automatic recording device and must be manually checked is deployed a short distance south of the tower.

Topography should have a strong influence on the meteorological parameters measured at this site. Winds at the site are channeled by the Yakima Ridge that lies to the west and northwest. The site is located near the mouth of a valley that descends from west to east between the Yakima Ridge (to the north) and the Rattlesnake Hills (to the south). The valley is not symmetrical;

most of the valley is composed of a 2° slope that descends from the south to meet valley's steep northern slope. Dry Creek runs along the floor of the valley just south of the steep northern slope. The monitoring site is located near Dry Creek and is, therefore, subjected to diurnal drainage flows along the valley floor. Winds and temperatures at the site may also be impacted by drainage flows that may develop within the Cold Creek Valley to the east.

The vegetation near the base of the tower consists of desert grasses and shrubs. The dense line of short trees and shrubs that run along the line of Rattlesnake Springs and Dry Creek should not impact the winds at the site to any significant degree. Photographs of the site are presented in Figures 57-59.

Access to ALE lands, including Rattlesnake Springs monitoring site, is restricted by fences and locked gates. A gate key must be obtained and used to enter the ALE reservation and visit the monitoring site. In addition, the road to the site crosses the creek into which the Rattlesnake Springs flow. A four-wheel drive vehicle with a high suspension may be needed to ford the creek.

To reach the site, take Highway 240 to gate 218[a]. This gate is located on Highway 240 about 5.5 mi (8.9 km) south of the intersection of the highway and Hanford Route 11-A (near the Yakima Barricade). Unlock the gate, drive through and re-lock the gate; then proceed southwest on this road for about 1.7 mi (2.7 km). At this point, the road turns perpendicularly toward the creek into which the local springs flow. If the creek can be successfully forded, continue forward for about 300 ft (90 m). The road will intersect another gravel road. Turn right (west) and proceed ahead for about 150 ft (45 m), then turn left (south) onto the path that leads the 150 ft (45 m) to the base of the 30-ft tower. The exact location of the Rattlesnake Springs monitoring site can be found on the Riverland Quadrangle - Washington

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(a) Gate 218 is on the west side of the highway; gate 118 is the corresponding gate on the east side of the highway.

(1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 292940 m E, Y = 5163600 m N.

Army Loop Road Monitoring Site (ARMY - Site 3)

The Army Loop Road monitoring site is located about 4 mi (6 km) south of the 200 East Area and about 1 mi (2 km) northeast of Highway 240. The 30-ft tower is positioned 100 ft (30 m) south of Army Loop Road about 1 mi (2 km) east of Goose Egg Hill. The site is at 46° 29' 19" N latitude and 119° 32' 53" W longitude. The elevation of the site is 565 ft (170 m) above sea level.

The monitoring site is located on flat terrain that slopes gradually toward the floor the Cold Creek Valley to the southwest. An automatic air quality sampler is operated near the base of the tower. An interesting topographic feature located near the site is Goose Egg Hill. This small hill, about a mile west of the site, rises only about 60 ft (18 m) above the surrounding terrain. When viewed from above it is decidedly egg-shaped, from the side it looks something like a pyramid. This feature should have a negligible impact on meteorological monitoring, but it is a good landmark for locating the site.

There is sparse vegetation on the sandy, rocky soil near the base of the tower. The tower sits on the east end of a 50-ft (15-m) diameter gravel pad that has been denuded of vegetation. Outside this immediate area are desert grasses and shrubs. Photographs of the site are presented in Figures 60-63. To reach the site from the intersection of Hanford Route 11-A and Route 6, proceed south on Route 6 (which becomes Army Loop Road) for 10 mi (16 km). At the intersection with the road that heads north along the east side of the 200 West Area, take the right fork and continue to the east. The 30-ft tower is on the south side of the road about 3.3 mi (5.3 km) east of the fork in the road. The exact location of the Army Loop Road monitoring site can be found on the Iowa Flats Quadrangle - Washington (1974 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 304450 m E, Y = 5151270 m N.

Yakima Barricade Monitoring Site (YAKB - Site 10)

The Yakima Barricade monitoring site is a short distance from the Yakima Barricade guardhouse. The Yakima Barricade is located near the intersection of Hanford Route 11-A and State Highway 240 at the western edge of the Hanford Site. The monitoring site is at 46° 34' 41" N latitude and 119° 43' 30" W longitude. The elevation of the site is 795 ft (240 m) above sea level.

The 30-ft tower is located about 230 ft (70 m) north-northeast of the guardhouse within the boundaries of the Hanford Site. A dirt road leads past a shed to the base of the tower. An array of automatic air quality samplers is deployed around the tower. In addition to the standard wind and temperature measurements made at the monitoring site, precipitation is also measured. A Weather Measure P501-I automatic tipping rain gage is deployed about 15 ft (5 m) away from the base of the tower.

This site is located on the 200 Area Plateau. The southern edge of the plateau is just over 0.6 mi (1 km) south-southeast of the site. Higher terrain is located just over 0.6 mi (1 km) to the west of the site. There are no major topographical features in the immediate vicinity of the site. The vegetation in the area consists of desert grasses and shrubs. Photographs of the site are presented in Figures 63-65.

To reach the monitoring site from the Hanford Site side of the Yakima Barricade, turn north by the brown shed located to the northeast of the guardhouse and proceed north on the dirt road for about 70 ft (20 m). The exact location of the Yakima Barricade monitoring site can be found on the Riverland Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 291200 m E, Y = 5161670 m N.

200 East Monitoring Site (200E -Site 6)

The 200 East monitoring site is located within the confines of the 200 East Area. The monitoring site is about 0.4 mi (0.7 km) north of the Plutonium Uranium Extraction (Purex) Plant. An individual must have a Hanford security badge with 200 East Area access to visit this site. The site is at 46° 33' 23" N latitude and 119° 31' 14" W longitude. The elevation of the site is 680 ft (205 m) above sea level.

The 30-ft tower is located about 100 ft (30 m) south of 7th Street at a point about 0.85 mi (1.4 km) east of Baltimore Avenue. The Critical Mass Laboratory is about 0.25 mi (0.4 km) to the west of the site. A waste storage tank farm is located a short distance to the northeast. An above-ground steam line runs between 7th Street and the 30-ft tower. The tower is within a radiation contamination zone; the zone begins just south of 7th Street and includes the steam line and the land south. Therefore, direct access to the tower and its instruments are severely restricted, although the tower can be safely viewed from 7th Street.

The topography within the 200 East Area is flat. The impact of 200 East buildings on the winds measured at the monitoring site should be negligeable. Temperatures recorded at this site may be affected by the reduced amount of vegetation and high percentage of cleared land (e.g., roads, gravel lots, parking areas) present in the 200 East Area. Photographs of the site are presented in Figures 66-68.

To reach the monitoring site from the west gate to the 200 East Area, proceed east from the guardhouse for about 0.7 mi (1.1 km) to Baltimore Avenue. Turn left (north) on Baltimore Avenue and proceed for about 0.4 mi (0.6 km) to 7th Street. Turn right (east) on 7th Street. The 30-ft tower is to the right (south) of the road about 0.85 mi (1.4 km) from the intersection of Baltimore and 7th. The exact location of the 200 East monitoring site can be found on the Gable Butte Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 306780 m E, Y = 5158730 m N.

30-FT INSTRUMENTED TOWER MONITORING SITES WITH BATTERY POWER

At present, battery powered monitoring sites are in operation at two locations: the Vernita Bridge and 200 West monitoring sites. A third such site is planned for deployment in late 1988 or 1989 in the Beverly area; additional monitoring sites of this type may be deployed in the future at locations where AC power is not available. Each of the battery powered monitoring sites is supplied with electricity from a deep-cycle 12-volt battery. The battery is recharged using a Solarex Model MSX56 solar trickle charger. The trickle charger uses a 36-Watt collection panel. Because of power restrictions, an electrical heater cannot be used to warm the wind sensors in freezing weather. As a result, slightly different monitoring equipment may be used at this type of site.

Winds at each site are measured at 30 ft (9 m) above ground level using either a Climatronics F460 or a R. M. Young wind sensor. Temperatures are measured at 5.5 ft (1.7 m) above the ground using a Climatronics Fast Response Air Temperature Sensor - Model 100093-3. The thermistors are protected from direct and scattered sunlight by a naturally aspirated shield.

<u>200 West Monitoring Site (200W - Site 7)</u>

The 200 West monitoring site is currently located about 400 ft (120 m) west of Hanford Route 6 and 2.4 mi (3.9 km) south of Hanford Route 11-A. The site is several hundred meters outside the 200 West Area fenceline. The site is at 46° 32' 35" N latitude and 119° 39' 41" W longitude. The elevation of the site is 635 ft (195 m) above sea level.

The monitoring site is currently at its third location. Prior to 1985, this site was located within the confines of the 200 West Area, at UTM coordinates: X = 298350 m E, and Y = 5157400 m N. The tower was located approximately 500 ft (150 m) west of the 242 S Building. The monitoring site was removed from this location because of the potential for local meteorological interference from nearby buildings and trees, the site's proximity to the HMS, and the need for data at the Basalt Waste Isolation Project's (BWIP) exploratory shaft location (ESL). The monitoring site was transferred to a location about 300 ft (90 m) west of the ESL. Prior to the spring of 1988, when work was being conducted at the ESL, the monitoring site received AC power. With the termination of the BWIP, the ESL was closed, all equipment was removed, and operations began to restore the land to its original condition. At this time, the monitoring site was moved several hundred meters south-southeast to its present location and transformed for battery-powered operation. At present, this site still uses the same Climatronics F460 wind sensors that were used when the site received AC power.

The topography near the current location of the monitoring site is level; there is only a 10-ft (3-m) variation in elevation within a mile of the site. The tower has been erected on a gravel pad the extends from the nearby roadway to the tower's location. The soil surrounding the site is very sandy with desert grasses and sagebrush stabilizing the surface. Photographs of the site are presented in Figures 69-71.

To reach the monitoring site, travel about 2.5 mi (4 km) south on Hanford Route 6 from the intersection with Route 11-A and turn west (right) onto the paved road that intersects the highway. The 30-ft tower is on the north side of this paved road, about 400 ft (120 m) west of the intersection with Route 6. The exact location of the monitoring site can be found on the Riverland Bridge Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 295930 m E, Y = 5157600 m E.

Vernita Bridge Monitoring Site (VERB - Site 25)

The Vernita Bridge monitoring site is located about 0.2 mi (0.3 km) downriver (northeast) from the Vernita Bridge. The site is located just west of the abandoned highway that runs north toward the Columbia River from Hanford Route 6. The site is at 46° 38' 29" N latitude and 119° 43' 34" W longitude. The elevation of the site is 430 ft (130 m) above sea level.

Winds are measured at the top of the 30-ft tower using a R.M. Young Company Wind Monitor - Model 05701. In this monitor, the wind sensor is a four-blade propeller housed on the front end of a vane assembly. The higher mass of this sensor, compared to the Climatronics F460, makes it less likely to fail due to icing in moist, freezing conditions.

The tower is located about 400 ft (120 m) south of the Columbia River and 50 ft (15 m) west of the roadway. The tower is situated on what used to be a gravel parking lot. The parking lot serviced a ferry terminal that has been abandoned since the early 1940s. The parking lot is not easily recognized; sand and soil have been deposited on it, and weeds and brush have grown up through the gravel. A small concrete building, populated by a colony of bees when the site was inspected, is located about 80 ft (25 m) east-northeast of the 30-ft tower. Photographs of the site are presented in Figures 72-74.

About 80 ft (25 m) north of the tower the local topography begins a 30-ft descent to the waters of the Columbia River. The terrain south of the monitoring site rises gradually in elevation but appears quite flat. The meteorology at this site should be strongly influenced by the Columbia River and surrounding terrain. The vegetation in this area is dominated by desert grasses. A few rugged trees still grow near the site but should not impact meteorological measurements.

Travel north on Route 6 to reach the Vernita Bridge monitoring site from the intersection of Hanford Route 6 and Hanford Route 11-A. Take Route 6 past the turnoff for the B Reactor and continue north on the unmaintained portion of the highway. Follow the highway as it turns to the west. A four-wheel drive vehicle with a good suspension is recommended; reduce speed and carefully watch for potholes. About 300 ft (90 m) east of the locked gate that restricts access to the Hanford Site from Washington State Highway 240, Route 6 turns toward the north. Proceed north for about 0.4 mi (0.6 km); the 30-ft tower will be visible on the west side of the road near the end of the old highway. The exact location of the monitoring site can be found on the Vernita Bridge Quadrangle - Washington (1986 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 291360 m E, Y = 5168710 m N.

MONITORING SITES WITH SPECIAL CHARACTERISTICS

Meteorological monitoring is conducted at three sites that have special characteristics. Two of these sites are at the top of unused airport control towers. The third site is on the crest of Rattlesnake Mountain at an elevation of over 3500 ft (1070 m) above sea level.

At the airport sites, wind monitoring instruments are mounted on short instrument poles. The wind sensors at these two sites have recently been changed from Weather Measure to Climatronics equipment. The transition to the Climatronics equipment was conducted in 1988. The new sensors are Climatronics' F460 Wind Sensors. The wind direction sensors (P/N 100076) are counterbalanced, lightweight vanes. The wind speed sensors (P/N 100075) are three cup anemometers. The wind sensors are mounted on a 44-in. (112-cm) crossarm (P/N 100487) attached to a short pole mounted on the roof of the control tower. At present, heaters have not been deployed to prevent the sensors from failing in moist, freezing weather.

The Weather Measure wind sensors that were used at the airport sites are the Model W103 Cup Anemometer and Model W104-SC Lightweight Vane with sin-cos potentiometers. These instruments were mounted on a 37-in. (92-cm) crossarm - Model W1034. Heat tape had been used to prevent the instruments from failing in moist, freezing weather.

At the Rattlesnake Mountain monitoring site, instruments are mounted on a 15-ft (5-m) metal pole. Winds are measured using a R. M. Young Company Wind Monitor - Model 05701. The higher mass of this type of sensor and the heavy duty polypropylene propeller used to measure wind speeds make the instrument more durable and dependable in the high-speed wind conditions encountered at the site. In addition, instrument failure in moist, freezing temperatures is much less likely using this type of unheated sensor. A second, slightly larger wind sensor is mounted on a shorter instrument pole only a few meters from the 15-ft instrumented pole. This second sensor provides data only to the observatory and not to the Hanford Meteorology Monitoring Program. At each of these three special sites, temperatures are measured at the monitoring sites using a Climatronics Fast Response Air Temperature Sensor - Model 100093-3.

Rattlesnake Mountain Monitoring Site (RTMN - Site 20)

The Rattlesnake Mountain monitoring site is located near the Astronomical Observatory on the crest of Rattlesnake Mountain. The monitoring site is about 230 ft (70 m) southeast of the southern-most observatory dome. The site is located close to a U.S.G.S. Azimuth Marker at 46° 23' 40" N latitude and 119° ~~24' 40"~~ 35' 37" W longitude. The elevation of the site is 3560 ft (1065 m) above sea level.

Instruments at the site are mounted on a 15-ft pole that is sunk into a concrete support platform on the crest of Rattlesnake Mountain. The surrounding surface consists of rocks and gravel. Some desert grasses have established themselves on the rocky summit. Desert grasses are the dominant vegetation on both the east- and west-facing slopes of the mountain. Photographs of the site are presented in Figures 75-77.

Access to ALE lands, including the Rattlesnake Mountain monitoring site, is restricted by fences and locked gates. A key is required to unlock the gate that restricts access to the Rattlesnake Mountain Observatory, EOC, and ALE project land. To reach the site from State Highway 240, proceed west on Horn Rapids Road for about 1.5 mi (2.4 km) and then turn right (north) onto the ALE reservation and Rattlesnake Mountain access road. Very shortly after turning onto the access road, a locked access control gate will be encountered. Unlock the gate, drive through, and re-lock the gate; then proceed west for about 3 mi (5 km) and turn left (southwest) onto the observatory access road. Proceed for about 5 mi (8 km) up the side of Rattlesnake Mountain; then turn right to enter the main observatory complex. The monitoring site is located about 230 ft (70 m) southeast of the southern-most observatory dome. The exact location of the monitoring site can be found on the Iowa Flats Quadrangle - Washington (1974 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 300590 m E, Y = 5140920 m N.

Pasco Airport Monitoring Site (PASC - Site 22)

The monitoring site at the Pasco Airport is on the roof of the old control tower on the east side of the airport. The lower levels of the old control tower and adjacent building are used by Bergstrom Aircraft. The control tower is approximately five stories tall. The site is located at 46° 15' 48" N latitude and 119° 06' 18" W longitude. The elevation of the base of the control tower is 410 ft (125 m) above sea level.

The wind sensors are mounted at a height of about 5 ft (1.5 m) above the roof of the control tower, roughly 70 ft (20 m) above the ground. An unheated Weather Measure Corporation Model P501-I Tipping Bucket Rain Gage is also deployed on the control tower roof. Air temperature is measured at a height of 5.5 ft (1.7 m) above the ground on the north side of the control tower building. Photographs of the site are presented in Figures 78-80.

To reach the site from 20th Avenue in Pasco, proceed north toward the airport. Turn right (east) just prior to entering the airport and take the airport service road for about 0.8 mi (1.3 km) around the south side of the airport. Turn left (north) at the stop sign and proceed north-northwest for about 0.3 mi (0.5 km). The control tower is on the left (west) side of the road on the airport side of the Bergstrom Aircraft hanger. Bergstrom aircraft personnel will escort visitors to the stairways used to reach the trapdoor leading to the roof of the control tower. A 4 to 5 ft (1.2 to 1.5 m) high, weather beaten, moth eaten, stuffed dog guards the roof from his perch several feet away from the wind sensors. The exact location of the monitoring site can be found on the Glade Quadrangle - Washington (1979 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 338000 m E, Y = 5125250 m N.

Large aircraft hangers are located to the south of the control tower. The size and location of these buildings could impact the winds measured on the control tower under some circumstances.

Richland Airport Monitoring Site (RICH - Site 18)

The monitoring site at the Richland Airport is on the roof of the old control tower on the south side of the airport. The airport is located to the northwest of the main portion of the city, separated from the city by the Bypass Highway. The site is located at 46° 18' 04" N latitude and 119° 18' 01" W longitude. The elevation of the base of the control tower is 390 ft (120 m) above sea level.

The wind sensors are mounted about 10 ft (3 m) above the roof of the control tower at about 40 ft (12 m) above the ground. Air temperature is measured at a height of 5.5 ft (1.7 m) above the roof of the control tower on a short instrument tower at the northern edge of the roof. The dimensions of the control tower roof are roughly 30 ft (9 m) by 30 ft (9 m). Aircraft hangers are located to the south of the control tower. The size and location of these buildings could impact the winds measured on the control tower under some circumstances. Wind sensors for airport use are mounted on the hanger immediately south of the control tower. These sensors are not maintained, and their data are not accessed by the Hanford Meteorology Monitoring Program. Photographs of the site are presented in Figures 81-83.

To reach the site, take the Richland Airport exit off of the Richland Bypass Highway. Proceed for just under 0.2 mi (0.3 km) from the Bypass Highway and turn right (north) toward the control tower. The tower is owned by the Port of Benton and the lower level is used by the Airborne Express Company; access to the stairs leading to the observation level of the control tower is through the Airborne Express office. A ladder on the outside of the observation level must be climbed to reach the control tower roof. A key is required to open the lock on the door that leads to the outside observation deck. The instruments technicians at the HMS should have a copy of this key or the door can be unlocked by Port of Benton maintenance personnel. The exact location of the monitoring site can be found on the Richland Quadrangle - Washington (1978 edition) USGS 7.5-Minute Series Topographic Map at UTM coordinates: X = 322860 m E, Y = 5129860 m N.

ADDITIONAL INFORMATION AND TECHNICAL SPECIFICATIONS FOR KEY INSTRUMENTATION

In this section of the report, additional information and the technical specifications for key instruments used in the Hanford Meteorology Monitoring Program are presented.

WIND SENSORS

Four different types of wind sensors are currently being used in the Hanford Meteorology Monitoring Program: Climatronics F460, Weather Measure, Weathertronics Micro Response, and R. M. Young sensors. Bendix sensors were used for many years on the 410-ft tower but have been replaced by the Weathertronics equipment.

The Climatronics F460 Wind Speed Sensor (P/N 100075) and Wind Direction Sensor (P/N 100076) are currently being used, or soon will be installed, on all 200-ft, 40-ft, and AC-powered 30-ft towers. The wind speed sensor is a light-weight three-cup anemometer. A LED photochopper device and a 30-hole photochopper are used to output a 2.0-volt peak-to-peak AC signal. The frequency of the signal is directly proportional to wind speed. The wind direction sensor measures wind direction using a counterbalanced, arrow-shaped vane. A constant 1-volt potential is applied to a potentiometer (variable resistor) attached to the shaft of the wind vane. The potentiometer is used to output a variable magnitude DC voltage that is directly proportional to wind direction. Technical specifications for the Climatronics wind sensors are provided in Tables 2 and 3.

Weathertronics Micro Response Wind Sensors are installed on the 410-ft instrumented tower at the HMS. The Weathertronics winds sensors replaced the Bendix sensors that operated on the tower from 1958 to 1982. The Weathertronics Micro Response Anemometer - Model 2030 is a three-cup anemometer. A LED photochopper device and a 30-hole photochopper are used to output a 4-volt peak-to-peak AC signal. The frequency of this signal is proportional to

TABLE 2. Technical Specifications for the Climatronics F460 Wind Speed Sensor P/N 100075.

Accuracy	±0.15 mph (0.07 m/s) or ±1%
Threshold	0.5 mph (0.22 m/s)
Distance Constant	8.0 ft (2.4 m) of air max.
Operating Range	0 to 125 mph (0 to 56 m/s)
Operating Temperature	-40° to 140°F (-40° to 60°C)
Maximum Diameter	2.25 in. (5.7 cm)
Height	11.5 in. (29.2 cm)
Turning Radius	3.75 in. (9.5 cm)
Weight	< 2 lb (0.9 kg)

TABLE 3. Technical Specifications for the Climatronics F460 Wind Direction Sensor P/N 100076.

Accuracy	±2°
Threshold	0.5 mph (0.22 m/s)
Distance Constant	3.7 ft (1.1 m) of air max.
Damping Ratio	0.4 at 10° initial angle of attack
Operating Range	0° to 360°
Operating Temperature	-40° to 140°F (-40° to 60°C)
Maximum Diameter	2.25 in. (5.7 cm)
Height	11.5 in. (29.2 cm)
Turning Radius	16.5 in. (41.9 cm)
Weight	< 2 lb (0.9 kg)

wind speed. The Weathertronics Micro Response Vane - Model 2020 measures wind direction using a counterbalanced, arrow-shaped vane. A constant 5-volt potential is applied to a wire-wound potentiometer attached to the vane shaft. Instrument output is a variable magnitude DC voltage that is proportional to wind direction. Technical specifications for the Weathertronics wind sensors are provided in Tables 4 and 5.

Weather Measure wind sensors have been deployed on AC-powered 30-ft towers since the late 1970s. These wind sensors are being replaced on the towers with Climatronics F460 wind sensors; the last Weather Measure wind sensor should be replaced before October 1988. The Weather Measure Cup Anemometer - Model W103 uses a three-cup anemometer and a high-speed tachometer. The tachometer consists of an oscillator, a transmitter, and a receiver. A 14-notched disc connected to the anemometer shaft is located between the transmitter and receiver. A 12-volt square wave is produced as each notch rotates past the transmitter and receiver. The output from the receiver is a pulse train at a frequency of 14 pulses per revolution of the disc. The Weather Measure Lightweight Vane - Model W104-SC, measures wind direction using a counterbalanced, arrow-shaped vane. A constant voltage is applied to a sin-cos potentiometer that is attached to the shaft of the vane. Output from the potentiometer is in the form of a variable magnitude DC voltage that is proportional to wind direction. Technical specifications for the Weather Measure wind sensors are provided in Tables 6 and 7.

At the Rattlesnake Mountain and Vernita Bridge monitoring sites, R. M. Young Wind Monitors are used to measure wind speed and direction. The R. M. Young instruments are shaped like an airplane fuselage. A propeller is mounted on the front of the fuselage of the vane assembly. The rotation of the propeller induces a current in a stationary coil inside the housing of the fuselage via the six-pole magnet attached to the propeller shaft. Output is a 2-volt peak-to-peak AC signal; the frequency of which is proportional to wind speed. Wind direction is determined by the R. M. Young sensor by applying a constant 1-volt potential to a wire-wound potentiometer that is

TABLE 4. Technical Specifications for the Weathertronics Model 2030 Micro Response Anemometer.

Accuracy	±0.15 mph (0.07 m/s) or ±1%
Threshold	0.5 mph (0.22 m/s)
Distance Constant	5 ft (1.5 m)
Operating Range	0 to 100 mph (0 to 45 m/s)
Operating Temperature	-40° to 140°F (-40° to 60°C)
Diameter	2.75 in. (7.0 cm)
Height	12 in. (30.5 cm)
Turning Radius	3.8 in. (9.7 cm)
Weight/Shipping Weight	2.5 lb (1.1 kg) / 7 lb (3.2 kg)

TABLE 5. Technical Specifications for the Weathertronics Model 2020 Micro Response Vane.

Accuracy	±2°
Resolution	<1%
Threshold	0.5 mph (0.22 m/s)
Damping Ratio	0.4
Delay Distance	3.5 ft (1.07 m)
Operating Temperature	-40° to 140°F (-40° to 60°C)
Diameter	2.75 in. (7.0 cm)
Height	12 in. (30.5 cm)
Turning Radius	18 in. (45.7 cm)
Weight/Shipping Weight	2.5 lb (1.1 kg) / 7 lb (3.2 kg)

TABLE 6. Technical Specifications for the Weather Measure Model W103 Cup Anemometer

Accuracy	±0.15 mph (0.07 m/s) or ±1%
Threshold	0.6 mph (0.27 m/s)
Distance Constant	5 ft (1.5 m)
Operating Range	0 to 100 mph (0 to 45 m/s)
Operating Temperature	-30° to 140°F (-34° to 60°C)
Diameter	7 in. (17.8 cm)
Height	16.75 in (42.6 cm)
Weight	2 lb (0.9 kg)
Shipping Weight	3.5 lb (1.6 kg)

TABLE 7. Technical Specifications for the Weather Measure Model W104 Lightweight Vane.

Resolution	0.72°
Threshold	0.75 mph (0.34 m/s)
Distance Constant	3.5 ft (1.1 m)
Potentiometer Linearity	0.5%
Diameter	37 in. (94.0 cm)
Height	17 in. (43.2 cm)
Weight	4 lb (1.8 kg)
Shipping Weight	5 lb (2.3 kg)

attached to the vane shaft. Output is in the form of a variable magnitude DC voltage that is proportional to wind direction.

Two types of R. M. Young Wind Monitors are used: the Model 05701-RE at Vernita Bridge and the Model 05305-AQ at Rattlesnake Mountain. The Model 05701-RE uses a four-blade, polystyrene plastic, helicoid-shaped propeller. The Model 05305-AQ uses a propeller of similar design but is made of polyproylene plastic. The Model 05701-RE instrument has a lower wind speed start-up threshold. The Model 05305-AQ instrument is designed to be sturdier under high wind speed conditions, such as encountered near the summit of Rattlesnake Mountain. The technical specifications for the R. M. Young wind sensors are provided in Tables 8 and 9.

Between 1958 and 1982, wind directions and speed were measured on the 410-ft tower using the Bendix Aerovane Wind Transmitter - Model 120. This instrument is similar in shape to the R. M. Young wind sensor. A three-blade propeller (described in the instrument's literature as an "impeller") is attached to the front of the fuselage of the wind vane. The propeller is connected to the armature of a tachometer magneto. A voltage proportional to the speed of rotation of the propeller is output from the tachometer. Wind direction is measured by a synchro rotor that is coupled to the vane. The synchro electrically transmits the vane position to a remote synchro.

AIR TEMPERATURE SENSORS

There are two types of air temperature sensors deployed at the Hanford site: Climatronics Fast Response Air Temperature Sensors, Weathertronics Platinum Temperature Probes. The Climatronics temperature sensors are deployed on the 200-ft, 40-ft, and 30-ft towers. The Weathertronics temperature sensors are deployed on the 410-ft tower and are used for sub-surface monitoring.

The Climatronics Fast Response Air Temperature Sensor - Model 100093-3 uses a two-thermistor composite that is directly exposed to the air from

TABLE 8. Technical Specifications for the R. M. Young Wind Monitor - Model 05701-RE with the Polystyrene Propeller

Threshold for Vane Assembly....	0.9 mph (0.4 m/s) at 10° displacement
Damping Ratio for Vane	0.65
Threshold for Propeller	0.5 mph (0.2 m/s)
Distance Constant	3.1 ft (1 m)
Operating Range	0 to 70 mph (0 to 30 m/s)
Diameter of propeller	8.7 in. (22 cm)
Pitch of propeller	11.7 in. (30 cm)
Height	14.8 in. (38 cm)
Length	25.4 in. (65 cm)
Sensor Weight	1.5 lb (0.7 kg)
Shipping Weight	8 lb (2.7 kg)

TABLE 9. Differences in Technical Specifications for the R. M. Young Wind Monitor - Model 05305-AQ with the Polypropylene Propeller

Threshold for Vane Assembly....	1.0 mph (0.5 m/s) at 10° displacement
Damping Ratio for Vane	0.45
Threshold for Propeller	0.9 mph (0.4 m/s)
Distance Constant	10.5 ft (3.3 m)
Operating Range	0 to 112 mph (0 to 50 m/s)
Diameter of propeller	7.1 in. (18 cm)
Pitch of Propeller	30 cm (11.7 in)

inside a protective cage. When a constant voltage is applied to the device, a variable magnitude DC voltage is output that is proportional to the temperature of the air around the thermistors. The technical specifications for the Climatronics temperature sensor are provided in Table 10.

Two types of Climatronics sensor shields are used to shield the Climatronics temperature sensors from direct and diffuse solar radiation and precipitation: the Naturally Aspirated Shield P/N 100552 and the TS-10 Motor Aspirated Shield P/N 100325. The naturally aspirated shield has a louvered design that consists of three anodized aluminum sectional louvers. The louvers are separated to provide natural aspiration while shading the sensor. Under full sun, with winds in excess of 7 mph (3 m/s), absolute errors typically do not exceed 0.7°F (0.4°C). The motor aspirated shield is designed to shield the sensor from both short- and long-wave radiation. The motorized fan provides a high air flow rate past the sensors, ensuring a proper mixture of ambient air for measurement. The shield can house four different types of Climatronics sensors: a temperature, two dew point, and a relative humidity sensor. The open end of the shield's cylinder should be faced north to keep the sun from shining into the cylinder and causing errors. The unit is about 34.1 in. (87 cm) long, 8 in. (20 cm) wide, and 17.75 in (45 cm) high with the optional dew point shield.

On the 200-ft towers, the temperature difference (ΔT) between the 200-ft and 30-ft levels on the tower are monitored using a matched pair of Climatronics temperature sensors. Data from the sensors are used to determine the air temperature at the sensor's respective measurement level and also the temperature difference between the 200-ft and 30-ft levels on the tower.

The Weathertronics Platinum Temperature Probe - Model 4470 uses the variable resistivity of a platinum wire at different temperatures as the temperature sensing element. The platinum element is mounted in a stainless steel housing that is approximately 6 in. (15 cm) long. The output is a voltage that is directly proportional to the air temperature. The sensor is mounted in a Model 8150 motor aspirated shield to protect it from direct

TABLE 10. Technical Specifications for the Climatronics Fast Response Air Temperature Sensor Model 100093-3.

Range	-22.0° to 122°F (-30.0° to 50.0°C)
Accuracy & Interchangeability	±0.27°F (0.15°C)
Time Constant	0.6 s
Linearity	±0.29°F (0.16°C)
Leads	3

solar radiation. Air is continually drawn through the mechanically aspirated shield past the sensor. The technical specifications for the Weathertronics Platinum Temperature Probe are provided in Table 11.

SUBSURFACE TEMPERATURE SENSORS

The Weathertronics Model 4470A Platinum Temperature Probe is used to measure subsurface soil temperature. This instrument is an enhanced version of the Model 4470 sensor. The technical specifications for this Weathertronics temperature probe are provided in Table 12.

DEW POINT SENSORS ON THE 200-FT TOWERS

To measure the dew point at the 5-ft (1.5 m) level on the 200-ft towers, Climatronics Dew Point Sensors - Model 101197 are currently used. These sensors are mounted inside the Climatronics motor aspirated shields that also house the Climatronics air temperature sensors. The dew point sensor consists of two gold wire electrodes wound around a fiberglass wick impregnated with lithium chloride (LiCl). The wick also encloses a thermistor temperature sensor. When the hygroscopic LiCl crystals absorb moisture from the atmosphere, the crystals change to a liquid solution. This causes the electrical conductivity of the wick to increase, allowing a current to flow between the gold wires. The AC voltage applied across the gold wire electrodes causes an increase in temperature due to resistive heating. This increase in temperature causes water to evaporate from the wick allowing the LiCl to recrystallize. This causes a decreases in the wick's electrical conductivity and resistance heating. Eventually a dynamic equilibrium is reached between the vapor pressure of the salt and the surrounding air. The air temperature at this dynamic equilibrium is the liquid-crystal transition point temperature, and it is sensed by the thermistor temperature sensor. The transition temperature is then converted to the dew point temperature using a signal conditioning translator.

TABLE 11. Technical Specifications for the Weathertronics Platinum Temperature Probe - Model 4470

Range	-58° to 212°F (-50° to 100°C)
Accuracy	±0.2°F (0.1°C)
Time Constant	15 s
Cable Length	16 ft (5 m)
Number of Conductors	3
Active Element Size	0.75 in. (1.9 cm) at tip
Size	0.4 in. diameter by 6 in. length (10 mm by 150 mm)
Weight/Shipping Weight	0.5 lb / 1 lb (0.22 kg / 0.45 kg)

TABLE 12. Technical Specifications for the Weathertronics Platinum Temperature Probe - Model 4470-A

Range	-58° to 212°F (-50° to 100°C)
Accuracy	±0.2°F (0.1°C)
Time Constant	15 s
Cable Length	5 ft (2 m)
Number of Conductors	4
Active Element Size	0.75 in (1.9 cm) at tip
Size	0.25 in. diameter by 6 in. length (6 mm by 150 mm)
Weight/Shipping	0.5 lb / 1 lb (0.22 kg / 0.45 kg)

The Climatronics dew point sensor will measure dew point temperatures from -40° to 120°F (-40° to 50°C). Output from this instrument is in the form of an AC signal. The instrument will operate in relative humidities from 100% down to the relative humidity at which the LiCl temperature is about 4°F (2°C) above the ambient temperature, generally between 18 and 11% depending on the temperature. The response time of the instrument depends on the rate of air flow over the wick and the direction of change of the dew point. The higher the airflow over the probe the greater the response time. Likewise, a declining relative humidity increases the response time.

PRECIPITATION MONITORING

Automatic monitoring of precipitation is conducted at the Yakima Barricade, Rattlesnake Springs, and Pasco Airport monitoring sites. The instrument used at these sites is a Weather Measure P501-I Remote Recording Rain Gage. The instrument has a 8 in. (20 cm) diameter opening for collecting precipitation. Two chrome-plated brass buckets alternately fill with precipitation and tip causing momentary closure of a mercury switch. Data from the rain gage are recorded at each site by the IMP-834 and transmitted to the HMS, along with other data, every 15 min. The technical specifications for this Weathertronics temperature probe are provided in Table 13.

SOLAR RADIATION MONITORING

Two instruments manufactured by the Eppley Company are used to measure solar radiation. One instrument measures direct solar radiation and the other instrument monitors indirect solar radiation. The instruments are deployed to the south of the HMS. Data from the instruments are transferred to the HMS over a buried, dedicated line. Values are recorded on a strip chart in Room 110 of the HMS. Hourly values are later input to the 622 VAX for permanent storage.

TABLE 13. Technical Specifications for the Weather Measure P501-I Remote Recording Rain Gage

Orifice	8 in. (20 cm)
Default Calibrations	0.01 in. or 0.25 mm
Switch	Mercury with 0.1 s closure
Accuracy	0.5% (calibrated at 0.5 in./hr)
Materials	Aluminum and brass
Size	20 in. high by 9.5 in. outer dia. (51 cm high by 24 cm outer dia.)
Weight/Shipping	10 lb (4.8 kg) / 13 lb (7.3 kg)

HYGROTHERMOMETER

At the HMS, a Hygrothermometer System Model HO83 is used to measure the dew point temperature. The monitor is located at 5 ft (1.5 m) above ground level or the near-surface instrument array located northwest of the 410-ft tower. This instrument was developed by the Technical Services Laboratory for the National Weather Service. The instrument is a climatic thermometer and dew point indicator composed of three parts: an aspirator, transmitter, and a display unit. The aspirator, a mushroom-shaped object, is the monitoring unit. The waterproof transmitter is housed within 5 ft (1.5 m) of the aspirator. The remote display unit is located in the HMS and receives data from the transmitter via a dedicated line. The unit displays the dew point temperature using an incandescent digital display.

The hygrothermometer uses a chilled-mirror system to monitor the dew point. At the dew point temperature, water vapor begins to condense forming optically detectable droplets. Using a feedback loop, a mirror in the instrument is maintained at the temperature at which a thin film of condensate is barely detectable on the surface of the mirror. This temperature is then measured by a thermal sensor on the mirror. Output is a DC voltage that is converted to a digital signal at the transmitter. The technical specifications for this instrument are provided in Table 14.

DOPPLER SODAR

The Remtech doppler sodar uses three antennas to emit and receive acoustic signals that are used to monitor the thermal structure of the atmosphere. The antennas are large, hollow, distorted cylinders with emitter/receivers inside. One antenna is pointed vertically, the other two point at an angle of 18° from the vertical and are oriented at an angle of 90° from each other. The antennas emit a series of acoustic waves into the atmosphere. These waves are partially reflected back to the antennas by slight variations in the temperature structure of the atmosphere. The reflected signal is received

TABLE 14. Technical Specifications for the Model H083 Hygrothermometer

Operating Temperature	-58° to 158°F (-50° to 70°C)
Relative Humidity	5 to 100 %
Wind	0 to 50 knots (0 to 26 m/s)
Ambient Temperature Accuracy	±1°F from -58° to 122°F (±0.6°C from -50° to 50°C)
Dew Point Accuracy	±1.0°F (0.6°C), when > 32°F (0°C)
Sample Rate	2.5 per second
Aspirator Size and Weight	14 in. x 8.5 in. x 8 in. and 6 lb (36 cm x 22 cm x 20 cm and 2.7 kg)
Transmitter Size and Weight	19 in. x 14 in. x 6 in. and 28 lb (48 cm x 36 cm x 15 cm and 13 kg)
Display Unit Size and Weight	19 in. x 5.5 in. x 15 in. and 14 lb 48 cm x 14 cm x 38 cm and 6 kg

back at the antennas, which act as receivers as well as transmitters, as a continuous echo train. The sodar uses the phase difference of the outgoing and incoming acoustic signals to compute the horizontal wind speed, the direction theta of the horizontal wind, the vertical wind speed (w), the standard deviation of w, and the standard deviation of theta at various levels between the surface and 2000 ft (600 m) above the ground.

The return signal from the sodar is analyzed on a small DEC computer that is part of the Remtech sodar system. Processed output is transmitted to the HMS from the 200-ft tower monitoring sites via microwave links. At the HMS, output is displayed in a numerical format on a monitor screen at the HMS. More detailed information on the sodar is provided in Appendix A.

CLIMATRONICS IMP-834 REMOTE TELEMETRY UNIT AND SIGNAL INTERFACE

This device is composed of the IMP-834 Signal Interface, Model #SK-001157, and the IMP-834 Telemetry Unit, Model #SK-001268. The purpose of this device is are to acquire, process, and transmit data from remote monitoring sites to the HMS (via a repeater on Rattlesnake Mountain). Inputs to the device may be analog, counter, or digital. The device has 12 analog channels and 4 counters. The IMP-834 scans its channels for information every 5 s (every second for the tipping rain gage), stores the information for 15 min, and sends out 15-min averaged values. Values are transmitted on the hour, the half-hour, and 15 min before and after the hour. The output is a digital sequence of numbers, transmitted at 416.5 MHz with 4 watts of power.

The IMP-834 is used at most locations to process the analog signals from the instruments, average the data, and transmit these data to the HMS. At some monitoring sites a Climatronics signal conditioner may be used to pre-condition signals before they reach the IMP-834. This pre-conditioning is required at sites using the Weather Measure anemometers with their sin-cos potentiometers but is optional at other monitoring sites.

DATA PROCESSING AND TRANSMISSION

In this section of the report, additional information is presented on how signals from the monitoring instruments are converted to meaningful data and transmitted to the HMS for usage and storage.

INSTRUMENTATION ON THE 410-FT TOWER

The wind and temperature sensors on the tower send their output signals to the Weathertronics Signal Conditioning Module (SCM). The Weathertronics Anemometers send an AC signal with a frequency range of 0 to 1014 Hz and the vanes send a variable magnitude DC voltage signal. The SCM produces two output signals for each instrument. One output is a 0- to 10-millivolt DC signal that is proportional to the wind direction or speed. This signal is sent by dedicated line to a strip chart recorder located at the HMS. The other output signal is a 0- to 5-volt DC signal that is also proportional to the wind direction or speed.

The Weathertronics Platinum Temperature Probes also send their output signals to the SCM. The SCM produces two output signals for each instrument. One output is a 0- to 1-volt DC signal that is proportional to the measured temperature. This signal is sent by dedicated line to a strip chart located at the HMS. The other signal is a 0- to 5-volt DC signal that is also proportional to temperature.

Output signals from the SCM travel through a dedicated line to a Multitronics multiplexer located at the HMS. The multiplexer is an electronic device that converts analog inputs from each of its 30 channels to digital information. The multiplexer processes the analog signals from the SCM into digital information. The HMS's VAX 11/750 minicomputer scans all the channels of the multiplexer every 5 s (through an RS-232 link), and the information obtained by the VAX is stored on the computer's hard disk.

When Bendix Aerovane Transmitters were used to measure winds on the tower, their output signals went, via a dedicated cable, to Bendix-Friez Model 141 Aerovane Wind Recorders at the HMS. The recorder is a two-element device that simultaneously produces, in separate channels, inked traces of wind direction and speed on a continuous paper chart. The chart could be set to advance at 1.5, 3, or 6 inches per hour. The wind speed output voltage was on the order of 0 to 10 volts. Data on the strip charts were analyzed by the duty meteorologist at the HMS and averages were recorded in the log book.

SURFACE INSTRUMENTATION

The information from the hygrothermometer are sent by the instrument's transmitter over a dedicated line to the display unit. Values are manually recorded by the duty meteorologist and are interactively entered into the HMS VAX 11/750's meteorological database. Output from the wind and air temperature sensors on the near-surface instrument array follows the same data transmission pathway as does data from the 410-ft tower. Similarly, data from the Weathertronics subsurface temperature sensors follow the same data transmission pathway as the air temperature sensors on the 410-ft tower.

Data from the solar radiation instruments are continuously transmitted over a dedicated line to the HMS where they are displayed on strip charts in Room 111. Data on the charts are read hourly by the duty meteorologists and are manually keypunched in the HMS VAX 11/750's meteorological database.

Data from the station's tipping rain gage is sent over a dedicated line to a strip chart in Room 111 of the HMS. Data on the chart are read hourly by the duty meteorologists and are manually keypunched in the HMS VAX 11/750's meteorological database.

DOPPLER SODAR

The REMTECH Doppler Sodar sends data to a continuous tape, which stores data for 3 days before recycling and writing over the first day on the tape. The Sodar equipment package near each 200-ft tower is located in the site's climate-controlled instrument shed. The data are 15-min averages. Currently, there is no method of long-term data storage, except on the erasable tape. The information from the sounder is transmitted via microwave to a receiver in the 200 West Area; from there the signals are sent by wire to the HMS.

Serious problems have been experienced in using the REMTECH Doppler Sodars on an operational basis. The maximum height at which these sodars seem to monitor has been about 1300 ft (400 m), significantly less than the projected 2000 ft (600 m). Reliable performance has only been achieved during fair weather and when the instrument has been operating in a temperature range of 77° to 86°F (25° to 30°C). In addition, the interface between the VAX and the sodar has caused problems for the HMS's VAX computer. Also, AC noise from such devices as the HMS's air conditioners have interfered with the sodar's performance. Assistance is being obtained from the REMTECH Corporation to help remedy the problems that have been encountered.

INSTRUMENTATION ON THE 200-FT, 40-FT, AND 30-FT TOWERS

Instruments on the 200-ft and 40-ft towers send their output signals to their monitoring site's Climatronics Remote Meteorological Station (RMS) signal conditioner. The Climatronics F460 Wind Speed Sensor outputs a 2.0-volt peak-to-peak AC signal, and the F460 vane outputs a variable magnitude DC voltage. The Climatronics Dew Point Sensors and Climatronics Fast Response Air Temperature Sensors send similar signals to the RMS. The signals from the air temperature sensors at the 30-ft (9-m) and 200-ft (60-m) levels on the 200-ft towers are used to compute ΔT, in addition to being used for directly monitoring local air temperature.

For 30-ft towers equipped with Weather Measure wind sensors, signals are output as 0- to 5-volt DC signals. For sites equipped with the R. M. Young Wind Monitor, the anemometer sends an AC signal with a frequency range of 0 to 456 Hz and the vane sends a 0- to 1-volt DC signal.

Output signals from the instruments go to the RMS, which produces one output signal for each instrument. The output signal is a 0- to 5-volt DC signal that is proportional to the parameter being measured. This signal is sent to the IMP-834 to be digitized and transmitted.

The IMP-834 unit scans its channels for incoming information every 5 s. This information is stored for 15 min and processed into a 15-min average. Every 15 min, starting on the hour, the IMP transmits the 15-min averaged data via a UHF digital signal (at 416.500 MHz) to the repeater located on Rattlesnake Mountain. The repeater then sends this signal to the UHF base station at the HMS. From the base station, data are sent to the VAX 11/750 via an RS-232 serial data link.

MAINTENANCE AND CALIBRATION PROCEDURES

In this section of the report, the routine maintenance and calibration procedures for the instruments used in the Hanford Meteorology Monitoring Program are presented. Most of the instruments in the program undergo routine maintenance and calibration at least once a year. In addition to routine procedures, additional instrument repair, maintenance, and calibration are done on an "as needed" basis.

A formal program of in-house annual maintenance and calibration is in place for most instruments, with procedures carefully outlined in the PNL Quality Assurance Manual (PNL MA-70). For new instruments, the manufacturer's recommended procedures are generally followed until formal procedures are prepared. For some instruments, a formal program for maintenance and calibration has not been developed because outside organizations have assumed responsibility for these functions (e.g., the National Weather Service services the stations mercury barometer).

FORMAL PROGRAM FOR MAINTENANCE AND CALIBRATION

Annual maintenance and calibration are performed for all wind and temperature sensors. A formal program of annual maintenance and calibration began in 1975. This program incorporated many of the procedures that had been conducted on a routine basis as part of the existing in-house program of maintenance and calibration. Formal maintenance and calibration procedures exist for the instruments specified in Table 15.

Details of the calibration and maintenance procedures for the instruments listed in Table 15 are presented in Appendix B.

Table 15. List of Instruments for which Formal Maintenance and Calibration Procedures Exist.

- Weathertronics wind sensors
- Climatronics wind sensors
- Weather Measure wind sensors
- Weathertronics platinum temperature probes
- Climatronics temperature sensors on towers
- Radio telemetry translator
- Radio telemetry translator calibration for the Weather Measure Model SC701 Signal Conditioning System
- Remote radio telemetry data acquisition system (Climatronics 1MP-834)
- Weathertronics Model 5141 humidity monitoring system
- Remote Telemetry Station System Calibration

PROCEDURES FOR INSTRUMENTS THAT ARE NOT PART OF THE FORMAL PROGRAM

The solar radiation sensors at the HMS are not calibrated by HMS technicians, but are sent to National Oceanic and Atmospheric Administration (NOAA) laboratories for calibration every few years. The two solar radiation instruments were last calibrated in 1981 and 1984 and prior to that in the mid-1970s. During these calibration procedures, the units were both found to be operating correctly and properly calibrated.

The hygrothermometer at the HMS is not manually calibrated. The instrument has a built in self-check system. If problems arise, the instrument is shipped to the NOAA to be fixed.

Formal maintenance procedures have not been written for the Climatronics Dew Point Sensor. At the present time, the manufacturers maintenance procedures are being followed (Appendix C).

The Doppler Sodar self-calibrates every hour. The systems output is routinely examined to search for mechanical failures. The only maintenance performed is the cutting of weeds and grass around the sodar antennas to prevent the impedance of the acoustic signals.

The mercury barometer at the HMS is calibrated every few years by a technician from the National Weather Service. This calibration is performed at the discretion of the weather service and is consistent with the calibrations performed at the weather service's own stations. Every 6 h the microbarograph is calibrated to match the mercury barometer.

FIGURES

FIGURE 1. A Map of the Hanford Site and Surrounding Areas. The location of the HMS is indicated by a darkened square. Other meteorological monitoring locations are denoted by darkened circles. Site identification numbers are plotted alongside the symbols. Using smaller type, Hanford route numbers are also plotted on the map as are "240" for State Highway 240 and "ALR" for Army Loop Road.

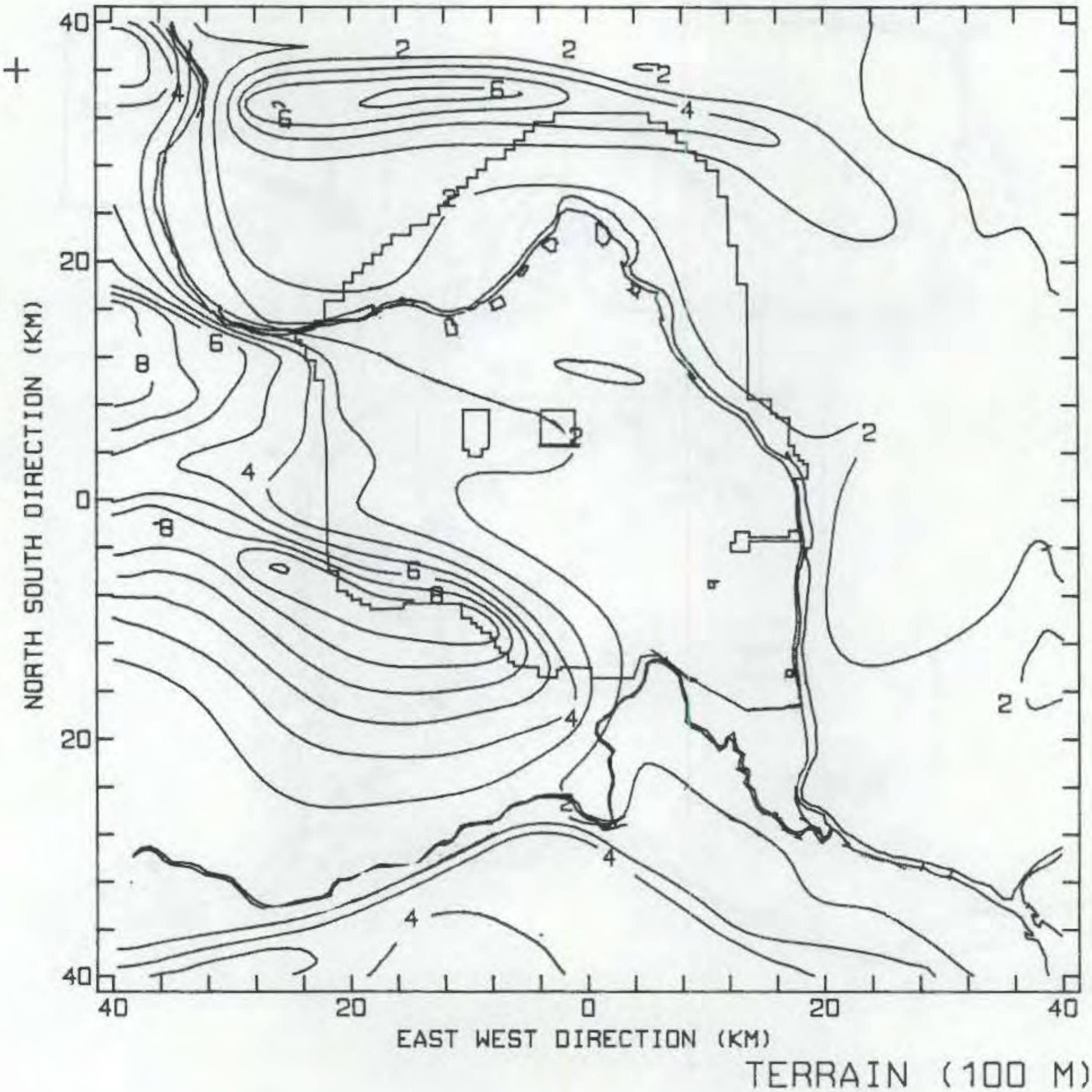


FIGURE 2. A Map of the Terrain of the Hanford Site and Surrounding Areas. The contour lines are labeled by single digit numbers that represent elevation above sea level in hundreds of meters. Each contour line represents a change in elevation of 200 m (660 ft).

FIGURE 3. A View to the North-Northwest of the HMS (622 R Building).

FIGURE 4. A View to the East of the HMS's Doppler Sodar Antennas and the 410-ft Instrumented Tower.

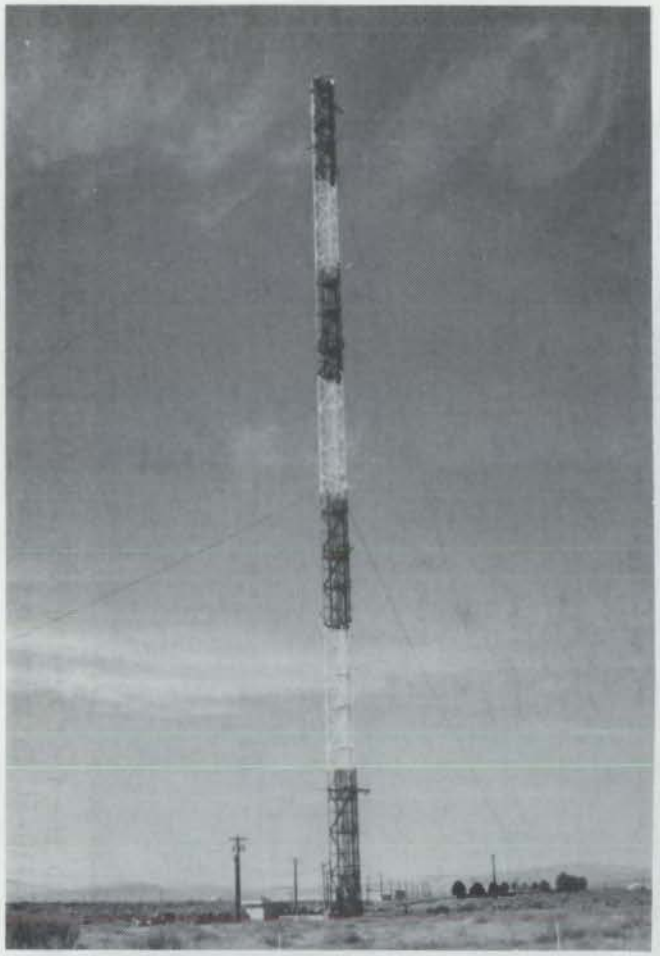


FIGURE 5. A View to the West-Southwest of the 410-ft Instrumented Tower. The HMS is 1600 ft (500 m) to the west of the tower and is visible (bracketed by trees) in the lower right hand corner of the picture.

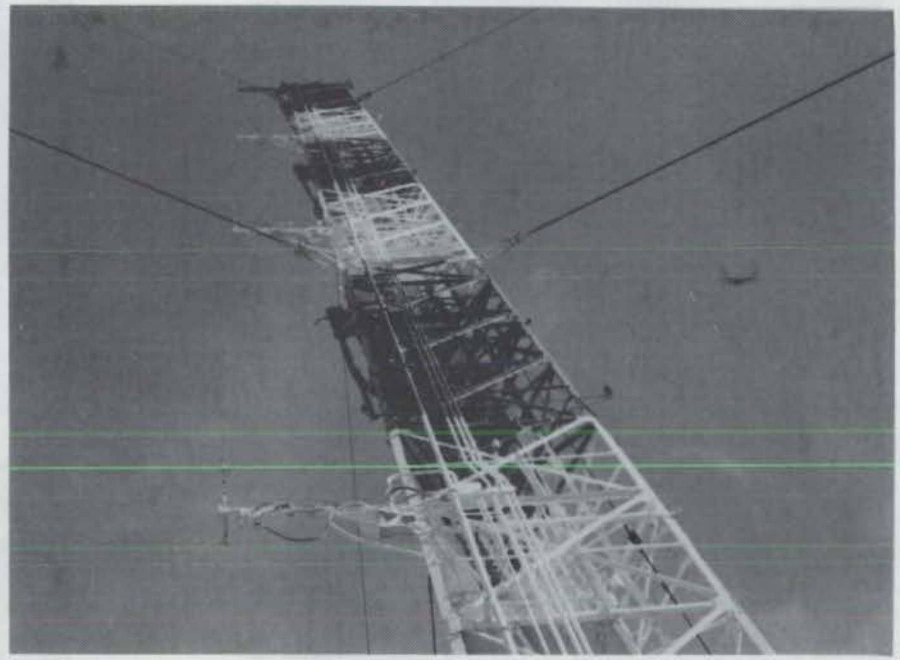


FIGURE 6. A Close-Up View of the Middle and Upper Portions of the 410-ft Tower. Instruments are mounted on the booms that are visible at the 100-, 200-, 300-, and 400-ft levels on the tower.

FIGURE 7. A Close-Up View of the Two Lower Monitoring Levels on the 410-ft Tower. The instrument booms at the 30- and 50-ft levels on the tower are visible. To gage the influence of the tower on the wind, measurements are made on two oppositely pointing booms at the 50-ft level.

FIGURE 8. The Instrument Array Deployed 70 ft (25 m) North-Northwest of the Base of the 410-ft Tower. Wind sensors are deployed at 7 ft (2.1 m) above ground level, an air temperature sensor and a hygrothermometer at 5.5 ft (1.7 m) above ground level, and three subsurface temperature sensors at varing depths in the sandy soil.

FIGURE 9. A View to the Northeast of the Base of the 200-ft Tower at the 300A Monitoring Site. The base of the tower is surrounded by a gravel pad laid on a partially stabilized sand dune. A corner of the site's instrument shed is visible on the right edge of the picture. The 300 Area is in the background.

FIGURE 10. A View to the South-Southwest from Near the Base of the 200-ft Tower at the 300A Monitoring Site. The tower's gravel service road extends to the antennas for the doppler sodar. A large "blow-out" formation is present on the sand dune a short distance to the south of the sodar antennas.

FIGURE 11. A View to the North-Northeast of the 200-ft Tower at the 300A Monitoring Site. The doppler sodar antennas are in the foreground slightly below the level of the base of the 200-ft tower.

FIGURE 12. A Close-Up View of the 200-ft Tower at the 300A Monitoring Site. Instruments are mounted at the 30-, 100-, and 200-ft levels. Also on the tower are a UHF radio antenna and a microwave receiver/transmitter.

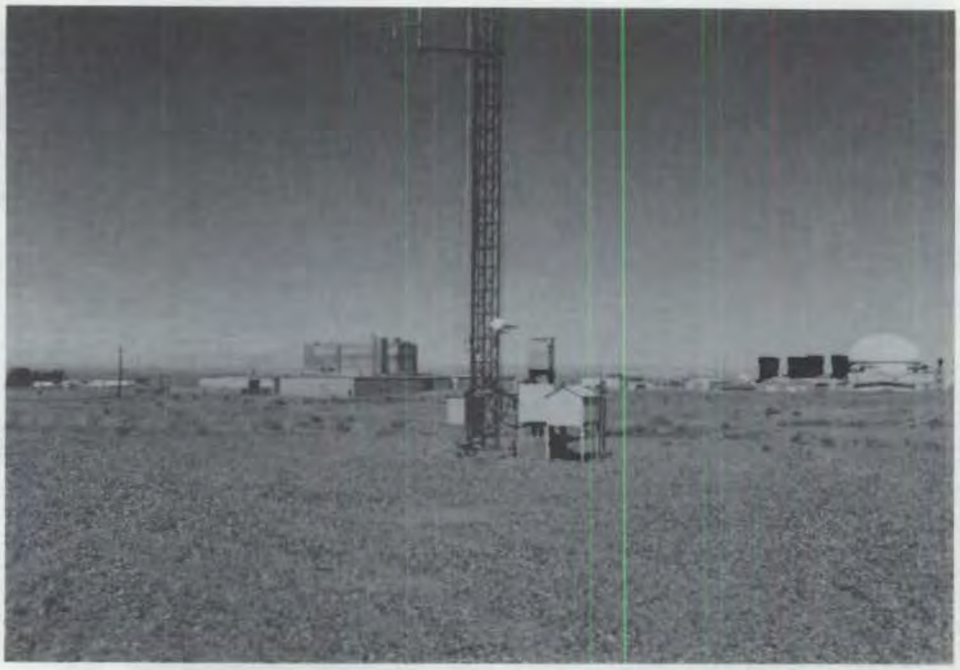


FIGURE 13. A View to the North-Northwest of the Base of the 200-ft Tower at the FFTF Monitoring Site. The base of the tower is situated near the middle of a large gravel pad. The FFTF reactor dome is visible on the right side of the picture.

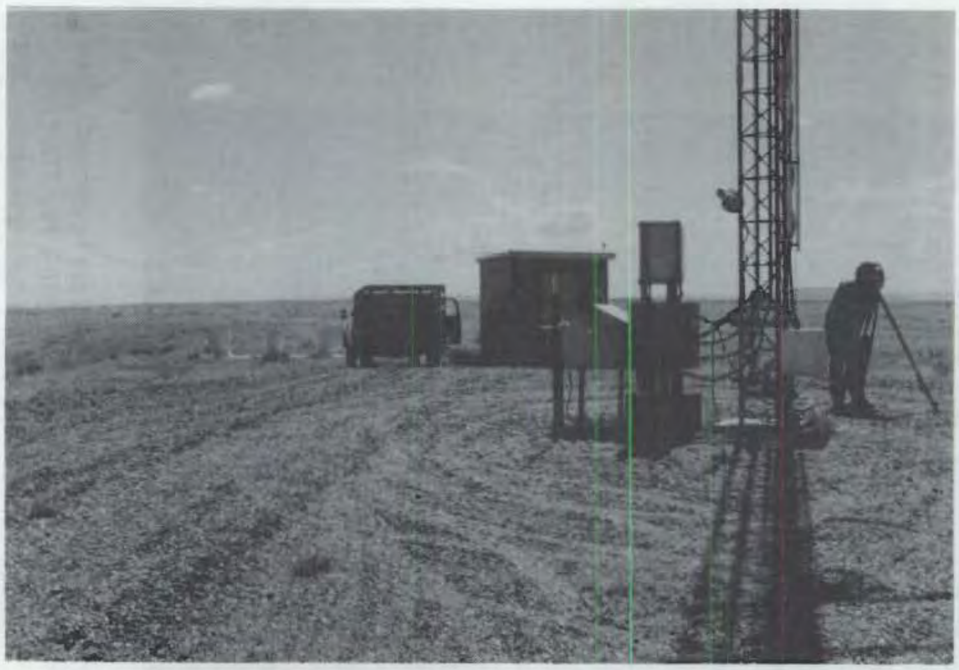


FIGURE 14. A View to the South-Southwest of the Base of the 200-ft Tower at the FFTF Monitoring Site. The site's instrument shed is to the right of the truck, and the doppler sodar's three antennas are visible in the background to the left of the truck.

FIGURE 15. A View to the West-Southwest of the 200-ft Tower at the FFTF Monitoring Site. A large "blow-out" sand dune formation is located northeast of the site.

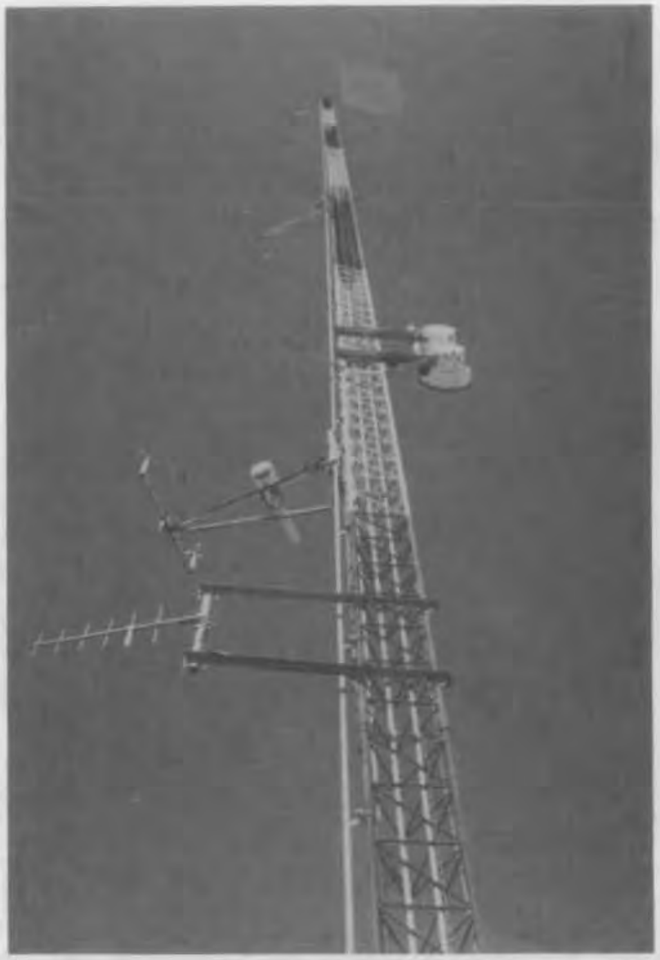


FIGURE 16. A Close-Up View of the 200-ft Tower at the FFTF Monitoring Site. Instruments are mounted at the 30-, 100-, and 200-ft levels. Also on the tower are a UHF radio antenna and a microwave receiver/transmitter.

FIGURE 17. A View to the Northeast of the Base of the 200-ft Tower at the 100N Monitoring Site. The base of the tower is situated on a large gravel pad. The site's doppler sodar antennas are visible between the tower and the instrument shed. The 100-D Area is in the background.

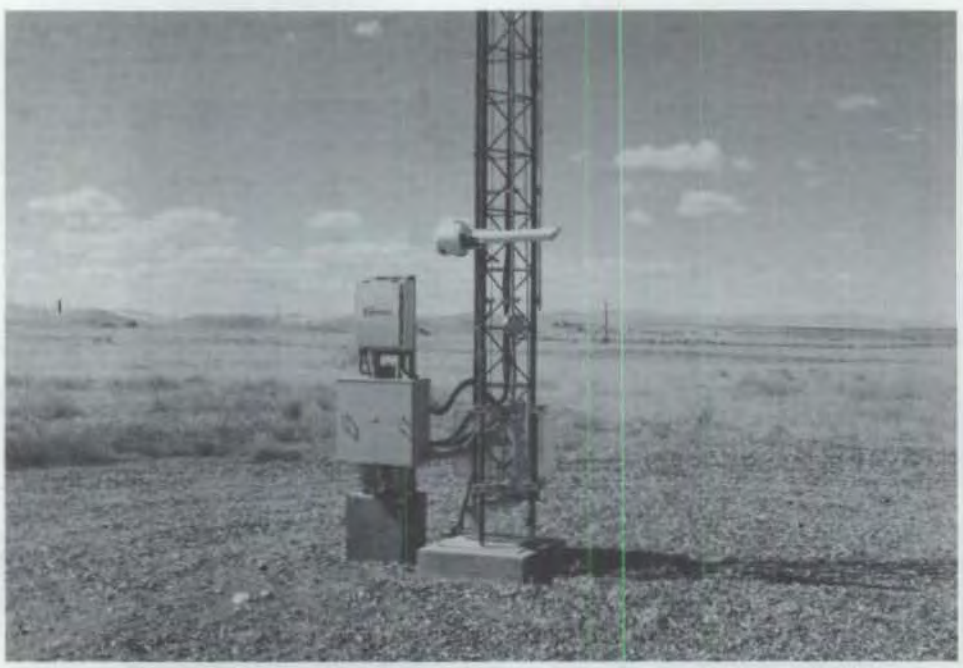


FIGURE 18. A View to the West-Southwest of the Base of the 200-ft Tower at the 100N Monitoring Site. The 100-N Area is hidden from view behind the natural formation of earthen mounds that are visible in the background to the left of the tower.

FIGURE 19. A View to the Southwest of the 200-ft Tower at the 100N Monitoring Site. The site's three doppler sodar antennas are in the foreground. The 100-N Area is hidden from view by the mounds visible behind the monitoring site.

FIGURE 20. A Close-Up View of the 200-ft Tower at the 100N Monitoring Site. Instruments are mounted at the 30-, 100-, and 200-ft levels. Also on the tower are a UHF radio antenna and a microwave receiver/transmitter.

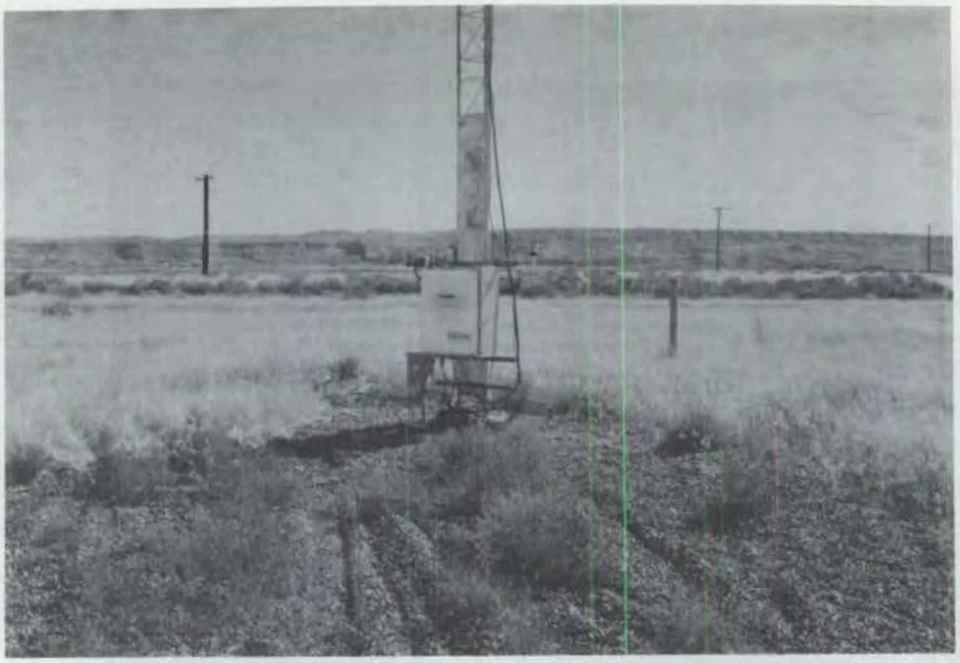


FIGURE 21. A View to the East of the Base of the 40-ft Tower at the 100F Monitoring Site. The base of the tower sits on a gravel pad onto which vegetation has intruded. In the background are the bluffs on the east side of the Columbia River.

FIGURE 22. A View to the North from Near the Base of the 40-ft Tower at the 100F Monitoring Site. The truck in the middle of the picture is at the intersection of Hanford Routes 1 and 2N.

FIGURE 23. A View to the West of the 40-ft Tower at the 100F Monitoring Site. The western end of Gable Mountain is in the background to the left of the tower.

FIGURE 24. A View to the East of the 40-ft Tower at the GABW Monitoring Site. The western end of Gable Mountain fills the background.

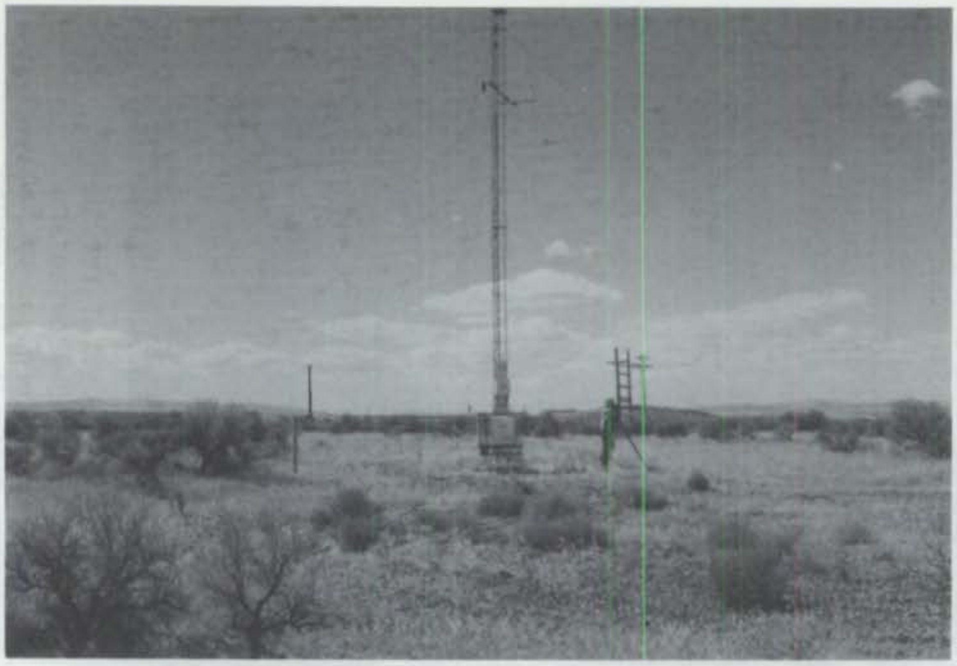


FIGURE 25. A View to the West of the 40-ft Tower at the GABW Monitoring Site. A gravel pad surrounds the base of the tower. Gable Butte (to the west of Gable Mountain) is barely visible behind the utility poles in the background to the right of the tower.

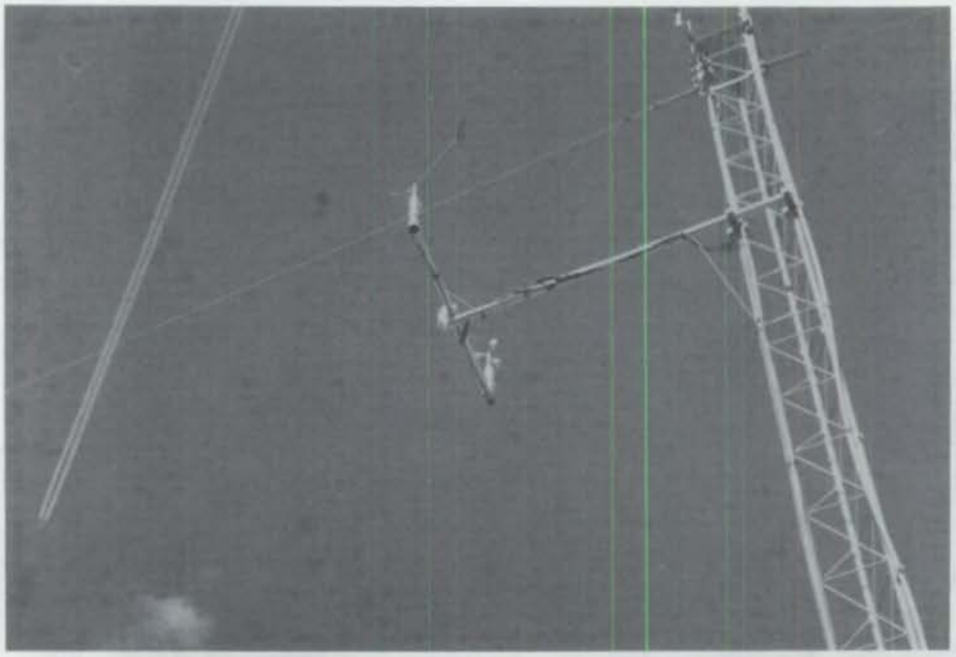


FIGURE 26. A Close-Up View of the Wind Sensors on 40-ft Tower at the GABW Monitoring Site. The wind sensors on the 40-ft towers are mounted at approximately 30 ft (9 m) above the ground.

FIGURE 27. A View to the West-Southwest of the 30-ft Tower at the PROS Monitoring Site. The tower is on a partially stabilized sand dune. Rattlesnake Mountain is in the background.

FIGURE 28. A View to the East-Northeast from Near the 30-ft Tower at the PROS Monitoring Site. The cars are parked on the west side of Hanford Route 10 near the former location of the Prosser Barricade.

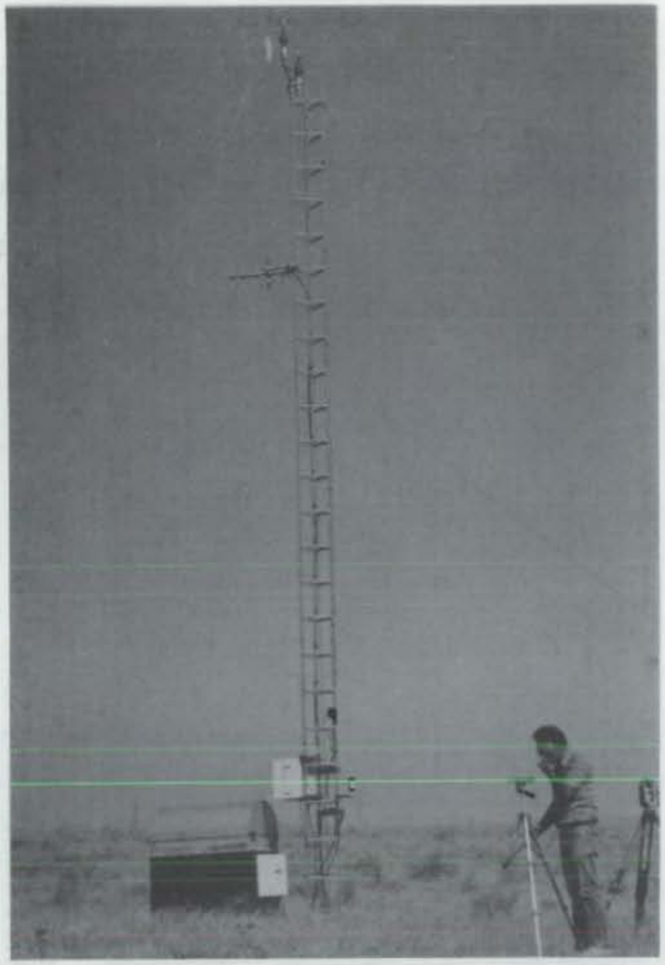


FIGURE 29. A View to the North of the the 30-ft Tower at the PROS Monitoring Site.

FIGURE 30. A View to the Northwest of the 30-ft Tower at the EOCC Monitoring Site. The tower is situated at the edge of a large gravel lot near the northwest corner of the Ecology Reserve compound.

FIGURE 31. A View of the Buildings and Gravel Lot to the Southeast of the EOCC Monitoring Site. On the left, slightly out of focus in the near foreground, is a close-up view of the naturally aspirated shield that houses the site's air temperature sensor.

FIGURE 32. A View to the West-Northwest of the Base of the 30-ft Tower at the EOCC Monitoring Site. Rattlesnake Mountain is in the background. The surveying instrument in the foreground was used at each of the monitoring sites to determine their exact locations.

FIGURE 33. A View to the East of the 30-ft Tower at the FRNK Monitoring Site. The tower is situated between a gravel road (on the right) and a short dirt road (on the left). Rows of apple trees are north and south of the roads. Cultivated fields surround the orchard.

FIGURE 34. A View to the West from Near the Base of the 30-ft Tower at the FRNK Monitoring Site. Farm equipment is stored to the west of the tower.

FIGURE 35. A View to the South from Near the Base of the 30-ft Tower at the FRNK Monitoring Site. South of the tower the rows of apple trees are only a few trees deep. The rows to the north of the tower are substantially longer.

FIGURE 36. A View to the North-Northwest of the 30-ft Tower at the RING Monitoring Site. The poplar trees are located on the other side of the junction of Rickert and Ranger Roads, about 230 ft (70 m) away from the tower. The northwestern rim of the Ringold Valley is visible in the background.

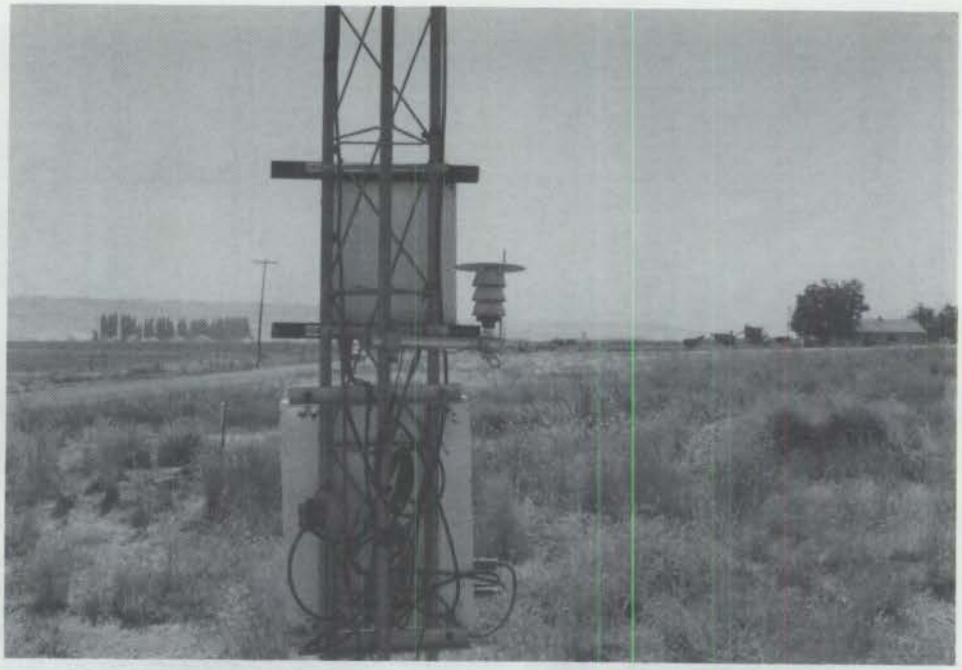


FIGURE 37. A View to the South-Southeast from Near the Base of the 30-ft Tower at the RING Monitoring Site. The southeastern rim of the Ringold Valley is visible in the background.

FIGURE 38. A View to the East from Near the Base of the 30-ft Tower at the RING Monitoring Site. Cultivated fields dominate the landscape to the east of the site.

FIGURE 39. A View to the East-Northeast of the 30-ft Tower at the SAGE Monitoring Site. An electrical substation is in the background to the left of the tower. This picture was taken from the east edge of Mountain Vista Road.

FIGURE 40. A View to the West of the 30-ft Tower at the SAGE Monitoring Site. The trees in the background are across Mountain Vista Road from the site. The row of poplar trees is about 1000 ft (300 m) away.

FIGURE 41. A View to the Southeast of the Base of the 30-ft Tower at the SAGE Monitoring Site. Beyond the desert grasses and brush near the tower, cultivated fields dominate the landscape to the south.

FIGURE 42. A View to the East-Northeast of the Base of the 30-ft Tower at the WPPS Monitoring Site. The base of WNP-2's 200-ft meteorological tower and its instrument sheds are visible behind the 30-ft tower. The WNP-2 reactor building is in the background on the right side of the picture.

FIGURE 43. A View to the West of the 30-ft Tower at the WPPS Monitoring Site. The base of the tower is situated on sandy soil with desert grasses, not on the gravel pad at the end of the access road. Rattlesnake Mountain is in the background.

FIGURE 44. A View of the 30-ft Tower at the WPPS Monitoring Site. WNP-2's 200-ft meteorological tower, with instruments mounted at the 30- and 200-ft levels, is in the background.

FIGURE 45. A View to the East of the Base of the 30-ft Tower at the WYEB Monitoring Site. The Wye Barricade guardhouse is in the background behind the tower. Air sampling instruments are in the foreground near the base of the tower.

FIGURE 46. A View to the East-Northeast of the 30-ft Tower at the WYEB Monitoring Site. The base of the tower is situated on a partially stabilized sand dune, a "blow-out" dune formation is in the foreground. The Wye Barricade guardhouse is visible at the extreme right.

FIGURE 47. A View to the West-Southwest of the 30-ft Tower at the WYEB Monitoring Site. The tower is on a partially stabilized sand dune. Rattlesnake Mountain is in the background just visible behind the tower and air sampling equipment.

FIGURE 48. A View to the West-Northwest of the 30-ft Tower at the GABL Monitoring Site. The tower is located on the east summit of Gable Mountain. A small instrument building and a tower are down the slope to the right of the 30-ft tower.

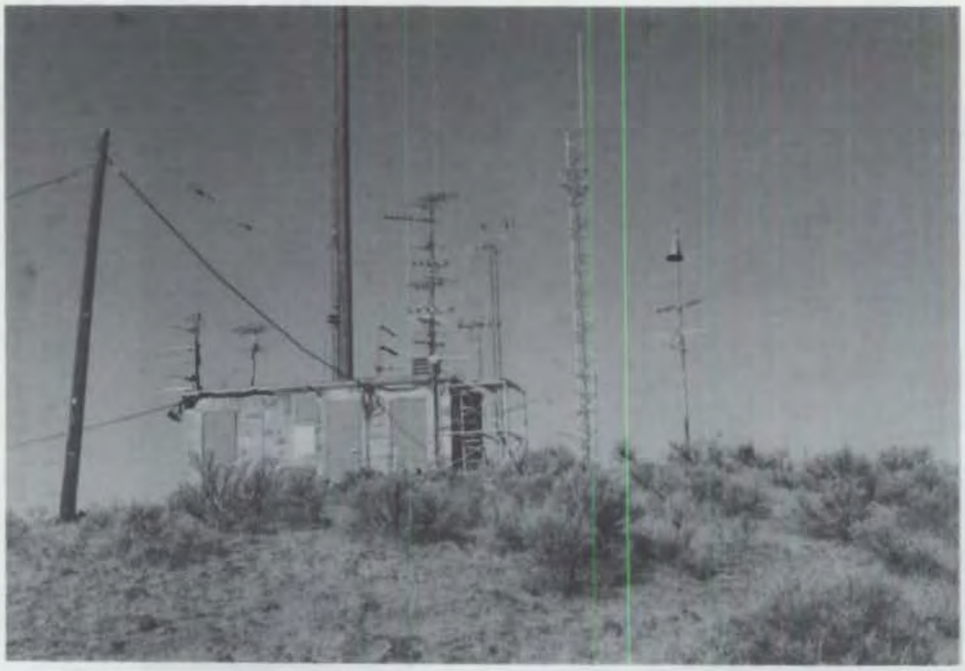


FIGURE 49. A View to the West-Southwest of the East Summit of Gable Mountain. The upper half of the 30-ft Tower at the GABL Monitoring Site is visible behind the scaffolding near the right edge of the small cinderblock building on the east summit.

FIGURE 50. A View to the Northeast from the East Summit of Gable Mountain. The GABL Monitoring Site is at an elevation of nearly 650 ft (200 m) above the level of the Columbia River.

FIGURE 51. A View to the Southeast of the 30-ft Tower at the EDNA Monitoring Site. Trees at the old Hanford Townsite are visible in the background to the left of the tower. The tower is located on clay-like soil near the foundation of a small building.

FIGURE 52. A View to the South of the 30-ft Tower at the EDNA Monitoring Site. Two parallel lines of gravel mounds border a pit to the east of the tower.

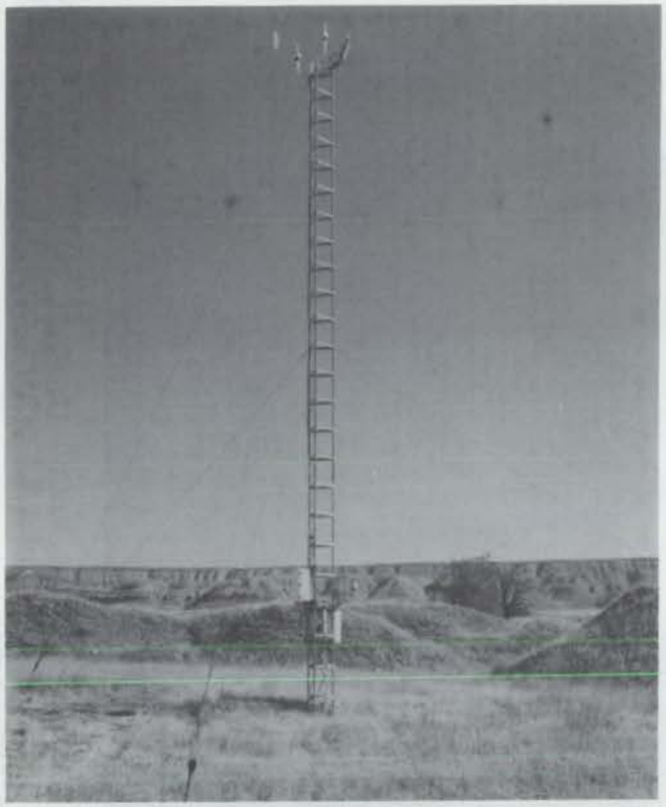


FIGURE 53. A View to the East of the 30-ft Tower at the EDNA Monitoring Site. The bluffs on the east side of the Columbia River are visible in the background behind the gravel mounds.

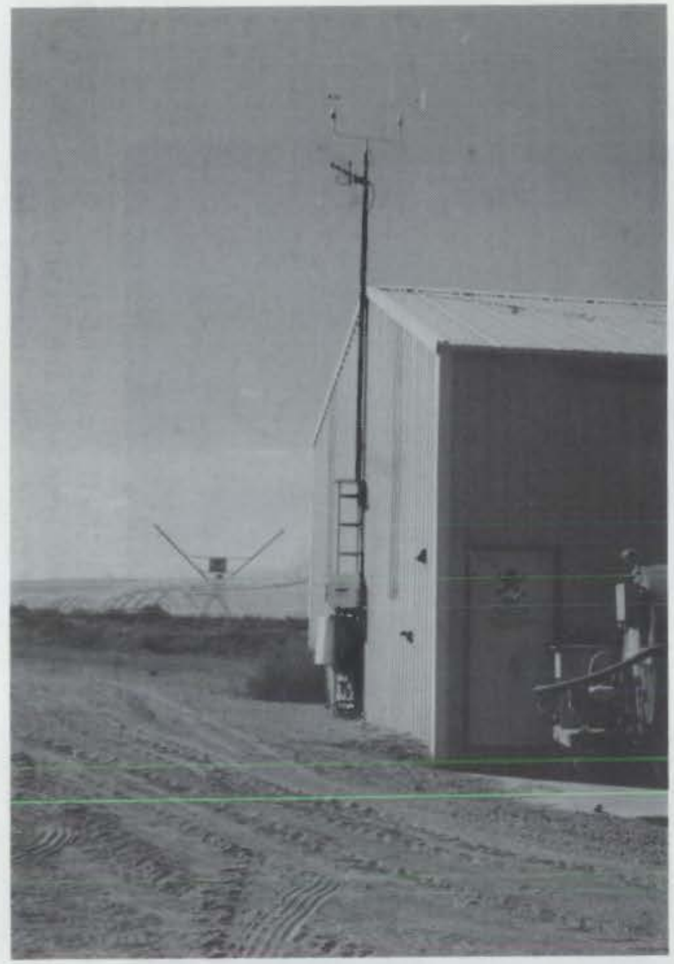


FIGURE 54. A View to the West-Northwest of the 30-ft Tower at the WAHL Monitoring Site. The tower stands against the south wall of a metal building. Cultivated fields are to the west of the site.

FIGURE 55. A View to the North-Northeast of the 30-ft Tower at the WAHL Monitoring Site. The tower is mounted against the south wall of a metal-sided storage building. A line of trees form a north-south running windbreak a short distance to the east of the tower.

FIGURE 56. A View to the South from Near the Base of the 30-ft Tower at the WAHL Monitoring Site. The irrigation pond is immediately south of the tower. The line of trees that forms a north-south running windbreak extends toward the south on the left side of the picture. The Umtanum Ridge is visible in the background.

FIGURE 57. A View to the North of the Base of the 30-ft Tower at the RSPG Monitoring Site. The site's rain gage is visible to the left of the tower. The trees in the background border the creek that contains the outflow from Rattlesnake Springs.

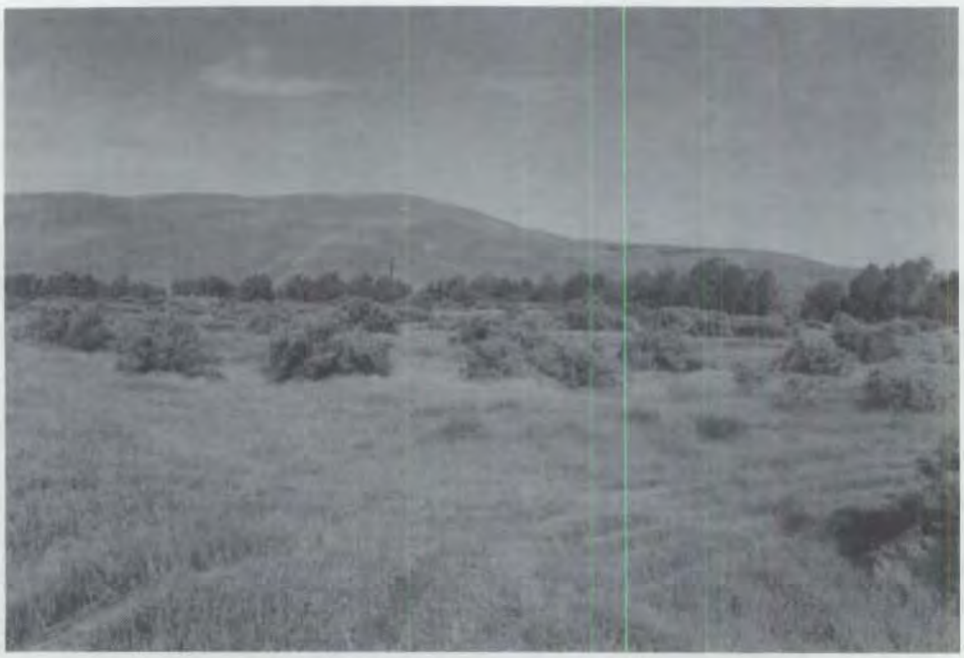


FIGURE 58. A View to the West-Northwest from Near the Base of the 30-ft Tower at the RSPG Monitoring Site. The trees in the background border the creek that contains the outflow from Rattlesnake Springs. The eastern edge of the Yakima Ridge is visible above the tree line.

FIGURE 59. A View to the South-Southwest of the 30-ft Tower at the RSPG Monitoring Site. In the background, across the Dry Creek Valley, are the Rattlesnake Hills.

FIGURE 60. A View to the South-Southeast of the 30-ft Tower at the ARMY Monitoring Site. The southern end of Rattlesnake Mountain is visible in the background.

FIGURE 61. A View to the West-Southwest of the Base of the 30-ft Tower at the ARMY Monitoring Site. Washington State Highway 240 runs across the middle of the picture along the floor of the Cold Creek Valley. Rattlesnake Mountain is in the background.

FIGURE 62. A View to the East-Northeast of the Base of the 30-ft Tower at the ARMY Monitoring Site. The tower sits on the edge of a gravel pad.

FIGURE 63. A View to the South-Southwest of the 30-ft Tower at the YAKB Monitoring Site. The Yakima Barricade guardhouse is visible behind the tower. The site's automatic rain gage is the small cylindrical object to the right of the base of the tower.

FIGURE 64. A View to the North of the 30-ft Tower at the YAKB Monitoring Site. A dirt road leads from the near the Yakima Barricade to the base of the tower.

FIGURE 65. A View to the West of the 30-ft Tower at the YAKB Monitoring Site. Air sampling equipment is positioned around the base of the tower.

FIGURE 66. A View to the South Across 7th Street of the 30-ft Tower at the 200E Monitoring Site. The tower is situated in a roped-off radiation zone. The PUREX Plant is in the background.

FIGURE 67. A View to the Southwest Across 7th Street from the 200E Monitoring Site. A steam pipe runs east-west along the south side of the road. The smoke stack on the right side of the picture is near the Critical Mass Laboratory.

FIGURE 68. A View to the North from 7th Street Near the 200E Monitoring Site. A portion of a waste storage tank farm is on the right side of the picture. Gable Mountain is in the background.

FIGURE 69. A View to the East-Northeast of the Base of the 30-ft Tower at the Battery Powered 200W Monitoring Site. The site is located near the southwestern boundary of the 200 West Area. Facilities within the 200 West Area are visible on the horizon. A tumble weed is lodged on the 30-ft tower between two support struts.

FIGURE 70. A View to the North-Northeast of the 30-ft Tower at the 200W Monitoring Site. The site's battery is recharged by the solar panel mounted on the lower portion of the tower. A short gravel path leads to the base of the tower.

FIGURE 71. A View to the South-Southeast of the 30-ft Tower at the 200W Monitoring Site. The local soil is very sandy with sparse vegetation between the desert brush. Rattlesnake Mountain is in the background.

FIGURE 72. A View to the Northwest of the 30-ft Tower at the Battery Powered VERN Monitoring Site. The Vernita Bridge, which crosses the Columbia River, is visible to the left of the 30-ft tower. In the foreground is an unmaintained portion of the road leading to the old Vernita ferry dock.

FIGURE 73. A View to the South-Southeast of the 30-ft Tower at the VERN Monitoring Site. This photo was taken at a point approximately halfway down the slope between the tower and the Columbia River. The site's battery is recharged by the solar panel mounted on the lower portion of the tower.

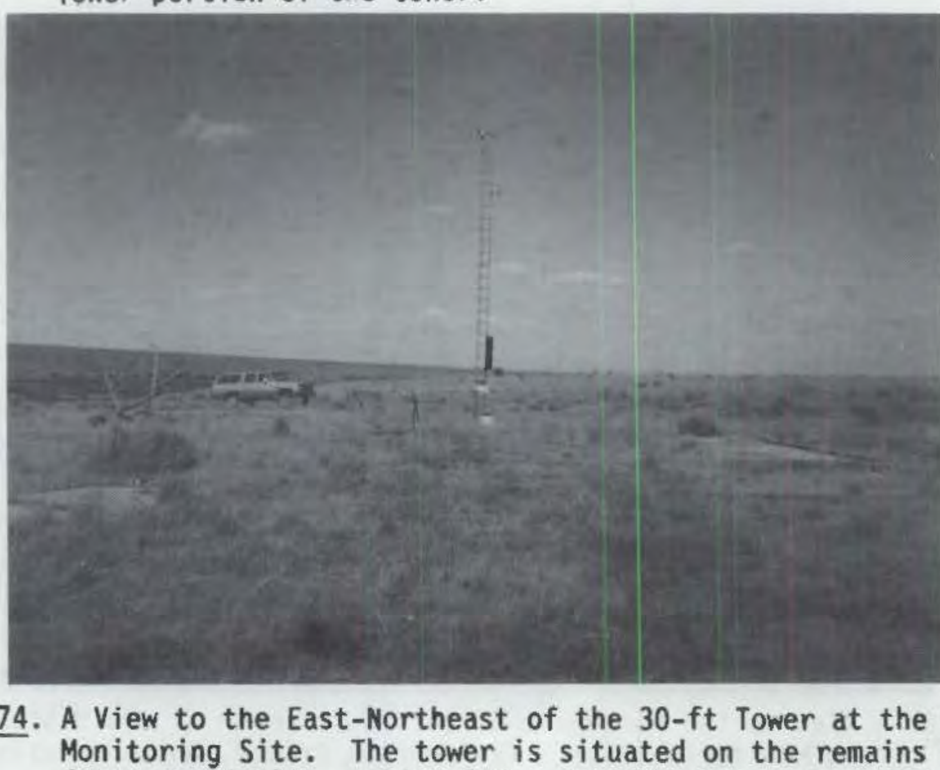


FIGURE 74. A View to the East-Northeast of the 30-ft Tower at the VERN Monitoring Site. The tower is situated on the remains of the ferry terminal's parking lot. Desert grasses now grow up through the gravel. The foundations of two small buildings are visible in the foreground.

FIGURE 75. A View to the Northwest of the Meteorological Instruments at the RMTN Monitoring Site. The monitoring site is located on the rocky crest of Rattlesnake Mountain; vegetation is sparse. The site is near the astronomical observatory. Two of the observatory's domes are visible in the background on the right side of the picture.

FIGURE 76. A View to the North, Down the Slope of Rattlesnake Mountain, From Near the RMTN Monitoring Site. The northeastern slope of the mountain is fairly steep as it drops away from the narrow crest.

FIGURE 77. A Close-Up View to the Southwest of the Meteorological Instruments at the RMTN Monitoring Site. The site's wind sensors are mounted at the top of the taller pole. The larger wind instrument on the shorter pole provides data for the astronomical observatory and is not part of the site.

FIGURE 78. A View to the North of the Wind Sensors at the PASC Monitoring Site. The wind sensors are mounted on the roof of the airport's old control tower.

FIGURE 79. A View to the East-Northeast of the PASC Monitoring Site. The site's wind sensors are mounted on the roof of the old control tower. Also visible on the roof is a large, stuffed, toy dog. The lower levels of the tower are occupied by Bergstrom Aircraft.

FIGURE 80. A View to the South-Southeast from the Roof of the Pasco Airport's Old Control Tower.

FIGURE 81. A View to the Northwest of the RICH Monitoring Site. Wind and temperature monitoring instruments are mounted on the roof of the airport's old control tower. The ground floor of the tower is used by Airborne Express.

FIGURE 82. A Close-Up View to the Southwest of the Wind Sensors at the RICH Monitoring Site. The wind sensors are mounted on a short pole near the middle of the control tower roof.

FIGURE 83. A View to the South from the Roof of the Richland Airport Control Tower. Aircraft hanger buildings are located to the south of the control tower. The airport's wind sensors are mounted on the building immediately south of the control tower.

REFERENCES

DOE. 1982. Site Characterization Report for the Basalt Waste Isolation Project. DOE/RL 82-3, Vol. II, U. S. Department of Energy, Office of Terminal Waste Disposal and Remedial Action, Washington, D.C.

Stone, W. A., J. M. Thorp, O. P. Gifford, and D. J. Hoitink. 1983. Climatological Summary for the Hanford Area. PNL-4622, Pacific Northwest Laboratory, Richland, Washington.

APPENDIX A

SELECTED INFORMATION FROM THE REMTECH DOPPLER SODAR OPERATING MANUAL

REMTECH

DOCUMENT N° 84/148 A

-=ooo REMTECH DOPPLER SODAR ooo=-

OPERATING MANUAL

(01/85)

2 et 4 avenue de l'Europe - 78140 Velizy - France - Tél. (3) 946.58.58 - Télex 698 227
S.A. au capital de 1.200.000 F - R.C. Versailles B 325 061 935

2. - OPERATING PRINCIPLES

The REMTECH DOPPLER SODAR functions like a pulsed radar, but instead of an electromagnetic wave, it emits an acoustic wave at a frequency of 1600 Hz (or 2400 Hz).
The SODAR has three antennas, which for convenience, will be numbered 1, 2 and 3 throughout this manual; 3 is the vertical antenna, 1 and 2 are antennas tilted from the vertical at an angle of 18° (15,5° for 2400 Hz.).
Seen from above, the angle between the axes of antennas 1 and 2 is nominally equal to 90° as shown in figure 2.1.

This three-dimensional configuration of the REMTECH SODAR permits the measurement of three-dimensionnal wind speed (horizontal wind speed and the direction theta of the horizontal wind, and vertical wind speed w) as well as the standard deviation of w and the standard deviation of theta. These are highly useful turbulence/stability indicators. For each of the three antennas the measurement cycle is composed of a brief acoustic burst whose pulse length is on the order of 150 ms. The acoustic power used is 60 W (300 W of electrical power).

The series of acoustic waves propagating outward through atmosphere are partially reflected back to the antenna as a continuous echo train due to slight variations of temperature (and thus of density) along the pulse path.

To detect these returning echoes, the compression driver is electronically switched into a sensitive microphone configuration, immediately after the acoustic burst has been generated.

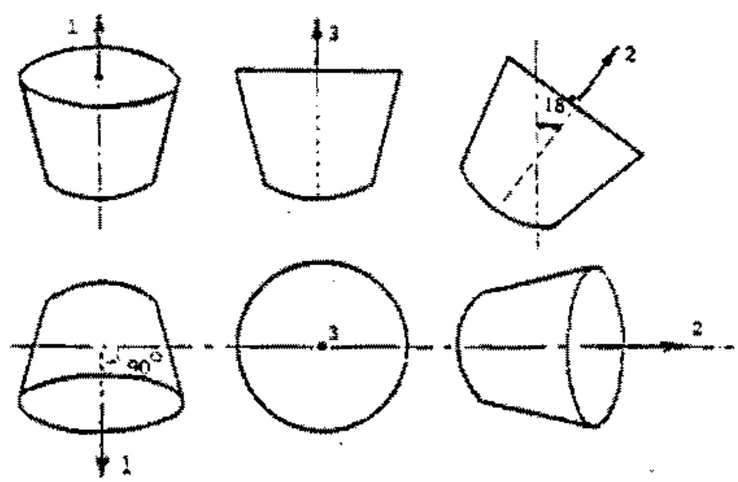


Figure 3.1. - Orientation of antennas

The altitude from which a given portion of the sound energy was backscattered is easily calculated by noting that at the end of a period of time "t" following a transmission, the sound has made a round trip of :

$x = t \times c$, where c is the speed of sound.

Since it is a round trip, the corresponding altitude :

$$z = \frac{x}{2}$$

We have therefore :

$$z = t \times \frac{c}{2}$$

In the case of tilted antennas :

$$z = t \times \frac{c}{2} \times \cos i$$

where i is the angle of tilt from vertical.

To accomplish these measurements layer by layer (by consecutive 25 m layers, for example), it is necessary to divide the time after transmission into corresponding segments of time.

The following diagram is a summary of these principles.

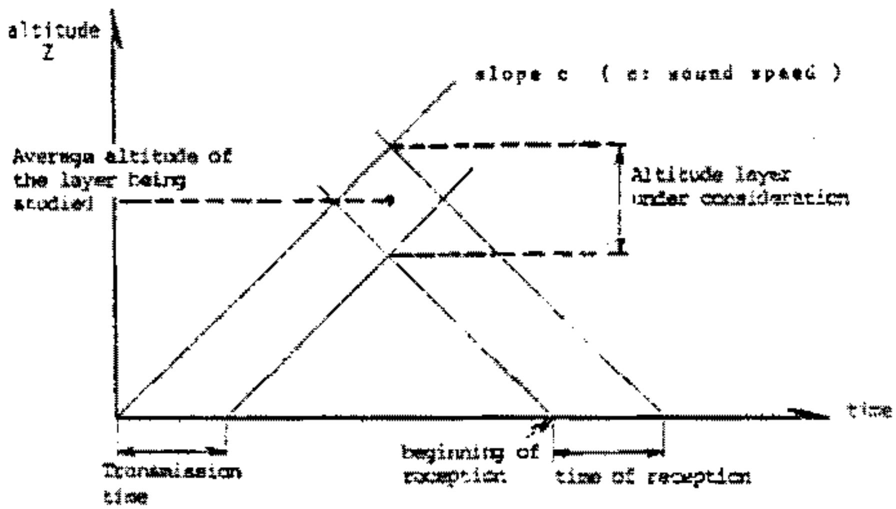


Figure 2.2. - Height determination

The echo received by the antenna after a pulse transmission has certain characteristics.

First of all, the signal is extremely weak.

To illustrate this statement, the voltage applied to the terminals of a compression driver during transmission is around 60 volts. However, during reception it can be as weak as 30 nv and never exceeds 80 v, unless a very high degree of ambient noise is present during the measurement. Therefore, the received echo is not audible to the operator because it is several dB lower than the auditory threshold of the human ear.

With such a weak received signal the question arises as to the plausibility of obtaining any measurements at all.

In fact, using the techniques outlined below it is perfectly feasible, since :

- the antennas are directional, thus limiting by 50 dB any ambient noises perceived by the secondary lobes parallel to the ground. In addition, the antennas were specifically designed for very low noise transmission reception.

- The receiver's thermal and electronic noise does not exceed 65 nv by using performance filters, and by making scientifically sound choices in reference to the amplification chain and its associated electronic components.

- Finally, the method employed by the minicomputer in processing the returned pulse allows the use of signals "polluted" by high levels of ambient noise.

Because of all of these factors the nominal admissible environmental noise level is at least 65 dBA for basic systems.
That means, if the ambient noise is less or equal to 65 dBA, the Sodar system will provide a minimum range of 200 m. in 90 % of cases in <u>all meteorological conditions</u> (Standard System).
But, because the relevant parameter for measurement is the signal to noise ratio, it is possible to measure at higher ambient noise level in good meteorological conditions

N.B.: Ambient noise does not affect data quality because the software takes care of signal to noise ratio and can invalidate individual measurement in case of too high ambient noise without "spoiling" average wind speed.

The REMTECH SODAR is an exceptionally effective tool for making atmospheric measurements. The first piece of information extracted from the measurement is the intensity of the effective backscattered signals. The SODAR subtracts the ambient noise from the information received by the compression drivers, retaining only the echo return.

The intensity of this received echo depends, as in the case of any radar, on the length and power of the transmitted pulse, the beam of width of the receiving antenna, the atmospheric scattering characteristics and the attenuation during the round trip passage.
The power of the scattered echo is proportional to the temperature structure function : C_T^2, defined as :

$$C_T^2 = \frac{\overline{(T(x+r) - T(x))^2}}{r^{2/3}}$$

In this equation :

- the horizontal line represents a temporal average,
- T (x + r) and T (x) are respectively the air temperature at the end points of the vectors x + r and x,
- r is on the order of the 1/2 length of an acoustic wave (10 cm at 1600 Hz operating frequency).

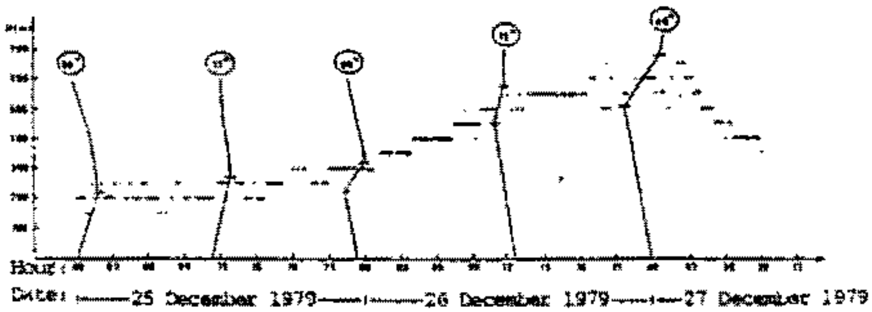
Expressed in a simpler manner, C_T^2 is a measure of the intensity of the small scale fluctuations of the air temperature.

The REMTECH SODAR thus, does not measure average temperature, but rather the quantity : C_T^2. This is valuable because C_T^2 has large values, and repeatable patterns, during conditions such as : ground based radiation inversions, within elevated inversion layers, at the periphery of convective columns or thermals (with which glider pilots are familiar), in sea breeze/land breeze frontal surface and in a general way at the boundary between masses of air of different temperatures.

The REMTECH SODAR thus provides an excellent and continuous record of the atmospheric thermal structure.

For example, it readily provides the height of the "mixed layer" so necessary to air pollution modeling and control efforts.

A totally automated inversion detection routine based on SODAR outputs has been tested and is shown in following figure 2.3.



<u>figure 2.3. - Continuous automatic monitoring of the thermal structure of the lower atmosphere</u>

Localization of a temperature inversion from numerized data furnished by the SODAR at quarter-hour intervals

The second kind of information that the SODAR calculates based on the backscattered echo received by each antenna, is the radial wind speed along the beam axis at each altitude layer sampled. The small elements of thermal

turbulence responsible for the C_T^2 move at the speed of the wind, thus a double Doppler effect results. When the acoustic beam reaches them, the first Doppler effect is realized while the observer is fixed and the target is in motion. Then, when these cells rebroadcast by backscattering a part of the sound energy they have received, a second Doppler effect is obtained from the point of view of the observer, who is still in a fixed position, but this time the Doppler effect is caused by a mobile transmitter. By way of example, the frequency variation is on the order of 10 Hz for each meter per second of radial wind speed, at a signal frequency of 1,600 Hz. Of course, in practice this frequency shift can be strongly skewed or even erased by the presence of excessive ambient noise, but this problem will be discussed further in paragraph 3.2. entitled "Signal Processing Technique".

Radial speeds for each altitude layer sampled are therefore obtained for every transmission-reception cycle, along the beam axis of each antenna. To do this the timing is divided into discrete steps starting at the end of each pulse transmission.

The minicomputer then cycles the transceiver to begin the same procedure on another antenna, and so on, the simplest cycle obviously being the 1,2,3/1,2,3 etc.....

Since the REMTECH SODAR has three antennas by a simple mathematical coordinate transformation, it can calculate the three-dimensional wind speed components. In addition the resultant speed (V) and direction (theta) of the horizontal winds and vertical (w) winds are also calculated.

This is schematized following page.

The echo intensity information is only obtained from the vertical antenna.

In addition to the average wind speed and direction information, the standard deviation of theta and w are also provided.

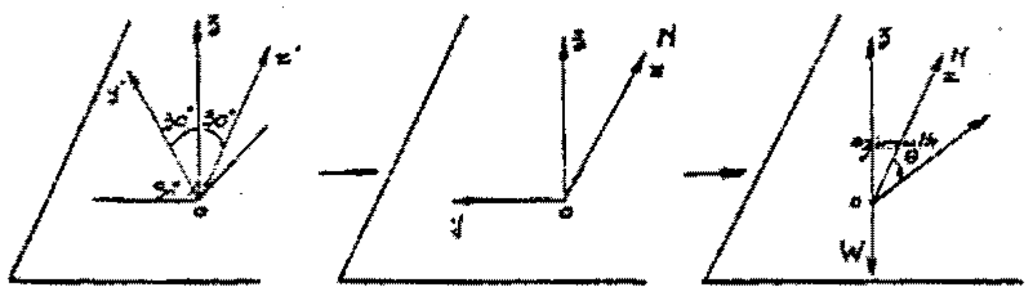


Figure 2.4. - Three axis velocity transformation to provide U, V and W wind components

The following table is a typical data display from the minicomputer :

(here with the option displaying the standard deviation of radial wind speeds)

8 13 84 8 10 3 334 348 2s/

ALTITUDE	ECHO	S ECHO	SPEED	TETA	S TETA	W	S W	SO1	SO2	SO3
** INV **	180	300	0	0	0	0	0			
900	76	-9999	494	327	-9999	-23	-9999	37	17	44
860	-9999	-9999	482	321	-9999	-9999	-9999	35	51	151
820	73	-9999	-9999	-9999	-9999	-14	-9999	119	11	26
780	-9999	-9999	374	322	-9999	-9999	-9999	22	36	270
740	75	34	-9999	-9999	-9999	19	27	73	34	27
700	58	-9999	325	304	-9999	1	-9999	32	25	17
660	71	-9999	250	263	-9999	-1	-9999	46	20	9
620	100	39	279	255	-9999	-16	25	30	18	25
580	144	23	282	259	11	-14	19	29	17	19
540	114	22	281	252	16	-8	17	19	31	17
500	111	21	358	289	9	-11	27	28	28	27
460	199	28	362	270	5	1	18	16	22	19
420	178	14	414	258	6	7	24	20	21	24
380	134	37	524	263	5	11	23	21	25	23
340	168	16	623	258	4	16	28	30	27	28
300	261	19	634	254	3	4	24	22	30	24
260	388	21	789	251	2	23	19	34	30	19
220	217	-9999	820	242	3	21	-9999	29	37	2
180	695	9	627	238	0	15	34	20	17	34
140	756	15	570	231	3	18	30	22	27	30
100	527	16	395	226	5	16	23	20	27	23
60	375	7	337	200	4	12	24	25	35	24

3. SIGNAL PROCESSING METHOD

3.1. - Antenna "tuning"

3.1.1. - Automatic temperature compensation

Unlike the speed of electromagnetic waves, the speed of sound, c, varies as a function of the temperature.

The antenna of a SODAR is thus unsuitable for continuous use, if these variations in c, and therefore in for a given transmission frequency, are not somehow accounted for. During the reception cycle the situation is even more delicate, since it is no longer c which must be considered, but $c + 2 v_R$, v_R being the radial speed of the wind along

the beam axis at a given range from the transmitter. Now although $2v_R$ is negligible as compared to the speed of

electromagnetic waves, $2v_R$ (for example 10 m/s) can repre-

sent a significant fraction of the speed of sound c (about 330 m/s). Therefore, in order to reduce v_R for a given horizontal wind speed, we tilt our antennas at a rather narrow angle (18° at 1600 Hz. and 15,5° at 2400 Hz.).

In order to "tune" an antenna to the transmission, the REMTECH SODAR automatically varies the emission frequency according to temperature changes.

An example of how dramatic the effect of a temperature change can be is shown in Figure 3.1. In this figure the antenna gain varies as a function of the angle from the antenna axis, when the temperature is 6°C (solid curve) and when it is -18°C (dashed curve) for a given frequency of 1579 Hz.
The REMTECH DOPPLER SODAR will automatically change its transmitting frequency from 1579 hz at 6°c to 1512 hz at -18°c to maintain the optimum antenna pattern (solid curve). Without temperature correction, the secondary lobes would increase by 6 dB for the temperature variation shown. This is equivalent to increasing the environmental noise in the antenna by a factor of four.

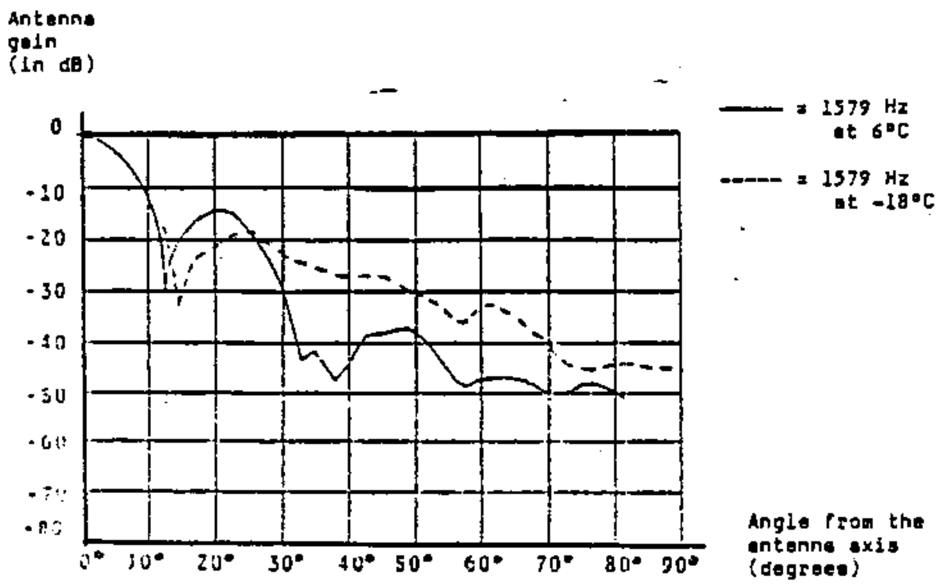


Figure 3.1. - Antenna gain (dB) versus angle from the antenna axis (degrees) for ambient temperatures of 6°C (solid) and -18°C (dashed) at 1579 Hz nominal frequency

3.1.2. - Automatic antenna pattern optimization
relative to environmental noise
and fixed echoes

Most environmental noise propagates parallel to the ground. Therefore, the ability of the antenna to distinguish between the echo (signal) and the ambient noise (one part of the transfer function of the antenna) is directly related to the secondary lobe effect. We need to be concerned with an angle in the 72° range from the axis of the tilted antennas and in the 90° range from the axis of the vertical antenna.

Figure 3.2. following shows the antenna transfer function versus frequency for an angle of arrival of 72° (a given tilted antenna). This assumes that the incoming environmental noise propagates parallel to the ground.

Of course, if the main noise source does not propagate parallel to the ground (noise caused by wind in trees for instance), the antenna transfer function will be different. In all cases the dynamics between minima and maxima in the antenna transfer function relative to acoustic noise are at least 6 dB.

There are only two solutions to his problem :

- take into account the antenna transfer function,
- increase the minimum signal to noise ratio threshold by 6 dB and then decrease the signal to noise capability of the system by a factor of 4.

Let us now consider the optimization of the antenna to remove fixed echoes. One can understand easily, bearing in mind the discussion about environmental noise, that a SODAR should be able to minimize the antenna gain for returns coming from the same direction as the fixed echo. If this is not properly done, there can be cases where the fixed echo is so strong that it totally cancels the useful backscattered signal.

Angle of arrival from the antenna axis : 72°

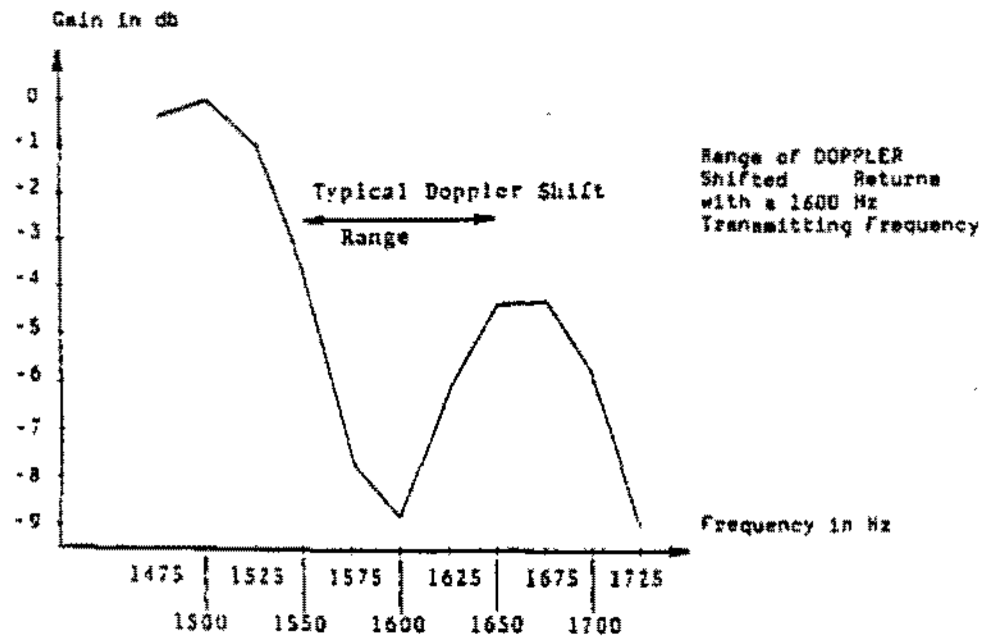


Figure 3.2. - Antenna gain (dB) versus frequency (Hz) of the return signal. The angle between the arriving signal and the antenna axis is 72°

3.2. - Signal processing technique

3.2.1 - General considerations

It has been stated that at 1,600 Hz the Doppler shift is about 10 Hz per m/s of radial speed. For equipment whose antennas are tilted at 18° in relation to vertical, there will therefore be a shift of 10 Hz for 3.2 m/s of horizontal component. (See figure 3.3. following).

As a result, if it is desired to measure up to 20 m/s on one component, the signal needs to be analysed for a bandwidth of ± 60 Hz centered on the transmission frequency f_o.

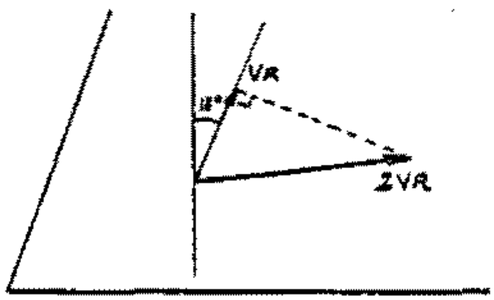


Figure 3.3.

In order to limit the influences of ambient interference as much as possible, a band-pass filter is used.

With respect to the backscattered signal, a pure signal is transmitted, but not received.

The backscattered signal has been phase and amplitude modulated for several reasons other than the Doppler shift.

Some of them are :

- disturbances along the round-trip path,
- velocity turbulence within the backscattering volume,
- imperfections of the antenna during transmission and reception,
- uneven spatial distribution of the thermal cells in the backscattering volume,
- curvature of the acoustic rays due to wind shear which lead to the tilting of received rays with respect to the axis of the antenna. This tilting has the obvious consequence of changing the time of passage, and, as a result, alters the antenna gain and introduces phase shifts.

All of these accumulated effects culminate by the enlargement of the frequency, the result of which is that the received signal possesses an energy distribution as follows in figure 3.a.

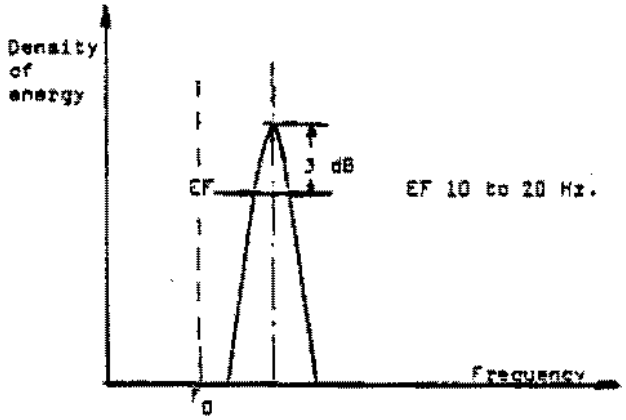


Figure 3.4.

After passing through the antenna and the band-pass filter, the signal to be processed (which is a mixture of ambient noise and backscattered energy) looks like this :

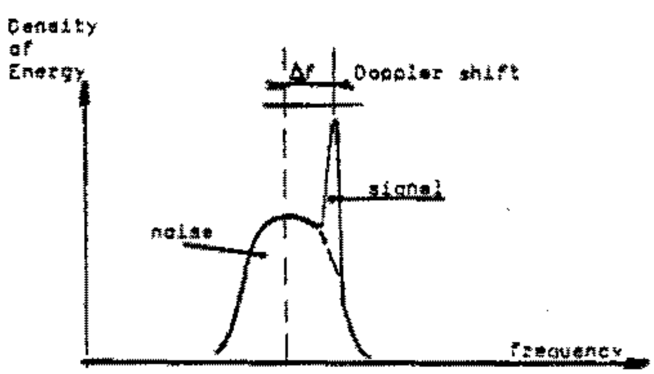


Figure 3.5.

3.2.2 - Fast Fourier Transform : why and how

There are still commercial SODARs which use so-called integral methods for estimating DOPPLER shifts. These methods such as zero crossings associated with signal to noise correction, complex covariance and PLL (phase locked loop), infer that ambient noise is nearly flat ("white") across the filter bandwidth. This of course is not correct specifically in the case of fixed echoes, which, by the way, none of the above method can detect.
(See following figure 3.6).

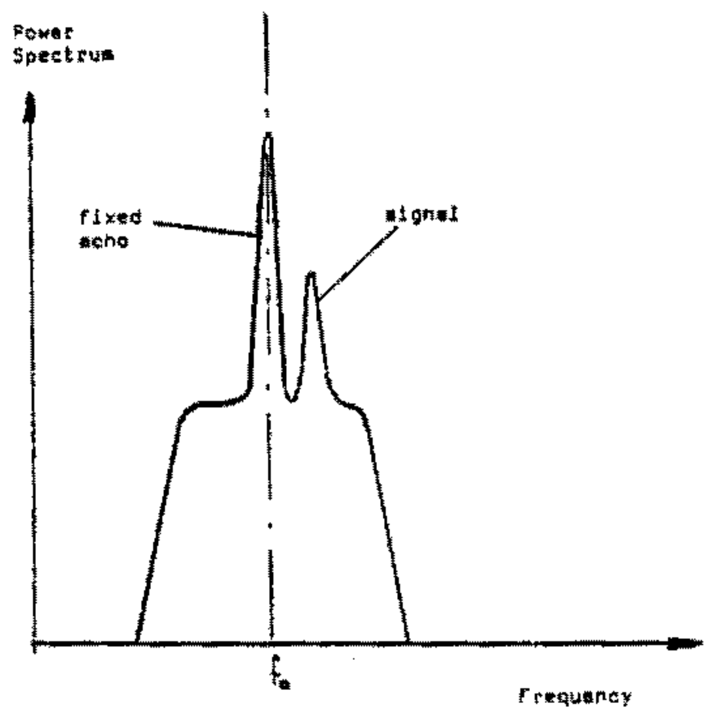


Figure 3.6.

Therefore one needs an accurate frequency analysis of the backscattered signal. This is accomplished in the REMTECH SODAR by using Fourier Analysis. Our system "mixes" the emitted frequency f_o with the returning signal providing its real and imaginary components to the minicomputer Analog to Digital (A/D) converter board.

See following figure 3.7.

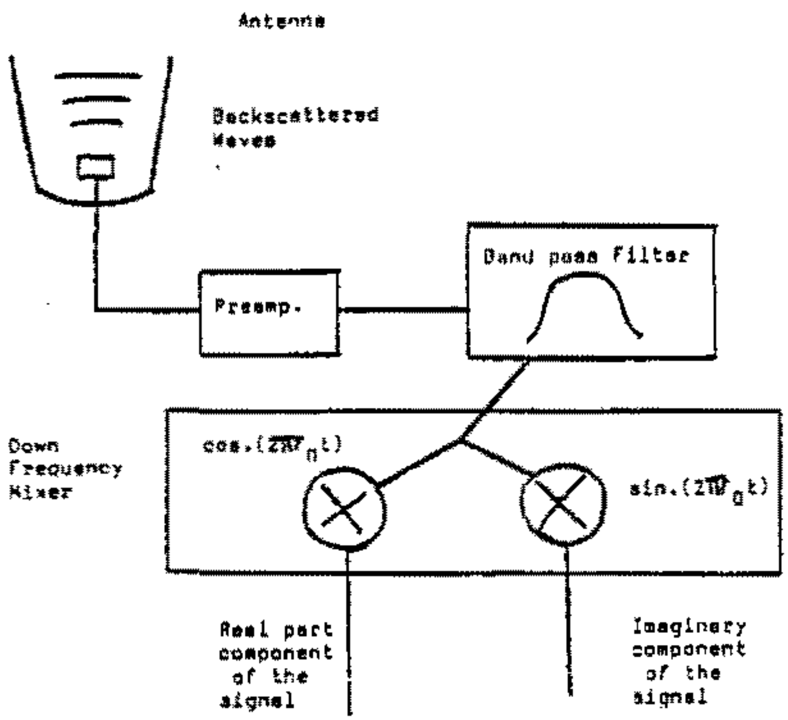


Figure 3.7. : Signal processing diagram

The corresponding digital values are then processed by software using a complex Fast Fourier Transform (FFT) at 32 frequency points. Presently we are only using the amplitude information and not the phase information contained within the signal. More exactly we compute a power spectrum by squaring and adding the two Fourier components (real and imaginary) at each frequency point.

As we are dealing with random type of signal and noise, we apply a windowing technique. A typical result is shown following figure 3.8. with a printing output and corresponding graphics.

DT 84/148 A   -=0 29 0=-

```
ANTENNA 1
 J  JSPY    S/N   ECHO          SPEED

 8 1010    33.          0.4E+03        -2.3 3.0 2.3  -273.5

                            2 1 1 1         2
                      5 3   6 0 8 9 2 : 1 2 0 8 8 8   1
0 0 0 0 0 0 0 5 1 6 8 0 4 7 4.5.4 3 8 8 5 5 5 4 5 0 8 5|0|1 0    18
```

SO(arbitrary units) in corresponding frequency band.

Central frequency

frequency band (5 Hz. at 1600 Hz.; 7,5 Hz. at 2400 Hz.)

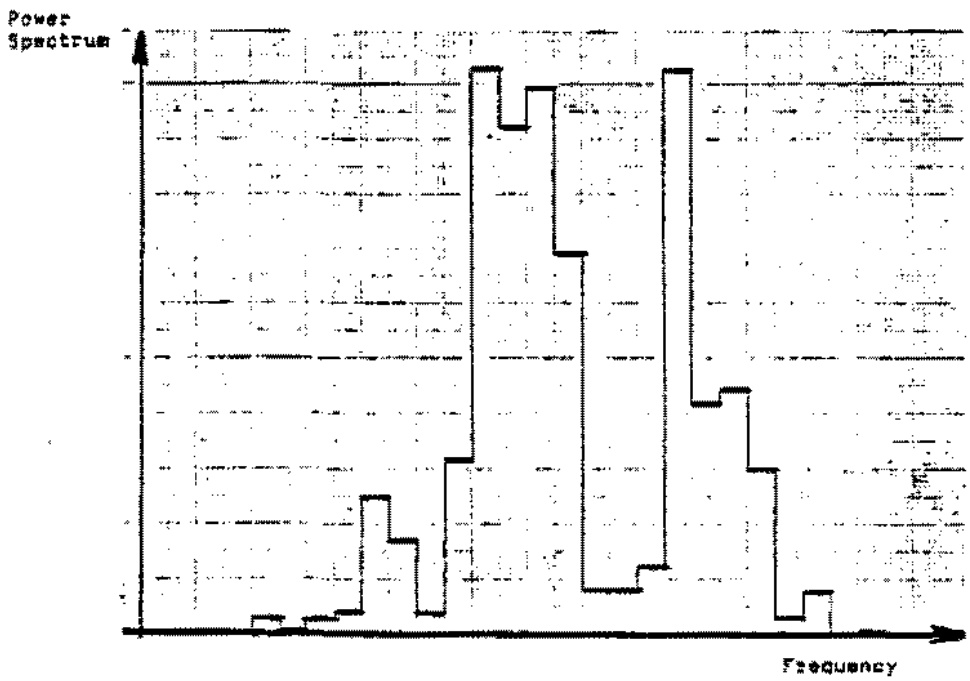


Figure 3.8.

Please note the two frequency peaks which correspond to our frequency coded pulse. See next paragraph.

3.2.3. - Double frequency pulse

You will notice that two "peaks" appear on the previous figure. This is because our system is not monochromatic, but actually uses two different frequencies during the pulse emission. The reason for this is very simple. With a monochrometic system the acceptance level of the signal to noise ratio must be unnecessarily high, or the probability of accepting noise as signal will be unacceptable. With two pulses one does not know where the two corresponding peaks of the returning signal will be frequency located but one knows what the distance between these two peaks should be.

This complementary information reduces the probability of accepting noise as signal and allows the system to operate on noise polluted signals.

The following figure 3.9. shows this clearly.

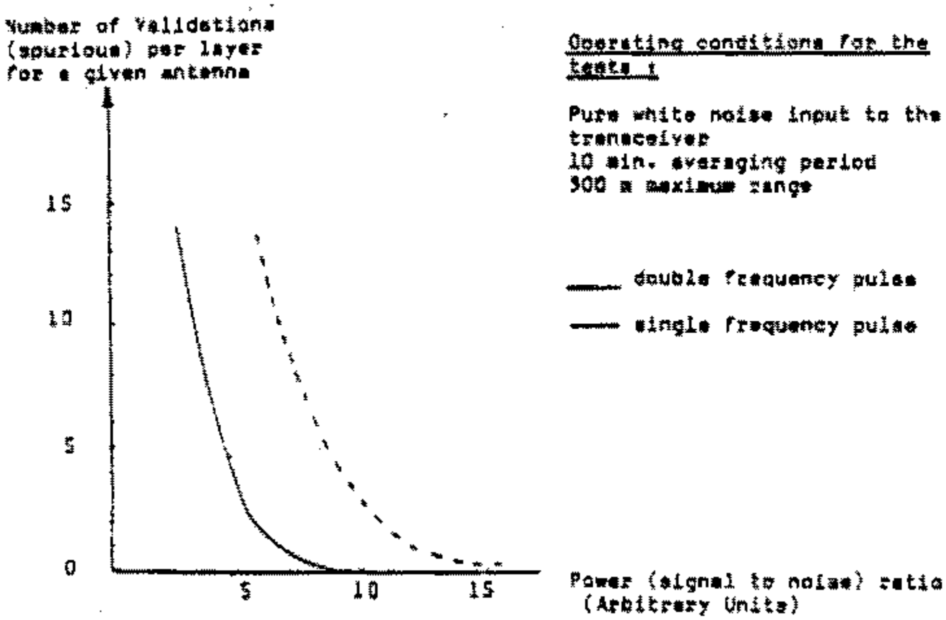

Number of Validations
(spurious) per layer
for a given antenna
15
10
5
0
5
10
15
Power (signal to noise) ratio
(Arbitrary Units)
Operating conditions for the tests :
Pure white noise input to the transceiver
10 min. averaging period
500 m maximum range
double frequency pulse
single frequency pulse

Figure 3.9.

This coding technique is also very useful for detecting fixed echoes. Typically, the software will come to the wrong conclusion in 20 % of the cases with monochromatic technique. Especially with small DOPPLER shifts, this is probably the best that can be expected which is of course unacceptable. With our technique we only make mistakes in 4 % of the cases as the joint probabilities calculation shows:

$$1 - 0.2 \times 0.2 = 0.96$$

Finally this technique leads to very interesting results regarding precision. Not only is each radial wind speed computed as an average of two independent radial wind speeds but the jitter between the two is also used as an estimate of the measurement error when calculating sigma w.

As a summary the coded pulse we are using allows an improvement in :

- signal to noise ratio,
- capability of fixed echo detection,
- measurement accuracy.

Of course much more sophisticated coding techniques can be used and this without any hardware modification on our system due to the fact that the pulse shape is calculated by the mini-computer and then stored in the transceiver RAM memory.

3.2.4. – Sigma teta ($\sigma\theta$) and Sigma w (σw) calculation :

3.2.4.1. – Sigma teta ($\sigma\theta$) calculation :

At level j $\sigma\theta$ is given at the end of the averaging period by :

$$\sigma\theta_j = \frac{1}{N} \sum_{k=1}^{N} (\theta_{jk} - \bar{\theta}_j)^2$$

in which :

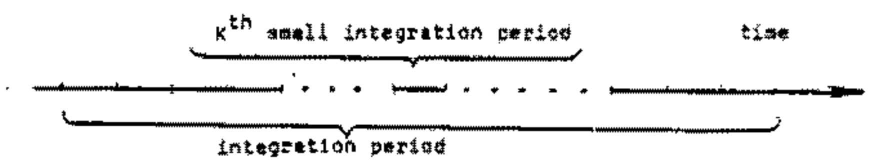
θ_{jk} is the "instantaneous" θ value at level j,

$\bar{\theta}_j$ is the averaged value at level j,

N is the total number of individual measurements.

Of course a monostatic SODAR which points at different volumes at a given layer cannot really give instantaneous values of θ.

Therefore we split the full integration period (say 15 min.) in smaller periods for which individual wind profiles are computed.



Presently the small integration periods are typically one minute.

3.2.4.2. - Sigma w (σ w) calculation :

On the other hand σ w is computed using all good measurements gained at one level during the full integration period and then applying an error correction as follows :

$$\sigma w = \left(\sigma w^2 r - Err^2 \right)^{\frac{1}{2}}$$

where :

σwr is the raw σw measurement

Err is the measurement error which is estimated, as already stated, using the jitter between the two backscattered peaks.

A frequency representation of what is performed is the following figure 3.10.

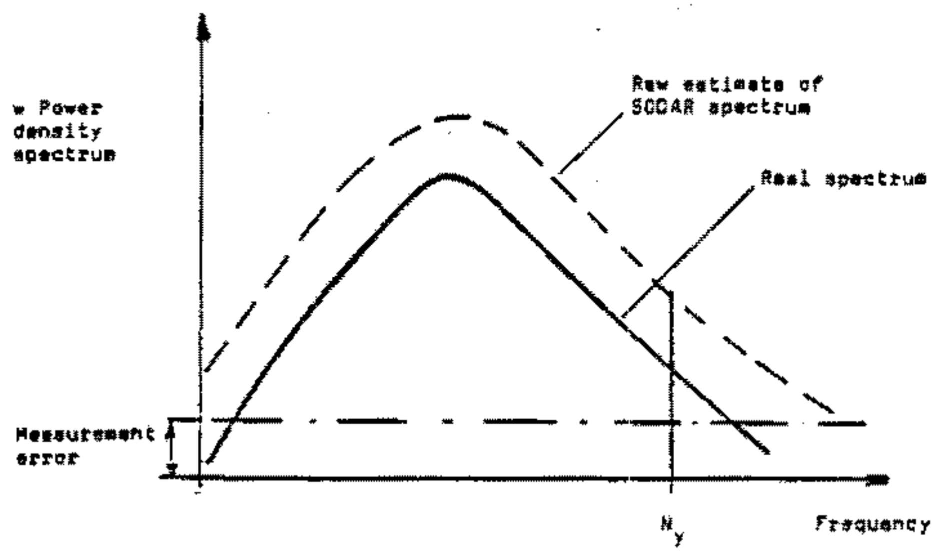


Figure 3.10.

Ny is the SODAR NYQUIST Frequency which is typically 0.05 Hz for 500 m.range and three-dimensional operation mode. We did not show aliasing effect.

Contrary to what is usually stated, this low frequency sampling rate, contrary to turbulence spectrum estimates when one has to face aliasing, is not a limiting factor for a σ_w estimate because the sampling itself is very quick (200 ms for 100 feet layer).

We think that the most limiting factor is the size of the sampled volume which leads to significant spatial averaging.

3.3. - Software description

3.3.1 - General

The SODAR program runs on a PDP 11/03 from DIGITAL EQUIPMENT CORPORATION (DEC) under the RT11 operating system.

The operating system and SODAR program are stored on the system tape (or system floppy disk) and are loaded automatically in the RAM memory of the computer when switching on (automatic boot-strap).

The SODAR program is written partly in FORTRAN language and partly in MACRO assembly language. RENTECH provides this program only in object code form.

Briefly the SODAR software performs the following tasks :

- Management of electronic transceiver.
- Management of I/O.
- Computation of Fast Fourier Transforms.
- Extraction of wind components from spectra.
- Optional real time application softwares such as automatic temperature inversion detection.

The SODAR system is designed to work automatically and to produce reliable data which does not require interpretation by a specialist.

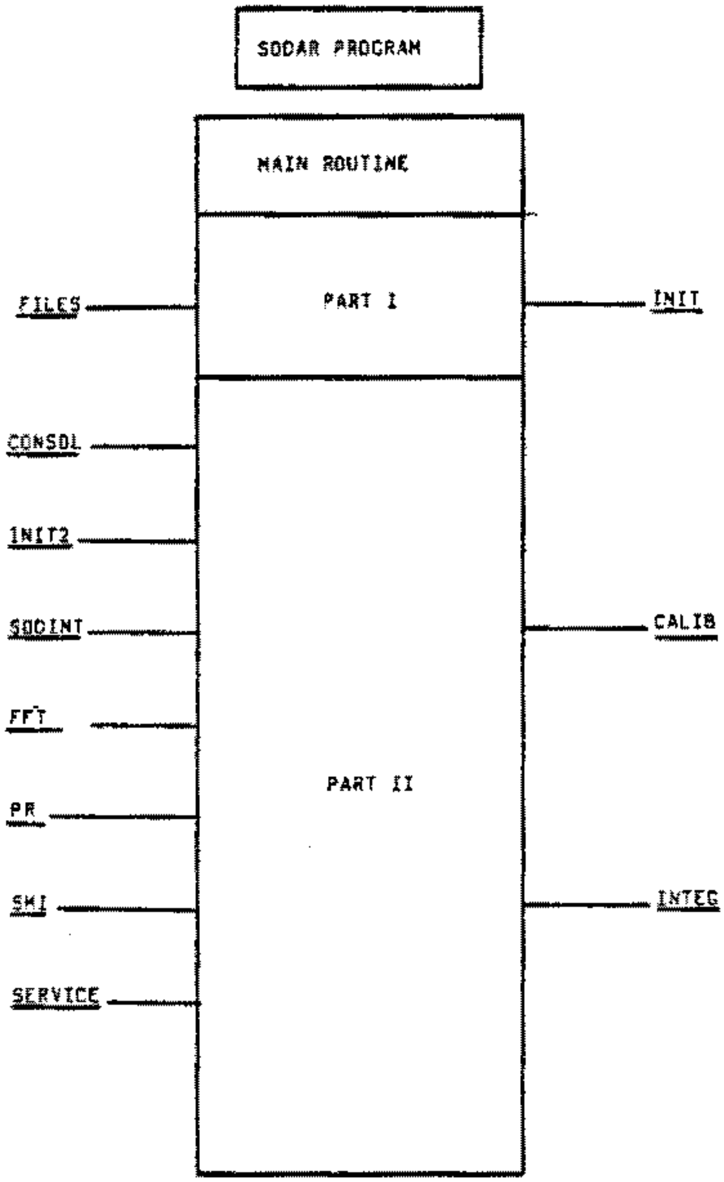
The purpose of this description is simply to provide some general information. For operational purposes, please refer to the Operating Parameters section.

3.3.2. - Description

The SODAR software is made up of a main routine and of specific task subroutines.

A block diagram of the program follows :

(See next page)


SODAR PROGRAM
MAIN ROUTINE
PART I
FILES
INIT
CONSOL
INIT2
SODINT
CALIB
FFT
PART II
PR
SMI
INTEG
SERVICE

Tasks performed by these different subroutines are :

- Part I of main routine :

This part is executed only once when the SODAR program is loaded.

Called subroutines :

FILES : This subroutine checks if a previous data file exists on tape or floppy disk. If it is the case, it opens this file - if not, it creates and opens a new one.

It also opens the Parameters File (Name SODCON.INI) which contains values of working parameters necessary for operating the Sodar.

INIT : This subroutine performs initialisations such as setting operating parameters to their correct values (reading SODCON.INI), restoring date and time by reading the hardware clock, computing shape of pulse ...

- Part II of main routine :

This part consists of an infinite loop. Each time completed, the loop performs on one antenna the following operations :

- Emission

- Reception

- Signal processing

- Determination of instantaneous wind speed

This loop is interrupted at given times for special operations such as antennas calibration or averaging period computations.

Subroutines called at each completion of the loop are :

- CONSOL : This subroutine manages I/O between computer and terminals (Example : changing a parameter value from the master console).

- INIT2 : This subroutine performs initialisations for parameters which can vary from one pulse to another.

- SODINT : This subroutine written in MACRO assembly language is used for driving the Sodar Electronic Transceiver and performs processes including :

  * frequencies generation by addressing a programmable divider,
  * relays sequence,
  * mixing of signal by emission frequency,
  * signal sampling,
  * ....

- FFT : This subroutine computes a Fast Fourier Transform on 32 complex points and gives spectral density on 32 frequency points for each layer.

If the number of slices is set to 20, 20 FFT are computed.

- PR : This subroutine starts from a spectrum and tries to extract wind speed at each layer for each antenna (See next section for details).
It also has special outputs through RS-232 such as spectrum visualisation.

- SMI : This subroutine computes averages and standard deviation.
These values are not computed at the end of an averaging period but are continously up-dated after each pulse.

- SERVICE : Services software modules.

Subroutines called at specific times :

- CALIB : This subroutine performs a calibration procedure.

Based on a user selected interval, typically every two or three hours, a white noise is emitted to obtain the transfer function of the antenna and an optimum emission frequency is determined according to ambient noise and air temperature.

- INTEG : This subroutine is called at the end of averaging time and performs the final checking of results before outputting them. This subroutine also performs automatic detection of temperature inversion (optional).
(See details in the next section).

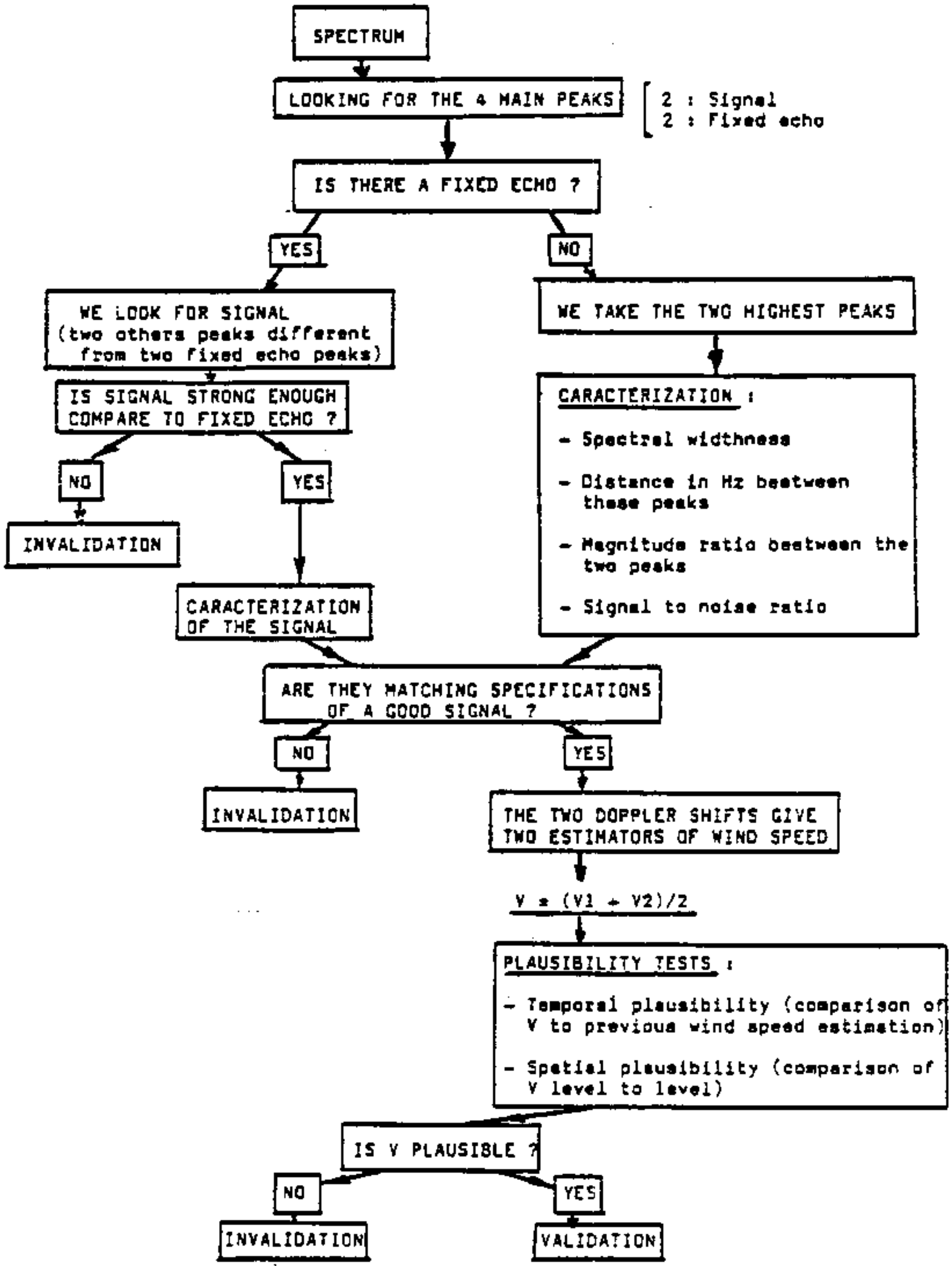
3.3.3. – Description of subroutines PR and INTEG

- PR : This subroutine computes the instantaneous wind speed component obtained at different altitudes. These instantaneous values will be averaged to provide an average values of wind speed for a given integration period.

  . The determination of radial wind speed from the spectrum is performed by PR.

In the following description, keep in mind that we emit two frequencies with the pulse and so are waiting for two significant peaks in the spectra.

See next page.


SPECTRUM
LOOKING FOR THE 4 MAIN PEAKS
2 : Signal
2 : Fixed echo
IS THERE A FIXED ECHO ?
YES
NO
WE LOOK FOR SIGNAL
(two others peaks different
from two fixed echo peaks)
WE TAKE THE TWO HIGHEST PEAKS
IS SIGNAL STRONG ENOUGH
COMPARE TO FIXED ECHO ?
CARACTERIZATION :
- Spectral widthness
- Distance in Hz beatween
these peaks
- Magnitude ratio beatween the
two peaks
- Signal to noise ratio
NO
YES
INVALIDATION
CARACTERIZATION
OF THE SIGNAL
ARE THEY MATCHING SPECIFICATIONS
OF A GOOD SIGNAL ?
NO
YES
INVALIDATION
THE TWO DOPPLER SHIFTS GIVE
TWO ESTIMATORS OF WIND SPEED
V = (V1 + V2)/2
PLAUSIBILITY TESTS :
- Temporal plausibility (comparison of
V to previous wind speed estimation)
- Spatial plausibility (comparison of
V level to level)
IS V PLAUSIBLE ?
NO
YES
INVALIDATION
VALIDATION

- INTEG : This subroutine performs final checking of results.

Final tests are :

- We ask, at each layer and for each of the three components, for a minimum number of validations (number of cases where we were able to extract a wind component).

- We ask for a reasonable value of the standard deviations of the three components. The idea is that a spurious point in wind speed data produces a high standard deviation (The threshold value of standard deviation depends on turbulence conditions).

- We ask for a plausible wind profile.

If one of these final tests is negative, the software will invalidate the data at the incriminated layer.

4. - DESCRIPTION OF THE HARDWARE.

4.1. - General

The hardware consists of several parts, the major ones are listed below :

* the antennas and compression drivers, (3 for a three-dimensionnal DOPPLER SODAR) which perform the emission and reception of the acoustic signal.

The electronic cabinet including :

* the PDP 11-03 computer with its magnetic storage (cassette or floppy-disk) and other peripherals,

* the power amplifier for emitting the pulse,

* the SODAR transceiver (which is specifically designed for SODAR operations) and its power supply unit.

See general block diagram figure 4.1. following page.

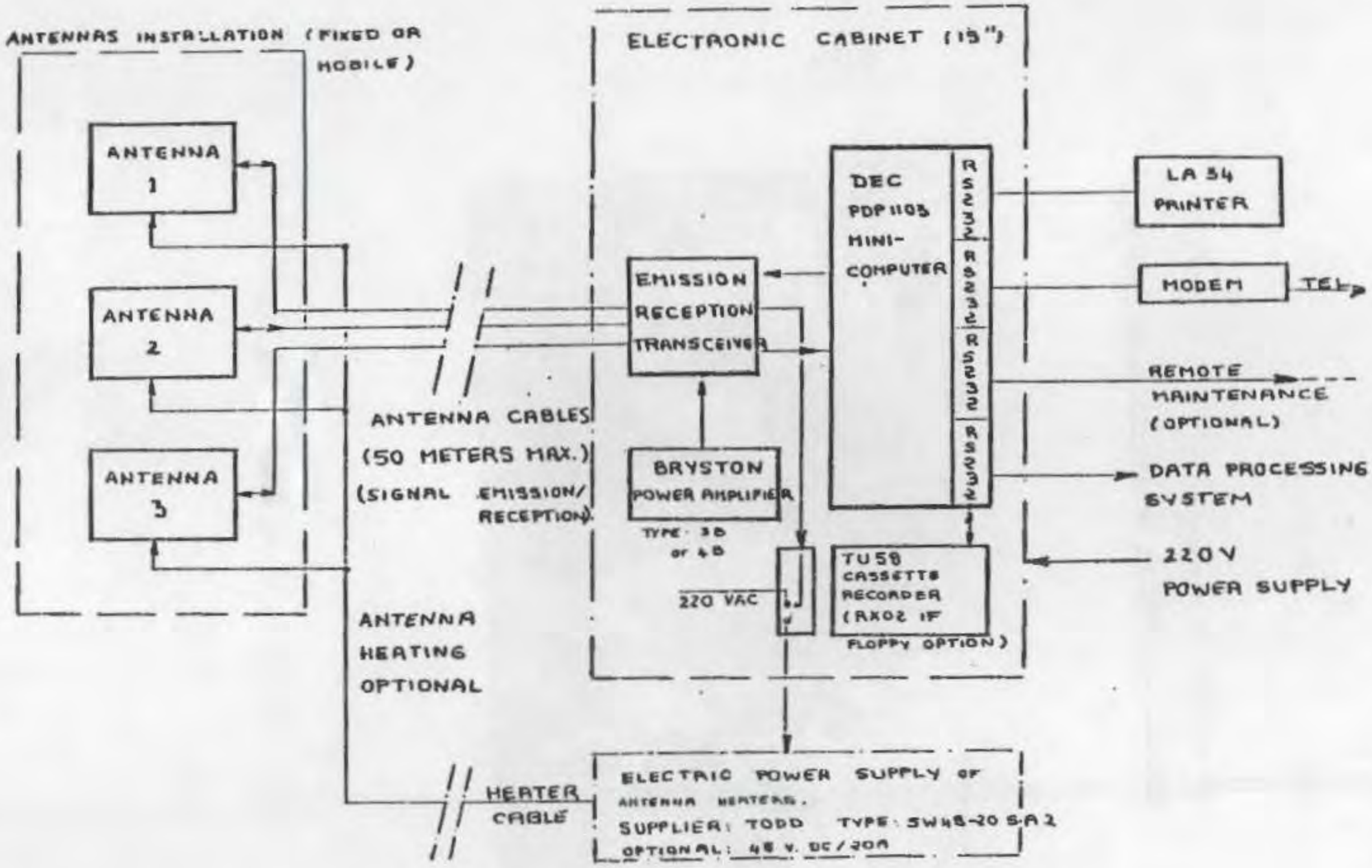


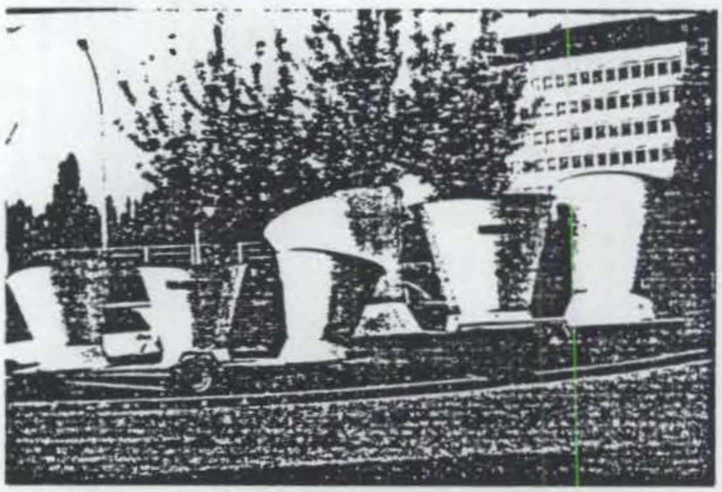
Figure 4.1. General block diagram

DT 84/148 A

REMTECH

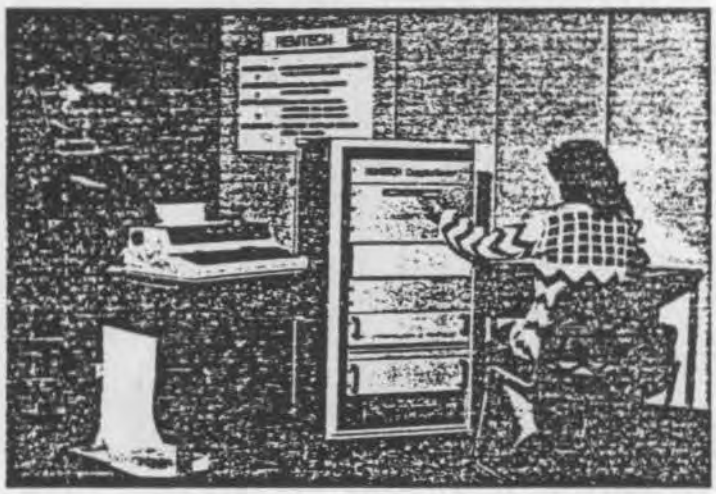
General view of the system :

Photo 1 : Antennas on trailer (three axis system)



(please note A-1 and A0 two types of antennas)

Photo 2 : Front view of the rack mounted hardware modules for the REMTECH SODAR



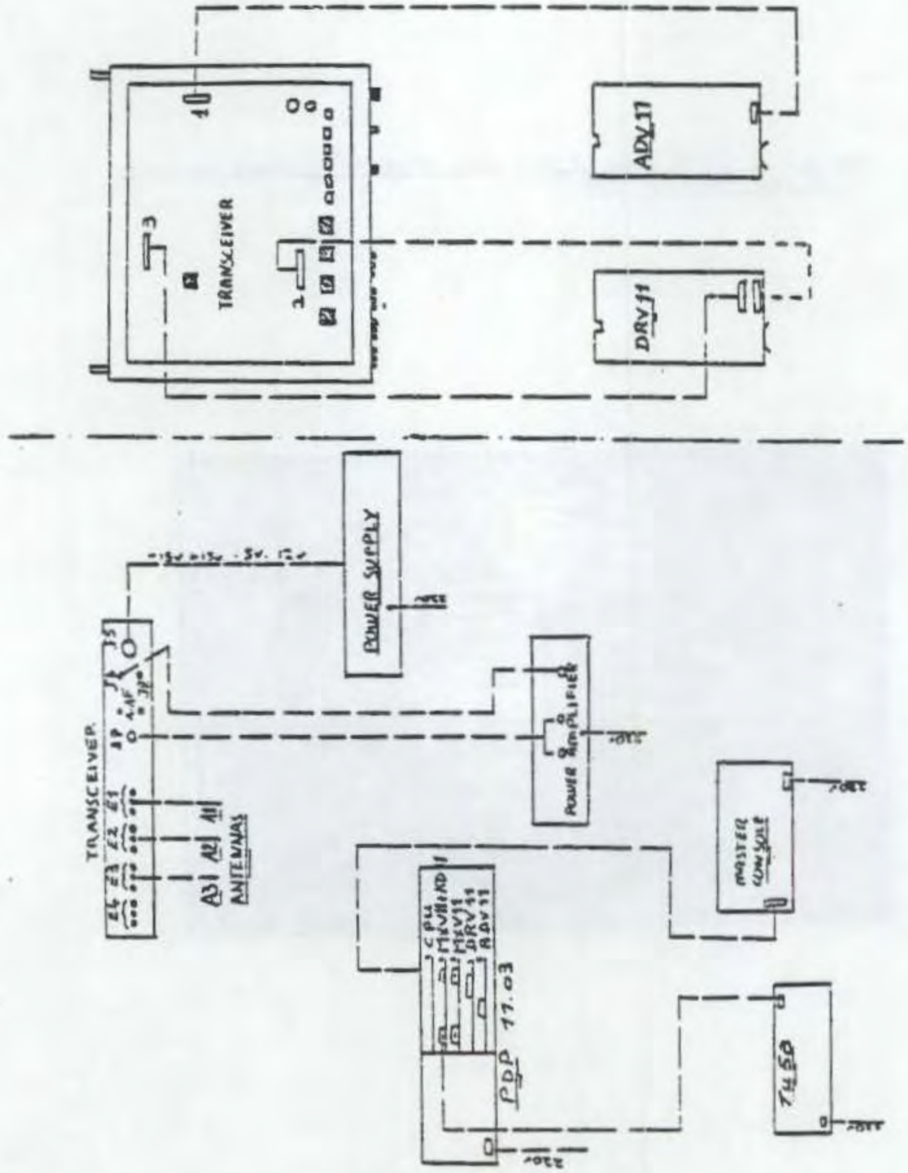
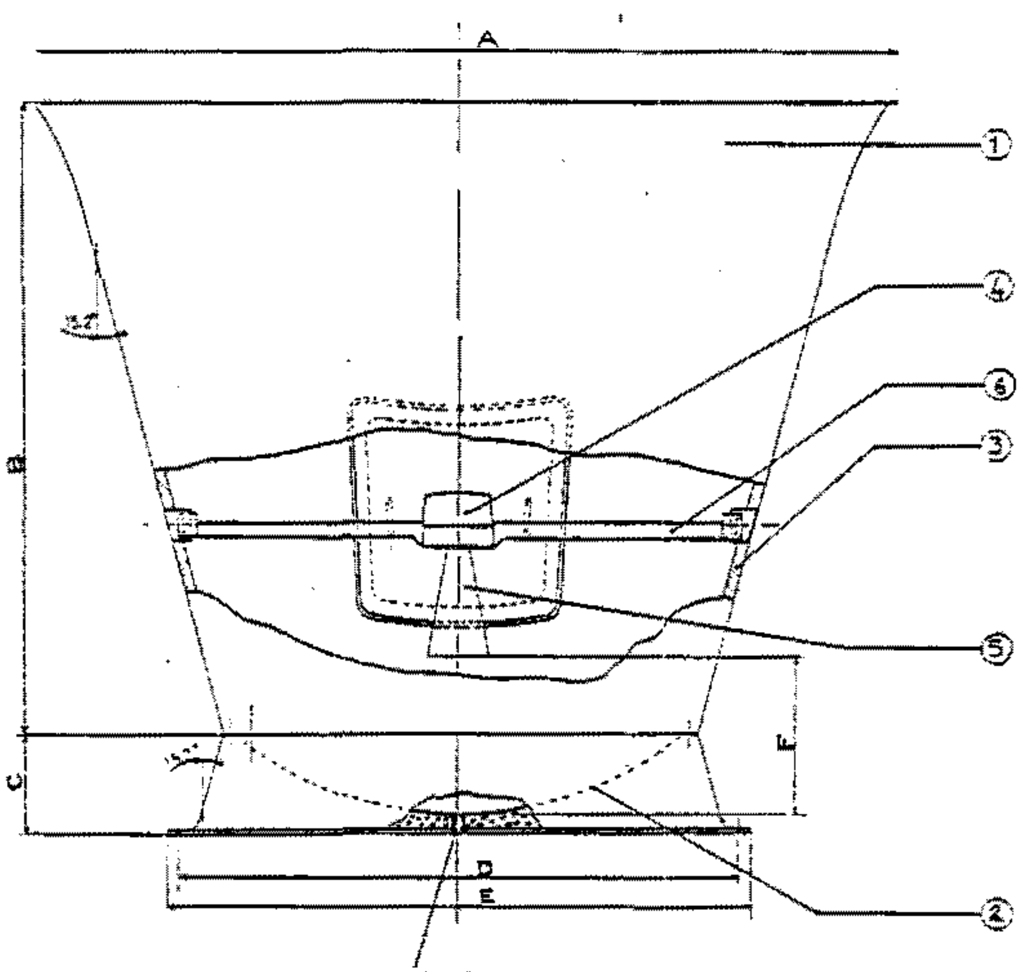


Figure 4.2. - Cables connection diagram for the whole system

4.2. - The antennas

Each antenna consists of :

- a fiberglass paraboloId and shelter (1, 2),
- an absorbing material (foam) inside the shelter (3),
- a compression driver (4) with a horn (5) whose output has to be set exactly at the focus point of the paraboloId.
- These two later items are supported by a stainless steel arm (6).



4.3. - Antenna schematic

The two types of antenna are :

- A 0 antenna working at a nominal frequency of 1600 Hz.

  Dimensions : A = 2,36 m
  B = 1,74 m
  C = 0,27 m
  D = 1,49 m
  E = 1,59 m

  Compression driver type : JBL 2445 (or 2482)

- A -1 antenna working at a nominal frequency of 2400 Hz :

  Dimensions : A = 1,583 m
  B = 1,160 m
  C = 0,200 m
  D = 1,040 m
  E = 1,140 m

  Compression driver type : JBL 2425

The shape of the A 0 and A -1 antennas are the same with a ratio of 1.5 for all dimensions.

4.3. - Mini-computer

The SODAR computer is a PDP 1103 from DEC (DIGITAL EQUIPMENT CORPORATION) with the following characteristics :

- 16 bit words
- 64 K bytes RAM memory
- floating point instruction set
- automatic bootstrap
- four RS 232 ports
- one 16 bit DIGITAL I/O parallel board
- one 12 bit A/D board with 16 single ended inputs (8 differential inputs).

As for the software our system operates under RT2 (subset of RT 11). RT 11 operating system and FORTRAN IV language are optionnal for research oriented users.

The mass storage is done using either TU 58 cassette recorder or double density floppy disk recorder. For very high storage requirements, a CIPHER q-track mag tape recorder can be provided with 2400 feet, 1600 BPI tapes.

An LA 34 (or LA 38) printer is used as the master console. For specific applications we offer the following options :

- Dot matrix printer with grey scale for fac-simile display in real time of the echo structure;

- 8 colors full graphics ID 100 video terminal with keyboard. This terminal can be used as a VT 100 from DEC for software development.

- color hard copy for the ID 100 video terminal.

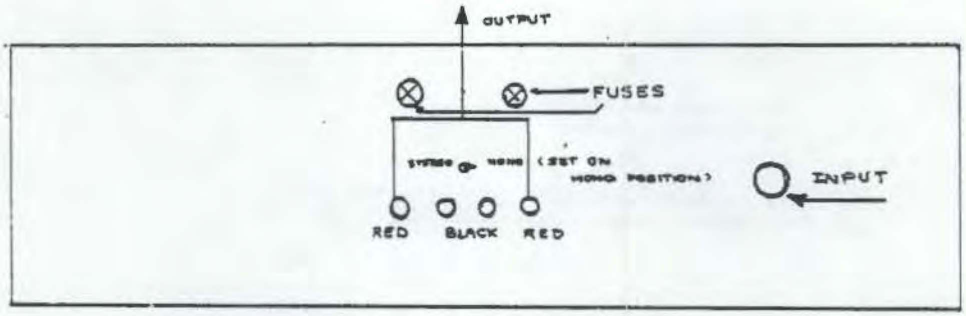
For a detailed description of the various computer modules and the RS 232 interface see Appendix N° 2.

4.4. - The power amplifier

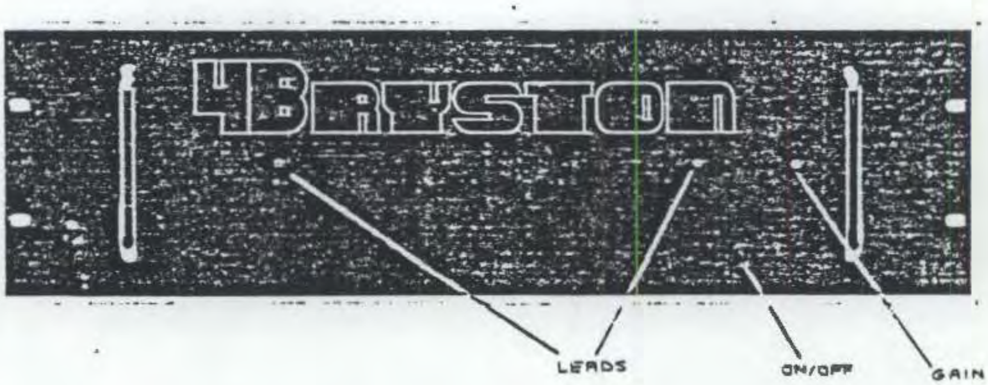
The types of power amplifier used with the SODAR varies according to the compression driver type :

- BRYSTON 4B for JBL 2445 J
- BRYSTON 3B for JBL 2425 J and JBL 2482

See following figure 4.4.



Rear view



Front view

Figure 4.4. - Shematic view of a 48 BRYSTON amplifier

4.5. - Transceiver and power supplies

The transceiver power supply unit is connected to a 110/220 VAC, 50/60 Hz. power line and provides four continuous voltages (5 V, 12 V, - 15 V, + 15 V) to the transceiver. The transceiver is controlled by the computer through three cables (see cabling plan).

See photo and a simplified functional diagram of the transceiver (Figure 4.5.) following pages.

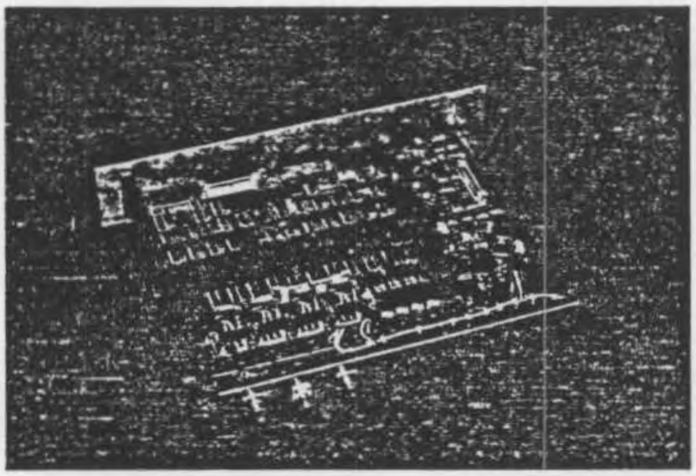


Photo of the Electronic

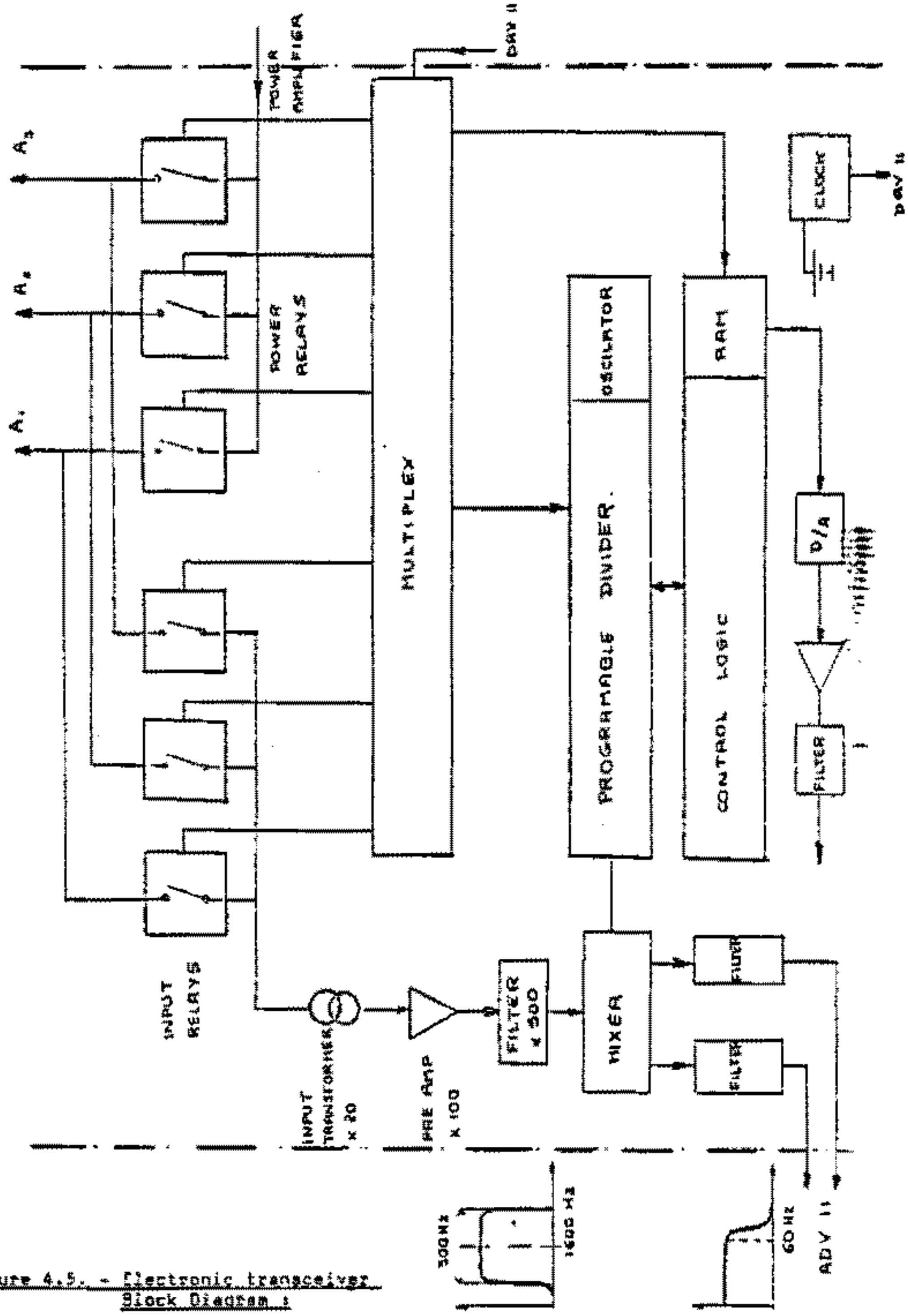


Figure 4.5. - Electronic transceiver Block Diagram :

APPENDIX B

FORMAL CALIBRATION AND MAINTENANCE PROCEDURES

Revision No. 2 Date 3-17-87

NQAI Manual Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE	Procedure No. 622R-10	Page 1 of 2
	Initial Issue Date 2-6-79	To Be Reviewed 3-17-88

Issued/Reviewed/Revised by Craft Services	Date	Approved by (Mgr., Craft Services)		Date
Dean Rohde *DR*	3-17-87	*[signature]*		3-17-87
Title		**Facility**	**Area**	**Bldg.**
Supervisor, General Instrument Services		A.S.D.	600	622R

I PROCEDURE TITLE (Description Of Operation Or Service)

RADIO TELEMETERING TRANSLATOR CALIBRATION

CERTIFIED PROCEDURE
[signature] 3-17-87
DATE
CRAFT SERVICES

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Electrical Shock - Remote chance of shock at 115 volt AC input connector.
Pinch Points - Folding-type Cabinet - Use care in closing.

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Calibrated 4 1/2 digit voltmeter required because a balanced system is necessary to meet manufacturer's specifications.

Signal Generator - 0 to 500 Hertz, + 10 Volt peak capability.

Frequency Counter - To verify signal input.

IV PROCEDURE OR METHOD OUTLINE

1. Give "Two Seconds of Safety Thought" before proceeding.

2. Connect light-weight vane to translator - Do Not connect the anemometer. (In calibration, the frequency generator replaces the anemometer).

3. Set function switch in translator to W. S. Zero. Monitor TP-1, Card 1 (Ground) and TP-2, Card 2 and adjust R2, Card 2 for 0.00 VDC. Switch TP-2 lead to TP-2, Card 3 and adjust R3, Card 3 for 0.00 VDC.

   Card 4 and 5 (averaging) are adjusted using R3 on its respective board for 0.00 VDC out at TP-3. This should take about 20 minutes per each adjustment as the time constant for each board is about 5 minutes, and five time constants should be allowed for the board to settle to its final value.

TWO SECONDS FOR
SAFETY THOUGHT

A-1440-068 (12-86)

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

On cards 6 and 7 (offset buffers) short the junction at R2 and R14 to TP-5 and TP-4 (zero to IC-2) and adjust R3 on each board for 0.00 VDC at TP-2 on each card. Remove short when zero (R3) is set.

4. Apply a 491 Hertz, +10 Volt signal to wind speed cal. terminals (red and black banana jacks). Place function switch to zero sin/cos position. Set R3, Card 2 for 1.00 VDC at TP.1, Card 2. Set R4, Card 3 for -1.00 VDC at TP-1, Card 3. Wait about 20 minutes per adjustment and set R1 for -1.00 VDC at TP-1 on cards 4 and 5, using respective adjustments and test points on each card. Adjust R2 on Cards 6 and 7 (offset and buffer amplifiers) for 0.00 VDC at TP-2 using respective adjustments and test points for each card. Set function switch to F.S. sin/cos. Verify each time the function switch is changed that for 491 HZ input Card 2 TP-1 reads +1.00 VDC and Card 3 TP-1 reads -1.00 VDC. If they do not read appropriately, then adjust proper potentiometer (R3 Card 2 and R4 Card 3) so that they do so. Wait about 20 minutes, then adjust R4 for 10.00 VDC at TP-1 on Cards 6 and 7, using respective adjustments and test points on each card.

5. Set function switch to run and insert the 491 HZ +10 VDC into TP-8 Card 2 and again verify -1.00 VDC on Card 3 and +1.00 VDC on Card 2 at Test Point 1. This completes the calibration of the translator.

6. Restore work area to a good housekeeping condition. Any unsafe tool, equipment, material or condition should be corrected before the job is considered to be completed.

7. Complete documentation of calibration in accordance with SMP-GP-37.

Revision No. 1	Date 5-11-87

NQAT Manual Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE	Procedure No. 622R-13	Page 1 of 2
	Initial Issue Date 5-12-81	To Be Reviewed 5-11-88

Issued/Reviewed/Revised by Craft Services	Date	Approved by (Mgr., Craft Services)		Date
D. L. Rohde *DLR*	5-11-87	*[signature]*		5-11-87
Title		**Facility**	**Area**	**Bldg.**
Supervisor, Spec. Instrument Services		622R	600	622R

I PROCEDURE TITLE (Description Of Operation Or Service)

RADIO TELEMETERING TRANSLATOR CALIBRATION FOR THE WEATHER MEASURE MODEL SC 701 SIGNAL CONDITIONING SYSTEM

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Electrical Shock--remote chance of shock at 115 VAC input connector.

Pinch Points--folding type cabinet--use care in closing.

Lifting Strains--53 pounds--use proper lifting technique.

CERTIFIED PROCEDURE
[signature] *5/11/87*
CERTIFIED BY: DATE
CRAFT SERVICES

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Calibrated 4 1/2 Digit Voltmeter - required because a balanced system is necessary to meet specifications.

Oscilloscope - to determine 10 volt peak.

Frequency Generator - 0 to 500 Hertz, +10 volt peak input.

Frequency counter - to verify signal input frequency.

IV. PROCEDURE OR METHOD OUTLINE

1. Before proceeding, carefully consider the "safety aspects" of this job. Review Job Hazard Breakdown CS-79 on lifting heavy objects for assurance of proper technique.

2. Connect the light weight vane to the translator. Do Not connect the anemometer. (In calibration, the frequency generator replaces the anemometer).

3. Disconnect terminals 1 and 2 (terminal 1 is uppermost) of the module terminal strip 1 on the rear panel immediately behind the Wind Speed Module (not to be confused with TB-1 on the power supply).

4. Connect the positive lead of the 10-volt signal from the generator to terminal 1 and the negative lead to terminal 2 of module terminal strip 1.

TWO SECONDS FOR
SAFETY THOUGHT

A-1990-068 (12-84)

5. Set the function switch on the front panel to the "Low Cal" position and adjust the V-Out Low Potentiometer to obtain a zero voltage output (red banana jacket) on the Windspeed Module.

6. Adjust the V-Out Low Potentiometer for a zero voltage output (red banana jack) on the Buffer Amplifier Module.

7. Set the function switch on the front panel to the "RUN" position.

8. Set the generator for 491.5 Hertz, + or - 1%, but as accurately as possible, keeping in mind that high accuracy "in" enables good calibration "out".

9. Adjust the V-Out High Potentiometer on the wind speed module to obtain + 1.000 volt D.C. at the voltage output.

622R-13 2

10. Adjust the V-Out High Potentiometer on the Buffer Amplifier Module to obtain - 1.000 volt D.C. at the voltage output.

11. Set both "minutes" switches to zero on the Sine and Cosine Average Modules. (This removes the averaging time constants, thereby increasing technician efficiency in calibration time).

12. Turn the vane until you obtain a minimum reading at the voltage output of the Sine Average Module and adjust the V-Out Low Potentiometer for a zero reading.

13. Turn the vane until you obtain a maximum reading at the voltage output of the Sine Average Module and adjust the V-Out Hi Potentiometer for + 10.00 volts D.C.

14. Repeat steps 12 and 13 until satisfied there is no interaction between the two, affecting the readings.

15. Measuring the output of the Cosine Averaging Module, go through steps 12, 13 and 14, adjusting its V-Out Low and V-Out Hi Potentiometers as needed.

16. Return the "minutes" switches on the Sine Average and Cosine Average Modules to the "5 minutes" position.

17. Disconnect the generator from Terminals 1 and 2 of module terminal strip 1 and reconnect the original inputs.

18. Restore area to a good housekeeping condition. Any unsafe tool, equipment, material, or condition should be corrected before the job is considered to be completed.

19. Complete any needed calibration documentation in accordance with SMP-GP-37.

Revision No. 2 Date 5-11-87

NQA1 Manual Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE	Procedure No. 622R-14	Page 1 of 2
	Initial Issue Date 5-12-81	To Be Reviewed 5-11-88

Issued/Reviewed/Revised by Craft Services	Date	Approved by (Mgr., Craft Services)		Date
D. L. Rohde *DLR*	5-11-87	*Gary Bright*		5-11-87
Title		**Facility**	**Area**	**Bldg.**
Supervisor, Spec. Instrument Services		622-R	600	622-R

I PROCEDURE TITLE (Description Of Operation Or Service)

REMOTE RADIO TELEMETRY DATA ACQUISITION SYSTEM CALIBRATION (CLIMATRONICS IMP-834) STATIONS #1-19, 23 & 24

Prepared by Robert H. Castleberry - 622R Instrument Shop.

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

A. Electrical Shock - remote chance of shock at 115 VAC outlet.
B. Pinch Points - folding type cabinet.

CERTIFIED PROCEDURE
R E Dunkle *5/11/87*
CERTIFIED BY: DATE
CRAFT SERVICES

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

A. Calibrated 5 VDC source (Transmation 1040 Digital Calibrator or equiv).

B. Shop made Sensor Input Adapter Plug.

IV PROCEDURE OR METHOD OUTLINE

1. Open the IMP-834 enclosure.
2. Place the X-15 Jumper to position 1 (Left).
3. Set Topics 31 and 45 to 0.
4. Remove the Sensor Input from the bottom of the IMP, and connect adapter plug to IMP Input.
5. Set Topic 25 CH-1 to 5.000 (Primary Span).
6. Set Topic 46 to 1 (Engineering units enable).
7. Ensure Topic 21 CH-1 = 3 (5 volt input).

TWO SECONDS FOR SAFETY THOUGHT

A-1860-068 1 (2-86)

8. Monitor Topic 47 CH-1 for the applied voltage.

9. Connect voltage source to CH-1 and analog common of plug adapter.

10. Input the following voltages, verify the IMP display reads within tolerance. Record "As Found".

VOLTAGE APPLIED	DISPLAY VOLTAGE
0 VDC	0 +- .05 VDC
1.25 VDC	1.25 +- .05 VDC
2.50 VDC	2.50 +- .05 VDC
3.75 VDC	3.75 +- .05 VDC
5.00 VDC	5.00 +- .05 VDC

11. If in tolerance, record "As Left" voltage.

12. If out of tolerance, adjust R38, repeat Step 9, and record "As Left".

13. Remove plug adapter and reinstall sensor connector to IMP.

If not Doing an annual calibration

14. Set Topics 31 and 45 to 1, place Jumper X-15 to position - 2 (Right) and do a four second short reset.

15. Return remote station to normal operation.

16. Affix Level 1 calibration sticker and complete all required calibration records.

NQA1 Manual		Revision No. 1	Date 7-14-86
Battelle Pacific Northwest Laboratories		Procedure No. 622R-15	Page 1 of 2
STANDARD MAINTENANCE PROCEDURE		Initial Issue Date 7-23-81	To Be Reviewed 7-14-87
Issued/Reviewed, Revised by Craft Services: M. H. Napora [signature]	Date 7-14-86	Approved by (Mgr., Craft Services) [signature]	Date 7-14-86
Title: Foreman, General Instrument Services		Facility: Atmospheric Sciences; Area: 600 A.	Bldg. 622-R

I PROCEDURE TITLE (Description Of Operation Or Service)

CALIBRATION CHECK OF THE WEATHER MEASURE MODEL W104 LIGHTWEIGHT VANE

CERTIFIED PROCEDURE

[signature] 7-11-86
CERTIFIED BY: DATE

C & O SERVICES DEPT.

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Sharp Corners
Loose Calibration Top

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Digital Voltmeter (4 1/2) HEDL Calibrated
Calibration Unit (Battelle Developed) HEDL Calibrated
+1 and -1 Volt D.C. Source
PNLMA-60; PAP-1201; PAP-1203

IV PROCEDURE OR METHOD OUTLINE

1. Consider the "safety aspects" of this job before proceeding.
2. Install the lightweight vane into the calibration unit.
3. Connect the +1 Volt supply to pin G and the -1 Volt supply to pin H with the grounds going to pin F. Using the Voltmeter, make sure both supplies are as well balanced (both at 1.0000 Volt) as possible.
4. Read the output of pin D (sine output) and adjust the vane until you read as close as possible to zero. Adjust the calibrated top so that the vane is in the north position while still reading zero.
5. Read the output of pin E (cosine output). This should be within 1% of +1.0000 Volt, and any adjustment of the vane to obtain this reading shall not exceed + or - 3.6° of north.

A-1980-066.1 (2-86)

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

6. Adjust the vane to read "East" and obtain a new zero reading on pin E. The vane should end up within + or - 3.6° of east on the calibrated top. Then read the voltage on pin D. This reading should be +1.0000 volt (within 1%). Any adjustment of the vane to obtain that reading should be within + or - 3.6° of east.

7. Adjust the vane to read south and obtain a near zero reading on pin D. The vane should end up within + or - 3.6° of south on the calibrated top. Then read the voltage on pin E. This reading should be -1.000 Volt (+ or - 1%). Any adjustment of the vane to obtain that reading should be within + or - 3.6° of south.

8. Adjust the vane to read west and obtain a near zero reading on pin E. The vane should end up within + or - 3.6° of west on the calibrated top. Then read the voltage on pin D. This reading should be -1.000 Volt (+ or - 1%). Any adjustment of the vane to obtain that reading should be within + or - 3.6° of west.

9. Change the bearings in the lightweight vane. (See the weather measure manual, if unfamiliar with the procedure).

10. Do steps 2 through 8 again and, if calibration is verified, complete required level one calibration documentation. See SMP-GP-37.

11. Restore area to proper working condition. Any unsafe tool, equipment or condition should be corrected before the job is considered to be completed.

Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE	Revision No. 0 Date
	Procedure No. 622R-36 / Page 1 of 2
	Initial Issue Date 7-23-81 / To Be Reviewed 7-23-85

Issued/Reviewed/Revised By (CSD)	Date	Approved By (Mgr., Craft Services)	Date
M. H. Napora	7-23-84	[signature]	7-23-81
Title: Foreman, General Instrument Services		Facility: Atmospheric Sciences / Area: 600 A.	Bldg. 622-R

I PROCEDURE TITLE (Description Of Operation Or Service)

CALIBRATION CHECK OF THE WEATHER MEASURE MODEL W103-A ANEMOMETER USED IN THE HANFORD RADIO TELEMETRY SYSTEM

CERTIFIED PROCEDURE
J. [signature] 7/23/81
CERTIFIED BY: DATE
C & O SERVICES DEPT.

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Sharp corners on calibration unit might be considered hazardous.

Avoid placing instruments in locations where they might be dislodged.

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

TWO SECONDS FOR SAFETY THOUGHT

Frequency Counter - HEDL Calibrated
Calibration Unit (Battelle Developed)
300 RPM Drive Motor - HEDL Verified
1800 RPM Drive Motor - HEDL Verified
Calibration Record Card 80-1060-047 (5-78)
Shop Calibration Check List (Shop use only, shown on pg. 2)

IV PROCEDURE OR METHOD OUTLINE

1. Consider the safety aspects of this job before proceeding. Arrange instruments on clean surface to avoid dropping.

2. Mount the anemometer into the connector on the calibration units with its neck in the rest.

3. Place the 300 RPM drive motor in the calibration unit and secure to anemometer shaft.

4. Turn on the 300 RPM drive motor and read counts out by connecting the input to the frequency counter to the BNC connector on the calibration unit. Record the counts out in the appropriate location on the calibration check list form to show the "as found" condition.

5. Place the 1800 RPM drive motor in the calibration unit and secure to anemometer shaft.

A-1860-058.1 (1-80)

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

6. Turn on the 1800 RPM drive motor and read counts out on the frequency counter. Record counts in the appropriate location on the calibration check list form to show the "as found" condition.

7. Replace the bearings in the anemometer. (If unfamiliar with procedure, refer to weather measure manual).

8. Again do Steps 3, 4, 5 and 6, and record output counts in appropriate location on the check list form.

9. Fill out proper blocks of the calibration card, showing calibration verified.

10. Restore area to proper working condition. Any unsafe tool, equipment or condition should be corrected before the job is considered to be completed.

W103-A Anemometer Serial # ____________________

	As Found Output Counts	New Bearings Output Counts
300 RPM	________	________
1800 RPM	________	________

Date: ____________________

Checked By: ____________________

NQAI Manual		Revision No. 0	Date
Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE		Procedure No. 622R-18	Page 1 of 2
		Initial Issue Date 10-12-81	To Be Reviewed 10-12-87
Issued/Reviewed/Revised By (Craft Services) O. L. Rohde	Date 10-12-86	Approved By (Mgr. Craft Services)	Date 10-12-81
Title Supervisor, Spec. Instrument Services		Facility Atmospheric Sciences Area 600	Bldg. 622-R

I PROCEDURE TITLE (Description Of Operation Or Service)

CALIBRATION CHECK OF THE WEATHERTRONICS MODEL 5141 HUMIDITY MONITORING SYSTEM AT FIVE FOOT METEOROLOGY TOWER SITE.

CERTIFIED PROCEDURE
CERTIFIED BY: DATE 10/8/81
C & O SERVICES DEPT

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Bumping hazard from equipment hanging from boom.

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Two-way radio, thermometer - HEDL verified, distilled water.
Saturated solutions of lithium chloride crystals and potassium sulfate crystals in sealed containers.
Allen wrenches, screwdrivers, water pump pliers, camel hair brush.
Calibration record card BD-1060-047 (5-78).

IV PROCEDURE OR METHOD OUTLINE

TWO SECONDS FOR SAFETY THOUGHT

"TAKE TWO SECONDS FOR SAFETY THOUGHT"

1. Consider the safety aspects of this job before proceeding.
2. Remove probe from shelter and verify aspiration.
3. Remove sintered filter from probe. DO NOT TOUCH SENSING ELEMENT.
4. Insert probe into lithium chloride calibration chamber and wait approximately twenty minutes for stabilization to occur.
5. Record ambient temperature, calculated humidity from Figure 5.1 in Weathertronics Humidity Probe Manual, and humidity recorded in control room.
6. Insert probe into potassium sulfate calibration chamber and wait approximately thirty minutes for stabilization to occur.
7. Repeat Step #5.
8. Clean sintered filter with distilled water if required.
9. Turn off humidity translator.
10. Gently blow dust off sensing element; DO NOT USE COMPRESSED AIR.
11. Carefully wipe sensing element with camel hair brush dipped in distilled water.

A-1860-058.7 (1)

12. After probe has dried, turn humidity translator back on.
13. Repeat steps four through seven.
14. Final readings should be within ± 3 percent of the calculated readings. If they are not, refer to appropriate Weathertronics manuals and Leeds and Northrup Speedomax 250 Recorder Manual to systematically troubleshoot system.
15. If final readings are within limits, calibration check is complete. When sintered filter is dry, reinstall on probe and replace probe in housing.
16. Restore area to proper working condition. Any unsafe tool, equipment, or condition should be corrected before the job is considered complete.

Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE		Revision No. ____ Procedure No. 622R-19	Date ____ Page 1 of 4
		Initial Issue Date 2-4-87	To Be Reviewed 2-4-88
Issued/Reviewed/Revised by Craft Services: D. L. Rohde	Date: 2-4-87	Approved by (Mgr., Craft Services)	Date: 2-4-87
Title: Supervisor, Spec. Instrument Services		Facility: 622R Area: 600	Bldg. 622-R

I PROCEDURE TITLE (Description Of Operation Or Service)

REMOTE RADIO TELEMETRY MICROPROSSOR BASED DATA ACQUISITION SYSTEM CALIBRATION (CLIMATRONICS IMP-834) STATION #20

Prepared by Robert H. Castleberry - 622R Instrument Shop.

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Electrical Shock - remote chance of shock at 115 VAC outlet.
Pinch Points - folding type cabinet.

CERTIFIED PROCEDURE
CERTIFIED BY 2-4-87 DATE
CRAFT SERVICES

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Calibrated 1 VDC source (Transmation 1040 Digital Calibrator or equiv).
Calibrated Frequency Counter (Fluke 8060A or 1910A or equiv).
SHop Made Calibration Plug (optional).
Calibrated Function Generator (HP 3311A or equiv).
Oscilloscope.

IV PROCEDURE OR METHOD OUTLINE

1. Open the IMP-834 enclosure.
2. Place the X-15 jumper to position 1 (left).
3. Set topics 31 and 45 to 0.
4. Remove the sensor input from the bottom of the IMP.

TWO SECONDS FOR SAFETY THOUGHT

A-1880-058 1 (2-86)

IV. PROCEDURES OR METHOD OUTLINE (contd)

5. ANALOG/DIGITAL CONVERTER CALIBRATION:

   a. Remove the J-7 molex connector.

   b. Connect the Transmation to pin 1(-) and pin 2(+).

   c. Apply the voltage indicated in the following steps and read the counts shown at topic 47, channel 1. Record the "as found" readings on the Record of Calibrations sheet.

VOLTAGE APPLIED	READINGS (in counts)
(1) 0.000 VDC	0000 +/- 0005
(2) 0.250 VDC	1000 +/- 0005
(3) 0.500 VDC	2000 +/- 0005
(4) 0.750 VDC	3000 +/- 0005
(5) 1.000 VDC	4000 +/- 0005

   d. Adjust R38 if out of tolerance. Repeat steps c(1) to c(5) and record the "as left" counts on the Record of Calibrations sheet.

   e. Remove Transmation & remate J-7 molex connector.

6. 1 VOLT REFERENCE CALIBRATION CHECK:

   a. Install the Shop Made Calibration Plug.

      NOTE: The Shop Made Calibration Plug connects pin m (+1 vdc referance) to pin L (Analog 1). If you do not have the plug, the connection may be made with a jumper.

   b. Read topic 47, channel 1. Should read 4000 +/- 0005.

   c. Record the "as found" counts on the Calibration Sheet.

   d. Adjust R32 if out or tolerance-record "as left" reading.

7. COUNTER CALIBRATION CHECK:

   a. Monitor the output of the Function Generator with a Calibrated Frequency Counter and oscilloscope. Adjust for a 23 HZ, 0.4 VP/P Sine Wave with zero volts offset.

IV. PROCEDURE OR METHOD OUTLINE (contd)

7. COUNTER CALIBRATION CHECK: (contd)

b. Connect the red and black leads from the Shop Made Calibration Plug to the output of the Function Generator.

NOTE: The Shop Made Calibration Plug connects the Counter 1 input (pins G - GNDD and H - CT1) to the red and black leads. If you do not have a plug, the connections may be made with a jumper, or test leads.

c. Read topic 47, channel 17. It should read 0023 +/- 0002 counts. Record the "as found" reading on the Record of Calibrations sheet.

d. Adjust the Function Generator for 69 HZ. Topic 47, channel 17 should read 0069 +/- 0002 counts. Record the "as found" counts on the Record of Calibrations sheet.

e. Adjust the Function Generator for 138 HZ. Topic 47, channel 17 should read 0138 +/- 0002 counts. Record the "as found" counts on the Record of Calibrations sheet.

f. Adjust the Function Generator for 230 HZ. Topic 47, channel 17 should read 0230 +/- 0005 counts. Record the "as found" counts on the Record of Calibrations sheet.

g. Adjust the Function Generator for 414 HZ. Topic 47, channel 17 should read 0414 +/- 0005 counts. Record the "as found" counts on the Record of Calibrations sheet.

h. Remove the Calibration Plug.

i. Reconnect the sensor Plug.

8. VSWR CHECK:

a. Install the Byrd Model 43 Thruline Wattmeter.

b. Push "call button" and read forward power.

c. Record on Calibration Sheet.

d. Push "call button" and read reflected power.

e. Record on Calibration sheet.

f. Remove Wattmeter and reinstall Coax.

IV. PROCEDURE OR METHOD OUTLINE (contd)

9. Short Reset the IMP

10. Prepare and install Calibration tag. Complete all calibration documentation in accordance with SMP-GP-37.

Revision No. ______ Date ______

Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE	Procedure No. 622R-20	Page 1 of 3
	Initial Issue Date 2-9-87	To Be Reviewed 2-9-88

Issued/Reviewed/Revised by Craft Services	Date	Approved by (Mgr., Craft Services)	Date
D. L. Rohde	2-9-87		2-9-87
Title		**Facility / Area / Bldg.**	
Supervisor Spec. Instrument Services		General / All / All	

I PROCEDURE TITLE (Description Of Operation Or Service)

METEOROLOGY TOWER WIND SPEED FIELD CALIBRATION

Prepared by Dennis G. Knight - 622-R Instrument Shop

CERTIFIED PROCEDURE
2-9-87
CERTIFIED BY / DATE
CRAFT SERVICES

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Electric shock
Weather Exposure
Tower Elevation and Elevator Usage

"GIVE TWO SECONDS OF SAFETY THOUGHT BEFORE PROCEEDING"

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Precision Digital Multimeter
Frequency Counter
Weathertronics Card Extender P/N 17007
Precision Calibrated Motors 300 & 1800 RPM
Anemometer Test Jig
Portable Calculator
General Instrument Technician Tools
Calibration Record Card
Record of Calibration
SMP GP-37
Two-way Radio

NOTE: Ensure all HEDL test equipment used in calibration has current calibration stickers.

IV. PROCEDURES OR METHOD OUTLINE

The Weathertronics Wind Speed System is comprised of an anemometer (photo coupled chopper) and a pulse frequency sensitive, signal conditioning, module. The Weathertronics Model 1251 module produces two output voltages. One is a 0 to 10 millivolt output which drives the chino wind speed recorder and the 0 to 5 volt output is used for computer record and analysis. The wind velocity is measured on 8 levels: 7, 30, 50, 50 S.E., 100, 200, 300 and 400 feet. The system indication is by recorder only and it will be calibrated under a separate Standard Maintenance Procedure.

TWO SECONDS FOR
SAFETY THOUGHT

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

1. Inform the synoptic lab of the impending calibration. Verify the calibration date is current on the recorder for the tower level to be calibrated.

2. Locate the rack and the tower level module to be calibrated, as illustrated in Figure 2.

3. This procedure covers the calibration of the tower wind speed as a system and will require two technicians.

4. If an annual calibration is to be performed, which includes anemometer bearing changes, continue to step 5. If not, continue also, only disregard recording as found and as left data.

5. Remove the anemometer from the cross-arm assembly, remove cups and place in test jig.

6. Establish communication between tower levels and place the module mode switch in the lo-cal position. The voltages measured at both the blue and orange test points should be 0.00 in reference to black test point common.

7. Return the mode switch to operate and alternately monitor the blue and orange test points. Turn the anemometer at 300 and 1800 RPM. If not previously recorded, record as found.

8. Reference Figure 1 for wind speed, RPM and voltage equivalents.

9. Determine if voltages are in tolerance. If not, adjust output-1 and 2 hi/low potentiometers until zero and span voltages are achieved using the 300 and 1800 RPM motors. Go to Step 12 if just a board calibration is required.

10. Remove anemometer from test jig and refer to manufacturer's manual for bearing changes.

11. Repeat steps 7, 8 and 9, if in tolerance, record as left and go to Step 13. If module will not calibrate, commence troubleshooting.

12. The wind speed module calibration is as follows:

    A. Remove power and place wind speed card on extender.

    B. Restore power and turn mode switch to the Hi-Cal position.

    C. Measure internal test oscillator frequency at front Black (-) test point and the brown (+) test point located at the rear of the module. Make note of the frequency.

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

D. Move the position test lead to the blue test point, turn mode switch to Lo-Cal. If necessary, adjust VR 202 (signal out 1, lo) for 0.00 VDC.

E. With the oscillator frequency measured in Step C, calculate the following formula for wind velocity.

$$Vmph = \frac{FHZ}{10.19} + 0.52$$

F. Using the wind velocity calculated in Step E, calculate the Hi-Cal output voltage:

$$V\ out = \frac{5.0\ VDC}{100}\ Vmph$$

G. Place mode switch in Hi-Cal position. Adjust VR201 (signal out 1, HI) for voltage calculated in Step F.

H. Monitor the orange (+) test point. Adjust VR203 (signal out 2, HI) for a value 0.002 times the value calculated in Step F.

I. Make adjustments as required until Lo-Cal and Hi-Cal voltages are achieved on both output voltage ranges (0-10 mV and 0-5 VDC).

J. If all adjustments are complete, return to Step 10.

13. Before reinstalling anemometer verify lab recorder reads 0, 15.2 and 88.8 miles per hour, within the assigned tolerance. Restore system to normal operation.

14. Inform synoptic lab that calibration is complete and affix level-1 calibration sticker where it can be verified, complete Calibration Record card and Record of Calibration.

Attachment
622R-20

WEATHERTRONICS

MODEL 2030

ANEMOMETER

FREQ (HZ.)	SHAFT SPEED REV/MIN.	WIND SPEED MILES/HR.	WIND SPEED
25	50	3.0	1.33
30	60	3.5	1.55
60	120	6.4	2.9
150	300	15.24	6.8
450	900	44.7	20.0
504	1008	50.0	22.4
750	1500	74.1	33.1
900	1800	88.8	39.7
1014	2027	100.0	44.7
1021	2042	100.7	45.0
1135	2270	111.9	50.0

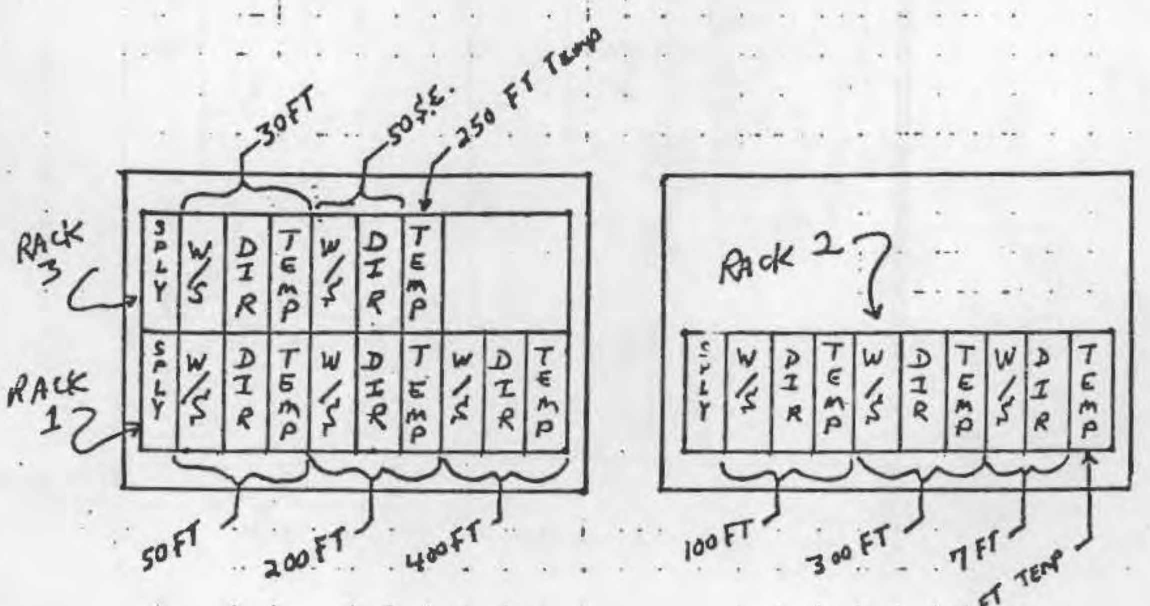
CALIBRATION TABLE

5 Volt Output	Tol
300 RPM = 0.762 VDC	(.712----→ .812)
1800 RPM = 4.44 VDC	(4.39----→ 4.49)
10 Millivolt Output	
300 RPM = 1.524 MVDC	(1.424---→ 1.624)
1800 RPM = 8.88 MVDC	(8.78----→ 8.98)

FIGURE 1

METEOROLOGY TOWER —

WEATHERTRONICS MODULE LOCATION



W/S – WIND SPEED
DIR – WIND DIRECTION

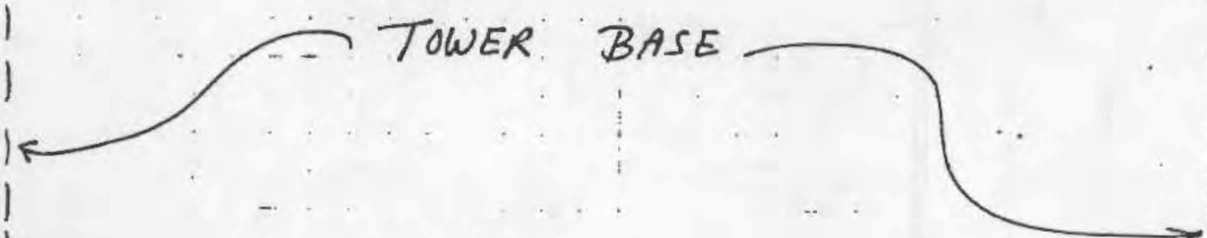


FIG-2

ATTACHMENT
622R-20

B.22

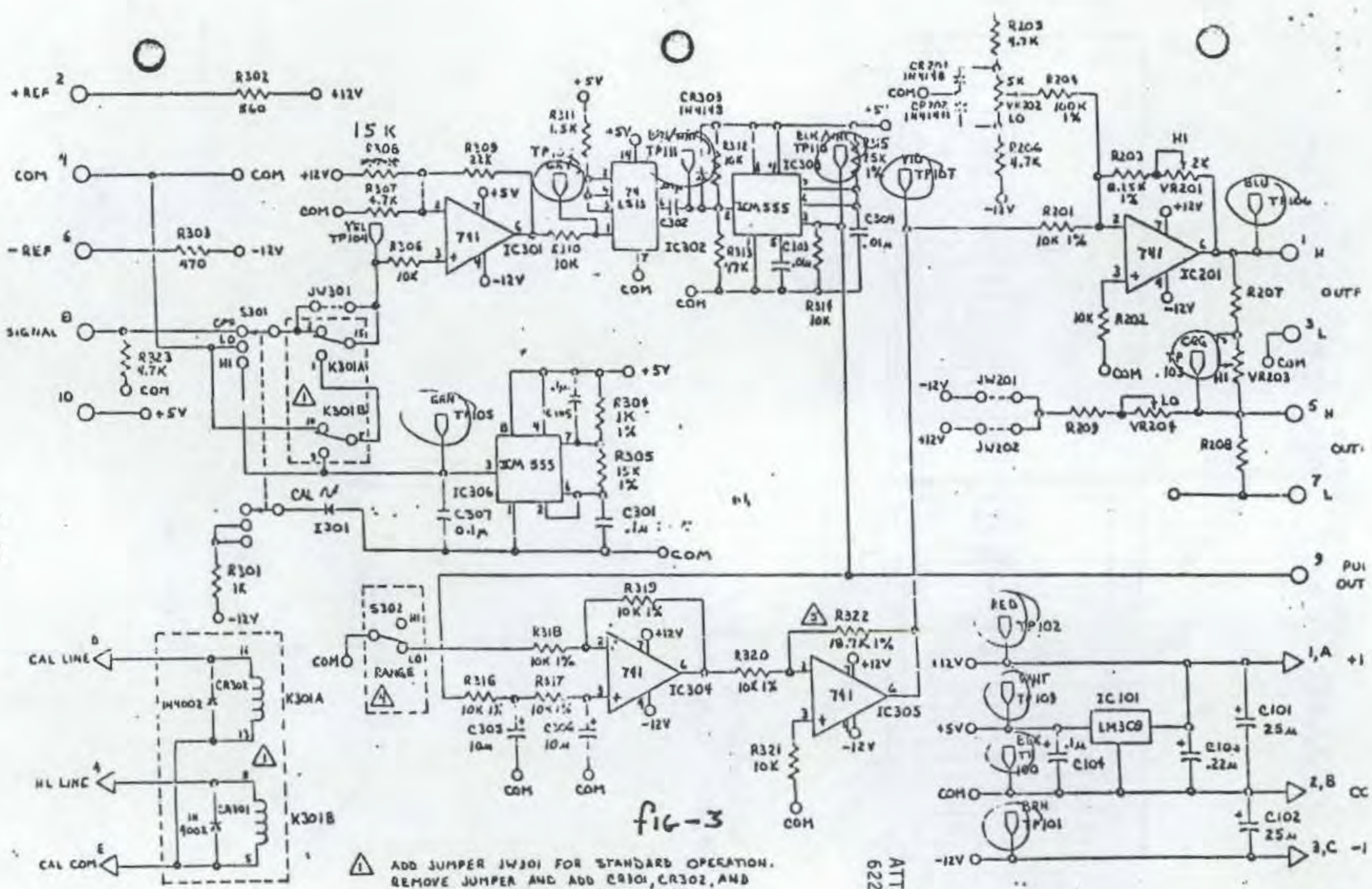


fig-3

ATTACHMENT 622R-20

◁ PC CONNECTOR

○ TERMINAL BLOCK

1. ADD JUMPER JW301 FOR STANDARD OPERATION. REMOVE JUMPER AND ADD CR301, CR302, AND K301 FOR REMOTE CALIBRATION OPTION.
2. ALL RESISTORS 1/4W 5% UNLESS OTHERWISE SPECIFIED.
3. OUTPUT 2 VALUES SELECTED PER CUSTOMER REQUIREMENTS.
4. ADD S302 AND R316 FOR DUAL RANGE OPTION.

WEATHERtronics

WIND SPEED MODULE PULSE INPUT MODEL 1220

Revision No. ______ Date ______

Battelle Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE	Procedure No. 622R-21	Page 1 of 4
	Initial Issue Date 2-9-87	To Be Reviewed 2-9-88

Issued/Reviewed/Revised by Craft Services	Date	Approved by (Mgr., Craft Services)	Date
D. L. Rohde *[signature]*	2-9-87	*[signature]*	2-9-87

Title	Facility	Area	Bldg.
Supervisor, Spec. Instrument Services	General	All	All

I PROCEDURE TITLE (Description Of Operation Or Service)

METEOROLOGY TOWER WIND DIRECTION FIELD CALIBRATION

Prepared by Dennis G. Knight - 622R Instrument Shop

CERTIFIED PROCEDURE
[signature] 2-9-87
CERTIFIED BY DATE
CRAFT SERVICES

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

Electrical Shock
Weather Exposure
Tower Elevation and Elevator Usage

"GIVE TWO SECONDS OF SAFETY THOUGHT BEFORE PROCEEDING"

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

Precision Digital Multimeter
Weathertronics Card Extender P/N 17007
BNW Vane Calibrator
Two-Way Radio
General Instrument Technician Tools

Report of Calibration
Calibration Record Card
SMP GP-37

Note: Ensure all HEDL calibration stickers are current on test equipment used for calibration.

IV. PROCEDURE OR METHOD OUTLINE

The Tower Wind Direction Measuring System is comprised of a Weathertronics sensor and signal conditioning module. It utilizes a Model 1251 module and a Model 2020, 540 degree potentiometer vane. The signal conditioner has two outputs, 0 to 10 millivolt range for the wind recorder and a 0 to 5 volt for computer record and analysis. Wind direction is sensed on eight tower levels--7, 30, 50, 50 SE, 100, 200, 300 and 400 feet. Wind direction is indicated on a chart recorder and calibrated under a separate Standard Maintenance Procedure.

TWO SECONDS FOR SAFETY THOUGHT

A-1000-058 1 (2-84)

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

1. Inform the synoptic lab of the impending calibration. Verify the calibration date is current on the recorder, for the tower level to be calibrated.

2. Locate the rack and the tower level module to be calibrated. Reference Fig. 2.

3. This procedure covers the calibration of the tower wind direction as a system and will require two technicians.

4. If an annual calibration is to be performed which includes bearing changes, continue to Step 5. If not, go to Step 6.

5. Reference maintenance section of manufacturer's manual for bearing change.

6. Secure the cross-arm assembly and remove the vane.

7. Place the vane in the vane calibrator, utilizing extension cable.

8. Remove power and place wind direction module in the card extender. First monitor the black (-) and blue (+) test points and restore power.

9. To align calibrator to north turn vane until the voltage reads 3.333 VDC. Then turn calibrator until the circular disc aligns with line marked north.

10. Establish communication between tower levels and verify voltages at the blue test point as the vane is rotated through 90 degrees east, 180 degrees south, 270 degrees west and 360 degrees north.

11. Repeat step 10 while monitoring the orange test point. This 10 millivolt output is used to drive the synoptic lab recorder.

12. Record as found voltages on the report of calibration sheet and determine if all voltages are in tolerance. If any adjustment is required, first adjust the output 1 Hi and Lo potentiometers, then the output -2 Hi potentiometer on the front of the module. These adjustments should bring both voltage spans within tolerance.

13. If in tolerance, go to Step 16. If not in tolerance, continue with module calibration.

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

14. The following steps verify the calibration of the wind direction module.

    A. Turn the mode switch to the 0-cal position. While monitoring black (-) and blue (+) test points, adjust VR202 (signal out 1, Lo) for 0.00 VDC.

    B. Monitor violet (+) test point. Turn mode switch to the 360-Cal position. Make a note of the negative voltage.

    C. Turn mode switch to the +360-cal position. If necessary adjust VR 301 (adjacent to the black test point) for the value measured in previous step.

    D. Repeat steps A, B and C until correct values are achieved.

    E. Monitor Blue (+) test point and place mode switch in the 360-cal position. Adjust VR 201 (signal out 1, Hi) for 3.333 VDC.

    F. Monitor the orange (+) test point. Adjust VR 203 (signal out 2, Hi) for .0067 VDC.

    G. Monitor blue (+) test point. Place the mode switch to the 0-cal position and adjust VR 202 (signal out 1, Lo) to 0.00 VDC.

    H. Repeat steps E, F and G until all the correct voltages are achieved.

    I. Once the module is calibrated, repeat Step 10 and if in tolerance, record as left and continue. If not in tolerance commence troubleshooting.

15. While the vane is still in the vane calibrator verify at least two compass points up to the synoptic lab recorder. Verify the recorder reads within the assigned system tolerance.

16. The wind direction system has now been electronically verified and or calibrated. In order to complete the alignment, the cross-arm and vane must be mechanically verified at true north. Reference Fig. 1.

    A. The sensor cross-arm must be checked to verify it is setting perpendicular to the tower boom.

    B. Locate a point top center and about 3 feet away from the cross-arm.

A-1860-058.2 (1-80)

IV. PROCEDURE OR METHOD OUTLINE (cont'd)

C. Measure from the center point on the boom to both ends of the cross-arm alternately. The measurements to both ends should be exactly equal.

D. If not equal, loosen set screws and rotate until equal.

17. Once the cross-arm has been verified at 90 degrees the vane must be physically oriented to true north.

A. Disconnect extension cables and reinstall vane on the cross-arm assembly.

B. Remove the anemometer and, while keeping the vane turned away from the anemometer end of the cross-arm, remove the counter weight and tail assembly.

C. Install spare vane and parallel rod on the anemometer end of the cross-arm. Extend the rod through the vane.

D. With the parallel rod holding the vane in place, monitor the voltage at the blue (+) and orange test points.

E. If required, loosen set screw and rotate the base of the vane and set it at the test voltages listed in Figure 1. Note the test voltages cover the 7 ft. level as well as all levels above 7 ft.

F. The offset voltage for all levels except 7 ft. were calculated based on boom angle, cross-arm alignment and tower orientation.

G. Once the test voltage is set within the tolerance indicated on the calibration sheet, restore system to normal operation.

H. Affix level-one calibration sticker, sign and complete Report of Calibration and Calibration Record card.

B.27

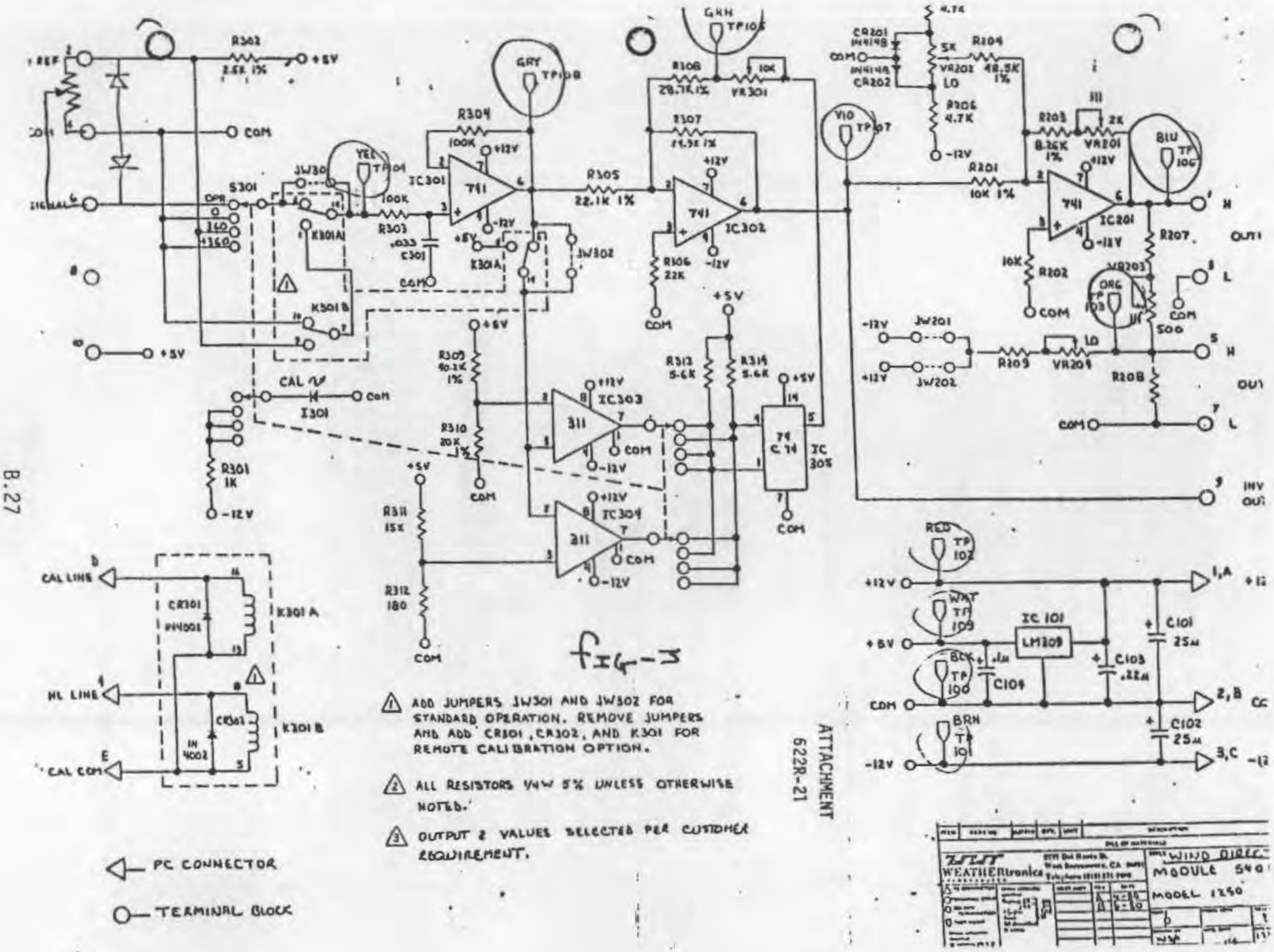


fig-3

⚠1 ADD JUMPERS JW301 AND JW302 FOR STANDARD OPERATION. REMOVE JUMPERS AND ADD CR301, CR302, AND K301 FOR REMOTE CALIBRATION OPTION.

⚠2 ALL RESISTORS 1/4W 5% UNLESS OTHERWISE NOTED.

⚠3 OUTPUT Z VALUES SELECTED PER CUSTOMER REQUIREMENT.

◁— PC CONNECTOR

○— TERMINAL BLOCK

ATTACHMENT
622R-21

Revision No. 0			Date
NQA1 Manual **Battelle** Pacific Northwest Laboratories STANDARD MAINTENANCE PROCEDURE		Procedure No. 622R-22	Page 1 of 5
		Initial Issue Date 4-15-87	To Be Reviewed 4-15-88
Issued/Reviewed/Revised by Craft Services: D. L. Rohde *DLR*	Date: 4-15-87	Approved by (Mgr., Craft Services): *Jerry Bright*	Date: 4-15-87
Title: Supervisor, Spec. Instrument Services	Facility: All	Area: 600	Bldg.: 622R

I PROCEDURE TITLE (Description Of Operation Or Service)

METEOROLOGY TOWER TEMPERATURE CALIBRATION

Prepared by Dennis Knight, 622R Instrument Shop.

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

1. Electric Shock
2. Weather Exposure
3. Tower Elevation and Elevator Usage

CERTIFIED PROCEDURE
[signature] *4/15/87*
CERTIFIED BY DATE
CRAFT SERVICES

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

1. Ice Bath and Calibrated Thermometer
2. Decade Box (shall cross 817-B or equiv.)
3. Digital Voltmeter
4. General Instrument Tech. Tools
5. Calibration Record Card
6. PNL E&CS Record of Calibration
7. SMP GP-37

IV. PROCEDURE OR METHOD OUTLINE

The Weathertronics Ambient Temperature System monitors temperature at eight tower levels. Temperature is monitored and recorded at 3, 30, 50, 100, 200, 250, 300 and 400 feet.

There are three components to the temperature system. The three main components are the Platinum Thermohm Sensor, Signal Conditioner Module and the EMF Chart Recorder. The Signal Conditioner has two calibrated analog outputs 0 to 1.0125 volts and 0 to 5.0625 volts. Calibration of the Temperature Recorder is done under a separate SMP.

TWO SECONDS FOR SAFETY THOUGHT

A-1860-058.1 (2-84)

1. Inform the Synoptic Lab of the calibration to be performed. Verify the calibration date of the Temperature Recorder is current.

2. Locate the Temperature Module in the Weathertronics Rack, (Rack-3), mounted in the Synoptic Lab Instrument Console.

3. This procedure performs an end to end calibration to the Temperature System and requires two technicians.

4. Refer to Figure 1A for resistance calibration values and Figure 1C Decade Box Connection Diagram. Reference Figure 3 for all five calibration points.

5. Set the Decade Box at the low end and monitor between the white and black (common) test points. It should read 7 volts, if not adjust VR101. This adjustment sets up the proper platinum probe current.

6. Monitor the violet test point. It should indicate 0.00 volts. If adjustment is required, adjust course zero VR302 for 0.00 volts.

7. Alternately monitor the Blue (5 volt) and the Orange (1 volt) test points. Record as found over the entire instrument span for both analog output ranges. Refer to Figure 3.

8. If all as found voltages are within assigned tolerances, go to step 11, if not continue.

9. If the output voltages are out of calibration, adjust as required. There is no zero adjust for the 1 volt output range.

10. If module cannot be calibrated commence troubleshooting and fill out Discrepancy Report in accordance with PAP-1201.

11. Record as left values.

12. After the Temperature Module has been successfully calibrated a system end to end check is required to verify the RTD Sensor.

13. Remove the probe from the aspirator and place it in an Ice Bath.

14. Using a calibrated thermometer determine that the Ice Bath has stabilized at 32 degrees F. Confirm that the Temperature Recorder reads 32 degrees F, within system tolerance.

15. Return system to normal operating condition and inform the Synoptic Lab that calibration is complete.

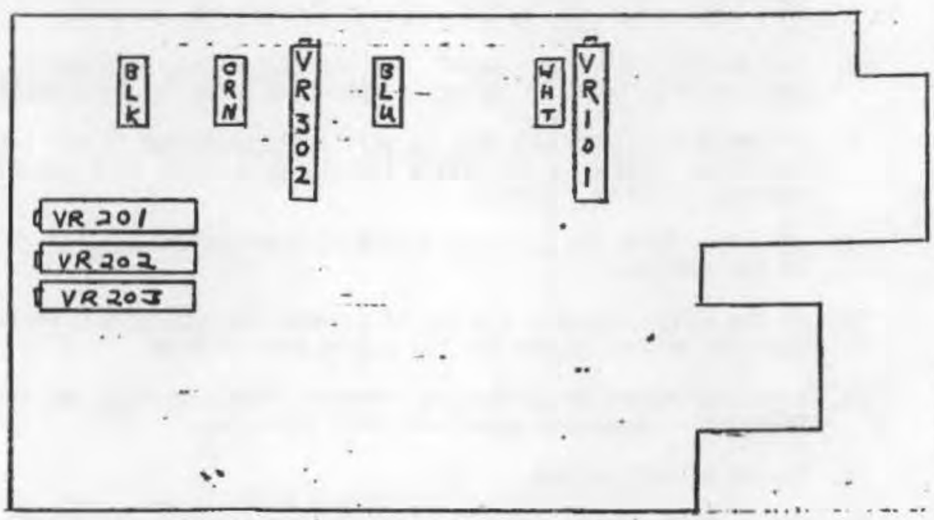
16. Affix Level I Calibration Sticker to Temperature Module. Update Calibration Record Cards and the Record of Calibration.

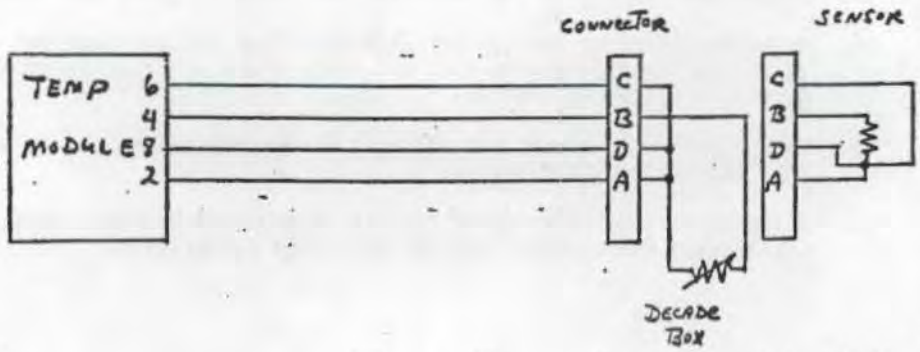
FIG - 1

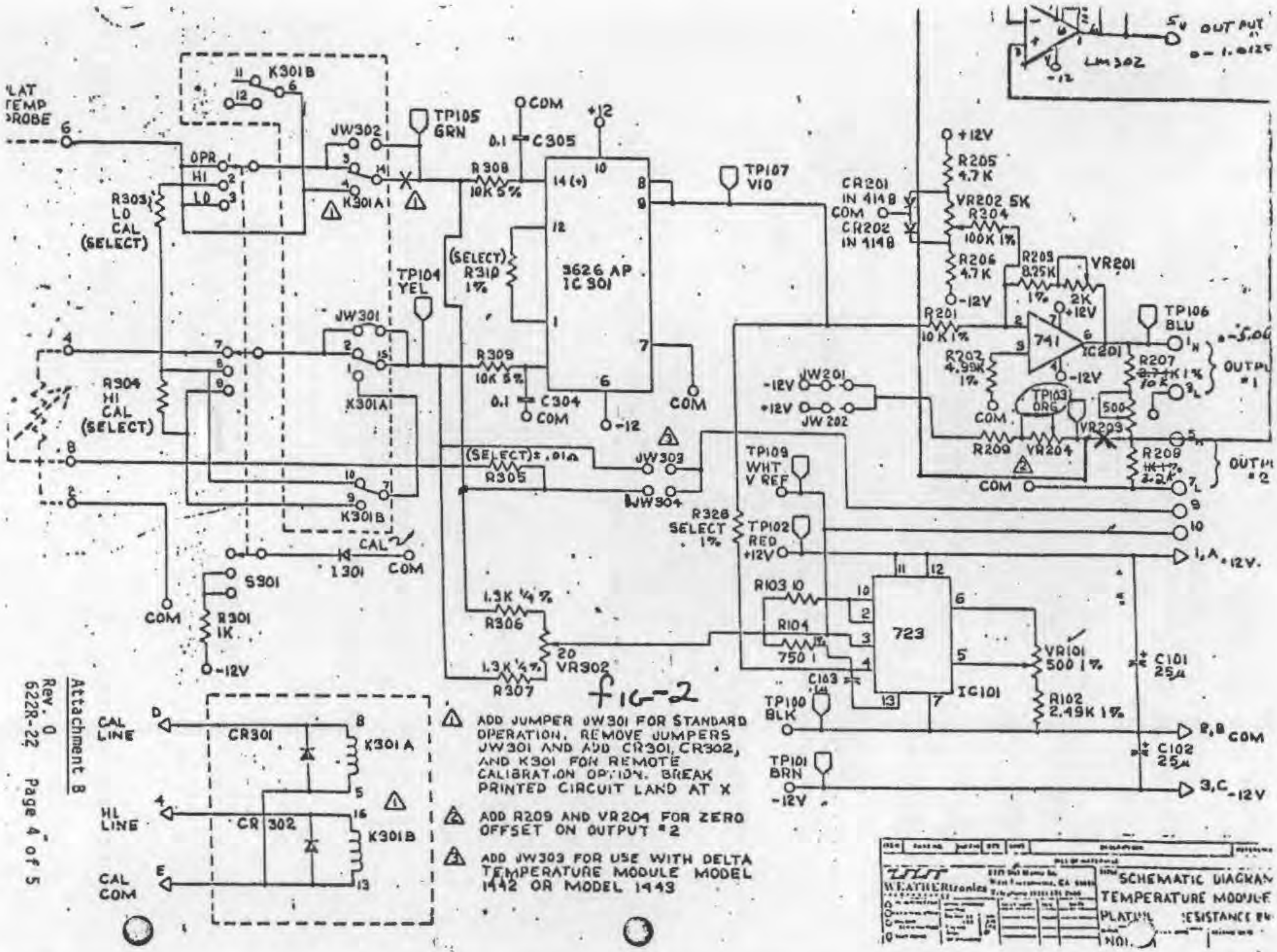
Input ohms	Output-1 Volts	Output Volts
84.19	0	0
119.93	5.0625	1.0125

(Resistance Includes 0.2 ohm Sensor Cable Resistance)

TEMP MODULE







Attachment B
Rev. 0
622R-22
Page 4 of 5

			Revision No. 0	Date
NQA1 Manual — Battelle Pacific Northwest Laboratories — STANDARD MAINTENANCE PROCEDURE			Procedure No. 622R-23	Page 1 of 6
			Initial Issue Date 11-19-87	To Be Reviewed 11-19-88
Issued/Reviewed/Revised by Craft Services: D. L. Rohde DLR	Date: 11-19-87	Approved by (Mgr., Craft Services): [signature]		Date: 11-19-87
Title: Supervisor, Spec. Instrument Services		Facility: General	Area: 200	Bldg. 622R

I PROCEDURE TITLE (Description Of Operation Or Service)

REMOTE TELEMETRY STATION SYSTEM CALIBRATION
STATIONS 9, 11 AND 13 (200 FOOT TOWER)

NOTE: This is a system calibration which includes sensors, signal conditioners and remote transmitting unit (IMP-834).

II JOB HAZARDS OR SPECIFIC SAFETY ASPECTS

a. Remote, but possible, Shock Hazard
b. Tower Winch Operation
c. Sensor Removal and Installation
d. Ladder and/or Ladder Truck Usage

CERTIFIED PROCEDURE
[signature] 11/19/87
CERTIFIED BY DATE
CRAFT SERVICES

III TOOL, EQUIPMENT, AND MATERIAL REQUIREMENTS

a. Voltmeter Fluke 8060A or Equivalent
b. 300 and 1800 RPM Precision Motors
c. Calibrated DC Voltage Source
d. New Dew Point Sensor (EA-1)
e. Climatronics Bearings and Bearing Replacement Procedure
f. Ice Bath and Vane Calibration Rod
g. 2"x4"x3' Wood Board
h. Anemometer Test Cable

IV. PROCEDURE OR METHOD OUTLINE

NOTE: This procedure assumes that the technician is already familiar with the IMP-834 programming and operation.

1. Perform IMP-834 calibration check per the SMP 622R-14. Verify "0" is in Topics 45 and 31.

2. Accessing Tower Sensors

   a. Using the tower winch, lower the 10 meter level sensors, cutting cable ties as it moves downward.

TWO SECONDS FOR
SAFETY THOUGHT

A-1880 058 1 (2 84)

b. Once the 10 meter level is at or near the bottom of the tower, place the 2x4 brace across the tower track to prevent the sensor assembly and crossarm from sliding off the end.

c. Mark the position of the cable with tape and remove the two U-bolt clamps.

d. Repeat the above steps for 25 and 60 meter sensor levels.

e. Disable the tower winch to prevent accidental operation.

3. Initial IMP-834 Setup and Operation

a. Ensure Topic 46 is set to 1.

b. Verify Topics 24 and 25 have the values listed below for channels 1 through 11.

Channel	TOPIC 24	TOPIC 25
1	0	100
2	0	540
3	0	100
4	0	540
5	0	100
6	0	540
7	-40	120
8	-10	25
9	-40	120
10	-40	120
11	-40	120

c. If values are not correctly set, change accordingly.

d. Set IMP to Topic 47 and observe engineering units on channel to be calibrated. (Reference Fig-1)

4. Wind Speed System Calibration

a. Starting with the 10 meter level, remove the anemometer from the crossarm.

b. Change the anemometer bearings in accordance with the Climatronics Bearing Removal Procedure. Do not re-install the cups or the anemometer.

c. Install anemometer test cable. With the precision motors turn the anemometer at 1800 and 300 RPM. Observe the windspeed in miles/hour on the appropriate IMP-834 channel.

d. If in tolerance, record as found and go to Step F.

e. If not in tolerance, check to make sure the motor is lined up and running freely. Verify zero and span voltages are correct. (Reference figures 1 & 2)

f. Record as left and install the anemometer without cups.

5. Wind Direction System Calibration

a. Remove the vane from the crossarm.

b. Remove the vane and vane hub but leave the shaft hub intact.

c. Replace bearings in accordance with the Climatronics Bearing Replacement Procedure.

d. Re-install the vane on the crossarm.

e. Using the vane calibration rod, line up the hubs and extend it between the anemometer and the vane.

f. Alternately rotate the calibration rod between North and South (0-180°) and read the azimuth as indicated on the appropriate INP channel. Record as found.

g. If both the indicated azimuths are in tolerance, go to Step K.

h. If out of tolerance, check zero and span voltages. (refer to Fig-1 and 2)

i. If there is no indication of a signal conditioner problem, azimuth must be adjusted mechanically.

j. Loosen set screws on the vane adapter base and rotate until in tolerance in both the 0° and 180° azimuth's.

k. Record as left.

6. Repeat steps 4 and 5 for the 25 and 60 meter levels.

7. RMS Signal Conditioner Calibration

a. After the wind system is calibrated, the remaining Rms rack signal conditioners must be checked for zero and span.

b. Verify zero and span for all tower temperatures, dew point, delta temp and status signal conditioners. Refer to figures 1 and 2 for calibration voltages and test points.

8. Temperature Probe Check

   a. Place the RTD Temperature Probe in a stabilized ice bath.

   b. Repeat Step A for all three temperature levels.

   c. While observing Topic 47, verify each channel reads within system tolerance of ± 1.6°F of 32°F.

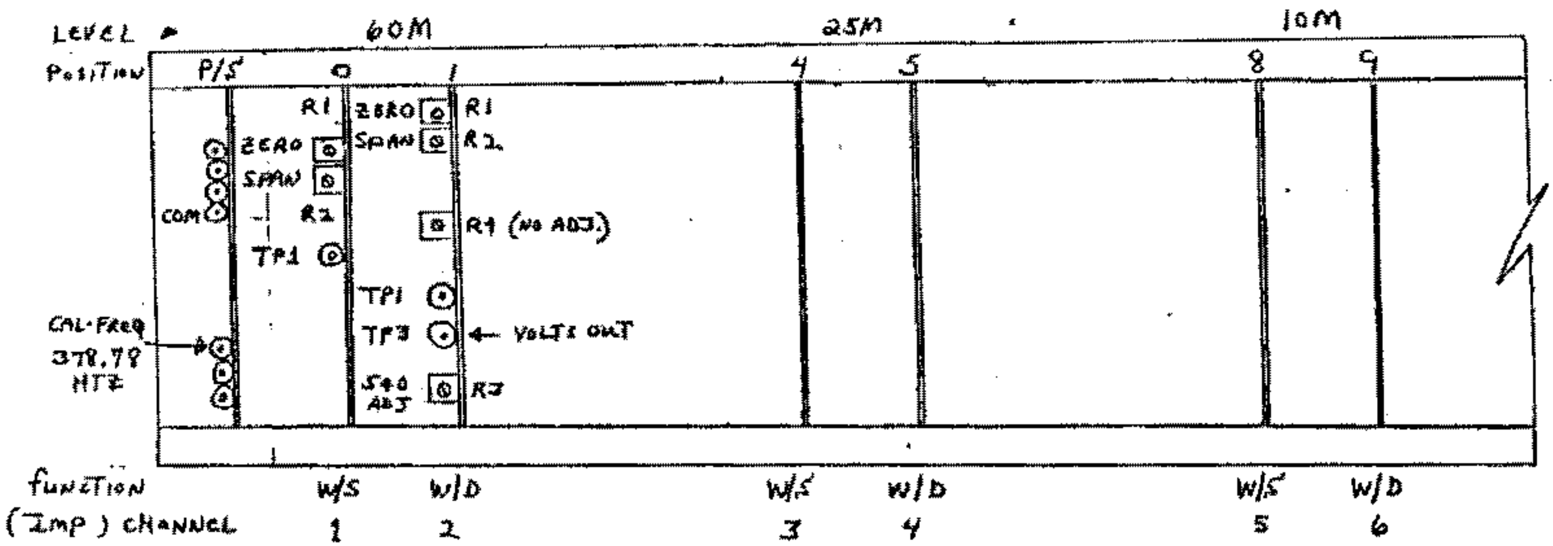
9. Dew point sensors will be changed annually or as needed. Refer to Climatronics manual for dew point maintenance procedures.

10. Restore all wind and temperature sensors to normal operating condition.

11. Ensure the RMS rack is in operation.

12. Set Topics 31 and 45 to 1. Return jumper X-15 to position 2 (right).

13. Complete all required documentation and affix level 1 sticker on IMP-834.



RMS RACKS (60M - 200ft TWR)

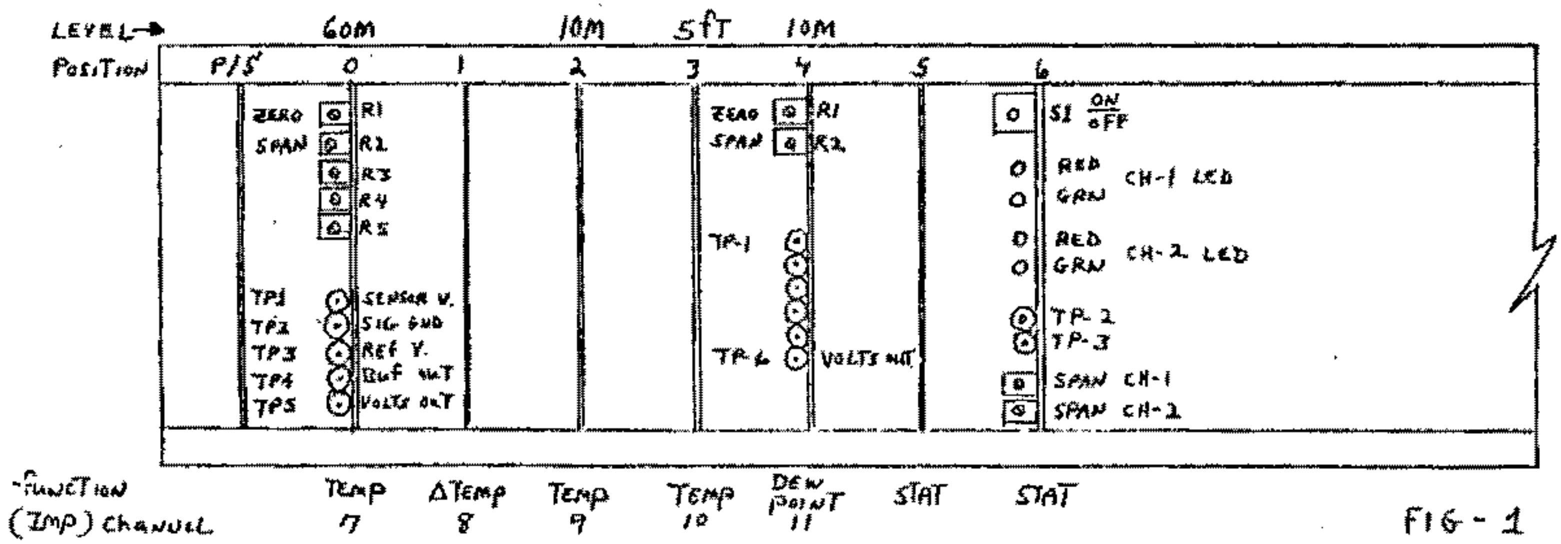


FIG - 1

RMS SYSTEM DESCRIPTION

RACK-1

SLOT NO.	TRANSLATOR MODEL #	FUNCTION	RANGE	OUTPUT	ZERO VOLTAGE	SPAN VOLTAGE	540 VOLTAGE	COMMENTS
0	100778	W/S	0-100 MPH	0-5 V	0.0250V	2.016 V		
1	100779	W/D	0-540°	0-5 V	0.0000V	2.777 V		
4	100778	W/S	0-100 MPH	0-5 V	0.0250V	2.016 V		
5	100779	W/D	0-540°	0-5 V	0.0000V	2.777V		
8	100778	W/S	0-100 MPH	0-5 V	0.0250V	2.016 V		
9	100779	W/D	0-540°	0-5 V	0.0000 V	2.777V		

RACK-2

SLOT NO.	TRANSLATOR MODEL #	FUNCTION	RANGE	OUTPUT	ZERO VOLTAGE	SPAN VOLTAGE	540 VOLTAGE	COMMENTS
0	100829	TEMP	-40° To 120° F	0-5 V	0.0000V	5.000V		
1	100829-1	DELTA TEMP.	-10° To 25° F	0-5 V	0.0000V	5.000V		
2	100829	TEMP	-40° To 120° F	0-5 V	0.0000V	5.000V		
3	100829	TEMP	-40° To 120° F	0-5 V	0.0000V	5.000 V		
4	100838	DEW PT.	-40 To 120° F	0-5 V	0.0000V	5.000 V		
5	101314	STATUS		0-5 V	0.5000 V	0.0000V		
6	101314	STATUS		0-5 V	0.5000 V	0.0000 V		

FIG-2

APPENDIX C

MAINTENANCE PROCEDURES FOR THE CLIMATRONICS DEW POINT SENSOR

8.0 MAINTENANCE

Periodic cleaning and recharging of the LiCl impregnated wick is required. Follow the steps outlined below.

A. Disconnect the sensor from the shield.

B. Soak the wick end in distilled water for at least 5 minutes to remove water soluble dirt and the old salt charge. Gentle stirring may be used. NOTE: The wick electrode assembly is delicate. Do not attempt to clean it with a brush, water jet, or ultrasonic bath.

C. If there is still evidence of contamination on the wick, rinse it with Freon TF or isophropyl alcohol. Note that overall darkening of the wick is to be expected. This does not affect the probe's performance. Localized darkening may indicate a burn path and should be suspected as possible probe failure.

D. Thoroughly dry the probe in an oven at 60° to 80°C.

E. Prepare an 8 percent by weight solution of lithium chloride in distilled water, or use Climatronics' P/N 100743-1 Lithium Chloride Solution.

F. Use an eyedropper to apply the LiCl solution to the wick. Keep applying until the wick is saturated.

G. Gently shake the probe to remove excess solution.

H. Dry the probe in an oven at 60 to 80°C.

I. If the probe is to be stored for a period of time before installation, replace the desiccant tube to keep the probe dry. If not, the probe can be reinstalled in the shield.

J. If the desiccant color is blue, this indicates that the desiccant is dry and can be used to keep the probe dry. If the color is pink, this indicates that a high moisture content is present in the desiccant and it needs to be replaced or recharged. Drying of the desiccant can be accomplished by using the following procedure.

1) Remove the red cap from the end of the desiccant tube.

2) Spread the desiccant, one granule deep, on a tray and bake for 1 hour at about 200°C (400°F).

3) Cool the desiccant in an airtight container before refilling the holder.

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