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Description of a Computer Data Base from Small Hill Impaction Study No. 2, Hogback Ridge, New Mexico

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Description of a Computer Data Base from Small Hill Impaction Study No. 2, Hogback Ridge, New Mexico

by

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ABSTRACT

As part of the U. S. Environmental Protection Agency's effort to develop and demonstrate a reliable model of atmospheric dispersion for pollutant emissions in irregular mountainous terrain, the Complex Terrain Model Development Program was initiated in 1980 with Environmental Research and Technology, Inc., as the prime contractor. In October 1982, a field experiment, Small Hill Impaction Study #2, (SHIS #2), was conducted along an approximately 1.5-km section of the Hogback Ridge near Farmington, New Mexico to extend the modeling data base to include a study of flow and dispersion around a two-dimensional ridge. Eleven quantative tracer experiments were performed, each lasting 8 hrs at night or early morning. Meteorological data were recorded on two instrumented towers up-wind of the ridge and two towers on the slope. Data consisted of direct and derived measures of wind, turbulence, and temperature averaged at 5-minute and 1-hour intervals. Hourly profiles of wind, temperature, pressure and humidity were recorded at one tethersonde site up-wind of the ridge, while another tethersonde was held level at the point of tracer release to record wind and temperature at 13-second intervals. Three sets of optical crosswind anemometers measured path-averaged wind speed across the base, slope and crest of the ridge. Thirty-minute averages of solar and net radiation were also recorded.

Tracer gas concentrations, SF6 and Freon 13B1, were detected by a network of 110 sampler sites located on the slopes of the ridge. The system used to collect the data, and the operational procedures used to run the system are presented along with values of 1-hour normalized tracer concentrations. Also recorded were concentrations from collocated samplers to establish comparative data for quality control, samplers operating at 10-minute intervals and samplers operating at different heights on two towers on the slope of the ridge. Tables of tracer gas release data, emission rates, heights and location of release, have been included to assist any modeling effort. All meteorological and tracer gas concentration data have been edited and recorded on magnetic tape and are now available upon request at the National Computer Center, Research Triangle Park, North Carolina, either as copies or by interactive computer access.

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LIST OF SYMBOLS AND ABBREVIATIONS

SYMBOLS

D	Scalar mean wind speed - triaxial props
DT	Temperature difference
DX	Scalar mean wind direction - cup & vane
Q	Tracer gas emission rate
N	Number
Θ	Wind direction
R,Θ,Z	HBR polar coordinates - origin Tower A
S	Scalar mean wind speed - triaxial props
SD	Standard deviation (σ_Θ) wind direction fluctuations - cup & vane
ST	Variance of fast response temperature (TF)
SU	Standard deviation (σ_u) of alongwind velocity fluctuations
SV	Standard deviation (σ_v) of crosswind velocity fluctuations
SW	Standard deviation (σ_w) of vertical velocity fluctuations
T	Temperature
TC	Calculated temperature (T + DT)
TF	Fast response temperature
U	Westerly wind component - triaxial props
UX	Westerly wind component - cup & vane
UW	Correlation between wind speed (S) and vertical wind component (W)
V	Southerly wind component - triaxial props
VX	Southerly wind component - cup & vane
WT	Correlation between fast response temperature (TF) and vertical wind component (W)
X1	Standard deviation (σ_Θ) of wind direction fluctuations - triaxial props
X2	Standard deviation (σ_Θ) of wind direction fluctuations - cup & vane (Yamartino's method)
X,Y,Z	HBR cartesian coordinates - origin Tower A

ABBREVIATIONS

A.I.R.	Atmospheric Instrumentation Research, Inc.
APS	Arizona Public Service Company
ARLFRD	Air Resources Laboratory Field Research Division
ASRL	Atmospheric Sciences Research Laboratory
ATDD	Atmospheric Turbulence and Diffusion Division
C	Centigrade
CF3BR	Freon 13B1
CCB	Cinder Cone Butte
CTDM	Complex Terrain Dispersion Model
CTMD	Complex Terrain Model Development
ECL	Executive Control Language
EPA	U.S. Environmental Protection Agency
ERT	Environmental Research & Technology, Inc.
FAA	Federal Aviation Administration
FMF	Fluid Modeling Facility
ft	feet
GC	Gas chromatograph
HBR	Hogback Ridge
Hz	Hertz
LASL	Los Alamos Scientific Laboratory
LMF	Linear mass flow meter
m	meter
m.r.	mixing ratio
MDA	Modelers' Data Archive
mb	millibars
MDT	Mountain Daylight Time
MSL	Mean Sea Level
MW	Megawatts
us/m3	Micro-seconds per cubic meter
NOAA	National Oceanic and Atmospheric Administration
ns/m3	Nano-seconds per cubic meter
ppt	Parts per trillion by volume
PNM	Public Service Company of New Mexico
R.H.	Relative Humidity
RTD	Resistance Thermometric Device
RTI	Research Triangle Institute
sec	seconds
SF6	Sulfur hexafluoride
SHIS	Small Hill Impaction Study
WPL	Wave Propagation Laboratory

ACKNOWLEDGEMENTS

This report is partly composed of excerpts from publications and documents produced by Environmental Research and Technology, Inc. (ERT), the prime contractor for the Complex Terrain Model Development project, who compiled the Hogback Ridge computer data base on magnetic tape. As referenced in the text, the Third Milestone Report - 1983 by Lavery et al. (1983) was an important source, as was the Quality Assurance Project Report for Small Hill Impaction Study #2 by Greene (1985). All credit for creation of the magnetic tape files in the computer data base and documentation of effort must go to the scientists and investigators at ERT. The purpose of this report was to condense available documentation into one volume that would serve as a convenient handbook for any investigators who might acquire and use these valuable data.

Special thanks go to Mrs. Hazel Hevenor who devoted so much time and effort to the production of this report.

SECTION 1

INTRODUCTION

1.1 EPA PROGRAM

The extensive development of energy resources, especially in the mountainous terrain of the western United States, has generated concern about the resulting impact on air quality (as well as on water and land quality). Even in relatively simple situations, it has been difficult to produce reliable calculations of atmospheric transport and diffusion. In complex terrain, mathematical modeling is confounded because the physical processes are more complicated and meteorological measurements are less "representative" than in level terrain settings. Responding to this fundamental problem, the U. S. Environmental Protection Agency (EPA) has embarked upon the Complex Terrain Model Development (CTMD) Program, a major effort to develop and demonstrate reliable models of atmospheric dispersion for emissions in mountainous terrain.

An early step in the development of this program was the convening of a workshop on problems in modeling atmospheric dispersion over complex terrain. In concert with recommendations of the workshop report (Hovind et al., 1979) EPA's CTMD Program involves a coordinated effort in mathematical model development, field experimentation, and scaled physical modeling. The Program's basic objective is the production of practical models with demonstrated reliability. Initially the CTMD Program has focused on the problem of stable plume impaction/interaction with elevated terrain. This phenomenon was singled out because of the likelihood of relatively high concentrations and because models that are in use have been challenged extensively. The approach has been to study stable plume interactions first in relatively simple terrain settings and subsequently in more complex situations.

EPA's prime contractor for carrying out the CTMD Program is Environmental Research and Technology, Inc. (ERT). Significant contributions are also being provided by EPA's Fluid Modeling Facility (FMF), by the National Oceanographic and Atmospheric Administration's Wave Propogation Laboratory (WPL) through their sophisticated measurement capabilities, and by NOAA's Air Resources Laboratory Field Research Division that conducted the flow visualization and tracer experiments and operated the real-time data acquisition and analysis system. The first phase, a comprehensive tracer field study was carried out on Cinder Cone Butte (CCB), a roughly axisymmetric, isolated 100-m tall hill, near Boise, Idaho during the autumn of 1980, Small Hill Impaction Study No. 1 (SHIS #1). The SHIS #1 tracer gas source data (emission rates, locations and heights of SF6, CF3BR and oil-fog releases), concentration data and meteorological data, from six towers, a tethersonde and free balloons, were subsequently delivered to EPA to form an accessible computer data base. The data base of meteorological and tracer gas concentrations generated by SHIS #1 has been described in a report (Truppi and Holzworth, 1983) that explains the system used to collect the data, the operational procedures used to run the system, and the resulting magnetic tape files that are available for access by the public either copies or by interactive computer operation.

Complete description of SHIS #1 at Cinder Cone Butte is contained in the First Program Milestone Report (Lavery et al., 1982) and in the Second Program Milestone Report (Strimaitis et al., 1983), while a third report (Greene and Heisler, 1982) illustrates the very thorough quality assurance procedures maintained during the study. For SHIS #2 at HBR, similar descriptions are available in the Third Milestone Program Report (Lavery et al., 1983) and in a report on quality assurance procedures adapted (Greene and Heisler, 1983).

1.2 OBJECTIVE

The purpose of this report is to describe the data collected during the second phase of CTMD, SHIS #2, a field study conducted along an approximately 1.5-km section of the Hogback Ridge (HBR) near Farmington, New Mexico in order to extend the modeling data base to include a study of flow and dispersion around a two-dimensional ridge. It is expected these new data will provide a good basis for testing and extending the Impingement and Neutral models and the dividing streamline concept for two-dimensional ridges.

This report describes the setting of HBR, the experimental approach, and the following data archived on magnetic tape in five sets of data files:

* Tower meteorological data - wind, temperature, turbulence scales (sigma-u,-v,-w), 5-minute, 1-hour averages:
  150-m tower instrumented at 10 levels,
  30-m tower instrumented at 5 levels,
  10-m tower instrumented at 3 levels,
  60-m tower instrumented at 2 levels;
* Tracer gas concentrations, SF6 & Freon 13B1 (CF3BR),
  10-minute, 1-hour averages;
* Three optical crosswind anemometers, wind speed,
  10-minute averages;
* Two tethersonde sites, height, wind temperature, R.H., M.R.
  one operated at source elevation to document meteorological conditions in vertical soundings at source of tracer release;
  one operated to measure vertical profiles upwind and near the base of the ridge;

* Surface meteorological data from ten stations operated by Public Service Company of New Mexico; 20-minute averages of wind speed and direction at all sites, with temperature, solar and net radiation at one site on the crest of HBR.

Tables of tracer gas release data, emission rates, location and heights of release are included in this report. Although lidar measurements and extensive photography were made of the oil fog plumes, those data are not available for this publication.

SECTION 2

FIELD STUDY AT HOGBACK RIDGE

2.1 GEOGRAPHIC AND METEOROLOGICAL SETTINGS

The Hogback Ridge (HBR) is located in the northwest corner of New Mexico, about 15 miles west of the city of Farmington. It lies on the semiarid Colorado Plateau near the western slopes of the San Juan Mountains (Figure 1). Three rivers, La Plata, Animas, and Chaco, drain into the San Juan River near Farmington. Terrain features of the area include occasional isolated ridges, like HBR, isolated buttes, low mesas and plateaus. The area is characterized by a sparse vegatative cover of desert shurbs and grasses.

SHIS #2 was conducted in the region of an approximately 1.5-km long section of the ridge north of the San Juan River (Figure 2). Here, the ridge is oriented NNE-SSW and rises about 85 m above its base elevation of 1600 m. HBR extends from just north of the SHIS #2 experimental area to about 8 miles south of the San Juan River. The ridge splits where the San Juan and Chaco Rivers flow westward and forms spearate "hogbacks". Waughan Arroyo is located just east (upwind) of the experimental section. Farther east a series of irregular mesas, arroyos, and surface coal mines extend all the way to Farmington.

Because of substantial reserves of coal and an adequate water supply from the San Juan River, two major electric generating facilities operate in the region. The San Juan Power Plant is located just east of the experimental area, and the Four Corners Power Plant is located south of the San Juan River. Public Service Company of New Mexico (PNM) and Arizona Public Service Company (APS), respective operators of the two generating stations, have

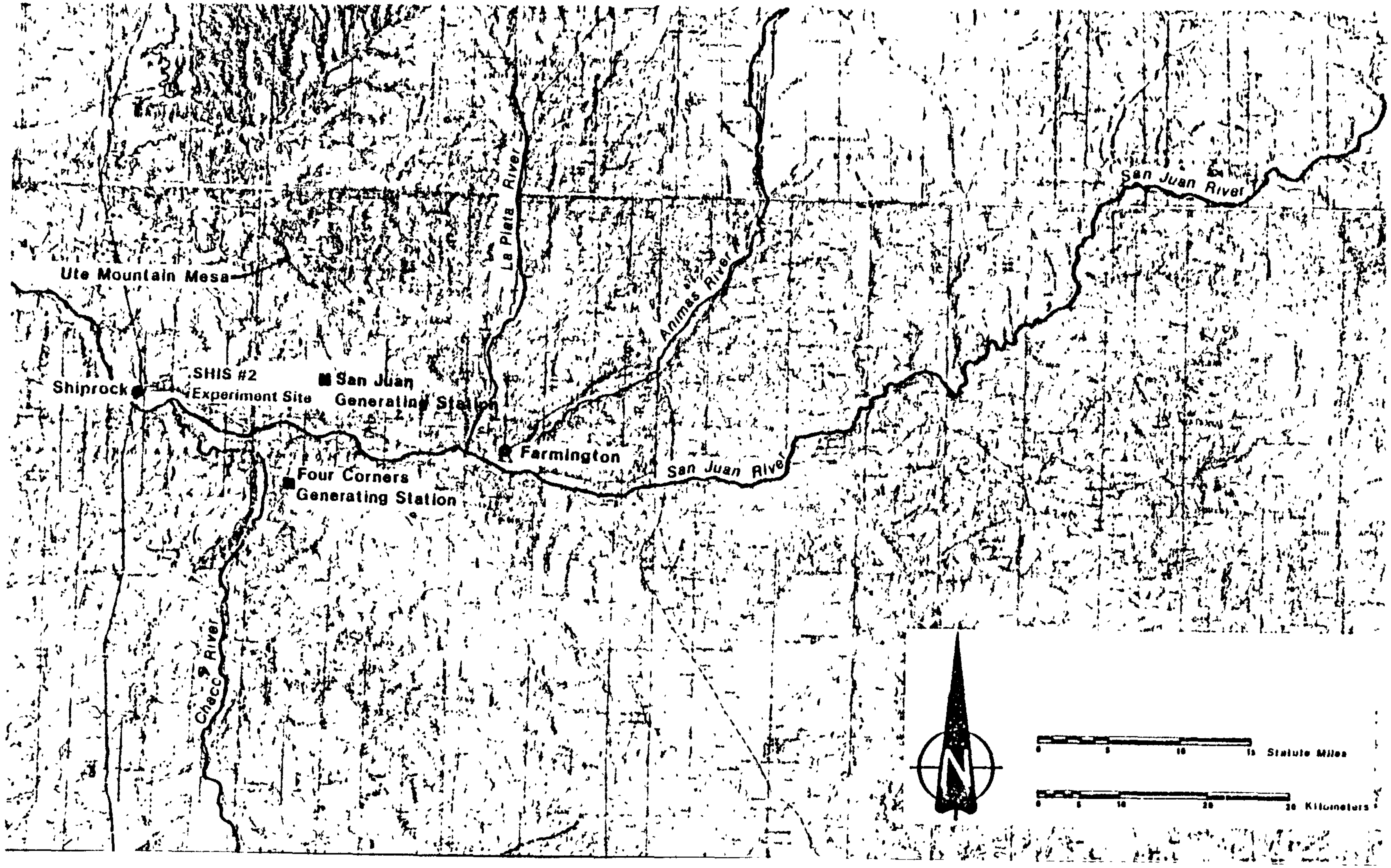


Figure 1. Region around SHIS #2 at the Hogback Ridge
(From Lavery et al., 1983)

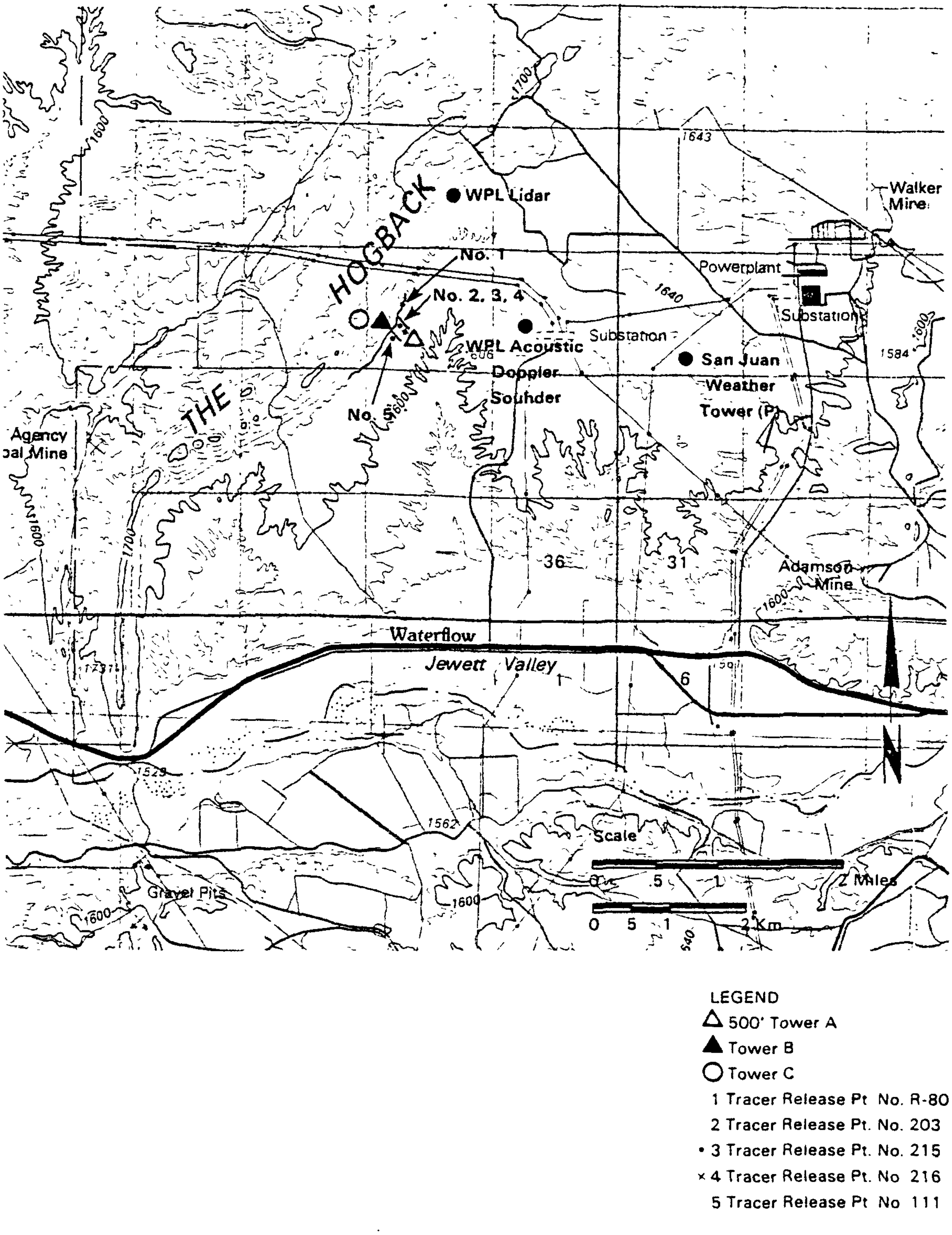


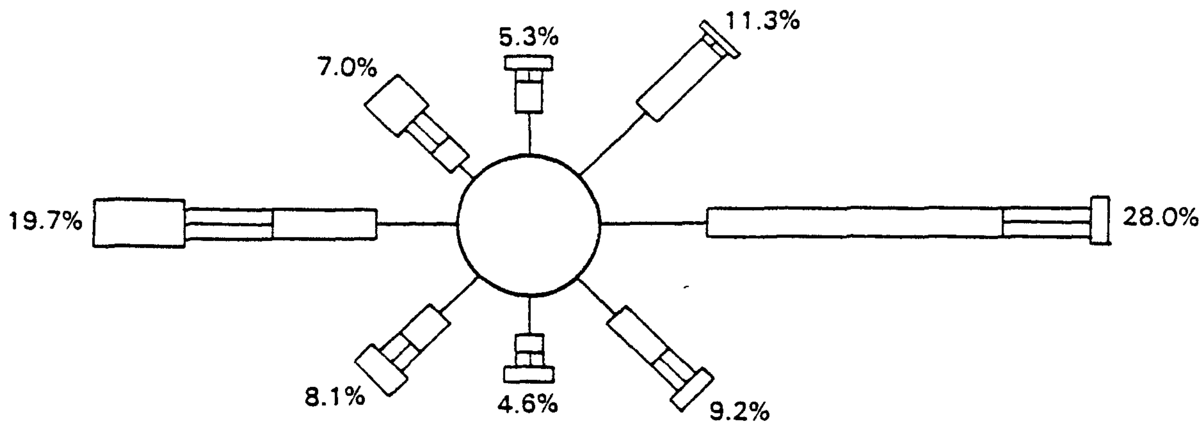
Figure 2. SHIS #2 field experiment layout
(From Lavery et al., 1983)

sponsored several meteorological and air quality measurement program. Also, the Federal Aviation Administration (FAA) operates a limited aviation weather reporting station at Farmington Municipial Airport; consequently, there was a wealth of meteorological data available during the site selection and experimental design phases. Meteorological measurements taken by PNM, APS and the FAA provide detailed information on the dispersion climatology of the HBR region.

Most of the available information has been analyzed and summarized in a NAPS report (Moore et al., 1981). Figure 3 from that report shows two wind roses derived from the FAA station at Farmington Airport. The first rose shows the annual distribution of winds during 1976; the second shows the distribution of winds for the months of October-December for stability "E" conditions. Figure 4 from an ERT report (Lavery et al., 1983) shows October hourly winds from the FAA station for four nighttime hours-2200, 0000, 0200, and 0400 MST for the years 1977 to 1981. Evidently, the wind typically "turns around" (Crow, 1975) from westerly to easterly during the night as drainage from the San Juan Mountains is established.

Drainage periods occur often during the summer and fall months and produce stable easterly flows toward HBR at night. The drainage and turn-around days are characterized by light winds all day. Cooling in the evening and night results in strong surface inversions. Dense air flows from the mountains and down the river valleys. Stable air flows toward HBR along the San Juan River valley from the northeast and occasionally from the southeast. Figure 5 (Moore et al., 1981) shows representative early morning upper air soundings during easterly drainage situations. The deep stable layer, which is uncoupled from the gradient westerly winds aloft, continues well into the morning until convective turbulence destroys the inversion, and the flow near the ground is again coupled with the gradient wind aloft.

In summary, available meteorological data suggested that frequently stable easterly winds occur at night during the fall months. This was the principal reason for selecting HBR as the site for SHIS #2. Other reasons



Climatological annual wind rose for Farmington, N.M.
(2927 valid data points, 3-hour NWS data for 1976).

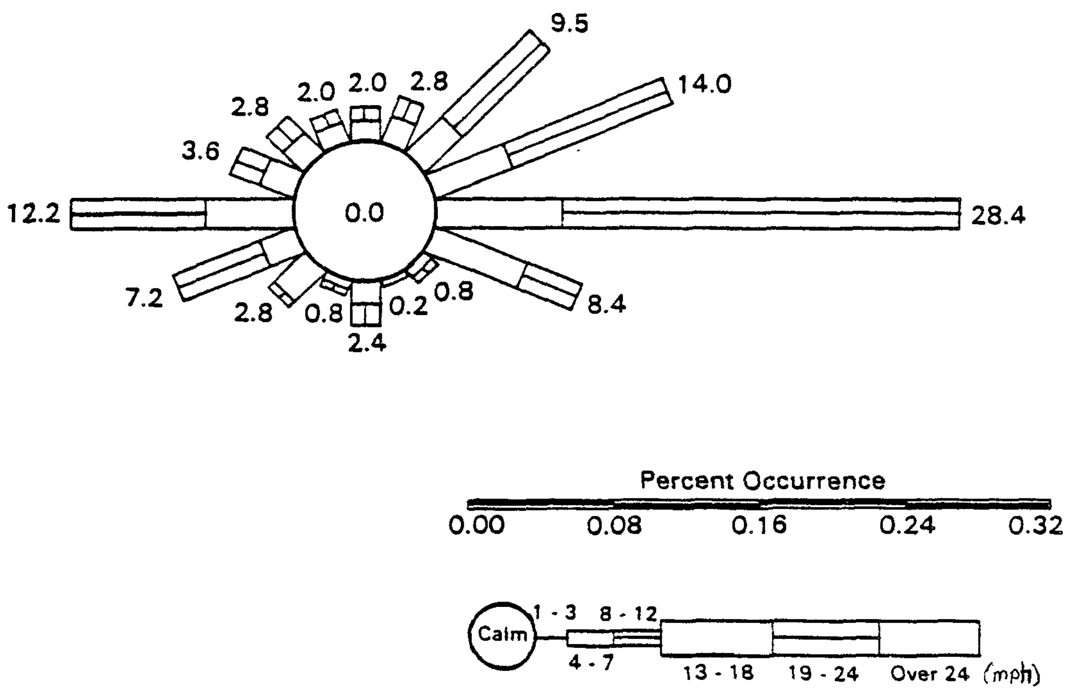
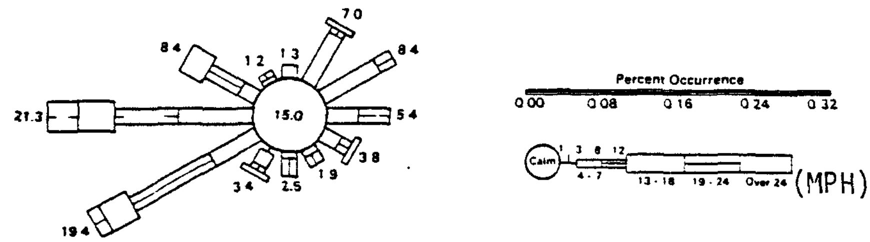
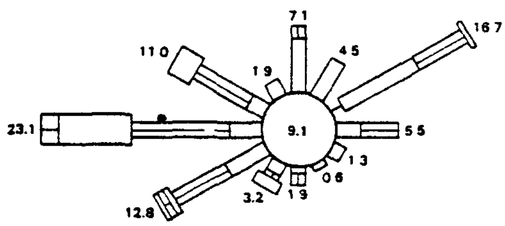


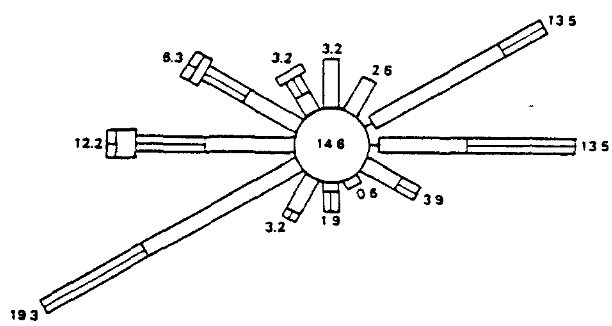
Figure 3. October-December stability E Farmington wind rose
(From Lavery et al., 1983)



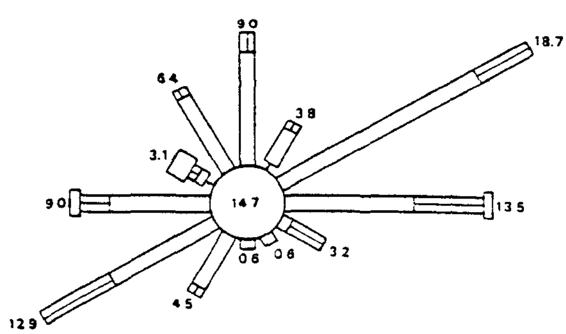
Farmington, New Mexico — Airport (FAA) October (1977-1981) Hourly Rose - Hour (LST) = 22



Farmington, New Mexico — Airport (FAA) October (1977-1981) Hourly Rose - Hour (LST) = 24



Farmington, New Mexico — Airport (FAA) October (1977-1981) Hourly Rose - Hour (LST) = 02



Farmington New Mexico — Airport (FAA) October (1977-1981) Hourly Rose - Hour (LST) = 04

Figure 4. October hourly wind roses for four nighttime hours: 2200, 0000, 0200, and 0400 MST (From Lavery et al., 1983)

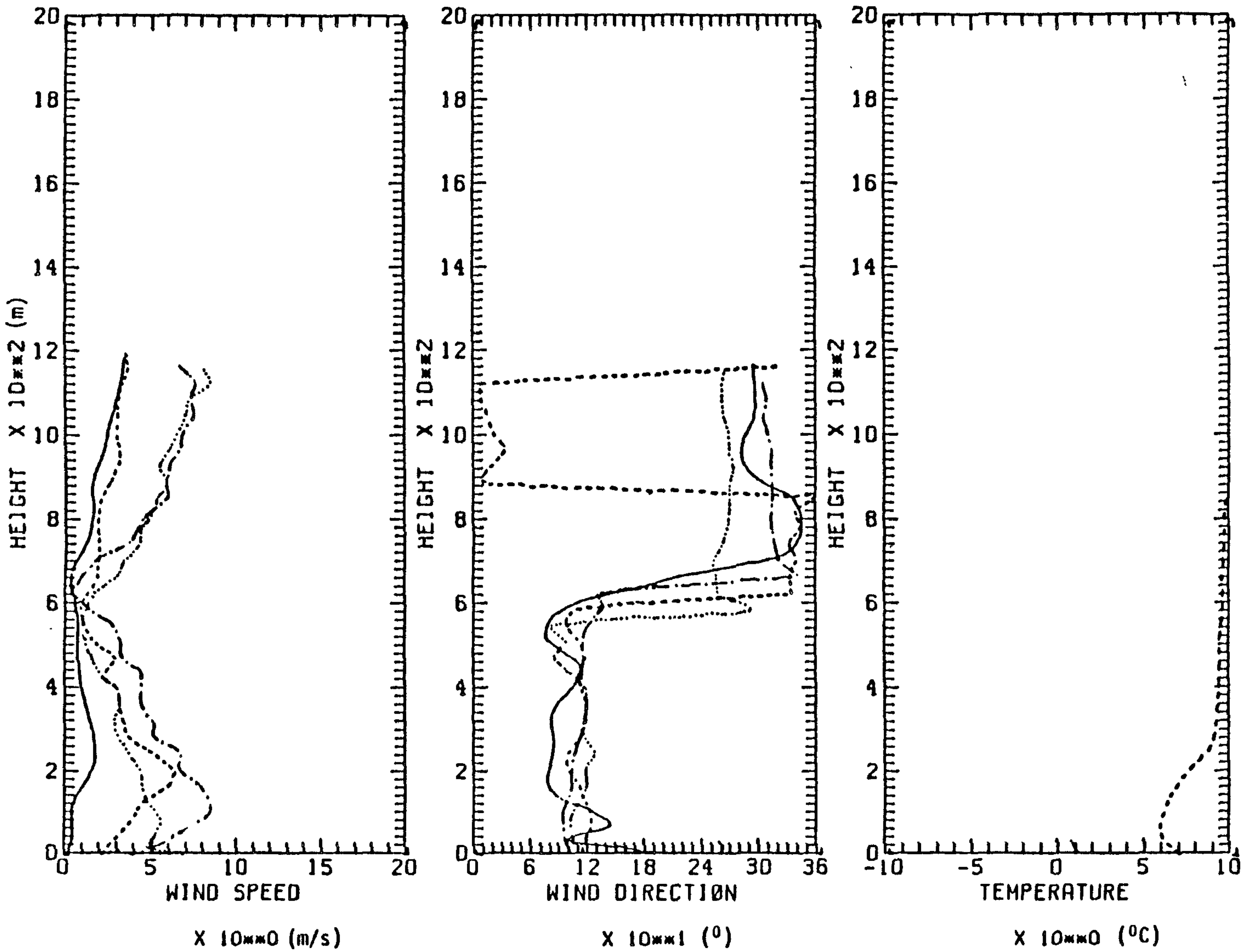


Figure 5. Upper air soundings at Four Corners Power Plant during turnaround meteorological conditions (From Moore et al., 1981)

included: (1) HBR was the dominant terrain feature in the area; (2) the area was easily accessible and had electric power available; (3) FAA at Farmington was a source of meteorological data taken near HBR and was willing to provide the data in real-time during the experiment; and (4) the Bureau of Land Management, which manages the HBR and the area to the east granted permission to use the ridge.

2.2 Experimental Design

The SHIS #2 at the Hogback Ridge was designed to obtain meteorological, flow visualization, and tracer gas emission and concentration data in the vicinity of a nearly two-dimensional ridge in order to enlarge the modeling data base and to provide a good basis for testing, evaluating, and refining the modeling concepts developed from the CCB data baseand the various FMF experiments. The experimental methods of SHIS #2 were similar to those used and tested at CCB. The experiment was conducted at HBR from October 5 to October 29, 1982 and included:

* Releases of two tracer gases, SF6 and Freon 13B1 (CF3Br) and oilfog, using a mobile 150-ft crane and a 150-m tower as source platforms;
* Fixed meteorological measurements from:
    - a 150-m tower "A" instrumented at ten levels,
    - a 30-m tower "B" instrumented at five levels,
    - a 10-m tower "C" instrumented at three levels,
    - a 60-m tower "P" instrumented at two levels,
    - two nonostatic acoustic sounders,
    - a doppler acoustic sounder, and
    - three optical crosswind anemometers;
* Two tethersondes:
    - one operated at source of tracer release to document meteorological conditions representative of the source,
    - one operated to measure vertical profiles of wind, temperature, pressure and humidity upwind of HBR;

* Ground-level tracer gas concentrations;
* Lidar measurements; and
* Photographs and videotapes.

After three smoke visualization experiments, 11 combined tracer and flow visualization experiments were performed. Three initial experiments were conducted to (1) understand the autumn weather conditions at HBR, that is, to verify the findings of the preliminary experiment conducted in June, (2) gain experience working at the HBR site, and finalize the release and sampling protocols. During the 11 tracer and simultaneous flow visualization experiments, SF6 and CF3Br were released, sampled and analyzed for concentrations recorded on the ridge. Meteorological data were archived and displayed in real-time by a system of onsite minicomputers. Real-time information on ambient meteorological conditions and the flexibility of releasing oil-fog and tracer gases at a wide variety of heights and locations allowed the field managers real-time control of the experiment in the selection of source positions to obtain useful information for model development purposes. Real-time meteorological feed-back was supplemented by near real-time lidar observations and approximately 48-hour turnaround on the photographs. Complete details of the experimental design of the SHIS #2 are presented in the "Work Plan for Small Hill Impaction Study #2," ERT Document P-B348-620, September 1982.

SECTION 3

TOWER METEOROLOGICAL DATA

3.1 FIXED METEOROLOGICAL NETWORK

Four meteorological towers, designated A, B, C, and P, were deployed during the SHIS #2 at HBR as shown in Figure 5a. Tower A, the 150-m "profile" tower was located on the windward side of HBR, roughly 800 m east, with its base at 1604 m MSL. The purpose of Tower A was to characterize the approach flow with regard to temperature stratification, wind speed and shear, and turbulence. To accomplish this, Tower A was instrumented at 10 levels, 2, 5, 10, 20, 30, 40, 60, 80, 100 and 150 m. Triaxial propeller wind sets were placed at all levels to obtain a profile of horizontal and vertical turbulence. In addition, three cup-and-vane wind sets were included, at 20, 40 and 60 m, for redundant, but not identical, wind measurements at those levels, which encompassed most tracer release heights. Comparisons between the two kinds of wind sets at these levels helped establish the effectiveness of calibration and correction functions used for all wind sets.

NOAA WPL provided two sonic anemometer systems that measured U, V, W, and temperature at a high frequency (20 Hz). The sonic systems were located at the 40-m and 5-m levels of the Tower A. WPL also provided a separate data logging system to archive the sonic data; these sonic data are not included in this data archive.

Temperature data were acquired at all ten levels. All temperatures above the 2-m base level were measured as delta-T. This increased the accuracy of the temperature gradients and lead to a better characterization of the hydrostatic stability of the approach flow. In addition, temperature data were recorded by fast-response thermistors at the 5- and 40-m levels.

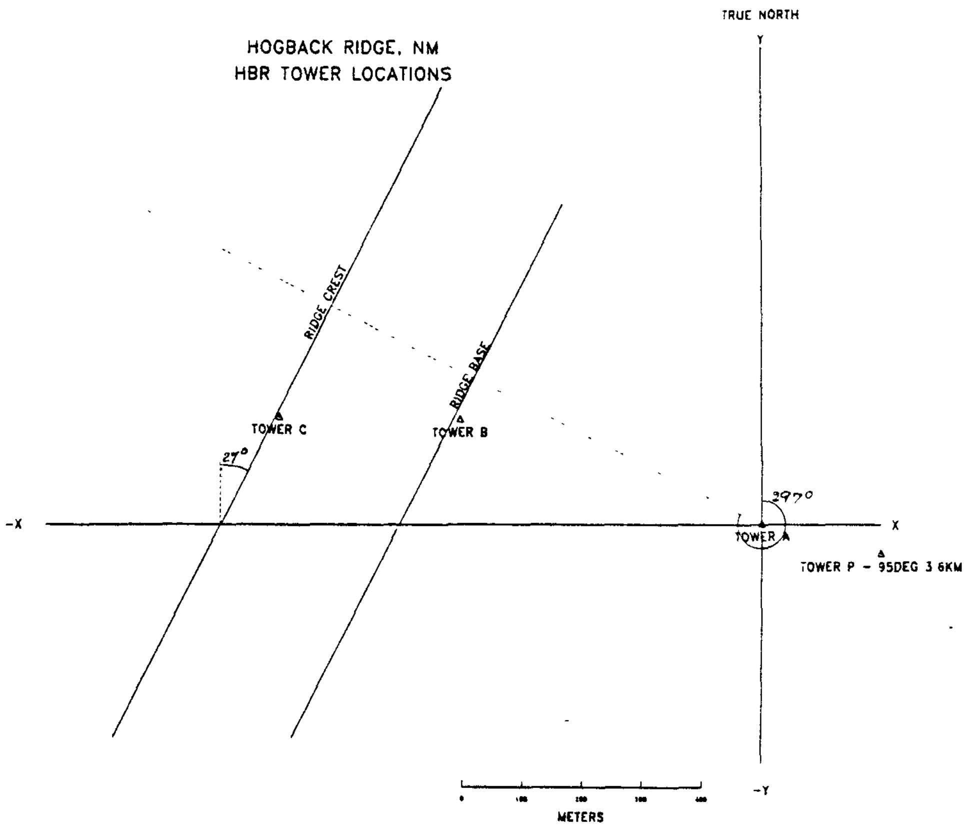


Figure 5a. HBR meteorological tower locations

Tower B, 30 m high, was located east of HBR near the base of the ridge between Tower A and the crest. This position was chosen to document changes in turbulence intensities in this highly distorted flow region as well as resolve what may be be a complex flow structure, including some measure of blocking and katabatic effects. Comparisons of wind speed and temperature gradients between Towers A and B will help in assessing the usefulness of simple stratified flow theories. Three triaxial propeller wind sets were used on Tower B at 5, 20 and 30 m levels, representing the majority of tracer plume release heights. Cup-and-vane wind sets were placed at 1 m and 10 m. Temperature was measured at 1 m, and delta-T sensors were located at the other four levels.

Tower C, 10 m, was located at the crest of HBR to record the wind, temperature, and turbulence at 10 m over the crest. Three triaxial propeller wind sets were installed at 2, 5 and 10 m, but no cup-and-vane sets were used because it was suspected there was sufficient W-component, up-slope flow, to degrade the accuracy of speed measurements made with cups. Temperature measurements were made at 2 m, with delta-T sensors at 5 m and 10m.

The 60-m Tower P ,San Juan Weather Tower, was operated by PNM. Two cup-and-vane wind sets were installed at 18.3 m and extended 61.0 m to observe the approach flow east of Tower A. PNM instruments recorded temperature at 9.1 m and delta-T at 59.7 m. Data from Tower P were available for the period of the SHIS #2 and were included in the data base. Table 1 shows the arrangement of instrumentation on each tower, and Tables 2-2a identify the codes used for each type of meteorological data measured.

3.1.1 Data Acquisition System

NOAA ARLFRD provided a real-time Meteorologic Data System (MDS) to acquire, process, display and store data. Figure 6 depicts the component structure of the system. Operating continuously during each experiment, the MDS sampled the 86 meteorological sensor inputs at a frequency of 1 scan per second, calculated the derived measures and stored the values on magnetic tape to form a "raw" data base from which a modeler could recreate any

TABLE 1. TOWER INSTRUMENTATION AND MEASURES

SITE	INSTRUMENTS*	DIRECT MEASUREMENTS**	DERIVED MEASUREMENTS+
Tower A	(Tower Base = 1604M MSL)		
Level 1 (2 M)	Triaxial Props RTD	U,V,W T	S,D,UW,SU,SV,SW,SD
Level 2 (5 M)	Triaxial Props RTD Fast Response Thermistor	U,V,W DT TF	S,D,UW,SU,SV,SW,SD TC ST,WT
Level 3 (10 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC
Level 4 (20 M)	Triaxial Props Cup-and-Vane	U,V,W SX,DX	S,D,UW,SU,SV,SW,SD UX,VX,X1,X2 TC
Level 5 (30 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC
Level 6 (40 M)	Triaxial Props Cup-and-Vane RTD Fast Response Thermistor	U,V,W SX,DX DT TF	S,D,UW,SU,SV,SW,SD UX,VX,X1,X2 TC ST,WT
Level 7 (60 M)	Triaxial Props Cup-and-Vane RTD	U,V,W SX,DX DT	S,D,UW,SU,SV,SW,SD UX,VX,X1,X2 TC
Level 8 (80 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC
Level 9 (100 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC
Level 10 (150 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC

TABLE 1. TOWER INSTRUMENTATION AND MEASURES (Continued)

SITE	INSTRUMENTS*	DIRECT MEASUREMENTS**	DERIVED MEASUREMENTS+
Tower B (Tower Base = 1619M MSL)			
Level 1 (1 M)	Cup-And-Vane RTD	SX,DX T	UX,VX, X1,X2
Level 2 (5 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC
Level 3 (10 M)	Cup-And-Vane RTD	SX,DX DT	UX,UV,X1,X2 TC
Level 4 (20 M)	Triaxial Props RTD	U,V,W DT	S,D,UW,SU,SV,SW,SD TC
Level 5 (30M)	Triaxial Props Cup-And-Vane RTD	U,V,W SX,DX DT	S,D,UW,SU,SV,SW,SD UX,VX,X1,X2 TC
Tower C (Tower Base = 1687M MSL)			
Level 1 (2 M)	Triaxial Props RTD	U,V,W T	S,D,UW,SU,SV,SW,SD
Level 2 (5 M)	Triaxial Props RTD	U,V,W TD	S,D,UW,SU,SV,SW,SD TC
Level 3 (10 M)	Triaxial Props RTD	U,V,W TD	S,D,UW,SU,SV,SW,SD TC
Tower P (Tower Base = 1620M MSL)			
Level 1 (9.1 M)	RTD(PNM)	T	
Level 2 (18.3 M)	Cup-And-Vane	SX,DX	UX,VX,X1,X2
Level 3 (59.7 M)	RTD(PNM)	DT	TC
Level 4 (61.0 M)	Cup-And-Vane	SX,DX	UX,VX,X1,X2

PNM = Public Service of Company of New Mexico

(Continued)

TABLE 1. TOWER INSTRUMENTATION AND MEASURES (Continued)

Climatronics Instruments

Type	Model No.
UVW Anemometer	WC - 11
UVW Translator	WC - 11
Cup-and-Vane Anemometer	F - 460
WS/WD Translator	F - 460
WS/WD Crossarm	F - 460
RTD Temperature Probe	100826
RTD Temperature Translator	100950
RTD Delta-T Translator	100950
Fast Response Thermistor Probe	100093-4
Motor Aspirated Temperature Shields	TS-10
Translator Mainframe	100081
Translator Power Supply	100074
W/S Calibrator Oscillator	100517

* All temperature sensors were mounted in aspirated radiation shields; an RTD is a Resistance Thermometric Device.

** Direct measures are those calculated by the data station microprocessors from outputs of the instrument translators. These measures are sampled at a frequency of 1.0 per second to form a "raw" data base from which a 5-minute data base and a 1-hour data base are developed. Direct measures include U,V,W wind components from the triaxial props, SX and DX from the cup and vane anemometers, and T,DT, and TF from the RTD temperature probe and the fast response temperature probe.

\+ Derived measures are those calculated by the data collector computer indirectly from formulae using one or more "raw" instrument outputs.

TABLE 2. DEFINITION OF THE MEASURES

Code	Measurement	Units
U, V, W	Vector averaged wind components - props	m/s
UX, VX	Vector averaged wind components - cups	m/s
S, D	Scalar mean wind speed and direction - props	m/s, degree
SX, DX	Scalar mean wind speed and direction - cups	m/s, degree
TF	Fast thermistor temperature	°C
T	Slow RTD temperature	°C
DT, TC	Slow RTD delta-T and calculated T [T(2m)* + delta-T]	°C
SU, SV, SW	Turbulence scales - sigma-u, sigma-v, sigma-w	m/s
SD	Sigma theta - props	degree
X1	Sigma theta - cups Equation 25 (Yamartino, 1984)	degree
X2	Sigma theta - cups	degree
UW	Correlation between S and W	$(m/s)^2$,
WT	Correlation between TF and W	m/s °C
ST	Variance of TF (Standard Deviation)^2	$[°C]^2$

* or 1 m for 30-m tower

Table 2a. FORMULAE FOR COMPUTING DERIVED METEOROLOGICAL MEASURES

1. Wind Speed and Direction - Props
S, D

u, v, = "raw" wind speed components from the prop sets

S = SQRT $(u^2 + v^2)$

D = $\tan^{-1}(u/v)$

2. Wind Speed Components - Cup and Vanes
UX, VX

DX = "raw" wind directions from vane

SX = "raw" wind speed from cups

UX = SX cos (DX)

VX = SX sin (DX)

3. Turbulence Scales
SU, SV, SW

u,v,w = "raw" wind speed components from the prop sets

$$SU = SQRT\left[\frac{1}{N}\left(\frac{\Sigma u^2(\Sigma u)^2 + \Sigma v^2(\Sigma v)^2 + 2\Sigma uv\Sigma u\Sigma v}{(\Sigma u)^2 + (\Sigma v)^2} - \frac{(\Sigma u)^2+(\Sigma v)^2}{N}\right)\right]$$

$$SV = SQRT\left[\frac{1}{N}\left(\Sigma u^2 + \Sigma v^2 - \frac{\Sigma u^2(\Sigma u)^2 + \Sigma v^2(\Sigma v)^2 + 2\Sigma uv\Sigma u\Sigma v}{(\Sigma u)^2+(\Sigma v)^2}\right)\right]$$

$$SW = SQRT\left[\frac{1}{N}\left(\Sigma w^2 - \frac{1}{N}(\Sigma w)^2\right)\right]$$

(Continued)

TABLE 2a. FORMULAE FOR COMPUTING DERIVED METEOROLOGICAL MEASURES (Continued)

4. Sigma Theta
SD, X2

u,v = "raw" wind speed components from the prop sets or the equivalent, UX,VX, components from the cup sets

$$s = \sqrt{u^2 + v^2}$$

$$SD = SQRT \left[\frac{1}{N} \Sigma \arctan^2 \left(\frac{v \Sigma (u/s) - u \Sigma (v/s)}{u \Sigma (u/s) + v \Sigma (v/s)} \right) \right]$$

5. Variance of TF,
ST

t = "raw" TF value

$$ST = \frac{1}{N} (\Sigma t^2 - \frac{1}{N} (\Sigma t)^2)$$

6. Correlation Between Prop Wind Speed(s) and Vertical Wind Component (w)
UW

u,v,w = "raw" wind speed components from the prop sets

$$UW = \frac{1}{N} (\Sigma (w \sqrt{u^2 + v^2}) - \frac{1}{N} \Sigma \sqrt{u^2 + v^2} \Sigma w)$$

7. Correlation Between Fast Thermistor Temp (TF) and Vertical Component (w)
WT

w = "raw" wind speed component from the w-prop

t = "raw" TF value

$$WT = \frac{1}{N} (\Sigma wt - \frac{1}{N} \Sigma w \Sigma t)$$

(Continued)

8. Sigma Theta (Yamartino Method)
X1

DX = "raw" wind direction from cup-and-vane sets

$$SA = \frac{1}{N} \Sigma \text{ SIN (DX)}$$

$$CA = \frac{1}{N} \Sigma \text{ COS (DX)}$$

$$e = \text{SQRT} \left[1 - (SA^2 + CA^2)\right]$$

$$X1 = \text{SIN}^{-1}(e)(1.0 + 0.1547e^3)$$

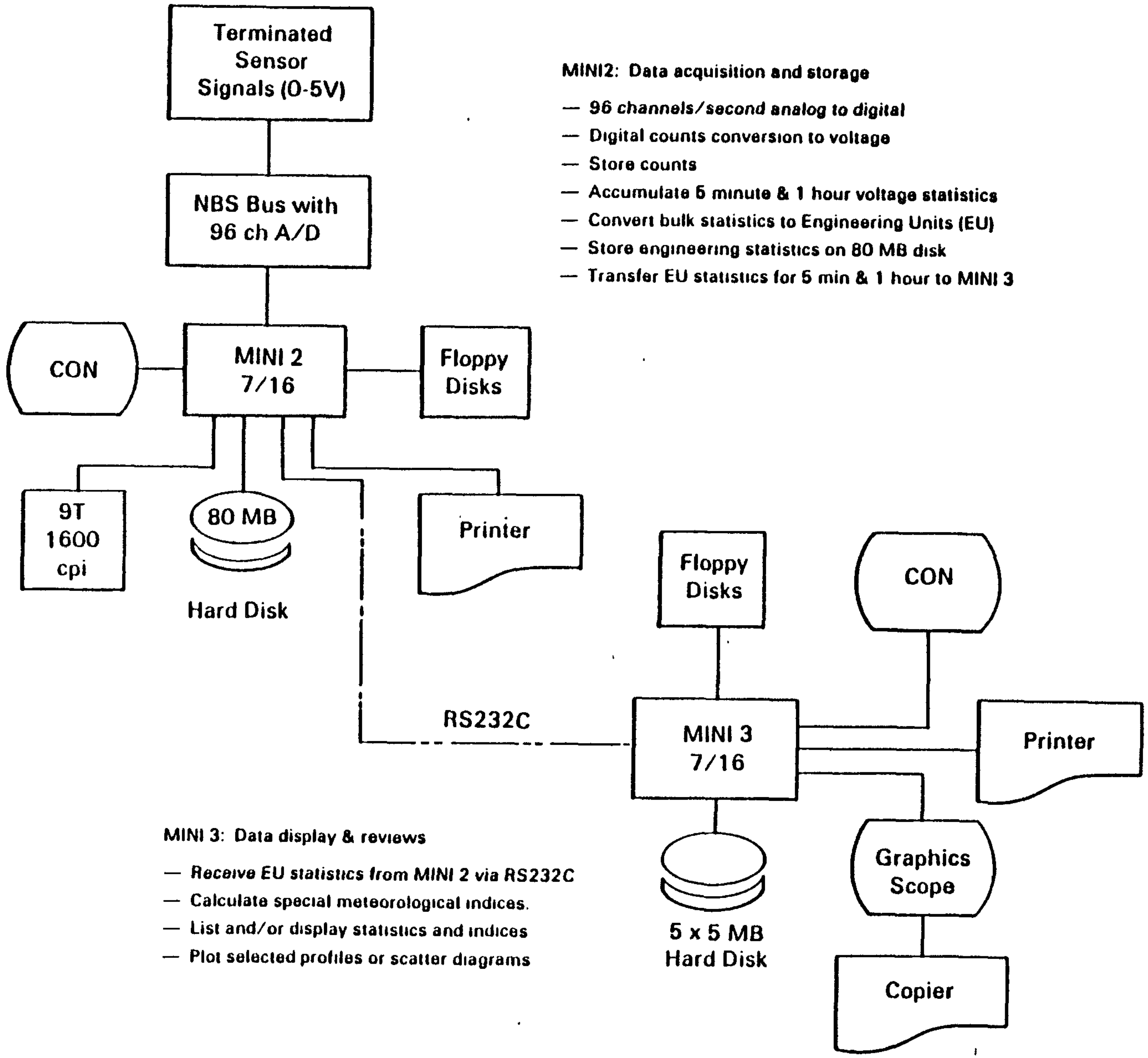


Figure 6. Meteorological data acquisition system
(From Lavery et al., 1983)

experiment. In addition, the MDS could display in real-time selected parameters and tower profiles. Data from the 10-m, 30-m and 60-m towers were transmitted by ARLFRD radio links to the command post near the 150-m tower. The 150-m tower data were transmitted to the command post by shielded signal cable to the data acquistion computer in the command post, a distance of about 50 m.

At least three different types of noise were observed in the 1-sec data during the SHIS# 2 experiments--large "hits", which drove the instrument output voltages outside their 0-5 VDC range; "channel-skipping," in which the data from one input channel was skipped and replaced by the data from the next sequentially polled channel, with the shift of the data continuing to the end of the 16-channel multiplexor; and "high frequency" noise bursts that caused a few seconds of data to oscillate unrealistically at consistent periods within each 5-minute averaging period. These three types of noise are more fully described in the Third Milestone Report (Lavery et al 1982) and in the HBR Quality Assurance Report (Greene and Heisler, 1983).

The large "hits" were generally easy to identify and remove from the data; the other two types of noise were less so. ARLFRD developed a "filtering" routine that examined the second-to-second changes in instrument output and replaced values that exceeded what they regarded as reasonable limits for such changes; these limits are shown in Table 3. Data removed from the 1-sec data by this filtering procedure were replaced by linear interpolation in time between the last good value and the next good value. Besides sampling output data from 86 meteorological sensors, voltages were converted to engineering units, derived measurements computed from measured values, and the raw 1-sec data base was filtered to remove obvious spurious data. A new flagged 1-sec data base was produced, and calculated 5-min and 1hour averages were compiled into two additional data bases using only data with "good" flags in the 1-sec data. The filtering and flagging process resulted in data flagged as follows:

TABLE 3. ALLOWABLE SECOND-TO-SECOND SENSOR CHANGES USED TO FILTER RAW DATA IN PROCESSING THE 1-SEC DATA BASE

Sensor	Max Voltage Increment	Approx. Change In Units
U, V, prop	0.200	2.0 m/sec
W prop	0.200	0.8 m/sec
cup anemometer	0.200	2.0 m/sec
wind vane	0.150	16.0 degrees
temperature	0.100	1.6 degrees C
delta-T	0.100	0.4 degrees C
fast temperature	0.100	1.6 degrees C

" "	(blank)	good data
"O"		Over maximum range limit
"U"		Under minimum range limit
"L"		Lost (first affected channel in channel-skip)
"M"		Moved (reassigned from previous channel by skip-correction)
"T"		Tower noise limit exceeded
"S"		Several (more than one) flag from the above

Only the " " and "M" flags indicate valid data.

In 5-min and 1-hour data bases, data quality flags have been appended to values averaged from the 1-sec data as follows:

E (excellent): 97% or more of points in average are valid
blank: 75% to 97% of points in average are valid
S (suspect): 50% to 75% of points in average are valid
B (bad): less than 50% of points in average are valid

UVW anemometer data in the 1-sec data base were treated by calibration factors determined by ERT at the FMF large wind tunnel at Research Triangle Park, NC. Also, correction factors for non-cosine response were found and applied to the data. Responses of the Climatronics instruments were generally a few percent lower than those derived by Clarke (1982) for the R.M. Young instruments. Stall regions of the Climatronics may also be wider; and the over-response for non-stalled props between 92 deg and 95 deg and between 265 deg and 268 deg for the V-prop seems not to have occurred with R.M. Young instruments.

The reason for this latter effect may be the propeller shaft extensions on the Young instrument. Another possible contributor is a general divergence of flow around the Climatronics UVW system. A smoke streak in the FMF tunnel

(Greene 1985) into the center of the vertical W-arm rose quite noteceably as it approached the equiptment; this accounting for the fact that the W-props frequently turned in a positive (upward) sense when the horizontal arms were being tested for response. For complete details, the Quality Assurance Project Report for SHIS #2 (Greene, 1985) should be consulted.

3.1.2 Periods Of Data Collection

Table 4 shows the dates and times of the experiments and the concurrent periods of meteorological tower data collection. No meteorological data were collected for the first three experiments, October 5, 6 and 7. Collection began with experiment #4, which began on October 23 at 2300 hours MDT and ended on October 11 at 0900 hours. No data were recorded during experiment #13 due to wind flow from the wrong (westerly) direction.

3.2 TOWER METEOROLOGICAL DATA TAPE FILES

Data are stored at the National Computer Center, Environmental Research Center, Research Triangle Park, North Carolina on Sperry UNIVAC 1100/83 systems magnetic tape, nine track, odd parity, ASCII-quarter word mode, density 6250 BPI, tape number 004972. Record length is 132 characters, and the block size is 1320 words or 40 records per block. UNIVAC users may assign the tape, @ASG,T HBR,U9S//////Q,004972 using UNIVAC Executive Control Language (ECL). Upon request, copies can be furnished and translated into formats acceptable to any computer using 9-track tape drives.

3.2.1 Meteorological Data Tape File Index

Four sets of tower meteorological data files are recorded on tape number 004972. The first set, file numbers 1 to 176, contain data from Tower A, 5-minute averages, as illustrated in Table 5. There are 16 tape files for each experiment; the data fields in each file correspond to one or more meteorological measures as illustrated in Table 6. With the tape files partitioned in this manner, given a particular experiment, the parameter desired can be

TABLE 4. PERIODS OF SHIS #2 EXPERIMENTAL HOURS OF METEOROLOGICAL TOWER DATA

Experiment No.	Date Oct. 1982	Times MDT
1	5	---
2	6	---
3	7	---
4	10-11	10/2300-11/0900
5	12	12/0000-0700
6	12-13	12/2300-13/0800
7	13-14	13/2000-14/0800
8	14-15	14/2300-15/0800
9	20	20/0100-0900
10	21-22	21/2100-22/1000
11	22-23	22/2200-23/0900
12	23-24	23/2300-24/1100
13*	25	---
14	25-26	25/2100-26/1000
15	28-29	28/2200-29/1000

* Experiment 13 was terminated due to unfavorable weather.

TABLE 5. TOWER A METEOROLOGICAL DATA - 5 MINUTE AVERAGES
TAPE FILE NUMBERS

Record Type / Experiment No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
5	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
6	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
7	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
8	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
9	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
10	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
11	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
12	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
14	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
15	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176

TABLE 6. TOWER A DATA TAPE FILES

File Type	Data Fields	Data Measure
1	10	U - Westerly wind component from props, m/s
2	10	V - Southerly wind component from props, m/s
3	10	W - Vertical wind component from props, m/s
4	10	SU - Sigma u, Standard deviation of component of horizontal wind speed along mean wind direction from props, m/s
5	10	SV - Sigma v, Standard deviation of component of horizontal wind speed perpendicular to mean wind direction from props, m/s
6	10	SW - Sigma w, Standard deviation of vertical wind component from props, m/s
7	10	S - Scalar mean wind speed from props, m/s
8	10	D - Scalar mean wind direction from props, deg
9	6	SX - Scalar mean wind speed from cups, m/s
		DX - Scalar mean wind direction from vane, deg
10	6	UX - Westerly wind component average from cup & vane, m/s
		VX - Southerly wind component average from cup & vane, m/s
11	10	SD - Sigma theta, Standard deviation of wind direction from props deg
12	3	X1 - Sigma theta, Standard deviation of wind direction from cup & vane; Yamartino algorithm deg
13	10	T - Temperature from steel-encapsulated platinum resistance thermometric device (RTD), C
		TC - Calculated temperature = T + DT, C
14	9	DT - Temperature difference from reference temperature (RTD), C
15	10	UW - Vertical momentum flux, u'w' from props, where u is total horizontal speed, (m/s)2
16	9	TF - Temperature from "fast response" platinum bead thermistor, C
		WT - Vertical heat flux, w't' from w-prop and tf, m/s C
		ST - Variance of tf, C
		X2 - Sigma theta, Standard deviation of wind direction from cup & vane, deg

TABLE 6a. TOWER A METEOROLOGICAL RECORD TYPES

Tape Record Type	Measures	Levels
1	U - Westerly Wind Component	2m, 5m, 10m, 20m, 30m, 40m, 60m, 80m, 100m, 150m
2	V - Southerly Wind Component	"
3	W - Vertical Wind Component	"
4	SU - Sigma U, Turbulence Measure of U	"
5	SV - Sigma V, Turbulence Measure of V	"
6	SW - Sigma W, Turbulence Measure of W	"
7	S - Scalar Mean Wind Speed, Props	"
8	D - Scalar Mean Wind Direction, Props	"
9	SX, DX - Scalar Mean Wind Speed and Direction, Cup-and-Vane	20m, 40m, 60m
10	UX, VX - Scalar Averaged U and V Components, Cup-and-Vane	"
11	SD - Sigma Theta, Props	2m, 5m, 10m, 20m, 30m 40m, 60m, 80m, 100m, 150m
12	X1 - Sigma Theta, Cup-and-Vane Equation 25, (Yamartino, 1984)	20m, 40m, 60m
13	T, TC - Slow RTD Temperature and Calculated TC = [T(2m)+DT]	2m, 5m, 10m, 20m, 30m, 40m, 60m, 80m, 100m, 150m
14	DT - Slow RTD Temperature Differnce from T(2m)	"
15	UW - Correlation of S vs. W	"
16	TF, WT, ST, X2, - Fast Thermistor Temperature, Correlation of TF vs. W, Variance of TF, Sigma Theta Cup-and-Vane	"

TABLE 7. TOWERS B, C, P METEOROLOGICAL DATA - 5 MINUTE AVERAGES TAPE FILE NUMBERS

Record Type / Experiment No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192
5	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208
6	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
7	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
8	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256
9	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272
10	273	264	275	276	277	278	279	280	281	282	283	284	285	286	287	288
11	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304
12	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
14	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
15	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352

quickly accessed. Of the measures recorded, Table 6, U, V, W, T, DT, TF, SX and DX are simple 5-minute averages of direct, sometimes corrected, instrument output. All the rest were derived indirectly from algorithms using one or more of the direct instrument outputs. Table 6a indicates the tower levels where data were measured.

The second set of data files, file numbers 177 to 352, contain data from Towers B, C, and P, 5-minute averages as indicated in Table 7. There are 16 tape files for each experiment, the record types in each file corresponding to one or more meteorological measures as shown in Table 8. Record types differ from those in the first set since data from one or more towers are combined on each file, although the measures contained are the same as in the first set, with the exception of the last file (16) in each experiment where only X2, sigma-theta values for cup & vane anemometers are available for Towers B, C, and P.

The third set of data files, numbers 353 to 363, contain meteorological data from Tower A, 1-hour average as illustrated in Table 9. There are 11 tape files, one for each experiment, with data measures arranged in the same sequence as in the first set, 5-minute values.

The fourth set of data files, numbers 364 to 374, contain meteorological data from Towers B, C, and P, 1-hour averages as illustrated in Table 9. There are 11 tape files, one for each experiment, with data measures arranged in the same sequence as in the second set, 5-minute values.

3.2.2 Tape File Records

The first five records of each file contain alphabetic ASCII characters of identification information and column headings for the data fields in the records that follow. The first five records are FORTRAN, formatted (132A1). Column headings are coded in the last two heading records, where the first record identifies columns of date, time and the meteorological measures, and the second record identifies tower levels where the data were observed.

TABLE 8. TOWERS B, C, P METEOROLOGICAL RECORD TYPES

Tape Record Type	Measures	Towers	Levels
1	U - Westerly Wind Component	B C	5m, 20m, 30m 2m, 5m, 10m
2	V - Southerly Wind Component		"
3	W - Vertical Wind Component		"
4	SU - Sigma U, Turbulence Measure of U		"
5	SV - Sigma V, Turbulence Measure of V		"
6	SW - Sigma W, Turbulence Measure of W		"
7	S - Scalar Mean Wind Speed, Props		"
8	D - Scalar Mean Wind Direction, Props		"
9	SX, DX - Scalar Mean Wind Speed and Direction, Cup-and-Vane	B P	1m, 10m, 30m 18m, 60m
10	UX, VX - Scalar Averaged U and V Components, Cup-and-Vane		"
11	SD - Sigma Theta, Props	B C	5m, 20m, 30m 2m, 5m, 10m
12	X1 - Sigma Theta, Cup-and-Vane Equation 25, (Yamartino, 1984)	B P	1m, 10m, 30m 18m, 60m
13	T, TC - Slow RTD Temperature and Calculated TC	B C P	1m, 5m, 10m 20m, 30m 2m, 5m, 10m 9m, 60m
14	DT - Slow RTD Temperature Difference from T	B C P	5m, 10m, 20m, 30m 5m, 10m 60m
15	UW - Correlation of S vs. W	B C	5m, 20m, 30m 2m, 5m, 10m
16	X2 - Sigma Theta, Cup-and-Vane	B P	1m, 20m, 30m 18m, 60m

TABLE 9. METEOROLOGICAL DATA - 1-HOUR AVERAGES TAPE FILE NUMBERS

Experiment No.	TOWER A	TOWERS B, C, P
4	353	364
5	354	365
6	355	366
7	356	367
8	357	368
9	358	369
10	359	370
11	360	371
12	361	372
14	362	373
15	363	374

All data records following the first five alphabetic heading records have data fields arranged as shown in Table 10.

TABLE 10. DATA RECORDS FORMAT

Position	Contents	FORTRAN Format
1 to 4	Year 1982	I4
5 to 6	Month 10	I2
7 to 8	Day	I2
9 to 10	Hour 00-23	I2
11 to 12	Minute 00-55	I2
13 to 14	Second 00	I2
15 to 16	Blank	2X
17 to 24	Meteorological Data	F8.3
25	Data Quality Flag	A1
26 to 132	Meteorological Data & Data Quality Flags	(F8.3,A1)

Table 11 is a printout of the heading records from the first 16 files, experiment #4, from the first set of meteorological data files from Tower A. All five heading records and the first two data records are presented for tape file #1, while only the last two heading records and two data records are shown for tape files #2 to #16. It illustrates how the alphabetic heading records identify columns of data fields in the data records that follow. Each data record contains 5-minute averages of observed or derived meteorological measures from the levels on Tower A as indicated by the notations on the heading records.

Table 12 is a similar printout, experiment #4, from the second set of meteorological data files from Towers B, C, and P. There are six alphabetic

TABLE 11. FIRST SET OF METEOROLOGICAL DATA FILES: TOWER A 5-MINUTE AVERAGES SAMPLE PRINTOUT

TAPE FILE # = 1
SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
EXP. 4 - 150 M TOWER A METEOROLOGICAL DATA

YYYYMMDDHHMMSS	U 2 M	U 5 M	U 10 M	U 20 M	U 30 M	U 40 M	U 60 M	U 80 M	U 100 M	U 150 M
198210102250 0	.411E	.586E	.520E	.747E	.810E	.986E	1.824E	1.249E	.930E	.562E
198210102255 0	.534E	.457E	.415E	.449E	.734E	1.018	1.545	1.235	.740	.547

TAPE FILE # = 2

YYYYMMDDHHMMSS	V 2 M	V 5 M	V 10 M	V 20 M	V 30 M	V 40 M	V 60 M	V 80 M	V 100 M	V 150 M
198210102250 0	.399E	.357E	.258E	.179E	.140	-.200E	-1.429E	-2.201	-2.493E	-3.097E
198210102255 0	.818E	.858E	.865E	.921E	.972E	.635E	-.251E	-1.249E	-1.943E	-2.353

TAPE FILE # = 3

YYYYMMDDHHMMSS	W 2 M	W 5 M	W 10 M	W 20 M	W 30 M	W 40 M	W 60 M	W 80 M	W 100 M	W 150 M
198210102250 0	-.061E	-.112E	-.143E	-.058E	.133E	-.005E	.138	.321E	.317E	.299E
198210102255 0	.048E	.042E	.076E	.070E	.109E	-.017E	.171E	.318	.258	.201E

TAPE FILE # = 4

YYYYMMDDHHMMSS	SU 2 M	SU 5 M	SU 10 M	SU 20 M	SU 30 M	SU 40 M	SU 60 M	SU 80 M	SU 100 M	SU 150 M
198210102250 0	1.377E	1.232E	1.229E	1.071E	1.087	.729	.550	.612	.459	.479
198210102255 0	.989E	1.001E	1.015	.940	.999	1.044	.700	.659	.637	.589

TAPE FILE # = 5

YYYYMMDDHHMMSS	SV 2 M	SV 5 M	SV 10 M	SV 20 M	SV 30 M	SV 40 M	SV 60 M	SV 80 M	SV 100 M	SV 150 M
198210102250 0	.376E	.477E	.614E	.761E	.750	.992	.878	.889	1.023	1.078
198210102255 0	.595E	.580E	.495	.556	.535	.663	1.099	1.381	1.116	.951

TAPE FILE # = 6

YYYYMMDDHHMMSS	SW 2 M	SW 5 M	SW 10 M	SW 20 M	SW 30 M	SW 40 M	SW 60 M	SW 80 M	SW 100 M	SW 150 M
198210102250 0	.348E	.340E	.384E	.425E	.370E	.399E	.391	.466E	.478E	.381E
198210102255 0	.389E	.380E	.381E	.421E	.449E	.448E	.428E	.492	.427	.440E

TAPE FILE # = 7

YYYYMMDDHHMMSS	S 2 M	S 5 M	S 10 M	S 20 M	S 30 M	S 40 M	S 60 M	S 80 M	S 100 M	S 150 M
198210102250 0	1.381E	1.346E	1.366E	1.363E	1.408	1.488	2.475	2.677	2.836	3.314
198210102255 0	1.308E	1.285E	1.270	1.289	1.443	1.521	1.958	2.249	2.344	2.563

TAPE FILE # = 8

YYYYMMDDHHMMSS	D 2 M	D 5 M	D 10 M	D 20 M	D 30 M	D 40 M	D 60 M	D 80 M	D 100 M	D 150 M
198210102250 0	230.752E	251.068E	265.627E	268.579E	275.313	286.932	303.338	324.700	333.544	345.458
198210102255 0	203.843E	199.236E	197.322	203.577	220.303	250.278	275.728	308.254	329.806	340.325

(Continued)

TABLE 11. FIRST SET OF METEOROLOGICAL DATA FILES
TOWER A 5-MINUTE AVERAGES SAMPLE PRINTOUT (Continued)

TAPE FILE # = 9										
YYYYMMDDHHMMSS	SX 20 M	SX 40 M	SX 60 M	DX 20 M	DX 40 M	DX 60 M				
198210102250 0	.978	1.431	2.325E	254.207	265.277	311.615E				
198210102255 0	1.239	1.452E	1.680E	204.651E	236.770E	284.696E				
TAPE FILE # = 10										
YYYYMMDDHHMMSS	UX 20 M	UX 40 M	UX 60 M	VX 20 M	VX 40 M	VX 60 M				
198210102250 0	.774S	1.217	1.649E	.005S	-.579	-1.577E				
198210102255 0	.487	1.138	1.500	.955	.697	-.496				
TAPE FILE # = 11										
YYYYMMDDHHMMSS	SD 2 M	SD 5 M	SD 10 M	SD 20 M	SD 30 M	SD 40 M	SD 60 M	SD 80 M	SD 100 M	SD 150 M
198210102250 0	76.900E	73.885E	84.084E	64.001E	64.981	52.486	22.200	20.175	21.191	18.780
198210102255 0	65.870E	68.704E	70.698	59.192	53.787	54.961	40.487	40.434	29.982	21.785
TAPE FILE # = 12										
YYYYMMDDHHMMSS	X1 20 M	X1 40 M	X1 60 M							
198210102250 0	30.383	24.162	10.442E							
198210102255 0	30.059E	22.592E	23.129E							
TAPE FILE # = 13										
YYYYMMDDHHMMSS	T 2 M	TC 5 M	TC 10 M	TC 20 M	TC 30 M	TC 40 M	TC 60 M	TC 80 M	TC 100 M	TC 150 M
198210102250 0	5.462E	6.024E	6.328E	6.777E	7.122E	7.467E	8.083E	8.730E	8.655E	8.401E
198210102255 0	5.010	5.705	6.496	7.036	7.297	7.547	8.108	8.867	8.872	8.675
TAPE FILE # = 14										
YYYYMMDDHHMMSS	DT 5 M	DT 10 M	DT 20 M	DT 30 M	DT 40 M	DT 60 M	DT 80 M	DT 100 M	DT 150 M	
198210102250 0	.562E	.866E	1.315E	1.660E	2.005E	2.622E	3.269E	3.193E	2.939E	
198210102255 0	.695E	1.486	2.026E	2.287	2.537	3.098	3.857	3.862	3.665	
TAPE FILE # = 15										
YYYYMMDDHHMMSS	UW 2 M	UW 5 M	UW 10 M	UW 20 M	UW 30 M	UW 40 M	UW 60 M	UW 80 M	UW 100 M	UW 150 M
198210102250 0	.047E	.058E	.040E	.060	.110	.061	-.040	-.140	-.134	-.102
198210102255 0	.165E	.176E	.170	.211	.220	.147	-.007	-.101	-.163	-.184
TAPE FILE # = 16										
YYYYMMDDHHMMSS	TF 5 M	TF 40 M	WT 5 M	WT 40 M	ST 5 M	ST 40 M	X2 20 M	X2 40 M	X2 60 M	
198210102250 0	5.379E	6.948E	.170E	.204	1.554E	1.680E	31.270	24.267	10.447E	
198210102255 0	4.701E	7.536E	.187E	.169	1.249E	1.226E	29.930E	22.56[illegible]	23.267E	

TABLE 12. SECOND SET OF METEOROLOGICAL DATA FILES; TOWERS B, C, AND P 5-MINUTE AVERAGES SAMPLE PRINTOUT

TAPE FILE # = 177
SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
EXP. 4 - TOWERS B, C, P METEOROLOGICAL DATA

YYYYMMDDHHMMSS	U	U	U	U	U	U
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	2.240E	2.736E	2.217E	2.600E	2.727E	2.699E
198210102255 0	2.147	2.475	2.355	2.604E	2.930	2.816E

TAPE FILE # = 178

YYYYMMDDHHMMSS	V	V	V	V	V	V
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	.086E	-.516E	-1.124E	.569E	.410	.279
198210102255 0	.534	-.001E	-.420E	.855E	1.149E	.909E

TAPE FILE # = 179

YYYYMMDDHHMMSS	W	W	W	W	W	W
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	.153	-.016E	-.083	.250	.125	-.045
198210102255 0	.209E	.139	.250	.149	.082	-.141

TAPE FILE # = 180

YYYYMMDDHHMMSS	SU	SU	SU	SU	SU	SU
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	.351E	.387E	.312	.195	.183	.199
198210102255 0	.370	.230	.226	.276	.222	.324

TAPE FILE # = 181

YYYYMMDDHHMMSS	SV	SV	SV	SV	SV	SV
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	.245E	.360E	.524	.231	.270	.354
198210102255 0	.245	.226	.289	.145	.164	.179

TAPE FILE # = 182

YYYYMMDDHHMMSS	SW	SW	SW	SW	SW	SW
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	.140	.170E	.255	.113	.088	.204
198210102255 0	.180E	.121	.216	.072	.062	.201

TAPE FILE # = 183

YYYYMMDDHHMMSS	S	S	S	S	S	S
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	2.260E	2.814E	2.546	2.677	2.785	2.736
198210102255 0	2.235	2.489	2.422	2.753	3.158	2.965

(Continued)

TABLE 12. SECOND SET OF METEOROLOGICAL DATA FILES: TOWERS B, C, AND P 5-MINUTE AVERAGES (Cont'd)

TAPE FILE # = 184

YYYYMMDDHHMMSS	D	D	D	D	D	D
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	268.488E	282.030E	297.615	257.692	261.452	264.213
198210102255 0	257.146	270.970	280.954	251.935	248.514	252.406

TAPE FILE # = 185

YYYYMMDDHHMMSS	SX	SX	SX	SX	SX	DX	DX	DX	DX	DX
	1 M	10 M	30 M	18 M	60 M	1 M	10 M	30 M	18 M	60 M
TOWER:	B	B	B	P	P	B	B	B	P	P
198210102250 0	1.854	2.725S	.106B	.271	.644	290.004E	290.944	315.529	193.570E	192.567E
198210102255 0	1.807E	2.849E	-.045B	.317	.506E	269.811E	277.190E	301.537E	206.603E	177.956E

TAPE FILE # = 186

YYYYMMDDHHMMSS	UX	UX	UX	UX	UX	VX	VX	VX	VX	VX
	1 M	10 M	30 M	18 M	60 M	1 M	10 M	30 M	18 M	60 M
TOWER:	B	B	B	P	P	B	B	B	P	P
198210102250 0	1.713	2.552S	.059B	.068	.149	-.633	-.931S	-.056B	.257	.612
198210102255 0	1.787E	2.818	-.039B	.142	-.048E	.023E	-.349	.023B	.282	.487E

TAPE FILE # = 187

YYYYMMDDHHMMSS	SD	SD	SD	SD	SD	SD
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	6.750E	8.205E	12.199	4.913	5.376	7.251
198210102255 0	6.624	5.199	7.142	3.130	3.033	3.709

TAPE FILE # = 188

YYYYMMDDHHMMSS	X1	X1	X1	X1	X1
	1 M	10 M	30 M	18 M	60 M
TOWER:	B	B	B	P	P
198210102250 0	9.478E	6.537	15.599	9.446E	15.464E
198210102255 0	8.709E	4.105E	5.873E	2.828E	15.042E

TAPE FILE # = 189

YYYYMMDDHHMMSS	T	T	T	TC	TC	TC	TC	TC	TC	TC
	1 M	2 M	9 M	5 M	10 M	20 M	30 M	5 M	10 M	60 M
TOWER:	B	C	P	B	B	B	B	C	C	P
198210102250 0	7.983E	7.534E	7.174	8.601E	8.920E	9.287E	9.350S	8.371	8.318E	8.319
198210102255 0	7.820E	7.020E	8.013E	8.389E	8.680E	9.236	9.137	7.808	7.875	8.496

TAPE FILE # = 190

YYYYMMDDHHMMSS	DT	DT	DT	DT	DT	DT	DT
	5 M	10 M	20 M	30 M	5 M	10 M	60 M
TOWER:	B	B	B	B	C	C	P
198210102250 0	.618E	.937E	1.304E	1.367S	.837	.785E	1.145E
198210102255 0	.569E	.861E	1.416	1.317	.788	.855	.403

(Continued)

TABLE 12. SECOND SET OF METEOROLOGICAL DATA FILES: TOWERS B, C, AND P 5-MINUTE AVERAGES (Cont'd)

TAPE FILE # = 191						
YYYYMMDDHHMMSS	UW	UW	UW	UW	UW	UW
	5 M	20 M	30 M	2 M	5 M	10 M
TOWER:	B	B	B	C	C	C
198210102250 0	-.017	.003	.002	.001	-.000	.002
198210102255 0	-.028	.003	-.000	-.003	.003	.003

TAPE FILE # = 192					
YYYYMMDDHHMMSS	X2	X2	X2	X2	X2
	1 M	10 M	30 M	18 M	60 M
TOWER:	B	B	B	P	P
198210102250 0	9.469E	6.617	19.031	9.541E	15.635E
198210102255 0	8.723E	4.109E	5.871E	3.138E	15.154E

header records in the first block of each file since and extra record is needed to specify the three towers. All six header records and the first two data records are presented for tape file #177, while only the last three heading records and two data records are shown for tape files #178 to #192.

Table 13 is a printout of an illustration of the first block of the first file, experiment #4 from the third set for data files, 1-hourly averages from Tower A. Since only eight or nine hours of observations were taken during each experiment, all meteorological measures were placed on one file for each experiment. A complete set of header records are presented on the first block of each file, while two header records identify measures and tower levels ahead for each of 16 groups of data.

Table 14 shows a printout of the first block of the first file, experiment #4, from the fourth set of data files containing 1-hour averages of meteorological data from Towers B, C, and P. As in the preceding set for data files, Each file contains 1-hourly averages for one experiment. A complete set of header records are presented on the first block of each file, while three header records identify measures, towers and tower levels for each of the 16 groups of data.

TABLE 13. THIRD SET OF METEOROLOGICAL DATA FILES: TOWER A 1-HOUR AVERAGES SAMPLE PRINTOUT

TAPE FILE NO. = 353

SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
EXP. 4 - 150 M TOWER A METEOROLOGICAL DATA

YYYYMMDDHHMMSS	U 2 M	U 5 M	U 10 M	U 20 M	U 30 M	U 40 M	U 60 M	U 80 M	U 100 M	U 150 M
1982101023 0 0	.521B	.592B	.445B	.490B	.588B	.851B	1.457B	1.259B	.905B	.525B
19821011 0 0 0	.658E	1.143	.102	1.755	.546	2.296	2.993	2.605	2.230	1.103
19821011 1 0 0	.886E	1.179E	-.273E	1.971E	.120E	2.031E	3.134	2.941	2.196	1.089
19821011 2 0 0	-.006E	.032	-.131	-.262	-.313	-.004	.305	.321	-.242	-.272
19821011 3 0 0	.066E	.098E	-.057E	-.343E	-.814E	-1.215E	-1.180E	-.729	-.423	-.431
19821011 4 0 0	.306	.337	.054	.270	.067	.006	-.394	-.389	-.050	.385
19821011 5 0 0	.067	.006	-.293	-.241	-.532	-.407	-.770	-1.135	-1.032	-.001
19821011 6 0 0	.135E	.406E	.248E	.560E	.481E	.294	-.371	-1.065	-1.572	-.115
19821011 7 0 0	.128E	.182	-.088	.214	.225	.377	.161	-.574	-1.155	-1.478
19821011 8 0 0	-.095E	-.028E	-.164E	.563	.378	.718	.371	.097	-.273	-1.285
19821011 9 0 0	.132E	.293E	.204E	.557	.457	.352	.106	-.171	-.452	-.630

YYYYMMDDHHMMSS	V 2 M	V 5 M	V 10 M	V 20 M	V 30 M	V 40 M	V 60 M	V 80 M	V 100 M	V 150 M
1982101023 0 0	.706B	.785B	.884B	.820B	.883B	.552B	-.357B	-1.121B	-1.794B	-2.385B
19821011 0 0 0	-.322	-.023	.149	.116	.094	-.097	-1.158	-1.467	-1.897	-2.346
19821011 1 0 0	-.692	-.520	-.464	-.936	-.793	-.812	-1.722	-1.545	-1.534	-1.606
19821011 2 0 0	-.930	-1.446	-1.639	-1.287	-.946	-.807	-.151	.176	-.051	-.635
19821011 3 0 0	-.849	-.968	-.857	-.486	-.012	.236	.644	.474	.361	.347
19821011 4 0 0	-.763	-.934	-.809	-.370	-.088	.000	.667	1.088	.785	.429
19821011 5 0 0	-.906	-1.371	-1.301	-.910	-.715	-.605	-.030	.518	1.017	.054
19821011 6 0 0	-.132	.173	.462	.610	.574	.318	.399	.544	.650	.063
19821011 7 0 0	-.296	-.082	.109	.496	.752	.627	.442	.301	.281	.148
19821011 8 0 0	-.493	-.250	-.031	.418	.740	.706	.965	1.305	1.555	.611
19821011 9 0 0	.098	.193	.269	.437	.596	.481	.841	1.174	1.447	1.005

YYYYMMDDHHMMSS	W 2 M	W 5 M	W 10 M	W 20 M	W 30 M	W 40 M	W 60 M	W 80 M	W 100 M	W 150 M
1982101023 0 0	.019B	-.021B	-.014B	.006B	.112B	-.001B	.115B	.245B	.271B	.200B
19821011 0 0 0	.108	.035	.095	.089	.231	.144	.279	.134	.142	.145
19821011 1 0 0	.092E	.034E	.064	.141	.194	.121	.221	.116	.263	.128
19821011 2 0 0	.037	.062	.055	.203	.230	.115	.056	.063	.055	.026
19821011 3 0 0	.061E	.076E	.073	.143	.178	.104	.121	.182	.122	.068
19821011 4 0 0	.050	.059	.061	.110	.156	.061	.038	.124	.067	.002

TABLE 14. FOURTH SET OF METEOROLOGICAL DATA FILES: TOWERS B, C, AND P 1-HOUR AVERAGES SAMPLE PRINTOUT

TAPE FILE NO. = 364

SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
EXP. 4 - TOWERS B, C, P METEOROLOGICAL DATA

YYYYMMDDHHMMSS	U 5 M	U 20 M	U 30 M	U 2 M	U 5 M	U 10 M
TOWER:	B	B	B	C	C	C
1982101023 0 0	2.011B	2.618B	2.272B	2.688B	3.016B	2.958B
19821011 0 0 0	3.269E	4.947E	4.966E	4.217E	4.440E	4.576E
19821011 1 0 0	1.951E	3.045E	3.482E	3.095E	3.276E	3.326E
19821011 2 0 0	.164E	-.003E	.307	.451E	.274E	.190E
19821011 3 0 0	.345E	.015E	-.108E	-.478E	-.549E	-.608E
19821011 4 0 0	.515E	.223	.252	-.424	-.494	-.491E
19821011 5 0 0	.366	.042E	.139	-.640E	-.716	-.784E
19821011 6 0 0	.653E	.473	.435	-.573	-.657	-.776E
19821011 7 0 0	.494	.592	.613	-.027	-.198	-.407
19821011 8 0 0	.784E	.702E	.713E	-.007	-.044	-.156E
19821011 9 0 0	.234	.241E	.358	-.268	-.194	-.167E

YYYYMMDDHHMMSS	V 5 M	V 20 M	V 30 M	V 2 M	V 5 M	V 10 M
TOWER:	B	B	B	C	C	C
1982101023 0 0	.549B	-.030B	-.523B	.722B	.920B	.738B
19821011 0 0 0	.229E	-.342E	-.618E	-.281E	.132E	.175E
19821011 1 0 0	-.023E	-.536E	-.759E	-.782E	-.652	-.630E
19821011 2 0 0	-.532E	-.822E	-.569E	.561E	.347	.400E
19821011 3 0 0	.002E	-.142E	.042	1.043	.861	.846E
19821011 4 0 0	.220E	.173	.261	1.017	.907	.958
19821011 5 0 0	-.139E	-.325E	-.251E	.748	.512	.605E
19821011 6 0 0	.747	.457	.683	1.239	1.075	1.038
19821011 7 0 0	.570	.472	.877	.991	.829	.790
19821011 8 0 0	.755E	.472	1.185	1.494	1.635	1.654
19821011 9 0 0	.795E	.458	.933E	1.287E	1.284E	1.345E

YYYYMMDDHHMMSS	W 5 M	W 20 M	W 30 M	W 2 M	W 5 M	W 10 M
TOWER:	B	B	B	C	C	C
1982101023 0 0	.215B	.215B	.251B	.185B	.094B	-.125B
19821011 0 0 0	.079E	-.185E	-.309E	.291	.115	-.004
19821011 1 0 0	.106	-.140	-.215	.338	.171	.077

SECTION 4

TRACER GAS DATA

4.1 TRACER GAS RELEASE SYSTEM

Two tracer gases, SF6 and CF3BR (Freon 13B1), were released at different heights from either Tower A, the 150-m tower, or from the boom of a mobile crane operating on one of three roads east of HBR. The roads were culverted, graded and graveled to support the 150-ft crane that lifted an oil-fog generator and the tracer gas release tubes. The SF6 release was collocated with the oil-fog release and dispersed from a common nozzle. Occasionally, the SF6 and the oil-fog were released from the tower while the CF3Br was released from the crane at a different location.

The SF6 and CF3Br tracer gases were stored in individual compressed gas cylinders at ground level. Piping carried each gas through a linear mass flow meter (LFM) system to the point of discharge into the atmosphere. A time history of each tracer release was used to describe the rate and the quantity of release of tracer. The LFM measured and displayed the rate of gaseous tracer discharge via real-time digital display, the total amount of gas discharged via a digital counter, and an analog output voltage directly proportional to the flow rate. The voltage was logged and monitored on a strip chart recorder. Pre- and post-test release weights of tracer gas cylinders were measured by certified scales. Beginning and ending times of tracer release and the time and character of any deviations from the design rate-of-release were logged. Table 15 presents the hourly average tracer release rates (g/sec) for both gases for each experiment along with the locations and height of release. Tracer release points (TRP) are shown in Figure 7a and are determined with respect to the base of Tower A. Elevation at release point (HT) is determined with respect to ground elevation at release point.

TABLE 15. TRACER RELEASE DATA - EMISSIONS (Q) SF_6 AND CF3Br

	SF6			CF3BR		
Hour End	Q g/sec	Ht. m	Release Point	Q g/sec	Ht. m	Release Point
Exp #4 - 10/11/82						
0200	0.77	20	4(216)	----	-	-
0300	0.77	20	"	1.45	10	4(216)
0400	0.90	30	"	1.42	20	"
0500	0.76	40	"	1.23	30	"
0600	0.84	20	"	1.35	10	"
0700	0.86	30	"	1.34	20	"
0800	0.86	30	"	1.34	20	"
EXP #5 - 10/12/82						
0100	0.70	40	2(203)	1.39	25	2(203)
0200	0.54	30	"	1.31	15	"
0300	0.49	25	"	1.32	20	"
0400	0.49	25	"	1.32	20	"
0500	0.60	20	"	1.33	15	"
0600	0.60	20	"	1.33	15	"
0700	0.68	30	"	1.26	25	"
EXP #6 - 10/13/82						
0000	0.37	40	5(111)	1.32	30	5(111)
0100	0.37	40	"	1.32	30	"
0200	0.32	30	"	1.35	20	"
0300	0.32	30	"	1.35	20	"
0400	----	--	-	----	--	-
0500	0.50	40	2(203)	1.56	30	2(203)
0600	0.37	35	"	1.33	25	"
0700	0.37	35	"	1.33	25	"
0800	0.37	30	"	1.30	20	"
EXP #7 - 10/14/82						
0200	0.52	30	2(203)	1.37	20	2(203)
0300	0.52	30	"	1.37	20	"
0400	0.46	20	"	1.37	15	"
0500	0.46	20	"	1.37	15	"
0600	0.51	15	"	1.36	10	"
0700	0.51	15	"	1.36	10	"
0800	0.43	25	"	1.31	5	"
EXP #8 - 10/15/82						
0000	0.26	30	3(215)	1.09	20	3(215)
0100	0.24	20	"	1.01	10	"
0200	0.24	10	"	1.00	5	"
0300	0.24	10	"	1.00	5	"
0400	0.23	40	"	0.97	30	"
0500	0.23	35	"	0.97	25	"
0600	0.23	35	"	0.97	25	"
0700	0.23	30	"	0.96	30	"
0800	0.23	30	"	0.98	15	"

(continued)

TABLE 15. Continued

TRACER RELEASE DATA - EMISSIONS (Q) SF6 and CF3Br

	SF6			CF3BR		
Hour End	Q g/sec	Ht. m	Release Point	Q g/sec	Ht. m	Release Point
EXP #9 - 10/20/82						
0500	0.20	30	2(203)	0.90	20	2(203)
0600	0.20	30	"	0.90	20	"
0700	0.20	40	"	0.93	20	"
0800	0.20	40	"	0.93	20	"
0900	0.20	40	"	0.93	20	"
EXP #10 - 10/22/82						
0100	0.22	30	2(203)	0.96	20	2(203)
0150	0.22	30	"	0.96	20	"
0200	----	--	-	----	--	
0300	0.23	50	TWR A	1.53	30	TWR A
0400	0.23	50	"	1.53	30	"
0500	0.21	70	"	1.31	30	"
0600	0.21	70	"	1.31	30	"
0700	0.21	70	"	1.31	30	"
0800	0.21	70	"	1.31	30	"
0900	0.21	70	"	1.31	30	"
1000	0.21	70	"	1.31	30	"
1100	0.21	70	"	1.31	30	"
EXP #11 - 10/23/82						
0000	0.27	40	2(203)	0.94	20	2(203)
0100	0.27	40	"	0.94	20	"
0200	0.27	40	"	0.94	20	"
0300	0.27	40	"	0.94	20	"
0400	----	--	-	----	--	-
0500	0.29	50	TWR A	1.31	25	TWR A
0600	0.29	50	"	1.31	25	"
0700	0.29	50	"	1.31	25	"
0800	0.29	25	"	1.35	10	"
0900	0.29	25	"	1.35	10	"
EXP #12 - 10/24/82						
0200	0.31	75	TWR A	1.13	40	TWR A
0300	0.31	75	"	1.35	40	"
0400	0.30	50	"	1.35	50	"
0500	0.30	50	"	1.35	25	"
0600	0.30	75	"	1.32	25	"
0700	0.31	75	"	1.32	25	"
0800	----	--	"	----	--	"
0900	0.30	50	"	1.34	40	"
1000	0.30	50	"	1.34	40	"
1100	0.30	50	"	1.34	40	"

(continued)

TABLE 15. Continued

TRACER RELEASE DATA - EMISSIONS (Q) SF6 and CF3Br

	SF6			CF3BR		
Hour End	Q g/sec	Ht. m	Release Point	Q g/sec	Ht. m	Release Point
EXP #14 - 10/25-26/82						
2300	0.28	5	TWR C	0.89	10	TWR C
2357	0.29	5	"	1.09	2	"
0100	----	-	-	----	-	-
0200	----	-	-	----	-	-
0300	0.30	40	2(203)	0.94	20	2(203)
0400	0.30	40	"	0.93	20	"
0500	0.30	40	"	0.93	20	"
0600	0.30	40	"	0.94	20	"
0700	0.30	40	"	----	--	-
0800	0.30	40	"	1.33	35	TWR A
0900	0.30	40	"	1.33	35	"
1000	0.30	40	"	1.33	35	"
EXP #15 10/29/82						
0000	0.30	20	1(R-80)	----	--	----
0100	0.30	20	"	1.36	40	TWR A
0200	0.30	20	"	1.36	40	"
0300	0.30	20	"	1.36	40	"
0400	0.29	40	"	1.36	40	"
0450	0.29	40	"			
0500	----	--	-----	1.36	40	"
0600	0.28	50	TWR A	1.36	40	"
0645	0.28	50	"	----	--	"
0700	----	--	"	1.34	40	"
0800	0.27	50	"	1.34	40	"
0900	0.27	50	"	1.34	40	"
1000	0.27	50	"	1.34	40	"
1058	0.28	50	"	1.34	40	"

Tracer Release Points TRP	Azimuth deg	Range m	X m	Y m	Z m
1 (R-80)	330.1	574.9	-287.5	497.9	21.7
2 (203)	313.0	454.8	-332.6	310.2	17.4
3 (215)	312.2	334.9	-248.1	225.0	12.9
4 (216)	312.1	324.9	-241.3	217.5	12.4
5 (111)	271.7	391.7	-391.5	11.9	12.5
TWR A	0.0	0.0	0.0	0.0	3.7
TWR C	282.9	829.1	-807.2	179.6	86.7

All azimuths, ranges and coordinates (X,Y,Z) are relative to the base of tower A (TWR A).
Datum (Z=0) = 1600 m MSL.

4.2 TRACER GAS SAMPLING SYSTEM

Tracer samples were collected in 2-liter Tedlar bags at about 110 locations on the ridge at a height of approximately 0.5 m above the ground. ARLFRD operated 125 samplers during each approximately 8-hour experiment. Each sampler contained 12 individual pumps, each of which intermittently (1-sec every 28 sec) filled a Tedlar bag over the period of interest. Thus, each sampler could take sequential 1-hour samples over a 12-hour period or sequential 10-minute samples over a 2-hour period. Twenty samplers were used to get 10-minute averages at five locations. The remaining 105 samplers were used to get 1-hour samples. Two of the 1-hour samplers were operated on the 30-m Tower B and one on the 10-m Tower C.

The bag samples were collected by means of modified EMI AQSIII or similar type of air sampler. Each sampler used 12 separate pumps, bags, and external tubes to draw in ambient air to fill 12 individual 2-liter Tedlar bags. The system was battery powered and electronically programmed in function and timing. Time was set and maintained by a crystal-controlled digital clock accurate to within 1 minute per month. Beginning and ending sampling times for the individual (sequential) whole air samples were controlled by this clock. The actual local time (MDT) for the beginning of the sampling sequence for each unit was preprogrammed during the servicing by sampling team technicians about 20 hours prior to the start of each experiment.

The sampler locations are shown in Figure 7. Samplers were deployed in rows parallel to the axis if HBR, often at points surveyed in a 20 x 20-m grid. Locations were selected on the basis of observations during the preliminary flow study performed in June 1982, wind tunnel and tow-tank simulations done by EPA FMF, and meteorological data collected by PNM. Tables 16 and 17 summarize the characteristics of the sampling grid.

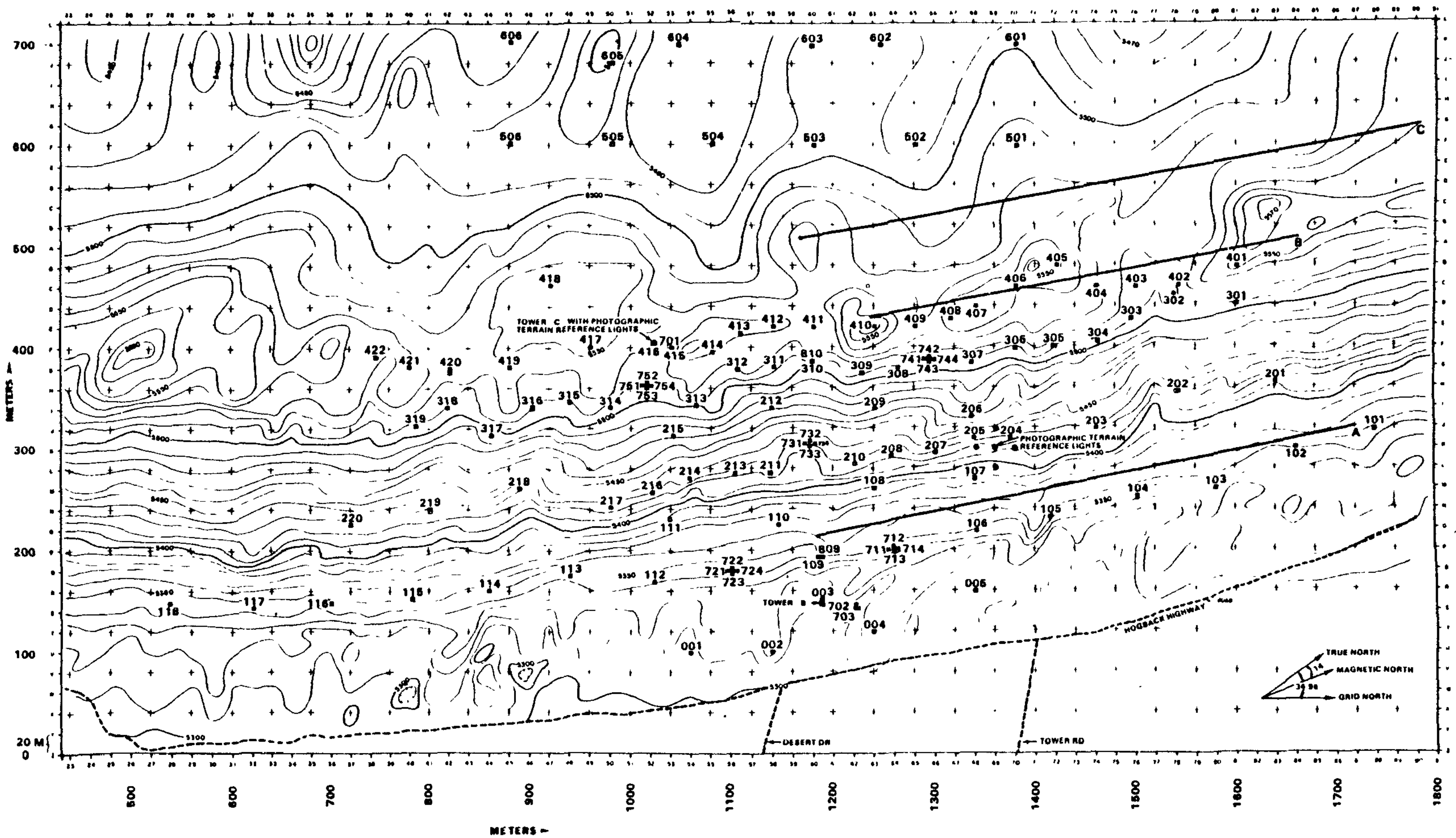


Figure 7. Tracer gas sampler locations and optical anemometer paths A, B, and C

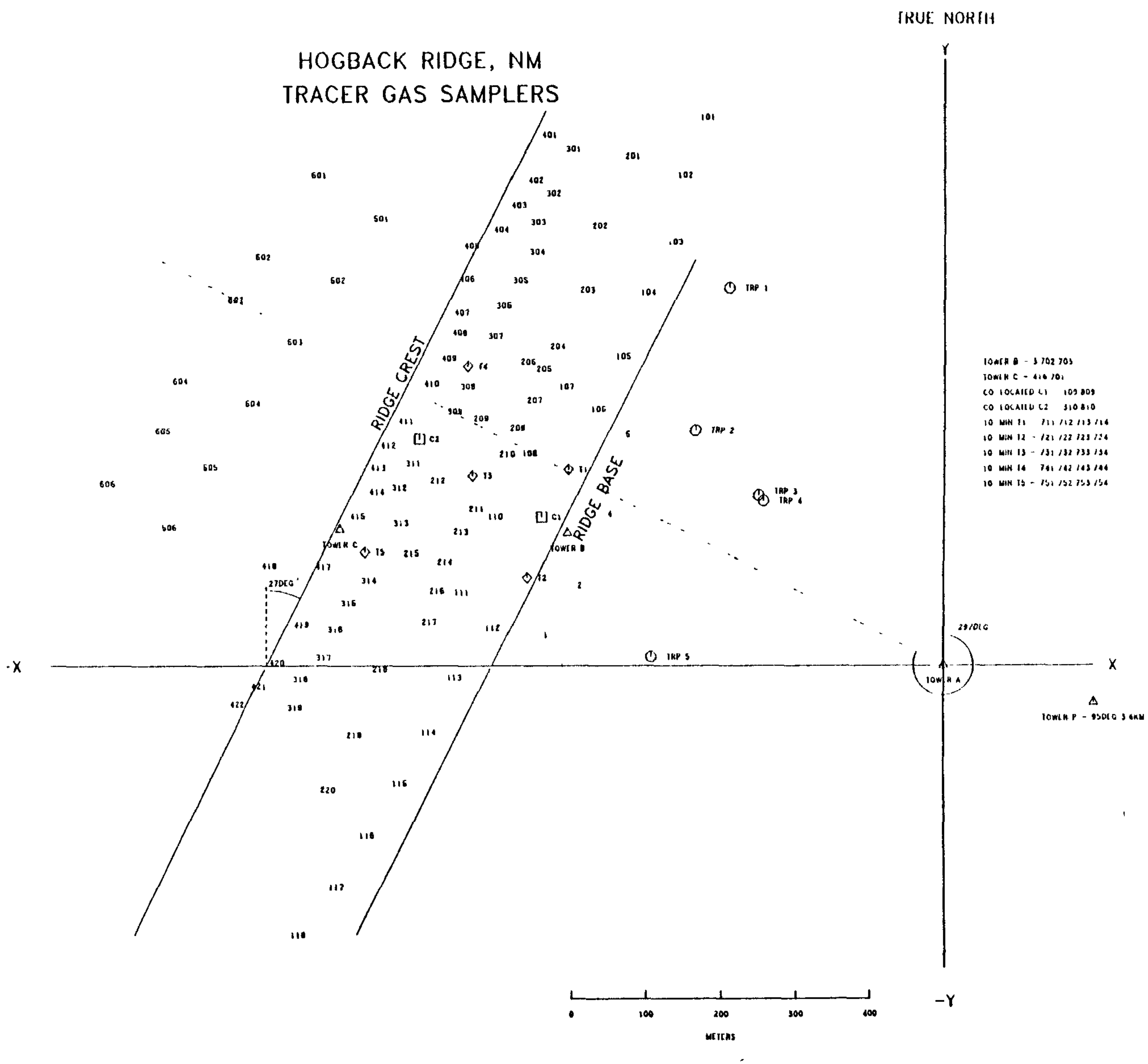


Figure 7a. Tracer gas sampler, tracer release points and tower locations

TABLE 16. PRIMARY SAMPLER LOCATIONS

A. Four Primary Sampler Rows on Windward Face Of HBR

- #1 10 m above base of Tower B
  - 16 locations centered on Tower B
  - 80-m horizontal spacing covering 1200 m
- #2 25 m above #1
  - 17 locations centered on Tower B
  - 40-m horizontal spacing out to 200 m, 80 m spacing to 460 m from center; total range is 920 m.
- #3 25 m above #2
  - 21 locations centered on Tower B
  - 40-m horizontal spacing covering 800 m
- #4 follows the crest of HBR; mean height is 10 m above #3
  - 22 locations centered on Tower B
  - nominal 40-m spacing covers 860 m

B Three Secondary Rows on Windward Face of HBR

- #1 lies among hillocks at base of HBR
  - 5 locations centered on Tower B; middle is at Tower B, adjacent 2 atop hillocks near the road, 2 ends are in low areas adjacent to these
- #2 lies between primary rows #1 and #2, 13 m above #1
  - 4 samplers centered on Tower B
  - 100 m spacing covers 300 m
- #3 lies between primary rows #2 and #3, 13 m above #2
  - 4 samplers centered on Tower B
  - 100 m spacing covers 300 m

C Two Lee-Side Rows

- 6 samplers in each row, centered on Tower B
- 100-m spacing along and between rows
- covers 500 m along each row
- covers out to 280 m west of crest

TABLE 17. ADDITIONAL SAMPLERS

A	Collocated Samplers: two locations along center of grid; one on primary row #1, one an primary row #3.
B	10-minute Samplers: five locations; one at grid center along primary row #2; two along primary row #1, 80 m to either side of center; two along primary row #2, 280 m apart, centered 20 m south of grid center
C	Background Samplers: one on the east side of Waughan Arroyo; one near the acoustic radar near the substation on the high ground of the east arroyo; data are not available at this time.
D	"Edge" Samplers: one to the north of the grid on the road up to the top of HBR beyond the lidar; one to the south where the San Juan River flows through a gap in the ridge; data are not available at this time.
E	Elevated Samplers: one on Tower C at 8 m; two on Tower B at 14 m and 25 m.

The grid was designed to give wide horizontal coverage near the base of the ridge and highest resolution between half way up and the crest. Three primary rows followed height contours and the fourth primary row ran near the crest. Samplers were deployed less densely in the lee. Some samplers near the top of the ridge were placed deliberately on rocky promontories or crests, some in cols, and some in the lee of rocky escarpments in an effort to measure concentrations in different exposures and to capture possible effects of flow separation.

Three elevated samplers were mounted on the shorter meteorological towers, 14 m and 25 m on Tower B at the base on the ridge, and one at 8 m on Tower C on the crest. The upper sampler on Tower B was at 30 m through Experiment #8, whereafter it was lowered so it would not affect the meteorologocal measurements at 30 m.

Within the main grid, two samplers were deployed at each of two sites as collocated samplers. The intent of these samplers was to provide QC information relating to the representativeness and reproducibility aspects of the precision of tracer measurements made by the intermittent 1-hour samplers. In fact the data from these pairs of samplers probably give the best estimates of the total precision of the concentrations (Greene, 1985).

At five locations, four samplers were set out to take samples only 10 minutes long to provide some basis for estimating the variability of concentrations within each sampling hour and the utility of modeling for short time periods. These sampler sites were selected to give some spatial coverage of the intended impact area.

Other samplers were set out to get concentration data farther afield. "Background" samplers were deployed to the east of the ridge in the expected approach flow. One sampler was near the power substation by the Doppler acoustic sounder in case SF6 were emitted there or ad vected from Farmington; one was near the east side of the main arroyo northeast of the experiment site to measure any tracer that might drift over from the San Juan Power Plant. A third sampler was located part-way up the ridge about a mile NNE of the release area to become an "edge" sampler, and a fourth remote sampler was located north of the San Juan River near the outlet of the arroyo to the east of HBR. Data from these samplers are not available for inclusion with samplers on HBR, but will be available at a later time.

Table 18 shows the list of all sampler site by number with locations indicated by range and azimuth from the base of Tower A, and by X,Y coordinates with an origin at Tower A. Elevations Z, are measured from a datum of 1600 m MSL.

TABLE 18. TRACER GAS SAMPLER NETWORK

Sampler ID	θ (deg)	R (m)	X (m)	Y (m)	Z (m)
1	274.1	536.6	-535.2	37.9	17.3
2	281.9	500.2	-489.3	103.5	21.5
3 B	289.1	533.1	-503.7	174.6	20.0
4	293.7	489.7	-448.4	196.9	23.1
5	305.5	520.2	-423.8	301.7	20.0
101	335.7	791.2	-325.4	721.2	35.9
102	331.1	735.5	-354.9	644.2	34.6
103	326.5	666.5	-368.0	555.6	30.7
104	320.4	634.4	-404.7	488.6	29.2
105	312.7	595.9	-437.9	404.3	31.9
106	305.5	578.2	-470.9	335.5	30.1
107	305.4	630.2	-513.9	364.8	41.9
108	296.2	627.6	-563.0	277.2	41.9
109 C1	290.0	572.6	-537.9	196.2	30.4
110	287.6	638.4	-608.4	193.2	41.9
111	278.2	660.9	-654.2	94.5	42.3
112	274.4	614.4	-612.6	46.9	27.9
113	268.4	664.7	-664.4	-18.5	29.2
114	262.5	705.0	-699.1	-91.5	30.4
115	257.9	754.6	-737.8	-158.3	31.3
116	253.7	813 9	-781.4	-227.9	29.8
117	250.2	873.7	-822.2	-295.7	28.2
118	247.6	994.9	-873.7	-359.9	29.2
201	327.6	793.0	-425.1	669.5	53.5
202	320.9	744.1	-468.9	577.7	54.5
203	315.3	691.4	-486.0	491.8	54.1
204	308.4	671.3	-526.1	416.9	54.5
205	305.5	668.3	-544.0	388.2	57.5
206	305.1	691.2	-565.6	397.3	67.3
207	301.9	656.1	-556.7	347.2	54.5
208	298.1	657.3	-579.6	310.0	52.6
209	297.2	706.2	-627.9	323.0	67.6
210	294.9	653.7	-592.7	275.6	53.8
211	287.8	665.6	-633.6	203.9	55.1
212	289.4	727.1	-685.9	241.1	67.9
213	284.8	677.5	-654.9	173.3	52.9
214	281.2	689.8	-676.6	134.3	57.2
215	281.4	736 2	-721.7	145.4	67.6
216	277.9	694.4	-687.7	96.2	55.1
217	274.5	700.7	-698.5	54.8	52.9
218	269.4	763.5	-763.4	-7.9	55.4
219	263.2	803.6	-797.9	-95.2	54.8
220	258.7	849.9	-833.3	-167.2	54.5

(Continued)

Table 18. TRACER GAS SAMPLING NETWORK (Continued)

Sampler ID	θ (deg)	R (m)	X (m)	Y (m)	X (m)
301	323.4	845.9	-504.6	678.9	79.1
302	319.4	817.0	-531.3	620.7	79.4
303	316.5	802.7	-552.1	582.7	79.4
304	314.5	774.7	-552.9	542.6	78.5
305	311.2	765.6	-575.9	504.4	79.4
306	308.3	760.6	-596.7	471.6	78.8
307	305.3	745.2	-608.1	430.7	78.2
308	299.5	741.6	-645.4	365.3	78.8
309	296.6	741.5	-663.1	331.8	79.8
310 C2	293.1	762.2	-701.2	298.7	79.4
311	290.2	765.7	-718.7	264.1	80.4
312	287.5	773.1	-737.5	232.1	81.3
313	284.1	757.9	-735.0	184.9	78.8
314	278.1	785.5	-777.7	110.1	78.5
315	275.7	808.9	-804.9	80.2	79.4
316	273.2	823.6	-822.4	45.4	79.4
317	270.5	838.2	-838.2	8.0	79.4
318	268.6	869.7	-869.5	-20.9	79.1
319	266.2	878.5	-876.5	-58.8	79.1
401	322.5	880.7	-536.8	698.3	92.2
402	318.9	845.2	-554.8	637.6	82.5
403	316.3	836.5	-577.7	604.9	80.9
404	313.6	829.5	-600.7	572.1	86.2
405	310.7	844.4	-640.0	550.8	92.2
406	308.1	821.4	-646.6	506.6	89.2
407	305.3	800.2	-653.1	462.3	89.2
408	303.6	787.5	-656.2	435.2	90.1
409	300.9	782.2	-671.2	401.7	87.7
410	297.9	786.1	-694.1	368.9	97.4
411	293.7	795.6	-728.5	319.8	84.6
412	290.9	804.4	-751.5	287.0	86.5
413	288.6	807.7	-765.4	257.9	86.2
414	286 4	799.9	-767.3	226.1	85.5
415	283.7	815.8	-792.4	193.6	84.6
416 C	282.5	826.9	-807.2	179.6	86.5
417	278.7	848.1	-838.3	128.1	87.1
418	278.1	919.6	-910.4	129.8	87.9
419	273.4	869.3	-867.8	51.1	83.7
420	270.1	900.5	-900.5	0.9	84.0
421	268.1	925.7	-925.2	-30.8	86.5
422	266.7	955.8	-954.3	-54.4	85.8
501	307.6	961.2	-761.3	586.9	80.1
502	301.7	961.8	-818.6	504.9	70.9
503	295.8	972.8	-875.9	423.0	73.9

(Continued)

Table 18. TRACER GAS SAMPLING NETWORK (Continued)

Sampler ID	θ (deg)	R (m)	X (m)	Y (m)	Z (m)
504	290.2	993.2	-932.2	342.8	67.6
505	284.7	1024.0	-990.7	259.2	72.4
506	279.7	- 1062.1	1046.9	178.9	71.5
601	307.4	1061.1	-843.2	644.2	76.1
602	300.3	1062.8	-918.1	535.5	73.4
603	296.6	1069.3	-955.9	479.2	74.9
604	289.9	1096.2	-1031.0	372.4	71.8
605	286.2	1098.8	-1055.1	306.7	76.4
606	281.9	1155.1	-1130.4	237.4	65.7
701 C	282.5	826.9	-807.2	179.6	96.2
702 B	289.1	533.1	-503.7	174.6	34.0
703 B	289.1	533.1	-503.7	174.6	48.9
71X T1	297.3	565.3	-502.4	259.1	29.2
72X T2	281.4	589.5	-577.8	116.6	29.2
73X T3	291.7	678.4	-630.2	250.9	55.4
74X T4	301.9	748.8	-635.9	395.4	79.4
75X T5	280.9	788.5	-774.0	150.2	78.8
809 C1	290.0	572.6	-537.9	196.2	30.4
810 C2	293.1	762.2	-701.2	298.7	79.4

All angles (0), ranges (R), and coordinates (X,Y), are centered at base of tower A.
Datum : Z = 0 = 1600 m MSL
B = Tower B
C = Tower C
C1 = Collocated (109, 809)
C2 = Collocated (310, 810)
T1, T2, T3, T4 = 10-minute samplers

4.3 TRACER ANALYSIS SYSTEM

A box with 12 compartments was assigned to each sampler for identification and transportation of the bags to HBR and then back to Farmington for analysis. The Tedlar bags were analyzed for SF6 and CF3BR (Freon) by electron-capture gas chromatographs (GC). The GC systems are automated adaptions of the 1972 Lovelock prototype. A functional diagram of the analysis procedure is shown in Figure 8. The sample bag was checked in and assigned to a GC for analysis, a calibrated volume of air from the sample was injected into the GC, the output of the electron-capture detector (ECD) was analyzed by an electronic integrator to yield areas proportional to the concentration of the two tracers, and these areas were translated to concentrations by efficiency curves determined from calibrations performed with "known standard" mixtures of the two tracers. Calibration concentrations were corrected for pressure and temperature in the GCs.

4.3.1 Analytical Procedures

The analytical procedures were in large part automated. The configurations of the principal components of the data acquisition system is shown in Figure 9. The voltage outputs of the GCs' electronic capture detector were recorded on strip charts, where their characteristics could be examined to ensure that the GCs were functioning properly, and the inputs to the Spectra Physics SP4000 Integrator, which calculated the peak areas from the voltage trace, were reliable. This microcomputerized integrator supported all four GCs at Farmington. It communicated peak areas, date and time of analysis, and internal constants involved in integration to a Perkin-Elmer minicomputer (P/E 7/16), which calculated the tracer concentrations (ppt) from the output of the SP4000. The peak areas, date and time of analysis, and concentrations were then stored in disk files, which were used for follow-up analyses and for development of archive tapes. These files were reconciled with the sample check-in files to determine that all samples analyzed corresponded to those checked in. A summary printout after each GC analysis run provided visual assurance of matching of the data with the sample ID.

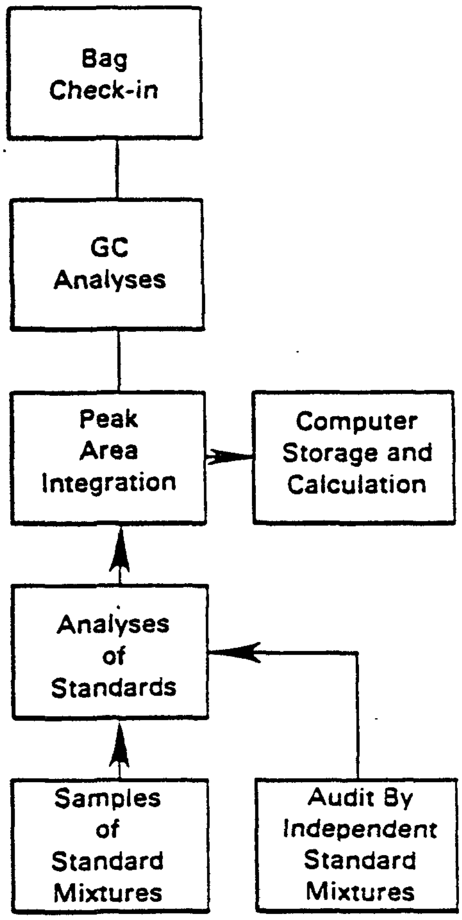


Figure 8. Tracer gas analysis procedure
(From Lavery et al., 1983)

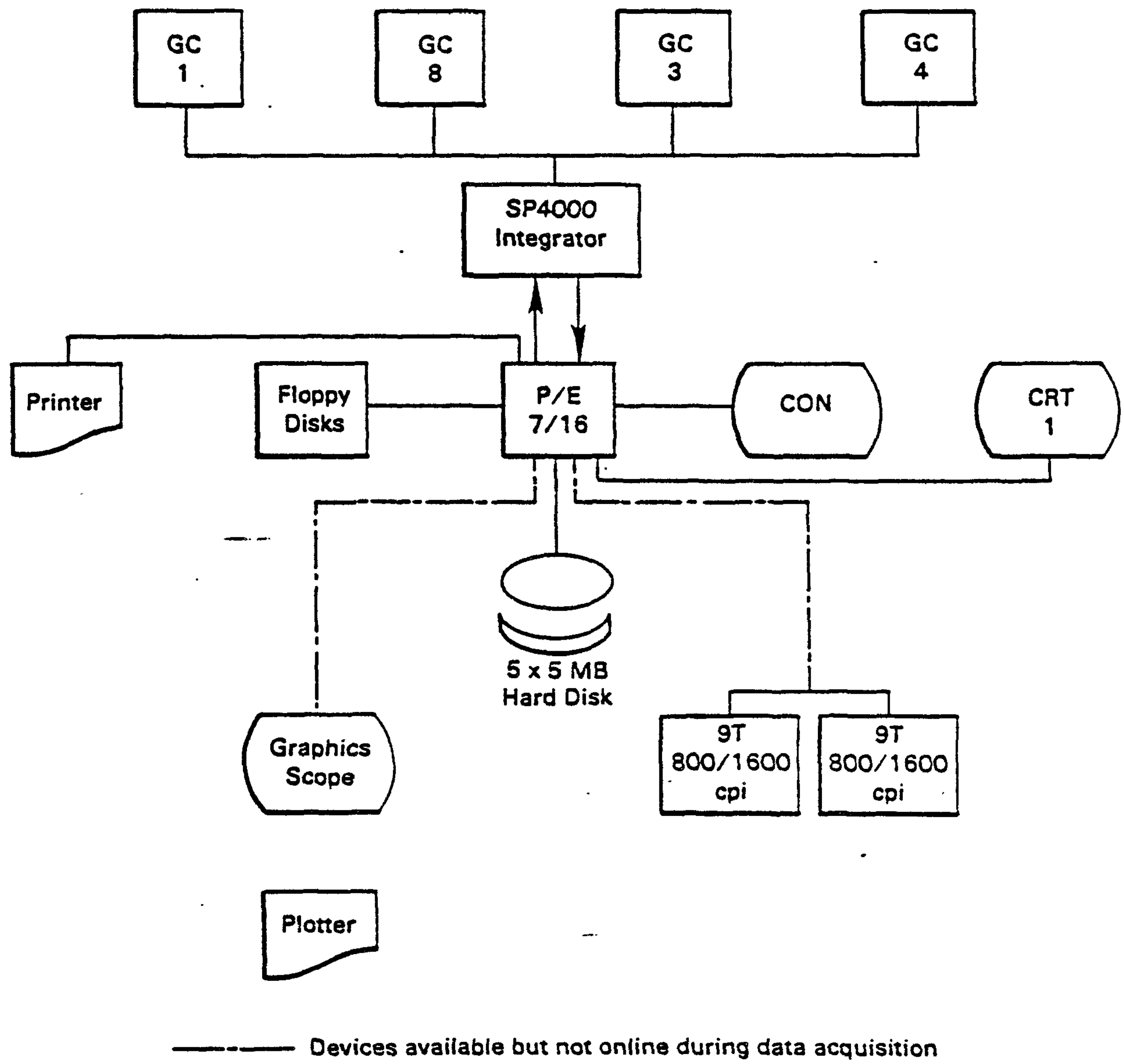


Figure 9. Tracer gas data acquisition system
(From Lavery et al., 1983)

Although the laboratory in Farmington had eight GC systems available, only four GCs were used in the analysis of SHIS #2 tracer samples.

A decision was made a the beginning of SHIS #2 to present tracer concentration data not only as Chi (ppt) as was done in SHIS #1, CCB, but also as normalized values, Chi/Q, nanoseconds/meter3, (ns/m3). The concentrations detected by the GCs were divided by emission rate of tracer released during the hour of sampling. The emission rate Q(g/sec) is an average mass release rate from the time at which the release valve was opened to the time at which it was closed. In some cases, this period was less than 1 hour, but in most cases it was several hours. The start and stop times for the release are referenced to the beginning and end times of each experiment hour.

4.4 TRACER GAS DATA TAPE FILES

Data are stored at the National Computer Center, Environmental Research Center, Research Triangle Park, North Carolina Carolina on Sperry UNIVAC 1100/83 systems magnetic tape, nine track, odd parity, ASCII-quarter word mode, density 6250 BPI, tape number 004972. Record length is 132 character, and the block size is 1320 words, or 40 records per block.

UNIVAC users may assign the tape, @ASG,T HBR,U9S//////Q,004972. Upon request, copies can be furnished and translated into fromats acceptable to any computer using nine-track tape drives.

4.4.1 Tape File Index

There are 22 data tape files, one for each experiment for each tracer, numbered 375 to 396 following the hourly meteorological data records on tape number 004972. The first 11 files, 375 to 385, contain SF6 concentrations, and the next 11, 386 to 396, contain data for CF3Br (Freon 13B1). Table 19 shows how tape files are related to experiments.

TABLE 19. TRACER GAS CONCENTRATION DATA
TAPE FILE NUMBERS

Experiment No.	SF_6	CF_3BR
4	375	386
5	376	387
6	377	388
7	378	389
8	379	390
9	380	391
10	381	392
11	382	393
12	383	394
14	384	395
15	385	396

4.4.2 Tape File Records

The first five records of each file contain alphabetic ASCII characters of identification information and column headings for the data fields in the records that follow. The first five records are FORTRAN formatted (132A1). Column headings are coded in the last two header records.

All data records following the first five alphabetic header records have data fields arranged as indicated in Table 20.

TABLE 20. TRACER DATA RECORDS FORMAT

Position	Contents	FORTRAN Format	Heading
1	blank	1X	blank
2 to 4	Sampler ID	I3	ID
5 to 9	Bag #	I5	Bag #
10	blank	1X	blank
11 to 14	Tracer ID	A4	Gas (SF6,13B1)
15 to 20	blank	6X	blank
21 to 27	Tracer conc.	F7.0	Chi/Q (ns/m3)
28 to 40	Label	11A1	'sampler ran'
41 to 42	Hour start	I2	HR (00 to 23)
43 to 44	Minute start	I2	MN (00 to 50)
45 to 48	Label	A4	' to '
49 to 50	Hour end	I2	HR (00 to 23)
51 to 52	Minute end	I2	MN (00 to 50)
53 to 56	Label	A4	' on '
57 to 58	Day	I2	Day of month
59 to 67	Month	9A1	DATE (Oct 1982)
68 to 79	Sampler type	12A1	SMP/TYPE 'HR SAMP' 'TOWR SAMP' '10 MIN SAMP'
80 to 81	blank	2x	blank
82 to 88	Tracer conc.	F7.0	CHI (ppt)
89 to 93	Emission rate	F5.2	Q(gm/sec)

Table 21 is a printout of the first block, 40 records, of block number 375. It illustrates how the alphabetic header records identify columns of the data fields that follow. Data records are listed in chronological order starting with the first hour of the experiment.

TABLE 21. TRACER GAS NORMALIZED CONCENTRATION DATA SAMPLE PRINTOUT

SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
SF6 AND CF3BR TRACER GAS FILES
DATE: 10/11/82 - EXP #4

SMP ID	BAG #	GAS	CHI/Q NS/M3		HRMN		HRMN		DATE	SMP TYPE	CHI PPT	Q GM/SEC
3	3	SF6	33.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
4	3	SF6	27.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	3.	0.77
5	3	SF6	23.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	3.	0.77
101	3	SF6	25.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	3.	0.77
102	3	SF6	31.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
103	3	SF6	35.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
104	3	SF6	55.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	6.	0.77
105	3	SF6	48.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	6.	0.77
106	3	SF6	32.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
107	3	SF6	44.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
108	3	SF6	23.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	3.	0.77
109	3	SF6	24.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	3.	0.77
110	3	SF6	42.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
111	3	SF6	38.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
112	3	SF6	41.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
113	3	SF6	41.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
114	3	SF6	44.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
115	3	SF6	51.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	6.	0.77
116	3	SF6	33.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
118	3	SF6	8.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	1.	0.77
201	3	SF6	35.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
202	3	SF6	44.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
208	3	SF6	59.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	7.	0.77
209	3	SF6	63.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	7.	0.77
211	3	SF6	36.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
212	3	SF6	9.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	1.	0.77
213	3	SF6	35.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
214	3	SF6	30.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	4.	0.77
215	3	SF6	68.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	8.	0.77
216	3	SF6	40.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77
218	3	SF6	13.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	2.	0.77
219	3	SF6	20.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	2.	0.77
220	3	SF6	23.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	3.	0.77
301	3	SF6	20.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	2.	0.77
303	3	SF6	46.	SAMPLER RAN	100	TO	200	ON	11 OCT 1982	HR SAMP	5.	0.77

SECTION 5

OPTICAL CROSSWIND ANEMOMETER DATA

5.1 OPTICAL ANEMOMETER NETWORK

An optical crosswind anemometer measures the path averaged crosswind speed of the component of flow in the horizontal plane and perpendicular to the path over a line-of-sight between a transmitter and receiver. This method avoids the problems of local obstructions and of low-speed nonlinearities to which conventional anemometers are subject. At HBR, heights of the paths were generally between 0.5 and 5 m; the ends of the paths were about 1 m or less above the surface. This anemometer operated around the clock with occasional servicing.

Three optical anemometers were used in SHIS #2. Figure 7 shows the alignment of all three paths on HBR. The first transmitter-receiver set was aligned parallel to the ridge in the targeted area and slightly upwind of the base of the ridge (path A). The second set was installed along the crest of HBR (path B), and a third set was placed on the lee (west) slope of HBR. The lengths of paths vary between 300 and 600 m. Data are recorded as 10-minute averages of wind speed component (m/s) at right angle, crosswind, to the alignment (path) of the transmitter-receiver set.

5.2 OPTICAL ANEMOMETER DATA TAPE FILES

Data are stored at the National Computer Center, Environmental Research Center, Research Triangle Park, North Carolina on Sperry UNIVAC 1100/83 systems magnetic tape, nine track, odd parity, ASCII-quarter word mode, density 6250 BPI, tape number 004972. Record length is 132 characters, and the block size is 1320 words, or 40 records per block.

5.2.1 Tape File Index

There are 3 data tape files, one for each optical anemometer path (A,B,C), numbered 397,398 and 399 following the tracer gas concentration on tape number 004972. Table 22 shows how tape files are related to the data.

TABLE 22. OPTICAL ANEMOMETER TAPE FILE NUMBERS

File Number	Contents
397	Path A (East base of HBR), 10 Oct 82 to 29 Oct 82, all experiments, 10-minute averages, m/s.
398	Path B (Ridge crest), 11 Oct 82 to 29 Oct 82, all experiments, 10-minute averages, m/s.
399	Path C (West of HBR), 13 Oct 82 to 29 Oct 82, all experiments, 10-minute averages, m/s.

5.2.2 Tape File Records

The first seven records of each day's hourly record of 10-minute average crosswind data have alphabetic ASCII characters of identification and column headings for the data fields in the records that follow for that day. There is one record for each hour of data with 6 field of 10-minute averages.

All data records following the seven header records for each day have data fields arranged as indicated in Table 23.

TABLE 23. OPTICAL ANEMOMETER DATA FORMAT

Position	Contents	FORTRAN Format	Heading
1 to 3	Hour (MDT)	I3	Hour (MDT)
4 to 8	blank	5X	blank
9 to 15	Crosswind, m/s	F7.2	10-minute averages
16 to 17	blank	2X	blank
18 to 24	Crosswind, m/s	F7.2	10-minute averages
25 to 26	blank	2X	blank
27 to 33	Crosswind, m/s	F7.2	10-minute averages
34 to 35	blank	2X	blank
36 to 42	Crosswind, m/s	F7.2	10-minute averages
43 to 44	blank	2X	blank
45 to 51	Crosswind, m/s	F7.2	10-minute averages
52 to 53	blank	2X	blank
54 to 60	Crosswind, m/s	F7.2	10-minute averages

Table 24 is a printout of a sample of the first day's record of data showing the header records and data records from file number 397.

TABLE 24. OPTICAL CROSSWIND ANEMOMETER DATA SAMPLE PRINTOUT

DATE: 10 OCT 82
SMALL HILL IMPACT STUDY #2, NEW MEXICO HOGBACK
OPTICAL CROSSPATH WINDS, POSITIVE FOR UPSLOPE COMPONENT

PATH: A (EAST BASE OF RIDGE)

HOUR (MDT)	10-MINUTE AVERAGES, M/S					
0	-1.97	-2.00	-2.00	-1.92	-1.94	-1.81
1	-1.62	-1.47	-1.96	-1.14	-0.23	-0.31
2	-0.34	-0.21	-0.19	-0.21	-0.11	-0.15
3	-0.08	-0.17	-0.22	-0.23	-0.26	-0.23
4	-0.15	-0.24	-0.23	-0.25	-0.21	-0.18
5	99.00	99.00	99.00	99.00	99.00	99.00
6	99.00	99.00	99.00	99.00	99.00	99.00
7	99.00	99.00	99.00	99.00	99.00	99.00
8	99.00	99.00	99.00	99.00	0.09	0.04
9	0.35	0.23	0.18	0.18	0.16	0.14
10	0.23	0.40	0.37	0.25	0.57	0.69
11	0.57	0.22	0.73	0.79	0.73	0.55
12	0.35	0.33	0.24	-0.01	0.02	0.26
13	-0.01	0.04	0.18	0.24	0.53	0.58
14	0.19	0.56	0.11	0.20	0.16	0.61
15	0.48	0.35	0.13	0.75	0.53	0.65
16	0.51	0.24	0.30	0.02	0.49	0.37
17	0.21	-0.01	-0.01	-0.04	-0.02	0.01
18	-0.03	-0.22	-0.15	-0.12	0.06	-0.02
19	0.05	0.06	-0.05	-0.06	-0.06	-0.13
20	-0.14	-0.18	-0.18	-0.19	-0.30	-0.32
21	-0.33	-0.57	-0.56	-0.55	-0.50	-0.21
22	-0.23	-0.72	-0.76	-0.83	-0.72	-0.67
23	-0.98	-1.83	-1.34	-1.19	-1.37	-1.74

DATE: 11 OCT 82
SMALL HILL IMPACT STUDY #2, NEW MEXICO HOGBACK
OPTICAL CROSSPATH WINDS, POSITIVE FOR UPSLOPE COMPONENT

PATH: A (EAST BASE OF RIDGE)

HOUR (MDT)	10-MINUTE AVERAGES, M/S					
0	-1.36	-1.07	-1.29	-1.01	-0.15	-0.22

SECTION 6

TETHERSONDE DATA

6.1 TETHERSONDE NETWORK

Two tethersonde instruments were operated to measure temperature, horizontal wind speed and direction, pressure and humidity. One tethersonde was operated by WPL to obtain vertical profiles from the ground up to about 300 m in the area east of HBR. A second sonde was operated by ATDD next to the source of SF6 tracer gas release, either the crane of the 150-m tower, so as to record temperature, wind speed and direction at the height and concurrently with the tracer release.

The WPL sonde was operated near Tower B at the base of HBR until October 15, then was moved east to near the doppler sounder location through the end of SHIS #2. The mode of operation for this tethersonde was to run vertical profiles from the surface up to about 300-m altitude. When the sonde was flown from the first location near the base of HBR, the balloon was often blown past the crest of the ridge when its altitude was only 300 m or less above the ground. The profiles were therefore not generally vertical but slanted towards the region of tighter streamline compression over the ridge. The difference in speed between the ascent and descent modes, however, may be as much as 0.5 m/s since WPL let out or hauled in the tether typically at about 0.5 m/s.

A scan was taken from the sondes approximately every 13 seconds, so that effective vertical resolution of WPL profiles was about 4 to 7 m. An ascent and descent were made once per hour during experimental periods. The accuracy of the reported heights, calculated from pressure and temperature measurements by the hypsometric equation, is probably about 5 m because of response time of the temperature probe and changes in ambient pressure during the course of the flight.

Since the ATDD sonde was held at the altitude of the tracer release and did not operate in an ascent-descent mode, wind speed errors would not appear due to tether hauling. Only temperature, wind speed and direction were recorded by the ATDD sonde.

The tethersondes used at SHIS #2 by WPL and ATDD were manufactured by A.I.R., Inc. The characteristics of the probes listed in Table 25, are those supplied by the manufacturer.

TABLE 25. CHARACTERISTICS OF A.I.R. TETHERSONDES

Sensor	Range	Precision	Resolution	Response	Description
Temp.	-70 to 50C	0.5 C	0.1 C	3 - 5 sec	2mm epoxy-coated bead thermistor
Wet	-70 to 50 C	0.5 C	0.1 C	12 sec	As Temp, wetted bulb by wick
Press	0 - 100 mb	1 mb	0.1 mb	1 - 2 sec	Aneriod capsules w/moving dia-phram capacitor
Wind speed	0 - 20 m/s	0.25 m/s	0.1 m/s	2.4 m	3-cup anemometer light chopper
Wind direction	2 - 358 deg	5 deg	1 deg	15 m	Balloon as vane; senses with mag-netic compass

6.2 TETHERSONDE DATA TAPE FILES

Data are stored at the National Computer Center, Environmental Research Center, Research Triangle Park, North Carolina on Sperry UNIVAC 1100/83 systems magnetic tape, nine track, odd parity, ASCII-quarter word mode, density 6250 BPI, tape number 004972. Records length is 132 characters, and the block size is 1320 word or 40 records per block.

6.2.1 Tape File Index

There are 28 data tape files, 13 for WPL sonde data, numbers 400 to 412, and 15 files of ATDD data, number 413 to 427. These files follow the optical anemometer data files on tape number 004972. Table 26 indicates the periods of operation.

TABLE 26. TETHERSONDE TAPE FILE NUMBERS

File No.	Experiment No.	Date
	WPL - Tethersonde	
400	2	10/5-6/82
401	3	10/7-8/82
402	4	10/11/82
403	5	10/12/82
404	6	10/12-13/82
405	7	10/14/82
406	8	10/14-15/82
407	9	10/20/82
408	10	10/22/82
409	11	10/22-23/82
410	12	10/24/82
411	13	10/25/82
412	14	10/25-26/82
	ATDD - Tethersonde	
413	4	10/11/82
414	5	10/12/82
415	6	10/12-13/82
416	7	10/14/82
417	8	10/14-15/82
418	9	10/20/82
419	10	10/22/82
420	11	10/22-23/82
421	12	10/24/82
422	13	10/25/82
423	14	10/25-26/82
424	15	10/29/82

TABLE 27. TETHERSONDE DATA FORMAT

Position	Contents	WPL-Tethersonde FORTRAN Format	Heading
1 to 2	Month	I2	MO
3 to 4	Day	I2	DY
5 to 6	Year	I2	YR
7 to 8	blank	2X	blank
9 to 10	Hour	I2	HR
11 to 12	Minute	I2	MN
13 to 14	Second	I2	SC
15	blank	1X	blank
16 to 22	Pressure, mbs	F7.2	Pres.
23 to 29	Height, m	F7.1	Ht.
30	blank	1X	blank
31 to 37	Temperature, C	F7.1	Temp.
38 to 43	Rel Hum, %	F6.1	RH.
44 to 50	Mixing Ratio	F7.1	M.R.
51	blank	1X	blank
52 to 58	Wind Dir, deg	F7.1	Dirn.
59 to 64	Wind Spd, m/s	F6.1	Spd.
65 to 71	Potential Temp, K	F7.1	P.T.
		ATDD Tethersonde	
1 to 2	Hour	I2	HR
3	:	A1	:
4 to 5	Minute	I2	MN
6	:	A1	:
7 to 8	Second	I2	SC
9	blank	1X	blank
10 to 16	Temp, C	F8.1	Temp
17	Data Quality Flag	A1	blank = good B = bad
18 to 25	Wind Speed, m/s	F8.1	WS
26	Data Quality Flag	A1	blank = good B = bad
28 to 34	Wind Dir, Deg	F8.1	WD
35	Data Quality Flag	A1	blank = good B = bad

6.2.2 Tape File Records

For the WPL sonde data, the first six records of each ascent-descent sounding are header records and have ASCII alphabetic characters of identification and column headings for the data records that follow. Since there was one sounding per hour for each experiment, there were about eight soundings recorded in the tape files, separated by six header records. There is one data record for every 13 seconds of sounding.

For ATDD tethersonde, since the observations were held to the point of the SF6 tracer release, there was no ascent-descent profile. Data consisted only of temperature, wind speed and wind direction every 13 seconds near the location and height of tracer release. There are twelve alphabetic header records preceeding each group of 1-hour observations.

All data records following the six header records for every sounding have data fields arranged as indicated in Table 27.

Table 28 is a printout of the first block, 40 records, from tape file number 400, the first file of WPL tethersonde data. It illustrates how the data are presented with the heading records and the first data records at the beginning of a tethersonde ascent. Table 29 is a printout of the first block, 40 records, from tape number 414, the second file of ATDD tethersonde data. The first file, 413, was not representative of the remaining tape files. It shows the arrangement of header records and the data files prepresenting temperature and wind conditions at the point of tracer release.

TABLE 28. NOAA/WPL TETHERSONDE DATA SAMPLE PRINTOUT

SMALL HILL INPACT STUDY #2 - HOGBACK RIDGE, NEW MEXICO
TETHERSONDE DATA - NOAA WPL
LOCATION: BASE OF RIDGE, WEST OF 150M TOWER
DATE: 10/05-06/82; EXP #2

DATE MODYYR	TIME HRMMSC	PRES. (MBS)	HT. (M)	TEMP. (C)	RH. (%)	M.R.	DIRN. (DEG)	SPD. (MPS)	P.T. (K)
100582	231315	832.30	0.0	16.5	5.6	0.8	201.6	0.2	305.3
100582	231329	832.22	0.8	16.6	7.7	1.1	211.8	0.1	305.4
100582	231342	832.07	2.3	16.7	8.0	1.1	163.1	0.1	305.5
100582	231355	832.15	1.5	16.6	7.1	1.0	151.1	0.0	305.4
100582	2314 8	832.11	1.9	16.7	7.5	1.1	172.3	0.0	305.5
100582	231422	832.15	1.5	16.6	7.6	1.1	205.5	0.0	305.4
100582	231435	832.11	1.9	16.5	7.6	1.1	196.6	0.0	305.2
100582	231448	831.88	4.3	16.3	7.5	1.0	182.8	0.4	305.1
100582	2315 1	831.55	7.6	16.7	6.8	1.0	186.8	1.0	305.5
100582	231514	831.19	11.3	16.9	7.1	1.0	208.4	0.9	305.8
100582	231528	830.77	15.6	16.8	6.6	0.9	162.5	2.1	305.7
100582	231541	830.29	20.5	17.1	6.1	0.9	198.9	3.1	306.1
100582	231555	830.08	22.7	17.8	3.8	0.6	198.7	5.6	306.8
100582	2316 8	829.56	28.0	18.1	4.7	0.7	193.5	6.0	307.2
100582	231621	829.37	30.0	18.3	4.2	0.7	192.1	6.3	307.5
100582	231634	828.91	34.7	19.1	6.0	1.0	199.0	5.8	308.3
100582	231647	828.50	39.0	19.1	6.3	1.1	205.1	5.9	308.4
100582	2317 1	828.19	42.2	19.2	6.1	1.0	202.6	5.9	308.5
100582	231714	828.03	43.8	19.2	6.3	1.1	194.3	5.8	308.6
100582	231727	823.94	86.2	19.1	6.5	1.1	193.5	5.5	308.9
100582	231740	827.55	48.8	18.8	6.0	1.0	178.7	5.8	308.2
100582	231753	827.06	53.9	18.5	5.0	0.8	166.0	6.4	307.9
100582	2318 7	826.62	58.5	19.1	6.1	1.0	190.3	5.6	308.7
100582	231820	826.27	62.1	19.7	7.7	1.3	188.0	6.6	309.3
100582	231834	825.94	65.5	19.5	7.2	1.2	181.4	6.4	309.1
100582	231847	825.77	67.3	19.8	8.1	1.4	170.6	6.8	309.5
100582	2319 0	825.33	71.9	19.7	7.9	1.4	196.6	5.9	309.4
100582	231913	825.12	74.0	19.4	7.0	1.2	190.1	5.3	309.1
100582	231926	824.81	77.2	19.2	6.5	1.1	194.7	6.1	308.9
100582	231940	824.29	82.6	19.1	6.2	1.0	188.1	5.9	308.8
100582	231953	824.00	85.7	19.0	5.7	0.9	196.0	6.2	308.7
100582	2320 6	824.27	82.9	19.0	6.1	1.0	181.7	6.4	308.8
100582	232019	823.48	91.1	19.1	6.1	1.0	175.4	6.1	308.9
100582	232033	823.10	95.0	19.0	6.0	1.0	173.5	6.2	308.9

TABLE 29. NOAA/ATDD TETHERSONDE DATA SAMPLE PRINTOUT

PROFILE #13
SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
TETHERSONDE DATA - NOAA ATDL
SITE: RELEASE SITE - 40 M HT.
DATE: 10/10/82; EXPERIMENT #4

TIME	TEMP	WS	WD
HR:MN:SC	DEG C	M/S	DEG
23:31:51	10.1	3.8	285.3
23:32: 2	10.2	3.7	286.6
23:32:13	10.2	3.7	280.6
23:32:24	10.2	3.6	281.9
23:32:34	10.2	3.5	279.5
23:32:45	10.2	3.8	281.8
23:32:56	10.1	3.8	277.8
23:33: 7	10.1	4.0	280.9
23:33:18	10.0	4.1	282.3
23:33:28	9.9	4.0	284.6
23:33:39	10.0	4.1	285.6
23:33:54	10.0	4.0	282.9
23:34: 4	10.0	3.9	284.0
23:34:15	10.0	4.0	286.6
23:34:26	10.0	3.9	282.2
23:34:37	10.1	3.9	283.1
23:34:47	10.0	4.2	284.3
23:34:58	10.1	4.0	284.8
23:35: 9	10.1	3.9	284.2
23:35:20	10.2	3.8	286.5
23:35:31	10.2	4.1	282.5
23:35:41	10.2	3.8	289.6
23:35:52	10.3	3.8	286.8
23:36: 3	10.2	3.4	299.8
23:36:14	10.3	3.3	296.9
23:36:25	10.5	3.3	305.5
23:36:39	10.5	3.7	277.0
23:36:50	10.3	3.7	296.0

SECTION 7

PUBLIC SERVICE CONPANY OF NEW MEXICO METEOROLOGICAL DATA

7.1 ADDITIONAL METEOROLOGICAL DATA

Public Service Company of New Mexico (PNM) maintains a network of meteorological stations around HBR, Figure 10, and these data were made available by PNM for this data base as half-hour averages for the month of October 1982. Data were available from ten stations in the network. The most valuable of these stations would be numbers 103 and 105, both located on top of HBR. Station 103 is located about 5 km SW of the experiment area near the San Juan River, an 105 is just to the north of the experiment area. In addition, station 105 records temperature, solar radiation and net radiation, along with values of wind speed, direction and sigma-theta that all stations report.

7.2 PNM DATA TAPE FILES

Data are stored at the National Computer Center, Environmental Research Center, Research Triangle Park, North Carolina on Sperry UNIVAC 1100/83 systems magnetic tape, nine track, odd parity, ASCII-quarter word mode, density 6250 BPI, tape number 004972. Record length is 132 characters, and the block size is 1320 words or 40 records per block.

7.2.1 Tape File Index

There are 4 data tape files, number 428 to 431. These files follow the tethersonde data files on tape number 004972. Table 30 indicates how the data from the ten PNM stations are arranged within the files.

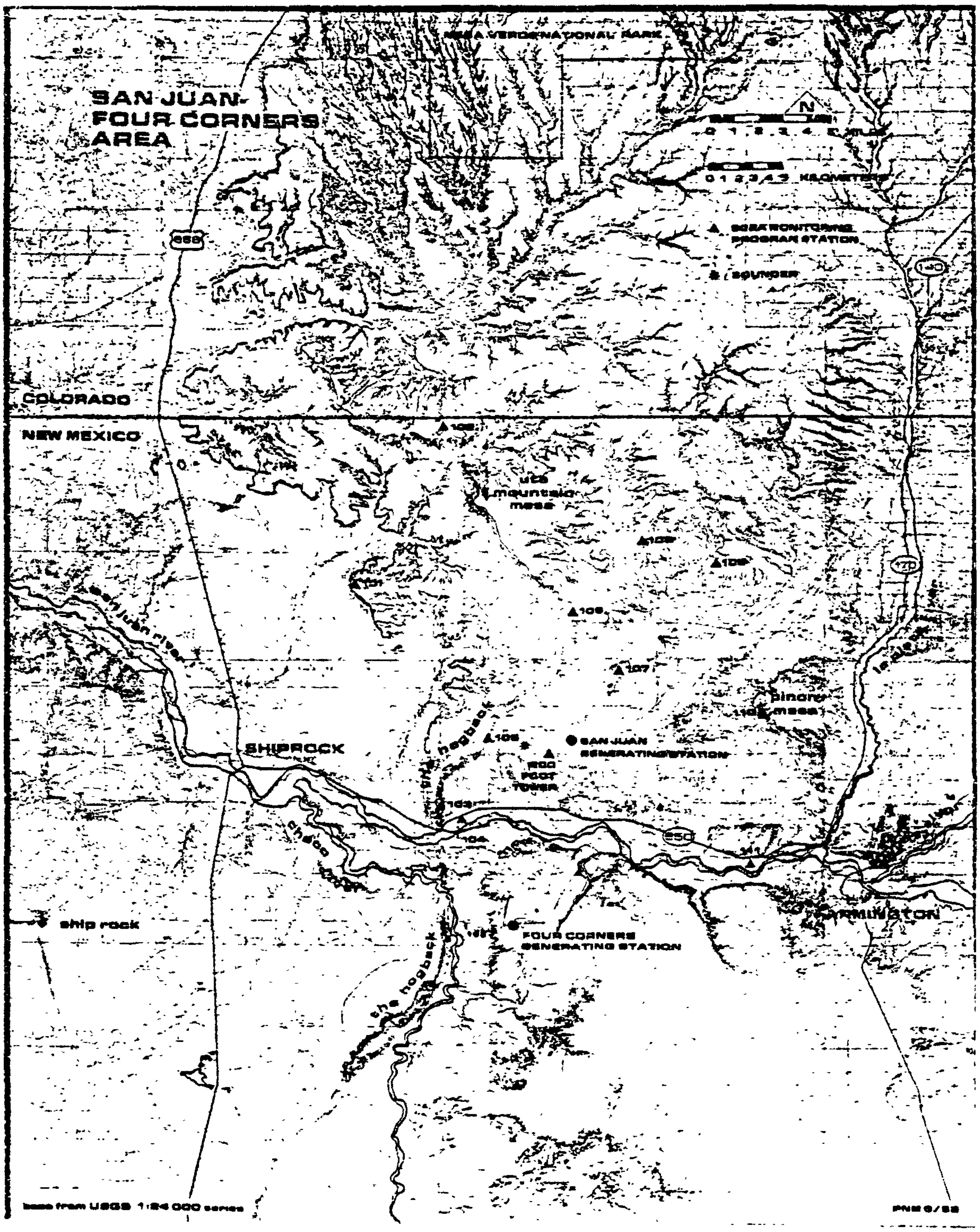


Figure 10. PNM air quality and meteorological monitoring sites
(From Lavery et al., 1983)

TABLE 30. PNM DATA TAPE FILE NUMBERS

File No.	Contents	Data
425	Stations: 102, 103, 104	Wind Speed & Direction, Sigma-Theta
426	Stations: 105, 106	Wind Speed & Direction, Sigma-Theta, Temperature Solar & Net Radiation
427	Stations: 107, 108, 109	Wind Speed & Direction, Sigma-Theta
428	Stations: 110, 112	Wind Speed & Direction, Sigma-Theta

Heights of instruments at the ten stations are:

Station	Instrument Level (m)
102	9.4
103	9.4
104	8.9
105	10.5
106	9.0
107	9.5
108	9.5
109	9.5
110	9.4
112	9.0

TABLE 31. PNM DATA FORMAT

Position	Contents	FORTRAN Format	Heading
	File 425		
1 to 2	Month	I2	MM
3 to 4	Day	I2	DD
5 to 6	Year	I2	YY
7 to 8	Hour	I2	HH
9 to 10	Minute	I2	MM (0,30)
11 to 18	Sta.102, Wind Dir	F8.3	WD (deg)
19	Flag	A1	blk=good, m=missing
20 to 27	Sta.102, Wind Spd	F8.3	WS (m/s)
28	Flag	A1	blk,m
29 to 36	STA.102, Sigma-T	F8.3	ST (deg)
37	Flag	A1	blk,m
38 to 45	Sta.103, Wind Dir	F8.3	WD (deg)
46	Flag	A1	blk,m
47 to 54	Sta.103, Wind Spd	F8.3	WS (m/s)
55	Flag	A1	blk,m
56 to 63	Sta.103, Sigma-T	F8.3	ST (deg)
64	Flag	A1	blk,m
65 to 72	Sta.104, Wind Dir	F8.3	WD (deg)
73	Flag	A1	blk,m
74 to 81	Sta.104, Wind Spd	F8.3	WS (m/s)
82	Flag	A1	blk,m
83 to 90	Sta.104, Sigma-T	F8.3	ST (deg)
91	Flag	A1	blk,m
	File 426		
1 to 2	Month	I2	MM
3 to 4	Day	I2	DD
5 to 6	Year	I2	YY
7 to 8	Hour	I2	HH
9 to 10	Minute	I2	MM (00,30)
11 to 18	Sta.105 Wind Dir	F8.3	WD (deg)
19	Flag	A1	blk,m
20 to 27	Sta.105 Wind Spd	F8.3	WS (m/s)
28	Flag	A1	blk,m
29 to 36	Sta.105 Sigma-T	F8.3	ST (deg)
37	Flag	A1	blk,m
38 to 45	Sta.105 Temp	F8.3	T (C)
46	Flag	A1	blk,m
47 to 54	Sta.105 Net Rad	F8.3	NR (ly/min)
55	Flag	A1	blk,m
56 to 63	Sta.105 Sol Rad	F8.3	IN (ly/min)
64	Flag	A1	blk,m
65 to 72	Sta.106 Wind Dir	F8.3	WD (deg)
73	Flag	A1	blk,m
74 to 81	Sta.106 Wind Spd	F8.3	WS (m/s)
82	Flag	A1	blk,m
83 to 90	Sta.106 Sigma-T	F8.3	ST (deg)
91	Flag	A1	blk,m

TABLE 31. PNM DATA FORMAT (Continued)

Position	Contents	FORTRAN Format	Heading
	File 427		
1 to 2	Month	I2	MM
3 to 4	Day	I2	DD
5 to 6	Year	I2	YY
7 to 8	Hour	I2	HH
9 to 10	Minute	I2	MM (00,30)
11 to 18	Sta.107 Wind Dir	F8.3	WD (deg)
19	Flag	A1	blk,m
20 to 27	Sta.107 Wind Spd	F8.3	WS (m/s)
28	Flag	A1	blk,m
29 to 36	Sta.107 Sigma-T	F8.3	ST (deg)
37	Flag	A1	blk,m
38 to 45	Sta.108 Wind Dir	F8.3	WD (deg)
46	Flag	A1	blk,m
47 to 54	Sta.108 Wind Spd	F8.3	WS (m/s)
55	Flag	A1	blk,m
56 to 63	Sta.108 Sigma-T	F8.3	ST (deg)
64	Flag	A1	blk,m
65 to 72	Sta.109 Wind Dir	F8.3	WD (deg)
73	Flag	A1	blk,m
74 to 81	Sta.109 Wind Spd	F8.3	WS (m/s)
82	Flag	A1	blk,m
83 to 90	Sta.109 Sigma-T	F8.3	ST (deg)
91	Flag	A1	blk,m
	File 428		
1 to 2	Month	I2	MM
3 to 4	Day	I2	DD
5 to 6	Year	I2	YY
7 to 8	Hour	I2	HH
9 to 10	Minute	I2	MM (00,30)
11 to 18	Sta.110 Wind Dir	F8.3	WD (deg)
19	Flag	A1	blk,m
20 to 27	Sta.110 Wind Spd	F8.3	WS (m/s)
28	Flag	A1	blk,m
29 to 36	Sta.110 Sigma-T	F8.3	ST (deg)
37	Flag	A1	blk,m
38 to 45	Sta.112 Wind Dir	F8.3	WD (deg)
46	Flag	A1	blk,m
47 to 54	Sta.112 Wind Spd	F8.3	WS (m/s)
55	Flag	A1	blk,m
56 to 63	Sta.112 Sigma-T	F8.3	ST (deg)
64	Flag	A1	blk,m

TABLE 32. PNM NETWORK DATA SAMPLE PRINTOUT

SMALL HILL IMPACTION STUDY #2 - HOGBACK RIDGE, NEW MEXICO
PUBLIC SERVICE COMPANY OF NEW MEXICO - 30 MINUTE METEOROLOGICAL DATA

MMDDYYHHMM	WD (DEG) 102	WS (M/S) 102	ST (DEG) 102	WD (DEG) 103	WS (M/S) 103	ST (DEG) 103	WD (DEG) 104	WS (M/S) 104	ST (DEG) 104
10 182 0 0	160.000	2.800	10.000	244.000	9.500	9.000	236.000	1.800	23.000
10 182 030	168.000	2.700	16.000	245.000	10.400	8.000	239.000	1.900	19.000
10 182 1 0	194.000	4.300	13.000	250.000	8.700	11.000	207.000	1.000	28.000
10 182 130	202.000	5.200	9.000	230.000	6.300	20.000	128.000	1.100	39.000
10 182 2 0	212.000	3.100	16.000	180.000	3.400	20.000	331.000	.800	45.000
10 182 230	70.000	1.000	49.000	229.000	4.100	12.000	262.000	1.200	23.000
10 182 3 0	130.000	1.000	39.000	228.000	5.100	11.000	240.000	1.200	67.000
10 182 330	186.000	2.300	21.000	115.000	1.500	64.000	1.000	.600	64.000
10 182 4 0	162.000	1.300	33.000	165.000	1.100	75.000	358.000	.500	81.000
10 182 430	161.000	2.200	27.000	134.000	3.800	16.000	74.000	.700	66.000
10 182 5 0	182.000	3.000	9.000	82.000	5.300	6.000	23.000	1.000	41.000
10 182 530	187.000	2.300	13.000	104.000	4.100	13.000	18.000	1.000	31.000
10 182 6 0	195.000	1.500	26.000	93.000	3.700	9.000	32.000	1.200	23.000
10 182 630	184.000	.700	54.000	83.000	2.900	16.000	48.000	1.300	25.000
10 182 7 0	33.000	1.100	15.000	75.000	3.900	6.000	72.000	1.300	31.000
10 182 730	128.000	.800	28.000	90.000	4.700	5.000	67.000	1.400	25.000
10 182 8 0	170.000	1.600	12.000	89.000	5.200	7.000	35.000	1.600	17.000
10 182 830	172.000	2.900	12.000	90.000	4.400	7.000	38.000	1.500	19.000
10 182 9 0	167.000	2.900	17.000	50.000	2.700	48.000	61.000	1.200	30.000
10 182 930	179.000	3.700	16.000	90.000	2.200	35.000	49.000	1.000	34.000
10 18210 0	178.000	3.800	20.000	266.000	1.200	34.000	212.000	.600	63.000
10 1821030	183.000	3.400	24.000	324.000	1.600	35.000	227.000	.700	59.000
10 18211 0	196.000	3.400	23.000	292.000	2.200	36.000	254.000	1.200	41.000
10 1821130	187.000	2.900	25.000	232.000	1.900	34.000	281.000	.900	52.000
10 18212 0	191.000	4.000	22.000	301.000	2.800	38.000	292.000	.500	70.000
10 1821230	199.000	4.200	19.000	272.000	3.800	29.000	337.000	1.500	39.000
10 18213 0	192.000	4.500	22.000	272.000	3.500	29.000	298.000	.900	51.000
10 1821330	202.000	4.600	22.000	268.000	4.900	19.000	303.000	.800	63.000
10 18214 0	194.000	4.500	18.000	259.000	3.800	30.000	318.000	1.500	39.000
10 1821430	227.000	2.800	37.000	259.000	2.200	53.000	298.000	.500	75.000
10 18215 0	279.000	2.400	29.000	260.000	3.500	27.000	271.000	.700	70.000
10 1821530	261.000	2.500	36.000	308.000	3.900	29.000	324.000	1.500	54.000
10 18216 0	287.000	2.200	36.000	299.000	3.200	33.000	347.000	2.100	37.000
10 1821630	298.000	2.500	29.000	310.000	3.700	19.000	360.000	.800	61.000
10 18217 0	284.000	3.200	23.000	311.000	3.800	17.000	346.000	1.800	22.000

SECTION 8

SUMMARY

8.1 Principal Accomplishments

The Hogback Ridge field study achieved its objective of extending the modeling data base to include a detailed set of meteorological tower data, tracer concentration, tethersonde and optical anemometer data from a two-dimensional ridge site. The field program has produced a set of about 179 tracer-hours for model testing, evaluation, and refinement.

Like SHIS #1, SHIS #2 has verified the basic concepts of experimental design. The release of gaseous and visible tracers from a mobile crane or fixed tower, using real-time meteorological data to guide the selection of release locations and heights, has resulted in a data base that covers a wide variety of dispersion conditions and concentration patterns. The meteorological data from four towers were archived in real-time via an onsite system of minicomputers that unfortunately introduced some noise into the archived data during the first few experiments. Subsequent onsite modifications to the data system were successful in reducing this noise, and later ARLFRD and ERT scientists developed procedures to eliminate the noise from all of the archived meteorological data.

The entire data base from SHIS #2 reside on one reel of 9-track computer tape, and it is available to the scientific community either as a direct copy of the tape or by interactive computer access with the UNIVAC computer at NCC at Research Triangle Park.

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