

**EXAMPLE COMPLIANCE ASSURANCE MONITORING:  
VENTURI SCRUBBER FOR PM CONTROL**

I. Background

A. Emissions Unit

Description:	FCCU catalyst regenerator
Identification:	FCCU-CR
Facility:	Facility B
	Anytown, USA

B. Applicable Regulation, Emission Limits, and Monitoring Requirements

Regulation:	40 CFR 60 Subpart J
CAM Emission Limits:	Particulate matter: 1 lb/1,000 lb coke burned
Pre-CAM monitoring requirements:	Coke burn rate, air blower rate, number of venturis online (permit) [Note: Although Subpart J requires a COMS, this alternate monitoring approach was approved by the State permitting authority and is reflected in the facility's permit.]

C. Control Technology, Capture System, Bypass, PTE:

Controls:	Four parallel venturi scrubbers
Capture System:	Closed-duct system
Bypass:	Not possible, based on the unit design
PTE before controls:	12,250 TPY (Based on licensor's estimated removal efficiency of 98%)
PTE after controls:	245 TPY

II. Monitoring Approach

The key elements of the monitoring approach are presented in the attached table. Normal process operations will not produce conditions that adversely affect the scrubbers without affecting the liquid to gas ratio in the scrubbers and/or the scrubber exhaust temperature; therefore, coke burn rate is the only process parameter monitored.

III. Response to Excursion

Excursion of any of the indicator ranges will trigger an inspection of the scrubbers and regenerator. Corrective action will be made as soon as practicable.

### MONITORING APPROACH

	Indicator No. 1	Indicator No. 2	Indicator No. 3
I. Indicator	Liquid to gas ratio	Scrubber exhaust temperature	Coke burn rate
Measurement Approach	Water flow: magnetic flowmeter. Air rate: venturi flowmeter. L/G: calculated.	Temperature measured using a thermocouple.	Calculated using NSPS (§60.106) equation.
II. Indicator Range <sup>a</sup>	3-hour average liquid to gas ratio less than 8.	3-hour average scrubber exhaust temperature greater than 165°F.	3-hour average coke burn rate greater than 56,000 lb/hr.
III. Performance Criteria			
A. Data Representativeness <sup>b</sup>	The magnetic flow meter (minimum accuracy of ±1.0% of flow rate) is located in the water inlet line. The venturi flowmeter (minimum accuracy of ±0.75% of flow rate) is located in the gas inlet duct.	Thermocouple located at scrubber exhaust with a minimum accuracy of ±3°F.	Analyzers and monitors are located in the regenerator inlet and exhaust duct.
B. QA/QC Practices	Magnetic water flowmeter and venturi flowmeter – calibrated at least once every 6 months.	Thermocouple—calibrated at least once every 6 months.	Gas analyzers: per 60.13 and Appendix B of 40 CFR 60. Flowmeter, thermocouple, and pressure indicator – calibrated at least once every 6 months.
C. Monitoring Frequency	Water flow and air rate are measured continuously.	Temperature is measured continuously.	O <sub>2</sub> , CO, CO <sub>2</sub> , air rate, off gas temperature and pressure are measured continuously.
Data Collection Procedure	L/G is calculated and recorded each minute.	Temperature is recorded each minute.	A coke burn rate is calculated and recorded each minute.
Averaging Period	3-hour average.	3-hour average.	3-hour average.

<sup>a</sup>An excursion of any single indicator triggers an inspection, corrective action, and a reporting requirement.

<sup>b</sup>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 is particulate matter from the catalyst regenerator of a fluid catalytic cracking unit (FCCU). The catalyst regenerator is equipped with a wet gas scrubber. The catalyst regenerator exhaust gases pass through four parallel venturi scrubbers. These scrubbers are the primary control devices for particulate matter emissions. After passing through the scrubbers, the off gases pass through a separating vessel and a spray grid prior to being vented to the atmosphere. The emission unit is regulated under 40 CFR 60 Subpart J--NSPS for petroleum refineries. The monitoring approach is reflected as a specific permit condition in the air permit. Based on the pollutant specific emissions unit design, bypass of the control device is not possible.

### II. Rationale for Selection of Performance Indicators

The following parameters will be monitored:

- Liquid-to-gas (L/G) ratio;
- Scrubber exhaust temperature; and
- Coke burn rate.

The licensor of the wet scrubber provided a graph relating the number of operating scrubbers required to maintain the design liquid to gas ratio, to the FCCU regenerator air blower rate. The regenerator air rate and the number of venturis in operation are an indirect measure of liquid to gas ratio, which is an indicator of scrubber performance. The regenerator air rate and the number of venturis in operation are monitored to ensure that these limitations are met.

Although the air permit only requires monitoring of coke burn rate, air blower rate, and number of venturis online, L/G ratio and scrubber exhaust temperature were added to the monitoring approach in early 1997 as further indicators of control device performance. The L/G ratio is determined by measuring scrubber water flow rate and comparing it to the regenerator air blower rate. In addition, the scrubber temperature is monitored downstream of the spray grid. The scrubber exhaust gas temperature was selected because it is indicative of scrubber operation and adequate water flow. With the scrubber water off, the scrubber exhaust temperature would be noticeably higher.

The coke burn rate is an indication of the PM loading to the scrubber.

### III. Rationale for Selection of Indicator Ranges

As mentioned above, a graph relating the regenerator air blower rate to the number of venturis necessary to maintain the design L/G ratio, was provided by the licensor of the scrubber. This graph, presented in Figure A.2-1, shows that at regenerator air rates of less than 100 kscfm at least two scrubbers must be operating to maintain the design L/G ratio. At regenerator air rates of greater than or equal to 100 kscfm to less than 136 kscfm, at least three scrubbers must be operating. At air rates of greater than 136 kscfm all four scrubbers must be operating. The facility monitors the regenerator air rate and the number of venturis in operation to ensure that these limitations are met.

The indicator range for L/G ratio is based on results of a January 1996 performance test and historical data. Three 1-hr test runs were conducted and the average measured PM emissions were 0.78 lb PM/1,000 lb coke burned, which is below the 1 lb/1,000 lb PM emission limit. During the performance test, L/G ratio was measured and recorded continuously, concurrent with each of the 1-hour test runs. The average L/G ratio for the three 1-hour test runs was 7.1. Hourly L/G ratio data for a 3-month period (October through December 1996) following the performance test were reduced to three-hour averages and evaluated to determine whether the L/G ratio during normal operation was above the minimum level selected based on the January 1996 performance test demonstrating compliance. During the 3-month period, the 3-hour average L/G ratio ranged from 8.5 to 14.9, and averaged 11.4, showing consistent operation at a L/G ratio above the level where compliance was demonstrated. The indicator range selected is a minimum L/G ratio of 8.

The maximum scrubber outlet temperature was selected based on data obtained during a performance test

conducted at the facility and historical data. The scrubber exhaust gas temperatures during the test averaged 144°F. Hourly scrubber outlet temperature data over a 3-month period (October through December 1996) were reduced to 3-hour averages. Scrubber outlet temperatures during this 3-month period generally ranged from 132° to 150°F, and averaged 137.5°F.

The selected indicator range for scrubber outlet temperature is less than 165°F. This range was selected by adding a 15 percent buffer to the average temperature demonstrated during the performance test (144°F) to account for variability among the data; the 3-months of monitoring data indicate that this temperature operating range can be achieved consistently. No lower action level is necessary.

To date, compliance has been demonstrated at a coke burn rate of 55.5 thousand (M) lb/hr. The performance test data obtained in January of 1996 indicate that while operating at a coke burn rate of 55.5 Mlb/hr (average of three 1-hour runs) the emissions unit was in compliance with the PM emission limit. The indicator range is established as less than 56 Mlb/hr. If operation at a higher coke burn rate is planned, additional testing will be conducted to demonstrate compliance with all emission limitations at the higher burn rate.

When an excursion of any of the indicator ranges 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.