A.25 ELECTROSTATIC PRECIPITATOR (ESP) FOR PM CONTROL--FACILITY FF

EXAMPLE COMPLIANCE ASSURANCE MONITORING
ELECTROSTATIC PRECIPITATOR (ESP) FOR PM CONTROL: FACILITY FF

I. Background

A. Emissions Unit

Description:	Coal-fired boilers
Identification:	B001, B002, B003
APCD ID:	ESP1, ESP2, ESP3
Facility:	Facility FF Anytown, USA

B. Applicable Regulation, Emissions Limit, and Monitoring Requirements

Regulation:	Permit, State regulation
Emissions Limits: PM:	 0.137 lb/mmBtu
Current monitoring requirements:	 None.

C. Control Technology: Electrostatic precipitator.

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.25-1. Secondary voltage and current are monitored in each field and the total power input to each ESP is determined.

TABLE A.25-1. MONITORING APPROACH

I. Indicator	ESP secondary voltage and current are measured for each field to determine the total power to each ESP.
Measurement Approach	The secondary voltage is measured using a voltmeter and the secondary current is measured using an ammeter. The total power (P) input to the ESP is the sum of the products of the secondary voltage (V) and current (I) in each field. ($P = V_1I_1 + V_2I_2$)
II. Indicator Range	An excursion is defined as a total power input less than 15 kW. Excursions trigger an inspection, corrective action, and a reporting requirement.
III. Performance Criteria A. Data Representativeness	The voltage and current are measured using the instrumentation the manufacturer provided with the ESP.
B. Verification of Operational Status	NA
C. QA/QC Practices and Criteria	Confirm the meters read zero when the unit is not operating.
D. Monitoring Frequency	The secondary voltage and current are measured once each hour and used to calculate the total power input once each hour.
Data Collection Procedures	The 3-hr average total power input is calculated and recorded.
Averaging period	3-hr.

MONITORING APPROACH JUSTIFICATION

I. Background

There are three 2-field ESP's controlling three coal-fired boilers (the emissions from each boiler are controlled by one ESP). The pollutant-specific emission unit is each ESP used to control PM emissions from a boiler. Boiler Nos. 1 and 3 are rated at 120,000 pounds of steam per hour and Boiler No. 2 is rated at 50,000 pounds of steam per hour. The three boilers are not subject to any New Source Performance Standards (NSPS). Boiler No. 1 typically operates from December through February, Boiler No. 2 typically operates from March through November, and Boiler No. 3 typically operates from December through March. The boilers normally are not operated at full capacity, but all emissions tests have been performed at or near full load. These units are not "large" CAM sources (their post-control PM emissions are less than 100 tons per year) so continuous monitoring is not required.

II. Rationale for Selection of Performance Indicators

In an ESP, electric fields are established by applying a direct-current voltage across a pair of electrodes, a discharge electrode and a collection electrode. Particulate matter suspended in the gas stream is electrically charged by passing through the electric field around each discharge electrode (the negatively charged electrode). The negatively charged particles then migrate toward the positively charged collection electrodes. The particulate matter is separated from the gas stream by retention on the collection electrode. Particulate is removed from the collection plates by shaking or rapping the plates.

As a general rule, ESP performance improves as total power input increases. This relationship is true when particulate matter and gas stream properties (such as PM concentration, size distribution, resistivity, and gas flow rate) remain stable and all equipment components (such as rappers, plates, wires, hoppers, and transformer-rectifiers) operate satisfactorily. In an ESP with many fields, the power distribution also plays a key role in the performance of the ESP. In this case, however, measurement of total power input is acceptable because the ESP has only two fields.

The secondary voltage drops when a malfunction, such as grounded electrodes, occurs in the ESP. When the secondary voltage drops, less particulate is charged and collected. Also, the secondary voltage can remain high but fail to perform its function if the collection plates are not cleaned, or rapped, appropriately. If the collection plates are not cleaned, the current drops. Thus, since the power is the product of the voltage and the current, monitoring the power input will provide a reasonable assurance that the ESP is functioning properly. In other words, problems that would be detected by monitoring other parameters individually also will be manifested in the power input.

III. Rationale for Selection of Indicator Ranges

The total power input to the ESP is the sum of the products of the secondary voltage and secondary current for each field. An excursion is defined as a 3-hr. average total power input less than 15 kW. 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 for the total power was selected based upon the level indicated from recent operation. The facility records parameter data once each hour. The normal operating voltage is set at the highest level achievable without having an excessive spark rate. Based on field experience, power levels less than 5 kW during normal operation result in opacity readings that approach 20 percent (typically the opacity of the ESP exhaust is less than 5 percent). During abnormal operation or malfunction, the ESP power levels are appreciably lower than normal operational levels. Table A.25-2 shows that during normal operating conditions, the total ESP power input for boiler No. 2 typically is between 18 and 22 kW. If one field in the ESP goes out of service, the total power input drops below 15 kW. [Note: Historically, the facility has monitored ESP operating parameters but has not recorded the data. Several days of historical data were recorded manually by the facility specifically to provide representative data to EPA for development of this CAM submittal; the facility provided a 1-hr reading for every other hour in its data set. The data shown in Table A.25-2 are instantaneous hourly readings and are not averages.]

The opacity normally is below 5 percent. The opacities were measured using a continuous opacity monitor installed in the boiler exhaust stack; however, the equipment does not meet the criteria in 40 CFR 60, Appendix B, Performance Specification 1. Therefore, it is not used for compliance monitoring. In addition, compliance with the boiler's 20 percent opacity limit would not necessarily indicate compliance with the PM limit, and continuous opacity monitoring is not required of this source.

TABLE A.25-2. BOILER NO. 2 NORMAL OPERATING CONDITIONS

Time	Total ESP Power (kW)	Boiler Load (lb/hr)	Opacity, percent
1:00 AM	21	46,000	1.9
3:00 AM	21	47,000	2.0
5:00 AM	18	50,000	1.9
7:00 AM	18	47,000	2.0
9:00 AM	21	46,000	1.9
11:00 AM	22	44,000	1.7
1:00 PM	21	44,000	1.7
3:00 PM	20	44,000	2.1
5:00 PM	21	46,000	1.9
7:00 PM	21	50,000	1.9
9:00 PM	21	47,000	2.0
11:00 PM	21	46,000	1.9

The PM emissions measured during the most recent performance tests are between 4 and 22 percent of the emissions limit (0.137 lb/mmBtu); each ESP has a large margin of compliance with the PM limit. Table A.25-3 presents data from the past six performance tests.

Because no monitoring data are available for Boilers No. 1 and 3, the current indicator ranges for Boilers No. 1 and 3 have been selected based on monitoring data for a similar source (Boiler No. 2). After data on power have been collected for six months, the indicator range for Boilers No. 1 and 3 will be reevaluated based on the monitoring data for each individual boiler.

Comment: In this example, we set the indicator range based on the performance test data and the historical monitoring data. Each of the units is operating at less than approximately 20 percent of the emission limit and therefore has a large margin of compliance. Because the units have this large margin of compliance, we set the indicator range using the historical monitoring data as well. An alternative to this approach is to base the indicator range solely on the performance test; for example, set the range based on 90 percent of the 3-hr average from the performance test. This would also be correct, although somewhat more stringent.

Comment: Total secondary power would not be an adequate indicator for a large multi-field ESP. Monitoring for an ESP with many fields becomes more complicated because emissions are highly dependent on how each field is performing. With multiple fields, monitoring should be based on the secondary power parameter for each separate field. Total secondary power provides a reasonable assurance of compliance when the ESP has only a few fields (e.g., two fields) and when the emissions unit has a large margin of compliance.

TABLE A.25-3. PERFORMANCE TEST DATA

Boiler No.	Test Date	Average PM Emission Rate (lb/mmBtu)	Percent of Allowable PM Emissions Rate (%)	Average load (lb steam/hr)	Capacity (lb steam/hr)
1	1997	0.030	21.9	115,500	120,000
1	1991	0.013	9.5	114,500	120,000
2	1997	0.020	14.6	47,600	50,000
2	1994	0.017	12.4	51,800	50,000
2	1991	0.006	4.4	51,400	50,000
3	1994	0.015	10.9	120,900	120,000