ORLANDO UTILITIES COMMISSION

STANTON ENERGY CENTER
UNIT 1

QUALITY ASSURANCE PLAN FOR AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING PROGRAM

BLACK & VEATCH/consulting engineers

DOCUMENT CONTROL

Quality Assurance Plan For Ambient Air Quality and Meteorological Monitoring Program

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QUALITY ASSURANCE PLAN FOR AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING PROGRAM FOR ORLANDO UTILITIES COMMISSION STANTON ENERGY CENTER, UNIT 1

1.0 INTRODUCTION

Prevention of Significant Deterioration (PSD) regulatory requirements (40 CFR § 52.21) require 1 year of monitoring ambient air quality and meteorology in support of an application for a permit to construct and operate the proposed Stanton Energy Center, Unit No. 1. The center will have an ultimate capacity of at least 1,200 MW; the first unit will be a 400 MW coal-fired steam-electric generating unit which will be located approximately 10 miles east of Orlando, Florida. A description of the general site location, proximity to other major sources, and locations of existing air monitoring stations have been previously included in the Proposed Environmental Monitoring Plan dated January 8, 1980. A brief discussion of the siting rationale is included in Section 2.1, Site Selection. Due to the remote nature of the area of the proposed plant site, one monitoring station in the immediate vicinity of the proposed site will be utilized to collect baseline data on SO_2, NO and NO_2, CO, TSP, and inhalable/respirable fraction of particulate. Supportive meteorological data, such as wind, temperature, dew point all at 10 metres, and precipitation, will also be collected. It is anticipated that the proximity (10 miles in flat terrain) of the Orlando/McCoy Airport will justify the use of historical meteorological data from that location in dispersion modeling calculations used to predict the impact of the proposed unit. Upper air data from Tampa, Florida will be used, as this is the closest and most representative site having upper air data. The meteorological data collected from the proposed monitoring site will be compared with the historical Orlando data to verify the expected similarity of the meteorological conditions at the two sites.

Orlando Utilities Commission (OUC) has contracted with Black & Veatch (B&V) Consulting Engineers of Kansas City, Missouri to implement and carry out the required monitoring program. B&V personnel have proposed the monitoring plan, determined specific air monitoring requirements, and assisted OUC in the equipment acquisition. The onsite operation and maintenance, as well as laboratory functions, will be performed by personnel from Southern Science Applications Incorporated (SSAI) of Dunedin, Florida, a wholly owned subsidiary of B&V. B&V personnel will also be responsible for overall program management which will include performing systems audits as deemed necessary and arranging for the required independent performance audits. Further discussion of the program organization structure is found in Section 5.0.

40 CFR § 52.21 (3) requires the owner or operator to meet, during the operation of the monitoring station, the Quality Assurance Requirements for PSD air monitoring as specified in Appendix B to 40 CFR 58, promulgated on May 10, 1979. Accordingly, this manual includes descriptions of the policies, procedures, specifications, standards, and documentation necessary to meet the above-stated monitoring objective and quality assurance requirements given in Appendix B. Adherence to the proposed program will minimize loss of data due to equipment malfunctions and/or procedural errors.

Sections 2.0 and 3.0 are discussions of the quality control program. Information on the site and equipment selection, as well as a detailed instrument listing, is included in Section 2.0. Section 3.0 contains the standard operating procedures for the field and the laboratory, calibration and maintenance instructions, and data processing steps. These procedures will reflect quality control checks and corrective actions when problems become evident. The procedures are specific to the particular instruments utilized in this monitoring program.

A description of audit procedures, including data assessment, is included in Section 4.0. Performance audits, systems audits, and general corrective action are also described in this section.

The air monitoring program organizational structure is described in Section 5.0. Project positions for both operational and quality assurance aspects are identified in that section.

In developing this document, reliance has been placed on the EPA documents referred to in Appendix B, as cited above, along with an explanation dated July 10, 1979, written by the Air Surveillance Branch, Surveillance and Analysis Division, EPA Region IV, Atlanta, Georgia. Use was also made of a draft copy of sections of the Standard Operating Procedures Manual being developed by the Florida Department of Environmental Regulation (DER), Bureau of Air Quality Management. Other references are made to specific instruments operation manuals supplied by the manufacturers of the equipment to be used. Specific references in the text abbreviated as Volume I and Volume II refer to the EPA Quality Assurance Handbook For Air Pollution Measurement Systems EPA-600/9-76-005 and EPA-600/4-77-027a, respectively.

2.0 SITE AND EQUIPMENT SELECTION AND INSTALLATION

This section contains descriptions of the rationale and procedures followed in the preliminary site selection and the choice of the monitoring equipment to be used and in installation of the equipment.

2.1 SITE SELECTION

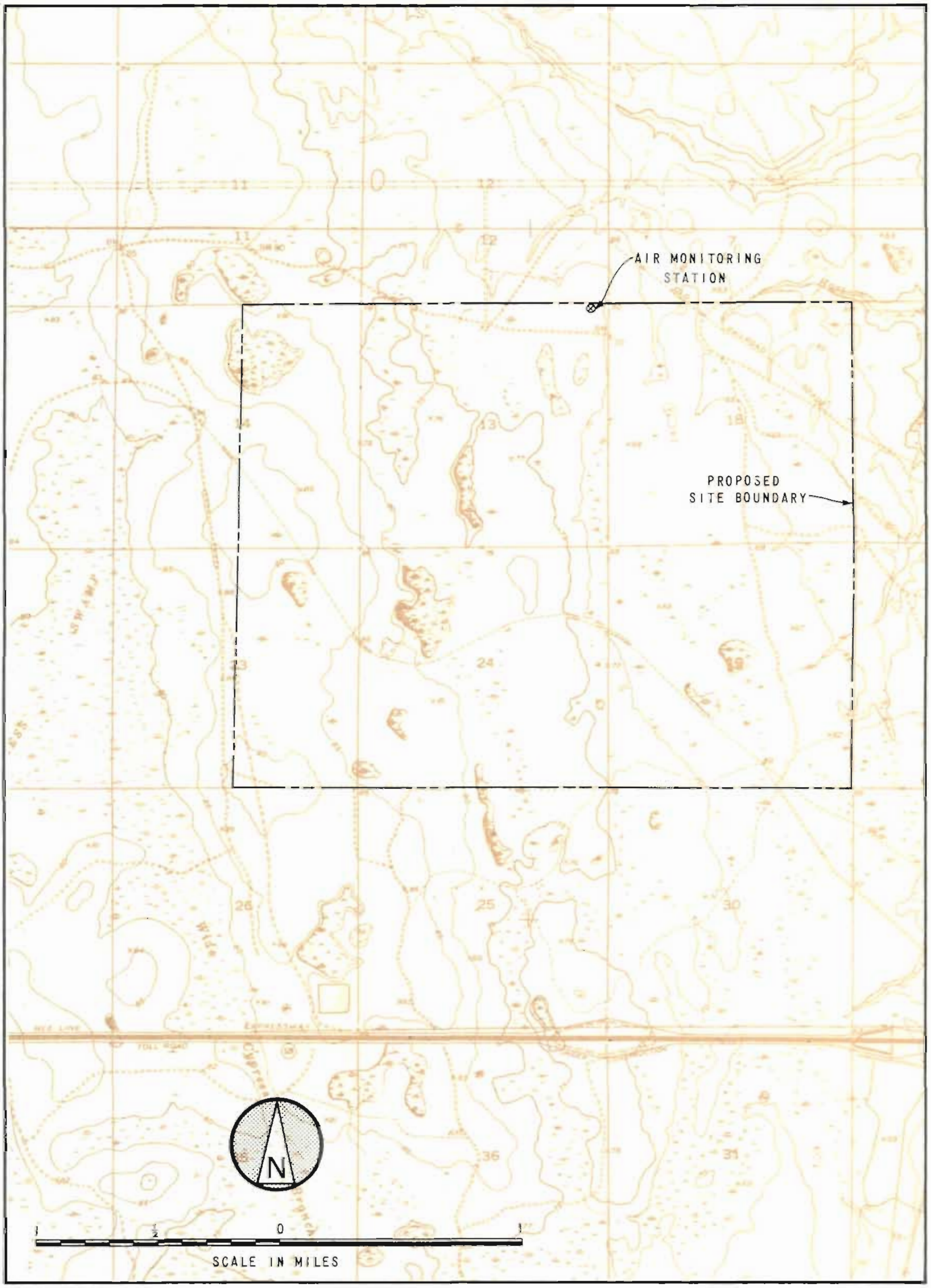
The previously submitted proposed monitoring plan contained a rationale for meeting the monitoring objective with a single monitoring station located in the vicinity of the proposed plant site. Baseline pollutant concentrations are expected to be uniformly low based on air quality data from Florida DER air monitoring stations in the area. In addition, preliminary dispersion modeling results show that the maximum short-term impact should be within about 1 kilometre of the source. Therefore, the proposed monitoring station can be placed near the proposed source at a specific location based on convenience and accessibility.

Thus, the primary considerations for exact site selection are land accessibility, availability of commercial electric power, instrument exposure, and local terrain considerations. These factors have led to the selection of the existing site. Approval for the location of the site was obtained from EPA on April 22, 1980, and from Florida DER on April 28, 1980. The SAROAD site identification number received from the Florida DER is 10-3240-002-J05.

The selected site is located in the northeast portion of Section 13, R31E, T23S. UTM coordinates (in Zone 17) are: 3151990N and 483995E. A map of the general site area showing the location of the air monitoring station is presented in Figure 2.1-1. Locations of the generating station components shown in this figure are preliminary. The site layout showing the concrete slabs, fencing, shelter, etc., is given in Figure 2.1-2. The site complies with all exposure requirements in Table 4 of 40 CFR 58, p. 27596, Vol. 44, No. 92, May 10, 1979.

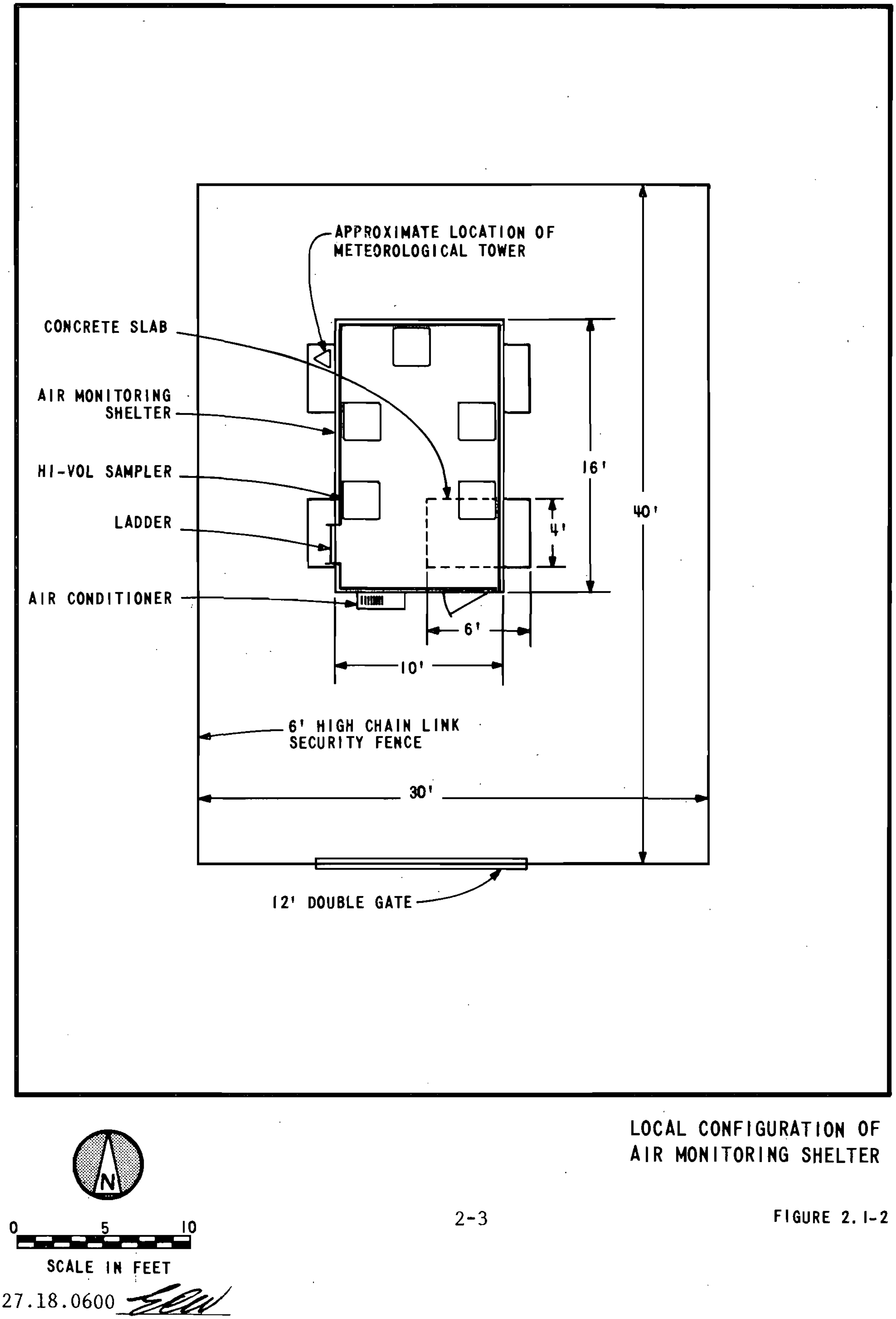
2.2 EQUIPMENT SELECTION AND INSTALLATION

The pollutants to be monitored are those for which the proposed source is expected to emit in excess of de minimis values proposed in EPA draft



TOPOGRAPHY AROUND THE AIR MONITORING STATION
STANTON ENERGY CENTER

FIGURE 2.1-1



LOCAL CONFIGURATION OF AIR MONITORING SHELTER

FIGURE 2.1-2

guidelines for ambient air monitoring (Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/2-78-019, October 1979, Draft). These pollutants are SO_2, NO_2, CO, and TSP. In addition, NO, NO_x, and the inhalable particulate (fractionated for respirable portion) will be measured.

Equipment to perform the measurement, recording, and calibration functions of the monitoring activities were chosen by mutual agreement with the SumX Corporation of Austin, Texas. SumX is the manufacturer of the data acquisition system and the shelter facility and the procurer of the air quality analyzers and meteorological sensors. "Reference" or "Equivalent" methods are used where applicable.

A listing of the major components in the air monitoring system is contained in Table 2.2-1. Initial equipment testing was done at the SumX offices in Austin. Final checkout and calibration were made onsite by SSAI, B&V, and SumX personnel. Commencement of official monitoring was May 1, 1980.

TABLE 2.2-1. INSTRUMENT LIST

Parameter	Manufacturer	Measurement Technique
1. Wind direction	MRI Model 1022	Vane
2. Wind speed	MRI Model 1022	Anemometer
3. Air temperature	MRI Model 892-1	Thermistor in aspirated, radiation shielded housing
4. Dew point temperature	MRI Model 892-1	LiCl
5. Precipitation	MRI Model 302	Tipping bucket
6. Sulfur dioxide	Meloy SA285E	Flame photometry
7. Nitrogen oxides	CSI 1600	Chemiluminescence
8. Carbon monoxide	ML 8310	Infrared absorption
9. Total suspended particulate	General Metals Works Model GMWL-2000H	High volume air sampler
10. Respirable fraction of particulate	Sierra Model 244	Dichotomous sampler
11. Data acquisition	SumX Model 410	Microprocessor
12. Data recording	Tandberg Model SCDR/BDL-1050	Nine-track magnetic tape
	Molytek	Strip chart recorder
13. Routine calibration	TECO Models 102 and 110	Capillary flow control; zero air source
14. Precision and accuracy checks	CSI Model 1700/1750	Mass flow controllers and gas phase titration; SO_2 permtube
15. Hi-vol calibrators	GMW-25 and 35	Orifice plates
16. Dry/Wet bulb temperatures	Weathertronics 5246	Psychrometry

3.0 STANDARD OPERATING PROCEDURES

Routine procedures included in this section are descriptions of the operation of the site (data gathering phase of the program), calibrations (validation of the measurements), laboratory analyses, equipment maintenance, and data reporting and validation (processing and presentation for analyses). Examples of operator checklists, calibration forms, and control charts are included. Each procedure description includes the data quality assessment method and corrective action procedure applicable when the assessment shows the measurement process to be beyond set tolerance limits.

Frequencies at which required checks are to be made and the tolerance limits specified are those required according to EPA guideline documents and/or manufacturer manuals, with defined exceptions. Actual operation will typically include more frequent checks than required, particularly during the initial period when instrument characteristics are being defined. Also, tolerance limits may become more stringent depending on resultant instrument characteristics. When significant changes become warranted in a routine procedure, revisions will be made to this manual.

Operational tasks required of the operator on routine site visits are described in Section 3.1. Quality control procedural tasks performed onsite are described in Section 3.2. Laboratory procedures including pre- and post-measurement conditioning and weighing of high-volume air sampler (hi-vol) filters and dichotomous sampler filters are given in Section 3.3. Elaboration on instrument specific maintenance and calibration activities is given in Sections 3.4 and 3.5, respectively. Data Reporting and Validation procedures are given in Section 3.6.

3.1 ROUTINE SITE OPERATIONS

Tasks required of the operator on routine site visits regarding normal operation of the instruments are described in this section. Onsite quality control procedures are given in Section 3.2.

3.1.1 Site Checklist

3.1.1.1 Purpose. The purpose of this procedure is to define the activities, provide frequencies of checks, and give a general overview of the operator activities at the Orlando Utilities Commission Ambient Air Monitoring Station. Specific techniques for operating various instruments are given in following subsections.

The purpose of an operator's visit to a station is to assure proper equipment operation, replenish expendables, perform routine maintenance, and annotate charts, logs, and data printouts to facilitate data reduction. The checklist in Appendix A is to serve as a reminder to the operator of the tasks and required conditions necessary in order to continue operation without corrective action being taken. The checklist also documents performance of these activities. Copies of it will be retained at the monitoring site and at SSAI offices in Dunedin, Florida.

An abbreviated form of this checklist is to be kept in the form in a field log. It will contain sufficient information to facilitate the data processing and validation activities. Copies of these field log sheets will be kept at the site and SSAI offices as well as sent with the data to be processed at B&V offices in Kansas City.

3.1.1.2 References.

(1) EPA-600/9-76-005--Quality Assurance Handbook for Air Pollution Measurement System, Volume I, Principles.

(2) EPA-600/4-77-027a--Quality Assurance Handbook for Air Pollution Measurement System, Volume II, Ambient Air Specific Methods.

(3) Draft version of Standard Operating Procedures Manual for Florida DER.

(4) Quality Assurance for Prevention of Significant Deterioration (PSD) Air Monitoring, 40 CFR 58, Appendix B explained, July 10,

1979. Air Surveillance Branch, Surveillance and Analysis Division, EPA, Athens, GA.

3.1.1.3 Procedure. The site operator/technician shall be responsible for performing and documenting the activities per the procedures summarized in the attached matrix, Table 3.1-1. It is intended that the operator will visit the site once every third day. This frequency is primarily dependent on the 3-day measurement cycle of the routine hi-vols. If periods of persistent problems arise, the visit schedule will be increased proportionately.

Procedures to follow for each station visit are summarized below. Further detail on normal instrument operating conditions is found in following subsections.

(1) Upon arrival, note station security, such as gates locked, no evidence of vandalism; at the same time, make visual inspection of tower, cables, meteorological sensors, and Hi-Vols.

(2) When entering the shelter, the operator is to note irregularities such as peculiar odors; inside temperature is to be within specified limits.

(3) The next step is to inspect the data system. Time (always use EST) should be correct, data printouts reasonable considering ambient conditions, strip charts working, automatic zero/span values within limits on control charts, and paper, ink pens, and magnetic tape supply adequate. Further detail is given in Subsection 3.1.3.

(4) Visually inspect instruments; check items on checklist such as correct flows, hydrogen supply above 300 psi, light indicators correct, and no apparent malfunction. See Subsection 3.1.2.

(5) Hi-Vol filters, flow charts, dichotomous filters, etc., should be changed when required. All records, such as identifying envelopes, etc., should be filled out.

(6) Records should be updated, i.e., strip charts marked with time, date, parameter, and appropriate remarks. Daily zero and span control charts are to be plotted for each instrument, and trends

TABLE 3.1-1. OPERATOR RESPONSIBILITIES--SITE ACTIVITY MATRIX

Activity	Method	Frequency	Corrective Action If Out of Limits
Operational Checklist	Subsection 3.1.1	Each visit	Problems to be noted in log and major problems to be identified to Field Services Manager immediately. Maintenance and calibration to be performed as applicable.
Hi-Vol Sampler			
1. Routine Measurement	1. Subsection 3.1.4	1a. Routine--3-day cycle 1b. Collocated--6-day cycle	1. Verify flow rate if indicated flow rates not 40-60 cfm or if suspect.
2. Calibration	2. Subsection 3.5.8	2. Monthly	2. Perform necessary calibration
3. Maintenance	3. Subsection 3.4.8	3. As required	3. Use spare sampler
Dichotomous Sampler			
1. Routine Measurement	1. Subsection 3.1.5	1. 6-day cycle (same as collocated TSP)	1. Perform maintenance
2. Calibration	2. Subsection 3.5.9	2. Quarterly	2. Perform maintenance
3. Maintenance	3. Subsection 3.4.9	3. As required	3. Remove from service
Psychrometer Reading	Subsection 3.1.6	Each visit	If inoperative, see Subsection 3.4.15
Zero-Span Check Control Chart Update	Subsection 3.2.1	Each visit	If results out of limits, see appropriate analyzer calibration in 3.5.
Calibrations			
1. One-point span "precision" checks on gas analyzers	1. Subsection 3.2.1	1. 12-day cycle	1. Perform multi-point calibration and maintenance
2. Multi-point calibration checks on gas analyzers and flow rate check on hi-vol	2. Appropriate sub-section in 3.5	2. Monthly	2. Perform necessary maintenance
3. Check calibrators and calibrate strip chart recorders	3. Appropriate sub-section in 3.5	3. 6-month cycle	3. Perform necessary maintenance

should be noted. An example of the type of control chart that will be used has been included in Appendix A. Log entries should be made in sufficient detail that all actions can be determined by others at a later date.

The operator is responsible for ensuring that the station is operating properly, all routine maintenance is accomplished, abnormal events are recorded, and supervisory personnel are notified in the event of data loss or malfunctions. A checklist is to be completed each visit. A sample checklist is shown in Appendix A. Further details on daily zero/span checks and precision checks are found in Section 3.2.

3.1.1.4 Corrective Action. Actions taken to correct significant problems shall be documented in applicable logs, charts, and forms. Notification shall be provided to the Field Services Manager as soon as is appropriate on significant problems.

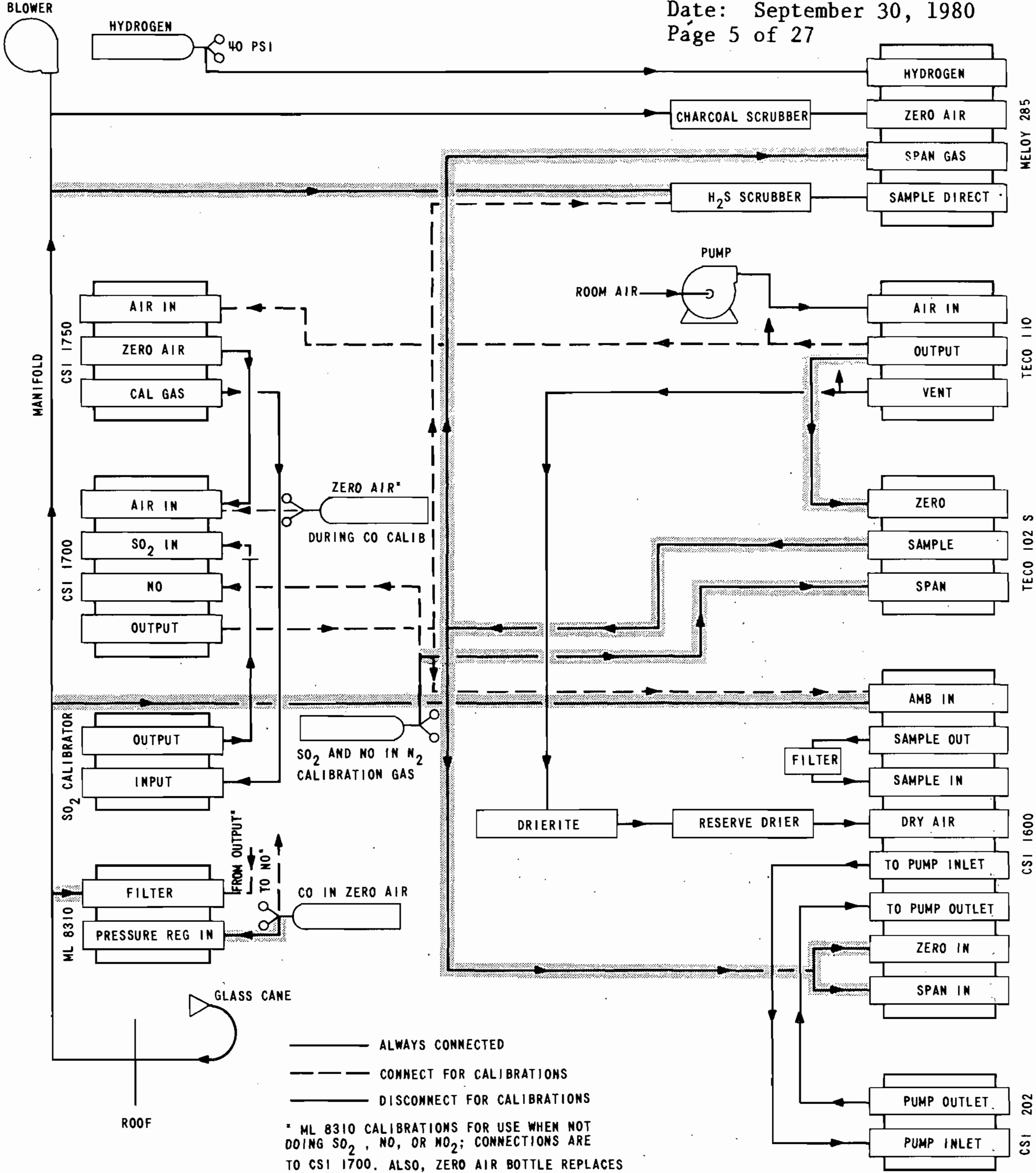
3.1.2 Normal Operation of the Continuous Analyzers

3.1.2.1 Purpose. This section defines procedures to be used on the continuous gas analyzers and meteorological sensors during ambient sampling. Instrument conditions given in this section are those which are included in the Operator's Checklist, which is described in Subsection 3.1.1.

3.1.2.2 References. Manuals supplied with each instrument.

3.1.2.3 Procedures. Meteorological sensors for wind, temperature, and dew point temperature are mounted at the 10-metre level of the tower adjacent to the shelter. Verify that the tower is fully extended and that the temperature sensor's aspirator motor is running. Cable connections are made to appropriately marked terminals on the rear of the SX-410.

Tubing connections for directing the flow of sample air, calibration gas, and operational air are connected according to Figure 3.1-1. Solid lines are always connected; dashed lines are only connected during multipoint calibrations, precision checks, or maintenance utilizing the CSI 1700/1750 system. Lines overlaid with dots are used during normal operation and daily zero/span checks, and are disconnected when the CSI 1700/1750 system is in use.



* ML 8310 CALIBRATIONS FOR USE WHEN NOT DOING SO_2 , NO, OR NO_2; CONNECTIONS ARE TO CSI 1700. ALSO, ZERO AIR BOTTLE REPLACES CSI 1750 ZERO AIR SOURCE.

SCHEMATIC OF SAMPLE AND CALIBRATION GAS LINES

FIGURE 3.1-1

All lines are to be FEP Teflon. All connectors are nylon or stainless steel. Use a soap solution, such as "Snoop" to check for leaks when making connections.

Follow particular instructions given in the appropriate instrument manuals for actual start-up procedures. Document the time and any appropriate remarks in the field logs. Perform any necessary initialization procedures required for the data system as described in Subsection 3.1.3.

3.1.2.3.1 Meloy SA285E Sulfur Dioxide.

(1) Check hydrogen supply in the tank; replace the tank when the supply is inadequate to last until the next visit. Allow for 100 pounds (pressure) per day. Check the hydrogen supply pressure at the second stage of the regulator: set for 40 psig. Check the hydrogen supply line and connections for leaks.

(2) Check that the zero air supply inlet line is connected from the sample manifold to the charcoal scrubber inlet. Check that the sample line is connected to the particulate filter, then to the H_2S scrubber (clipped on the rear of the instrument), and subsequently to the SAMPLE DIRECT inlet port. The daily zero/span check span gas enters the analyzer at the SPAN GAS inlet.

(3) Set the MODE switch to SAMPLE. Adjust the hydrogen flow (if necessary) to the value given on the H_2 rotameter (41 for 9L073). Check the AIR FLOW, it should be at the value given on the AIR rotamater, (59 for 9L073). Set the TIME CONSTANT switch to 1 SEC and the RANGE switch to 500. Check that the IGNITION light is not lit.

3.1.2.3.2 CSI 1600 Oxides of Nitrogen.

(1) Check for change in color of the Drierite material in the Main Dryer mounted under the instrument bench. When approximately 80 per cent of the material has changed from blue to purple, replace the material. Also check for discoloration in the Reserve Dryer unit. The outlet line from the Reserve Dryer goes into the DRY AIR inlet. Remote pump (CSI 202) line connections are shown in Figure 3.1-1.

(2) The sample line from the manifold passes through a filter, and subsequently into the AMB IN inlet. A line connects the SAMPLE OUT outlet through a filter to the SAMPLE inlet. The ZERO and SPAN inlets are set up to accept calibration gas from the TECO system in one line through a tee.

(3) Front panel switch and indicator positions are given in Table 3.1-2. These are also explained in Section 3.2 of the CSI 1600 manual. Note: Closely follow directions for instrument start-up given in Section 3.3 of the manual.

3.1.2.3.3 Monitor Labs 8310 CO Analyzer.

(1) Normal operation includes the power switch and the analyzer power switch being on. The MODE switch is to be in MON (monitor) position; this still allows for performing automatic calibrations.

(2) Span gas pressure should be approximately 17 inches of mercury gauge. Flow control meters should show 0.7 lpm. Converter temperature should be 210 C. When these conditions are not met, consult the maintenance procedures in Section 3.4 of this manual.

3.1.3 Data Recording System

3.1.3.1 Purpose. Specific procedures are given in this section to provide techniques for operating the data recording system; proper operation and documentation are essential in this vital area.

Signal voltages from the analyzers are taken in parallel directly to strip chart recorders and into the SX-410 Data Acquisition System. The SX-410 accepts data from each channel once every 5 seconds and computes 5-minute averages. These averages are stored internally until the end of each hour when the 5-minute and 1-hour averages are written on the magnetic tape and on hard copy by the teletype printer.

Status conditions such as cable disconnects, absence of hydrogen flame in the Meloy SA-285E, and automatic calibration mode are also monitored by the SX-410, and are recorded on the magnetic tape and hard copy output.

In addition to the primary data recording system, output signals from the analyzers and meteorological sensors are recorded on analog strip

TABLE 3.1-2. CSI 1600 OXIDES OF NITROGEN ANALYZER: FRONT PANEL SWITCH POSITIONS AND CORRECT INDICATORS

Switch	Position
SAMPLE	AMB
FILTER	5
METER	Optional
RANGE	0.5
03	in (on)
PWR	in (on)
SPANs and ZERO	Set during calibration

Indicator	Response		
Ozone	0.115		
Air	0.52		
INHIBIT light	off (on during electronic span or with ozone power off)		
COOLER light	on-off cycle		
HEATER light	on-off cycle		
DIAGNOSTICS	% of meter; calibration sheet values followed by acceptable limits in parentheses.		
1	0.1%	(0-5%):	Dark current
2	41%	(40-45%):	P/M chamber temperature
3	97%	(95-99%):	+15 V power supply voltage
4	98%	(95-99%:	-15 V power supply voltage
5	0	(0):	panel meter mechanical zero
6	25%	(20-25%):	Ozone generator ion current

charts. Their primary use is as a backup to the magnetic tape and the hard copy printout, though the analog presentation is useful in various diagnostic and analytic applications.

3.1.3.2 References.

(1) SX-410 Data Acquisition Manual, SumX Corporation.

(2) Section 1.4.10 of Volume I, previously cited.

(3) Section 2.0.3 of Volume II, previously cited.

3.1.3.3 Procedure. Operational commands necessary to obtain data are minimal; many question/response items are available to facilitate diagnoses of the data system and gas analyzers. Procedural steps are given below. These command key-ins are summarized in Table 3.1-3. More detail is available in the SX-410 Operating Manual. Strip chart recording techniques are given in Section 3.1.3.3.3.

3.1.3.3.1 Operator Command Key-Ins From Teletype Terminal (TTY).

(1) "I" initializes the system to identify channels to the data system according to the wiring pattern on the terminal panel. The operator responds to questions posed on the hard copy of the TTY. With this process, channels are identified, zero and full-scale values are defined in proper engineering units, and status and calibration bits are identified. To leave a response unchanged from the previous condition, type a RETURN as the entry. "CTRL A" causes the previous question to be re-asked, "CTRL Z" exits this routine. Table 3.1-4 shows the sequence of questions and responses applicable to the system connections in use.

(2) "P" prints the initialized information in the system at the time. The proper form is shown in Table 3.1-5.

(3) "R" releases the magnetic tape for changing. An example is shown in Table 3.1-6. This step is necessary to write necessary file marks on the beginning and end of the magnetic tape.

(4) "G" allows the operator to enter newly computed span gas concentrations. These are printed out as comparisons with results of the automatically (or manually) initiated calibration checks

TABLE 3.1-3. LIST OF OPERATOR KEY-INS AND CHARACTERS IN DATA FIELD

Key-Ins

C--Start an auto calibration sequence

D--Print daily summary

F--Print time of last power failure

G--Enter span gas values

H--Print out stored 5-minute averages

I--Initialize system

M--Accept a message from keyboard and transfer to magnetic tape

O--Echo print from keyboard or modem to printer

P--List system operating channels, name, units, and full scale settings

S--Print out status

T--Print time and date

Z--Print out results of last auto calibration

Characters In Data Field (By Priority)

Priority	Character	Meaning
1	F	Power not available
2	D	Channel invalidated by operator
3	B	Bad status
4	S	Span check
5	Z	Zero check
6	P	Purge period
--	<	Over 2/3, but less than all of components for average
--	-----	(Whole entry) average not computed

TABLE 3.1-4. INITIALIZATION SCHEME

Operator Responses are underlined.

```
>I
STATION NAME:  OUC STANTON #1
ACTIVE CHANNELS:  00 THRU 13
ENABLE RAINFALL ? (Y/N) Y

CHANNEL NUMBER = nn (nn is 0 through 13 in sequence)
CHANNEL NAME = XXXXXX (00 is WD/DEV, etc. as in Table 3.1-6)
STANDARD DEVIATION ? (Y/N) Y (for Channel 00 only, N for other channels)
CHANNEL UNITS = XXX (DEG for Channel 00, etc. as in Table 3.1-6)
FULL SCALE VALUE = XXXX (540 for Channel 00, etc, as in Table 3.1-6)
ZERO VALUE = XXXX ( 0 for Channel 00, etc. as in Table 3.1-6)
BAD STATUS = XXXXXXXX XXXXXXXX (for Channel 00, etc. as in Table 3.1-6)
AUTO-CAL CHANNEL ? (Y/N) Y for Channels 04-10; N for others
INSTRUMENT ? n Only asked if last response is Y; for Channel 04, n
     is 1; for Channels 05, 06, and 10, n is 2, and for Channel 07,
     n is 3
When initialization is completed:
CHANNEL NUMBER = RETURN key.
>
```

TABLE 3.1-5. PROPER RESPONSE TO THE 'P' COMMAND

```
INITIALIZED PARAMETERS      11:35:20  07/21/80     OUC STANTON #1
ACTIVE CHANNELS ARE: 00 THRU 13
*******************************************************************************
CHANNEL NUMBER        00       01       02       03       04       05       06       07
CHANNEL NAME        WD/DEV     WS      TOS      TIN      SO2      NOX       NO       CO
CHANNEL UNITS        DEG      MPH      DGC      DGC      PPB      PPB      PPB      PPM
FULL SCALE VALUE     540      100     50.0     50.0      500      500      500     50.0
ZERO VALUE             0        0    -30.0    -30.0        0        0        0       .0
AUTO-CAL CHANNEL                                           1        2        2        3
-------------------------------------------------------------------------------

BAD STATUS
00      XXXXXXXX  XXXXXXXX
01      XXXXXXXX  XXXXXXXX
02      XXXXXXXX  XXXXXXXX
03      XXXXXXXX  XXXXXXXX
04      00XXXXXX  XXXX1XXX
05      XX0XXXXX  XXXXX1XX
06      XX0XXXXX  XXXXX1XX
07      XXX0XXXX  XXXXXX1X

*******************************************************************************
CHANNEL NUMBER        10       11       12       13
CHANNEL NAME         NO2      DPT      DIR      SPD
CHANNEL UNITS        PPB      DGC      DEG      MPH
FULL SCALE VALUE     500     50.0      540      100
ZERO VALUE             0    -30.0        0        0
AUTO-CAL CHANNEL       2
-------------------------------------------------------------------------------

BAD STATUS
10      XX0XXXXX  XXXXX1XX
11      XXXXXXXX  XXXXXXXX
12      XXXXXXXX  XXXXXXXX
13      XXXXXXXX  XXXXXXXX


RAINFALL :ENABLED
```

TABLE 3.1-6. PROPER RESPONSES TO THE 'R' AND 'G' COMMANDS

Operator responses are underlined.

'R' key-in used to begin and end magnetic tapes.

```
>R
```

DO YOU WANT TO INITIALIZE THE MAG TAPE? Y

DO YOU WANT TO SAVE EXISTING DATA ON THE TAPE? N (normally, Y if a new tape is not yet mounted)

```
>
```

BEGINNING OF TAPE followed by present time and date

```
>
```

Initialized parameters are then printed out like the 'P' response

'G' key-in used to set span gas value reported with automatic daily zero/span check results.

```
>G
```

SET SPAN GAS

CHANNEL NUMBER = nn (nn = 04 for SO_2, 06 for NO, 07 for CO, use zero for 10 for NO_2)

SPAN GAS VALUE = XXX (XXX = value in proper units, use zero for NO_2)

CHANNEL NUMBER = (RETURN) (or other channels if desired) using the TECO system. This entry does not control the concentrations given to the analyzers. A sample entry is shown in Table 3.1-6. Exit the routine by pressing RETURN in response to a "Channel Number" question.

(5) "D" causes the accumulated hourly averages for the present day to be printed out. The cumulative average is also computed and printed.

(6) "Y" causes the previous day's 24 hourly and daily averages to be printed out.

(7) "H" causes the accumulated 5-minute averages from the current hour, along with the average thus far, to be printed out.

(8) "T" causes the present system time and date to be printed out. This information is also available on the SX-410 display. Its value is realized when interrogating the system remotely.

(9) "F" causes the time of the last power failure to be printed out.

(10) "S" causes the current status bit conditions to be printed out.

(11) "M" allows the operator to enter a worded message on the tape and printout. Exit routine with a "CTRL Z".

(12) "Z" causes the last automatic calibration cycle to be printed. Caution: This printout shows the current contents of the "known" span gas concentration. Hence, if the "G" command was used to change this value, then this manually initiated calibration result could be erroneous.

(13) "C" causes the SX-410 to perform the automatic calibration cycle, the daily zero/span check using the TECO system. Once into this sequence, some options are possible. After typing "C", the system will ask: "DO YOU WANT TO DISABLE THE AUTO CALIBRATION SEQUENCE?" "Y" (yes) does that, then no auto calibration is initiated at midnight, and the next "C" entry prompts, "DO YOU WANT TO ENABLE THE CALIBRATION SEQUENCE?" "N" (no) prompts the question: "DO YOU WANT TO START A CALIBRATION SEQUENCE?" "Y" does so on the next 5-minute point, "N" exits the routine.

(14) "H" causes a channel to be flagged as having a bad status or invalid data; the channel is said to be "downed." Enter the appropriate channel number when so requested.

(15) "U" causes a channel previously "downed" to be returned to being on-line recording valid data, the channel is said to be "up." Enter the appropriate channel number when so requested.

3.1.3.3.2 Characters in the Data Field. One column space to the right of each numerical group of data in columns is available for a flag indicating abnormal operating modes. These flags can show power failures, operator signifying an inoperative channel, bad status condition, calibration (zero or span), purge, and that there are less than the required number of components for an average (2/3). These characters are shown, along with their corresponding priority in Table 3.1-3. Following are the explanations of the meanings of these characters; the sequence of presentation is the relative priorities assigned when multiple flags are applicable.

(1) "F" indicates power failure.

(2) "D" indicates that the operator "downed" the channel, that is, the channel is identified as invalid. This can be done by the "#" key-in described above or by pressing the red button marked OFF for the appropriate channel on the face of the SX-410.

(3) "B" indicates a bad status condition was detected by the status flag system in the SX-410.

(4) "S" indicates that the automatic calibration cycle was operating in the span mode, that is, the span gas mixture was being supplied to the analyzer. The last of the three 5-minute averages in the sequence is the one recorded as the measured span value.

(5) "Z" indicates that the automatic calibration cycle was operating in the zero mode; that is, zero air was being supplied to the analyzer. The last of the two 5-minute averages in the sequence is the one recorded as the measured zero value.

(6) "P" indicates a purge condition. This typically is a 5-minute period during which ambient air is being sampled following one of the above conditions.

The priority sequence of the characters above is not applicable to the following two characters.

(1) "<" appears with a 1- or 24-hour average composed of greater than 2/3, but less than a full complement of components.

(2) "-----" indicates no average computed as less than 2/3 of the components were present.

3.1.3.3.3 Strip Chart Recording Techniques. Two types of strip chart recorders are used. One contains the wind speed and direction traces; these are recorded on separate 12.2 cm/(4 13/16 inches) wide areas. Reorder chart is Molytek 414055. Five recorders separately record SO_2, NO, NO_x, CO, and outside temperature; these traces are on 4-inch-wide fan-fold charts; re-order chart is Molytek 414001.

Load charts according to instructions on the respective recorders. Be sure that the holes are lined up evenly on the sprockets. Check the ink traces every visit; when the trace gets light, replace the pen.

3.1.3.4 Corrective Action. While there are several levels of redundancy in the data recording system, it is imperative that all malfunctions be identified and corrected immediately. Notification should be made as soon as is practical to the Field Service Manager and/or the Quality Assurance Coordinator when significant problems arise.

3.1.4 Routine Operation of High-Volume Sampler

3.1.4.1 Purpose. This procedure specifies the operational steps required in performing the high-volume air sampler (Hi-Vol) measurement of total suspended particulate matter (TSP). The procedure covers filter changing, flow recording, and general operation of the sampler.

3.1.4.2 Reference.

EPA-600/4-77-027a--Quality Assurance Handbook for Air Pollution Measurement System, Volume II, Ambient Air Specific Methods, Section 2.2.

3.1.4.3 Procedure. An activity matrix for sample collection functions is presented in Table 3.1-7. The matrix summarizes the sample collection activities and the operational checks described in this subsection.

3.1.4.3.1 Installation of Filter. Place the sampler in the servicing position by raising the sampler until the filter holder is above the top level of the shelter; then rotate the unit 1/8 turn so that it hangs from the top of the filter holder. During inclement weather, including high winds, the entire sampler (or cartridge) is to be removed to a protected location for servicing whenever practicable.

While the sampler is removed from the shelter or before the new filter is installed, the inside surfaces of the shelter cover and the surfaces around the filter holder should be cleaned of loose particles by wiping with a clean cloth.

To install a filter, remove the faceplate of the sampler by loosening the four wing nuts and swinging the bolts outward. Place the filter, rough side up, on the wire screen. Center the filter on the screen so that when the faceplate is in position, the gasket will form an airtight seal on the outer edge (1/2 inch) of the filter. When aligned correctly, the edges of the filter should be parallel both to the edges of the screen behind it and to the faceplate gasket above it. The results of poorly aligned filters appear as uneven white borders around the filter.

When the filter is aligned and the faceplate is in place, the four wing nuts are tightened just enough to prevent leakage. Excessive tightening may cause the filter to stick to the gasket and result in permanent damage to the gasket.

The entire motor assembly (sampler) is then rotated and lowered to its normal operating position.

3.1.4.3.2 Flow Rate Measurements.

(1) Record the sampler number, start time and date on the backside of the new flow rate chart and on the appropriate envelope.

(2) Remove any moisture from inside the recorder case by wiping with a clean cloth. Carefully insert the new chart into the recorder,

TABLE 3.1-7. ACTIVITY MATRIX FOR SAMPLING PROCEDURE

Activity	Acceptance limits	Frequency and method of measurement	Action if requirements not met
Filter installation	Filter rough side up, centered on screen, edges parallel to edges of screen and to face-plate gasket. Gasket tightened to prevent leakage.	Visually check each filter	Void filter, install substitute filter
Operational checks	1. Flow rate: stabilized initial flow rate = established initial flow rate ± 10% 2. Sampling time: 23-25 hours	1. Visually check each filter 2. Timing device	1. Perform listed steps in order until flow rate is within limits or cause of discrepancy is identified -measure line voltage -change filter -check calibration -calibrate sampler 2. Void sample
Final flow rate check	Greater than 1.14 m^3/min ($40\ ft^3$/min)	Check each sample	Void sample
Sample handling	Absence of evidence of malfunction in post-sampling check	Visually check each sample	Void, correct cause of malfunction
Documentation	Pertinent names, sampling dates, times, sample no., filter no., station no., unusual conditions, flow rates, handling dates. (Above to be recorded on sample envelope).	Visually check each sample envelope	Complete or correct documentation if unavailable, void sample

being careful not to bend the pen arm beyond its limits of travel. An easy way to do this is to push in on the extreme top of the pen arm with the right hand to raise the pen head while inserting the chart with the left hand. Be careful not to damage or weaken the center tab on the chart and make certain that the tab is centered on the slotted drive so that the chart will rotate the full 360 degrees in 24 hours with no binding or slippage.

(3) Check to see that the pen head rests on zero (i.e., the smallest diameter circle on the chart). If it does not, tap the recorder lightly to make certain the pen arm is free; if it still does not read zero, adjust to zero with the adjustment screw.

(4) Check the time indicated by the pen. If it is in error, rotate the chart in a clockwise direction, by inserting a screwdriver or coin into the slotted drive in the center of the chart face, until the correct time is indicated. The correct time for the recorder chart is the starting time on the clock switch.

(5) Put a small amount of ink into the hole in back of the pen tip if necessary.

(6) Turn on sampler (never turn on the sampler unless a filter is in place because the transducer and recorder may be damaged), and observe long enough to determine whether the transducer and recorder are operating properly. Record initial flow rate as instructed in the next section.

(7) Turn off sampler and set the clock switch for correct start and stop times.

3.1.4.3.3 Routine Flow Rate Check. Record the initial and final flow rate readings for each sample in the log book maintained with the sampler and on the filter envelope. Allow a 5-minute warm-up time before recording flow rates.

After each calibration, average the first four initial flow rate measurements. Future initial flow rates deviating more than ±10 per cent from this average should be investigated. If the change has been gradual over a period of time, a calibration is required.

When large deviations occur between successive samples, the operator should wait 5 minutes and make an additional reading. If the second reading falls within ±10 per cent of the average, continue normal operation. If the second reading falls out of bounds, check the line voltage and/or replace the filter. A calibration check is made if neither of the above checks identifies the trouble. Continue normal operations if the calibration check is satisfactory, or perform a complete calibration if the check is unsatisfactory.

The same procedure is used for final flow rate measurements except that ±20 per cent of the average is initially used. Other valid limits may be determined for any sampling site as data are accumulated. A final flow rate deviating from the average by more than 20 per cent may result from short-term weather changes. The occurrence of such conditions is noted on the data sheet for that sample. If a final flow rate less than 1.14 m^3/min (40 ft^3/min) is observed, the sample is voided, because at this low air flow the motor heats up and a valid flow rate measurement cannot be obtained.

3.1.4.3.4 Time Measurements. Start and stop times for samplers are taken from the timer's clock start and stop settings. The timer clock is checked, and set if necessary, for the correct time at each filter change. Because timer clocks cannot be set or read to less than ±15 minutes, an elapsed time meter must be used to determine the number of minutes sampled. Elapsed time meters must be checked prior to being used. Check, and set if necessary, the position of the DAY switches to verify that the sampler will operate on the correct day.

Record the number of minutes of sample collection, determined by an elapsed time meter, on the hi-vol field data sheet and envelope. Total time includes the pre- and post-run flow rate checks with the filter in place.

3.1.4.3.5 Removing Exposed Filter. Start hi-vol motor, allow for a 5-minute warm-up, and record the final flow rate on the filter envelope. Stop the hi-vol and record elapsed time.

Place the sampler in the servicing position. Remove the faceplate and lift the exposed filter from the supporting screen by grasping it gently at the ends, not at the corners. With the exposed side in, fold the filter lengthwise at the middle, and if the collected sample is not centered on the filter (i.e., the unexposed border is not uniform around the filter) fold so that deposit touches only deposit.

Place the filter in its numbered envelope. Remove the corresponding flow recorder chart, record the stop time on the chart, and place it inside the filter envelope with the inked side against the envelope and the back side against the filter.

3.1.4.3.6 Routine Checks. The following listed checks are to be made when removing an exposed filter.

(1) Check the filter for signs of air leakage. Leakage may result from a worn faceplate gasket or an improperly installed gasket. If a leakage is observed, void the sample, determine the cause, and take corrective action before starting another sampling period. Generally a gasket deteriorates slowly, and the operator can decide well in advance (by increasing fuzziness of the sample outline) to change the gasket before a total failure results.

(2) Visually inspect the gasket face to see if glass fibers from the filter are being left behind, resulting from over-tightening of the faceplate wing-nuts and cutting the filter along the gasket interface.

(3) The operator is to check the exposed filter for physical damage that may have occurred during or after sampling. Physical damage to the filter after sampling does not always invalidate the sample as long as all pieces of the filter are included in the envelope. However, any loss of sample due to leakages during the sampling period or to loss of loose particulate from the filter after sampling (e.g., loss of particulate when folding the filter) invalidates the sample. The operator is to mark all such samples void and forward them to the laboratory.

(4) The appearance of the particulates should be checked. Any changes from the normal color, for example, may indicate new emission sources or construction activity in the area. The change should be noted on the filter envelope along with any obvious reasons for the change.

3.1.4.4 Corrective Action. Action to be taken if requirements are not met during the operation of the hi-vol samples has been included with the procedure description in the previous subsection.

3.1.5 Dichotomous Sampler

3.1.5.1 Purpose. Procedures in this section are descriptions of the steps necessary to operate the Sierra Model 244, Dichotomous Sampler (Virtual Impactor).

3.1.5.2 Reference.

Sierra Instruments, Inc., Model 244, Dichotomous Sampler, Instrument Operation Manual.

3.1.5.3 Procedure. The following steps describe the filter installation, and operation of the Series 244 Dichotomous Sampler and the Model 302 Digital Timer/Programmer.

(1) Install preweighed 37 mm Teflon filters in filter holders. Unscrew knurled filter holder nuts by hand. Remove Model FH-240-AO Filter Holder cassettes. Open the two halves of the cassette by carefully pulling them apart. Handle the filters with tweezers only. Carefully place and center the filter on the lower half of filter holder with the sampling surface side of the filter up (the Teflon side of the filter, rather than the non-woven polypropylene side). The lower half of the filter holder is the half without the "O" ring. Carefully put the upper half of the filter holder (the half with the "O" ring) over the filter. Press the two halves together tightly. Note which filters were designated for "Coarse" and "Fine," respectively.

(2) Install the filter holders in the Sampling Module. Put both filter holders on the filter screens. The lower half of the

filter holder (the one without the "O" ring) goes over the filter screen. The lower half is also the side having the shortest distance (approximately 1/16 inch) to the filter surface. Screw on both knurled filter holder nuts tightly by hand. The coarse-particle filter is the one with the 1/4-inch O.D. tubing, and the fine-particulate filter is the one with the 3/8-inch O.D. tubing. The filters also can be distinguished by the fact that the coarse-particle filter is on the center line of the virtual impactor head and aerosol inlet, and the fine-particle filter is off-set.

(3) Connect the two tubes. The 1/4-inch O.D. and 3/8-inch O.D. tubes should be interconnected between the Sampling Module and the Control Module. First, hand-tighten the nuts on the tube connectors as much as possible and then wrench-tighten 1-1/4 revolutions.

(4) Unlock and open the front cover of the enclosure of the Control Module. The latch is opened by turning the knob counterclockwise and released by turning the indicator 1/4 turn counterclockwise. It is locked by reversing this process.

(5) Be sure the flow selector valve on the bottom of the total flow mark is open.

(6) Turn SAMPLER switch on the Model 302 to ON. Push the POWER switch on the 302 ON (push in). Pump will turn on.

(7) Set total flow rate. Turn the flow selector valve on the bottom of the total flow meter and select a flow rate of 16.7 lpm. The vacuum gage will read approximately 1 to 2 inches Hg for a 2 to 3 micron pore size membrane filter. Note: From test to test the flow selector valve will need, at most, only slight adjustment.

(8) Set the coarse-particle flow rate. Turn the flow selector valve on the top of the coarse-particle flow meter and select a flow rate of 1.67 lpm. The vacuum gage will read approximately zero. Note: From test to test the flow selector valve will need, at most, only minor adjustment.

(9) Set SAMPLE START TIME of Day. (Note: Digits will flash until set).

<u>IMPORTANT</u> <u>NOTE:</u> SAMPLE START TIME must be at least 10 minutes after TIME OF DAY. The DISPLAY Selector Switch must not be in the SAMPLE START TIME position 10 minutes prior to sampling.

- (a) DISPLAY Switch--set to SAMPLE START TIME.
- (b) FAST/SLOW Switch--hold up or down as appropriate to set sample start time (24-hour format).

(10) Set Present Time of Day. (Note: Digits will flash until set).

- (a) DISPLAY Switch--set to TIME OF DAY.
- (b) FAST/SLOW Switch--hold up or down to set present time of day (24-hour format).

(11) Delay Start (Sample after X Days, 0 to 8 days). Set SAMPLE AFTER switch to number of days to be skipped before first sampling period. Position "0" will initiate first sampling period the first time the TIME OF DAY = SAMPLE START TIME. Thus, for example, if the present time of day is 10:00 and the start time is 8:00 the first sample will start in 22 hours. Position 1 will delay start 1 day (24 hours) after TIME OF DAY = SAMPLE START TIME. Position 2 will delay start 2 days (48 hours), etc.

(12) Sampling Period (Sample For Z Hours, 1 to 24 hours). Set the SAMPLE FOR switch for 24 hours.

<u>IMPORTANT</u> <u>NOTE:</u> The switches referred to in these sections are positive detent switches that provide exact timing. If the switch is not in the detent, it is not usable.

(13) Set Timer--push SET switch down to TIMER position for approximately 2 seconds.

<u>IMPORTANT</u> <u>NOTE:</u> Step 13 <u>must</u> <u>be</u> <u>done</u> <u>after</u> the preceding steps.

(14) Timed Sampling--place SAMPLER switch in TIMER position. This initializes all timing functions.

(15) Filter Removal--filters are removed using the same steps as for installation, except the steps are for removing versus installing

the filters themselves. Be sure that each filter is returned to its properly numbered plastic petri dish. Note elapsed time of run on envelope.

NOTES:

(a) Flashing time display indicates AC and battery power failure.

(b) AC Power Fail light (dot) indicates failure of AC power during sampling period.

(c) Display may be left on; however, standby battery life may be shortened to approximately 24 hours if AC power fails.

(d) The Digital Elapsed Time Indicator (9999.99 hours maximum, nonresettable) records the total elapsed time the sampler is on (both TIMED and ON positions of SAMPLER switch). AC power fail stops elapsed time indicator until power returns.

(e) Power switch incorporates circuit breaker. When circuit is broken, the power ON button pops up. If more than 15 amps are drawn, the circuit breaker will trip even if the button is held on (in). Reset is accomplished by pushing ON button in (just like turning the unit on).

(f) Manual Operation--the timer can be bypassed by placing the SAMPLER switch in the ON position to independently turn the sampler on during non-cycle periods. The OFF position turns both timed and manual sampler power off.

3.1.5.4 Corrective Action. Calibration procedures given in Subsection 3.5.9 are to be used when the flow rate is beyond required limits. Applicable maintenance procedures are given in Subsection 3.4.9.

3.1.6 Psychrometer--Manual Determination of the Dew Point Temperature

3.1.6.1 Purpose. This procedure specifies the technique used in obtaining the manual determination of the dew point temperature derived from the wet/dry bulb measurement. The dew point reading is used to check operation of the automated measurement and to provide data during periods for which the automated instrument is inoperable.

3.1.6.2 Reference. Manual for Weathertronics 5246 Psychrometer.

3.1.6.3 Procedure.

(1) Preparation.

(a) Remove the psychrometer from the carrying case.

(b) Raise the instrument cover and firmly place three batteries (D Size 1.5V) in the instrument with the center (+) contact of each battery facing the back of the instrument, that is, away from the intake.

CAUTION: Placing the batteries in the wrong direction causes reverse air flow.

(2) Operation.

(a) Open the instrument cover.

(b) Using the distilled water bottle, place the tip of the bottle at the wick and saturate it with the distilled water.

CAUTION: Avoid using tap water, if possible, since this reduces the useful life of the wick. Also, when applying the water, avoid splashing or dropping water on the dry bulb.

(c) Replace the distilled water bottle and close the instrument cover. Hold or set the instrument horizontally, with the graduations of the thermometers facing the operator.

NOTE: The air intake and exhaust ports must be entirely free of obstructions. Also, never allow strong light to shine into the intake port. Radiation upon the wet bulb causes evaporation not accounted for in the psychrometric formula.

(d) Turn the on-off intensity control in the clockwise direction. Initially, a click should be heard, which starts the fan motor and aspiration.

(e) After the fan operates, the wet bulb temperature will begin to rapidly depress. A reading should not be taken until the depression completely stops. This may take from 1 to 2 minutes, depending on the dryness of the air. If the wet bulb temperature stabilization does not occur within 2-1/2 minutes, the fan motor is probably running too slowly due to weak batteries.

(f) Record the dry and wet bulb temperatures on the site log form in degrees Celsius.

(g) Change these to Fahrenheit degrees using this equation:

$$F = (1.8 \times C) + 32,$$

where

F and C are the respective Fahrenheit and Celsius temperatures. Use one-place accuracy (xx.x).

(h) Consult the tables in Appendix A to obtain the dew point temperature corresponding to the dry bulb temperature and wet bulb depression (difference between the dry and wet bulb temperatures).

(i) Convert this dew point temperature, in degrees F, to degrees Celsius using this equation:

$$C = (F-32)/1.8.$$

Record the dew point temperature in degrees Celsius in the log and compare it with the dew point temperature on the printout. There will often be a valid difference in dew point temperatures between the manually derived value and the continuously monitored parameter, due to measurement principles and spatial separation.

3.1.6.4 Correction Action. Replace the wick when dirty and the batteries when fan operation becomes sluggish or when the wet bulb temperature has not stabilized within 2.5 minutes. Consult maintenance instructions in Subsection 3.4.15 for replacement procedures and for repair of a split mercury column in a thermometer.

3.2 SITE QUALITY CONTROL PROCEDURES

Quality control procedures defined in this section are done routinely, either automatically by the system or manually by the operator when required by conditions or by the site activity matrix shown in Table 3.1-1. Items covered include the assessment of the quality of the monitoring data and the control procedures utilized to improve data quality when inadequacies are detected. Instrument specific maintenance and calibration procedures are found in Sections 3.4 and 3.5, respectively.

3.2.1 Daily Zero/Span Check

3.2.1.1 Purpose. An automatic zero/span check is made daily on the sulfur dioxide, oxides of nitrogen, and carbon monoxide analyzers by a method described below. Span gas concentrations typically used are 80-100 ppb for SO_2 and NO, and 8-10 ppm for CO. This match with the levels used on precision checks is to facilitate comparisons. These daily checks are meant to be the "Level 1" checks described in Section 2.0.9 of Volume II. While no adjustments will be made based on these check results, they are used to decide to initiate a calibration and possible adjustments. Moreover, the capability of invalidating monitoring data for less than 24 hours at a time is advantageous for maximizing data recovery.

Results of the daily zero/span checks appear on the strip charts, the printed output, and on magnetic tape. The results are compared with computed values of the "known" concentrations and recorded on control charts described in Subsection 3.1.1. Corrective actions are taken as specified below.

3.2.1.2 References.

(1) Previously cited--Quality Assurance Handbook for Air Pollution Measurement System, Volumes I and II.

(2) Operation Manual for SX-410, SumX Corp.

(3) Operation Manual for TECO 102S Calibrator, Thermo-Electron Corp.

3.2.1.3 Procedure. At 2345 EST each day, the SX-410 unit instructs the TECO 102S to supply span gas to the SO_2 and NO_x analyzers for 15 minutes. The concentration level for this check is to be between 80 to 100 ppb for

SO_2 and NO. Span gas for the CO analyzer is derived within the analyzer itself using bottled CO in zero air gas; the resulting concentration is between 8 to 10 ppm. This "span" check is followed by 15 minutes of "zero air" and 5 more minutes of a purge with ambient air. This procedure is complete by 0020 EST and ambient sampling is resumed. Thus, neither hour during which calibrations occur will be invalidated as monitoring data will be taken for the required 2/3 of the hour. The zero and span values recorded are the final 5-minute averages obtained during the appropriate periods.

The "known" concentrations of the span gas supplied to the instrument are derived from the ratio of flow rates measured by a procedure given in Subsection 3.5.4 of this manual. Tubing connections for the daily zero/span check are given in Figure 3.1-1 which includes the normal sampling mode. For convenience, the calculation is repeated here.

The span gas concentration (SC) supplied to the instrument is computed by the following equation:

$$SC = BC \times (BCF/(BCF + ZAF)),$$

where BC is the gas concentration in the bottle, certified traceable to NBS SRM's,

BCF is the flow rate of the bottled gas, and

ZAF is the flow rate of zero air.

The calibration cycle may be initiated using the 'C' key-in described in Subsection 3.1.3. Also, the span may be initiated by pressing the ZERO and the SPAN buttons; zero is initiated by just pressing the ZERO button, or by re-pressing the SPAN button if already in span mode.

Results of the daily checks are plotted by the operator on control charts described in Subsection 3.1.1.3. An example of a typical control chart has been included in Appendix A. Appropriate ordinate values for the span chart are to be determined by the operator/technician depending on the known span gas concentration. When zero or span results exceed the tolerance levels, corrective action is to be followed as described below.

Whether the results exceed limits or not, trends are to be noted to anticipate problems before they occur. Further information on interpretation is found in Section H.4 of the previously cited Volume I.

Initial tolerance limits will conform to those given in Table 3.2-1. After a suitable period of station operation, closer tolerance limits may be determined if feasible.

3.2.1.4 Corrective Action. When any irregular results are found, the first step is to verify proper operation of the TECO calibrator by inspection of components and, if necessary, calibrate according to Subsection 3.5.4. If the "known" span gas concentration has changed due to a change in flow rates, recompute the span gas concentrations supplied to the analyzers. Enter this value into the data system by techniques described in Subsection 3.1.3 using the 'G' instruction. Now initiate an automatic calibration by pressing appropriate buttons on the SX-410 Data System (Subsection 3.1.3) and compare instrument response to known concentrations.

When the zero or span results deviate from the known result beyond the first tolerance level shown in Table 3.2-1, adjustments are to be made as specified in the maintenance sections of appropriate instrument manuals and Section 3.4 of this manual. If the result exceeds the next level, a full multi-point calibration is to be performed according to procedures specified in instrument manuals and Section 3.5 of this manual (then make adjustments and re-calibrate). Finally, when span results exceed the third tolerance level, the data are invalid, and maintenance procedures are to be initiated.

3.2.2 Precision Checks

3.2.2.1 Purpose. General procedures for performing precision checks are given in this section. Minimum frequencies are specified in the activity matrix shown in Table 3.1-1. Methods for doing these one-point span checks on the specific gas analyzers are given in Section 3.5.

3.2.2.2 References.

(1) Florida DER, Standard Operating Procedures, No. DER-02-1, Section 2.

TABLE 3.2-1. OPERATIONAL LIMITS APPLIED TO DAILY ZERO/SPAN CHECK RESULTS (ABRIDGED FROM TABLE 9.1 OF SECTION 2.0.9 OF VOLUME II)

Action	"Zero" Deviation		"Span" Deviation
	CO	SO_2 & NO/NO_x	CO, SO_2, NO/NO_x
Adjust analyzer	$3\sigma_o$*	$3\sigma_o$*	$3\sigma_s$*
Calibrate (multi-point)	±2.5 ppm	±25 ppb	±15 per cent of span
Invalidate data Calibrate Perform maintenance	N/A	N/A	±25 per cent of span

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*The adjustment levels must not exceed those shown requiring a calibration.

(2) 40 CFR 58, Appendix B, May 10, 1979.

(3) EPA-600/4-77-027a--Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods.

3.2.2.3 Procedure.

3.2.2.3.1 Continuous Gas Analyzers. Precision checks are to be performed at least every other week on the Meloy SA285E SO_2 Analyzer, the CSI 1600 Oxides of Nitrogen Analyzer, and the Monitor Labs 8310 Carbon Monoxide Analyzer (or any replacement instruments which measure these parameters). Precision checks are one-point span checks made at concentrations in the following ranges. For SO_2, NO, and NO_2, the range is 80 to 100 ppb; for CO, it is 8 to 10 ppm. Span gas concentrations for these checks is supplied by the CSI 1700/1750 system, which includes a permeation tube for SO_2, and the capability to perform a gas phase titration (GPT) to supply NO_2. Procedures for obtaining the appropriate span gas concentrations vary for each analyzer; these are described in the appropriate portions of the specific calibration procedures in Section 3.5.

Results of these precision checks are to be completely documented in the field logs, including serial numbers of all instruments and test equipment used, computations of known concentrations, and measurement results. Examples of the types of forms intended for use are included in Appendix A.

Precision check results are combined quarterly as a partial assessment of data quality by a method given in Subsection 4.3.1 by data processing personnel at B&V in Kansas City. These results are then included along with the ambient monitoring data. Also, control charts will be kept on these precision check results.

3.2.2.3.2 High Volume Air Sampler. The precision assessment for the TSP measurement is accomplished by making a duplicate measurement on the designated collocated sampler every sixth day. The measurement procedures, including all filter handling, are identical to those used on the routine procedures. Calculations are given in Subsection 4.3.1.

3.3 ROUTINE LABORATORY PROCEDURES

All filter conditioning and TSP filter weighing procedures will be carried out in a specially prepared portion of the SSAI facility in Dunedin, Florida. Section 2.2 of the previously cited Volume II of the EPA Quality Assurance Handbook (referred to as Volume II in this section) contains explicit guidance on these procedures; appropriate portions were used almost verbatim in the preparation of this section as they apply to specific instruments used in this program. Filter selection, preparation, and weighing procedures are summarized in Table 3.3-1. Audit procedures are included in Section 4.0 of this manual. Dichotomous sampler weighings are to be performed at the University of South Florida's Marine Science Division facility in St. Petersburg, Florida. Conditioned filters will be stored in individual plastic petri dishes.

Bottled span gases will be obtained as certified traceable to NBS standards. Verification of concentration stability and necessary re-analyses will be performed according to the EPA/EMSL report "Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Air Pollution Analyzers (Protocol No. 2)," dated June 15, 1978.

3.3.1 Filter Identification and Conditioning

Filters used in the hi-vol measurement of TSP are purchased from a source which pre-numbers the filters. This number will be retained on the envelope containing the exposed filters and in the filter paper log book held at SSAI.

3.3.1.1 Filter Examination. Examine each new filter according to the following steps.

(1) Each filter must be visually inspected with the aid of a light table.

(2) Discard (or return to the supplier) filters with pinholes and other defects such as tears, creases, or lumps.

(3) Remove loose particles with a soft brush.

Post-measurement filter examination procedures follow.

TABLE 3.3-1. ACTIVITY MATRIX FOR FILTER SELECTION AND PREPARATION

Activity	Acceptance limits	Frequency or method of measurement	Action if requirements are not met
Filter selection and collection efficiency[1]	(1) 0.3-μm diameter particle collection; efficiency ≥99% (2) No pinholes, tears, creases, etc.	(1) Manufacturer's proof of DOP test ASTM-D2986-71 (2) Visual check of each filter with light table	(1) Reject shipment or return to supplier (2) Reject individual filters
Filter identication	Identification number in accordance with specifications	Visual check of each filter (See Subsection 3.3.1)	Identify properly or discard filter
Filter equilibration	Equilibration in controlled environment ≥24 h; constant humidity chamber with saturated chemical solution for RH of <50% constant within ±5%; average temperature between 20 F and 25 C with less than ±3 C variation	For each sample, record in the filter log book the room and chamber conditions, and the equilibration (See Subsection 3.3.1)	Repeat equilibration after ≥48 h at ambient conditions
Filter weighing	Indicated filter weight determined to nearest mg within 30 s after equilibration	Gravimetric check (See Subsection 3.3.2)	Reweigh after ≤48 h at ambient conditions; repeat the equilibration

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[1] Items marked as "(1)" are included in the ordering process; those marked as "(2)" are performed on groups of individual filters.

(1) Upon receipt of the sample from the field, remove the filter from the envelope and check information on envelope to determine whether all data necessary to verify the sample for analysis and to calculate concentration have been provided. Void the sample if:
   (a) data are missing and unobtainable.
   (b) sampler malfunction is evident, e.g., obvious faceplate gasket leakage.

(2) Examine the shipping envelope for sample material that may have become dislodged from the filter. If such material is observed, recover as much as possible by brushing it from the envelope to the deposit on the filter with a soft camel hair brush.

(3) Examine the filter for insects embedded in the sample deposit and if found, remove them with Teflon-tipped tweezers, using care to avoid disturbing more of the sample deposit than is necessary. If more than 10 insects are observed, refer the sample to the supervisor for a determination whether to accept or reject it.

(4) Record data verification, sample inspection, and removal of insects under Remarks in the filter log and on the envelope.

3.3.1.2 Filter Conditioning. Equilibration of filters before and after weighing is accomplished by the following method.

(1) Place the filters in the rack provided so they do not touch each other.

(2) Check to see if the desiccant tray contains sufficient dry desiccant. Temperature in the chamber must be between 20 C and 25 C (68 F and 77 F) and vary by not more than ±3 C (5 F). Temperature is regulated by the air conditioner setting or a heater. Relative humidity in the equilibration chamber must be below 50 per cent and vary by not more than ±5 per cent during the 24-hour conditioning process; 40 per cent is the desirable level.

3.3.1.3 Filter Handling. A quantity of new filters sufficient for at least a 3-month period for each sampler is to be weighed at one time.

Weighing procedures are given in the next section. After weighing, pack the filters in their original container or a box of similar size such that each filter is separated by a sheet of 8 1/2- by 11-inch tracing paper. Be sure that the filters are stacked in the box in numerical order so that the operator will use the proper filter first. Keep the envelopes with the identifier numbers and initial weights along with the filters to ensure their availability at the time of exposure.

3.3.2 Gravimetric Analyses

Balance operation and filter weighing procedures are the same for both pre- and post-exposure measurements. Clean filters are usually processed in lots, that is, several at one time (filters are weighed individually). Before weighing the first filter, perform a balance check by weighing a standard Class "S" weight of between 3 and 5 grams. Record the actual and measured weights, the date, and the operator's initials in the filter log book. If the actual and measured values differ by more than ±0.5 mg (0.0005 g), perform maintenance on the balance (See Subsection 3.4.14).

If the actual and measured values agree to within ±0.5 mg, weigh each filter to the nearest mg. Record the temperature and humidity in the equilibration chamber in the filter log book. Weigh each filter within 30 seconds after removal from the equilibration chamber, record the tare weight and serial number of each filter in the filter log book and on the filter envelope. Filters must not be folded or creased prior to weighing or use. Once exposed, do not unfold the filters. Return exposed filters to their respective envelopes. These are then stored in the designated area.

Dichotomous sampler filters are weighed at University of South Florida facilities according to the following procedures. Filters are weighed to the nearest 0.01 mg on a Perkin-Elmer Model AD-2 electrobalance. To minimize the effects which changes in humidity and temperature have on the weights, the balance is kept in an environmental room with a constant temperature of 70 ± 2 F and a relative humidity of 50 ± 5 per cent. The effects of static electricity on the filter weights is lessened by passing the filters over an alpha source prior to each weighing. The balance chamber also contained two alpha sources.

The actual weighing procedure is as follows. First, the balance is zeroed. It is then calibrated using a 10 mg Class M (or better) calibration weight. Next, each of the first five samples are weighed and their weights recorded only after the balance has stabilized for at least 45 seconds. After every fifth sample, the calibration weight is reweighed. This procedure is repeated until all samples are weighed. Finally, every fifth sample is reweighed. Weights are manually entered and stored on a Hewlett-Packard 9825A microprocessor for later retrieval.

3.3.3 Certification of Span Gas Concentrations

Span gases used in calibrations are purchased certified traceable to proper standards.

3.4 INSTRUMENT SPECIFIC MAINTENANCE PROCEDURES

Procedures in this section pertain to maintenance activities for specific instruments. Minor troubleshooting can be performed onsite. Major repairs will be made after discussing the specific problems with the manufacturer via telephone. If the operator/technician is unable to make necessary repairs, then a manufacturer's representative or consultant will be brought onsite or to the Dunedin laboratory to assist with repairs. As a last resort, the instrument would be returned for service, and attempts would be made to arrange for a temporary replacement.

Automatic daily zero/span check results (particularly when plotted on control charts such as the one included in Appendix A) are used to determine when to make analyzer adjustments, perform full calibrations, and if necessary invalidate the ambient monitoring data. The zero/span limits are given in Table 3.2-1 and are discussed in Subsection 3.2.1.

Preventive maintenance procedures are to be followed according to manufacturer specifications. This information is included in instrument manuals. For emphasis, information from portions of those manuals is included in this manual.

3.4.1 Meloy SA 285E, SO_2 Analyzer

Options included on the analyzer being used on this project include the zero/span solenoids which can be operated manually by switches on the front panel, (S-26); the "press to read" button on the airflow rotameter, (S-25); teflon coating on the burner block, (S-5), and the automatic re-ignition, (S-30). These items allow for frequent performance checks to anticipate problems before instrument performance is degraded to the degree of requiring data invalidation. The automatic re-ignition feature also improves data recovery.

Adjustment calibration procedures (electronic alignment) are given in the instrument manual in Section VI-F, steps 1 and 2 (Function and Complement Amplifiers Adjustments) are on pages VI-7 through VI-9. These should be rigorously followed. Refer to the specific calibration data sheet accompanying the instrument in use. Provide full documentation for "before" conditions prior to making adjustments or performing maintenance.

Preventive maintenance on the Meloy SA285E primarily involves the pneumatic subsystem and the burner assembly. Electronic alignment should only be performed as a repair item. Timetables and procedures given in the manual apply to a reasonably clean environment. Specific steps to perform the preventive maintenance are given in the manual in Section VI-A on pages VI-1 through VI-7. These are briefly discussed in the following paragraphs. A summary of the recommended procedures and schedule is given in Table 3.4-1.

(1) Items in the pneumatic system needing attention include the internal teflon lines and fittings which need replacing annually. The flow restrictor capillary needs to be replaced when the hydrogen flow cannot be maintained and other components are functioning properly. The charcoal scrubbing zero air filter needs to be repacked every 3 to 6 months or after 300 to 600 hours of actual use. Rotameters need cleaning annually or more often if the ball becomes restricted in movement. The hydrogen regulator and the sample solenoid valve should only need replacement every other year. The cartridge life of the H_2S scrubber is 45 ppm hours, though annual replacement is recommended.

(2) The burner module needs cleansing at least annually, special care is needed due to the teflon coating. The optical window needs cleaning or replacement at least annually, though a loss of sensitivity of measurement may indicate the need for replacement. The exhaust air and dilution air orifices also need cleaning at least annually. The exhaust orifice can be protected by changing the exhaust filter every 3 to 6 months. Lastly, the chassis, fan, and air filter need cleaning when at all dirty, or at least annually.

TABLE 3.4-1. RECOMMENDED MAINTENANCE SCHEDULE: **Meloy SA285E**

Item	3 Month Maintenance	Annual Maintenance	Biennial Maintenance
Pneumatic Sampling System:			
Teflon Line		Replace*	
Flow Restrictor Capillary			Replace**
Zero Air Filter (Option S-25, S-26, or S-27)	Replace*		
Rotameters		Clean*	
Hydrogen Regulator			Replace
Solenoid Valves (Option S-25, S-26, or S-27)			Replace
Vacuum Pump		Rebuild	
H_2S Scrubber		Replace*	
FPD Burner Module:			
Burner Chamber		Clean*	
Optical Window		Replace	
Exhaust Orifice		Clean	
Exhaust Filter	Replace		
Dilution Orifice		Clean*	
Chassis, Fan, Air Filter		Clean	
Hydrogen Filter		Replace**	

* NOTE: These items may require maintenance more or less often, depending on cleanliness of their environment and the exposure rate.

** NOTE: Should only be replaced if not functioning properly.

(3) Further alignment procedures for the temperature controller and low and high voltage power supplies are found in Section VI of the Meloy 285E manual on pages VI-10 through VI-11, steps 6-8. A lengthy leak check procedure is given on pages VI-12 through VI-15, as Section G. This leak check procedure is to be performed annually, or if the analyzer appears to be unusually noisy, unstable, or has a high base line current. Erratic operation or peculiar odors are also indications to perform a leak check.

(4) Diagnostic maintenance procedures (trouble-shooting) are given in Section VII of the Meloy 285E manual. Thirteen symptoms are listed with probable causes and corresponding corrective actions. When in doubt, contact the Field Services Manager or the Quality Assurance Coordinator.

3.4.2 Columbia Scientific Industries 1600 Oxides of Nitrogen Analyzer

Routine, periodic maintenance items are described below. Specific procedures and diagrams are given in Section 6 of the CSI 1600 manual.

(1) Inlet filters need close attention. The teflon filters should be changed at least monthly, more frequently when required. The stainless steel capillary filters should be replaced annually.

(2) A 13X molecular sieve desiccant cartridge is used to insure that dry air is supplied to the ozone generator assembly. A blue indicator visible through the acrylic cartridge indicates that the molecular sieve cartridge is dry. If the blue indicator fades to neutral or slightly pink in color, this indicates that the cartridge must be replaced. Replacement is also required if the main air drier is expended and not refilled promptly. During proper operation, this will not occur as the reserve unit is used only when refilling main dryer. Also, to insure that the filter pads are not clogged, replace contents and pads every 90 days of operation (or more often if necessary). A refill kit (P/N M951-8037) is available from Columbia Scientific.

(3) A main air dryer (P/N M410-0004) is used in conjunction with a reserve unit to insure that dry air is supplied to the ozone generator assembly. The drying agent is normally blue and as it is expended, it turns pink. This depletion of the drying agent can be seen through the clear plastic housing of the air drier. Replacement normally will be at 30-day intervals of continuous operation at 50 per cent relative humidity. In more humid regions, depletion will occur more rapidly. The contents should be replaced before all of the drying agent has turned pink to avoid depletion of the reserve dryer.

(4) An activated charcoal cartridge assembly is used to destroy any residual ozone from the exhaust gases prior to exhausting the gases from the instrument. Replacement of the internal filter pads and charcoal should be made every 60 to 90 days. A refill kit which includes filter pads, (P/N M951-8036), will be ordered from Columbia Scientific. The entire assembly (P/N M01200201) will be replaced every 12 months.

(5) Two fans are mounted on the rear panel. The flush mounted muffin fan is used to remove heat from the instrument. This fan has permanently sealed bearings and requires no attention other than twice yearly (or more often if required) cleaning to remove dust accumulation. The second and larger fan is a squirrel cage fan externally mounted to the rear panel (P/N M260-0008). This fan requires oiling every 6 months. Two drops (i.e., 0.125 ml) of SAE 20 weight lubricating oil are to be applied to each of the two oil holes. A preferred oiling technique uses a small hypodermic syringe so that 0.125 ml of lubricating oil can be applied to each oil hole easily. Dust accumulation should be removed from the inlet screen every 60 days (or more often if required).

(6) The interior of the instrument should be cleaned with a vacuum cleaner at least twice annually. Dust generally accumulates around the fan and the heat sink mounted on top of the PM chamber

assembly. It is particularly important to periodically check to see that the ozone generator is free from dust build-up as arc-over of the high voltage leads may occur otherwise causing malfunction of the instrument. Cleaning of the inlet and exit areas of the two fans should be thorough.

(7) The $\underline{NO_x}$ <u>to</u> <u>NO</u> <u>converter</u> <u>material</u> (P/N M951-8013) should be replaced as determined by efficiency tests, or every 12 months of operation.

(8) <u>Trouble-shooting</u> <u>and</u> <u>corrective</u> <u>maintenance</u> <u>procedures</u> are given in Section 7 of the CSI 1600 manual. Section 7.1 (of that manual) is the electronic alignment procedure; this is performed when printed circuit boards are replaced or when zero air span adjustments are not possible with the front panel controls. Section 7.2 is a general trouble-shooting guide covering 14 symptoms with the corresponding probable causes and corrections. Finally, Sections 7.3 and 7.4 are corrective instructions to be followed depending on the results of Diagnostic 1.

3.4.3 <u>Monitor Labs 8310 CO Analyzer</u>

Preventive maintenance items to be performed are briefly described in this section and are summarized in Table 3.4-2. Explicit techniques are given in the manual on pages 6-1 through 6-5.

(1) Probably the most important item for prolonged stable operation is the <u>sample</u> <u>inlet</u> <u>filter</u>. The 8310 uses two identical filters, one to remove incoming sample particulates and dust and one downstream of the CO-CO_2 converter. The latter prevents the migration of catalyst or glass packing material particles into the reference cell. It need not be replaced as often as the sample filter because the converter releases particles only for a short while after being serviced.

(2) The <u>sample</u> <u>filter</u>, on the other hand, is continuously removing sample-borne particulates and dust. The effect of ingested dust is to coat the windows and reflective surfaces, gradually reduce

TABLE 3.4-2. ML 8310 CO ANALYZER MAINTENANCE SCHEDULE

Item	Examine	Clean	Replace	Frequency	Comments
Sample Filter	X			Weekly	
			X	Monthly	
Flow Control Orifices	X			Weekly	Check by observing flowmeter.
		X		As required	
Pump	X			Weekly	Check by observing flowmeter, or by noise. Replace diaphragm.
			X	As required	
CO-CO_2 Converter			X	Semiannually	Replace catalyst if calibration shows excessive signal loss.
Flow Cells	X			As required	Clean if output drifts or if sample has ingested particulates.
Span Gas Cylinder	X			As required	Check cylinder pressure - replace when pressure is below 100 psi.

the transmitted IR energy, and cause a reduction in signal. This, of course, requires removal and disassembly of the sample and reference cells and thorough cleaning of the windows and inside surfaces. Depending upon the environment, the sample filter should be replaced at least once every 30 days.

(3) The <u>$CO\text{-}CO_2$ converter</u> function is purely catalytic and, as such, does not wear out or deplete but does lose efficiency by contamination. Loss of conversion efficiency will show up during calibration as a low analyzer response. The low response would be due to some CO passing through the converter to the reference cell causing a positive reference and reducing the differential betweem "sample" and "reference" absorption.

Under normal usage the converter should retain full efficiency for 6 to 12 months. The converter filter is to be replaced whenever the converter is serviced.

(4) <u>Diagnostic procedures</u> are given in Section 7.0 (Trouble-shooting) of the ML 8310 manual. Symptoms are linked to possible probable causes with corresponding corrective actions in a flow chart type format. Symptoms and sections are Analyzer Light Does Not Come On, 7.1; No Sample Flow, 7.2; No or Low Output, 7.3; and Output Drifts, 7.4. Electrical test points are given in Figure 7-5, and periodic check points are given in Figure 7-6.

3.4.4 <u>Thermo Electron Model 110 Zero Air Supply</u>

Preventive maintenance items are described below. Consult the instrument manual for repair items.

Scrubber filters are to be changed every 6 to 8 months or sooner if zero air degrades in purity. New filters are available from Thermo Electron Corporation. Refer to the manual.

3.4.5 <u>Columbia Scientific Industries Model 1700/1750 Calibrator</u>

Preventive maintenance items are discussed below. These are also given in Section 6 of the CSI 1700 manual with a figure, and in Section 4 of the 1750 manual.

(1) Always protect the internal system of the 1700 with clean 7 micron sintered element stainless steel filter elements provided. Spare filter elements (P/N 952-0005) are to be used for change out. These elements are to be replaced every 12 months of continuous usage. The metal seal is not to be crushed during installation of filter.

(2) The interiors of the CSI 1700/1750 calibrators are to be cleaned with compressed air annually. Dirt generally accumulates on all parts and is to be removed to ensure proper normal operation.

(3) The activated charcoal in the scrubber in the 1750 needs to be replaced after 6 months, or sooner if necessary.

(4) Extensive trouble-shooting guides are found in the manuals for each instrument. The CSI 1700 instructions are in Section 7, while those for the CSI 1750 are found in Section 5, of the respective manuals.

3.4.6 SumX Corp SX-410, Data Acquisition System

Section 4 of the SX-410 manual covers the theory of operation of the data acquisition system. Section 4.1 contains descriptions of the functions of the system, e.g., Status, Auto Calibration, etc. Section 4.2 contains the next level of operational detail, such as board layout and functional descriptions of particular components. Included in these detailed descriptions are some adjustments that may be made, though advice from the manufacturer is necessary before performing maintenance at this level. Schematics are given in Section 4.3.

One board is kept as a spare part, the 1802 CPU Board. This may be exchanged with the one in use when problems exist as a diagnostic (and possibly repair) tool. The 1802 Board is in slot F, the sixth from the right; it is coded green. If a problem exists in the 1802 Board in use, the new one should rectify that. If further (or other) problems exist, an operational 1802 Board is necessary to further diagnose problems.

3.4.7 Molytek Strip Chart Recorders

The following summarized preventive maintenance procedures are to be performed at 6-month intervals or more frequently if the instrument is used in a dusty environment. Repair items are covered in the manual.

(1) Remove outside case and visually inspect the instrument for any obvious faults such as frayed or loose dial cord, loose or broken wiring, dirty or pitted switch contacts, and discolored components. Check all hardware such as switches, gears, and connectors for tightness.

(2) Clean the outside of the recorder using a soft cloth and mild detergent. The inside is to be cleaned using a vacuum cleaner or low pressure compressed air to remove accumulated dust. Printed circuit board connectors are to be cleaned using a commercial cleaner or alcohol applied with a stiff brush.

(3) The pen and chart drive motors are sealed units lubricated for life at the factory. Pen and chart drive gears are to be given a light coating of lubricating grease such as "Versilube," a trademark of General Electric, or an equivalent.

3.4.8 General Metals GMWL-2000H, High-Volume Air Sampler

Scheduled or preventive maintenance of the sampling equipment will result in a reduction of downtime and remedial maintenance requirements. Since the sampling equipment is only operated on an intermittent basis, the frequency of maintenance is a function of the actual number of hours of use. Normally two to three remedial maintenance activities are required per year. Table 3.4-3 at the end of this section is an activity matrix summarizing the quality assurance aspects of major maintenance checks. Record all maintenance activities in a maintenance log book. Maintenance can be best performed within the laboratory facility and not in the field. Often spare motors, on which maintenance has been performed, are carried to the field for installation and then calibration. Keep at least one spare recorder on site also.

TABLE 3.4-3. ACTIVITY MATRIX FOR MAINTENANCE OF HI-VOL SAMPLER

Equipment	Acceptance limits	Frequency and method of measurement	Action if requirements not met
Sampler motor	-400 hours operation of motor brushes -Absence of malfunction	Visually check upon receipt and after each 400 hours of operation	-Replace motor brushes -Other maintenance as indicated
Faceplate gasket	Absence of leaks at filter seal	Visually check after each sampling period	Replace gasket
Rotameter	-Absence of foreign materials -Stable operations	Visually check for each sample	Clean; replace if damaged
Motor gaskets	Leak tight fit	Visually check each 400 hours of operation	Replace gaskets
Sampling head	Absence of leaks	Visually check each 200 hours of operation	Replace sampling head

3.4.8.1 Sampler Motor. Motor brushes usually require replacement after 400 to 500 hours of operation (15-20 normal runs). The brushes should be replaced before they are worn to the point that motor damage can occur. The optimum replacement interval must be determined from experience. Manufacturer's instructions should be followed in replacing the brushes. Recalibration of the rotameter is necessary after brushes are replaced. The recalibration should not, however, be performed on a motor without an initial break-in period to properly seat the brushes against the armature. This period usually requires running the sampler against a resistance equivalent to a clean filter or a Number 18 calibration plate for a period of several hours. Replace worn parts and re-calibrate.

Record all sampler maintenance operations with data performed and operator's initials in the sampler log book and on a label which is to be attached to the sampler motor. Include the Hi-Vol unit number, maintenance and calibration dates, and the dates that the next maintenance and calibration are due.

3.4.8.2 Faceplate Gasket. A worn faceplate gasket is characterized by a gradual blending of the interface between collected particulates and the clean filter border. Any decrease in the sharpness of this interface indicates the need for a new faceplate gasket.

The old gasket can be removed with a knife and the surface properly cleaned. A new gasket is then sealed to the faceplate with rubber cement or double-sided adhesive tape.

Record all gasket replacements with date and operator's initials in the sampler log book.

3.4.8.3 Sampling Head. Leaks in the sampling head are not experienced frequently. The welded seams and the condition of the guide pins on the top surface of the head should be checked initially by visual inspection. Should a defect be suspected, assemble the sampling head to the motor, install a filter for resistance, and apply a soap solution to the suspect problem area. Disassemble the sampling head and examine the inside of the head for the presence of soap solution. If the soap solution is present inside the sampling heads, a leak is present. Repair or discard the sampler head.

3.4.8.4 Motor Gaskets. Two gaskets are employed with each sampler. The top gasket is approximately 3/16-inch thick rubber, and the bottom gasket is approximately 3/4-inch thick foam rubber. Both should be inspected for wear, and replaced if necessary.

3.4.8.5 Flow Recorder. There is no routine maintenance required with respect to this device. Should a malfunction occur, it should be replaced with a new recorder. Check hose fittings prior to classifying a recorder as defective.

3.4.9 Sierra Model 244 Dichotomous Sampler

The sampling module should be disassembled for maintenance. All parts are sealed with "O" rings. Particulate internal loss deposits accumulate primarily on the outer and inner surfaces of the tip of the receiver tube in the virtual impactor head. The receiver tube is to be inspected periodically for such particulate deposits and cleaned as required. A receiver tube cleaning schedule of every 3 months is required. The remaining inner surfaces are to be cleaned every 6 to 12 months. Cleaning is to be done with alcohol or water using a camel hair brush or by washing. The diametral "O" rings in the aerosol inlet are to be cleaned periodically during the summer months. The bug screen is exposed for cleaning by pulling the aerosol inlet off the aerosol inlet tube. A diametral "O" ring in the aerosol inlet acts as the seal.

After approximately 12 to 24 months of sampling, the inlet filters for the coarse and fine particle flows may need replacement. In normal operation, air entering these filters is filtered by the two 37 mm membrane filters in the sampling module. Hence, inlet filter replacement is infrequent.

If AC power has not failed during operation, the dry cell battery for stand-by power for the Model 302 Digital Timer/Programmer need be replaced only every 2 to 3 years. If AC power has failed during operation, as indicated by the dot light on the Model 302 panel, the battery must be replaced more frequently. Battery replacement instructions are in the instrument manual.

The diaphragm of the Model 727CA418 Diaphragm Vacuum Pump is replaced periodically at 1 to 2 year intervals. Instructions are found in the instrument manual.

3.4.10 MRI 1022, Wind

Visual inspection of the sensors and cables are made on each site visit. Loose connections or components are to be tightened; check for dirt and clean out if necessary. Lubrication, including disassembly, instructions follow.

3.4.10.1 Lubrication. The Wind Speed shaft and Wind Direction shaft bearings should be cleaned, lightly oiled, and drained until almost dry once every 6 months. Use a watch-cleaning solution and Elgin M-56-b oil, or equivalent. Replace if required.

To remove the bearings, use the steps listed below. Be sure to work in a clean area, and clean as needed any of the sensor parts as you go along. Be careful when removing the sensor from the tower not to bend or misshape the cup alignment. Numbered items refer to designations in the assembly view shown in the instrument manual.

(1) Remove the cup set, which is held by two small hex set screws.
(2) Remove the retaining ring and gasket, items 4 and 5.
(3) The Top Housing, #6, can be slipped off the lower assembly.
(4) Remove the retaining ring and gasket, #8 and 9, from the Bottom Housing groove.
(5) Slowly separate the Bottom and Inner housing assemblies. There is wiring from the electro-optical assembly to the connector.
(6) Remove the two 2-56 screws, #20, to free the optical assembly, #22. Carefully rotate the unit around and away from the chopper disc. Put these assemblies to one side.
(7) Assemble the cup set to the shaft and hold at hub only while removing the screw, washer, and optical assembly, #10, 11, 12, and 13, from the lower end of the shaft. Remove the cup set.

(8) Remove the small retaining rings, #14 and 16, from the shaft.

(9) Slide the bearings, #15 and 17, off the close end of the shaft. Some shafts may have a spacer washer between the upper bearing and retaining ring. Be sure to replace this washer during re-assembly.

(10) Clean and lubricate bearings as specified in the beginning of this section.

(11) Re-assemble the sensor by reversing steps 1 through 9.

(12) At step 7, a small amount of Loctite 242 should be used to secure the 2-56 screw.

(13) Replace neoprene gaskets #5 and 9 as required.

3.4.10.2 Problem Diagnosis. If trouble occurs, try to isolate it by a quick operational and visual check. First check the cabling, then check the settings of all controls. Operate the controls and rotate the vane and cups to see what effect, if any, they have on the trouble. The normal or abnormal operation of each may help to establish the trouble symptoms. Look first for simple causes to any trouble. The type of symptom will generally indicate what further checks are to be made or what action taken.

Since the 1022 derives its operating power from an external source, check to see the voltages are in accordance with the requirements and are from a stable source. Voltages to check are given in the instrument manual. Circuit diagrams are included in the manual.

3.4.11 MRI 892-1, Temperature and Dew Point Sensors

Visual inspection of the glass shields and cable is made each visit. Tighten loose connections; replacement of the glass shield is given in the instrument manual. Blower motor is also checked each visit. Inoperative blower motors are to be replaced; instructions are on page 14 of the instrument manual. No periodic maintenance is advised for the temperature element, though the glass shield is to be cleaned at 6-month intervals.

The dew point sensor element requires retreatment at 6-month intervals or more frequent if warranted.

To retreat the bobbin, it must be removed from its housing. A preliminary cleaning with hot water with a small amount of detergent added will remove soluble matter and ordinary soil. If a very greasy deposit is found on the bobbin, it may be cleaned with Stoddard's solvent. After the initial cleaning, the bobbin should be rinsed several times with clean water (preferably distilled) and excess water shaken off. In cleaning, one should avoid rubbing or otherwise disturbing the active section of the bobbin. In the retreatment kit will be found a test tube and a bottle of retreatment solution. The cleaned bobbin (damp) is dipped into the treatment solution in the test tube. The bobbin should be allowed to soak in the treatment solution for a minimum of 5 minutes with occasional dipping motions for agitation to insure adequate treatment. After dipping the bobbin, excess solution should be shaken from it and wiped from the plastic parts. The wet bobbin should then be dried in a horizontal position. An oven set at 180 F, an infrared bulb, a hair-dryer, or any other low temperature source of heat is satisfactory for this. If reasonable care was taken during the washing and rinsing operations, the dipping solution may be returned from the test tube to the bottle and used repeatedly. The solution should be replaced after 10 to 15 retreatments; count may be kept on the label of the bottle.

3.4.12 MRI 302B, Precipitation Gauge

Mechanical operation of the precipitation gauge is to be checked quarterly. Remove the cover and verify that the bucket tips freely and registers the proper number of tips.

Other than cleaning when necessary, no routine maintenance is suggested. Consult the instrument manual for abnormal problems.

3.4.13 Tandberg Magnetic Tape Recorder

Most repair items on this unit will be performed by a manufacturer's representative. Proper care and routine periodic maintenance can alleviate such problems. These routine items are described following and are summarized in Table 3.4-4, which includes the frequency of performance.

TABLE 3.4-4. PREVENTIVE MAINTENANCE SCHEDULE FOR TANDBERG RECORDER

Maintenance Operation	Frequency
(1) Clean head assembly, tape guides and capstan	Weekly
(2) Clean ceramic tape cleaner	500 hours
(3) Clean housing and dust cover door	As required

3.4.13.1 Tape Cleaner, Head Assembly and Tape Guide Cleaning. To gain access to the head assembly, tape cleaner and tape guides, lift off the two-part head assembly dust cover.

(1) Clean the components with a lint-free, non-abrasive swab moistened with isopropyl alcohol or head cleaner (Miller-Stephenson MS200 or equivalent). Wipe off excess cleaner and allow components to dry before replacing the dust covers.

(2) Clean roller guides 1 and 2, upper and lower compliance arm guides with a lint-free, non-abrasive wipe or a cotton swab moistened with isopropyl alcohol or head cleaner (Miller-Stephenson MS200 or equivalent).

CAUTION: Do not soak the guide with cleaner. Excess solvent may break down the bearing lubricant.

3.4.13.2 Capstan Cleaning.

CAUTION: DO NOT use alcohol, head cleaner, or other solvents to clean capstan sleeve.

Clean the capstan sleeve with a lint-free, non-abrasive wipe moistened with a non-solvent degreaser such as FREON, Type TF.

3.4.13.3 Housing and Dust Cover Cleaning.

CAUTION: DO NOT use rough or abrasive material to clean the dust cover door as permanent scratches may result.

Clean the housing, dust cover door, and control panel with Miller-Stephenson MS260 or equivalent commercial grade cleaner.

3.4.14 Sartorius 2432-SR/W Analytic Balance

No operator maintenance specified.

3.4.15 Psychrometer

Instructions are given following to repair a split mercury column in a thermometer and to replace various components. A parts list and figures are given in the instrument manual.

(1) Split Mercury Column. A split or separated mercury (or organic) condition may result if the instrument is dropped. This is noticed by a gap in the mercury column inside the thermometer and

will cause erroneous readings. To reunite a separated mercury column, proceed as follows.

(a) Raise the instrument cover and hold open by placing water bottle between the rheostat and case bottom.

(b) Loosen the bolts that secure the thermometer rubber grommets and turn the retaining clips 90 degrees.

(c) With needle nose pliers, carefully grasp the rear grommet of the split column thermometer, lift the thermometer up, and gently pull out.

(d) A slight separation can usually be reunited by heating the bulb slowly in a soft flame (match) until the separated mercury and the main column both run into the safety chamber at the top of the thermometer bore. Remobe the grommet to allow viewing at the top of the scale. A slight jar will then reunite the mercury.

CAUTION: Never completely fill the expansion chamber with fluid as internal pressure will cause breakage. Care should be taken not to heat the thermometer bulb too fast.

If the safety chamber is too small to hold all the separated mercury, it is better to cool the bulb in dry ice until all the mercury runs into the bulb. When using this method, apply the dry ice to the bulb but not to the bore. If the mercury freezes solid, it can melt slowly at room temperature without danger of breakage provided it is not frozen in the bore.

(e) With the column congealed, replace the grommets so they align with the slots in the frame and set the thermometer gently in position.

(f) Insert the thermometer by depressing with thumb on grommet until thermometer is fully seated in frame. Failure to do this will cause the cover to not fully close and create air leaks and provide erroneous readings.

(g) Tighten retainers.

(2) Striker Plate. To replace striker plate, proceed as follows.

(a) Clean striker plate and area on cover to which the plate is to be adhered.

(b) Place instrument upside down with the water bottle wedge sideways between the rheostat and case to hold the cover apart from the magnet.

(c) With Devcon Corporation's "5-MINUTE EPOXY", or equivalent, (follow directions), apply a thin film of epoxy to one side of the plate only.

(d) Immediately place plate opposite magnetic on cover and allow to cure.

(3) Wick Replacement. If the wet bulb wick becomes contaminated and is difficult to wet, proceed as follows.

(a) Remove the wet bulb thermometer, see Section (1) above.

(b) Remove the wick and thoroughly clean the bulb.

(c) Slip 1-1/2-inch length of tubular wicking over the bulb with about 1/4 inch of material above the top of the bulb onto the stem.

(d) Secure the wick at the neck of the stem by looping a fine white cotton thread several times around and finally tie a tight square knot.

(e) Form a loop with a second thread and place it about 3/4 of the way down the bulb and pull toward the bottom. This will stretch the wick tight. When the loop slips over the end tie with a double square knot. Avoid touching the wick as much as possible.

(f) Replace the thermometer per Section (1) above.

(4) Batteries. The three D cell (1.5 volts) batteries are placed by simply raising the instrument cover and removing the batteries. Only a good grade of leak-proof batteries should be used as replacements. When the instrument is stored for a long period of

inactivity, replace the batteries. Always observe proper polarity when replacing.

(5) Lamp. To replace the lamp, proceed as follows.

(a) Raise the instrument cover and completely remove the two bolts, two nuts (located at bottom), and two retainers that secure the thermometer frame.

(b) Remove the thermometer frame.

(c) To remove the old lamp, depress and turn counter-clockwise.

(d) To install a new lamp, reverse the above steps.

3.5 INSTRUMENT SPECIFIC CALIBRATION PROCEDURES

Specific techniques for performing single and multi-point calibrations on the individual instruments are given in this section. Stepwise procedures are outlined in these sections; further detail on exact techniques is found in the appropriate instrument manual. References in all cases are the manufacturer manuals; further guidance on hi-vol calibrations is given in Section 2.2.6.2 of the EPA Quality Assurance Handbook, Volume II.

3.5.1 Meloy SA285E, SO_2 Analyzer

Calibration procedures for the Meloy SA285E SO_2 Analyzer are summarized in this section. Explicit techniques for performing the calibration and instrument checks are amply provided in the Meloy manual and should be consulted when performing these checks.

Calibration Data Sheet--Each individual analyzer is calibrated at the factory against a NBS permeation tube. A Calibration Data Sheet is supplied with each unit. This sheet contains information on temperature, flow, voltage, and current settings of the analyzer. Figure 3.5-1 depicts a typical data sheet. Items on the sheet are explained below, and on pages V-4 through V-6 of the instrument manual.

(1) Model Number--Indicates which model of analyzer (SA 285E).

(2) Serial Number--Manufacturer number assigned to the specific analyzer. Number also given on rear of analyzer (9L073).

(3) Options Number--Indicates the option numbers of the options supplied with the analyzer (S-5, S-25, S-26, S-30).

(4) Calibrator--Person's initials that performed the calibration.

(5) Date--The date of calibration.

(6) Oven Temperature--Temperature of photomultiplier tube module oven (houses photomultiplier tube and hydrogen restrictor).

(7) Block Temperature--Temperature of burner block.

(8) Test Number 1--High voltage verification.

(9) Test Number 2--Amplifier electrical check.

(10) Rotameter Flow Setting--The calibrated rotameter setting for hydrogen and sample air.

CALIBRATION DATA SHEET

Model Number: ______________________ Serial Number: ______________

Options: ____

Calibrator: ______________________ Date: ____________________

Temperature Settings:

Oven Temperature: __________ °C
Block Temperature: __________ °C

Test Position Meter Reading:

Test #1 (High Voltage): __________ % of meter
Test #2 (Amplifier) : __________ % of meter

Rotameter Flow Setting:

Hydrogen Flow: __________ mm
Air Flow : __________ mm

ZERO and SPAN Control Settings:

ZERO Knob: __________
SPAN Knob: __________

High Voltage: - __________ volts D.C.

Current Readings:

Flame-Off : ______________ AMPS
Flame-On (Zero Air) : ______________ AMPS
With 10 ppb SO_2 (net)* : ______________ AMPS
With 50 ppb SO_2 (net)* : ______________ AMPS
With 100 ppb SO_2 (net)* : ______________ AMPS
With 500 ppb SO_2 (net)* : ______________ AMPS
With 1000 ppb SO_2 (net)*: ______________ AMPS

*The net value is obtained by subtracting the flame-on current from the gross span reading or by setting the baseline to read zero with the zero adjustment while introducing zero air into the analyzer before taking span reading.

Figure 3.5-1. Typical Calibration Data Sheet for SA 285E

(11) Zero Knob--"ZERO" potentiometer setting.

(12) Span Knob--"SPAN" potentiometer setting.

(13) High Voltage--The voltage to the photomultiplier tube, measured between ground and TP1.

(14) Current Readings--The output current reading in amperes of the photomultiplier tube under conditions of flame-off (burner block not lit), flame-on (burner block lit and zero air introducted into analyzer), and with selected stated concentrations of sulfur dioxide introduced into burner block. These latter readings have the flame-on current subtracted to give a net reading due to only the sulfur dioxide concentration.

3.5.1.1 General Instructions. In addition to the required monthly multipoint calibration checks, the analyzer should be calibrated whenever the following is performed.

(1) Alignment or replacement of amplifier assembly, power supply board, temperature control board, or PMT.

(2) Changing of hydrogen or air flow rate from recommended values.

(3) Cleaning or replacement of burner block or Teflon lines.

For the FPD detector monitoring ambient air, there are no large effects by the constituents found in ambient air. There are some effects from the oxygen and carbon dioxide which, if they vary greatly, could cause significant error in the analyzer response. However, at a given location, the change in the oxygen and carbon dioxide is generally minimal. But, it is important that concentration of these constituents be the same in the zero and span gases as in the sample gas. This is very easy to accomplish. For zero air, draw sample gas through a charcoal column (to remove sulfur dioxide) and then to the analyzer. The air is to be obtained from the sample manifold or from the outside since the concentration of oxygen and carbon dioxide can vary inside a shelter, particularly when several persons are present.

For span gas, add a known amount of sulfur dioxide to charcoal scrubbed sample air. Gas cylinders, heatless dryers, carbon dioxide adsorption column such as soda lime or Ascarite should not be used in the zero air or span gas systems unless it is verified these systems yield the same oxygen and carbon dioxide concentration as in the ambient sample air.

3.5.1.2 Calibration Procedures. Single-point "precision checks" and multi-point calibration checks are to be performed using the CSI 1700/1750 Calibrator System, which utilizes an NBS traceable permeation tube to supply SO_2, and mass flow controllers to regulate the mixture of SO_2 and zero air to supply span gas at desirable concentrations.

(1) Preliminary Set-Up--connect the output of the CSI 1700 manifold (vented) to the H_2S scrubber, which in turn enters the analyzer at the ambient input port labelled SAMPLE DIRECT. Use sample line that is the same length and inside diameter as is used in ambient sampling. Verify that the analyzer has stabilized, and that the flows, voltages, temperatures, and amplifier and output boards are functioning and set correctly. Also, check that the span gas flow is at least 300 cc/minute to provide adequate sample flow to the analyzer. Use the SX-410 Data System readout for all analyzer output readings.

Set the front panel function switches as follows.

(a) Set SPAN and ZERO pots to values recorded at last calibration.

(b) Set the hydrogen flow to the value listed on the calibration data sheet supplied with the analyzer or printed on the front panel near the bottom of the rotameter.

(c) Allow 15 minutes for the internal temperatures of the instrument to stabilize and reset the hydrogen flow as above.

(d) Place the MODE switch in the SAMPLE position.

(e) Use the 0-500 ppb range (as for ambient monitoring) and the time constant at 1 second.

(2) Analyzer Calibration Procedure.

(a) Introduce zero air (from the CSI 1700) into the SAMPLE line.

(b) After a stable reading is obtained, adjust the ZERO control on the front panel so that the analyzer output reads 0 ppb on the SX-910 readout.

(c) Introduce (at ambient pressure) a SO_2 concentration equivalent to 90 per cent full scale of the range to be calibrated (i.e. for the 500 ppb scale introduce 450 ppb into the SAMPLE line).

(d) Record the output after a stable reading is obtained. If this value is not within 25 ppb of the input concentration, check flow and accuracy of span spource. If everything appears to be functioning correctly, perform maintenance checks and, if necessary, electronic alignment as described in Section 3.4.

(e) If the output is within 25 ppb of the input concentration, adjust the SPAN control so that the output reads the desired value.

(f) Repeat steps "a" through "e" until no further adjustments of the ZERO and SPAN controls are necessary.

(g) For each range to be calibrated, introduce five accurately known concentrations approximately evenly spaced across the scale for that range and zero air. For example, on the 500 ppb range, 450, 300, 200, 100, 50, and 0 ppb are recommended. Record the output readings on the SX-410 readout for each concentration.

(h) Plot the measured concentration versus concentration. This curve represents the calibrated output of the analyzer. If the curve does not appear linear, perform an electronic re-alignment described in Section 3.4.

Record the measured and input concentrations, and retain the plot relating the two.

3.5.2 Columbia Scientific Industries (CSI) 1600, Oxides of Nitrogen Analyzer

Calibration procedures for the CSI 1600 are given in this section. These procedures utilize the CSI 1700/1750 Calibration System to provide zero air; ozone is also provided by the CSI 1700/1750 to perform the gas phase titration analysis to calibrate the NO_2 channel of the CSI 1600.

Further detail on explicit techniques for performing the calibration and instrument checks is provided in the CSI 1600 manual. Additional instructions are found in the CSI 1700/1750 manual. Calibrations in this section presume proper operation of the CSI 1700/1750 system; the maintenance procedures for the CSI 1600 are found in Subsection 3.4.5.

Principle--the gas phase titration (GPT) calibration technique is based upon the rapid gas phase reaction between NO and O_3 (ozone) to produce stochiometric quantities of NO_2 in accordance with the following equation.

$$NO + O_3 \rightarrow NO_2 + O_2$$

The quantitative nature of this reaction is such that when the NO concentration is known, the concentration of NO_2 can be determined. Ozone is added to excess NO in a dynamic calibration system, and the NO channel of the analyzer is used as an indicator of changes in NO concentration. Upon the addition of O_3, the decrease in NO concentration observed on the calibrated NO channel is equivalent to the concentration of NO_2 produced. The amount of NO_2 generated may be varied by adding variable amounts of O_3 from a stable uncalibrated ozone generator.

3.5.2.1 NO Calibration. Nitric oxide (NO) gas is included in the bottle of calibration gas at concentrations traceable to NBS standards. Concentrations fed to the CSI 1600 Oxides of Nitrogen Analyzer are controlled by the mass flow controllers in the CSI 1700 Calibrator. Accurate measurement of NO is essential for accurate calibration and ambient measurement of NO_2.

(1) Connect the calibration gas bottle containing NO (and SO_2) in N_2 to the NO port on the rear of the CSI 1700; the AIR (zero air) port is connected to the AIR OUT port of the CSI 1750.

(2) Adjust the flow rates of calibration gas and zero air through the respective mass flow controllers in the CSI 1700 to obtain the desired concentration levels using the proper correction curves. For single-point span and precision checks, this level should be between 80 and 100 ppb. Multi-point calibration checks are to be performed at five intervals and zero, i.e., 0, 50, 100, 200, 300, and 450 ppb. Concentrations are computed as given in the beginning of Section 3.2.

(3) Record the measured zero and span concentrations along with the corresponding input concentrations. Perform NO and NO_x span adjustments when appropriate, and note in the logs whether adjustments were made. NOTE: Do not make adjustments prior to precision checks or a "before" version of a multi-point calibration check.

3.5.2.2 NO_2 Calibration.

(1) Adjust the CSI 1700 such that approximately 450 ppb of NO is being input to the CSI 1600; record the measurement. Sample lines are positioned the same as above.

(2) Add a small amount of ozone to the stream of calibration gas. The exact ozone concentration is not significant. Note the decrease in the NO concentration; this should equal the amount of NO_2 measured. Record the original NO concentration, the ozone setting on the CSI 1700, and the observed NO, NO_2, and NO_x concentrations.

(3) Increase ozone flow rates by an incremental amount and repeat the observations as in the previous step. Do this until the NO concentrations are approximately 1 per cent of the original level. At least five points should be obtained.

(4) Plot the observed NO_2 concentrations versus the difference between the original and final NO concentrations. Compute the linear regression. When the slope is less than 0.9 or over 1.1, or when the intercept is over 25 ppb, or less than -25 ppb, perform maintenance checks described in Subsection 3.4.2. Also consult maintenance procedures if the correlation coefficient is less than 0.9, or if the plotted points exhibit a non-linear trend about the regression line.

3.5.2.3 Converter Efficiency. Efficiency of the NO_2 to NO converter is determined using data obtained during the GPT above. The amount of NO_2 converted is computed as:

$$NO_2\ (conv) = NO\ (orig) - NO\ (rem) - [NO_x\ (orig) - NO_x\ (rem)],$$

where: orig and rem are the respective original and remaining concentrations.

Compute a linear regression of the NO_2 (converted) on the y-axis versus the [NO (orig) - NO (rem)] on the x-axis. The slope computed is the converter efficiency and should not be less than 96 per cent. If less, consult the maintenance procedures given in Subsection 3.4.2.

3.5.3 Monitor Labs (ML) 8310, Carbon Monoxide Analyzer

Calibration procedures on the ML 8310 CO analyzer are presented in this section. Further detail on techniques is given in the instrument manual.

Procedures follow for performing calibration checks and adjustments. Do not make adjustments until obtaining a complete calibration check. Daily zero/span check procedures are different, and are given in Subsection 3.5.3.2.

3.5.3.1 Calibration Procedures.

(1) Connect the output of the CSI 1700 Calibrator to the SAMPLE inlet of the analyzer. Connect the CO span gas bottle to the NO in port, and the zero air bottle to the zero air source.

(2) Set the CSI 1700 for approximately 2 liters per minute. Use the correction curves for CO-in-air.

(3) Verify that the range switch on the CO analyzer is set to 50 ppm for the entire calibration (and any adjustments). Leave the mode switch on MONITOR.

(4) Observe and record the zero air response after 5 minutes of stabilization time. Use the SX-410 Data System readout for all analyzer response observations.

(5) Set the CSI 1700 for approximately 30 ppm; concentrations are computed by using the equation given in the beginning of Section 3.2. Wait at least 5 minutes for stabilization. Record this response.

(6) Repeat the last step for concentration levels near 20, 10, 5, and 0 ppm.

(7) Plot the input versus responses on linear graph paper. Compute and plot the linear regression equation, and record the correlation coefficient. If the plotted points do not appear linear

(correlation coefficient less than 0.9), if the slope is excessive (greater than 1.1 or less than 0.9), or if the intercept is greater than 5 or less than -5, perform the calibration over. If, by visual inspection, one point is extremely out of line with the other points, then re-do that point only, and re-compute the linear regression. If the second calibration results are similar, perform maintenance actions described in Subsection 3.4.3.

3.5.3.2 Daily Zero/Span Check. This analyzer (S/N 81) is equipped with Option 02A, which includes a system of solenoid-operated valves, a CO gas flow restrictor, and pressure regulator. Front panel controls enable the operator to perform a zero and one-point span check at a predetermined level. While not as accurate as the procedure given above, it is useful for frequent checking to determine the necessity of performing a full-scale calibration and possible adjustments or maintenance.

Option 07A is also included. This is a 24 volts dc power supply which allows for remote operation of the zero/span check. The SX-410 auto-calibration control includes this parameter.

In Zero mode, valve SV1 is operated and causes both Reference and Sample gas streams to pass through the CO-CO_2 converter. Thus, the analyzer sees no difference between the two gas streams and produces a Zero output.

In Span mode, both valves SV1 and SV2 are operated. Thus, both Reference and Sample gas streams pass through the CO-CO_2 converter, but a metered quantity of span gas is added to the Sample gas stream. This causes the analyzer to produce a Span output dependent on the concentration and quantity of CO span gas added.

(1) Connect the CO calibration cylinder to the CO span gas pressure gauge inlet, which in turn leads to valve SV2.

(2) These checks may be made by pressing the ZERO and SPAN buttons on the front of the analyzer. When finished, leave the analyzer in the MONITOR mode, which will allow for automatic checking by the SX-410.

3.5.4 Thermo-Electron Corporation 110 and 102S Calibrators

The TECO calibrators supply zero air and the dilution control of span gas for the "daily zero/span checks" described in Section 3.2. Internal pressure regulators and capillary tubes determine flow rates. These flow rates are checked by use of the bubble meter apparatus described in Subsection 3.5.10. Instructions for use of the bubble meter are found in that instrument manual.

3.5.5 Columbia Scientific Idustries Model 1700/1750 Calibrator

Calibration procedures for the CSI 1700 unit are limited to flow control verification by use of the bubble meter, whose operation is described in Subsection 3.5.10. Proper operation of the mass flow controllers is essential to calculating concentrations used in other calibrations.

Cross-checks on output of the SO_2 permeation tube are made by verification of the flow rates across the permeation tube. The tube is certified for generation of SO_2 at a given flow rate and precise temperature range, within ±0.1 C. Internal equipment checks specified in the instrument manuals will assist in verification of these operational parameters.

3.5.6 SumX Corporation SX-410, Data Acquisition System

No specific calibration procedures are specified for the SX-410. System redundancies allow for comparisons of functions of the SX-410. Consult maintenance procedures when discrepancies arise.

3.5.7 Molytek Strip Chart Recorder

Operational functions of the strip chart recorders, including zero, span, and timing functions will be checked at least monthly according to manufacturer specified procedures. Timing is continually checked when the charts are marked on site visits and data examined during data processing checks.

Zero position is checked by shorting the terminals of the recorder. An adjustment for pen position is on the front of the recorder. Span positions can be checked by comparing the voltage observed on the SX-410 digital readout and the pen position on the chart. Consult maintenance procedures in Subsection 3.4.7 for span adjustments.

3.5.8 General Metals GMWL 2000H High Volume Air Sampler

Samplers were calibrated when first purchased; further calibrations are to be done after major maintenance (e.g., replacement of motor or motor brushes), any time the flow rate measuring device (recorder) has to be replaced or repaired, or any time a one-point audit check deviates more than ±7 per cent from the calibration curve.

In using the orifice calibration unit to calibrate a sampler, correct the indicated flow rate if the ambient temperature or barometric pressure is substantially different (see Step 13) from those recorded when the orifice unit was calibrated. Orifice calibration conditions come with the curves, field ambient conditions are obtained from the site's outside air temperature and the barometric pressure reading made on site.

Steps to be used in calibrating the hi-vol follow. All data taken during the initial and final calibrations for one hi-vol are recorded on the same page in the hi-vol calibration log. If the sampler is being calibrated after it has been serviced, record the data on the "Initial" section of the calibration log. If the sampler is being calibrated prior to scheduled maintenance, record the data under the "Final" section of the calibration log. An example of the type of form used is given in Appendix A.

The stepwise calibration procedure for this model of hi-vol sampler is presented below.

(1) Assemble a hi-vol with a clean filter and operate it for at least 15 minutes at 115 volts. If a step-down transformer is used during normal operation, then calibration should be performed with the transformer in operation. The transformer is not in use now.

(2) Record the flow recorder number and data on three gummed labels. Affix one gummed label to the very top of the metal face on the front of the flow recorder. Affix another gummed label to the

middle of the vacuum hose and affix the last gummed label to the other side of the hi-vol motor.

(3) Install a clean recorder chart and check the recorder for proper operation. Zero the pen if necessary.

(4) Remove the filter holder.

(5) Attach the calibrated orifice with one of the load plates between the motor and the orifice.

(6) Turn the motor on and record the water manometer and flow recorder readings after they stabilize.

(7) Turn the motor off.

(8) Repeat Steps 5-7 for each of the other load plates.

(9) Repeat Steps 5-8 once.

(10) Determine and record the air flow rate as read from the hi-vol orifice calibration curve for each manometer reading.

(11) Record the barometric pressure in mm Hg and temperature in C.

(12) Determine the per cent difference between the temperature and barometric pressure recorded and the temperature and barometric pressure measured when the hi-vol orifice was calibrated.

  (a) If the recorded barometric pressure is within ±15 per cent range and the recorded temperature is within ±100 per cent range, proceed to step 15.

  (b) Otherwise, proceed to step 13.

(13) Convert the temperature measured when the hi-vol orifice was calibrated (T_1) and the temperature recorded in Step 12 above (T_2) to absolute temperature (K), by adding 273 K to T_1 and T_2.

(14) Determine the true flow rates corrected to the barometric pressure and temperature recorded in step 12 above. This is done by substituting each of the flow rates determined in step 11 above for Q_1 in the following equation and solving for Q_2.

$$Q_2 = Q_1 \left(\frac{T_2 P_1}{T_1 P_2} \right)^{1/2} \qquad \text{(Equation 3.5-1)}$$

where

Q_1 = flow rate determined in step 11 above,
Q_2 = corrected flow rate,
P_1 = barometric pressure measured when the hi-vol orifice was calibrated,
P_2 = barometric pressure recorded in step 12 above,
T_1 = absolute temperature determined at the time the hi-vol orifice was calibrated, K,
T_2 = absolute temperature determined from step 12, K.

(15) Plot the flow recorder readings versus the air flow rates.

(16) Use a French curve or a curve-fitting technique such as the least squares fit, to draw a best fit smooth curve through the calibration points.

(17) If any calibration point does not fall within ±5 per cent of the curve, or causes the curve to be S-shaped or have a sharp turn, rerun that point, recalculate, and replot. The per cent deviation can be calculated by taking the questionable rate (Q_o) and the calibration curve flow rate (Q_c) for the same flow meter reading.

$$\text{Per cent deviation} = \frac{(Q_o - Q_c)}{Q_c} \times 100 \qquad \text{(Equation 3.5-2)}$$

The per cent deviation should fall within ±5 per cent.

(18) Compute a linear regression of the air flow rates (corrected from steps 11 and 12 if necessary), Y, taken from the manometer as a function of the indicated flow rate on the recorder, X. This equation is to be used in data reduction as discussed in Subsection 3.6.2.2.

3.5.9 Sierra Instruments Model 244 Dichotomous Sampler

Flow rate checks are to be performed on the dichotomous sampler using the manufacturer supplied Model 247 Total Flow Audit Analyzer. This is a device which provides a flow measurement point in the lines. The Bubble

Meter (described in Subsection 3.5.10) is used to measure flow rates. The largest cylinder, 1,000 cc, is adequate for the 1.67 lpm flow rate of the coarse flow portion.

3.5.10 Teledyne-Hastings-Raydist Bubble Meter

Gas from the instrument being calibrated enters the inlet. The appropriate graduated tube is selected from the set of different sizes depending upon the range needed. Soap bubbles are introduced by squeezing a rubber bulb and raising the soap solution above the inlet. The gas rises through the cylinder with the bubble; the rise of the bubble between selected volume markings is timed. The bubbles act as frictionless pistons. A pressure of 0.02 inches H_2O is all that is required to raise the bubbles at a uniform rate.

Typically, soap bubble meters are accurate to within 1 per cent. However, with carefully controlled conditions and for relatively nonreactive and insoluble gases, accuracies of ±0.25 per cent have been achieved. As the flow rate decreases to 1 or 2 ml/min, the accuracy declines because of gas permeation through the soap film.

When correcting for standard temperature and pressure conditions, it is necessary to include the vapor pressure of water. The flow rate at standard conditions is given by the following equation.

$$\text{Flow (Std. cc/min)} = \frac{\text{Volume (cc)}}{\text{Time (min)}} \quad \frac{(P-Pv)(Hg)}{29.92} \quad \frac{293}{T(C)+273}$$

The vapor pressure of water (Pv) is given (in inches of mercury) in Table 3.5-1.

TABLE 3.5-1. VAPOR PRESSURES OF WATER

Sampled Temperature C	Pv in. Hg	T	Pv
15	0.50	24	0.88
16	0.54	25	0.96
17	0.57	26	0.99
18	0.61	27	1.06
19	0.65	28	1.12
20	0.69	29	1.18
21	0.73	30	1.25
22	0.78	31	1.33
23	0.83	32	1.40

3.6 DATA REPORTING AND VALIDATION

3.6.1 Introduction

This section contains descriptions of the procedures used in the reduction, validation, and presentation of ambient meteorology and air quality data collected at the Curtis H. Stanton Energy Center location near Orlando, Florida. Items covered herein include the shipping, processing, validation, and summarizing of the continuous monitor and the 24-hour integrated sample particulate data.

3.6.2 Data Transmission

Steps and schedules used in sending the data from SSAI offices in Florida to the Black & Veatch offices in Kansas City are described in this section.

3.6.2.1 Continuous Monitor Data. The magnetic tape from the Tandberg recorder, the printer output, and the paper strip charts are to be changed and then sent with copies of the field log sheets to B&V in Kansas City twice monthly at approximately equally spaced intervals. Copies of the field logs will be retained at the site and at SSAI offices as described in Subsection 3.1.1. One of these bi-monthly data changes should occur on or soon after the first of the month, but not the end of the previous month. The tape(s) and field log sheet(s) should be sent together in one package and printer output and the strip charts in another package. The two packages should be sent by different methods (e.g. US Mail and UPS) and/or on different days. Once received in Kansas City, the items are to be recorded as having arrived and subsequently stored for use in processing; magnetic tapes are to be given to Computer Services personnel.

3.6.2.2 Particulate Data. All filters will be retained by SSAI except those sent elsewhere for microscopic and/or elemental analyses. Photocopies of the TSP and Dichotomous Sampler filter envelopes, containing all information spaces filled in or explanations for missing items, are to be sent to Kansas City with one of the above-mentioned data packages. The photocopies will be stored with data as described above.

3.6.3 Data Reduction

All data-handling steps are described in this section, including those done by the SX-410 data acquisition system at the monitoring site. These include editing procedures involving "flagging" (annotating specific data portions) for data validation. Actual editing, which will typically involve data deletion, is made only after the suspect data are shown to be invalid after inspection by a qualified person. Finally, a data file of the valid 1-hour averages is created which may be subsequently summarized for analysis.

3.6.3.1 Data Acquisition System. The data acquisition system used at the monitoring site is the SX-410 manufactured by the SumX Corporation of Austin, Texas. This unit basically consists of two microprocessors which perform automatic control functions of handling incoming data, recording status information, and controlling the automatic daily zero/span checks. Some onsite control over operational parameters is possible by addressing the system through the keyboard printer. Such entries are recorded on the magnetic tape and the hard copy generated by the onsite printer. A list of the possible keyboard entries and the function for each is given in Table 3.1-3. Examples of printer output are contained in Appendix A. An internal clock routinely keeps time and also keeps time during power outages, which are documented at the time of the automatic re-start when the power is on again.

Analyzer signal readings are made once every 5 seconds; these values are averaged for 5 minutes, stored in the SX-410, and are written to the magnetic tape and the keyboard printer hourly along with 1-hour averages and all applicable status information. The averages are arithmetic mean values (scalar averages); vector averages are computed from the wind speed and direction data. The standard deviation of the wind direction is computed for the 5-minute sampling time and then averaged for 1 hour. Status information included with the data is an indication of operational status, manual or automatic calibration modes, and power outages.

Operation of the system is described in manufacturer literature, including "Application Note (AN80-003) SX-410 Magnetic Tape Recording

Format." Further information on procedures used by the onsite operator are contained in the field operations procedures in Section 3.1.

In summary, the resulting data file contains 5-minute, 1-hour, and daily averages in engineering units with status flags where applicable, along with power outage records and operator initiated messages.

3.6.3.2 Continuous Monitor Data. Magnetic tapes are changed at least twice monthly and are sent to the B&V offices in Kansas City along with printer output, strip charts, and field logs. While the SX-410 data acquisition system computes hourly and daily averages, the routine offsite processing begins by creating a usable file of 5-minute averages in order to apply further edit criteria and to allow for using different constants in relating signal voltage to actual concentrations. These data are checked for status information; calibration data are kept separate from ambient monitoring data. Input parameters to the computerized data reduction program include constants (derived from analyzer calibration results) which relate recorded data to actual concentrations. The concentrations in the preliminary output will be expressed in parts per billion by volume (ppb) for more efficient comparisons with field notes and strip chart data; wind speeds will similarly be in miles per hour.

As a step in data validations, the 5-minute averages of ambient monitoring data are automatically checked for possible outliers in both absolute and relative senses. The specific limits for absolute values and for differences between successive readings will reflect the remote nature of the site, i.e., the limits will be low numbers. For example, the respective absolute and relative limits for NO, NO_2, NO_x, and SO_2 will be 100 and 50 ppb. These limits may be raised or lowered depending on the preliminary data collected; too high a limit can allow invalid data to be processed undetected, while limits which are too low cause excessive data flagging, which can mask invalid data.

One-hour averages are computed for clock-hours for which at least 2/3 (eight of twelve) valid observations were recorded. Five minute average air quality data concentrations which are below the minimum detectable limit (MDL) of the instrument, as specified by the manufacturer, are recorded in the data file as a concentration equal to one-half the MDL. A printout of the hourly averages is generated which includes status information from the SX-410, flags generated by the B&V computer indicating possible edits, zero/span check results, and the five highest 1-hour average concentrations reported for each air quality parameter in the reporting period.

An additional parameter, atmospheric stability, is created and included in the data file which will make sorting for data summaries and correlations more efficient in analytic routines applied later. For this program, stability will be based on the standard deviation of the wind direction ("sigma theta") according to values given in "Meteorology and Atomic Energy" (1968; AEC; D. Slade, ed.; p. 102). These category midpoint values, which relate the 1-hour averages of the 5-minute sampling time sigma theta data to the six standard Pasquill stability categories used in dispersion modeling considerations are A = 25°, B = 20°, C = 15°, D = 10°, E = 5°, and F = 2.5°.

Once the suspect points are flagged, a qualified person knowledgeable of the data will examine the annotated printout to begin the editing portion of the validation process. Portions of the data are examined which are of doubtful validity as identified by the automatic flagging by the B&V computer program, by daily zero/span check results showing excessive deviations from input concentrations, or by notes made by the onsite operator in the field logs. Examination of the data includes cross-checking data printouts with field logs, daily zero/span check results, and strip charts. Those portions of the data from periods associated with zero/span drifts in excess of 25 per cent deviation from the input span value are invalidated. Other periods are similarly invalidated which are known to contain invalid data based on notes from the field operator concerning instrument malfunctions or on knowledgeable examination of the notes and strip charts. Data judged to be invalid by the above criteria are deleted from the file of 1-hour averages.

Once a file of valid 1-hour averages is created, the units for the air quality parameters will be changed to micrograms per cubic meter by appropriate conversions, the speeds to meters per second, and precipitation to millimeters.

3.6.3.3 Strip Chart Data. Analog traces of all data are recorded on paper charts in parallel to the digital magnetic tape system described previously. These data are primarliy used to validate data shown to be suspect by automatic flagging procedures or by operator notes. The details contained in the analog traces are useful in these validation processes.

Should the SX-410 data acquisition system fail, the data will be retrieved from strip charts. Ambient monitoring data as well as the daily zero/span check results will be recorded on these strip charts.

Strip chart data reduction procedures to be utilized will be those described in pages 8-10 of Section 2.0.3 in Volume II of the EPA Quality Assurance Handbook (EPA-600/4-77-027a). These data will then be used to create a data file and inserted into the data processing stream at the appropriate point.

3.6.3.4 Manually Sampled Data. Total suspended particulate (TSP) data and the respirable fraction of inhalable particles data (from the dichotomous sampler) are processed using gravimetric procedures and records of airflow through the samplers. The calculations for determining concentrations are described in Section 2.2.6 of Volume II of the EPA Quality Assurance Handbook. Approximately 7 per cent of the calculations will be repeated by B&V (Kansas City) personnel to validate the computations.

Data reporting requirements specify standard conditions. Equation 3.6-1 is a general expression which uses the hi-vol flow rate, obtained from the corrected flow rate based on the flow recorder and calibration results, to determine the total volume of air sampled.

$$V_s = Q_2 t \left(\frac{P_2 T_s}{P_s T_s} \right) \qquad \text{(Equation 3.6-1)}$$

where

V_s = sample volume at 760 mm Hg and 298 K,
Q_2 = corrected flow rate at sampling conditions, m^3/min,
t = time, min,
P_2 = atmospheric pressure at sampling conditions, mm Hg,
T_s = ambient temperature at standard conditions, 298 K,
P_s = standard pressure, 760 mm Hg, and
T_2 = ambient temperature at sampling conditions, K.

Due to the relative insensitivity of this calculation to the small daily average pressure variations, the above equation is modified to that given in equation 3.6-2. For this, the annual average pressure (1,018 mb) was used. Thus, $P_2/P_s = 1.0047$.

Steps in computing Total Suspended Particulate data are as follows.

(1) Obtain average indicated flow rate from chart.

(2) Obtain corresponding time average flow, Q_t, by relating the indicated flow rate to a true flow rate derived from the calibration results. Uses the slope and intercept in a linear equation as given following.

$$Q_t = m \times Q_i + b, \qquad \text{(Equation 3.6-2)}$$

Where "m" and "b" are the slope and intercept, respectively, derived from the linear regression computed in Step 18 of Section 3.5.8. Both flow rates are in cubic feet per minute (ft^3/min.).

(3) Obtain daily average temperature outside, T (K), from the Daily Summary printout, add 273.2.

(4) Compute volume sampled (standard temperature and pressure).

(Equation 3.6-3)

$$V_{STP}\ (m^3) = Q_t\ (ft^3/min) \times \text{time (elapsed, min.)} \times 8.48/T(K).$$

(5) Compute average particulate mass concentration as follows.

(Equation 3.6-4)

$$TSP\ (\mu g/m^3) = \frac{\text{[Final - Initial] Weight (mg)} \times 1000}{V_{STP}\ (m^3)}$$

Mass collected on the dichotomous sampler filters is derived in the same method as that given above for hi-vol filters, with the following corrections included.

A correction is made for the relatively small mass of fine particles collected on the coarse filter.

$$C_f = \frac{M_f}{Q_f t} \qquad 3.6\text{-}4$$

$$C_c = \frac{M_c - C_f\ Q_c t}{Q_T t} = \frac{1}{Q_T t}\left(M_c - \frac{Q_c}{Q_f} M_f\right) \qquad 3.6\text{-}5$$

where

M_f = the particulate mass on the fine-particle filter (micro-grams), obtained gravimetrically,

M_c = the particulate mass on the coarse-particle filter (micro-grams), obtained gravimetrically,

t = the sampling time (hours), from the digital elapsed time indicator,

Q_f = fine-particle flow rate (cmh), from the front panel rotometer,

Q_c = coarse-particle flow rate (cmh), and

Q_T = $Q_f + Q_c$ total flow rate (cmh), from the front panel rotometer.

Inserting the operating values of the flow rates of 0.1, 0.9 and 1.0 cmh for Q_c, Q_f, and Q_T, respectively, in the above equations, the concentrations are calculated using the following equations.

$$C_f = \frac{1.11\ M_f}{t} \quad \text{and} \qquad 3.6\text{-}6$$

$$C_c = \frac{M_c - 0.111\ M_f}{t} \qquad 3.6\text{-}7$$

3.6.4 Data Summaries

At this point in the continuous monitor data processing scheme, there is a file of valid 1-hour averages in proper units. These units are degrees for wind direction, meters per second for wind speed, degrees celsius for temperatures and dew point, millimeters for precipitation, and micrograms per cubic meter for all air quality parameters.

Running averages of 3, 8, and 24 hours will be computed and listed for the parameters pertaining to appropriate national ambient air quality standards (NAAQS). The five highest concentrations of each parameter occurring during the reporting period are tabulated separately. The 24-hour integrated samples of particulate data will be handled separately due to their inherently different nature compared to the continuous monitor data.

Wind data are to be summarized monthly, quarterly, and annually using standard bivariate distribution of 6-speed and 16-direction categories that are used in dispersion modeling.

The computer software at B&V has the capability of displaying data in many different ways. Typical summaries of meteorological data and air quality data can be generated. Stability wind roses and pollution roses are examples. Hourly sequences of meteorological parameters can be produced which are compatible with specific EPA atmospheric dispersion models. Those data displays that are determined to be of value to this specific project will be generated.

4.0 AUDIT PROCEDURES

Quality assurance procedures outlined in Appendix B to 40 CFR 58 (Vol. 44, No. 92, p. 27582-4) are included throughout the preceding sections describing initialization and routine data gathering and processing procedures. The procedures described in this section are the quality control procedures applied to the overall program. This phase of the quality assurance includes performance and system audits, data assessment, and subsequent corrective actions.

Once during each quarter of the operational year, the "accuracy" of each analyzer will be assessed in accordance with procedures specified in Sections 3.2 and 3.4 and calculations made according to Sections 4.2 and 5.2, all of Appendix B in 40 CFR 58. Section 2.08 of the EPA Quality Assurance Handbook will contain basically the same information when included in Volume II (EPA.600/4-77-027a).

Independence is achieved in that an outside contractor, anticipated to be the SumX Corporation, will supply personnel and equipment to perform this function. The calibration equipment used for the continuous monitors will be the same type as that used on the precision checks.

4.1 PERFORMANCE AUDITS

Quantitative assessment data are collected during performance audits by the independent multi-point calibration checks on the continuous gas analyzers and by the flow calibrations on the hi-vol units.

4.1.1 Continuous Monitors

Accuracy assessment on the continuous gas analyzers is made by performing a multi-point calibration check at specified concentration levels using separate personnel and test equipment from that used in routine operations. Levels used will be those specified in Section 3.2 of Appendix B to 40 CFR 58. The CSI 1750 calibration unit contains an SO_2 permeation tube which provides the source of SO_2 span gas. The CSI 1700 unit contains mass flow controllers which regulate the concentration levels by mixing zero air with the appropriate span gases.

These results will be tabulated on appropriate forms (similar to those used for other multi-point calibration checks examples are shown in Appendix A). Calculations to assess data quality are described in Section 4.3 of this manual.

4.1.2 Manual Method--TSP and Dichotomous Samples

Accuracy assessment for the hi-vol TSP measurement consists of a flow calibration using the resistance plate in a calibration head method. This procedure was described in Section 3.3. The flow calibration for the dichotomous sampler is also described in Section 3.3. Calculation procedures are given in Section 4.3 of this manual.

4.2 SYSTEM AUDITS

Periodic qualitative onsite inspections will be carried out by B&V (Kansas City) personnel at the main monitoring site and at the SSAI laboratory facility.

In addition, EPA personnel will be invited to perform a systems audit on the program after commencement of the measurements.

4.3 DATA ASSESSMENT CALCULATIONS

Assessment of the monitoring data consists of computation of precision, accuracy, and completeness. Methods of performing these computations are given in this section; these were taken from Sections 4 and 5 of Appendix B to 40 CFR 58. These procedures are done quarterly, and the results are included with monitoring data.

4.3.1 Precision

One-point span checks performed every other week on the continuous gas analyzers using the CSI 1700/1750 system are used to compute precision. The assessment parameter for gas analyzer precision is the difference between the "measured" and the "known" concentrations. The mean and standard deviations of the differences are computed as follows.

In the following equations, "Σ" refers to the sum of each "i" term from the first on through the "nth" check or comparison point; also known as:

$$\sum_{i=1}^{n} .$$

(1) Calculate the percentage difference (d_i) for each precision check according to the following equation.

$$d_i = \frac{Y-X}{X} \cdot 100$$

Where Y is the measured concentration from the analyzer and X is the known concentration of the precision check gas.

(2) Calculate the quarterly average percentage difference ($\bar{d}$) by the following equation.

$$\bar{d} = \frac{1}{n} \Sigma \, d_i$$

Where n is the number of precision checks on the instrument made during the quarter period.

(3) Calculate the standard deviation (S) of the concentration differences according to the following equation.

$$S = \sqrt{\frac{1}{n-1}\left[\Sigma \, d_i^2 - \frac{1}{n}(\Sigma \, d_i)^2\right]},$$

Where n is the number of precision checks.

(4) Calculate the 95 per cent probability limits for the precision check results using the following equations.

$$\text{Upper 95 per cent probability limit} = \bar{d} + 1.96S$$

$$\text{Lower 95 per cent probability limit} = \bar{d} - 1.96S$$

These summary statistics are computed for the quarterly period for each parameter.

Precision for the TSP measurement is similarly computed using the differences between the TSP values measured by the routine and the collocated samplers. The same equations as above are used where Y is the concentration of pollutant measured by the duplicate sampler and X is the concentration of pollutant measured by the official sampler. Calculate the 95 per cent probability limits for the precision of the collocated samplers using the following equations.

$$\text{Upper 95 per cent probability limit} = \bar{d} + 1.96\ S/\sqrt{2}$$

$$\text{Upper 95 per cent probability limit} = \bar{d} - 1.96\ S/\sqrt{2}$$

4.3.2 Accuracy

Computation of "accuracy" data for gas analyzers is simply to calculate the differences between the "measured" and the "known" concentrations derived from the checks described in Section 4.1. The resulting differences for each audit level are reported quarterly with monitoring data.

Similarly for the hi-vol samplers, the difference in flow rates are computed between the "known" value from the calibration head and the "measured" value from the normal instrument indicator. These, too, are reported quarterly with monitoring data. No summary statistics are computed for the "accuracy" data.

4.3.3 Completeness

Amount of the monitoring data collected is to be reported as a data recovery rate quarterly with monitoring data. Usable data are hourly averages of valid monitoring data and calibration periods. Ambient monitoring guidelines for PSD studies (EPA-45012-78-019, OAQPS 1.2-096, May 1978) require 90 per cent recovery on meteorological data and 80 per cent on air quality data.

4.3.4 Quality Assurance Data Reporting

At the end of each sampling quarter, B&V will report to EPA and Florida DER the quarterly precision and accuracy data. Examples of this type of reporting are included in Appendix A.

4.4 CORRECTIVE ACTION

While there are no specific limits for quality assurance data acceptance as are applied to the daily zero/span checks, it is recognized that the data should be invalidated if precision limits do not meet the ±25 per cent criteria applicable to the daily checks. Control charts similar to those used for daily zero/span checks will be kept up for precision checks. Thus, problems will be recognized well before the end of a quarter period. When such precision problems become apparent, stricter maintenance and more frequent multi-point calibration checks will be made until the cause of a lack of precision is alleviated.

Accuracy checks are different in that the results are based on a single multi-point calibration check. If these results show excessive deviations compared to the monthly calibration results, it will first be necessary to verify that the deviation is in fact due to an anlyzer discrepancy and not the independent calibrator. In turn, the CSI 1700/1750 system used for the precision checks would have to be compared to the independent calibrator. True instrumental problems recognized with an analyzer would result in further investigation to determine whether the problem had just arisen or was the result of a systematic procedural error.

It is not possible to enumerate every possible source of error which could be discussed by application of quality assurance assessment procedures. Nevertheless, the structure of having frequent contact between the persons responsible for the program will assure minimal loss of air quality data when situations arise with data found to be out of the specified control limits.

5.0 AIR MONITORING PROGRAM STRUCTURE

5.1 ROUTINE OPERATION STRUCTURE

The program structure consists of a Project Manager at B&V (Kansas City) who is responsible for overall program management. He is assisted by the Field Services Manager from SSAI. The Field Services Manager is responsible for all operations performed onsite and in the Dunedin laboratory. In this capacity, the Field Services Manager supervises the operator/technician who performs the onsite operations and maintenance functions. Also at B&V, the Quality Assurance Coordinator is responsible for supervising, reviewing, and updating the quality assurance program for this air monitoring project.

5.2 QUALITY ASSURANCE PROGRAM STRUCTURE

5.2.1 Quality Assurance Coordinator

This person's responsibilities include the following.

(1) Develops and carries out quality control program; develops and updates quality assurance procedures.

(2) Schedules quality assurance activities such as audits. Quarterly performance audits will be contracted to an independent organization (e.g. SumX).

(3) Evaluates data quality and maintains records of calibrations, audits, etc.

(4) Coordinates and/or conducts investigations of problems identified through quality assurance activities.

(5) Maintains awareness of current quality assurance recommendations of EPA and Florida DER.

(6) Advises management as to status of B&V's quality assurance activities and makes appropriate recommendations for correction and improvement as may be necessary.

5.2.2 Operator/Technician

This person has been factory-trained in the operation and maintenance of most major equipment items in the air monitoring system. His duties include the following.

(1) All routine operation of the system, e.g., items on operators checklist.

(2) Most corrective maintenance on air quality analyzers, data acquisition system, and meteorological equipment. Specialists from SumX may be called in to assist in curing more difficult problems on these items.

(3) Completion of checklists, station logs, and daily check control charts during each visit.

(4) Inspection of station for abnormal conditions during each visit.

APPENDIX A
SAMPLE FORMS

Samples of forms used in documentation procedures are included in this Appendix. Page numbers refer to those in this Appendix.

(1) Operational Checklist--Pages 3 through 13 are to be filled out by the operator on each site visit day. One copy is to be kept on-site and one at SSAI offices. "OK" or a checkmark is a valid entry where applicable. Number entries are required in some places. A full explanation in the station log is required for items which do not meet required condition criteria.

(2) Filter Envelope and Routine Site Log entry form.

   (a) Page 14 shows the information used to identify TSP filters after exposure.

   (b) Stamp used in field log book on each site visit entry.

(3) Sample printout from data acquisition system.

   (a) Page 15 is the 5-minute averages for the 2300 hour. "S" in the last three readings of channels 04 through 07 indicates that these parameters were undergoing a <u>span</u> check.

   (b) Page 16 is the same, but is for the next hour. "Z" in channels 04 through 07 in the first three readings indicated that these parameters were undergoing a <u>zero</u> check. In the next line, the "P" signifies the purge condition following the span/zero check.

   (c) Page 17 is the first of two pages of the hourly summaries given once daily along with the daily summaries, for channels 00 through 07.

   (d) Page 18 is the second page following the preceding one. This portion includes the zero/span and known "span gas" concentrations from the zero/span checks just performed.

(4) Daily Zero/Span Drift Control Chart--Page 19.

(5) Sample Audit/Calibration forms.

   (a) Page 20 for NO/NO_x as an example of gaseous analyzers.

   (b) Page 21 for Hi-Vol samplers.

(6) Sample forms for Data Assessment Reports and Audit Results.
  (a) Page 22, Part I Report for gaseous analyzers.
  (b) Page 23, Part II Report for gaseous analyzers.
  (c) Page 24, Part I Report for Hi-Vol samplers.
  (d) Page 25, Part II Report for Hi-Vol samplers.

(7) Dew Point Temperature to Relative Humidity Conversion Tables. Page 26, 27, and 28.

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

METEOROLOGICAL SENSORS	Required check condition	Inspection Date				
W/D VANE	OK					
ANEMOMETER CUPS	OK					
TOWER	RAISED & SECURE					
CABLES	OK					
PRECIPITATION GAUGE	OK					
TEMPERATURE/DEW POINT BLOWER	RUNNING					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

STATION INSIDE	Required check condition	Inspection Date				
POWER	ON					
HEATER/AIR COND.	OK					
TEMP. INSIDE	65 - 90 F ENTER TEMP					
LIGHTS	OK					
CLEAN & ORDERLY	OK					
SECURE	OK					
GLASS MANIFOLD	CLEAN & SECURE					
MANIFOLD EXHAUST BLOWER	ON					
DAILY ZERO/SPAN CONTROL CHART	UPDATE					
FIELD LOG	ENTRY					
HYDROGEN BOTTLE	AT LEAST 300 LBS					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ___________
To ___________

DATA SYSTEM	Required check condition	Inspection Date				
MAG TAPE SUPPLY	OK					
PRINTER PAPER SUPPLY	OK					
STRIP CHART PAPER	OK					
TIME CORRECT	OK					
DATE CORRECT	OK					
STRIP CHART PENS INKING	OK					
CHARTS ANNOTATED	OK					
PRINTER READOUT	OK					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From __________
To __________

MELOY 285 SO_2 ANALYZER	Required check condition	Inspection Date				
POWER	ON					
MODE SELECT SW. SETTING						
H_2 FLO RATE						
AIR FLO RATE						
IGNITION LITE	OFF					
AUOT CAL ZERO READING						
ZERO POT SETTING						
AUTO CAL SPAN SO_2 CONC.						
AUTO CAL SPAN READING						
SPAN POT SETTING						
TIME CONSTANT SWITCH	1 SEC.					
RANGE SWITCH	.5					
TEST NO. 1						
TEST NO. 2						

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

MELOY 285 SO_2 ANALYZER (cond't)	Required check condition	Inspection Date				
H_2 CYLINDER PRESSURE TO INST.	40 LBS.					
CHARCOAL SCRUBBER	OK					
SO_2 DATA PRINTOUT	MATCH METER					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

CSI 1600 NO/NO_x	Required check condition	Inspection Date				
POWER SWITCH	ON					
O_3 SWITCH	ON					
O_3 FLOW RATE						
AIR FLOW RATE						
INHIBIT LITE	OFF					
COOLER LITE	BLINKING					
HEATER LITE	BLINKING					
SAMPLE SWITCH	AMB					
NO METER READING						
NO_x METER READING						
NO_2 METER READING						
DIAGNOSTIC SWITCH #1	0 to 5%					
DIAGNOSTIC SWITCH #2	40 to 45%					
DIAGNOSTIC SWITCH #3	95 to 99%					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ___________
To ___________

CSI 1600 NO/NO_x (cont'd)	Required check condition	Inspection Date				
DIAGNOSTIC SWITCH #4	95 to 99%					
DIAGNOSITC SWITCH #5	0					
DIAGNOSTIC SWITCH #6	20 to 50%					
RANGE SELECTED	0.5					
FILTER SELECTED						
NO AUTO CAL ZERO READING						
NO_x AUTO CAL ZERO READING						
ZERO POT SETTING						
SPAN INPUT CONC.						
NO AUTO CAL SPAN READING						
NO_x AUTO CAL SPAN READING						
NO SPAN POT SETTING						
NO_x SPAN POT SETTING						
PUMP VACUUM GAUGE						

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

CSI 1600 NO/NO_x (cont'd)	Required check condition	Inspection Date				
% DRIERITE PINK	MAX. 80%					
NO/NO_x/NO_2 DATA PRINTOUT	MATCH METER					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

MONITOR LABS 8310 CO	Required check condition	Inspection Date				
POWER SWITCH	ON					
CATALYST TEMP.						
SPAN GAS PRESSURE GAUGE						
SAMPLE ROTOMETER FLOW						
REF. ROTOMETER FLOW						
RANGE SW. SELECTION	50					
AUTO SPAN VALUE						
AUTO SPAN READING						
AUTO ZERO VALUE						
SPAN GAS CYLINDER PRESSURE						

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ____________
To ____________

HI-VOLUME SAMPLER	Required check condition	Inspection Date				
SELECTED HI-VOL RUNNING	Number(s)					
TIME CORRECT	OK					
FILTER CHANGED	OK					
FLO CHART CHANGED & INKING	OK					
TIMER SET PROPERLY	OK					
FILTER ENVELOPE MARKED	OK					

OPERATIONAL CHECKLIST

Ambient Air Monitoring Program
Orlando Utilities Commission

B&V Project 8927
Date: From ___________
To ___________

DICHOTOMOUS SAMPLER	Required check condition	Inspection Date				
CLOCK TIME	SET					
DISPLAY SWITCH	OFF					
"SAMPLER AFTER" SW.						
"SAMPLE EVERY" SW.						
"SAMPLE FOR" SW.	24-HOUR					
FINE FLO RATE	16.7LPM					
COARSE FLO RATE	1.67LPM					
VACUUM GAUGE	1-2 in Hg					
FILTERS INSTALLED	CHECK					

SOUTHERN SCIENCE APPLICATIONS, INC.
DIVISION OF BLACK & VEATCH

FILTER NUMBER ______________
SITE LOCATION & NUMBER ______________
HI VOL NUMBER ______________
START TIME & DATE ______________
END TIME & DATE ______________
CFM START (FLOW CHART) ______________
CFM END (FLOW CHART) ______________
LAPSED TIME INDICATOR (START) ______________
LAPSED TIME INDICATOR (END) ______________
REMARKS:

FINAL WEIGHT ______________
INITIAL WEIGHT ______________
PARTICULATE WEIGHT ______________

AVERAGE FLOW RATE ______________
CORRECTED FLOW RATE ______________

TIME (MIN) ______________
VOLUME (m^3) ______________

PARTICULATE LOADING ($\mu g/m^3$) ______________

		ALL	STATUS				NEW				CALIB				PSYCHR			
DAY	TIME	OK	SO_2	NO_x	CO	MET	HI VOL	DIC SAM	CHT	TAPE	INST	ZERO	SPAN	KNOWN	T	TW	CHT MRK	OPER

```
/
STATUS     23:45:05  07/13/80    11110000 00000000 11111111
>


HOURLY SUMMARY               00:00:00  07/14/80     OUC STANTON #1
******************************************************************************
CHANNEL NUMBER        00        01        02        03       04        05        06        07
CHANNEL NAME       WD/DEV       WS       TOS       TIN      SO2       NOX        NO        CO
CHANNEL UNITS         DEG      MPH       DGC       DGC      PPB       PPB       PPB       PPM
FULL SCALE VALUE      540      100      50.0      50.0      500       500       500      50.0
ZERO VALUE              0        0     -30.0     -30.0        0         0         0        .0
AUTO-CAL CHANNEL                                              1         2         2         3
------------------------------------------------------------------------------
23:05            248/ 13         5      27.0      23.2       -3        11        -4        .1
23:10            246/ 11         6      27.0      21.9       -3        12        -4        .2
23:15            249/ 13         5      27.0      23.2       -3        12        -4        .1
23:20            248/ 10         4      26.9      21.6       -3        12        -4        .2
23:25            256/  8         5      26.9      23.1       -3        12        -4        .1
23:30            253/ 10         6      26.9      21.8       -3        12        -4        .2
23:35            257/ 11         6      27.0      23.1       -4        12        -4        .1
23:40            257/  9         6      27.0      22.0       -4        12        -5        .2
23:45            251/ 11         5      27.0      23.0       -4        12        -4        .1
23:50            258/  9         5      27.0      22.2      97S       84S       40S      9.2S
23:55            255/  9         4      27.0      22.8      89S       94S       74S      9.5S
00:00            256/ 11         4      26.9      22.3      90S       96S       82S      9.2S

AVERAGE          253/ 10         5      27.0      22.6      -3<       12<       -4<       .1<

******************************************************************************
CHANNEL NUMBER        10        11        12        13
CHANNEL NAME         NO2       DPT       DIR       SPD
CHANNEL UNITS        PPB       DGC       DEG       MPH
FULL SCALE VALUE     500      50.0       540       100
ZERO VALUE             0     -30.0         0         0
AUTO-CAL CHANNEL       2
------------------------------------------------------------------------------
23:05                  4      22.4       248         5
23:10                  5      22.4       246         6
23:15                  4      22.4       250         5
23:20                  5      22.4       249         4
23:25                  5      22.4       257         5
23:30                  5      22.5       253         6
23:35                  6      22.5       257         6
23:40                  6      22.5       257         6
23:45                  5      22.6       250         5
23:50                35S      22.6       258         5
23:55                10S      22.6       256         4
00:00                 3S      22.6       257         4

AVERAGE               5<      22.5       253         5


RAINFALL :    .00   INCHES


>
STATUS     00:01:55  07/14/80    11110000 00000000 10101010
>
```

```
>
STATUS     00:15:20  07/14/80    11110000 00000000 00000000
>


HOURLY SUMMARY              01:00:00  07/14/80    OUC STANTON #1
******************************************************************************
CHANNEL NUMBER         00       01      02      03      04      05      06      07
CHANNEL NAME       WD/DEV       WS     TOS     TIN     SO2     NOX      NO      CO
CHANNEL UNITS         DEG      MPH     DGC     DGC     PPB     PPB     PPB     PPM
FULL SCALE VALUE      540      100    50.0    50.0     500     500     500    50.0
ZERO VALUE              0        0   -30.0   -30.0       0       0       0      .0
AUTO-CAL CHANNEL                                         1       2       2       3
------------------------------------------------------------------------------
00:05             252/ 11        5    26.8    22.6      5Z     19Z      6Z     .6Z
00:10             252/ 11        5    26.8    22.3      2Z      9Z     -3Z    -.2Z
00:15             245/ 11        5    26.7    22.6      4Z      9Z     -3Z    -.2Z
00:20             245/ 13        4    26.6    22.5     -3P     13P     -4P     .1P
00:25             243/ 10        4    26.6    22.6      -3      13      -4      .2
00:30             246/ 10        4    26.6    22.5      -3      13      -4      .1
00:35             243/ 14        4    26.6    22.6      -3      13      -4      .2
00:40             243/ 12        4    26.5    22.2      -3      13      -4      .1
00:45             245/ 10        4    26.5    22.8      -4      13      -4      .1
00:50             243/ 12        3    26.5    22.0      -4      13      -3      .1
00:55             235/ 10        3    26.4    23.0      -4      13      -3      .1
01:00             226/ 11        4    26.3    22.0      -4      12      -4      .1

AVERAGE           244/ 11        4    26.6    22.5     -4<     13<     -4<     .1<

******************************************************************************
CHANNEL NUMBER         10       11      12      13
CHANNEL NAME          NO2      DPT     DIR     SPD
CHANNEL UNITS         PPB      DGC     DEG     MPH
FULL SCALE VALUE      500     50.0     540     100
ZERO VALUE              0    -30.0       0       0
AUTO-CAL CHANNEL        2
------------------------------------------------------------------------------
00:05                  2Z     22.6     253       5
00:10                  1Z     22.6     252       5
00:15                  1Z     22.6     246       5
00:20                  6P     22.6     245       4
00:25                   6     22.6     243       4
00:30                   6     22.6     247       4
00:35                   5     22.6     242       4
00:40                   5     22.6     245       4
00:45                   6     22.6     245       4
00:50                   6     22.6     242       3
00:55                   6     22.6     235       3
01:00                   4     22.5     227       4

AVERAGE                5<     22.6     244       4

RAINFALL :    .00   INCHES
```

```
>
STATUS     00:01:55  07/14/80    11110000 00000000 10101010
>


DAILY SUMMARY                 00:02:00  07/14/80     OUC STANTON #1
*****************************************************************************
CHANNEL NUMBER          00      01       02       03       04      05      06      07
CHANNEL NAME         WD/DEV     WS      TOS      TIN      SO2     NOX      NO      CO
CHANNEL UNITS           DEG    MPH      DGC      DGC      PPB     PPB     PPB     PPM
FULL SCALE VALUE        540    100     50.0     50.0      500     500     500    50.0
ZERO VALUE                0      0    -30.0    -30.0        0       0       0      .0
AUTO-CAL CHANNEL                                            1       2       2       3
-----------------------------------------------------------------------------
01:00               223/ 12      5     25.0     22.6      -4<     14<     -4<     .2<
02:00               228/ 12      3     24.4     22.5      -4      13      -4      .2
03:00               242/ 12      5     24.4     22.5      -4      11      -4      .2
04:00               236/ 12      5     24.0     22.5      -4      11      -4      .2
05:00               235/ 13      3     23.7     22.5      -3      12      -4      .2
06:00               236/ 12      3     23.6     22.4      -2      13      -4      .2
07:00               216/ 11      4     24.5     22.5      -1      15      -3      .2
08:00               243/ 14      7     26.5     22.6      -3      13      -3      .1
09:00               250/ 14      9     28.7     22.5      -3      11      -3      .1
10:00               253/ 13     12     30.2     22.6      -3       8      -4      .1
11:00               260/ 14     12     31.5     22.5      -3       7      -4      .1
12:00               259/ 14     11     32.3     22.4      -3       8      -4      .1
13:00               258/ 14     12     33.0     22.4      -4       8      -4      .1
14:00               250/ 15     11     33.4     22.3      -4       8      -4      .1
15:00               251/ 14     11     33.5     22.5      -3       8      -4      .1
16:00               251/ 15     11     33.8     22.3      -3       7      -4      .1
17:00               245/ 14     10     33.4     22.4      -4       8      -4      .1
18:00               241/ 14      9     32.4     22.4      -4       8      -4      .1
19:00               260/ 12      9     31.8     22.5      -4       8      -4      .1
20:00               249/ 12      8     30.6     22.6      -4       8      -4      .1
21:00               244/ 12      5     29.4     22.5      -4      10      -4      .1
22:00               242/ 12      4     28.4     22.6      -4      10      -4      .1
23:00               238/ 11      4     27.4     22.5      -4      11      -4      .1
00:00               253/ 10      5     27.0     22.6      -3<     12<     -4<     .1<

AVERAGE             248/ 13      7     28.9     22.5      -3      10      -4      .1
```

```
*********************************************************************************
CHANNEL NUMBER        10      11      12      13
CHANNEL NAME         NO2     DPT     DIR     SPD
CHANNEL UNITS        PPB     DGC     DEG     MPH
FULL SCALE VALUE     500    50.0     540     100
ZERO VALUE             0   -30.0       0       0
AUTO-CAL CHANNEL       2
---------------------------------------------------------------------------------
01:00                 6<    19.5     227       6
02:00                  6    19.8     229       3
03:00                  3    19.3     242       6
04:00                  4    18.5     237       5
05:00                  5    18.6     236       3
06:00                  6    19.2     236       3
07:00                  7    20.2     217       4
08:00                  5    22.0     240       7
09:00                  3    23.4     250      10
10:00                  1    23.4     253      13
11:00                  1    23.1     260      13
12:00                  1    23.3     260      11
13:00                  1    23.0     257      13
14:00                  1    23.4     250      12
15:00                  1    23.3     250      12
16:00                  1    22.8     252      12
17:00                  1    23.0     245      11
18:00                  1    23.0     241      10
19:00                  1    22.6     260       9
20:00                  1    22.5     249       8
21:00                  3    22.6     244       5
22:00                  3    22.6     241       4
23:00                  3    22.5     238       4
00:00                 5<    22.5     253       5

AVERAGE                3    21.8     245       8

RAINFALL :   .00   INCHES


>
LAST AUTO-CALIBRATION STARTED  23:45:00  07/13/80
CALIBRATION RESULTS

             ZERO         SPAN         SPAN GAS

   SO2         4Z          90S          90

   NOX         9Z          96S         119

    NO        -3Z          82S         119

    CO       -.2Z         9.2S         9.0

   NO2         1Z           3S           0

>
STATUS       00:15:20  07/14/80     11110000 00000000 00000000
>
```

DAILY ZERO/SPAN DRIFT CONTROL CHART

Project ORLANDO UTILITIES COMMISSION

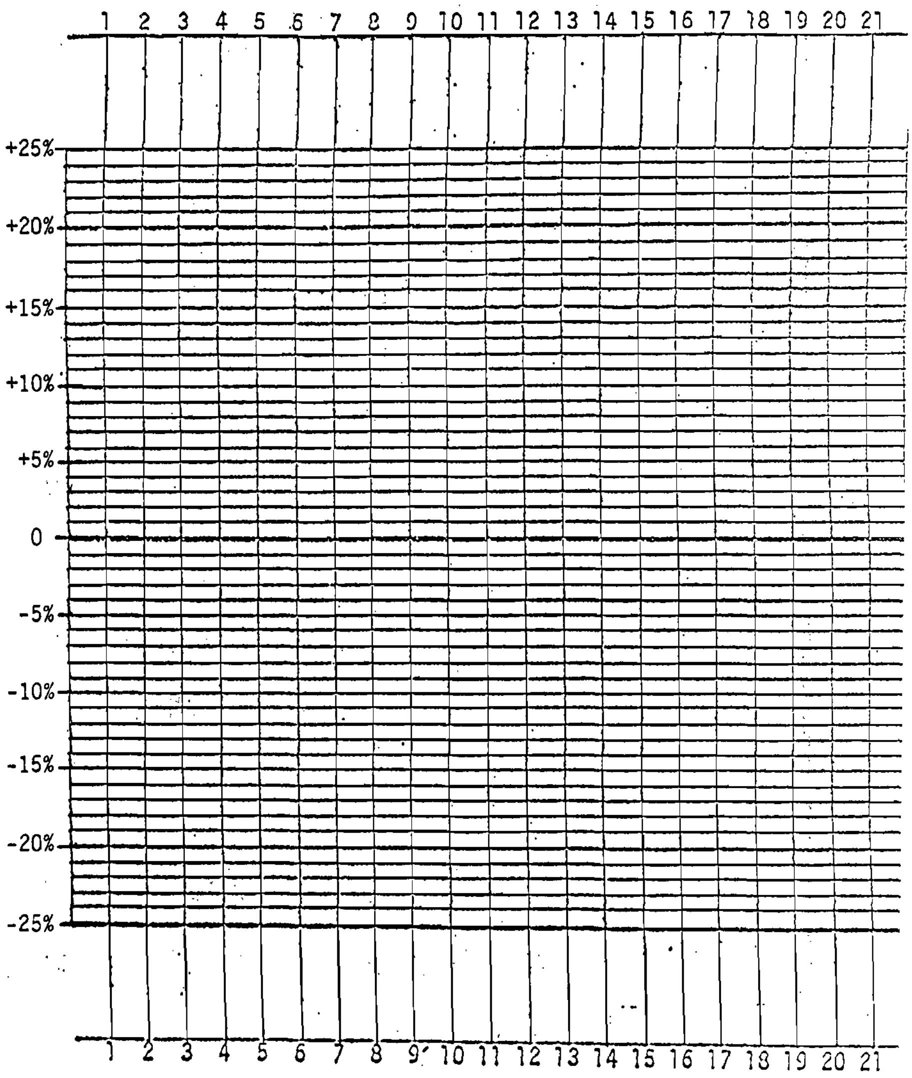
Site STANTON #1

Analyzer ____________

Serial No. ____________

Parameter ____________

Zero or Span ____________



Span Input Value ____________

Upper 25% ____________

Upper 15% ____________

Upper Control Limit (3σ) ____________

Lower Control Limit (3σ) ____________

Lower 15% ____________

Lower 25% ____________

Zero Control Limit (3σ) ____________

Month ____________

NO, NO_x QUALITY ASSURANCE AUDIT

Section 1: (To be completed by Auditor)

Location	Panora, Iowa	Parameter	NO, NO_x
Site	Trailer 016	Instrument Mfg.	CSI 1600
Auditor	C. Underriner	Instrument S/N	8697
Date	11/16/78	Instrument Range	0 - 0.5 ppm
Date of Last Calibration	11/6/78		

Calibrator Type	Bendix 8861	Serial No.	55367-60
Source Gas Cylinder No.	FF6878	Concentration	98.6 ppm

Section 2: (Auditor results)

Input concentration % of full scale	Input concentration (A) (ppm)	Analyzer Response (B) ppm		Relative Error 100(B-A)/A=%	
		NO	NO_x	NO	NO_x
0	0.000	0.004	0.004		
10	0.050	0.049	0.050	-2.0	0.0
20	0.100	0.102	0.103	+2.0	+3.0
40	0.200	0.208	0.208	4.0	4.0
60	0.300	0.308	0.314	2.7	4.7
90	0.450	0.468	0.471	4.0	4.7

NO: mean relative error (dj) 2.1 %

standard deviation (Sj) 2.5 %

95% confidence limits: upper = 7.0 % lower = -2.8 %

NO_x: mean relative error (dj) = 3.3 %

standard deviation (Sj) = 1.8 %

95% confidence limits: upper = 6.8 % lower = -0.2 %

Comments:

HI-VOL QUALITY ASSURANCE AUDIT

Section 1: (to be completed by Auditor)

City	Panora, Iowa	HIVOL #	1
Site	T/013	Temperature	0.0 °C 273 °K
Saroad #		Stn pressure	732 mm Hg
Calibration Kit #	11015	Date:	11-17-78
Auditor	C. Underriner	Time:	1200 hrs

Comments:

Section 2: (to be completed by data reduction personel)

Date of most recent calibration 7-30-78

Stn pressure 744 mm Hg Temperature 22.8 °C 296 °K

Slope = 1.0979 intercept = -1.5192

Section 3: (Definitions and equations on reverse)

Orifice Plate Number	* ΔP (in H_2O)	Q_s (St. CFM)	Q_t (eq 1) (CFM)	* Indicated recorder response	Q_c (CFM)	Q_a (eq 2) (CFM)	Δ% $\frac{Q_a - Q_t}{Q_t}$ X 100
18	9.5	54.8	53.7	50	53.4	51.2	-4.6
13	7.8	49.7	48.7	47	50.1	48.1	-1.3
10	6.3	44.7	43.8	42	44.6	42.8	-2.3
7	4.0	35.7	35.0	34	35.8	34.4	-1.7
5	2.5	28.3	27.7	28	29.2	28.1	+1.2

dj = -1.7 % Sj = 2.1 %

95% confidence limits: upper = +2 % lower = -6 %

* *Auditor to complete these columns*

Table 2-A (continuous monitors)

DATA ASSESSMENT REPORT FOR PSD AIR QUALITY DATA - PART I

Organization Name: Iowa Electric Power and Light
Organization Address: Panora, Iowa
Reporting Period: From 2-1-79 **to** 4-30-79
month/day/year month/day/year

Continuous Analyzers (CO, NO_2, O_3, SO_2) or Integrated Samplers (TSP)

Pollutant	**Analyzer Identification Code**	**Precision**			**Accuracy**		
		No. of Span Checks or Collocated Samples	**95% Limit***		**Audit Date**	**95% Limit***	
			Lower	**Upper**		**Lower**	**Upper**
SO	T013	86	-27.8	10.6	2-17-79	-6.2	4.8
NO	T013	87	-13.6	9.1	2-17-79	-5.2	-0.8
NOx	T013	87	-13.4	9.2	2-17-79	-5.0	1.2
NO_2	T013				2-17-79	-8.4	5.0
SO_2	T016	86	-13.0	10.0	2-18-79	-9.2	15.2
NO	T016	86	-14.1	6.5	2-18-79	-13.4	1.4
NOx	T016	86	-11.9	10.1	2-18-79	-12.0	1.5
NO_2	T016					-17.4	16.8

*Show + or - sign with limit value.

Table 2-B (continuous monitors)

Organization Name Iowa Electric Power and Light
Organization Address Panora, Iowa
Reporting Period: From 2-1-79 (month/day/yr) To 4-30-79 (month/day/yr)

AUDIT RESULTS FOR CONTINUOUS ANALYZERS (CO, NO_2, O_3, SO_2)

Pollutant	Analyzer Identification Code	Concentration, ppm									
		Point 1		Point 2		Point 3		Point 4		Point 5	
		Known	Diff.*	Known	Diff.*	Known	Diff.*	Known	Diff.*	Known	Diff.*
SO_2	T016	0.050	+0.006	0.100	+0.005	0.200	+0.006	0.300	-0.002	0.450	-0.020
NO	T016	0.050	-0.000	0.100	-0.005	0.200	-0.015	0.300	-0.023	0.450	-0.045
NOx	T016	0.050	-0.000	0.100	-0.004	0.200	-0.014	0.300	-0.018	0.450	-0.041
NO_2	T016	0.050	+0.007	0.100	+0.002	0.200	-0.008	0.300	-0.018	0.450	-0.033
SO_2	T013	0.050	+0.002	0.100	-0.003	0.200	-0.001	0.300	-0.005	0.450	-0.010
NO	T013	0.050	-0.002	0.100	-0.004	0.200	-0.003	0.300	-0.009	0.450	-0.011
NOx	T013	0.050	-0.002	0.100	-0.003	0.200	0.000	0.300	-0.002	0.450	-0.009
NO_2	T013	0.050	+0.002	0.100	-0.001	0.200	-0.006	0.300	-0.012	0.450	-0.020

*Calculate audit difference using the equation below. Show + or - sign when recording difference.

Diff. = measured $\text{conc.}_{\text{ppm}}$ - known $\text{conc.}_{\text{ppm}}$

Table 2-C (TSP)

DATA ASSESSMENT REPORT FOR PSD AIR QUALITY DATA - PART I

Organization Name: Iowa Electric Power and Light

Organization Address: Panora, Iowa

Reporting Period: From 2-1-79 (month/day/year) **to** 4-30-79 (month/day/year)

Continuous Analyzers (CO, NO_2, O_3, SO_2) or Integrated Samplers (TSP)

Pollutant	Analyzer Identification Code	Precision			Accuracy		
		No. of Span Checks or Collocated Samples	95% Limit*		Audit Date	95% Limit*	
			Lower	Upper		Lower	Upper
TSP	T013 Hi-Vol #1				3-8-79	-10.3	6.1
	Hi-Vol #2				3-8-79	-14.0	9.6
	Hi-Vol #3				3-8-79	-10.9	8.7
	Hi-Vol #4				3-8-79	-9.2	10.4
	Hi-Vol #5	21	-20.5	12.7	3-8-79	-13.2	11.8
TSP	T016 Hi-Vol #1				3-8-79	-13.8	9.8
	Hi-Vol #2				3-8-79	-5.0	9.8
	Hi-Vol #3				3-8-79	-8.3	6.5
	Hi-Vol #4				3-8-79	-5.3	3.3

*Show + or - sign with limit value.

Table 2-D (TSP)

Organization Name Iowa Electric Power and Light
Organization Address Panora, Iowa
Reporting Period: From 2-1-79 (month/day/yr) To 4-30-79 (month/day/yr)

AUDIT RESULTS FOR HIGH VOLUME SAMPLERS

Pollutant	Analyzer Identification Code	Concentration, ppm									
		Point 1		Point 2		Point 3		Point 4		Point 5	
		Known	Diff.*	Known	Diff.*	Known	Diff.*	Known	Diff.*	Known	Diff.*
TSP	T013 Hi-Vol #1	51.2	+1.6	48.5	-4.1	42.3	-0.1	35.4	-0.6	27.3	-0.9
	Hi-Vol #2	54.1	-0.4	49.1	+1.1	43.9	+1.7	35.0	-2.0	27.9	-3.0
	Hi-Vol #3	52.7	-0.1	48.2	+1.2	42.3	+1.8	35.8	-1.3	28.4	-2.4
	Hi-Vol #4	52.1	-1.2	46.9	-1.8	42.2	-0.6	32.8	+0.7	25.6	+2.2
	Hi-Vol #5	56.8	0.0	51.5	+0.4	46.0	+2.1	36.2	-4.2	26.2	+0.9
TSP	T016 Hi-Vol #1	44.7	-1.1	39.4	+0.8	35.8	-2.2	27.9	+0.6	24.4	-2.6
	Hi-Vol #2	43.7	-0.3	40.1	+0.3	37.1	-0.8	27.9	+1.3	22.5	+1.6
	Hi-Vol #3	45.0	-0.8	40.5	+0.8	36.2	+0.8	29.9	0.0	24.4	-1.7
	Hi-Vol #4	51.8	-0.9	47.6	-1.1	40.9	+1.2	33.7	-0.4	29.4	-0.6

*Calculate audit difference using the equation below. Show + or - sign when recording difference.

Diff. = Indicated flow (CFM) - Known flow (CFM)

TABLE I.—*Temperature of dew point in degrees Fahrenheit*—Continued

[Pressure=30.0 inches]

Air temperature *t*	Vapor pressure *e*	Depression of wet-bulb thermometer (*t*−*t*′)														
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
20	0.103	18	16	14	12	10	8	5	2	−2	−7	−13	−21	−37		
21	.108	19	18	16	14	12	9	7	3	±0	−4	−9	−16	−27	−60	
22	.113	20	19	17	15	13	11	8	5	+2	−2	−6	−12	−20	−36	
23	.118	21	20	18	16	14	12	10	7	4	±0	−4	−9	−16	−26	−57
24	.124	23	21	19	17	15	13	11	9	6	+2	−1	−6	−12	−20	−35
25	0.130	24	22	20	19	17	15	13	10	8	5	+1	−3	−8	−15	−25
26	.136	25	23	22	20	18	16	14	12	9	7	3	−1	−5	−11	−18
27	.143	26	24	23	21	19	18	16	13	11	8	5	+2	−2	−7	−14
28	.150	27	25	24	22	21	19	17	15	13	10	7	4	±0	−4	−9
29	.157	28	26	25	23	22	20	18	16	14	12	9	6	+3	−1	−5
30	0.164	29	27	26	25	23	21	20	18	16	14	11	8	5	+2	−2
31	.172	30	28	27	26	24	23	21	19	17	15	13	10	8	4	±0
32	.180	31	30	28	27	25	24	22	21	19	17	15	12	10	7	+3
33	.187	32	31	29	28	27	25	24	22	20	18	16	14	12	9	6
34	.195	33	32	30	29	28	26	25	23	22	20	18	16	13	11	8
35	0.203	34	33	31	30	29	28	26	25	23	21	19	17	15	13	10
36	.211	35	34	32	31	30	29	27	26	24	23	21	19	17	15	12
37	.219	36	35	33	32	31	30	28	27	26	24	22	21	19	17	14
38	.228	37	36	34	33	32	31	29	28	27	25	24	22	20	18	16
39	.237	38	37	35	34	33	32	31	29	28	27	25	23	22	20	18
40	0.247	39	38	37	35	34	33	32	30	29	28	26	25	23	21	20
41	.256	40	39	38	36	35	34	33	31	30	29	27	26	24	23	21
42	.266	41	40	39	38	36	35	34	33	31	30	29	27	26	24	23
43	.277	42	41	40	39	37	36	35	34	32	31	30	28	27	25	24
44	.287	43	42	41	40	38	37	36	35	34	32	31	30	28	27	25
45	0.298	44	43	42	41	40	38	37	36	35	34	32	31	30	28	27
46	.310	45	44	43	42	41	40	38	37	36	35	33	32	31	29	28
47	.322	46	45	44	43	42	41	40	38	37	36	35	33	32	31	29
48	.334	47	46	45	44	43	42	41	40	38	37	36	35	33	32	31
49	.347	48	47	46	45	44	43	42	41	40	38	37	36	34	33	32
50	0.360	49	48	47	46	45	44	43	42	41	40	38	37	36	34	33
51	.373	50	49	48	47	46	45	44	43	42	41	40	38	37	36	34
52	.387	51	50	49	48	47	46	45	44	43	42	41	40	38	37	36
53	.402	52	51	50	49	48	47	46	45	44	43	42	41	40	38	37
54	.417	53	52	51	50	49	48	47	46	45	44	43	42	41	40	38
55	0.432	54	53	52	51	50	50	49	48	47	45	44	43	42	41	40
56	.448	55	54	53	53	52	51	50	49	48	47	46	44	43	42	41
57	.465	56	55	54	54	53	52	51	50	49	48	47	46	45	43	42
58	.482	57	56	55	55	54	53	52	51	50	49	48	47	46	45	44
59	.499	58	57	56	56	55	54	53	52	51	50	49	48	47	46	45
60	0.517	59	58	57	57	56	55	54	53	52	51	50	49	48	47	46
61	.536	60	59	59	58	57	56	55	54	53	52	51	50	49	48	47
62	.555	61	60	60	59	58	57	56	55	54	53	53	52	51	50	48
63	.575	62	61	61	60	59	58	57	56	55	55	54	53	52	51	50
64	.595	63	62	62	61	60	59	58	57	57	56	55	54	53	52	51
65	0.616	64	63	63	62	61	60	59	59	58	57	56	55	54	53	52
66	.638	65	64	64	63	62	61	60	60	59	58	57	56	55	54	53
67	.661	66	65	65	64	63	62	62	61	60	59	58	57	56	55	54
68	.684	67	67	66	65	64	63	63	62	61	60	59	58	57	57	56
69	.707	68	68	67	66	65	64	64	63	62	61	60	59	59	58	57
70	0.732	69	69	68	67	66	65	65	64	63	62	61	61	60	59	58
71	.757	70	70	69	68	67	67	66	65	64	63	62	62	61	60	59
72	.783	71	71	70	69	68	68	67	66	65	64	64	63	62	61	60
73	.810	72	72	71	70	69	69	68	67	66	66	65	64	63	62	61
74	.838	73	73	72	71	70	70	69	68	67	67	66	65	64	63	62
75	0.866	74	74	73	72	71	71	70	69	68	68	67	66	65	64	64
76	.896	75	75	74	73	72	72	71	70	69	69	68	67	66	66	65
77	.926	76	76	75	74	73	73	72	71	71	70	69	68	67	67	66
78	.957	77	77	76	75	75	74	73	72	72	71	70	69	69	68	67
79	0.989	78	78	77	76	76	75	74	73	73	72	71	70	70	69	68
80	1.022	79	79	78	77	77	76	75	74	74	73	72	72	71	70	69

Table I.—*Temperature of dew point in degrees Fahrenheit*—Continued

[Pressure=30.0 inches]

Air temperature *t*	Vapor pressure *e*	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0
		Depression of wet-bulb thermometer (*t*−*t*′)														
25	0.130	−51														
26	.136	−32														
27	.143	−23	−45													
28	.150	−17	−29													
29	.157	−12	−20	−39												
30	0.164	−7	−14	−25	−57											
31	.172	−4	−10	−18	−31											
32	.180	−1	−6	−12	−21	−42										
33	.187	+2	−2	−7	−14	−26										
34	.195	5	+1	−3	−9	−17	−32									
35	0.203	7	4	±0	−5	−11	−20	−41								
36	.211	10	7	+3	−1	−6	−14	−25	−58							
37	.219	12	9	6	+2	−3	−8	−16	−29							
38	.228	14	11	8	5	+1	−4	−10	−19	−36						
39	.237	16	13	11	8	4	±0	−5	−12	−22	−47					
40	0.247	18	15	13	10	7	+3	−1	−6	−14	−26					
41	.256	19	17	15	12	10	6	+2	−2	−8	−16	−30				
42	.266	21	19	17	14	12	9	6	+2	−3	−9	−18	−36			
43	.277	22	20	19	16	14	11	9	5	+1	−4	−11	−21	−45		
44	.287	24	22	20	18	16	13	11	8	4	±0	−5	−12	−24	−60	
45	0.298	25	23	22	20	18	15	13	10	7	+4	−1	−6	−14	−27	
46	.310	27	25	23	21	20	17	15	13	10	7	+3	−2	−7	−16	−30
47	.322	28	26	25	23	21	19	17	15	12	9	6	+2	−3	−9	−17
48	.334	29	28	26	25	23	21	19	17	14	12	9	5	+1	−4	−10
49	.347	30	29	28	26	24	23	21	19	16	14	11	8	5	±0	−5
50	0.360	32	30	29	27	26	24	22	21	18	16	13	11	8	+4	±0
51	.373	33	32	30	29	27	26	24	22	20	18	16	13	10	7	+3
52	.387	34	33	32	30	29	27	26	24	22	20	18	16	13	10	7
53	.402	36	34	33	32	30	29	27	26	24	22	20	18	15	13	10
54	.417	37	36	34	33	32	30	29	27	25	24	22	20	18	15	12
55	0.432	38	37	36	34	33	32	30	29	27	25	24	22	20	17	15
56	.448	40	39	37	36	34	33	32	30	29	27	25	24	22	19	17
57	.465	41	40	39	37	36	34	33	32	30	29	27	25	24	21	19
58	.482	42	41	40	39	37	36	35	33	32	30	29	27	25	23	21
59	.499	44	43	41	40	39	37	36	35	33	32	30	29	27	25	23
60	0.517	45	44	43	41	40	39	38	36	35	33	32	30	29	27	25
61	.536	46	45	44	43	42	40	39	38	36	35	33	32	30	29	27
62	.555	47	46	45	44	43	42	40	39	38	36	35	33	32	30	29
63	.575	49	48	47	45	44	43	42	41	39	38	36	35	34	32	30
64	.595	50	49	48	47	46	44	43	42	41	39	38	37	35	34	32
65	0.616	51	50	49	48	47	46	45	43	42	41	40	38	37	35	34
66	.638	52	51	50	49	48	47	46	45	44	42	41	40	38	37	35
67	.661	53	53	52	50	49	48	47	46	45	44	43	41	40	38	37
68	.684	55	54	53	52	51	50	49	48	46	45	44	43	42	40	39
69	.707	56	55	54	53	52	51	50	49	48	46	45	44	43	42	40
70	0.732	57	56	55	54	53	52	51	50	49	48	47	46	44	43	42
71	.757	58	57	56	55	54	53	52	51	50	49	48	47	46	45	43
72	.783	59	58	58	57	56	55	54	53	52	51	50	48	47	46	45
73	.810	60	60	59	58	57	56	55	54	53	52	51	50	49	48	46
74	.838	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48
75	0.866	63	62	61	60	59	58	57	56	55	55	54	52	51	50	49
76	.896	64	63	62	61	60	60	59	58	57	56	55	54	53	52	51
77	.926	65	64	63	62	62	61	60	59	58	57	56	55	54	53	52
78	.957	66	65	64	64	63	62	61	60	59	58	57	56	55	54	53
79	0.989	67	66	66	65	64	63	62	61	60	59	59	58	57	56	55
80	1.022	68	68	67	66	65	64	63	63	62	61	60	59	58	57	56

Table I.—*Temperature of dew point in degrees Fahrenheit*—Continued

[Pressure=30.0 inches]

Air temperature *t*	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5
	Depression of wet-bulb thermometer (*t*−*t*′).														
47	−35														
48	−20	−41													
49	−12	−22	−53												
50	−6	−13	−26												
51	−1	−7	−15	−29											
52	+3	−2	−8	−17	−33										
53	7	+2	−3	−9	−18	−39									
54	10	6	+2	−4	−10	−20	−47								
55	12	9	6	+1	−4	−12	−23	−59							
56	15	12	9	5	+1	−5	−13	−25							
57	17	14	12	9	5	±0	−6	−14	−27						
58	19	17	14	11	8	+4	−1	−6	−15	−30					
59	21	19	17	14	11	8	+4	−1	−7	−16	−33				
60	23	21	19	17	14	11	8	+4	−2	−8	−17	−36			
61	25	23	21	19	17	14	11	8	+3	−2	−8	−18	−40		
62	27	25	23	21	19	16	14	11	7	−3	−2	−9	−19	−45	
63	29	27	25	23	21	19	17	14	11	7	+3	−2	−9	−20	−49
64	31	29	27	25	23	21	19	17	14	11	7	+3	−3	−10	−21
65	32	31	29	27	25	24	21	19	17	14	11	7	+3	−3	−10
66	34	32	31	29	27	26	24	22	19	17	14	11	7	+2	−3
67	36	34	32	31	29	28	26	24	22	19	17	14	11	7	+2
68	37	36	34	33	31	29	28	26	24	22	19	17	14	11	7
69	39	37	36	34	33	31	30	28	26	24	22	19	17	14	11
70	40	39	38	36	34	33	31	30	28	26	24	22	20	17	14
71	42	41	39	38	36	35	33	31	30	28	26	24	22	20	17
72	44	42	41	40	38	37	35	33	32	30	28	26	24	22	20
73	45	44	43	41	40	38	37	35	34	32	30	28	27	25	22
74	47	45	44	43	41	40	39	37	35	34	32	30	[illegible]	[illegible]	[illegible]
75	48	47	46	44	43	42	40	39	37	36	34	32	31	29	27
76	49	48	47	46	45	43	42	41	39	38	36	34	33	31	29
77	51	50	49	48	46	45	44	42	41	39	38	36	35	33	31
78	52	51	50	49	48	46	45	44	43	41	40	38	37	35	33
79	54	53	52	50	49	48	47	46	44	43	42	40	38	37	35
80	55	54	53	52	51	50	48	47	46	44	43	42	40	39	37

t	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
	Depression of wet-bulb thermometer (*t*−*t*′)														
64	−54														
65	−22														
66	−11	−22													
67	−3	−11	−23												
68	+2	−3	−11	−24											
69	7	+2	−3	−11	−24										
70	11	7	+2	−3	−11	−24									
71	14	11	7	+3	−3	−11	−24								
72	17	14	11	7	+3	−3	−11	−24							
73	20	17	15	11	8	+3	−3	−11	−24						
74	23	20	18	15	12	8	+3	−3	−10	−24					
75	25	23	21	18	15	12	8	+4	−2	−10	−23				
76	27	25	23	21	18	15	12	8	+4	−2	−10	−22			
77	29	28	26	23	21	18	16	13	9	+4	−2	−9	−21		
78	31	30	28	26	24	21	19	16	13	9	+5	−1	−9	−20	
79	34	32	30	28	26	24	22	19	16	13	10	+5	−1	−8	−20
80	36	34	32	30	28	26	24	22	20	17	13	10	+6	±0	−7

TABLE I.—*Temperature of dew point in degrees Fahrenheit*—Continued

[Pressure=30.0 inches]

Air temperature t	Vapor pressure e	Depression of wet-bulb thermometer $(t-t')$														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
80	1.022	79	77	76	74	73	72	70	68	67	65	63	62	60	58	56
81	.056	80	78	77	75	74	73	71	70	68	66	65	63	61	59	57
82	.091	81	79	78	77	75	74	72	71	69	67	66	64	62	60	59
83	.127	82	80	79	78	76	75	73	72	70	69	67	65	64	62	60
84	.163	83	81	80	79	77	76	74	73	71	70	68	66	65	63	61
85	1.201	84	82	81	80	78	77	75	74	72	71	69	68	66	64	62
86	.241	85	83	82	81	79	78	76	75	73	72	70	69	67	65	64
87	.281	86	84	83	82	80	79	78	76	75	73	72	70	68	67	65
88	.322	87	85	84	83	81	80	79	77	76	74	73	71	69	68	66
89	.364	88	86	85	84	82	81	80	78	77	75	74	72	71	69	67
90	1.408	89	87	86	85	83	82	81	79	78	76	75	73	72	70	69
91	.453	90	88	87	86	85	83	82	80	79	78	76	75	73	71	70
92	.499	91	89	88	87	86	84	83	81	80	79	77	76	74	73	71
93	.546	92	90	89	88	87	85	84	83	81	80	78	77	75	74	72
94	.595	93	92	90	89	88	86	85	84	82	81	79	78	76	75	73
95	1.645	94	93	91	90	89	87	86	85	83	82	80	79	78	76	74
96	.696	95	94	92	91	90	88	87	86	84	83	82	80	79	77	76
97	.749	96	95	93	92	91	89	88	87	85	84	83	81	80	78	77
98	.803	97	96	94	93	92	90	89	88	87	85	84	82	81	79	78
99	.859	98	97	95	94	93	92	90	89	88	86	85	83	82	81	79
100	1.916	99	98	96	95	94	93	91	90	89	87	86	85	83	82	80
101	1.975	100	99	97	96	95	94	92	91	90	88	87	86	84	83	81
102	2.035	101	100	98	97	96	95	93	92	91	89	88	87	85	84	83
103	.097	102	101	99	98	97	96	94	93	92	91	89	88	86	85	84
104	.160	103	102	100	99	98	97	95	94	93	92	90	89	88	86	85
105	2.225	104	103	101	100	99	98	96	95	94	93	91	90	89	87	86
106	.292	105	104	102	101	100	99	98	96	95	94	92	91	90	88	87
107	.360	106	105	103	102	101	100	99	97	96	95	93	92	91	90	88
108	.431	107	106	104	103	102	101	100	98	97	96	95	93	92	91	89
109	.503	108	107	105	104	103	102	101	99	98	97	96	94	93	92	90
110	2.576	109	108	106	105	104	103	102	100	99	98	97	95	94	93	91
111	.652	110	109	108	106	105	104	103	102	100	99	98	96	95	94	93
112	.730	111	110	109	107	106	105	104	103	101	100	99	98	96	95	94
113	.810	112	111	110	108	107	106	105	104	102	101	100	99	97	96	95
114	.891	113	112	111	109	108	107	106	105	103	102	101	100	98	97	96
115	2.975	114	113	112	110	109	108	107	106	104	103	102	101	99	98	97
116	3.061	115	114	113	111	110	109	108	107	105	104	103	102	101	99	98
117	.148	116	115	114	112	111	110	109	108	107	105	104	103	102	100	99
118	.239	117	116	115	113	112	111	110	109	108	106	105	104	103	101	100
119	.331	118	117	116	114	113	112	111	110	109	107	106	105	104	102	101
120	3.425	119	118	117	115	114	113	112	111	110	108	107	106	105	104	102
121	.522	120	119	118	116	115	114	113	112	111	109	108	107	106	105	103
122	.621	121	120	119	118	116	115	114	113	112	110	109	108	107	106	104
123	.723	122	121	120	119	117	116	115	114	113	112	110	109	108	107	106
124	.827	123	122	121	120	118	117	116	115	114	113	111	110	109	108	107
125	3.933	124	123	122	121	119	118	117	116	115	114	112	111	110	109	108
126	4.042	125	124	123	122	120	119	118	117	116	115	113	112	111	110	109
127	.154	126	125	124	123	121	120	119	118	117	116	114	113	112	111	110
128	.268	127	126	125	124	122	121	120	119	118	117	116	114	113	112	111
129	.385	128	127	126	125	123	122	121	120	119	118	117	115	114	113	112
130	4.504	129	128	127	126	124	123	122	121	120	119	118	116	115	114	113
131	.627	130	129	128	127	125	124	123	122	121	120	119	117	116	115	114
132	.752	131	130	129	128	126	125	124	123	122	121	120	119	117	116	115
133	4.880	132	131	130	129	127	126	125	124	123	122	121	120	118	117	116
134	5.011	133	132	131	130	129	127	126	125	124	123	122	121	119	118	117
135	5.145	134	133	132	131	130	128	127	126	125	124	123	122	120	119	118
136	.282	135	134	123	132	131	129	128	127	126	125	124	123	122	120	119
137	.422	136	135	134	133	132	130	129	128	127	126	125	124	123	121	120
138	.565	137	136	135	134	133	131	130	129	128	127	126	125	124	122	121
139	.712	138	137	136	135	134	132	131	130	129	128	127	126	125	123	122
140	5.862	139	133	137	136	135	133	132	131	130	129	128	127	126	124	123

TABLE I.—*Temperature of dew point in degrees Fahrenheit*—Continued

[Pressure=30.0 inches]

Air temperature t	Vapor pressure e	Depression of wet-bulb thermometer $(t-t')$														
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
80	1.022	54	52	50	47	44	42	39	36	32	28	24	20	13	6	−7
81	.056	55	53	51	49	46	43	41	38	34	31	27	22	17	10	±0
82	.091	57	55	52	50	48	45	42	39	36	33	29	25	20	14	+7
83	.127	58	56	54	52	49	47	44	41	38	35	31	27	23	18	11
84	.163	59	57	55	53	51	48	46	43	40	37	34	30	26	21	15
85	1.201	61	59	57	54	52	50	48	45	42	39	36	32	28	24	19
86	.241	62	60	58	56	54	52	49	47	44	41	38	34	31	27	22
87	.281	63	61	59	57	55	53	51	48	46	43	40	36	33	29	25
88	.322	64	62	61	59	57	55	52	50	47	45	42	38	35	31	27
89	.364	66	64	62	60	58	56	54	51	49	46	44	41	37	34	30
90	1.408	67	65	63	61	59	57	55	53	51	48	45	43	39	36	32
91	.453	68	66	65	63	61	59	57	55	52	50	47	44	41	38	35
92	.499	69	68	66	64	62	60	58	56	54	51	49	46	43	40	37
93	.546	71	69	67	65	63	62	60	58	55	53	51	48	45	42	39
94	.595	72	70	68	67	65	63	61	59	57	55	52	50	47	44	41
95	1.645	73	71	70	68	66	64	62	60	58	56	54	52	49	46	43
96	.696	74	72	71	69	67	66	64	62	60	58	55	53	51	48	45
97	.749	75	74	72	70	69	67	65	63	61	59	57	55	52	50	47
98	.803	76	75	73	72	70	68	66	64	63	61	58	56	54	52	49
99	.859	78	76	74	73	71	69	68	66	64	62	60	58	56	53	51
100	1.916	79	77	76	74	72	71	69	67	65	63	61	59	57	55	52
101	1.975	80	78	77	75	74	72	70	69	67	65	63	61	59	56	54
102	2.035	81	80	78	76	75	73	72	70	68	66	64	62	60	58	56
103	.097	82	81	79	78	76	74	73	71	69	68	66	64	62	60	57
104	.160	83	82	80	79	77	76	74	72	71	69	67	65	63	61	59
105	2.225	84	83	82	80	78	77	75	74	72	70	68	67	65	63	61
106	.292	86	84	83	81	80	78	77	75	73	72	70	68	66	64	62
107	.360	87	85	84	82	81	79	78	76	75	73	71	69	67	66	64
108	.431	88	86	85	84	82	81	79	77	76	74	72	71	69	67	65
109	.503	89	88	86	85	83	82	80	79	77	75	74	72	70	68	66
110	2.576	90	89	87	86	84	83	81	80	78	77	75	73	72	70	68
111	.652	91	90	88	87	86	84	83	81	80	78	76	75	73	71	69
112	.730	92	91	90	88	87	85	84	82	81	79	78	76	74	72	71
113	.810	93	92	91	89	88	86	85	84	82	80	79	77	76	74	72
114	.891	94	93	92	90	89	88	86	85	83	82	80	79	77	75	73
115	2.975	96	94	93	92	90	89	87	86	84	83	81	80	78	76	75
116	3.061	97	95	94	93	91	90	88	87	86	84	83	81	79	78	76
117	.148	98	96	95	94	92	91	90	88	87	85	84	82	81	79	77
118	.239	99	98	96	95	94	92	91	89	88	86	85	84	82	80	79
119	.331	100	99	97	96	95	93	92	91	89	88	86	85	83	82	80
120	3.425	101	100	98	97	96	94	93	92	90	89	87	86	84	83	81
121	.522	102	101	100	98	97	96	94	93	91	90	89	87	86	84	83
122	.621	103	102	101	99	98	97	95	94	93	91	90	88	87	85	84
123	.723	104	103	102	100	99	98	96	95	94	92	91	90	88	87	85
124	.827	105	104	103	102	100	99	98	96	95	94	92	91	89	88	86
125	3.933	106	105	104	103	101	100	99	97	96	95	93	92	90	89	88
126	4.042	107	106	105	104	102	101	100	99	97	96	94	93	92	90	89
127	.154	109	107	106	105	104	102	101	100	98	97	96	94	93	91	90
128	.268	110	108	107	106	105	103	102	101	99	98	97	95	94	93	91
129	.385	111	109	108	107	106	104	103	102	101	99	98	97	95	94	92
130	4.504	112	110	109	108	107	106	104	103	102	100	99	98	96	95	94
131	.627	113	112	110	109	108	107	105	104	103	101	100	99	97	96	95
132	.752	114	113	111	110	109	108	106	105	104	103	101	100	99	97	96
133	.880	115	114	112	111	110	109	108	106	105	104	102	101	100	98	97
134	5.011	116	115	114	112	111	110	109	107	106	105	104	102	101	100	98
135	5.145	117	116	115	113	112	111	110	108	107	106	105	103	102	101	99
136	.282	118	117	116	114	113	112	111	110	108	107	106	104	103	102	101
137	.422	119	118	117	116	114	113	112	111	109	108	107	106	104	103	102
138	.565	120	119	118	117	115	114	113	112	110	109	108	107	105	104	103
139	.712	121	120	119	118	116	115	114	113	112	110	109	108	107	105	104
140	5.862	122	121	120	119	117	116	115	114	113	111	110	109	108	106	105