EXAMPLE COMPLIANCE ASSURANCE MONITORING SUBMITTALS

The purpose of this document is to supplement Appendix A of the Compliance Assurance Monitoring (CAM) Technical Guidance[1]. The example CAM submittals presented in this supplement are based upon "case studies" of the current monitoring approaches in use at actual facilities and historical data obtained from the monitoring system. The development process for these examples included: (1) identifying facilities which currently monitor control device parameters, had long-term monitoring data available for review, had conducted a performance/ compliance test, and were willing to participate, (2) obtaining information on the monitoring approach and monitoring data from the facility, (3) reviewing and analyzing the monitoring approach and data, (4) discussing the information with plant personnel and, in some cases, conducting a site visit, and (5) preparing an example monitoring approach submittal from the information.

The basic approach used was to evaluate the monitoring conducted by the facility against CAM general (design) and performance criteria. A monitoring approach submittal based upon the facility's current monitoring, modified as necessary to comply with CAM requirements, was then drafted. If sufficient information was available to evaluate alternative approaches (e.g., different indicators, indicator ranges, or data averaging periods), alternative approaches also were investigated. Note that the resulting examples are not necessarily the only acceptable monitoring approaches for the facility or similar facilities; they are simply examples of approaches used by particular facilities. The owner or operator of a similar facility may propose a different approach that satisfies part 64 requirements. Also, the permitting authority may require additional monitoring.

One purpose of this supplement is to provide **nonprescriptive** examples of monitoring approaches that meet the CAM submittal requirements for the specific cases studied. Each example monitoring submittal contains background information (including identification of the pollutant specific emissions unit), a description of the monitoring approach, and the rationale for selecting the indicators and indicator ranges. These examples represent the level of detail recommended by EPA, but States may develop their own guidance as to the level of detail (more or less) required in CAM monitoring approach submittals. Table 1 lists the examples contained in this supplement. Information has been collected for other control devices and monitoring approaches and example monitoring approach submittals for these cases are being prepared for future release.

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[1]U.S. Environmental Protection Agency. Technical Guidance Document: Compliance Assurance Monitoring, August 1998. Available on the EPA web site at http://www.epa.gov/ttn/emc/cam.html.

Table 1. Example CAM Submittals Included in this Supplement

Number	**Example Title**
A.4b	Scrubber for VOC Control - Facility Q
A.9b	Wet Electrostatic Precipitator (WESP) for PM Control - Facility P
A.11	Electrified Filter Bed (EFB) for PM Control - Facility K
A.16	Control Device Bypass - Facility R
A.17	Venturi Scrubber for PM Control - Facility S
A.18	Carbon Adsorber for VOC Control - Facility T
A.19a	Baghouse for PM Control - Facility V
A.19b	Baghouse for PM Control - Facility V
A.20	Absorber for SO_2 Control - Facility W
A.24	Carbon Adsorber for VOC Control - Facility EE
A.25	Electrostatic Precipitator (ESP) for PM Control - Facility FF
A.27	Flue Gas Recirculation (FGR) for NO_x Control - Facility HH

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 equilibriumbased 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.

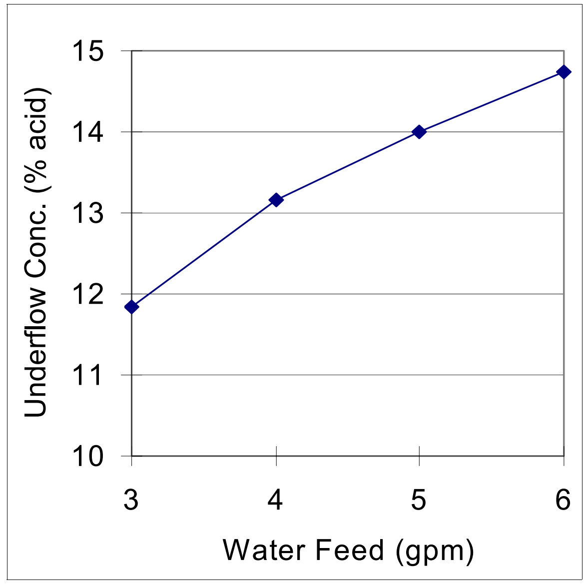

Figure A.4b-1. Compliance curve.

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.

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.

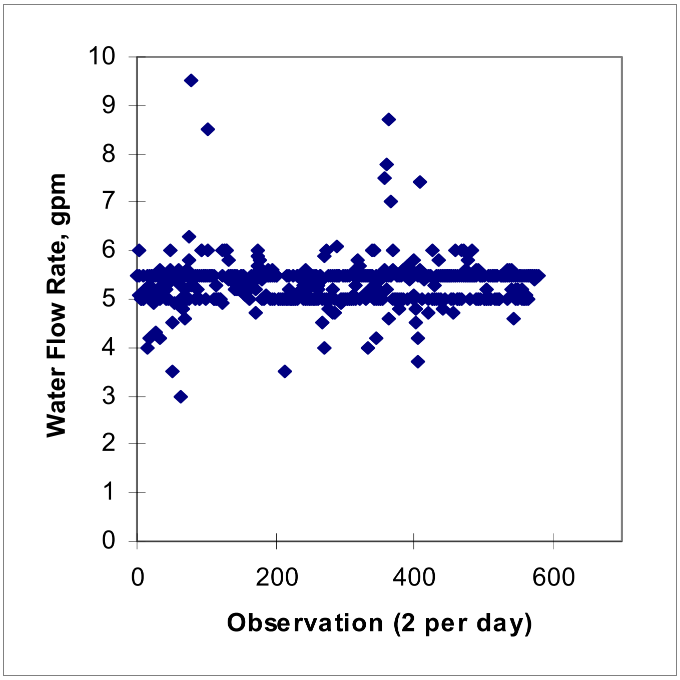

Figure A.4b-2. 1997 scrubber water flow rate data.

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.

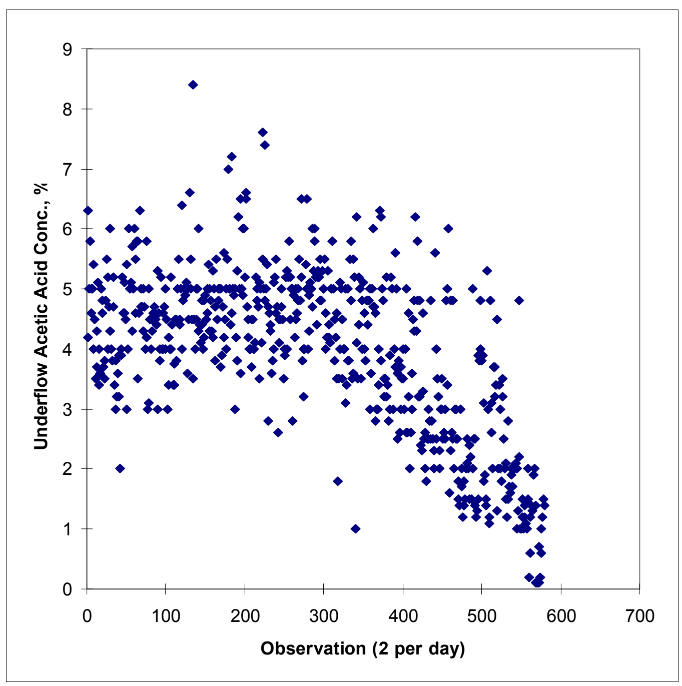

Figure A.4b-3. 1997 underflow acetic acid concentration data.

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.

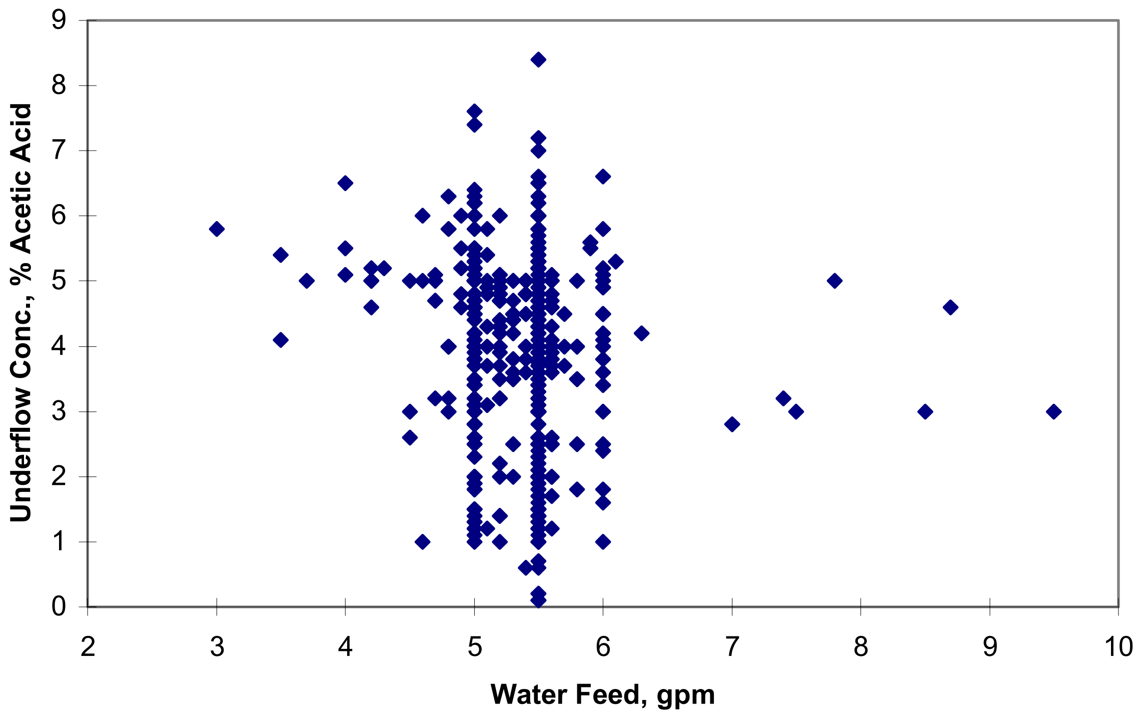

Figure A.4b-4. 1997 underflow acetic acid concentration vs. scrubber water flow. (2 measurements per day)

A.9b WET ELECTROSTATIC PRECIPITATORS (WESP) FOR PM CONTROL OF VENEER DRYERS – FACILITY P

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EXAMPLE COMPLIANCE ASSURANCE MONITORING
WET ELECTROSTATIC PRECIPITATORS (WESP) FOR PM CONTROL – FACILITY P

I. Background

A. Emissions Unit

Description:	Steam-heated dryers used in plywood manufacturing
Identification:	Veneer Dryers 1-6 (EU2)
APCD ID:	WESP 1, WESP 2
Facility:	Facility P Anytown, USA

B. Applicable Regulation and Emission Limit

Regulation No.:	Permit, State Regulation
Emission limits:	
Particulate Matter (PM):	0.3 lb/1,000 ft^2 (MSF) dried (3/8-inch thickness basis)
Monitoring Requirements:	Monitor WESP secondary voltage, quench inlet temperature, and WESP outlet temperature.

C. Control Technology

Wet electrostatic precipitator

II. Monitoring Approach

The key elements of the monitoring approach are presented in Table A.9b-1. The selected indicators of performance are: WESP secondary voltage, quench inlet temperature, and WESP outlet temperature. The selected indicator ranges are based on hourly average values.

TABLE A.9b-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2	Indicator No. 3
I. Indicator	WESP secondary voltage.	Quench inlet temperature.	WESP outlet temperature.
Measurement Approach	The WESP secondary voltage is monitored using a voltmeter.	The gas temperature is measured with a thermocouple at the quench inlet.	The gas temperature is measured with a thermocouple at the WESP outlet.
II. Indicator Range	An excursion is defined as an hourly average voltage less than 35 kV. Excursions trigger an investigation, corrective action, and a reporting requirement.	An excursion is defined as an hourly average quench inlet temperature >375°F. Excursions trigger an investigation, corrective action, and a reporting requirement.	An excursion is defined as an hourly average outlet temperature >175°F. Excursions trigger an investigation, corrective action, and a reporting requirement.
III. Performance Criteria A. Data Representativeness	The monitoring system consists of a voltmeter that is part of the WESP instrumentation (TR controller). The minimum accuracy of the voltmeter is ±0.5 kV.	The monitoring system consists of a thermocouple located in the quench inlet ductwork. The minimum accuracy of the thermocouple is ±2.2°C (±4°F) or 0.75 percent of the measured temperature in °C, whichever is greater.	The monitoring system consists of a thermocouple located in the WESP outlet ductwork. The minimum accuracy of the thermocouple is ±2.2°C (±4°F) or 0.75 percent of the measured temperature in °C, whichever is greater.
B. Verification of Operational Status	NA	NA	NA
C. QA/QC Practices and Criteria	Voltmeter zero check during scheduled maintenance performed every 3 weeks.	Thermocouples calibrated annually by comparison against an instrument of known accuracy. The acceptance criteria is ±4°F.	Thermocouples calibrated annually by comparison against an instrument of known accuracy. The acceptance criteria is ±4°F.
D. Monitoring Frequency	The voltage on each WESP is monitored continuously (one data point per minute).	The quench inlet temperature is monitored continuously (one data point per minute).	The WESP outlet temperature is monitored continuously (one data point per minute).
Data Collection Procedure	Data are recorded on the continuous parameter monitoring system (CPMS) computer.	Data are recorded on the CPMS computer.	Data are recorded on the CPMS computer.
Averaging Period	Hourly block average.	Hourly block average.	Hourly block average.

MONITORING APPROACH JUSTIFICATION

I. Background

The pollutant-specific emissions units (PSEU) are the two WESPs that control six veneer dryers. The dryers are longitudinal, steam-heated dryers manufactured by Coe and Moore and are used in the manufacture of plywood. Veneer is introduced into the dryer either manually or using automated veneer sheet feeders. The dried veneer sheets pass through a moisture detector as they exit the dryer where any sheets not meeting moisture specifications are marked and sorted for redrying. Dry veneer sheets are coated with mixed glue and formed into panels.

Two WESPs, also referred to as E-tubes, remove particulate matter from the dryer exhaust. WESP No. 1 serves dryers Nos. 1, 5, and 6 and WESP No. 2 serves dryers Nos. 2, 3, and 4.

II. Rationale for Selection of Performance Indicators

A WESP is designed to operate at a relatively constant voltage. A significant decrease in voltage is indicative of a change in operating conditions that could lead to an increase in emissions. Low voltage can indicate electrical shorts or poor contacts that require maintenance or repair of electrical components. However, the regular flush cycles the WESPs undergo to remove the particulate from the collection surfaces may also cause drops in voltage of short duration. These brief voltage drops are part of the normal operation of the WESP.

Monitoring gas stream temperature can provide useful information about the performance of a WESP. Quench inlet temperature primarily is an indication that the inlet gas stream is not so hot that a fire may develop in the duct work or WESP. In addition, the gas stream needs to be cooled in order for some of the pollutants to condense. The WESP outlet temperature indicates that the gas stream has been sufficiently saturated to provide for efficient particle removal, and that the water spray prior to the WESP inlet is functioning. High outlet temperatures could be the result of plugged nozzles, malfunctioning pumps, or broken or plugged piping.

III. Rationale for Selection of Indicator Ranges

The selected indicator ranges are given below:

Secondary voltage:	≥35 kV
Quench inlet temperature:	≤375°F
Stack outlet temperature:	≤175°F

An excursion is defined as (1) an hourly average voltage less than 35 kV; (2) an hourly average quench inlet temperature greater than 375˚F; or (3) an hourly average WESP outlet temperature greater than 175˚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. An hourly average was chosen to account for the intermittent flush cycles the WESPs undergo that cause the voltage to drop temporarily.

The indicator level for the WESP voltage was selected based upon the level maintained during normal operation. Typical operating voltages range from 35 to 55 kV. During the most recent performance test, the voltage ranged from 35 to 54 kV and the PM emissions were below allowable levels. An indicator level at the low end of the normal operating range was selected (35 kV). During a malfunction (such as an electrical short), the WESP voltage levels are appreciably lower than normal operational levels. The voltage also drops for a short period during the normal flush cycles that are performed every few hours to clean the tube surface where particulate is collected. Figure A.9b-1 displays the hourly average WESP secondary voltage during October 1997 for WESP No. 1.

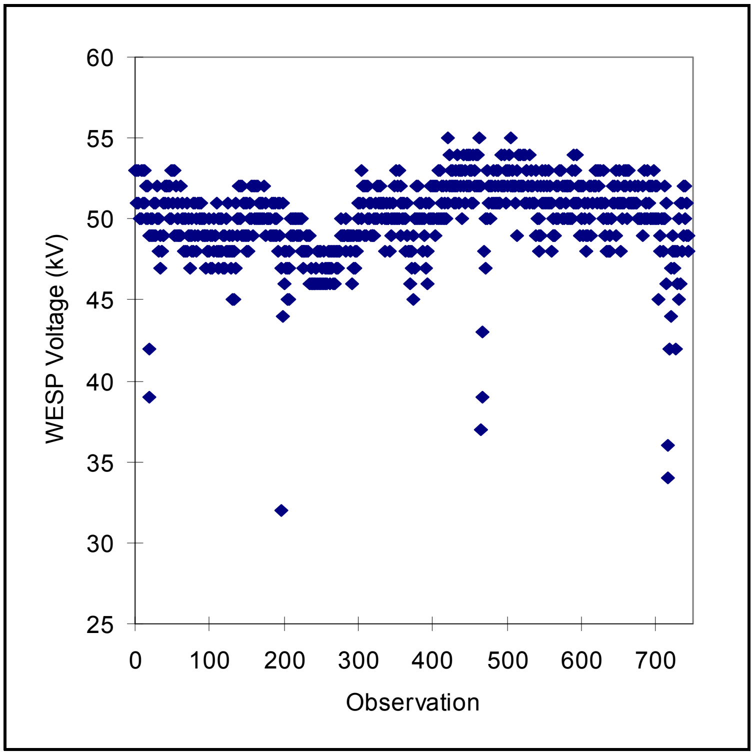

Figure A.9b-1. October 1997 hourly average secondary voltage (WESP No. 1).

The indicator levels for the quench inlet and WESP outlet gas temperatures also were selected based on levels maintained during normal operation. High temperatures may indicate a fire in the dryer or ductwork or a lack of water flow to the WESP. Temperature action levels were selected that are slightly higher than normal operating temperatures. If the water flow to the WESP is lost, the WESP outlet temperature will begin to approach the inlet temperature, which is much higher than 175˚F. Figures A.9b-2 and A.9b-3 display the hourly average quench inlet and WESP outlet temperature during October 1997 for WESP No. 1.

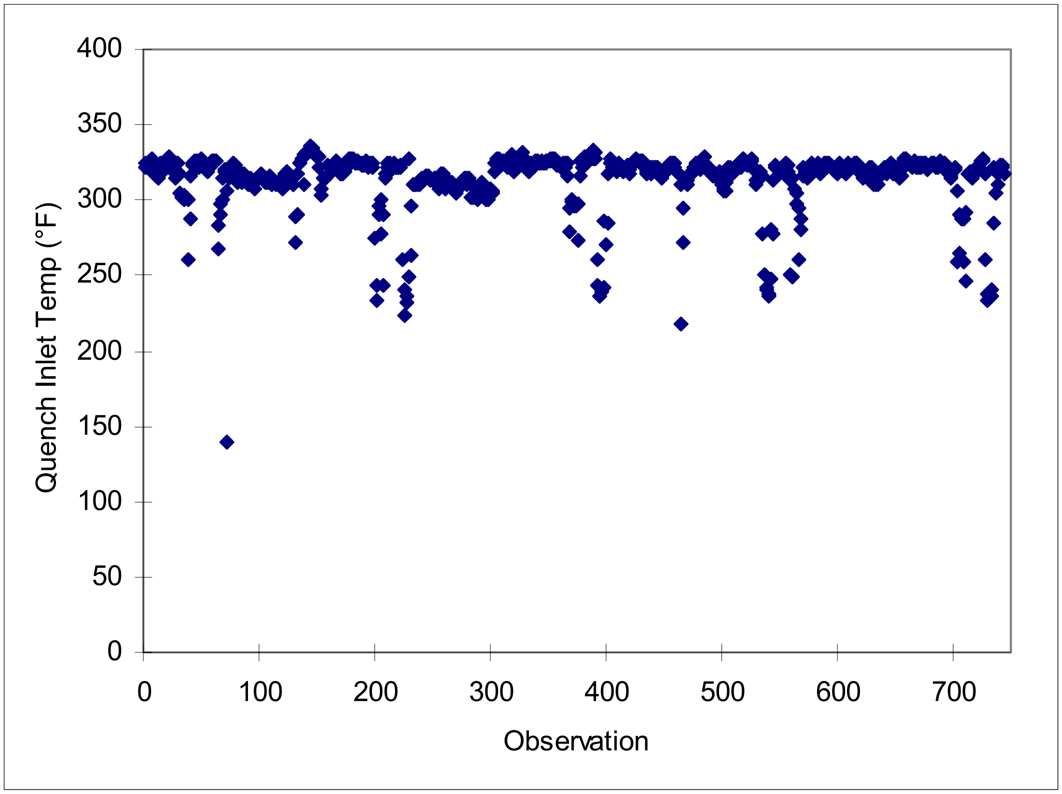

Figure A.9b-2. October 1997 Hourly Average Quench Inlet Temperature (WESP No. 1)

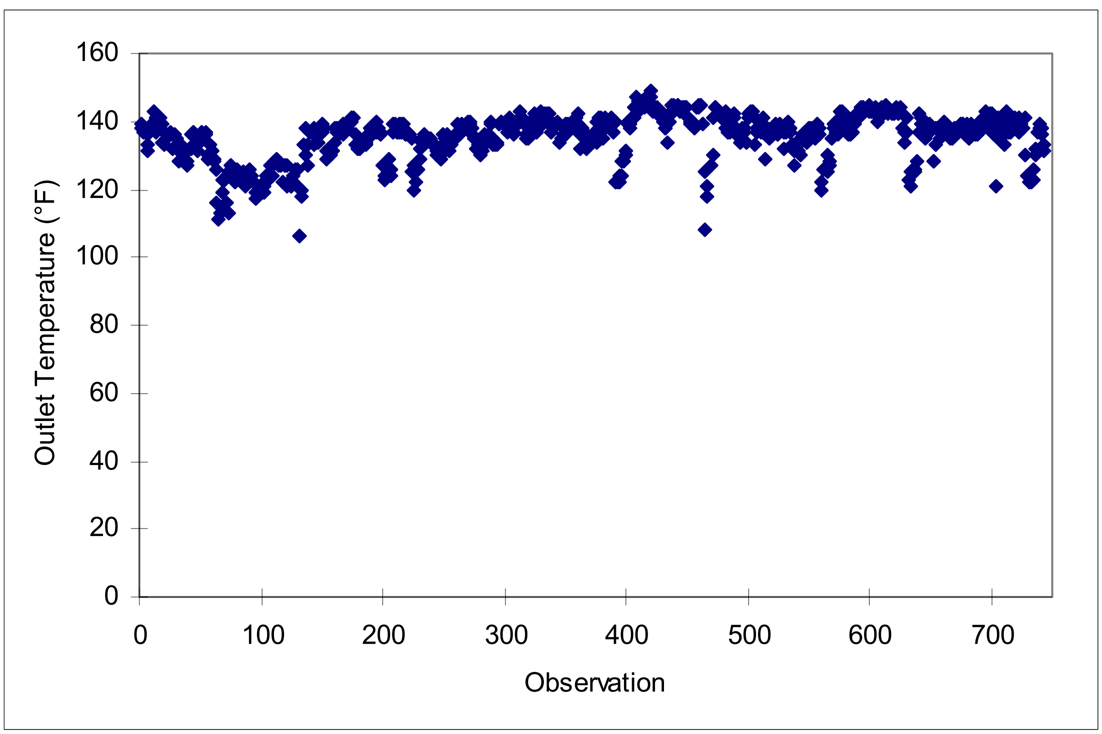

Figure A.9b-3. October 1997 Hourly Average WESP Outlet Temperature (WESP No. 1)

Indicator data for December 1995 to January 1996 and for October 1997 through December 1997 were reviewed. These data included hourly average WESP secondary voltage, quench inlet temperature, and WESP outlet temperature measurements. The maximum hourly average quench inlet temperature for WESP No. 1 was 336˚F, while the maximum for WESP No. 2 was 352˚F. The maximum hourly average stack outlet temperature for WESP No. 1 was 151˚F, while the maximum stack outlet temperature for WESP No. 2 was 178˚F. The average monthly voltages ranged from 47 to 51 kV for WESP No. 1 and from 40 to 46 kV for WESP No. 2.

Data obtained during the most recent performance test (October 1996) confirmed the unit was in compliance. During this test, the average measured PM emissions were 0.19 lb/MSF dried for WESP No. 1 and 0.21 lb/MSF dried for WESP No. 2. The measured particulate emissions were below the emission limitation of 0.3 lb/MSF dried (3/8-inch thickness basis). The WESP operating parameters during the performance test are summarized in Table A.9b-2.

TABLE A.9b-2. WESP OPERATING PARAMETERS DURING THE MOST RECENT PERFORMANCE TEST

WESP No.	Run	Production, ft^2/hr	Particulate, lb/MSF dried (3/8-inch basis)	WESP voltage, kV	Quench inlet T (˚F)	WESP outlet, T (˚F)
1	1	22,760	0.24	54	317	134
	2	23,419	0.17	54	318	134
	3	23,075	0.17	--	--	--
	Average	23,085	0.19	54	318	134
2	1	23,899	0.24	35	328	147
	2	32,238	0.17	38	332	143
	3	26,897	0.20	40	331	147
	Average	27,678	0.21	38	330	146

A.11 ELECTRIFIED FILTER BED FOR PM CONTROL OF VENEER DRYERS – FACILITY K

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EXAMPLE COMPLIANCE ASSURANCE MONITORING
ELECTRIFIED FILTER BED (EFB) FOR PM CONTROL – FACILITY K

I. Background

A. Emissions Unit

Description:	Natural gas-fired dryers used in plywood manufacturing
Identification:	Veneer Dryer 1, Veneer Dryer 2
Facility:	Facility K Anytown, USA

B. Applicable Regulation, Emission Limit, and Monitoring Requirements

Regulation:	Permit, State regulation
Emission Limits:	
Particulate matter (PM):	0.30 lb/1000 ft^2 (MSF) dried (3/8-inch thickness basis), 4.1 lb/hr
Monitoring Requirements:	EFB inlet temperature, EFB voltage, and EFB ionizer current.

C. Control Technology EFB

II. Monitoring Approach

The key elements of the monitoring approach are presented in Table A.11-1. The selected indicators of performance are: EFB inlet temperature, voltage, and ionizer current. The selected indicator ranges are based upon hourly average values.

TABLE A.11-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2	Indicator No. 3
I. Indicator	EFB inlet temperature.	EFB voltage.	EFB ionizer current.
Measurement Approach	Temperature is measured using a thermocouple.	Voltage is measured with a voltmeter.	Ionizer current is measured with an ammeter.
II. Indicator Range	An excursion is defined as an hourly average EFB inlet temperature greater than 170˚F (>145˚F when drying pine veneer). Excursions trigger an investigation, corrective action, and a reporting requirement.	An excursion is defined as an hourly average EFB voltage less than 8 kV. Excursions trigger an investigation, corrective action, and a reporting requirement.	An excursion is defined as an hourly average EFB ionizer current less than 2 mA. Excursions trigger an investigation, corrective action, and a reporting requirement.
III. Performance Criteria A. Data Representativeness	The monitoring system consists of a thermocouple installed at the inlet of the EFB. The minimum accuracy of the thermocouple is ±2.2˚C (±4˚F) or 0.75 percent of the measured temperature in ˚C, whichever is greater.	The monitoring system consists of a voltmeter on the EFB unit. The minimum accuracy of the voltmeter is ±0.5 kV.	The monitoring system consists of an ammeter on the EFB unit. The minimum accuracy of the ammeter is ±0.5 mA.
B. Verification of Operational Status	NA	NA	NA
C. QA/QC Practices and Criteria	The accuracy of the thermocouple is checked annually (or as needed) by calibration using a signal transmitter. The thermocouple wells are periodically checked and cleaned (at least annually).	Voltmeter zero is checked when the unit is not operating.	Ammeter zero is checked when the unit is not operating.
D. Monitoring Frequency	The EFB inlet temperature is measured continuously (at least 4 times per hour).	The EFB voltage is measured continuously (at least 4 times per hour).	The EFB ionizer current is measured continuously (at least 4 times per hour).
Data Collection Procedure	Data are stored electronically and archived for at least 5 years..	Data are stored electronically and archived for at least 5 years..	Data are stored electronically and archived for at least 5 years..
Averaging Period	Hourly block average.	Hourly block average.	Hourly block average.

MONITORING APPROACH JUSTIFICATION

I. Background

The pollutant-specific emissions unit (PSEU) consists of two natural gas direct-fired veneer dryers controlled by an EFB. Dryer 1 is manufactured by Moore and has one zone and four decks. Dryer 2 is manufactured by Coe and has two zones and five decks. The dryers are used in the manufacture of plywood.

II. Rationale for Selection of Performance Indicators

Wood dryer exhaust streams contain dry PM, products of combustion and pyrolysis, and aerosols formed by the condensation of hydrocarbons volatilized from the wood chips. Since some of the pollutants from the dryers are in a gas phase at the normal dryer exhaust temperature of 250˚ to 300˚F, these pollutants must be condensed in order to be collected by the EFB. The gas stream is cooled to a temperature of about 180˚F by the evaporative gas cooler that precedes the EFB, using a water mist. The pollutants condense into fine liquid droplets and are carried into the EFB. The EFB ionizer gives the particles in the gas stream an electrical charge. The high voltage electrode in the gravel bed creates charged regions on the gravel. As the gas passes through the bed, the charged particles are removed from the gas and transferred to the surface of the bed. Liquid and dust continuously build up on the gravel surface; the liquid slowly travels through the bed and is allowed to drip into the drain outlet in the bottom of the unit. The gravel is periodically replaced (about one-third of the gravel is replaced each month).

Factors that affect emissions from wood dryers include wood species, dryer temperature, dryer residence time, dryer loading rate, and previous drying history of the wood. The rate of hydrocarbon aerosol formation (from vaporizing the extractable portion of the wood) is lower at lower dryer temperatures. Small increases in dryer temperature can produce relatively large increases in the PM emission rate. If particles are held in the dryer too long, the surfaces can volatilize; if these emissions are released into the ambient air, a visible blue haze can result.

The CAM indicators selected are EFB inlet temperature, EFB voltage, and EFB ionizer current. The EFB must be maintained at the proper temperature to allow collection of the hydrocarbon aerosol and particulate matter from the dryer. The EFB inlet temperature is monitored to indicate the gas stream was cooled to the proper temperature range before entering the EFB and that the bed is operating at the proper temperature. Information from the EFB manufacturer indicates that high EFB temperatures (e.g., temperatures in excess of 200˚F) may result in excess stack opacity, as will low gravel levels (a low gravel level may cause insufficient PM collection). The voltage on the gravel and the current on the ionizer must be maintained so negatively charged particles in the exhaust gas are attracted to positively charged regions on the gravel bed. An adequate ionizer current level indicates the corona is charging the particles in the gas stream. The bed voltage level indicates the intensity of the electric field in the bed. A drop in voltage or current could indicate a malfunction, such as a short or a buildup of dust or hydrocarbon glaze on the ionizer or the gravel. A short in the bed will show as high current with little or no voltage. A foreign object in the gravel bed which bridges the gap between the electrode and grounded louvers can short the bed, as can a cracked electrical insulator. The bed's PM collection efficiency increases as the voltage and current increase within the unit's operating range.

The parameters selected for monitoring are consistent with technical information on the operation, maintenance, and emissions for EFB's and dryers provided in EPA's September 1992 draft Alternative Control Technology (ACT) document for PM-10 emissions from the wood products industry. These parameters also were recommended by the manufacturer as parameters to monitor to ensure proper operation of the EFB unit.

III. Rationale for Selection of Indicator Ranges

Indicator data for June through August were collected and reviewed. These data include EFB cooler inlet and outlet temperature, bed temperature, bed voltage, and ionizer current measurements. No indicator ranges are specified in the current operating permit, but the permit does state that the EFB bed temperature shall not exceed 145˚F when pine veneer is being dried. Based on the manufacturer's recommendations, historical data, and data obtained during source testing, the following indicator ranges were selected:

EFB bed inlet temperature:	<170˚F (<145˚F when drying pine veneer)
EFB bed voltage:	>8 kV
EFB ionizer current:	>2 mA

An excursion is defined as an hourly average of any parameter which is outside the indicator range. 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.

Figure A.11-1 shows the hourly average EFB inlet temperature for June. The permit requires that the EFB bed temperature be less than 145˚F while drying pine veneer. The EFB inlet temperature is used as a surrogate for bed temperature. During normal operation, the typical inlet temperature was 160 to 165˚F when drying species other than pine. There were short periods of operation at 130 to 140˚F when drying pine veneer, and lower temperatures that indicate the dryers were not operating (e.g., on Fridays during the routine maintenance shutdown). Similar operating ranges were observed for July and August. The maximum hourly average EFB inlet temperatures for June, July, and August were 174˚F, 173˚F, and 176˚F, respectively. The manufacturer recommends maintaining the EFB at a temperature of 160 to 180˚F. Therefore, based on this recommendation and on normal operating conditions, the indicator range chosen was an hourly average inlet temperature less than 170˚F (less than 145˚F when drying pine veneer). If the EFB inlet temperature exceeds 170˚F (145˚F when drying pine), corrective action will be initiated.

Figure A.11-2 shows the hourly average EFB voltage for June. From Figure A.11-2, it can be observed that the EFB typically operates in the range of 10 to 15 kV. Some short periods of operation occur from 5 to 10 kV. The mean hourly voltages for June, July, and August are given below. These statistics do not include data from periods during which the EFB was not operating and the voltage was recorded as 1.0 or zero. (For example, the EFB is shut down every Friday for maintenance.)

Month	Mean hourly average voltage, kV
June	12.4
July	11.6
August	10.9
Average	11.6

The manufacturer's recommended bed voltage range is 5 to 10 kV. The average voltages during the 1992, 1993, and 1996 performance tests were 6.7 kV, 11 kV, and 14 kV, respectively. Based on all data reviewed, greater than 8 kV was chosen as the indicator range for the hourly average EFB bed voltage. If the hourly average bed voltage drops below 8 kV during periods of normal operation (excludes shutdown periods), corrective action will be initiated.

Figure A.11-3 shows the hourly average EFB ionizer current for the month of June. From Figure A.11-3 it can be seen that the EFB typically operates at an ionizer current in the range of 2 to 5 mA. The mean hourly average currents for June, July, and August are shown below. In addition, the manufacturer's recommended range is 2 to 4 mA. Therefore, the indicator range chosen was an hourly average current greater than 2 mA. If the hourly average ionizer current drops below 2 mA during normal operation (excludes shutdown periods), corrective action will be initiated.

Month	Mean hourly average current, mA
June	2.8
July	2
August	2
Average	2.3

Emissions test results and indicator data are presented below for the 1992, 1993, and 1996 performance tests. The 1992 and 1993 tests were conducted while drying pine; the 1996 test was conducted while drying Douglas fir. The EFB is subject to a PM emission limitation of 0.30 lb/MSF (4.1 lb/hr). Both limits were met during all three performance tests.

Year	PM emissions, gr/dscf	PM emissions, lb/MSF	PM emissions, lb/hr	Average voltage, kV	Average ionizer current, mA	Average EFB inlet temperature, ˚F
1992	0.016	0.16	1.5	6.7	4.9	153
1993	0.015	0.22	2.0	10.8	2.8	154
1996	0.02	0.30	1.1	14	1.4	189

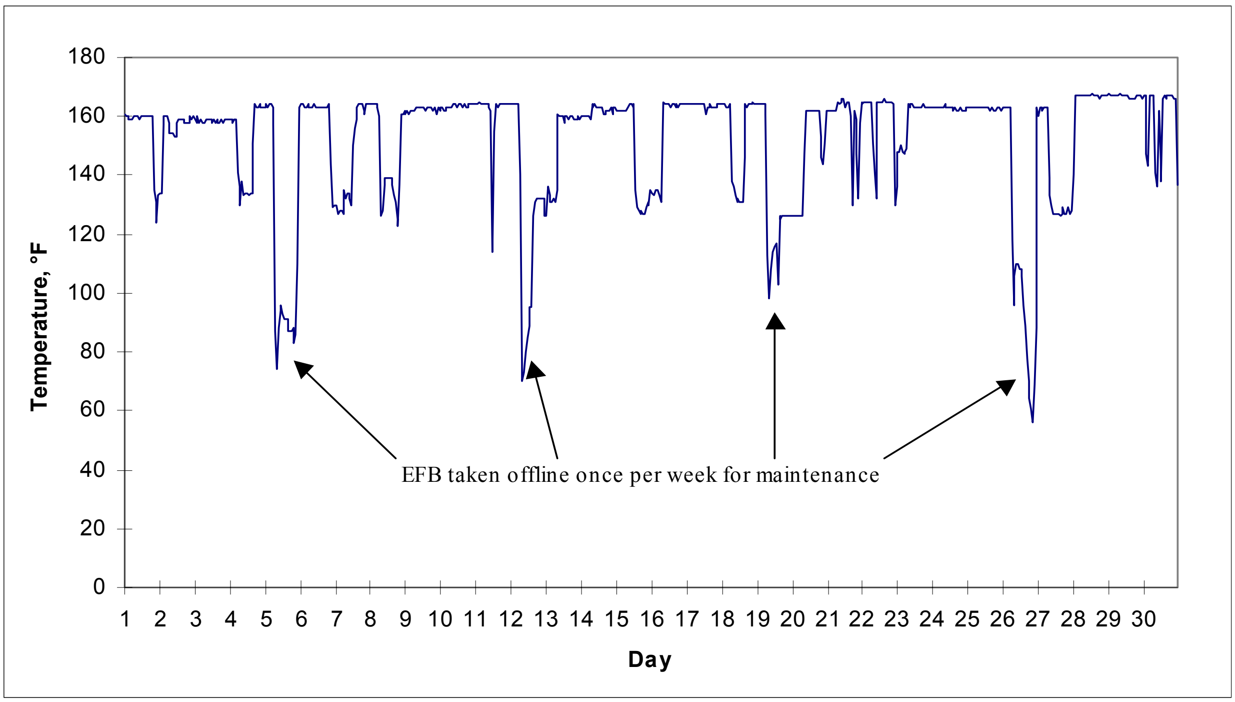

Figure A.11-1. June EFB inlet temperature (hourly average).

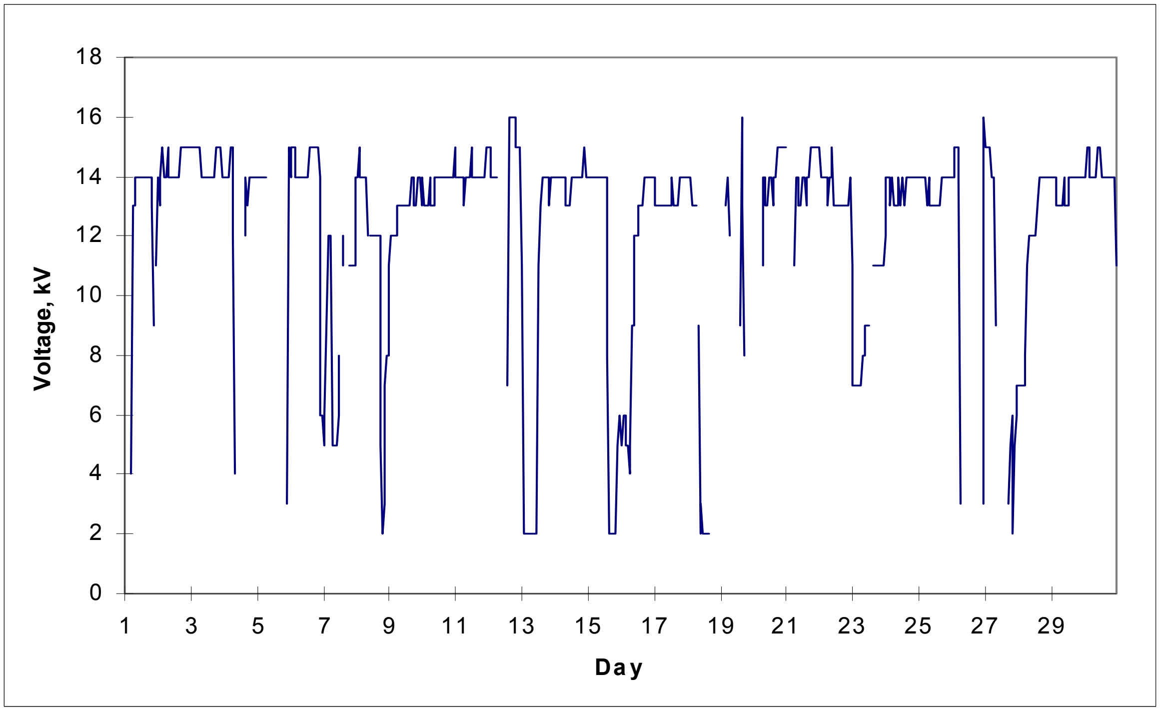

Figure A.11-2. June EFB bed voltage (hourly average).

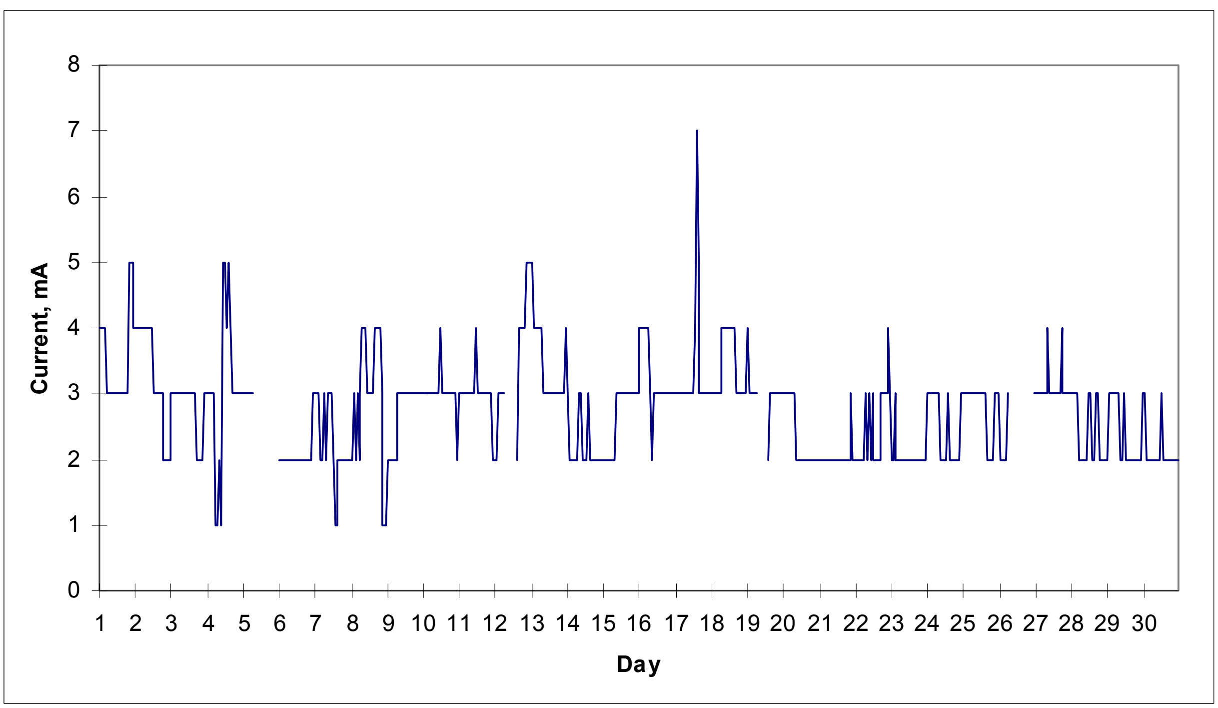

Figure A.11-3. June EFB ionizer current (hourly average).

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A.16 CONTROL DEVICE (BOILER) BYPASS – FACILITY R

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EXAMPLE COMPLIANCE ASSURANCE MONITORING
CONTROL DEVICE (BOILER) BYPASS – FACILITY R

I. Background

A. Emissions Unit

Description:	APCD (boiler) bypass valve
Identification:	East and West boilers
Facility:	Facility R Anytown, USA

B. Applicable Regulation, Emissions Limit, and Bypass Monitoring Requirements

Regulation:	Permit, State regulation
Emissions Limits:	
CO:	200 ppm
Monitoring Requirements:	Temperature downstream of bypass valve.

C. Control Device

Two boilers in parallel.

II. Monitoring Approach

The key elements of the bypass monitoring approach are presented in Table A.16-1. The selected indicators are the temperatures in the horizontal and vertical portions of the bypass line downstream of the boiler bypass valve. The temperatures are measured continuously; instantaneous temperature values are recorded every 15 minutes.

Note: This compliance assurance monitoring example is presented as an illustration of one approach to monitoring for control device bypass. The example presents only the parameters monitored to ensure the control device is not being bypassed. Parameters to ensure the control device is operating properly also are monitored, but are not discussed in this example.

TABLE A.16-1. BYPASS MONITORING APPROACH

I. Indicator	Vertical and horizontal bypass line temperatures
Measurement Approach	Thermocouples downstream of bypass valve.
II. Indicator Range	An excursion is defined as a vertical line temperature of greater than 550˚F or a horizontal line temperature of greater than 250˚F. An excursion shall trigger an inspection, corrective action as necessary, and a reporting requirement.
III. Performance Criteria A. Data Representativeness	Gas temperature is measured using thermocouples in two locations downstream of the bypass valve, prior to the common exhaust stack. The minimum accuracy of the thermocouples is 2.2˚C (±4˚F) or ±0.75 percent of the temperature measured in ˚C, whichever is greater.
B. Verification of Operational Status	NA
C. QA/QC Practices and Criteria	The thermocouples are checked annually with a redundant temperature sensor. Acceptance criteria: ±15˚F of the measured value.
D. Monitoring Frequency	The temperatures are measured and recorded every 15 minutes.
Data Collection Procedures	The temperatures are recorded by the computer control system every 15 minutes.
Averaging period	None.

MONITORING APPROACH JUSTIFICATION

I. Background

The FCCU regenerator flue gas contains approximately 10 percent CO by volume, and is referred to as "CO gas." The CO gas is routed to two tangentially-fired boilers (East and West) in parallel, designed with sufficient residence time, turbulence, and temperature to fully combust the CO to CO_2. The exhaust from each boiler enters a common stack, where an emission limit of 200 ppm CO must be met. The FCCU regenerator is equipped with piping that enables the CO gas to bypass the boilers and flow directly to the common stack. Use of the bypass line is essential for the safe operation of the boilers during startup and shutdown periods. The piping is equipped with a butterfly valve. The position of this valve is monitored by the computer control system, and is kept fully closed during normal operation. The operators routinely pack the valve with ceramic fiber insulation to prevent leaks. A process schematic is shown in Figure A.16-1.

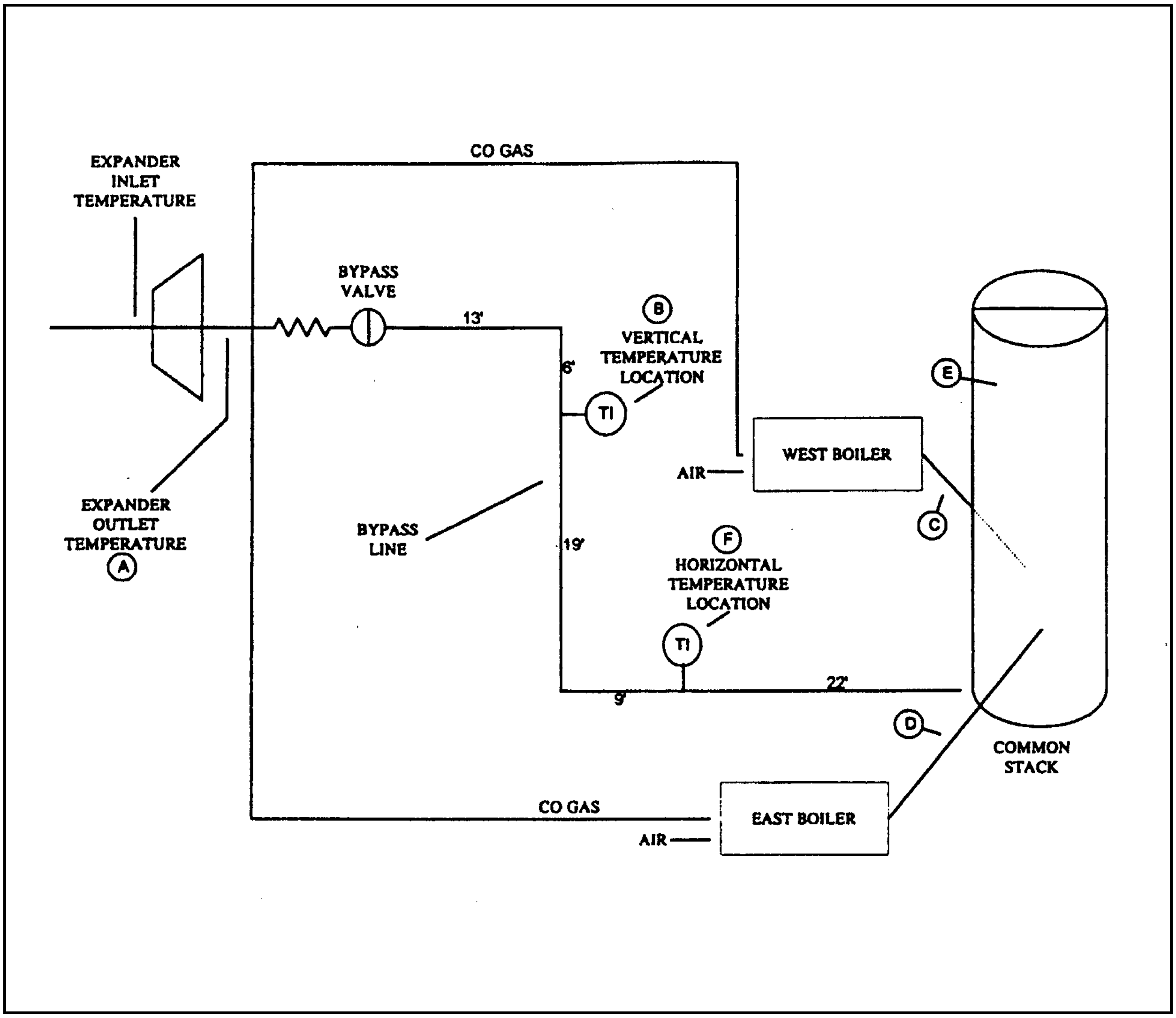

Figure A.16-1. Process schematic.

II. Rationale for Selection of Performance Indicator

Although the bypass valve position is computer-controlled, it has a tendency to leak if not tightly packed with insulation. Therefore, the operators need an indicator to detect leakage of the valve that might cause excess CO emissions. Testing was performed to determine the effect of boiler load on CO emissions. The results showed the boilers emitted negligible CO regardless of operating load. The effect of a leaky valve on CO emissions (measured in the stack) and the gas temperature downstream of the bypass valve then was examined. The results showed that as the amount of valve leakage increases and the CO concentration in the common stack increases, the temperature downstream of the valve also increases because of the high temperature of the CO gas (the temperature of the CO gas upstream of the valve is approximately 960˚F). Therefore, the selected indicator of a leaky or open bypass valve is the temperature downstream of the bypass valve.

III. Rationale for Selection of Indicator Range

A test program was conducted to determine the relationship between the gas temperature downstream of the bypass valve and the CO emissions. The gas temperature in the bypass line and the CO concentration in the common stack were measured at baseline conditions (no leakage) and for eight different leak conditions. Temperature was measured at two locations: the vertical section of the bypass line (19 feet downstream of the valve) and the horizontal section of the bypass line (47 feet downstream of the valve). During normal conditions, when the CO level in the common stack was less than 50 ppm, the temperature in the vertical section was roughly 410˚F, while the temperature in the horizontal section was 110˚F.

To induce leakage of the valve, the valve was opened 5 percent on day 1 and 3 percent on day 2, and immediately closed. The packing material broke loose during each opening. On inducing the leaks, the temperature downstream of the valve rose quickly and eventually reached a stable temperature. To evaluate the effect of adding packing to the valve on downstream temperatures and CO levels in the common stack, the valve was progressively packed with ceramic fiber insulation and allowed to stabilize. The level of CO in the stack and the downstream temperatures decreased with the amount of insulation added.

For each of the seven test runs or conditions, multiple data points were collected and recorded for the temperatures and the CO concentrations. Rather than calculating the average as the representative value for each run as is traditionally done with performance test data, a percentile measure was determined from the data for each run. The percentile value for temperature and for CO concentration were selected independently. All of the temperature readings for the run were ranked from lowest to highest, and the value that coincides with the 5^{th} percentile for all of the temperature readings for that run was selected. Then, all of the CO concentration readings for the run were ranked lowest to highest, and the value that coincides with the 95^{th} percentile for all of the CO concentration readings for that run was selected. These percentile values were selected to represent the test run instead of an average value. Table A.16-2 shows a summary of the readings for each test condition or run; both the average values and the percentile values are shown. Table A.16-2 shows data for the vertical duct temperature, horizontal duct temperature, and CO concentration for each test condition.

Figures A.16-2 and A.16-3 show the relationship between CO emissions and the gas temperature at the horizontal and vertical locations. The 5^{th} percentile temperature readings reflect levels at the lower end of the range for each condition that can alert the boiler operator to bypass valve leakage. Conversely, since the CO levels varied during each test condition, the 95^{th} percentile CO levels for each test condition were selected to be conservative (on the high side). For added confidence, indicator ranges were developed for both measurement locations (it is expected that the two thermocouples will not fail at the same time). Based on the data collected during testing, an excursion is defined as a vertical duct temperature of greater than 550˚F or a horizontal duct temperature of greater than 250˚F. An excursion will trigger an inspection, corrective action as necessary, and a reporting requirement.

TABLE A.16-2. SUMMARY OF TEMPERATURE AND CO EMISSIONS LEVELS DURING TEST CONDITIONS

Condition	Test Period (minutes)	Vertical Temperature Readings (°F)		Horizontal Temperature Readings (°F)		CO Level (ppmvd at 50% excess air)	
		Average	5th Percentile	Average	5th Percentile	Average	95th Percentile
Baseline -- Normal operation, minimal leakage	222	410	405	112	109	39.5	44.5
Open1 -- Open/close bypass valve to force leakage (day 2)	8	*Transient Data Period*					
Leak -- Monitoring period following valve open/close	98	683	641	463	426	351	358
Pack1 -- Monitoring period after one tube of packing was injected into valve	10	*Transient Data Period*					
Pack2 -- Monitoring period after a second tube of packing was injected	57	676	671	453	449	229	230
Pack3 -- Monitoring period after a third tube of packing was injected	1084	634	629	341	307	169	191
Pack 45 -- Monitoring period after a fourth and fifth tube of packing was injected	176	482	443	179	160	30.0	35.7
Open 2 -- Close/open bypass valve to force leakage a second time (day 3)	9	*Transient Data Period*					
Leak 2 -- Monitoring period following valve open/close #2	105	641	604	443	411	242	248
Pack1X -- Monitoring period after one tube of packing was injected into valve after Leak 2	20	*Transient Data Period*					
Pack 2X -- Monitoring period after a second tube of packing was injected into valve after Leak2	122	588	577	397	389	123	127

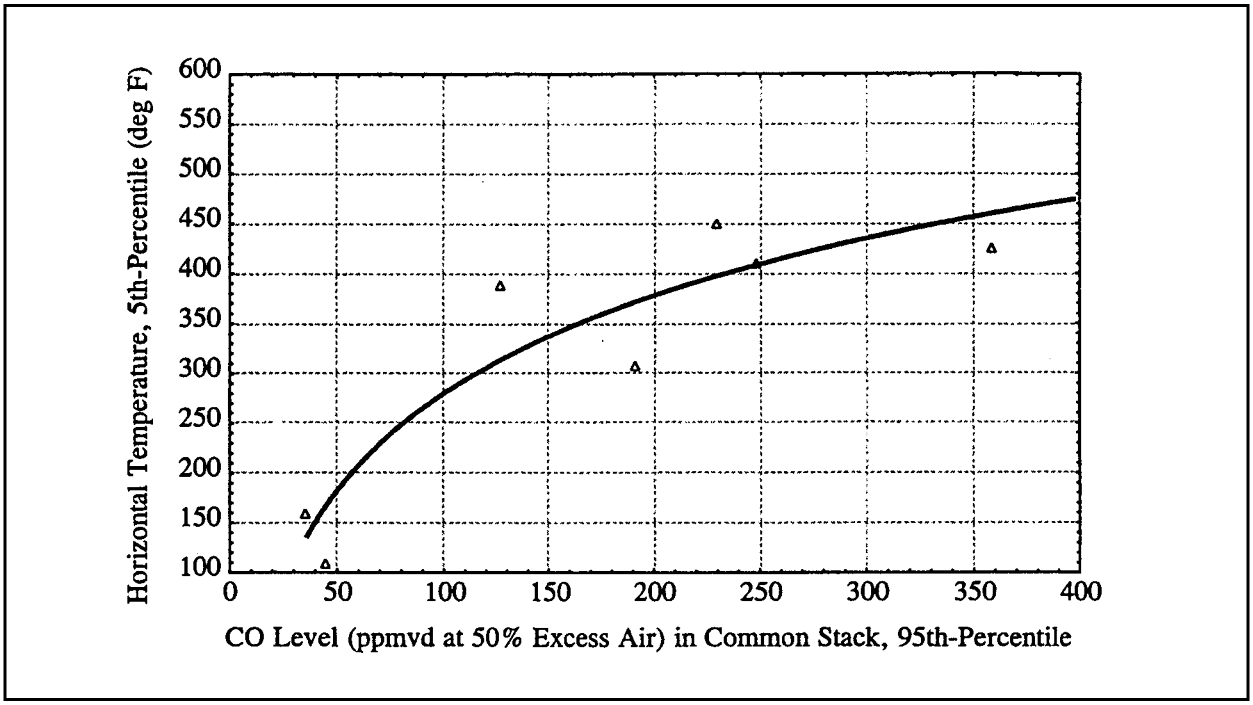

Figure A.16-2. CO Level (95th Percentile) in the Common Stack vs. Horizontal Temperature Measurement (5th Percentile).

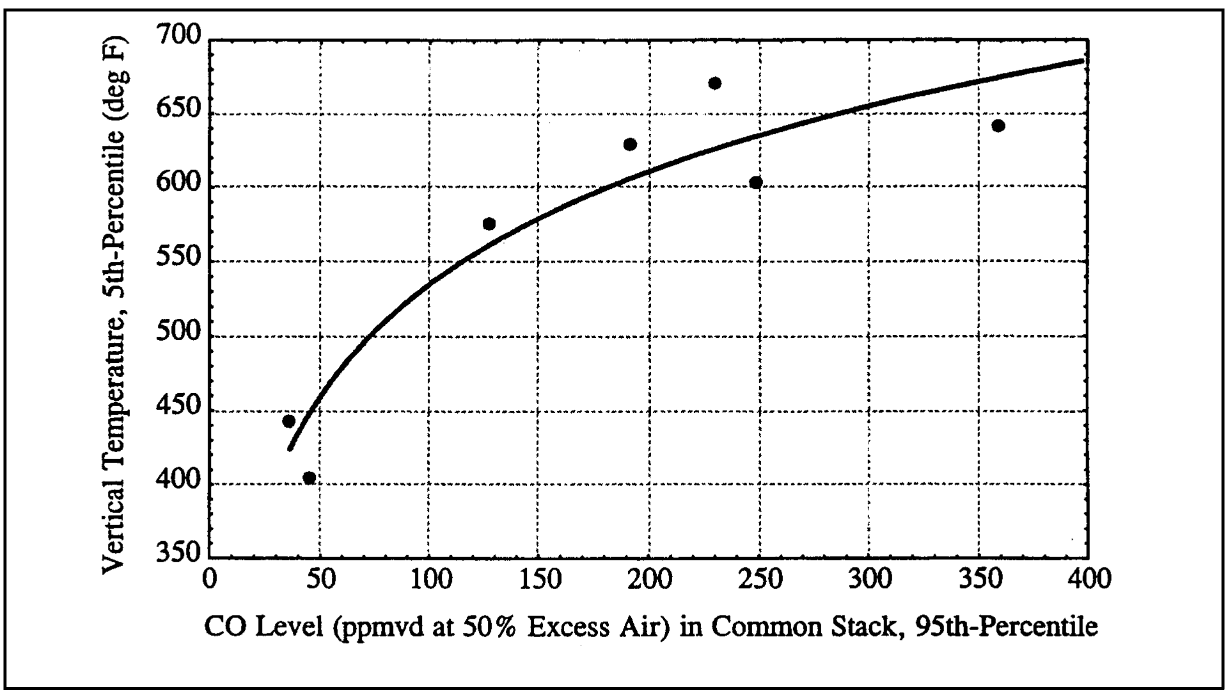

Figure A.16-3. CO Level (95th Percentile) in the Common Stack vs. Vertical Temperature Measurement (5th Percentile).

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A.17 VENTURI SCRUBBER FOR PM CONTROL--FACILITY S

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EXAMPLE COMPLIANCE ASSURANCE MONITORING
VENTURI SCRUBBER FOR PM CONTROL: FACILITY S

I. Background

A. Emissions Unit

Description:	Wood-fired boiler
Identification:	Boiler A
Facility:	Facility S Anytown, USA

B. Applicable Regulation, Emissions Limit, and Monitoring Requirements

Regulation: State regulation (Federally enforceable)

Emissions Limit:
Particulate Matter (PM): Determined using the following equation:

$$P = 0.5 * (10/R)^{0.5}$$

where:

P = allowable weight of emissions of fly ash and/or other PM in lb/mmBtu.

R = heat input of fuel-burning equipment in mmBtu/hr based on the measured percent of O_2 and volumetric flow rate.

The State rule also specifies that the opacity of visible emissions cannot be equal to or greater than 20 percent, except for one 6-minute period per hour of not more than 27 percent.

Monitoring Requirements: Continuous Opacity Monitoring System (COMS)

C. Control Technology

Venturi scrubber

II. Monitoring Approach

The key elements of the monitoring approach are presented in Table A.17-1. The indicators of performance are the boiler exhaust O_2 concentration (a measure of excess air level) and the differential pressure across the scrubber venturi.

TABLE A.17-1. MONITORING APPROACH

	Indicator No. 1	Indicator No. 2
I. Indicator	Exhaust gas oxygen concentration	Scrubber differential pressure
Measurement Approach	O_2 monitor	Differential pressure transducer.
II. Indicator Range	An excursion is defined as an hourly boiler exhaust O_2 concentration of less than 11 or greater than 16 percent. Excursions trigger an inspection, corrective action, and a reporting requirement.	An excursion is defined as a 1-hour average differential pressure below 10.0 inches of water. Excursions trigger an inspection, corrective action, and a reporting requirement.
III. Performance Criteria A. Data Representativeness	The O_2 monitor is located in the boiler exhaust.	The differential pressure transducer monitors the static pressures upstream and downstream of the scrubber's venturi throat.
B. Verification of Operational Status	NA	NA
C. QA/QC Practices and Criteria	Daily zero and span checks. Adjust when drift exceeds 0.5 percent O_2.	Quarterly comparison to a U-tube manometer. Acceptance criteria is 0.5 in. w.c.
D. Monitoring Frequency	Measured continuously.	Measured continuously.
Data Collection Procedures	1-minute averages are computed and displayed. The PC then computes and stores a 1-hour average using the 1-minute averages.	1-minute averages are computed and displayed. The PC then computes and stores a 1-hour average using the 1-minute averages.
Averaging period	1-hour.	1-hour.

MONITORING APPROACH JUSTIFICATION

I. Background

The pollutant-specific emissions unit (PSEU) is PM from a wood-fired boiler. Particulate matter in the boiler's exhaust stream is controlled by a venturi scrubber. A COMS is required by the applicable State rule. However, water droplets in the boiler exhaust will interfere with the COMS measurements and consequently make the use of a COMS impractical. An alternative monitoring program utilizing parametric monitoring has been proposed. The monitoring approach includes continuous monitoring of the wood-fired boiler's excess air, the steam production rate, and the differential pressure across the scrubber's venturi throat.

II. Rationale for Selection of Performance Indicators

The operating conditions for this type of source (wood-fired boiler) can have a significant impact on the amount of particulate emissions created. Furthermore, for a venturi scrubber, the inlet particulate matter loading to the scrubber will have an impact on the emissions level from the scrubber (i.e., emissions from the scrubber are expected to increase as the loading to the scrubber increases for the same scrubber operating conditions). Site-specific emissions test data confirm these expectations. Therefore, indicators of performance of both the control device and process were selected for this source.

The scrubber differential pressure was selected as the indicator of control device performance. The differential pressure is proportional to the water flow and air flow through the scrubber venturi throat and is an indicator of the energy across the scrubber and the proper operation of the scrubber within established conditions.

Excess air levels can have a significant impact on boiler performance. Excess air is defined as that air exceeding the theoretical amount necessary for combustion. Insufficient excess air will result in incomplete combustion and an increase in emissions. A minimum of about 50 percent excess air is necessary for combustion of wood or bark fuels. Provision of too much excess air causes the furnace to cool and also can result in incomplete combustion. Therefore, the proper excess air level is important for proper operation of the boiler. The percent oxygen in the exhaust gas stream is an indicator of the excess air level (0 percent oxygen would equal 0 percent excess air, 8 percent oxygen is approximately 50 percent excess air, and 12 percent oxygen is approximately 100 percent excess air).

III. Rationale for Selection of Indicator Ranges

Baseline information on the relationship among process operating conditions, control device operating conditions, and emissions was necessary to establish the indicators and ranges. A series of test runs was performed at several different boiler operating conditions because parametric monitoring is being proposed as an alternative to COMS.

Emissions tests were performed to establish a basis for indicator ranges that correspond to compliance with the PM emissions limit. A set of nine test runs was performed on the boiler at three different levels of steam generation (three test runs were performed at each steam generation level). Emissions sampling was based on EPA Methods 1 through 5 (40 CFR 60, Appendix A). The results of the first series of emissions tests indicated a problem meeting the emissions limits at the lower load level; the lack of a means to control excess air levels during boiler operation was suspected as the cause of the excess emissions. A second series of tests were performed a year later after automatic boiler control equipment was installed. The second series of tests also was comprised of nine runs at three operating loads. The results of these 18 tests were used in selecting the indicator ranges. The results of these tests are presented and discussed in the following paragraphs.

Figure 1 graphically presents the excess air level versus the nominal boiler load (steam generation rate) for the tests. During the first series of tests, before automatic boiler controls were added, the boiler operated at a very high level of excess air (over 500 percent) at the low-level operating load, at a high level of excess air (over 200 percent) at the mid level operating load, and below 200 percent at the high-level operating load. Without the automatic boiler controls, the same amount of air was being introduced to the boiler regardless of the operating load (wood feed rate), resulting in a significant increase in excess air levels as wood feed rate decreased. After the automatic controls were added, the excess air was maintained at lower levels for the low-level and mid-level load conditions (less than 300 percent and 200 percent, respectively).

The results of the two test series are summarized in Table A.17-2. Three test runs were performed at each steam generation rate.

TABLE A.17-2. TEST RESULTS[a]

	Nominal steam generation rate (lb/hr)	Venturi differential pressure (in. H_2O)	Boiler exhaust O_2 (%)	Particulate emissions (lb/MMBtu)	Allowable particulate emissions (lb/MMBtu)
Series 1: (Before Boiler Control Modifications)	25,000	15.6	18.1	0.73	0.25
	40,000	22.9	16.2	0.43	0.21
	60,000	22.2	12.6	0.06	0.16
Series 2: (After Boiler Control Modifications)	33,000	12.0	15.5	0.07	0.25
	52,000	12.1	13.9	0.06	0.21
	77,000	12.0	13.0	0.05	0.17

[a] All values are 3-run averages.

At the first level of steam generation (25,000 lb/hr), the amount of excess air ranged from 544 percent to 752 percent by volume. The particulate emissions rate ranged from 0.528 to 1.12 lb/MMBtu. The maximum allowable emissions ranged from 0.23 to 0.27 lb/MMBtu. The maximum allowable emissions varies because it is based on the heat input rate. The allowable emissions rate was exceeded for all three test runs. The second set of test runs was performed at a nominal steam generation level of 40,000 lb/hr. The amount of excess air ranged from 244 to 830 percent. The particulate emissions rate ranged from 0.21 to 0.82 lb/MMBtu. The maximum allowable emissions ranged from 0.17 to 0.28 lb/MMBtu. The maximum allowable emissions rate was exceeded for all three test runs. The third set of test runs was operated at a nominal steam generation level of 60,000 lb/hr. The steam generation level actually ranged from 60,000-70,000 lb/hr but dropped below 50,000 lb/hr midway through the third of the three tests performed. The amount of excess air for these three test runs ranged from 123 to 188 percent. The particulate emissions rate ranged from 0.05 to 0.06 lb/MMBtu. The maximum allowable emissions ranged from 0.15 to 0.17 lb/MMBtu. The boiler was well within the maximum allowable emissions rate for all three test runs.

For the test series conducted after the addition of automatic controls, at the first level of steam generation (33,000 lb/hr nominal), the amount of excess air ranged from 255 to 341 percent by volume (15 to 16 percent oxygen). The particulate emissions rate ranged from 0.062 to 0.081 lb/MMBtu. The maximum allowable emissions ranged from 0.23 to 0.29 lb/MMBtu. The particulate emissions were less than the allowable emissions rate for all three test runs. The second set of test runs was performed at a nominal steam generation level of 77,000 lb/hr. The amount of excess air ranged from 128 to 194 percent (12 to 14 percent oxygen). The particulate emissions rate ranged from 0.045 to 0.057 lb/MMBtu. The maximum allowable emissions ranged from 0.16 to 0.18 lb/MMBtu. The particulate emissions were less than the allowable emissions rate for all three test runs. The third set of test runs was performed at a nominal steam generation level of 52,000 lb/hr. The amount of excess air for these three test runs ranged from 196 to 223 percent (13 to 14 percent oxygen). The particulate emissions rate ranged from 0.056 to 0.067 lb/MMBtu. The maximum allowable emissions ranged from 0.20 to

0.21 lb/MMBtu. The boiler operated within the maximum allowable emissions rate for all three test runs.

Figure 2 presents the particulate emissions rate versus boiler load for the two test series. Figures 3 and 4 present the particulate emissions rate versus excess air and boiler exhaust oxygen level, respectively. The test results show that during the first test series the emissions increase significantly as the excess air increases. The allowable emissions limit was exceeded at the low- and mid-level operating loads. The results of the second test series conducted after automatic boiler controls were added also show a relationship among the excess air level, boiler load, and particulate emissions rates. However, the particulate emissions rates were well within the allowable emissions rates for all test runs at all load conditions. Note that the performance of the system (boiler and venturi scrubber) was significantly better during the second series of tests when the automatic boiler controls were being used to control air levels even though the venturi scrubber was operating at a lower pressure drop (12 versus 22 in. w.c.).

The indicator selected for monitoring boiler operation is exhaust gas oxygen concentration. The selected indicator range for the boiler exhaust gas oxygen is greater than 12 and less than 16 percent O_2 (one-hour average). The indicator range was chosen based upon the 1-hr test run averages for the January 1999 test data. During these tests, the average oxygen concentration was maintained between 12 and 16 percent. The oxygen concentration is measured continuously. An excursion triggers an inspection, corrective action, and a reporting requirement. The selected range will promote maximum efficiency and provide a reasonable assurance that the boiler is operating normally.

The indicator range selected for monitoring venturi scrubber operation is a pressure differential of greater than 10 in. w.c. (one-hour average). An excursion triggers an inspection, corrective action, and a reporting requirement. The differential pressure is measured several times per minute. A one-minute average is calculated, and an hourly average is calculated from the one-minute averages. The selected indicator range was chosen by examining the January 1999 test data. During these tests, the differential pressure was maintained between 10 and 15 in. w.c. The measured particulate emissions limit during these tests at all three boiler loads was approximately one third of the allowable emissions rate (large margin of compliance). Therefore, a differential pressure of greater than 10 in. w.c. was selected as the indicator range.

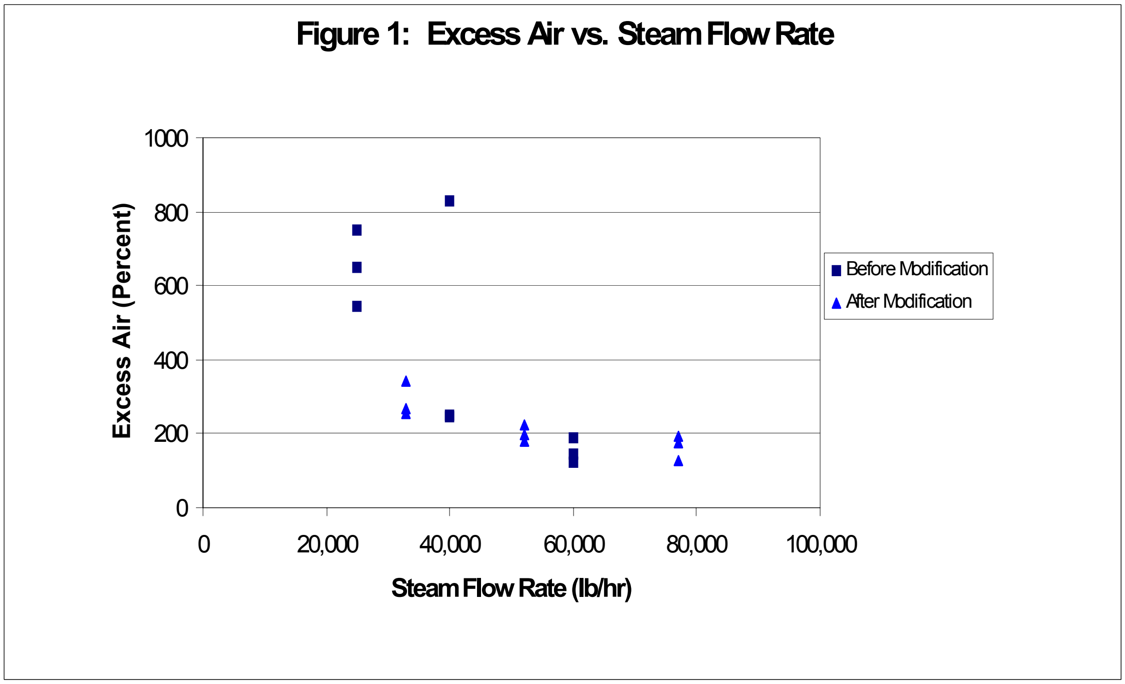
Figure 1: Excess Air vs. Steam Flow Rate
1000
800
600
400
200
0
Excess Air (Percent)
0
20,000
40,000
60,000
80,000
100,000
Steam Flow Rate (lb/hr)
Before Modification
After Modification

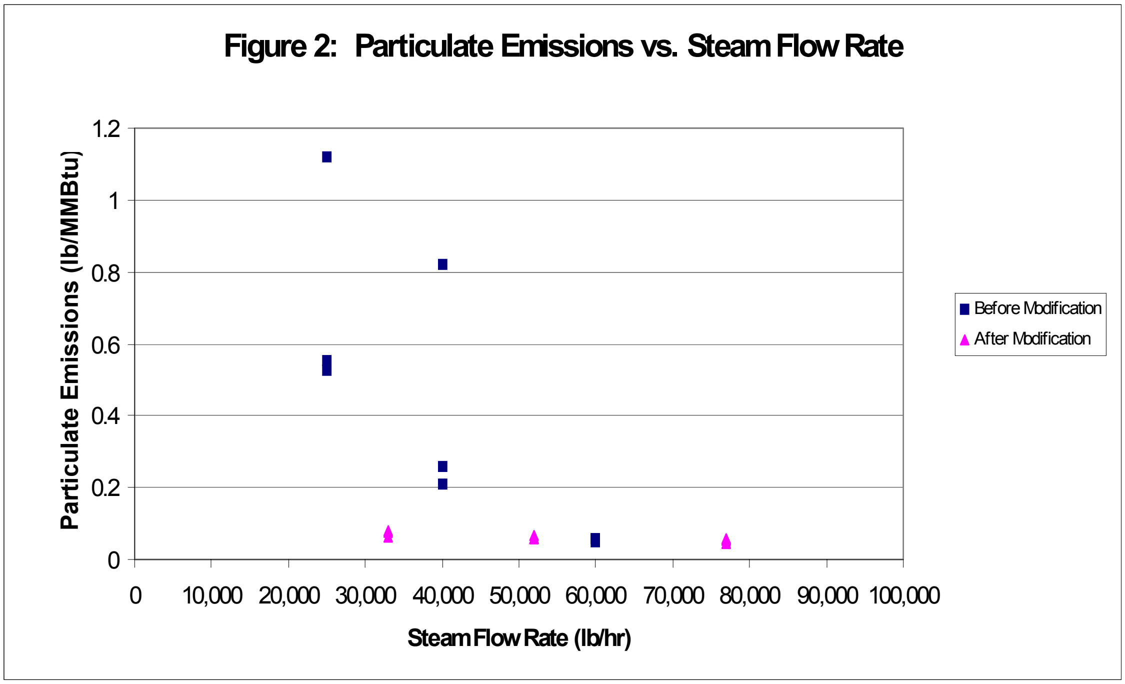
Figure 2: Particulate Emissions vs. Steam Flow Rate
1.2
1
0.8
0.6
0.4
0.2
0
Particulate Emissions (lb/MMBtu)
0
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
Steam Flow Rate (lb/hr)
Before Modification
After Modification

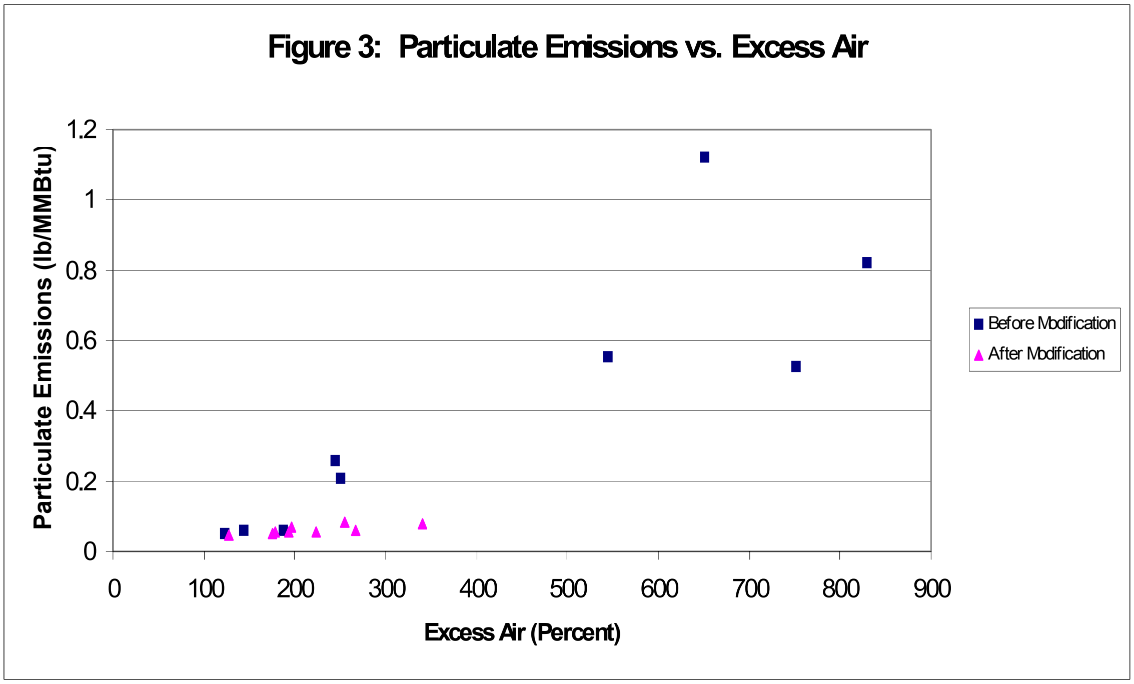
Figure 3: Particulate Emissions vs. Excess Air
Particulate Emissions (lb/MMBtu)
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
500
600
700
800
900
Excess Air (Percent)
Before Modification
After Modification

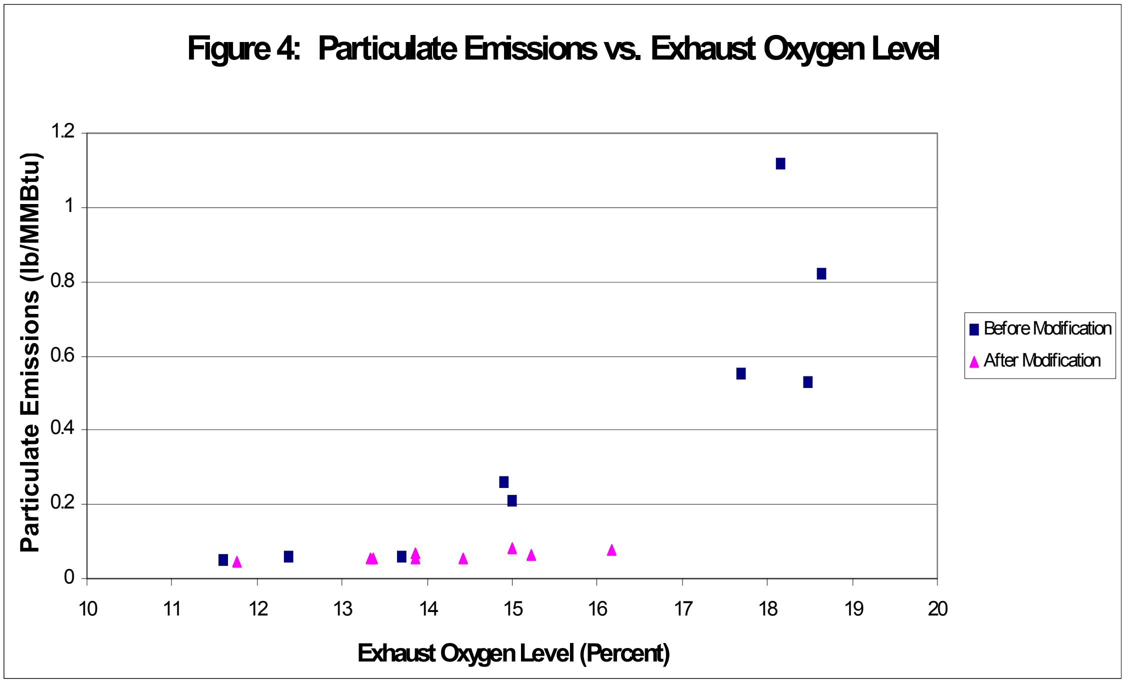
Figure 4: Particulate Emissions vs. Exhaust Oxygen Level
Particulate Emissions (lb/MMBtu)
1.2
1
0.8
0.6
0.4
0.2
0
10
11
12
13
14
15
16
17
18
19
20
Exhaust Oxygen Level (Percent)
Before Modification
After Modification

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.

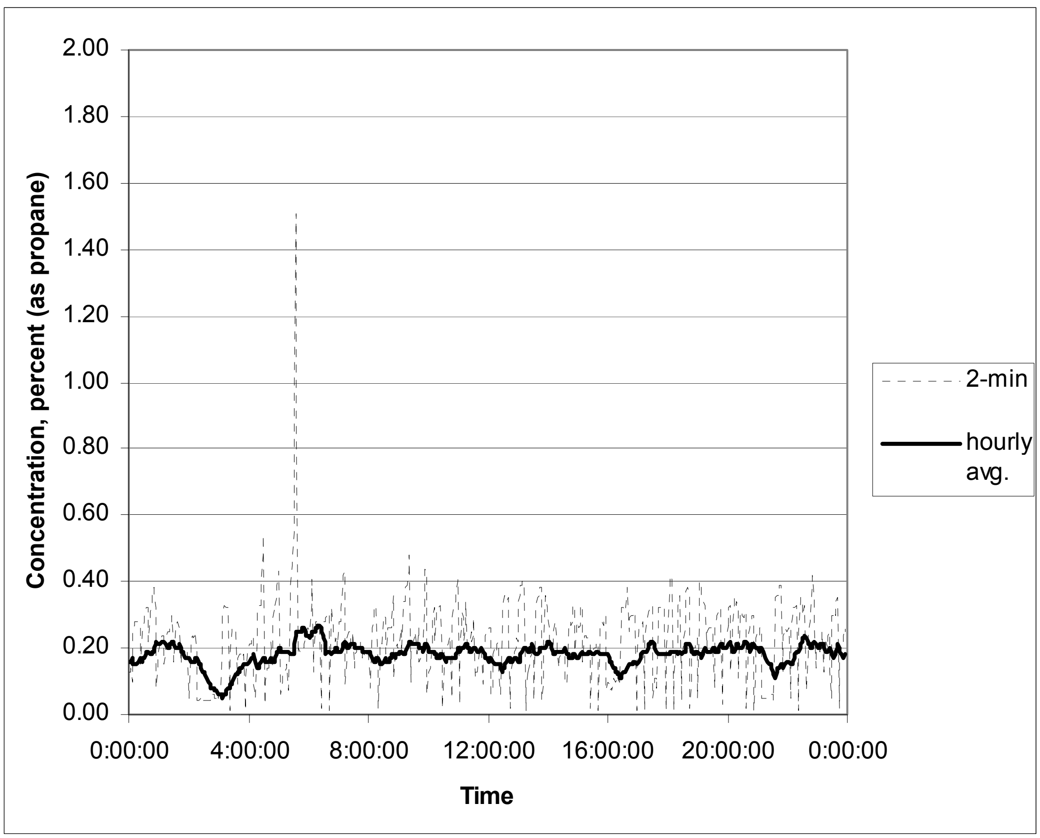

Figure A.18-1. A typical day's concentration data.

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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