A.1a. THERMAL INCINERATOR FOR VOC CONTROL–FACILITY A

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EXAMPLE COMPLIANCE ASSURANCE MONITORING

Thermal Incinerator for VOC Control: Facility A - Example 1

I. Background

A. Emissions Unit

Description:	Coater 1, Coater 2, and Coater 3
Identification:	Stack No. XXX/ Ct. YYYYY
Stack designation:	Incinerator
APC Plant ID No.	XXXXX
Facility:	Facility A Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation No.:	Permit
Regulated pollutant (PSEU):	VOC
Emission limit:	95 percent reduction
Monitoring requirements in permit:	Continuously monitor chamber temperature [NOTE 1]

C. Control Technology: Thermal oxidizer

II. Monitoring Approach

The key elements of the monitoring approach, including the indicators to be monitored, indicator ranges, and performance criteria are presented in Table A.1a-1.

Note that this CAM submittal is intended as an example of monitoring the operation of the incinerator and does not address capture efficiency. Capture efficiency is a critical component of the overall control efficiency of the air pollution control system, and indicators of the performance of the capture system should be incorporated into the monitoring approach. However, sufficient information was not available from this case study to include monitoring of the capture system performance.

III. Data Availability [NOTE 2]

The minimum data availability for each semiannual reporting period, defined as the number of hours for which monitoring data are available divided by the number of hours during which the process operated (times 100) will be:

Chamber temperature: 90 percent

The data availability determination will not include periods of control device start up and shut down. For an hour to be considered a valid hour of monitoring data, a minimum of 45 minutes of data must be available.

TABLE A.1a-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2
I. Indicator	Chamber temperature	Work practice
Measurement Approach	The chamber temperature is monitored with a thermocouple.	Inspection and maintenance of the burner; observation of the burner flame.
II. Indicator Range	An excursion is defined as temperature readings less than 1500°F; excursions trigger an inspection, corrective action, and a reporting requirement.	An excursion is defined as failure to perform annual inspection or daily flame observation.
QIP Threshold[a]	No more than six excursions below the indicator range in any semi-annual reporting period.	Not applicable
III. Performance Criteria A. Data Representativeness[b]	The sensor is located in the incinerator chamber as an integral part of the incinerator design. The minimum tolerance of the thermocouple is ±4°F or ±0.75% (of temperature measured in degrees Celius), whichever is greater. The minimum chart recorder sensitivity (minor division) is 20°F.	Not applicable
B. Verification of Operational Status	Not applicable	Not applicable
C. QA/QC Practices and Criteria[b]	Accuracy of the thermocouple will be verified by a second, or redundant, thermocouple probe inserted into the incinerator chamber with a hand held meter. This validation check will be conducted at least annually. The acceptance criterion is ±30°F.	Not applicable
D. Monitoring Frequency	Measured continuously.	Annual inspection of the burner; daily observation of the burner flame.
Data Collection Procedure	Recorded continuously on a circular chart recorder.	Record results of annual inspections and daily observations.
Averaging Period	No average is taken.	Not applicable

[a]The QIP is an optional tool for States; QIP thresholds are not required in the CAM submittal.

[b]Values listed for accuracy specifications are specific to this example and are not intended to provide the criteria for this type of measurement device in general.

Note: Capture efficiency is a critical component of the overall control efficiency of the air pollution control system, and indicators of the performance of the capture system should be incorporated into the monitoring approach. However, sufficient information was not available from this case study to include monitoring of the capture system performance.

MONITORING APPROACH JUSTIFICATION

I. Background

This is a coating facility that performs polyester film coating and paper liner coating with solvent based coatings. Three coaters are operated at the facility. Emissions from the three coaters are vented to the thermal incinerator. Emissions from mixing, coating, and drying operations are vented to this incinerator; some mixing vessels can also be vented to other oxidizers. A total of 27 sources are connected to the thermal incinerator.

II. Rationale for Selection of Performance Indicators

The incinerator chamber temperature was selected because it is indicative of the thermal incinerator operation (combustion occurring within the chamber). If the chamber temperature decreases significantly, complete combustion may not occur.

It has been shown that the control efficiency achieved by a thermal incinerator is a function of its operating temperature, or outlet temperature. By maintaining the operating temperature at or above a minimum, a level of control efficiency can be expected to be achieved. Attachment 1 presents information from the literature on incinerator control efficiency as a function of temperature.

The work practice comprised of an annual inspection and tuning of the incinerator burner was selected because an inspection verifies equipment integrity and periodic tuning will maintain proper burner operation and efficiency. In addition, a daily observation of the burner flame selected to monitor proper operation of the burner (blue flame) is appropriate.

[Sufficient information regarding bypass of the control device is not available. The damper on the bypass line, or purge line, on each coater must be closed during coating process operation to ensure that the vent stream is routed to the thermal incinerator.]

III. Rationale for Selection of Indicator Ranges

The selected indicator range for the incinerator chamber temperature is "greater than 1500°F at all times." When an excursion occurs corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. Furthermore, if the duration of a temperature excursion exceeds 10 minutes, the coating line operation will be curtailed. All excursions will be documented and reported. The selected QIP threshold level is six excursions per semiannual reporting period [see NOTE 3]. This level is less than 0.05 percent of the process operating time (based on 2,800 operating hours). If the QIP threshold is exceeded in a semiannual reporting period, a QIP will be developed and implemented. This QIP threshold is supported by 6-months of monitoring data following the performance test.

The air pollution control permit issued by the State agency specifies that the incinerator must be designed to operate with a minimum operating temperature of 1500°F measured at the center of the incinerator chamber. Attachment 1 indicates that a thermal incinerator is expected to achieve 95 percent or greater destruction efficiency (DRE) at this temperature. The permit requirement is 95 percent DRE. The incinerator employs a temperature controller that maintains the desired chamber temperature by using a natural gas-fired auxiliary burner; the temperature controller is set to maintain a temperature of at least 1500°F.

Review of historical monitoring data for a 6-month period (July-December 1993) indicates that 1500°F can be maintained on a routine basis with some excursions. The historical monitoring data for temperature indicate that normal loading to the incinerator will result in chamber temperatures of 1500°F and higher loadings to the device will result in periods of higher operating temperatures for short durations, such as during the performance test. The historical monitoring data indicate that the indicator range was exceeded seven times in the 6-month period; two of the excursions were momentary.

The performance test confirms acceptable performance of the incinerator; the incinerator achieved the required DRE of 95 percent. During the performance test, the incinerator was operating with a temperature of at least 1500°F (in the range of 1540° to 1800°F). During the performance tests the incinerator temperature was generally nearer 1700°F than 1500°F. The higher temperatures during the performance test occurred because the facility was operated near the maximum production rate with higher VOC loadings to challenge the incinerator with maximum VOC loading. The higher operating temperatures during the performance test are not the result of a change in operation of the incinerator (i.e., changing the burner set point temperature).

The performance test of the thermal incinerator was conducted in October 1993 using EPA Reference Method 25. Three test runs (1 hour each) were conducted with 11 out of 27 sources operating and venting to the incinerator; this number of operating sources is considered normal. During the performance test, the chamber temperature was measured continuously and recorded on a circular chart (Attachment 2).

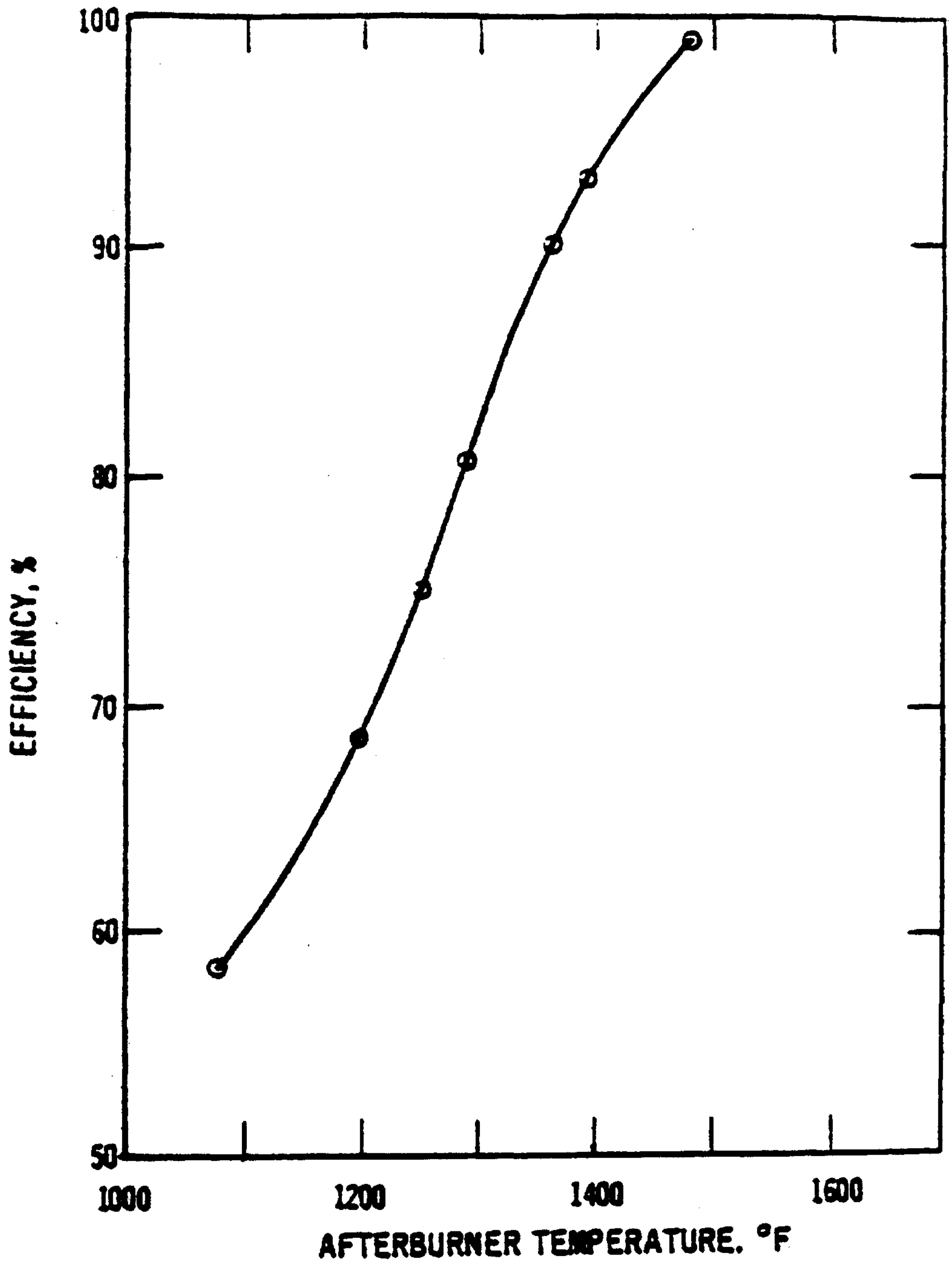
The total hydrocarbon (THC) emission limit is 154 pounds per hour (lb/hr); this limit was met. The facility's operating permit requires 95 percent reduction from the thermal incinerator. During the performance test, the thermal incinerator achieved a destruction efficiency of greater than 95 percent for all three runs (95.4, 95.5, and 97.8); average DRE for the three test runs is 96.2 percent).

The production rate during the performance test was representative of highest VOC loading to the incinerator. During the performance test, the VOC input calculated from coating usage and content was XXX lb/hr [facility requested coating usage not be presented]. By comparison, for the 6 month period for which monitoring data were reviewed, the average VOC loading to the system when all three coaters were operating (calculated as the sum of the average VOC input rate, lb/hr, of each coater) was 80 percent of the amount during the performance test.

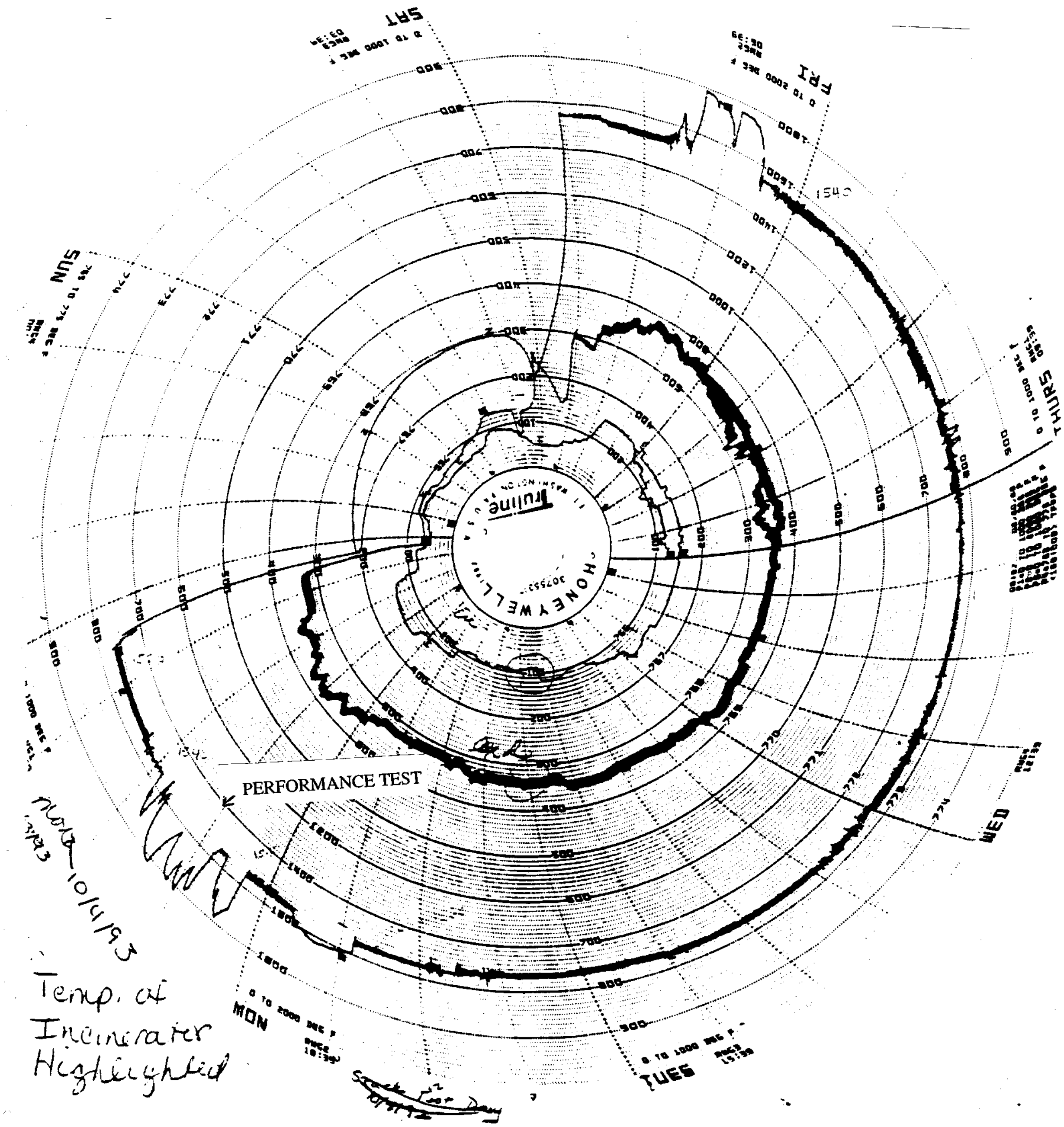
NOTE 1: CO monitoring also is a requirement in the facility's permit; however, for the purposes of this example CAM Plan, CO monitoring was not selected as an indicator. See CAM plan No. A.1b.

NOTE 2: Submittal of proposed data availability is optional; it is not a requirement of a CAM submittal.

NOTE 3: Submittal of a QIP threshold is optional; it is not a requirement of a CAM submittal.



Attachment 1. Direct-flame afterburner efficiency as a function of temperature.
Air Pollution Engineering Manual, Chapter 5 - Control Equipment for Gases and Vapors.



Attachment 2. Temperature chart during October 1993 performance test.

A.1b. THERMAL INCINERATOR FOR VOC CONTROL–FACILITY A

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EXAMPLE COMPLIANCE ASSURANCE MONITORING

Thermal Incinerator for VOC Control: Facility A - Example 1b

I. Background

A. Emissions Unit

Description:	Coater 1, Coater 2, and Coater 3
Identification:	Stack No. XXX/ Ct. YYYYY
Stack designation:	Incinerator
APC Plant ID No.	XXXXX
Facility:	Facility A Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation No.:	Permit
Regulated pollutant (PSEU):	VOC
Emission limit:	95 percent reduction
Monitoring requirements in permit:	Continuously monitor chamber temperature Continuously monitor CO concentration

C. Control Technology: Thermal oxidizer

II. Monitoring Approach

The key elements of the monitoring approach, including the indicators to be monitored, indicator ranges, and performance criteria are presented in Table A.1b-1.

Note that this CAM submittal is intended as an example of monitoring the operation of the incinerator and does not address capture efficiency. Capture efficiency is a critical component of the overall control efficiency of the air pollution control system, and indicators of the performance of the capture system should be incorporated into the monitoring approach. However, sufficient information was not available from this case study to include monitoring of the capture system performance.

III. Data Availability [NOTE 1]

The minimum data availability for each semiannual reporting period, defined as the number of hours for which monitoring data are available divided by the number of hours during which the process operated (times 100) will be:

Chamber temperature:	90 percent
Outlet CO concentration:	95 percent

The data availability determination does not include periods of control device start up and shut down. For an hour to be considered a valid hour of monitoring data, a minimum of 45 minutes of data must be available.

TABLE A.1b-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2
I. Indicator	Chamber temperature	Outlet CO concentration
Measurement Approach	The chamber temperature is monitored with a thermocouple.	The CO concentration is measured with a CEMS meeting 40 CFR 60 Appendix B, Performance Specifications.
II. Indicator Range	An excursion is defined as temperature readings less than 1500°F; excursions trigger an inspection, corrective action, and a reporting requirement.	An excursion is defined as a 1-hr average greater than 50 ppm (emission limit); excursions trigger an inspection, corrective action, and a reporting requirement.
QIP Threshold[a]	No more than six excursions below the indicator range in any semiannual reporting period.	No more than 14 excursions above the indicator range in any semiannual reporting period.
III. Performance Criteria A. Data Representativeness[b]	The sensor is located in the incinerator chamber as an integral part of the incinerator design. The minimum tolerance of the thermocouple is ±4°F or ±0.75% (of temperature measured in degrees Celius), whichever is greater. The minimum chart recorder sensitivity (minor division) is 20°F.	The system meets 40 CFR 60 Appendix B, Performance Specification 4 criteria.
B. Verification of Operational Status	Not applicable	Not applicable
C. QA/QC Practices and Criteria[b]	Accuracy of the thermocouple will be verified by a second, or redundant, thermocouple probe inserted into the incinerator chamber with a hand held meter. This validation check will be conducted at least annually. The acceptance criterion is ±30°F.	Calibration drift will be automatically checked every 24 hours by zero air and span gas.
D. Monitoring Frequency	Measured continuously.	CO concentration is measured continuously.
Data Collection Procedure	Recorded continuously on a circular chart recorder.	The average of six 10-second readings are recorded once per minute by the DAS (electronic record).
Averaging Period	No average is taken.	1-hour average of 60 1-minute readings.

[a]The QIP is an optional tool for States; QIP thresholds are not required in the CAM submittal.

[b]Values listed for accuracy specifications are specific to this example and are not intended to provide the criteria for this type of measurement device in general.

Note: Capture efficiency is a critical component of the overall control efficiency of the air pollution control system, and indicators of the performance of the capture system should be incorporated into the monitoring approach. However, sufficient information was not available from this case study to include monitoring of the capture system performance.

MONITORING APPROACH JUSTIFICATION

I. Background

This facility performs polyester film coating and paper liner coating with solvent based coatings. Three coaters are operated. Emissions from the three coaters are vented to the thermal incinerator. Emissions from mixing, coating, and drying operations are vented to this incinerator; some mixing vessels can also be vented to other oxidizers. A total of 27 sources are connected to the thermal incinerator.

II. Rationale for Selection of Performance Indicators

The incinerator chamber temperature was selected because it is indicative of the thermal incinerator operation (combustion occurring within the chamber). If the chamber temperature decreases significantly, complete combustion may not occur.

It has been shown that the control efficiency achieved by a thermal incinerator is a function of its operating temperature, or outlet temperature. By maintaining the operating temperature at or above a minimum, a level of control efficiency can be expected to be achieved. Attachment 1 presents information from the literature on incinerator control efficiency as a function of temperature.

The CO concentration at the outlet of the thermal incinerator is an indicator of incomplete combustion. Significant increases in CO indicate that combustion efficiency has decreased and corrective action should be taken.

[Sufficient information regarding bypass of the control device is not available. The damper on the bypass line, or purge line, on each coater must be closed during coating process operation to ensure that the vent stream is routed to the thermal incinerator.]

III. Rationale for Selection of Indicator Ranges

A. Thermal Incinerator Temperature

The selected indicator range for the incinerator chamber temperature is “greater than 1500°F at all times.” When an excursion occurs corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. Furthermore, if the duration of a temperature excursion exceeds 10 minutes, the coating line operation will be curtailed. All excursions will be documented and reported. The selected QIP threshold level is six excursions per semiannual reporting period (see NOTE 2). This level is less than 0.05 percent of the process operating time (based on 2,800 operating hours). If the QIP threshold is exceeded in a semiannual reporting period, a QIP will be developed and implemented. This QIP is supported by 6 months of monitoring data following the performance test.

The air pollution control permit issued by the State agency specifies that the incinerator must be designed to operate with a minimum operating temperature of 1500°F measured at the center of the incinerator chamber. Attachment 1 indicates that a thermal incinerator is expected to achieve 95 percent or greater destruction efficiency (DRE) at this temperature. The permit requirement is 95 percent DRE. The incinerator employs a temperature controller that maintains the desired chamber temperature by using a natural gas-fired auxiliary burner; the temperature controller is set to maintain a temperature of at least 1500°F.

Review of historical monitoring data for a 6-month period (July to December 1993) indicates that 1500°F can be maintained on a routine basis with some excursions. The historical monitoring data for temperature indicate that normal loading to the incinerator will result in chamber temperatures of 1500°F and higher loadings to the device will result in periods of higher operating temperatures for short durations, such as during the performance test. The historical monitoring data indicate that the indicator range was exceeded seven times in the 6-month period; two of the excursions were momentary.

The performance test confirms acceptable performance of the incinerator; the incinerator achieved the required DRE of 95 percent. During the performance test, the incinerator was operating with a temperature of at least 1500°F (in the range of 1540° to 1800°F). During the performance tests the incinerator temperature was generally nearer 1700°F than 1500°F. The higher temperatures during the performance test occurred because the facility was operated near the maximum production rate with higher VOC loadings to challenge the incinerator with maximum VOC loading. The higher operating temperatures during the performance test are not the result of a change in operation of the incinerator (i.e., changing the burner set point temperature).

The performance test of the thermal incinerator was conducted in October 1993 using EPA Reference Method 25. Three test runs (1 hour each) were conducted with 11 out of 27 sources operating and venting to the incinerator; this number of operating sources is considered normal. During the performance test, the chamber temperature was measured continuously and recorded on a circular chart (Attachment 2).

The THC emission limit is 154 pounds per hour (lb/hr); this limit was met during the test. The facility's operating permit requires 95 percent reduction from the thermal incinerator. During the performance test, the thermal incinerator achieved a destruction efficiency of greater than 95 percent for all three runs (95.4, 95.5, and 97.8); the average DRE for the three test runs is 96.2 percent. The average outlet CO concentration for each of the three performance test runs was 2.3, 10.2, and 1.6 ppmvd.

The production rate during the performance test was representative of highest VOC loading to the incinerator. During the performance test, the VOC input calculated from coating usage and content was XXX lb/hr [facility requested coating usage not be presented]. By comparison, for the 6-month period for which monitoring data were reviewed, the average VOC loading to the system when all three coaters were operating (calculated as the sum of the average VOC input rate, lb/hr, of each coater) was 80 percent of the amount during the performance test.

B. Outlet CO Concentrations

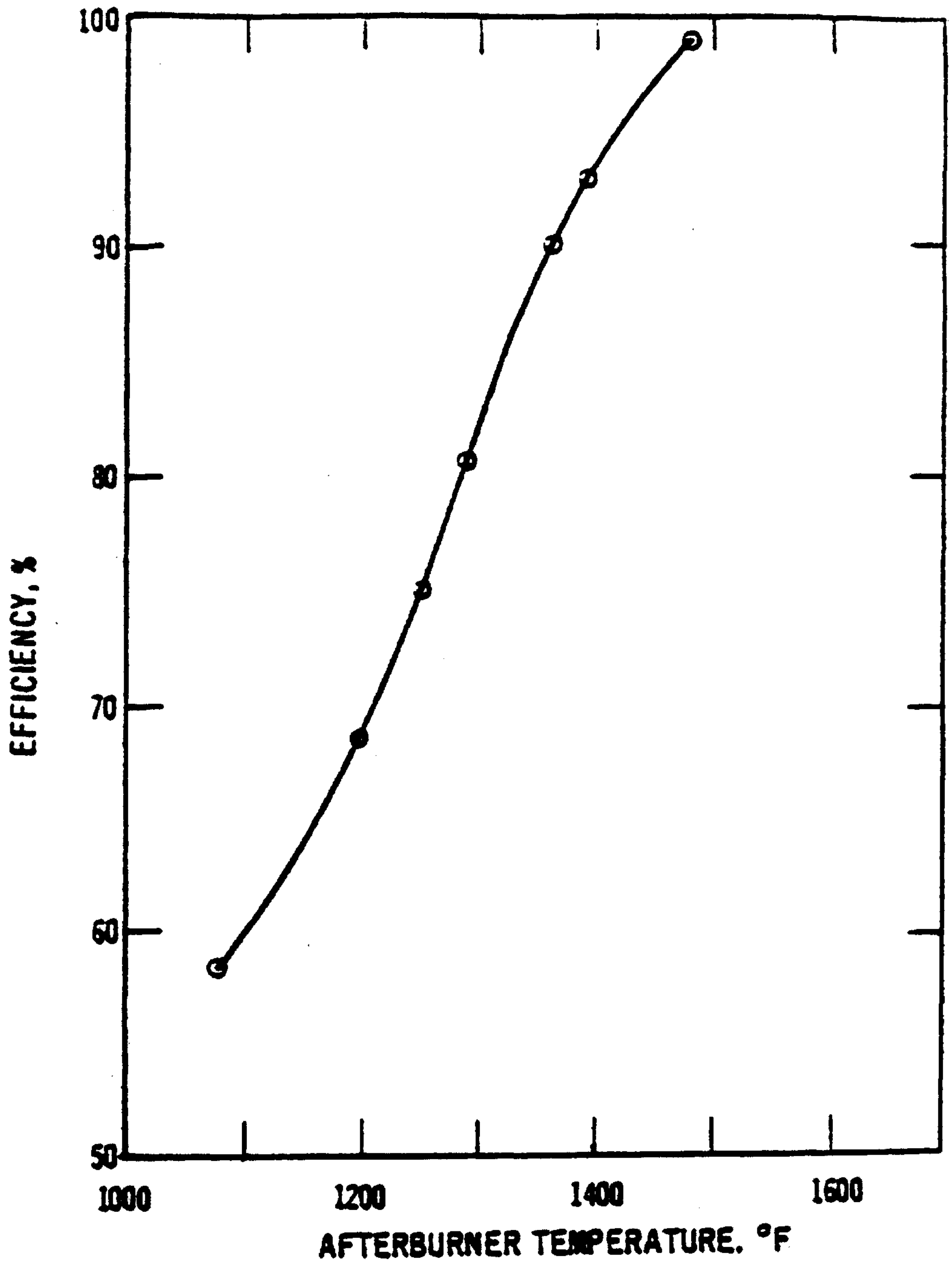
The selected indicator range for the 1-hour average CO concentration is "less than 50 ppmvd, as measured." When an excursion occurs corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. All excursions will be documented and reported. The selected QIP threshold level is 14 excursions per semiannual reporting period. This level is less than 0.5 percent of the process operating time (based on 2,800 operating hours). If the QIP threshold is exceeded in a semiannual reporting period, a QIP will be developed and implemented. This QIP is supported by 3 months of monitoring data following the performance test.

Review of historical monitoring data for a 3-month period (September through December 1993) indicates that the 50 ppmvd CO concentration limit can be maintained on a routine basis with some excursions. The historical monitoring data indicate that the indicator range was exceeded eight times in the 3-month period. Based upon these historical data, the threshold for excursions is no more than 14 excursions above 50 ppmvd in a 6-month period (i.e., 7 excursions per quarter).

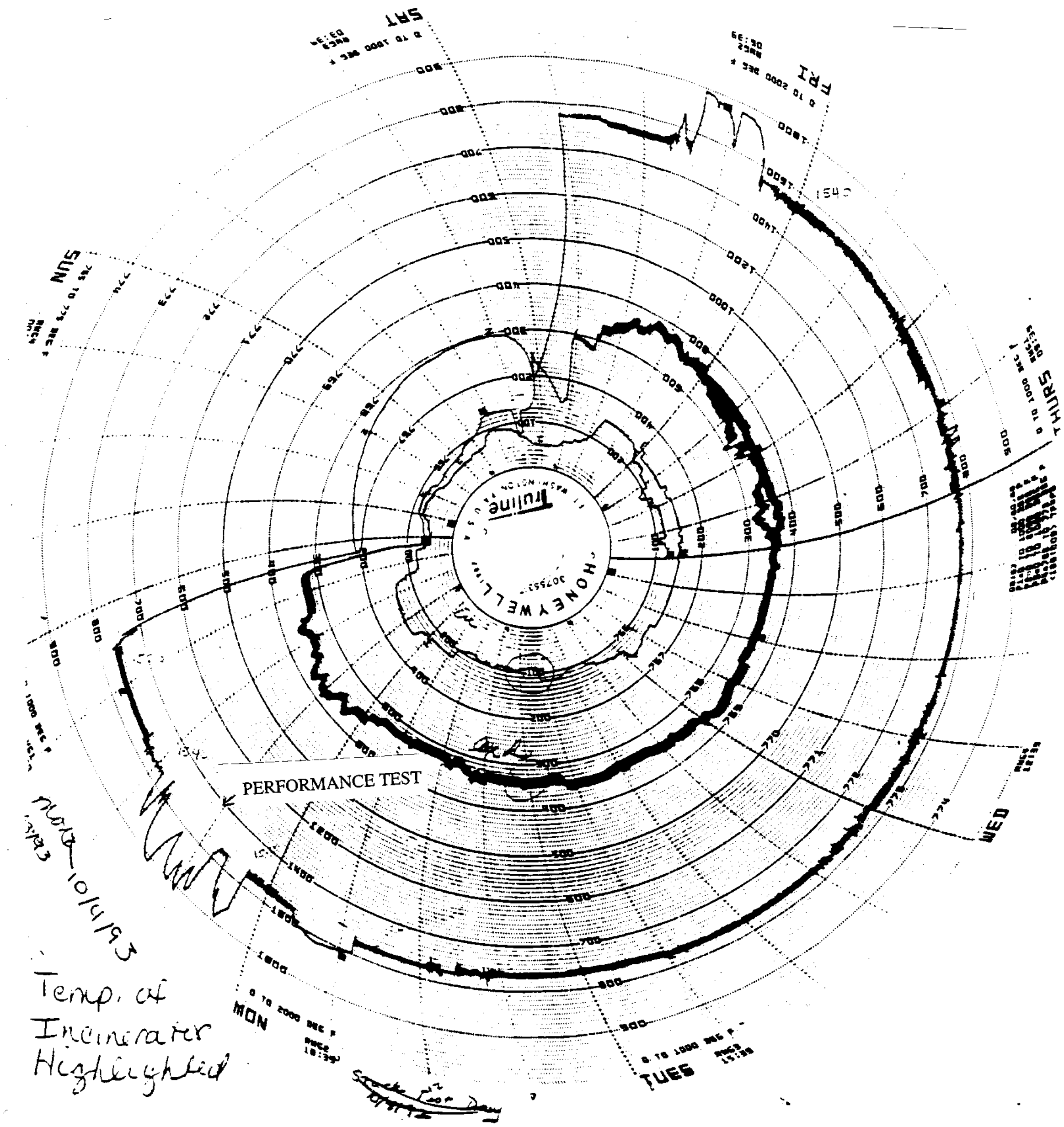
The performance test conducted in October 1993 is discussed above in section III.A. The CO concentrations were well under the 50 ppmvd limit (measured CO) for all three runs during the test.

NOTE 1: Submittal of proposed data availability is optional; it is not a requirement of a CAM submittal.

NOTE 2: Submittal of a QIP Threshold is optional; it is not a requirement of a CAM submittal.



Attachment 1. Direct-flame afterburner efficiency as a function of temperature.
Air Pollution Engineering Manual, Chapter 5 - Control Equipment for Gases and Vapors.



Attachment 2. Temperature chart during October 1993 performance test.

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A.3 CONDENSER FOR VOC CONTROL--FACILITY C

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EXAMPLE COMPLIANCE ASSURANCE MONITORING:
CONDENSER FOR VOC CONTROL--FACILITY C

I. Background

A. Emissions Unit

Description:	Storage tank
Identification:	T-200-7
Facility:	Facility C Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation No.:	40 CFR 63, Subpart G [Note 1]
Regulated pollutant (PSEU):	VOC
Emission limit:	95 percent reduction
Monitoring requirements:	Continuously monitor outlet vent temperature.

C. Control Technology: Two refrigerated condensers

II. Monitoring Approach

The key elements of the monitoring approach for VOC, including the indicators to be monitored, indicator ranges, and performance criteria, are presented in Table A.3-1.

TABLE A.3-1. MONITORING APPROACH

I. Indicator	Outlet vent temperature
Measurement Approach	The outlet vent temperature is monitored with a thermocouple.
II. Indicator Range	An excursion is defined as a daily average condenser outlet temperature of greater than -60°F. Excursions trigger an inspection, corrective action, and a reporting requirement.
III. Performance Criteria A. Data Representativeness[a]	The sensor is installed at the outlet vent of the condenser sufficiently close (within 2 feet) to the condenser to provide a representative outlet temperature. The minimum accuracy is ±4°F.
B. Verification of Operational Status	N/A
C. Quality Assurance and Control Practices	Annual calibration is performed: (1) on the thermocouple by measuring the voltage generated and (2) on the transmitter by attaching a calibrator to the input of the transmitter, generating a voltage, and checking the corresponding output of the transmitter.
D. Monitoring Frequency	Temperature is measured continuously.
Data Collection Procedures	15-minute data points are sent to the DCS.
Averaging Period	Hourly averages of four 15-minute temperature readings are calculated for tracking of the outlet temperature. A daily average of all 15-minute temperature readings is recorded for compliance purposes.

[a]Values listed for accuracy specifications are specific to this example and are not intended to provide the criteria for this type of measurement device in general.

JUSTIFICATION

I. Background

The pollutant specific emissions unit (PSEU) is the propionaldehyde storage tank (fixed roof). The storage tank capacity is 173,000 gallons. Emissions from the propionaldehyde storage tank are vented to two refrigerated condensers. The propionaldehyde emissions are vented to one of the two condensers at all times; one condenser is online while the other is defrosting on a 4-hour cycle. The condensers are used to reduce VOC emissions. Maximum uncontrolled emissions from this tank are estimated to vary from 154 lb/hr in the winter to 175 lb/hr in the summer. Based on the design of the PSEU, bypass of the control device cannot occur.

II. Rationale for Selection of Performance Indicators

Reduction of the emissions from storage tanks is required; these emissions are reduced with a refrigerated condenser. Monitoring of the outlet vent temperature indicates the level of condensation occurring in the condenser. Outlet vent temperature is a good indicator of the operation of the condenser because the concentration of the outlet vent stream can be determined based on temperature of the stream and vapor pressure equilibrium data. To achieve the outlet concentration, the outlet vent temperature must be maintained below a certain level (i.e., a maximum temperature). If the outlet vent temperature increases above the maximum temperature limit, condensation of the components to the level expected will not occur. An increase in outlet vent temperature indicates a reduction of performance of the condenser.

III. Rationale for Selection of Indicator Ranges

The indicator range was established based upon engineering calculations and historical monitoring data. The emission standard requires a 95 percent reduction efficiency. Maximum emission conditions for this tank are during tank loading at the highest ambient temperature the tank experiences (summer conditions). Engineering calculations were used to establish the required condenser vent temperature to achieve a 95 percent reduction under these conditions. The temperature of the vapor in the tank and at the inlet to the condenser were assumed to be ambient. The tank vapor was assumed to be at atmospheric pressure. The concentration of propionaldehyde in the vapor (calculated based on the vapor pressure of propionaldehyde at ambient conditions) and the fill rate during tank loading were used to determine the maximum uncontrolled emission rate. The emissions at a 95 percent reduction efficiency were calculated, and the corresponding temperature needed to achieve the allowed propionaldehyde concentration (vapor pressure) was determined. The maximum allowed outlet vent temperature was determined to be 7°F. The outlet vent temperature must be maintained at this temperature or lower to achieve 95 percent reduction in the summer. Under winter conditions, a 95 percent reduction is achieved at an outlet vent temperature of -50°F. No lower limit to the indicator range is necessary. No performance test has been performed on the control device, and no test is planned.

In addition to the engineering calculations performed, monitoring data were reviewed to determine whether the condenser temperature could be maintained during normal operation of the storage tank and condenser. Six weeks of monitoring data for outlet vent temperatures (April 23 through June 3, 1997) have been collected and reviewed. These outlet vent temperature data include hourly average temperatures for periods when the condensers were online (i.e., offline cycles, lasting 4 hours each, are not included on the graph). Figure A.3-1 presents these data. During the 6-week period, the hourly average outlet vent temperatures while online ranged from-85° to -64°F. Daily average temperatures while online for the 6-week period ranged from-80° to -78°F. The daily average temperatures are shown in Figure A.3-2. The condenser was consistently operating with both hourly and daily average outlet vent temperatures below the maximum temperature determined in calculations. Data for 15-minute temperature readings were also available for 4 days for both the online and offline cycles for both condensers. Two days of 15-minute readings are shown in Figure A.3-3, and 4 days of 15-minute readings are shown in Figure A.3-4. The 15-minute readings range from approximately -89° to -77°F.

The selected indicator range is "a daily average temperature of less than -60 °F." This range was selected by taking the highest daily average observed temperature value (-78°F) during the 6-week period for which monitoring data were available (April through June) and adding a 20 percent buffer. At the selected indicator range, the condenser will still be operating well below temperature required to achieve compliance (-50°F). When an excursion occurs, corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. All excursions will be documented and reported. No QIP threshold has been selected.

NOTE 1: This source is exempt from CAM because 40CFR63, Subpart G was proposed after November 15, 1990. Nonetheless, a CAM plan was prepared from information and data obtained from this facility as an example of a monitoring approach and the selection of an indicator range.

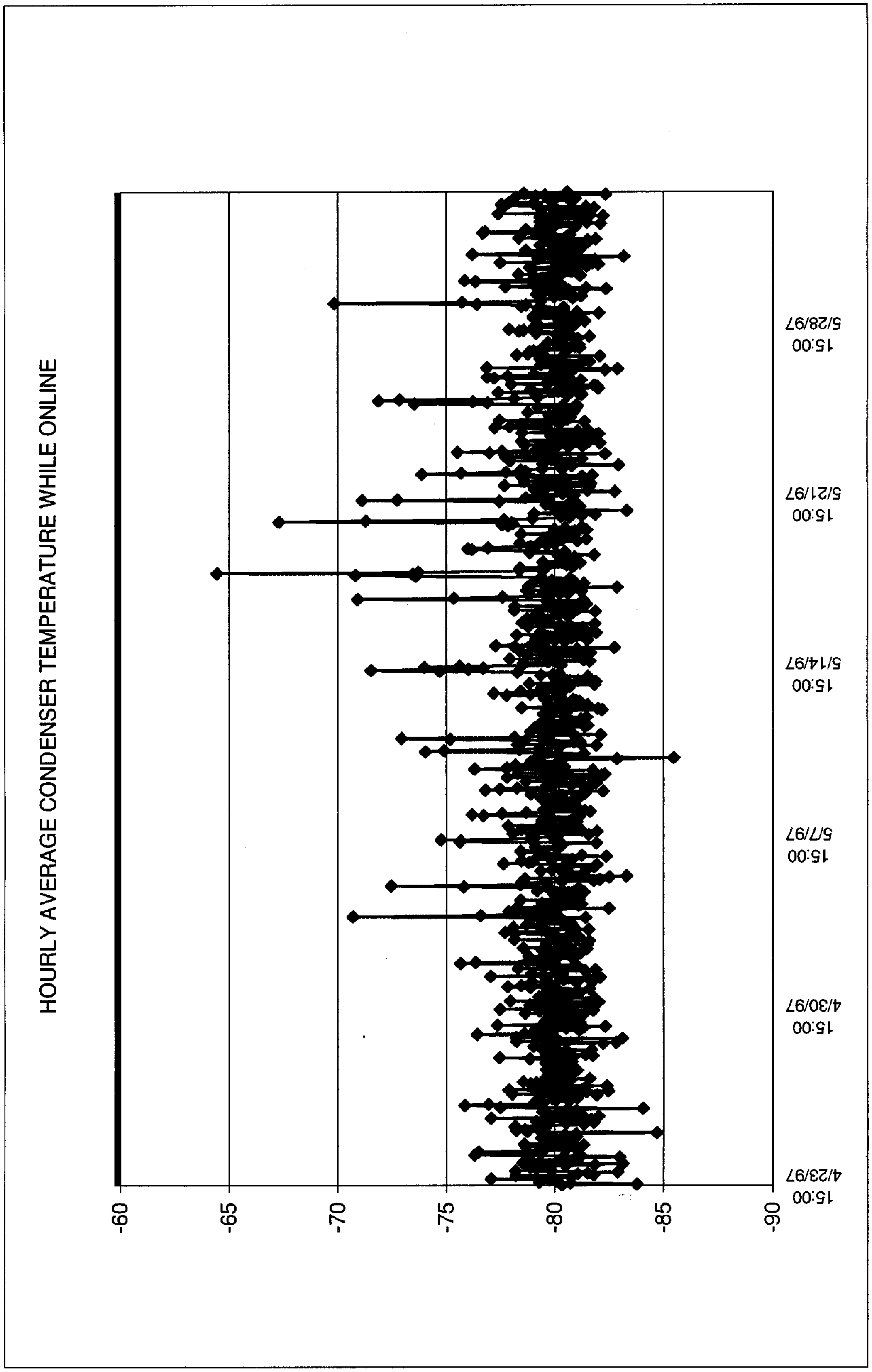
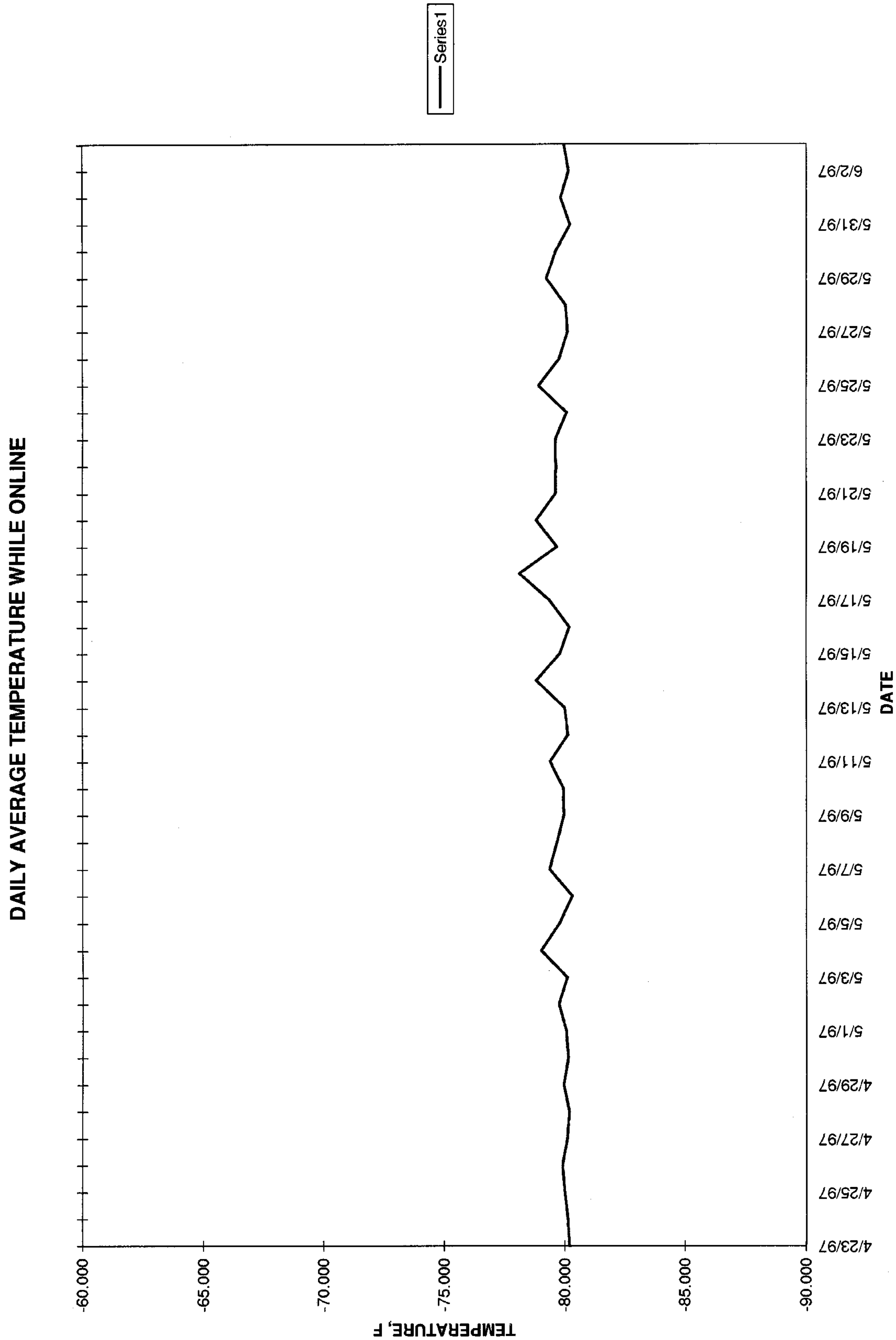

HOURLY AVERAGE CONDENSER TEMPERATURE WHILE ONLINE
-60
-65
-70
-75
-80
-85
-90
15:00 4/23/97
15:00 4/30/97
15:00 5/7/97
15:00 5/14/97
15:00 5/21/97
15:00 5/28/97

Figure A.3-1.


DAILY AVERAGE TEMPERATURE WHILE ONLINE
Series1
-60.000
-65.000
-70.000
-75.000
-80.000
-85.000
-90.000
TEMPERATURE, F
4/23/97
4/25/97
4/27/97
4/29/97
5/1/97
5/3/97
5/5/97
5/7/97
5/9/97
5/11/97
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5/15/97
5/17/97
5/19/97
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6/2/97
DATE

Figure A.3-2

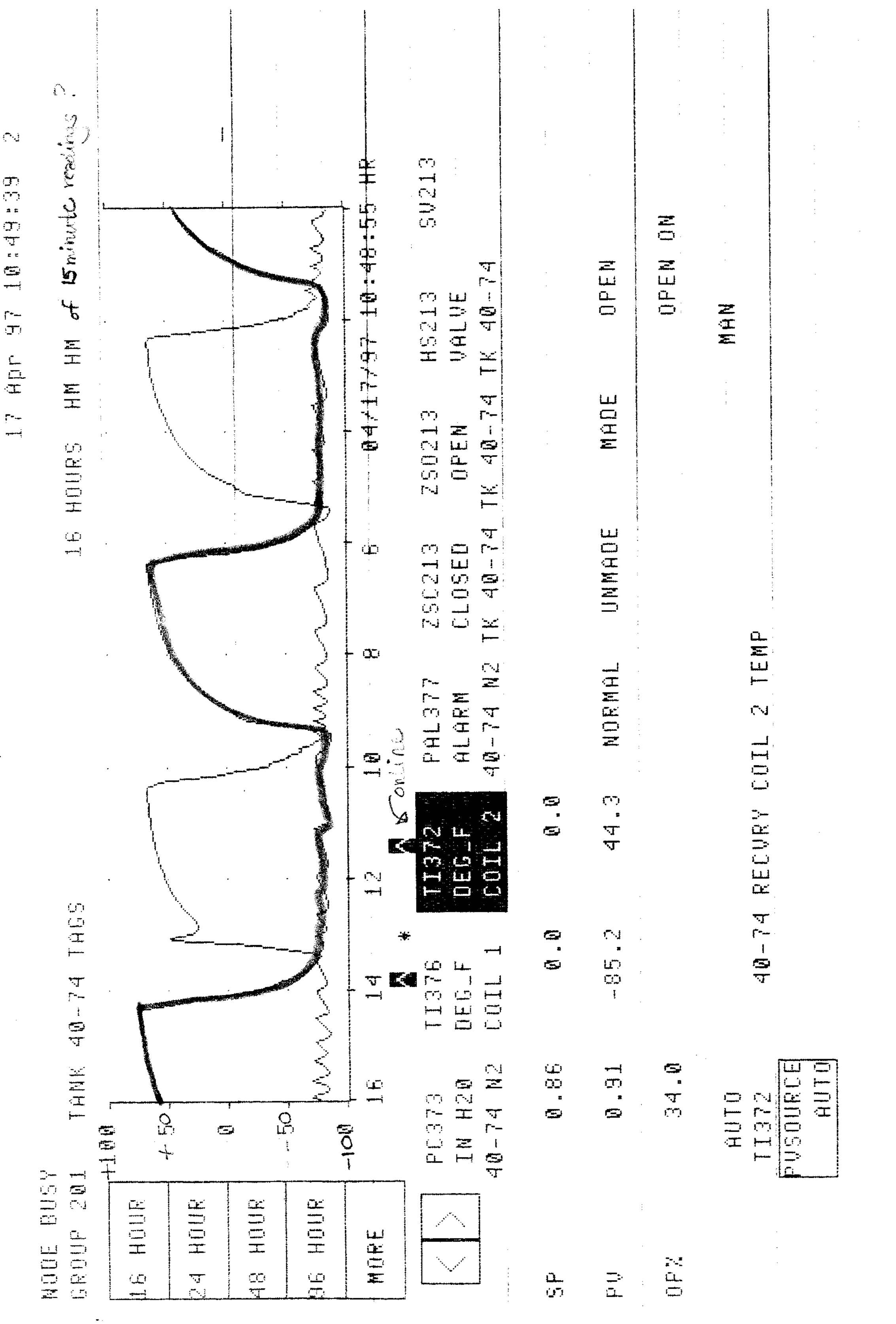
NODE BUSY
GROUP 201 TANK 40-74 TAGS
16 HOURS HM HM
17 Apr 97 10:49:39 2
16 HOUR
24 HOUR
48 HOUR
96 HOUR
MORE
PC373 IN H2O 40-74 N2
TI376 DEG_F COIL 1
TI372 DEG_F COIL 2
PAL377 ALARM 40-74 N2
ZSC213 CLOSED TK 40-74
ZSO213 OPEN TK 40-74
HS213 VALVE TK 40-74
SV213
SP 0.86 0.0 0.0
PV 0.91 -85.2 44.3 NORMAL UNMADE MADE OPEN
OP% 34.0 OPEN ON
AUTO MAN
TI372 40-74 RECVRY COIL 2 TEMP
PVSOURCE AUTO
04/17/97 10:48:55 HR

Figure A.3-3.

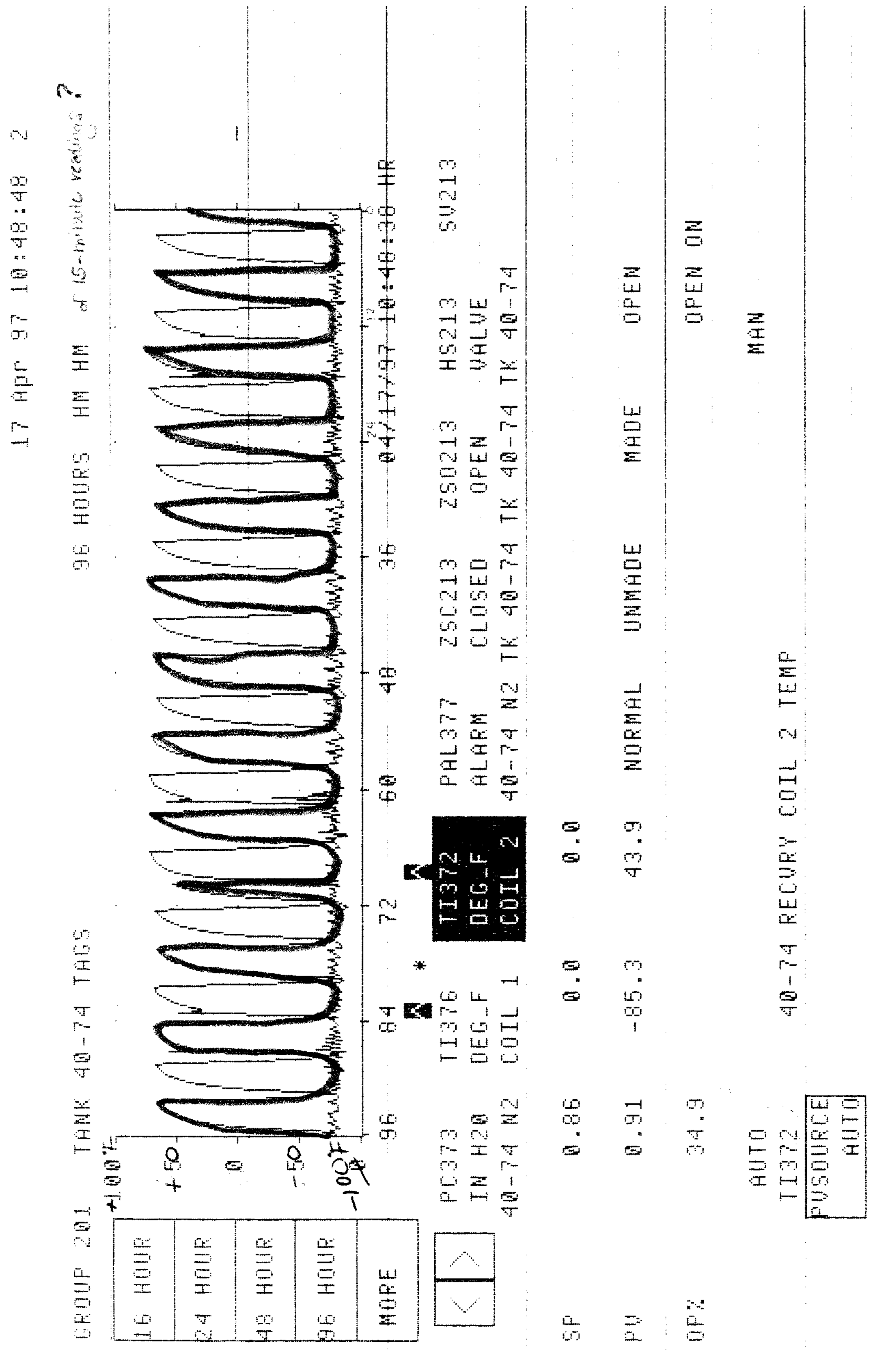
GROUP 201
TANK 40-74 TAGS
96 HOURS
HM HM
17 Apr 97 10:48:48
2
16 HOUR
24 HOUR
48 HOUR
96 HOUR
MORE
+100%
+50
0
-50
-100
96
84
72
60
48
36
24
04/17/97 10:48:30
HR
PC373
IN H20
40-74 N2
TI376
DEG_F
COIL 1
TI372
DEG_F
COIL 2
PAL377
ALARM
40-74 N2 TK 40-74
ZSC213
CLOSED
TK 40-74
ZSO213
OPEN
TK 40-74
HS213
VALVE
TK 40-74
SV213
SP
0.86
0.0
0.0
PV
0.91
-85.3
43.9
NORMAL
UNMADE
MADE
OPEN
OP%
34.9
OPEN ON
AUTO
MAN
TI372
40-74 RECVRY COIL 2 TEMP
PVSOURCE
AUTO

Figure A.3-4.

A.4 SCRUBBER FOR VOC CONTROL--FACILITY D

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EXAMPLE COMPLIANCE ASSURANCE MONITORING:
SCRUBBER FOR VOC CONTROL--FACILITY D

I. Background

A. Emissions Unit

Description:	Process tanks
Identification:	B-352-1, Vent A
Facility:	Facility D Anytown, USA

B. Applicable Regulation, Emission Limit and Monitoring Requirements

Regulation No.:	Permit
Regulated pollutant (PSEU)	VOC
Emission limit:	99 percent reduction
Monitoring requirements:	Continuously monitor water flow rate.

C. Control Technology: Packed bed scrubber

II. Monitoring Approach

The key elements of the monitoring approach for VOC, including the indicators to be monitored, indicator ranges, and performance criteria, are presented in Table A.4-1.

TABLE A.4-1. MONITORING APPROACH

		Permit Indicator No. 1
I.	Indicator	Water flow rate
	Measurement Approach	The water flow rate is monitored with an orifice plate and differential pressure gauge.
II.	Indicator Range	An excursion is defined as a daily average scrubber water flow rate of less than 1.2 gal/min. Excursions trigger an inspection, corrective action, and a reporting requirement.
III.	Performance Criteria A. Data Representativeness[a]	The orifice plate is installed in the scrubber water inlet line. The minimum accuracy is ± 0.05 gal/min.
	B. Verification of Operational Status	NA
	C. Quality Assurance and Control Practices	Weekly zero and quarterly upscale pressure check of transmitter.
	D. Monitoring Frequency	Measured continuously.
	Data Collection Procedures	Recorded once per minute.
	Averaging Period	Hourly averages of 60 1-minute flow rates are calculated. A daily average of all hourly readings is calculated and recorded.

[a]Values listed for accuracy specifications are specific to this example and are not intended to provide the criteria for this type of measurement device in general.

JUSTIFICATION

I. Background

The PSEU includes the tanks in the acetic anhydride department. Emissions from seven tanks are vented to a packed bed water scrubber. Six of these tanks are batch filled and one is continuously filled. The scrubber is used to reduce VOC emissions. Maximum emissions from these tanks are 39 lb/hr. Based on the PSEU design, bypass of the control device is not possible.

II. Rationale for Selection of Performance Indicators

The emissions from the process tanks are controlled using a packed bed water scrubber using once-through water. The performance indicator selected is liquid flow to the scrubber. To achieve the required emission reduction, a minimum water flow rate must be supplied to absorb the given amount of VOC in the gas stream, given the size of the tower and height of the packed bed. The L/G ratio is a key operating parameter of the scrubber. If the L/G ratio decreases belowz the minimum, sufficient mass transfer of the pollutant from the gas phase to the liquid phase will not occur. The minimum liquid flow required to maintain the proper L/G ratio at the maximum gas flow and vapor loading through the scrubber can be determined. Maintaining this minimum liquid flow, even during periods of reduced gas flow, will ensure the required L/G ratio is achieved at all times.

III. Rationale for Selection of Indicator Ranges

The minimum water flow is based on engineering calculations using ASPEN® programming and historical data. Computer simulation (modeling) of the scrubber system was performed for the maximum gas flow rate and VOC loading to the scrubber; the water flow rate necessary for achieving control at this gas flow rate was determined. The scrubber was modeled using an equilibrium-based distillation method and two ideal stages were assumed. Ideal behavior of the gas phase was assumed; liquid phase activity coefficients were estimated from an in-house vapor-liquid equilibria data base (parameters regressed from actual vapor-liquid equilibria data and UNIFAC) using the Wilson equations for binary systems. The minimum water flow rate to the scrubber (calculated based on maximum VOC emissions and gas flow rate) was determined to be 1.1 gal/min. The water flow rate to the scrubber must be maintained at this level or higher to achieve 99 percent emission reduction.

Monitoring data were reviewed to determine the minimum scrubber water flow rate maintained during normal operation of the process tanks and scrubber. Daily average data for a 60-day period (January 17 through March 17, 1997) were reviewed. The daily average flow rate ranges from 1.18 to 1.39 gal/min with 95 percent of the values equal to or greater than 1.2 gal/min; if values greater than 1.15 are rounded to 1.2, then 100 percent of the daily averages are equal to or greater than 1.2 gal/min. Attachment 1 lists the daily average values for the 60-day period. Hourly average data for a 30-day period (February 17 through March 17) also were reviewed. The hourly averages for this period range from 1.19 to 1.21. The scrubber has been consistently operated with both the hourly and daily average water flow rate equal to or greater than 1.2 gal/min.

The selected indicator range is a minimum daily average water flow rate of 1.2 gal/min (defined as greater than 1.15 gal/min). When an excursion occurs corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. All excursions will be documented and reported. The indicator range was selected by establishing the excursion level at the minimum water flow rate that has been established as the operational level and has been consistently maintained at all times as indicated by 2 months of monitoring data. This water flow rate is above the minimum level (1.1 gal/min) necessary to achieve compliance during maximum gas flow and VOC loading to the scrubber, as established through modeling. A daily average, rather than an hourly average, was selected for the indicator range because the historical data indicate that the flow rate is very constant with little hourly variation. Consequently, the daily average is a sufficient indicator of performance. No performance test has been conducted on the scrubber.

Attachment 1.
Daily average water flow to Vent A scrubber in gal/min.

DATE	TIME	32FC80
01/17/97	0:00	1.183
01/18/97	0:00	1.392
[illegible]19/97	0:00	1.211
01/20/97	0:00	1.200
01/21/97	0:00	1.200
01/22/97	0:00	1.200
01/23/97	0:00	1.200
01/24/97	0:00	1.200
01/25/97	0:00	1.200
01/26/97	0:00	1.200
01/27/97	0:00	1.200
01/28/97	0:00	1.200
01/29/97	0:00	1.200
01/30/97	0:00	1.200
01/31/97	0:00	1.200
02/01/97	0:00	1.200
02/02/97	0:00	1.200
02/03/97	0:00	1.200
02/04/97	0:00	1.200
02/05/97	0:00	1.200
02/06/97	0:00	1.200
02/07/97	0:00	1.200
02/08/97	0:00	1.200
02/09/97	0:00	1.200
02/10/97	0:00	1.200
02/11/97	0:00	1.200
02/12/97	0:00	1.200
[illegible]13/97	0:00	1.200
02/14/97	0:00	1.200
02/15/97	0:00	1.200
02/16/97	0:00	1.200
02/17/97	0:00	1.200
02/18/97	0:00	1.200
02/19/97	0:00	1.200
02/20/97	0:00	1.200
02/21/97	0:00	1.200
02/22/97	0:00	1.200
02/23/97	0:00	1.200
02/24/97	0:00	1.199
02/25/97	0:00	1.200
02/26/97	0:00	1.200
02/27/97	0:00	1.200
02/28/97	0:00	1.200
03/01/97	0:00	1.200
03/02/97	0:00	1.200
03/03/97	0:00	1.200
03/04/97	0:00	1.200
03/05/97	0:00	1.200
03/06/97	0:00	1.200
03/07/97	0:00	1.200
03/08/97	0:00	1.200
03/09/97	0:00	1.200
[illegible]0/97	0:00	1.200
03/11/97	0:00	1.200
03/12/97	0:00	1.200
03/13/97	0:00	1.200
03/14/97	0:00	1.199
03/15/97	0:00	1.200
03/16/97	0:00	1.200
03/17/97	0:00	1.200

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A.4b PACKED BED SCRUBBER FOR VOC CONTROL OF A BATCH PROCESS – FACILITY Q

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EXAMPLE COMPLIANCE ASSURANCE MONITORING:
PACKED BED SCRUBBER FOR VOC CONTROL – FACILITY Q

I. Background

A. Emissions Unit

Description: Batch mixers and tanks used in a chemical process

Identification: Scrubber B-67-2

Facility: Facility Q
Anytown, USA

B. Applicable Regulation, Emissions Limit, and Monitoring Requirements

Regulation: Permit, State regulation

Emissions limit:
VOC: 3.6 pounds per hour

Monitoring requirements: Inlet water flow, acetic acid concentration in scrubber underflow

C. Control Technology Packed bed scrubber

II. Monitoring Approach

The key elements of the monitoring approach for VOC are presented in Table A.4b-1. The selected indicators of performance are the scrubber inlet water flow rate and the acetic acid concentration in the scrubber water underflow. The scrubber inlet water flow rate is measured continuously and recorded twice daily. The scrubber water underflow is sampled twice daily; the acetic acid concentration of each sample is determined by titration.

TABLE A.4b-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2
I. Indicator	Scrubber inlet water flow rate.	Acetic acid concentration in underflow.
Measurement Approach	The scrubber inlet water flow rate is measured using a radiometer.	A sample of the underflow is taken and the acetic acid concentration determined by titration.
II. Indicator Range	An excursion is defined as any operating condition where the scrubber inlet water flow rate is less than 4 gpm. An excursion will trigger an investigation of the occurrence, corrective action, and a reporting requirement.	An excursion is defined as any operating condition where the underflow acetic acid concentration is greater than 10 percent. An excursion will trigger an investigation of the occurrence, corrective action, and a reporting requirement.
III. Performance Criteria A. Data Representativeness	The scrubber inlet water flow rate is measured using a variable area flow meter (radiometer) located in the scrubber water inlet line. The minimum acceptable accuracy of the meter is ±5 percent of the measured value and the range is 0 to 15 gpm.	The acetic acid concentration in the scrubber water effluent is measured by titrating a water sample extracted from the scrubber underflow.
B. Verification of Operational Status	NA	NA
C. Quality Assurance and Control Practices	Annual calibration and cleaning of radiometer. Acceptance criteria: ±5 percent of the measured value.	Only trained personnel perform sampling and titration. Laboratory QA/QC procedures are followed. Calibration standards are prepared to ensure the sample titration is being performed accurately.
D. Monitoring Frequency	The scrubber inlet water flow rate is measured continuously and recorded twice daily.	The scrubber water outlet acetic acid concentration is measured twice daily.
Data Collection Procedures	The scrubber inlet water flow rate is recorded twice daily. (The post-control emissions from this unit are less than the major source threshold, so continuous monitoring and recording is not required.)	A water sample is taken and titrated manually with phenolphthalein and NaOH solution. (The post-control emissions from this unit are less than the major source threshold, so continuous monitoring and recording is not required.)
Averaging Period	None.	None.

MONITORING APPROACH JUSTIFICATION

I. Background

The pollutant specific emissions unit (PSEU) consists of process equipment in the cellulose esters division controlled by a packed bed scrubber. The process consists of batch mixers that are used to convert cellulose into cellulose ester. Each mixer may be started at a different time and may be used to make several batches per day. While in the mixers, the intermediate product is dissolved in acetic acid. The ester solution is transferred to storage tanks before being pumped into the next step in the process. A vent system collects the vapors from the mixers and tanks and a fan operated at constant speed pulls the vapors through the vent lines and into the scrubber. It is not possible for the gas to bypass the scrubber. The VOC load to the scrubbers in this division primarily consists of acetic acid (and other carboxylic acids).

The scrubber is 4 feet in diameter and has about 8 feet of 2-inch packing. Fresh water is sprayed at the top of the packing at 4 to 6 gpm; water from the underflow is recirculated to the middle of the scrubber. The normal exit gas flow rate is approximately 1800 acfm.

II. Rationale for Selection of Performance Indicators

A packed bed scrubber is used to reduce VOC emissions from part of a chemical manufacturing process. Both batch mixers and process tanks are vented to this scrubber. The processes in this area of the facility are mostly semi-batch operations, so the production rate at any one time varies. Therefore, it is difficult to relate the production rate to the VOC load vented to this scrubber.

To comply with the applicable emission limit, a minimum water flow rate must be supplied to the scrubber to absorb a given amount of VOC in the gas stream, given the size of the tower and height of the packed bed. The liquid to gas (L/G) ratio is a key operating parameter of the scrubber. If the L/G ratio decreases below the minimum, sufficient mass transfer of the pollutant from the gas phase to the liquid phase will not occur. The minimum liquid flow required to maintain the proper L/G ratio at the maximum gas flow and vapor loading through the scrubber can be determined. Maintaining this minimum liquid flow, even during periods of reduced gas flow, will help ensure that the required L/G ratio is achieved at all times. The concentration of acetic acid in the scrubber underflow can be related to the water flow rate and acetic acid emissions, based on emissions test results and process modeling.

III. Rationale for Selection of Indicator Ranges

The indicator ranges were selected based on engineering calculations using ASPEN® process modeling software, emissions test data, and historical data. Computer modeling of the scrubber system was performed for the maximum allowable VOC concentration in the scrubber exhaust; the inlet water flow rate necessary for achieving adequate control was determined for several concentrations of acetic acid in the underflow. The scrubber efficiency was calculated using data obtained from emissions testing. The scrubber was modeled using an equilibrium-based distillation method and ideal behavior of the gas phase was assumed; liquid phase activity coefficients were estimated from a Wilson parameter fit of vapor-liquid equilibria data. It was assumed that the control device delivers three actual stages of counter-current mass transfer with a recycle stream pumped from the effluent to the center of the column to ensure adequate distribution of the liquid over the packing. The engineering model was calibrated for accuracy using the results of source testing conducted while at normal operating conditions.

Figure A.4b-1 is a plot of the modeled operating conditions (inlet water flow and scrubber underflow acetic acid concentration) necessary to maintain compliance. The line represents the operating conditions at maximum allowable emissions (3.6 lb VOC/hr); the scrubber's VOC emissions are below the limit when the scrubber is operated at conditions that fall below this line. For example, operating at a scrubber water flow rate of 4 gpm with an acetic acid concentration in the scrubber underflow of 12 percent provides a margin of compliance with the permitted VOC emission rate. The selected indicator ranges for inlet water flow and underflow acetic acid concentration were chosen based on the compliance curve and normal operating conditions. The indicator range (acceptable operating range) is defined as any operating condition where the scrubber inlet water flow is greater than 4 gpm and the scrubber underflow acetic acid concentration is less than 10 percent.

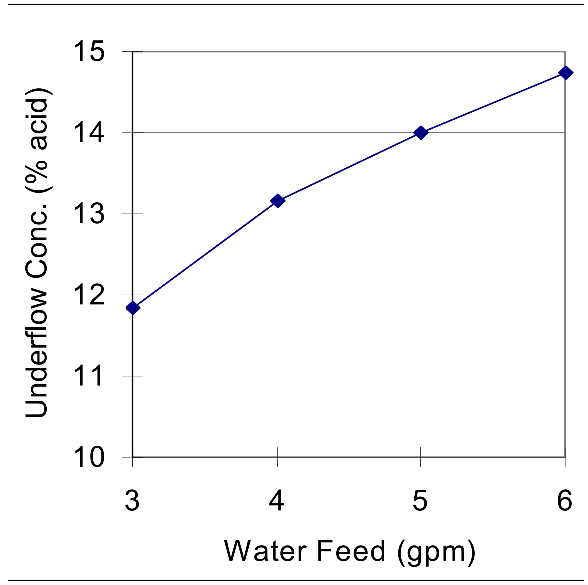

Figure A.4b-1. Compliance curve.

The 4 gpm level was chosen because it is the lower end of the preferred operating range. The 10 percent value was chosen because it is less than any point on the compliance curve (see Figure A.4b-1), and the 1997 historical data show that all measured concentration data were less than 8.4 percent (typical values were between 2 and 6 percent). When an excursion occurs (scrubber inlet water flow of less than 4 gpm and/or scrubber underflow acetic acid concentration of greater than 10 percent), corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. All excursions will be documented and reported.

The scrubber typically operates at a water flow rate of 4 to 6 gpm. Figure A.4b-2 shows scrubber water flow data collected in 1997. The range for the 1997 data is 3 to 9.5 gpm; the mean scrubber water flow rate was 5.3 gpm. There are four values less than 4 gpm, indicating four excursions. The bulk of the data falls between 5 and 6 gpm. Corrective action typically is taken (the flow is increased) when the scrubber water flow begins to fall below 5 gpm in order to avoid an excursion.

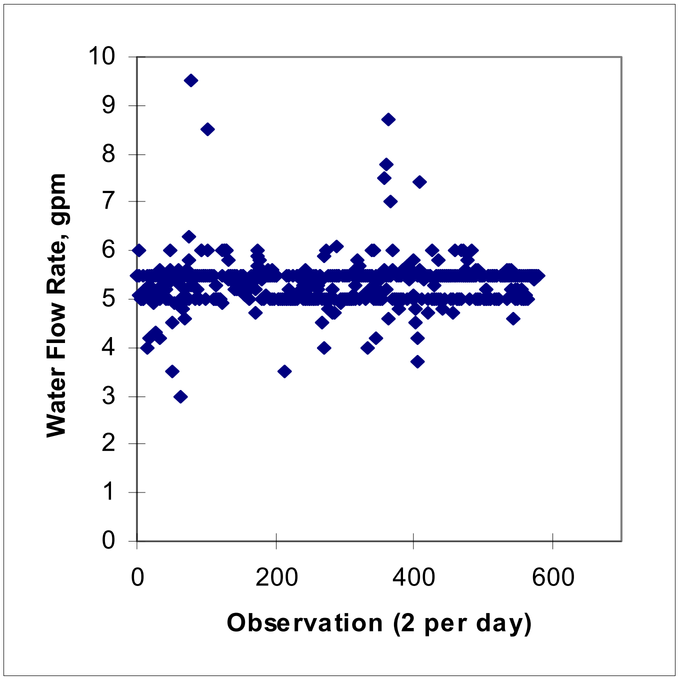

Figure A.4b-2. 1997 scrubber water flow rate data.

Historical data from 1997 show the acetic acid concentration in the underflow is typically less than 6 percent. Figure A.4b-3 shows scrubber underflow acetic acid concentration data for 1997. The maximum concentration was 8.4 percent, which is within the CAM indicator range. The mean concentration was 3.9 percent. The values decrease toward the end of the year because production was decreased due to temporary changes in the market for a key product. This further verifies the correlation between the acid concentration in the underflow and the VOC load to the scrubber. Because historical data show that the scrubber routinely operates within the indicator range, there is not much variability in the data during typical production periods, and the post-control emissions from this scrubber are below the major source threshold, the water flow rate and acid concentration are recorded only twice daily.

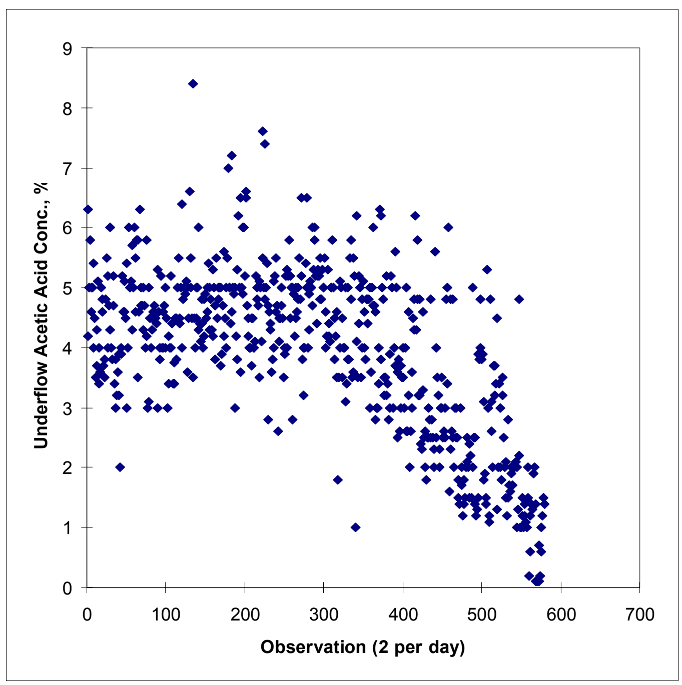

Figure A.4b-3. 1997 underflow acetic acid concentration data.

An emissions test was conducted on this scrubber in December 1994. An acetic acid sampling train validated using EPA Method 301 was used to measure acetic acid emissions and EPA Methods 1 through 4 were used to determine vent gas volumetric flow rates. The permitted emission limit is 3.6 lb VOC/hr. The average emissions during testing were 0.2 lb/hr, well below the emissions allowed for this scrubber. The inlet water flow rate was 5 gpm and the average scrubber underflow acetic acid concentration was 5 percent. The test parameters and measured emissions and underflow concentration were used in the ASPEN® computer model to calculate the efficiency of the scrubber. The model was then used with that same efficiency to generate the compliance curve in Figure A.4b-1.

Figure A.4b-4 shows the underflow acetic acid concentration versus the scrubber water flow rate for 1997. There were four excursions in 1997; the flow rate was less than 4 gpm during those excursions, but the underflow acid concentration was always less than 10 percent.

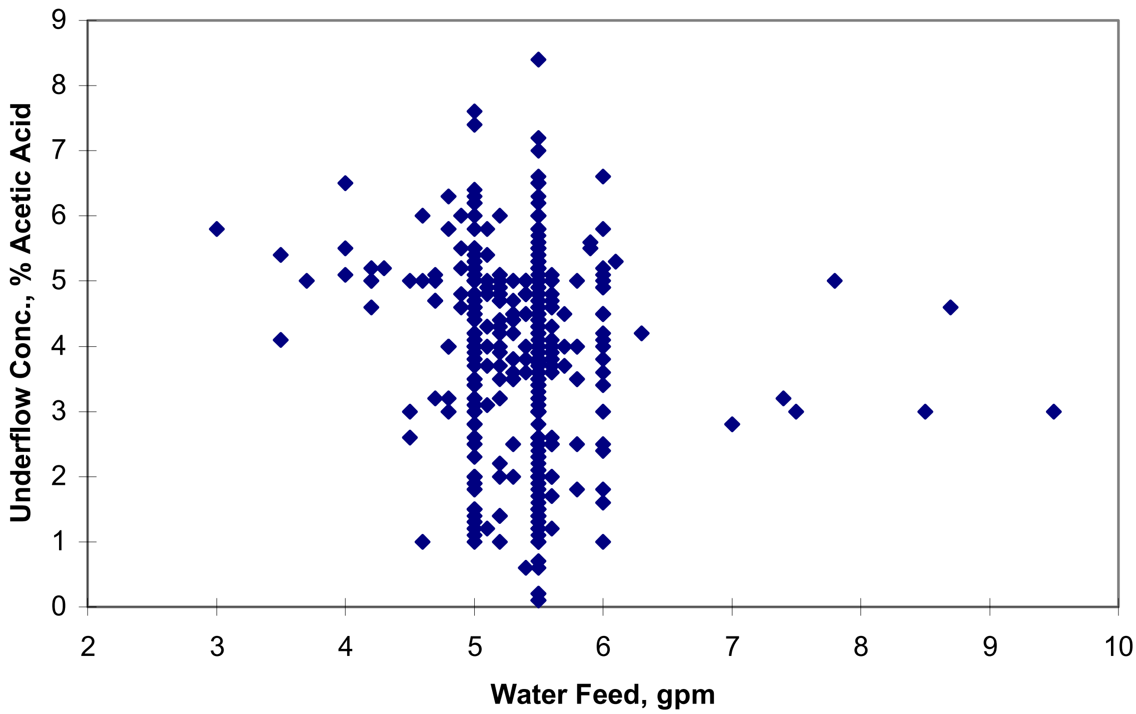

Figure A.4b-4. 1997 underflow acetic acid concentration vs. scrubber water flow.
(2 measurements per day)

A.5 CARBON ADSORBER FOR VOC CONTROL–FACILITY E

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EXAMPLE COMPLIANCE ASSURANCE MONITORING:
CARBON ADSORBER FOR VOC CONTROL--FACILITY E

I. Background

A. Emissions Unit

Description:	Chemical Process
Identification:	NA
Facility:	Facility E Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation No.:	Permit
Regulated pollutant (PSEU):	VOC
Emission limit:	95 percent reduction by cycle
Monitoring requirements:	Continuously monitor inlet and outlet VOC concentration.

C. Control Technology: Three carbon adsorbers

II. Monitoring Approach

The key elements of the monitoring approach for VOC, including the indicators to be monitored, indicator ranges, and performance criteria, are presented in Table A.5-1.

TABLE A.5-1. MONITORING APPROACH

I. Indicator	VOC removal efficiency
Measurement Approach	The inlet and outlet VOC concentrations are monitored with VOC analyzers.
II. Indicator Range	An excursion is defined as an efficiency less than 95.5 percent for each bed cycle. Excursions trigger an inspection, corrective action, and a reporting requirement.
QIP Threshold[a]	Six excursions per semiannual reporting period.
III. Performance Criteria	
A. Data Representativeness[b]	Two analyzers are installed on the carbon adsorber, one at the inlet and one at the outlet vent. The minimum accuracy is ±1 percent of span.
B. Verification of Operational Status	NA
C. Quality Assurance and Control Practices	Monthly calibration is performed on the analyzers using calibration gas. Maximum calibration drift is ±2.5 percent of span. Operators may request that additional calibration checks be performed in between the scheduled monthly checks. Monthly health checks of the monitors are also performed. Annual preventive maintenance procedures are performed.
D. Monitoring Frequency	VOC concentrations are measured every 2 minutes.
Data Collection Procedures	Efficiencies are determined (based on VOC concentration measurements) and recorded every 2 minutes.
Averaging Period	Average efficiencies are determined by cycle, per bed for tracking of the bed efficiency.

[a]Note: The QIP is an optional tool for States; QIP thresholds are not required in the CAM submittal.
[b]Values listed for accuracy specifications are specific to this example and are not intended to provide the criteria for this type of measurement device in general.

JUSTIFICATION

I. Background

Emissions from the chemical process are vented to three carbon adsorber beds in parallel. The emissions are vented to one or two of the three carbon adsorbers at all times; one or two beds are online while the other(s) is regenerating. The carbon adsorbers are used to recover VOC. Bypass of the control device is not possible based on the PSEU design.

II. Rationale for Selection of Performance Indicators

VOC emissions from the chemical process are recovered with three carbon adsorbers in parallel. Monitoring of the inlet and outlet VOC concentration to calculate the recovery efficiency of the control device has been selected as the monitoring approach. This monitoring method is a direct measure of the control device performance and provides the best assurance that the carbon beds are operating properly. A decline in recovery efficiency indicates reduced performance of the carbon adsorber. For this system, maintaining a high recovery efficiency is desirable because the recovered VOC is reused in the process. The facility opted to install VOC CEMS that provide a direct measure of recovery efficiency. This information allows the facility to maximize VOC recovery.

III. Rationale for Selection of Indicator Ranges

The selected indicator range is "greater than 95.5 percent efficiency for each carbon bed cycle." No upper indicator range limit is necessary. When an excursion occurs corrective action will be initiated, beginning with an evaluation of the occurrence to determine the action required to correct the situation. All excursions will be documented and reported. The selected QIP threshold level is six excursions per bed per semiannual reporting period. (Note: Establishing a proposed QIP threshold in the monitoring submittal is optional.) This level is less than 0.5 percent of the number of bed cycles in a semiannual reporting period. If the QIP threshold is exceeded in a semiannual reporting period, a QIP will be developed and implemented.

To monitor and evaluate performance, the carbon bed efficiency of each cycle for each bed is charted and evaluated using statistical techniques. The average and the upper and lower control limits (±3 standard deviations) are graphed. The process target level is 96 percent efficiency. The indicator range has been established at a level that is above the emission limitation (95 percent efficiency) but below the lower control limit during normal operating conditions.

Monitoring data were reviewed to determine whether the control efficiency is maintained during normal operation of the process and carbon adsorber. The average recovery efficiency per online cycle and the average daily efficiency for a 16-day period (May 6 to May 21, 1997) were reviewed for carbon bed 12; a total of 181 cycles for bed 12 were completed in these 16 days.

The cycle efficiency data are presented in Figure A.5-1. The average cycle efficiency ranged from 95.5 to 96.6 percent.

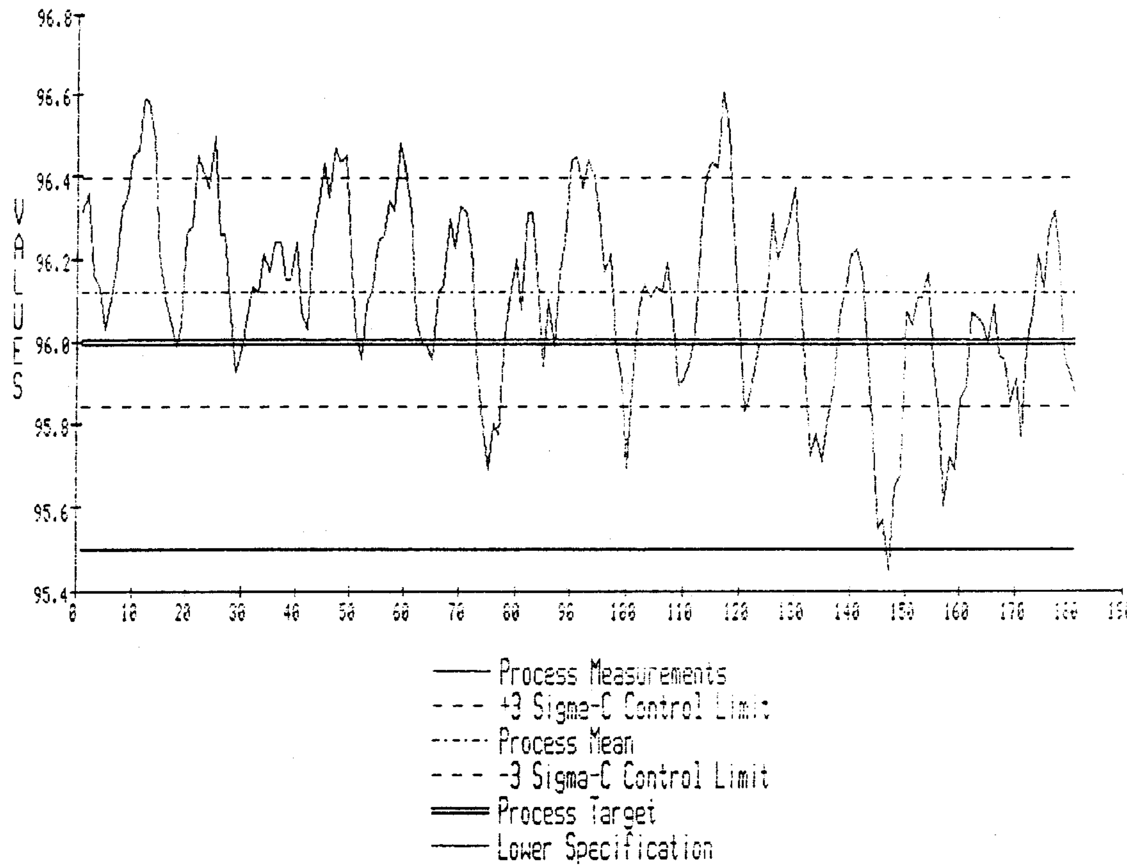
The upper and lower control limits (3 standard deviations) are 96.4 and 95.8 percent, respectively. During this 16-day period the selected indicator range of 95.5 percent (identified as the "lower specification" in Figure A.5-1) was exceeded once; i.e., one excursion occurred.

The daily average efficiencies are presented in Figure A.5-2. The daily average efficiencies ranged from 95.8 to 96.3 percent. During this 16-day period, the carbon adsorber bed was consistently operating with a recovery efficiency greater than or equal to 95 percent.

No performance test has been conducted on this control device and a performance test is not planned for the purpose of establishing the indicator range. The control efficiency is determined based upon the relative measurement of the inlet and outlet concentrations.

The monitors are calibrated monthly using calibration standards comprised of the single VOC present in the exhaust stream. Monthly calibrations were found to be sufficient based on calibration drift data collected over a 1 year period. These data indicate that calibration readings are consistent from month to month and rarely drift by more than ±2.5 percent of the span value.

% EFFICIENCY - CARBON BED 12 - BY CYCLE
FROM 5- 6-1997 TO 5-21-1997

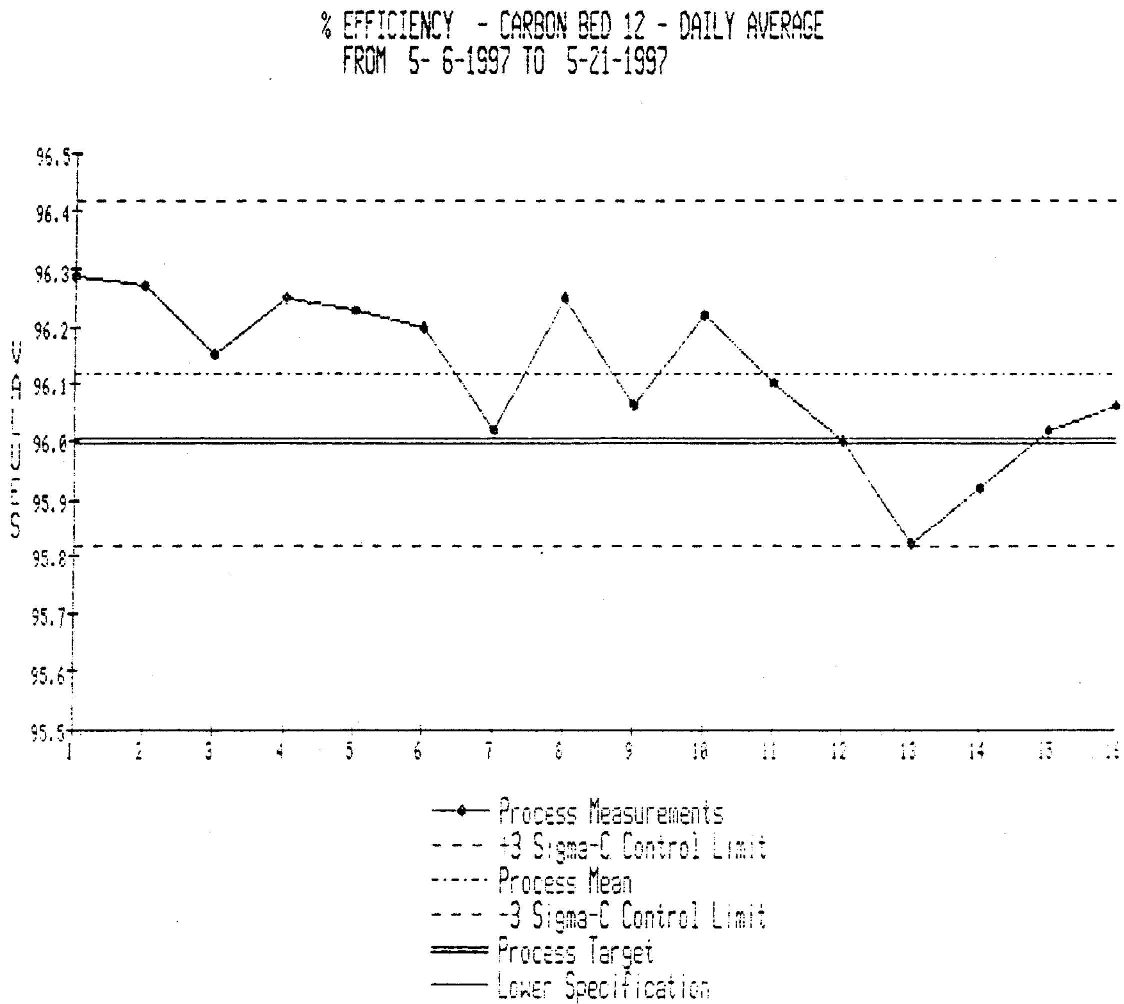


44 Points (24.3%) Out-of-Control: 10 11 12 13 14 22 23 25 45 47 48 49 59 60 74 75 76 77 90 91 93 94 [illegible]
1 Points (0.6%) Out-of-Spec: 147

Upper Control Limit	96.3931
Process Average	96.1191
Lower Control Limit	95.8451
Upper Specification	None
Process Target	96.0000
Lower Specification	95.5000
Sigma-S	0.2256
Sigma-C	0.0913
Sigma-S / Sigma-C	2.4705
N	181.0000

Points > UCL	23
Points < LCL	21
Points > USL	0
Points < LSL	1
Cycling ?	Yes
Run of 8 ?	Yes

Figure A.5-1.



Points Out-of-Control: none
Points Out-of-Spec: none

Upper Control Limit	96.4159
Process Average	96.1162
Lower Control Limit	95.8166
Upper Specification	None
Process Target	96.0000
Lower Specification	95.5000
Sigma-S	0.1382
Sigma-C	0.0999
Sigma-S / Sigma-C	1.3834
N	16.0000

Points > UCL	0
Points < LCL	0
Points > USL	0
Points < LSL	0
Cycling ?	No
Run of 8 ?	No

Figure A.5-2.

A.18 CARBON ADSORBER FOR VOC CONTROL – FACILITY T

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EXAMPLE COMPLIANCE ASSURANCE MONITORING
CARBON ADSORBER FOR VOC CONTROL – FACILITY T

I. Background

A. Emissions Unit

Description:	Loading Rack
Identification:	LR-1
APCD ID:	SRU-1
Facility:	Facility T Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation:	Permit
Emission Limits:	
VOC:	0.67 lb/1,000 gallons transferred (80 mg/L transferred)
Monitoring Requirements:	Monitor carbon adsorber outlet VOC concentration, monitor position of APCD bypass valve, conduct a leak detection and repair program.

C. Control Technology:

Carbon adsorber.

II. Monitoring Approach

The key elements of the monitoring approach are presented in Table A.18-1. The carbon adsorber outlet VOC concentration in percent by volume as propane is continuously monitored. The selected indicator range is based on a 1-hour rolling average concentration. Periodic leak checks of the vapor recovery unit also are conducted and the position of the carbon adsorber bypass valve is monitored to ensure bypass of the control device is not occurring.

Note: Facility T also monitors parameters related to the vapor tightness of connections and tank trucks and other parameters of the vapor recovery system, but this example focuses on the monitoring performed on the carbon adsorber.

TABLE A.18-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2
I. Indicator	Outlet VOC concentration (percent).	Equipment leaks.
Measurement Approach	Breakthrough detector (NDIR analyzer).	Monthly leak check of vapor recovery system.
II. Indicator Range	An excursion is defined as an hourly average outlet VOC concentration of 4 percent by volume (as propane) or greater. When this level is reached or exceeded, the loading rack will be shut down via an automated interlock system. An excursion will trigger an investigation, corrective action, and a reporting requirement.	An excursion is defined as detection of a leak greater than or equal to 10,000 ppm (as methane) during normal loading operations. An excursion will trigger an investigation, corrective action, and a reporting requirement. Leaks will be repaired within 15 days.
III. Performance Criteria A. Data Representativeness	The analyzer is located at the carbon adsorber outlet.	A handheld monitor is used to check for leaks in the vapor collection system during loading operations.
B. Verification of Operational Status	NA	NA
C. QA/QC Practices and Criteria	Daily zero/span drift. Adjust if drift is greater than 2.5 percent of span.	Follow procedures in 40 CFR 60, Appendix A, Method 21.
D. Monitoring Frequency	The outlet VOC concentration is monitored every 2 minutes.	Monthly.
Data Collection Procedures	The data acquisition system (DAS) collects the outlet VOC concentration every 2 minutes and calculates a rolling 1-hour average. Periods when breakthrough is detected and the interlock system shuts down the loading rack also are recorded.	Records of inspections, leaks found, leaks repaired.
Averaging period	1 hour (rolling).	None.
APCD Bypass Monitoring:	A pressure gauge on the vapor header line is used to detect if the relief valve is open. The valve opens if the pressure reaches 18 inches H_2O. The DAS records the instantaneous pressure reading every 2 minutes.	

MONITORING APPROACH JUSTIFICATION

I. Background

The pollutant specific emissions unit (PSEU) is a vacuum regenerative carbon adsorber used to reduce VOC emissions from a gasoline loading rack. (Note: This facility is not a major source of HAP emissions and is not subject to 40 CFR 63, Subpart R, or 40 CFR 60, Subpart XX.) The maximum throughput of the loading rack is 43,000,000 gallons per month, and the facility operates 24 hours per day, 7 days per week.

The carbon adsorber has two identical beds, one adsorbing while the other is desorbing on a 15-minute cycle. Carbon bed regeneration is accomplished with a combination of high vacuum and purge air stripping which removes previously adsorbed gasoline vapor from the carbon and restores the carbon's ability to adsorb vapor during the next cycle. The vacuum pump extracts concentrated gasoline vapor from the carbon bed and discharges into a separator. Non-condensed gasoline vapor plus gasoline condensate flow from the separator to an absorber column which functions as the recovery device for the system. In the absorber, the hydrocarbon vapor flows up through the absorber packing where it is liquefied and subsequently recovered by absorption. Gasoline product from a storage tank is used as the absorbent fluid. The recovered product is simply returned along with the circulating gasoline back to the product storage tank A small stream of air and residual vapor exits the top of the absorber column and is recycled to the on-stream carbon bed where the residual hydrocarbon vapor is re-adsorbed.

II. Rationale for Selection of Performance Indicators

A non-dispersive infrared (NDIR) analyzer is used to monitor the carbon adsorber outlet VOC concentration in percent by volume as propane and ensure breakthrough is not occurring. This monitor provides a direct indicator of compliance with the VOC limit since it continuously measures the outlet VOC concentration in percent. An interlock system is used to shut down loading operations when an excursion occurs.

A monthly leak inspection program also is performed to ensure that the vapors released during loading are captured and conveyed to the vapor recovery unit. A handheld monitor is used to detect leaks in the vapor collection system. The position of the vapor recovery unit's relief valve is monitored to ensure the control device is not bypassed.

III. Rationale for Selection of Indicator Ranges

The indicator range for the breakthrough detector was selected based on engineering calculations. The VOC emission rate can be expressed as follows (see 40 CFR 60.503):

$$E = K \frac{V \times C}{L \times 10^6}$$

where:

E = emission rate of VOC, mg/L
V = volume of air/vapor mixture exhausted, scm
C = concentration of VOC, ppm
L = volume loaded, L
K = density of calibration gas, 1.83×10^6 mg/scm for propane

Assuming 100 percent displacement of all vapors into the vapor recovery unit (e.g., if 300,000 L are loaded, 300,000 L of vapor pass through the unit) and assuming that breakthrough is occurring, it may be conservatively assumed that V is equal to L (V is actually less than L if the carbon adsorber is operating properly). Converting the volume displaced/exhausted (300,000 L) to cubic meters (300 scm) and substituting 300 scm for V, 80 mg/L for E, and 1.83×10^6 mg/scm for K gives C equal to 43,700 ppm, or 4.4 percent. Therefore, the indicator range for the outlet VOC concentration is 4 percent (rolling hourly average), to provide a reasonable assurance of compliance with the VOC limit of 80 mg/L loaded. If the hourly average outlet VOC concentration reaches or exceeds 4 percent, the unit will be shut down and loading prevented via an automated interlock system. All excursions will be documented and reported. Figure A.18-1 presents both 2-minute instantaneous (dotted line) and hourly average (solid line) outlet VOC concentration data for a typical day's operation. The outlet VOC concentration typically is less than 0.5 percent as propane.

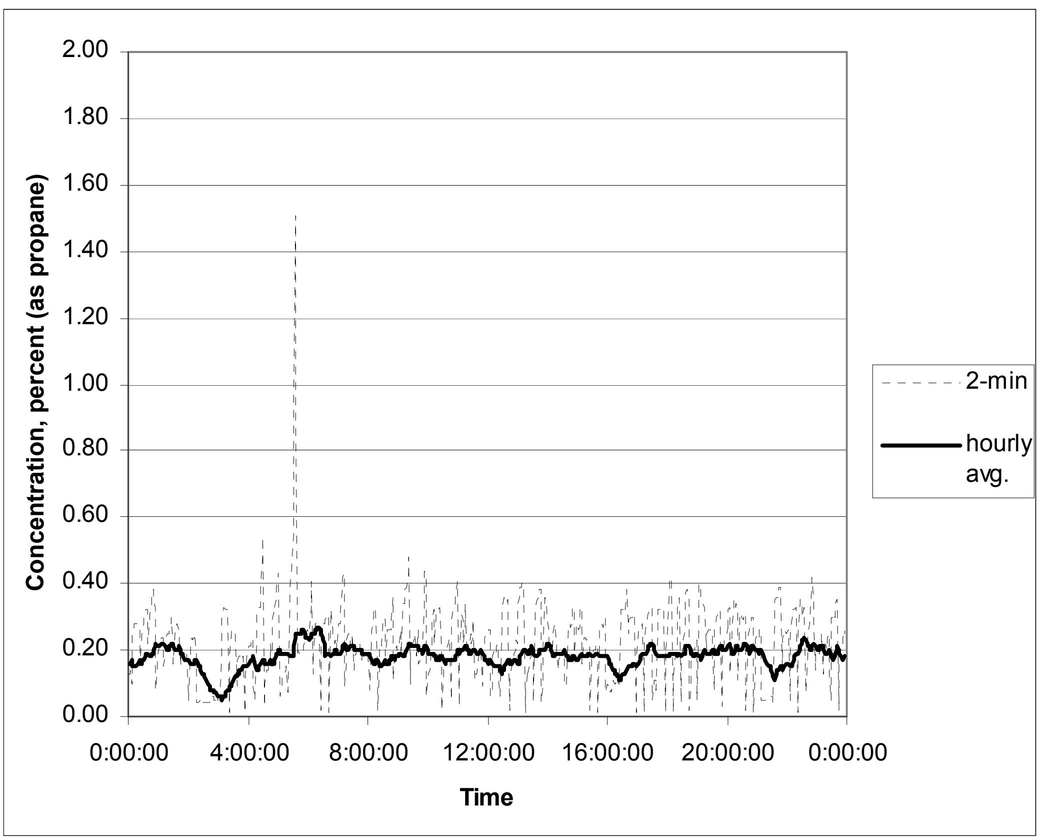

Figure A.18-1. A typical day's concentration data.

The most recent performance test conducted showed that the average hydrocarbon emissions were 10.37 mg/liter loaded. The average outlet concentration was 0.37 percent propane by volume, and the unit's efficiency was 98.6 percent.

For the second indicator, an excursion is defined as detection of a leak greater than or equal to 10,000 ppm (as methane) during normal loading operations. This is the limit established by the applicable requirement. If a leak is detected, corrective action will be initiated, and the leak will be repaired within 15 days. All excursions will be documented and reported.

Comment: During the review period, one commenter suggested setting an internal warning level for the bypass line pressure. For safety reasons, the bypass valve on the inlet APCD line is set to release at 18" w.c. With respect to APCD bypass, the CAM rule only requires that a facility monitor the bypass so that bypass events can be corrected immediately and reported. Consequently, establishing an indicator range at a level less than the release pressure is not required. However, if a facility wants to take extra precautions to avoid bypass events, it could establish a warning at a lower pressure, such as the 15" w.c., which would allow them to initiate corrective action before a bypass event, as suggested by this commenter.

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A.24 CARBON ADSORBER FOR VOC CONTROL--FACILITY EE

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EXAMPLE COMPLIANCE ASSURANCE MONITORING
CARBON ADSORBER FOR VOC CONTROL: FACILITY EE

I. Background

A. Emissions Unit

Description:	Loading Rack
Identification:	LR-1
APCD ID:	VRU-1
Facility:	Facility EE Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation:	Permit, State regulation
Emission Limits:	
VOC:	45 mg/liter of product loaded
Monitoring Requirements:	Monitor vacuum profile during carbon bed regeneration cycle, monitor for APCD bypass, test the carbon periodically, and conduct an inspection and maintenance program and a leak detection and repair program.

C. Control Technology: Carbon adsorber.

II. Monitoring Approach

The key elements of the monitoring approach are presented in Table A.24-1. The amount of time the regenerating carbon bed remains at or below -27 inches of Hg is monitored to ensure the bed has been fully regenerated. An inspection and maintenance program, including annual testing of the carbon activity, is conducted to verify proper operation of the vapor recovery unit (VRU). Periodic leak checks of the vapor recovery unit also are conducted and the carbon adsorber bypass valve is monitored to ensure bypass of the control device is not occurring.

Note: Facility EE also monitors parameters related to the vapor tightness of connections and tank trucks and other parameters of the vapor recovery system, but this example focuses on the monitoring performed on the carbon adsorber.

TABLE A.24-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2	Indicator No. 3
I. Indicator	Regeneration cycle vacuum. Specifically, the time the regenerating carbon bed remains at or below -27 inches Hg.	Documentation of inspection and maintenance program and annual carbon testing.	Equipment leaks.
Measurement Approach	Pressure transmitter.	Proper VRU operation is verified by performing periodic inspections and maintenance. Daily checks include verification of gasoline flow, purge air flow, cycle time, valve timing, and operating temperatures. Annual checks include carbon testing and pump and motor maintenance.	Monthly leak check of vapor recovery system.
II. Indicator Range	An excursion occurs when the regenerating carbon bed remains at or below -27 inches Hg for less than 2.5 minutes. When an excursion occurs, the loading rack will be shut down via an automated interlock system. An excursion will trigger an investigation, corrective action, and a reporting requirement.	An excursion occurs if the inspection or annual carbon test is not performed or documented or if corrective action is not initiated within 24 hours to correct any problems identified during the inspection of the unit or carbon testing. An excursion will trigger an investigation, corrective action, and a reporting requirement.	An excursion is defined as detection of a leak greater than or equal to 10,000 ppm (as methane) during normal loading operations. An excursion will trigger an investigation, corrective action, and a reporting requirement. Leaks will be repaired within 15 days.
III. Performance Criteria A. Data Representativeness	The pressure during the regeneration cycle is measured in the vacuum pump suction line. The minimum accuracy of the pressure transmitter is ±1.0 percent.	VRU operation verified visually by trained personnel using documented inspection and maintenance procedures. Representative carbon sample obtained from both beds.	A handheld monitor is used to check for leaks in the vapor collection system during loading operations.
B. Verification of Operational Status	NA	NA	NA
C. QA/QC Practices and Criteria	Pressure transmitter is calibrated annually.	Personnel are trained on inspection and maintenance procedures and proper frequencies.	Follow procedures in 40 CFR 60, Appendix A, Method 21.
D. Monitoring Frequency	Continuously during each regeneration cycle.	Varies. Carbon testing performed annually.	Monthly.

(TABLE A.24-1. Continued.)

	Indicator No. 1	Indicator No. 2	Indicator No. 3
Data Collection Procedures	The data acquisition system (DAS) records the pressure profile during each regeneration cycle. Periods when the interlock system shuts down the loading rack also are recorded.	Results of inspections and any maintenance necessary are recorded in VRU operating log. Results of carbon testing are maintained onsite.	Records of inspections, leaks found, leaks repaired.
Averaging period	None.	None.	None.
APCD Bypass Monitoring:	The pressure in the VRU vapor line is monitored with a pressure transmitter to ensure bypass of the control device is not occurring. If the pressure in the VRU vapor line exceeds 18 inches of water, the safety relief valve opens and bypass occurs. All instances of control device bypass are recorded.		

MONITORING APPROACH JUSTIFICATION

I. Background

The pollutant specific emissions unit (PSEU) is a vacuum regenerative carbon adsorber used to reduce VOC emissions from the loading of petroleum products (heating oil, diesel fuel, and gasoline). (Note: This facility is not a major source of HAP emissions and is not subject to 40 CFR 63, Subpart R, “National Emission Standards for Gasoline Distribution Facilities” or 40 CFR 60, Subpart XX, “Standards of Performance for Bulk Gasoline Terminals.”)

The carbon adsorber has two identical beds, one adsorbing while the other is desorbing on a 15-minute cycle. Carbon bed regeneration is accomplished with a combination of high vacuum and purge air stripping which removes previously adsorbed gasoline vapor from the carbon and restores the carbon's ability to adsorb vapor during the next cycle. The vacuum pump extracts concentrated gasoline vapor from the carbon bed and discharges into a separator. Non-condensed gasoline vapor plus gasoline condensate flow from the separator to an absorber column which functions as the recovery device for the system. In the absorber, the hydrocarbon vapor flows up through the absorber packing where it is liquefied and subsequently recovered by absorption. Gasoline product from a storage tank is used as the absorbent fluid. The recovered product is returned along with the circulating gasoline back to the product storage tank A small stream of air and residual vapor exits the top of the absorber column and is recycled to the on-stream carbon bed where the residual hydrocarbon vapor is re-adsorbed.

II. Rationale for Selection of Performance Indicators

The carbon adsorber system was custom-designed specifically for this installation based on the maximum expected loading and types of products loaded. The carbon beds and vacuum pump were sized appropriately. The vacuum profile during regeneration is an important variable in the performance of the VRU. If the carbon bed is overloaded, the time to achieve certain vacuum levels will be longer, and the bed will not be fully regenerated during the 15-minute cycle. Monitoring of the vacuum profile during regeneration, coupled with regular inspection and maintenance activities (including, daily verification of proper valve timing, cycle time, gasoline flow, and purge air flow) and annual testing of a carbon sample from each bed, serves to verify that the VRU is operating properly and provide a reasonable assurance of compliance.

A monthly leak inspection program is performed to ensure that the vapors released during loading are captured and conveyed to the VRU. A handheld monitor is used to detect leaks in the vapor collection system. The VRU’s relief valve in the VRU vapor line also is monitored to ensure the control device is not bypassed. Bypass occurs when the pressure in the vapor line exceeds the safe limit.

III. Rationale for Selection of Indicator Ranges

An engineering analysis was performed based on the worst case loading conditions expected. That analysis shows that if the regenerating carbon bed stays at or below -27 in Hg for at least 2.5 minutes the bed will be properly regenerated and will have the capacity to meet the VOC emissions limit under worst case loading conditions. Therefore, an excursion occurs when the regenerating bed does not stay at or below -27 in. Hg for at least 2.5 minutes. The expected vacuum profile during heavy loading is presented in Table A.24-2. All excursions will be documented and reported. An interlock system is used to shut down loading operations when an excursion occurs. Typical operating data show that the beds stay at or below -27 in. Hg for more than 5 minutes of the regeneration cycle, as shown in Table A.24-3.

The most recent performance test showed emissions of 3.8 mg/liter of gasoline loaded, less than 10 percent of the VOC limit. The unit's efficiency was calculated as 99.99 percent. The exhaust concentration equivalent of 45 mg/L loaded calculated at the time of the performance test was approximately 33,100 ppmv VOC. Table A.24-4 shows exhaust VOC concentration data for both beds collected over a period of several weeks using a portable VOC analyzer. The data show the carbon adsorber operated well under the VOC emission limit.

TABLE A.24-2. WORST-CASE MODELED VACUUM PROFILE (HEAVIEST LOADING)

Minute	Inches Hg Vacuum
1	14.0
2	19.6
3	22.3
4	24.3
5	25.0
6	25.3
7	25.6
8	26.0
9	26.2
10	26.5
11	26.8
12	27.0
13	27.3
13:30	27.5
14-15	At 13:30, the bed is re-pressurized.

TABLE A.24-3. TYPICAL VACUUM PROFILE DURING REGENERATION CYCLE

Bed 1		Bed 2	
Minute	Inches Hg Vacuum	Minute	Inches Hg Vacuum
1	12.5	1	10
2	20.5	2	18
3	24	3	23
4	25	4	26
5	26	5	27.5
6	26.5	6	27.6
7	26.8	7	27.6
8	27	8	27.7
9	27.1	9	27.8
10	27.1	10	27.8
11	27.2	11	27.9
12	27.3	12	27.9
13	27.4	13	28
14	At 13:30, the bed is re-pressurized.	14	At 13:30, the bed is re-pressurized.
15		15	

TABLE A.24-4. SAMPLE WEEKLY EXHAUST VOC CONCENTRATION DATA

Week	Bed 1 (ppmv)	Bed 2 (ppmv)
1	6,000	6,500
2	4,800	5,200
3	7,900	5,100
4	8,450	6,240
5	9,000	6,450
6	9,500	11,000
7	9,110	7,500
8	10,000	8,000
9	12,000	9,500
10	8,000	6,500

For the second indicator, an inspection and maintenance program is conducted, following documented procedures. This program is performed by terminal operators and contracted maintenance personnel. The results of all inspections and any maintenance performed are recorded in the VRU operating log. An excursion is defined as failure to conduct or document the required inspections or maintenance activities or failure to initiate corrective action within 24 hours to correct any problems identified during the inspection. All excursions will be documented and reported.

For the third indicator, an excursion is defined as detection of a leak greater than or equal to 10,000 ppm (as methane) during normal loading operations. If a leak is detected, corrective action will be initiated, and the leak will be repaired within 15 days. All excursions will be documented and reported. Control device bypass also is monitored. Bypass occurs when the pressure in the VRU vapor line exceeds 18 inches of water and the safety relief valve opens. All instances of control device bypass are recorded.

Comment: For regenerative carbon absorbers, an annual carbon activity check provides the facility with information on the condition and activity of the carbon. An alternative to periodic carbon activity checks would be periodic checks of the outlet VOC concentration using a portable monitor, or periodic (e.g., annual) Method 25A tests.

Furthermore, if an additional level of confidence in the monitoring approach were desired (e.g., if the unit had a small margin of compliance with the VOC limit), one option would be to require more frequent periodic (e.g., quarterly) monitoring of the carbon bed outlet concentration with a portable VOC analyzer in lieu of the annual carbon testing.

Comment: During the review period, one commenter suggested setting an internal warning level for the bypass line pressure. For safety reasons, the bypass valve on the inlet APCD line is set to release at 18" w.c. With respect to APCD bypass, the CAM rule only requires that a facility monitor the bypass so that bypass events can be corrected immediately and reported. Consequently, establishing an indicator range at a level less than the release pressure is not required. However, if a facility wants to take extra precautions to avoid bypass events, it could establish a warning at a lower pressure, such as the 15" w.c., which would allow them to initiate corrective action before a bypass event, as suggested by this commenter.

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