

Source Test Procedure **ST-19A**
SULFUR DIOXIDE, CONTINUOUS SAMPLING

(Adopted January 20, 1982)

REF: Regulations 9-1-302, 9-1-304 through 310, 10-1-301

1. APPLICABILITY

- 1.1 This method is used to quantify emissions of sulfur dioxide (SO₂). It determines compliance with Regulations 9-1-302, 9-1-304 through 310, and 10-1-301.
- 1.2 The EPA has granted alternate status to EPA Method 6 for this method. It determines compliance with sulfur dioxide emissions covered under Regulation 7 (New Source Performance Standards).

2. PRINCIPLE

- 2.1 A continuous representative gas sample is extracted from the sampling point and conditioned to remove water and particulate material. The sulfur dioxide concentration is determined by passing small portion of the sample through an ultraviolet analyzer.

3. RANGE AND SENSITIVITY

- 3.1 The minimum and maximum measurable concentrations of SO₂ depend on the sample cell length in the analyzer.
- 3.2 The minimum sensitivity of the UV analyzer shall be $\pm 2\%$ of full scale.

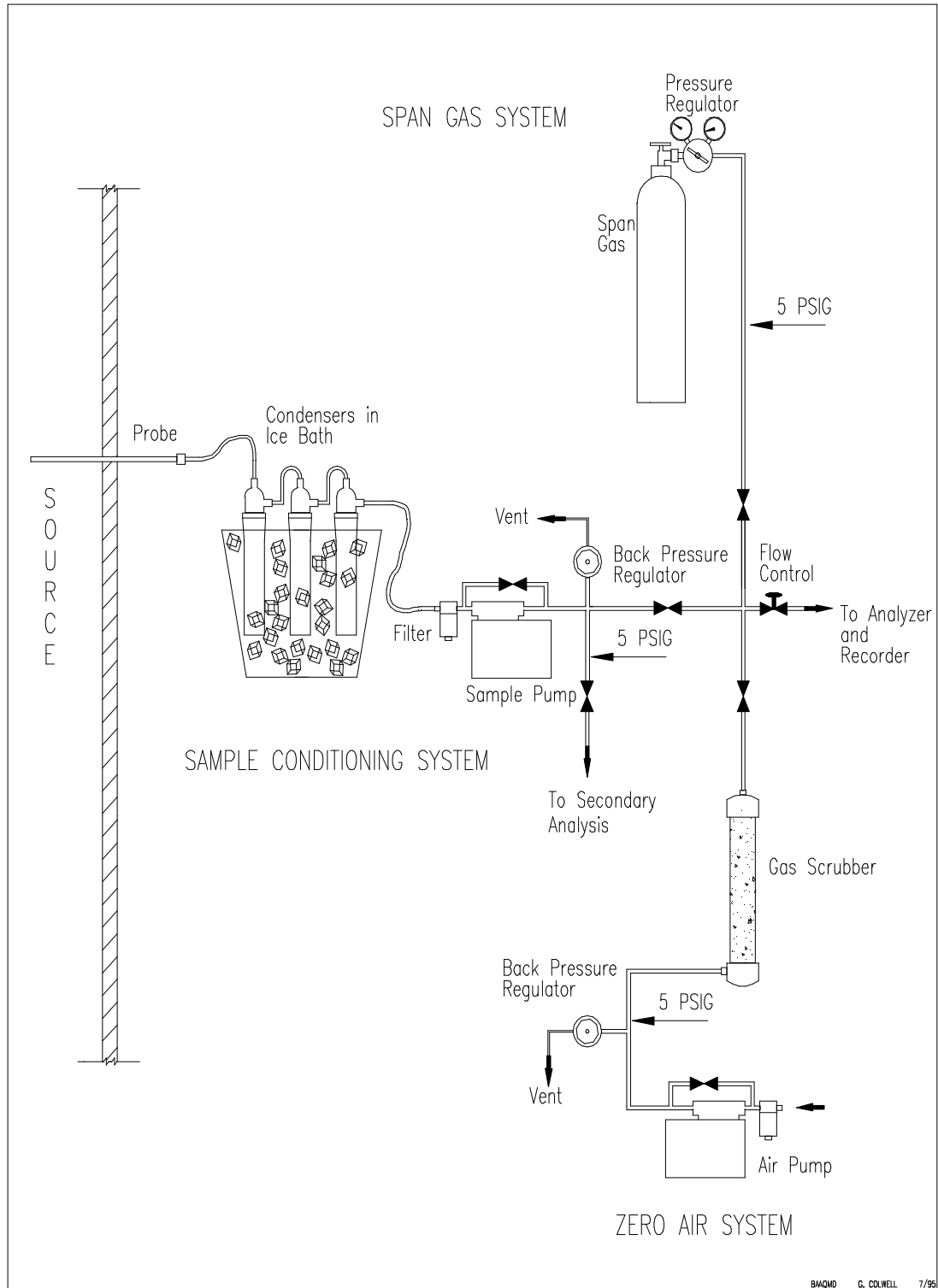
4. INTERFERENCES

- 4.1 Elemental sulfur, sulfur trioxide, and carbon disulfide will cause interferences.

5. APPARATUS

- 5.1 Sulfur Dioxide Analyzer. Use an E.I. DuPont de Nemours and Co. Model 400 photometric analyzer or its equivalent.
- 5.2 Chart Recorder. The recorder monitors and records the continuous output from the analyzer.
- 5.3 Sample conditioning, zero air, and span gas system. The assembly of this system is shown in Figure 19A-1. The sample conditioning system provides a dry, particulate free gas flow to the instrument. The zero air system provides clean dry atmospheric air for instrument calibration. The span gas system provides a known concentration of SO₂ for use in calibrating the analyzer. Except as specified, all materials which come in contact with either the sample or span gases must be constructed of Teflon or stainless steel.
- 5.4 Sample Probe. Use a borosilicate glass tube of sufficient length to traverse the stack being tested. If the stack temperature exceeds 425 °C (800 °F), use a quartz probe. Other probes are acceptable subject to approval by the Source Test Section.

Figure 19A-1
Sample Conditioning, Zero-Air, and Span-Gas Systems



- 5.5 Condensers. Use modified Greenberg-Smith impingers with the impaction plates removed and the inlet tube shortened to a length of 10 cm (4 inches), or equivalent.
- 5.6 Cooling System. Immerse the impingers in an ice bath during the test.
- 5.7 Particulate Filter. Use a Balston type 95 holder with a grade B filter, or equivalent, in the sample system.
- 5.8 Pumps. Use leak-free, Teflon-lined, diaphragm pumps in the sample and zero air system. The pumps must have a capacity of at least 28 liters/min (1.0 CFM).
- 5.9 Back-pressure Regulator. Use a back-pressure regulator to maintain the sample and zero gas sample pressures to the instrument at five psig.
- 5.10 Gas Scrubber. Use a bed of silica gel, Ascarite (or soda-lime), and charcoal to remove moisture, carbon dioxide, and hydrocarbons from the zero air system.
- 5.11 Span Gas. Use a high-pressure cylinder containing a known concentration of SO₂ in nitrogen. The span gas concentration must be in the same range as the source being tested.

6. PRE-TEST PROCEDURES

- 6.1 Warm-up the instrument according to manufacturer's instructions.
- 6.2 Assemble the sampling system as shown in Figure 19A-1.
- 6.3 Leak-test the sampling system by starting the pump, plugging the probe, and determining that the pressure to the analyzer falls to zero.
- 6.4 Introduce zero air, into the analyzer and zero the instrument according to manufacturer's instructions.
- 6.5 Introduce span gas into the analyzer and calibrate the instrument according to manufacturer's instructions.
- 6.6 Conduct a preliminary concentration traverse according to ST-18 to determine if stratification of the stack gases exists. If the SO₂ concentration at any point differs from the average concentration by more than 10%, traverse the stack during the test. If not, sample at any single point.
- 6.7 Set-up the chart recorder according to manufacturer's recommendations.

7. SAMPLING

- 7.1 Each test run shall be of thirty minute duration when testing from continuous operations. Each test run at batch process operations shall be for 90 % of the batch time or thirty minutes, whichever is less.
- 7.2 Introduce sample gas into the analyzer at the same flow rate used to calibrate the analyzer.
- 7.3 Maintain ice in the cooling system throughout the test.
- 7.4 Calibrate the analyzer before and after each test run. Record each step of the process clearly on the chart recording.
- 7.5 Conduct three test runs.

8. AUXILIARY TESTS

- 8.1 Stack Flow Rate. Use ST-17 to determine the stack gas flow rate after each test run.
- 8.2 Moisture Content. Use ST-23 to determine the moisture content of the stack gases.
- 8.3 Production Rate. Determine the sulfuric acid or sulfur production from plant data based on a 24 hour, daily production rate in tons per day, if the test is being conducted on a sulfur recovery unit or a sulfuric acid plant.
- 8.4 Oxygen Concentration. Use ST-14 to determine oxygen concentration of the stack gas.

9. CALCULATIONS

- 9.1 From the chart recording determine the time-averaged concentration of SO₂ on a dry basis for each run.

- 9.2 Mass emission rate of SO₂:

$$M_{SO_2} = KC_{SO_2}Q_o$$

Where:

M_{SO_2} = Mass emission rate of SO₂ Kg/hr (lb/hr)

C_{SO_2} = Concentration of SO₂, dry basis, ppm

Q_o = Stack gas flow rate, $\frac{SDM^3}{\min} \left(\frac{SDFt^3}{\min} \right)$

K = $(9.93 \times 10^{-6}) \frac{Lb}{(ppm)Ft^3} Hr.$ for English units

= $(1.59 \times 10^{-4}) \frac{Kg}{(ppm)M^3} hr$ for metric units

- 9.3 Mass emissions based on production rate:

$$M_{tp} = \frac{M_{SO_2}}{M_d}$$

Where:

M_{tp} = Mass emissions per ton of product, $\frac{Kg}{MetricTon} \left(\frac{lbs}{ShortTon} \right)$

M_{SO_2} = Mass emission rate of SO₂, $\frac{Kg}{hr} \left(\frac{lbs}{hr} \right)$

M_d = Production rate per hour. (Based on up to 48 hour average)

- 9.4 Oxygen Correction Factor:

$$F = \frac{21.95 - X_{O_2}}{21.95 \times P_{O_2}}$$

Where:

F = Oxygen Correction Factor

- X_{O_2} = Oxygen concentration to be corrected to; 0% for Sulfur Recovery Plants and 12% for Sulfuric Acid Plants.
- P_{O_2} = Oxygen content present in stack gas.

9.5 SO_2 concentration corrected for oxygen content:

$$C_{SO_2}F = F \times C_{SO_2}$$

Where:

$C_{SO_2}F = F \times C_{SO_2}$ = SO_2 concentration corrected for oxygen content.

10. REPORTING

10.1 The results of each test is reported as shown in Figure 19A-2.

Figure 19A-2

Report No.: _____ Test Date: _____	BAY AREA AIR QUALITY MANAGEMENT DISTRICT Summary of Source Test Results	Test Times: Run A: _____ Run B: _____ Run C: _____
Source Information		Test Representatives
Firm Name and Address	Firm Representative and Title Phone No. ()	
Permit Conditions:	Source: Plant No. Permit No. Operates Hr/Day & Day/Yr.	Operating Parameters
Applicable Regulations:		

Source Test Results and Comments:

<u>METHOD</u>	<u>TEST</u>	<u>RUN A</u>	<u>RUN B</u>	<u>RUN C</u>	<u>AVERAGE</u>	<u>LIMIT</u>
	Run time, minutes					
	Stack gas temperature, F°					
ST-17	Stack flowrate, SDCFM					
ST-14	Oxygen concentration, percent					
ST-5	Carbon Dioxide concentration, percent					
ST-6	Carbon Monoxide concentration, ppm					
ST-23	Water content, percent					
ST-19A	Sulfur Dioxide, ppm					
	Sulfur Dioxide, lb/hr					
	Sulfur Dioxide, lb/ton product					

Test Team Leader	Date	Reviewed by	Date	Approved By	Date
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