Source Test Procedure **ST-2**

BERYLLIUM

(Adopted January 20, 1982)

REF: Regulation 11-3-301

1. APPLICABILITY

1.1 This procedure is used to quantify emissions of Beryllium. It determines compliance with Regulation 11-3-301.

2. PRINCIPLE

2.1 Particulate matter (including Beryllium) is withdrawn isokinetically from the stack gas stream and collected on filters in the stack. The weight of the Beryllium collected is measured by atomic absorption spectrophotometry according to Analytical Procedure Lab-2.

3. RANGE

3.1 The minimum measurable emission of Beryllium is .001 gr/SDCF.

4. INTERFERENCES

None Known

5. APPARATUS

5.1 Probe Nozzle. The sampling train and its components are shown in Figure 2-1. The probe nozzle shall be constructed of borosilicate glass, quartz, or stainless steel.

5.2 Filter Medium. Use Millipore Type "A" glass fiber disc type or equivalent.

5.3 Connections. The connection between the filters and the first impinger must be able to withstand stack temperatures. Vinyl tubing is acceptable in making all other connections.

5.4 Pitot Tube. Use a Stauscheibe (Type-S), or equivalent, with a known coefficient which is constant within ± 5% over the entire working range. The pitot tube coefficient is determined by placing both the S-type and the standard pitot tube in a gas stream and measuring the pressure head with both over the entire velocity range of interest. Calculate the coefficient of the Type-S pitot tube as follows:

$$Cp_s = Cp_{std}\left[\frac{\Delta P_{std}}{\Delta P_s}\right]^{\frac{1}{2}}$$

where:

Cp_S = Type-S pitot tube coefficient

ΔP_S = Pressure head, Type-S pitot tube

ΔP_{std} = Pressure head, standard pitot tube
Cp_{std} = Standard pitot tube coefficient

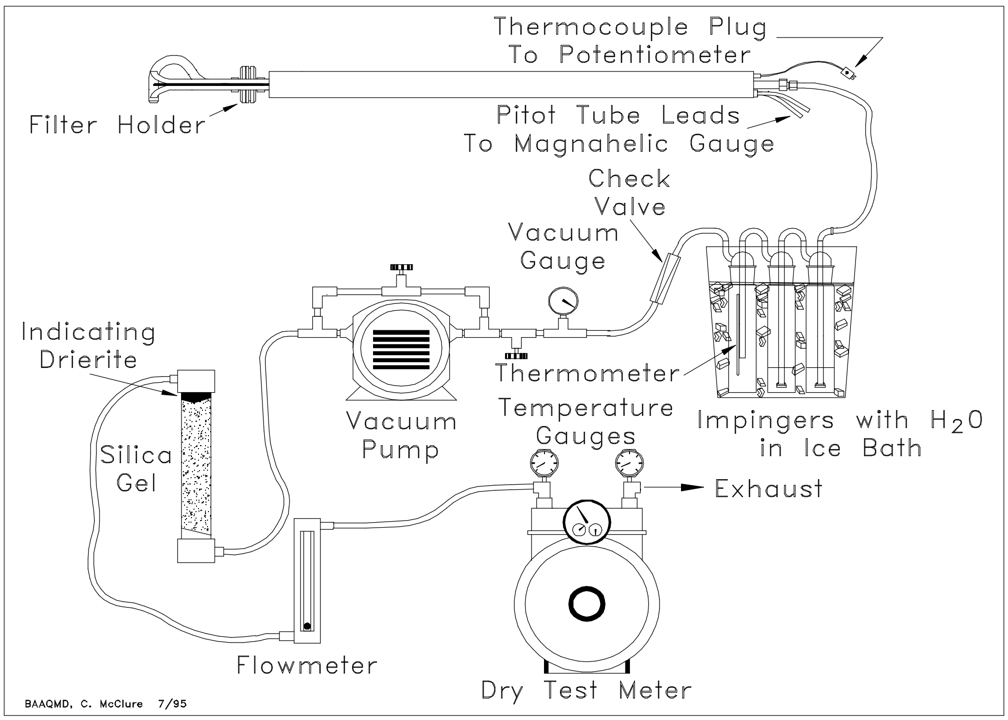
5.5 Temperature Measuring Device. Use a Chromel-Alumel thermocouple accurate to ± 15^{O}F, connected to a temperature compensated null type potentiometer, or equivalent, to measure stack temperatures.

5.6 Condensers. Use three Greenberg-Smith impingers. The third impinger shall be modified by removing the impaction plate and attaching a thermometer to the inlet stem.

5.7 Cooling System. Use an ice bath to contain the impingers.

Figure 2-1

Beryllium Sampling Train



5.8 Sample Pump. Use a leak-free vacuum pump capable of maintaining a 1.0 CFM flow rate at 15 inches of mercury. The pump must have a sample rate control valve and a vacuum gauge attached to the inlet.

5.9 Silica Gel Tube. Use approximately 500 cc of silica gel, followed by a Drierite indicator, to insure that the gas entering the dry test meter is free of H_2O.

5.10 Dry Test Meter. Use a 175 CFH dry test meter accurate within ± 2% of the true volume and equipped with a thermometer to measure the outlet temperature. The working pressure across the meter shall not exceed a one inch water column.

5.11 Rotameter. Use a calibrated rotameter to measure the sampling rate.

5.12 Pressure Gauge. Use a Magnehelic differential pressure gauge, or equivalent, in the same range as the velocity and static pressures being measured in the stack.

5.13 Analytical Balance. An analytical balance capable of measuring condensate weights to the nearest 0.1 gram is acceptable.

5.14 Barometer. Use a barometer that is accurate to within ± 0.2 inches of mercury.

6. PRE-TEST PROCEDURES

6.1 Impinger Preparation. Fill each of two unmodified Greenberg-Smith impingers with approximately 100ml of distilled water. Weigh and record the weights on the data sheet as shown in Form 2-1.

6.2 Nozzle Size Determination. (Same as Section 6.3.4 in ST-15)

6.3 Assemble the sampling train as shown in Figure 2-1.

6.4 The entire sampling train must be leak-checked before each test run. Plug the sampling probe, start the pump, and adjust the pump vacuum to 380 mm Hg (15" Hg). A leak rate through the meter which exceeds 0.57 lpm (0.02 CFM) is unacceptable.

7. SAMPLING

7.1 Each test run shall be of 50 minute duration when testing emissions from continuous operations. Each test run at batch process operations shall be for 90% of the batch time or 50 minutes, whichever is less.

7.2 When inserting the probe into the stack rotate the nozzle so it points down stream to avoid a particulate collection prior to sampling. Immediately before sampling rotate the probe so that nozzle points upstream.

7.3 Sample at the traverse points determined in acc ordance with ST-18.

7.4 Record the following information at five-minute intervals or whenever changing sampling locations on a field data sheet as shown in Form 2-2.

Stack velocity head
Sample time
Isokinetic sample rate
Cumulative sample volume
Impinger saturation temperature
Stack gas temperature
Impinger vacuum
Dry test meter temperature

7.6 Add ice as necessary to maintain impinger temperatures at 7 ^{o}C (45^{o}F) or less.

7.7 At the conclusion of each run, stop the pump, remove t he probe from the stack and record the final meter reading. Point the probe upward and purge the sample train with ambient air.

7.8 Conduct three consecutive test runs.

8. POST-TEST PROCEDURES

8.1 Analyze the filters and any material in the nozzle for Beryllium according to Analytical Procedure Lab 2.

9. AUXILIARY TESTS

9.1 Determine the CO_2, O_2 and CO concentrations simultaneously with each particulate run in accordance with ST-5, ST-14 and ST-6.

10. CALCULATIONS

10.1 Standard Dry Sample Volume:

$$V_o = \frac{17.71 V_m P_b}{T_m}$$

Where:

V_o = Standard dry sample volume, SDCF at 70 ^oF and 29.92 inches Hg

V_m = Actual metered volume, ft^3

P_b = Barometric pressure, inches Hg

T_m = Average meter temperature ^oR

17.71 = Constant correcting to 70 ^oF and 29.92 inches H_2O

10.2 Water Vapor Content

$$H_2O = \frac{(0.0474 W_c) + \frac{V_o P_{sat}}{P_b - P_i - P_{sat}}}{V_o + (0.0474 W_c) + \frac{V_o P_{sat}}{P_b - P_i - P_{sat}}} \times 100$$

Where:

W_c = Total condensate weight, all impingers, grams

P_{sat} = Water saturation pressure, inches Hg

P_b = Barometric pressure, inches Hg

P_i = Pump inlet vacuum, inches Hg

H_2O = Percent water vapor

0.0474 = Cubic feet of vapor resulting from 1 cubic centimeter of liquid H_2O

10.3 Stack Gas Molecular Weight

$$MW = 0.44\ (\%CO_2) + 0.32\ (\%O_2) + 0.28\ (\%N_2 + \%CO) + 0.18\ (\%H_2O)$$

Where:

MW = Molecular Weight

$\%CO_2$ = Percent Carbon Dioxide by volume(dry basis)

$\%O_2$ = Percent Oxygen by volume (dry basis)

%CO = Percent Carbon Monoxide by volume (dry basis)

$\%H_2O$ = Percent Moisture by volume

$\%N_2$ = Percent Nitrogen by volume (dry basis - determine by difference)

10.4 Stack Gas Flow Rate - Determine in accordance with ST-17.

10.5 Isokinetic Ratio. Calculate for each traverse point as:

$$R_i = \frac{T_{si}\ Q_{mi}}{60(100 - H_2O) A V_{si} t_i T_{mi}} \times 100\%$$

Where:

R_i = Isokinetic ratio at given point
t_i = Time, at point i, minutes
A = Nozzle area, ft^2
V_{si} = Stack velocity, point i, FPS
T_{mi} = Meter temperature, point i, ^oR
T_{si} = Stack temperature, point i, ^oR
Q_{mi} = Metered volume, point i
60 = Minutes/hr.

Overall isokinetic ratio for each run:

$$R = \frac{Q_{mi}}{60(100 - H_2O) A T_m V_{si} t_i T_{si}} \times 100\%$$

10.6 Mass emissions. the emission rate of Beryllium shall be calculated as:

$$M = \frac{W \times Q_o \times 60 \times T}{Vo}$$

Where:

M = Mass emission rate, g/day
W = Total weight of Be in filter and nozzle, grams (g)
Q_o = Stack gas flowrate, SDCFM
V = Sample Volume, SDCF
T^o = Plant operation, hr/day
60 = minutes/hour

11. REPORTING

11.1 The data and information indicated in Form 2-3 shall be reported.

Bay Area Air Quality Management District

Form 2-1

Source Test Laboratory Data Sheet

Impinger Weightings

Plant Name:	______________	Plant Number:	______
Source Operation:	______________	Test Date	______
Source Test #:	______________	Page:	1 of
Impinger Solution:	______________	Initial:	______

Impinger I. D. #	(A) Tare Weight (g)	(B) Filled Weight (g)	(C) Final Weight (g)

Impinger I. D. #	(C-A) Sample Weight (g)	(C-B) Condensate Wt. (g)	Condensate Weight / Run (g)
			Run A
			Run B
			Run C
			Run D

Bay Area Air Quality Management District

939 Ellis Street, San Francisco, CA 94109

Form 2-2

Source Test Data Sheet

Plant # ____________ Nozzle Diameter ____________

Source I.D. ____________ Pitot Tube I.D., Cp ____________

Sample Type ____________ Gas System ____________

Process Cycle ____________ Pbar, Barometer ____________

Duct Size ____________ Leak Test Rate ____________

Duct Shape ____________ Run # ____________ Date: ____________ Time @ Point ____________

Duct Pressure ____________ Temp Meter # ____________ Box ΔH@ ____________ # of Points ____________

Assumed %H_20 ____________ Mag. Gauge # ____________ Meter (Y) ____________ Time/Run (Min.) ____________

Sampling Train: Probe # ____________ Filter # ____________ Imp. # ____________ Imp. # ____________ Pump/Box # ____________

Initial Traverse Data					Sampling Data										
Trav. Point I.D.	Dist. from Wall	Duct Temp. ^{0}F	ΔP "H_20	Angle of Flow	Traverse Point I.D.	ΔP "H_20	Duct Temp. ^{0}F	Vs FPS	Time (minutes)	Meter Rate CFH	Meter Temp. ^{0}F	Meter Volume Ft^3	Train Vacuum "Hg	Sat'd Gas Temp. ^{0}F

Post Run Impinger Catch (ml) = ________ Source Test Team Comments: ____________

Assumed O_2 = ________

Assumed CO_2 = ________

Post Run Calculated %H_2O = ________

Form 2-3

Distribution: Firm Permit Services Enforcement Services Technical Services Planning Requester DAPCO	**BAY AREA** **AIR QUALITY MANAGEMENT DISTRICT** *939 Ellis Street* *San Francisco, California 94109* *(415) 771-6000* **Summary of** **Source Test Results**	**Report No.:** ________ **Test Date:** ________ **Test Times:** **Run A:** ________ **Run B:** ________ **Run C:** ________

Source Information		**BAAQMD Representatives**
Firm Name and Address	Firm Representative and Title Phone No. ( )	Source Test Engineers
Permit Conditions:	Source: Plant No. Permit No. Operates	Permit Services Division/Enforcement Division Test Requested By:
Operating Parameters:		
Applicable Regulations:		**VN Recommended:**

Source Test Results and Comments:

METHOD	TEST	RUN A	RUN B	RUN C	AVERAGE	LIMIT
ST-17	Stack Volume Flowrate, SDCFM					
	Stack Gas Temperature, ^{o}F					
ST-23	Water Content, Volume %					
ST-14	Oxygen, Volume %					
ST-5	Carbon Dioxide, Volume %					
ST-6	Carbon Monoxide, ppmv					
	Carbon Monoxide, lb/hr					
ST-2	Beryllium Emissions, gm/day					
	Isokinetic Ratio, act./theo.					

Air Quality Engineer II Date	Supervising Air Quality Engineer Date	Approved by Air Quality Engineering Manager