Source Test Procedure **ST-23**

WATER VAPOR

(Adopted January 20, 1982)

1. APPLICABILITY

1.1 This method is used to quantify the water vapor content of stack gases. It is applicable in all cases in which such data are needed by any other procedure in this manual.

2. PRINCIPLE

2.1 A gas sample is extracted from the stack at a constant rate. Moisture is removed from the gas through the use of cold condensers. The total condensate is weight determined gravimetrically. The residual water vapor is determined by calculation.

3. RANGE AND REPEATABILITY

3.1 The minimum measurable concentration of water vapor is 2% moisture by volume. The maximum measurable concentration is 100% water vapor.

3.2 The sensitivity of the procedure is ±1.0% water vapor.

4. INTERFERENCE

4.1 Compounds which will condense at 45 ^{o}F. The saturated gas temperature will cause a positive bias.

5. APPARATUS

5.1 Probe. The probe is constructed of either borosilicate glass or quartz and must be heated as necessary to avoid condensation in the probe. Other probe materials are acceptable when stack conditions allow.

5.2 Condensers. Use three Greenberg-Smith impingers as condensers. The third impinger has a thermometer attached to the inlet stem.

5.3 Cooling system. An ice bath is used to contain all the impingers.

5.4 Sample pump. Use a leak-free vacuum pump capable of maintaining a flow rate at 10 inches of Hg vacuum.

5.5 Dry test meter. Use a dry gas meter test meter accurate to within ±2% of the true volume and equipped with a thermometer to measure the outlet temperature.

5.6 Connections. All flexible tubing must be leak-free.

6. PRE-TEST PROCEDURES

6.1 Tare weights on each of the impingers are recorded to the nearest 0.1 gram on Form 23-1.

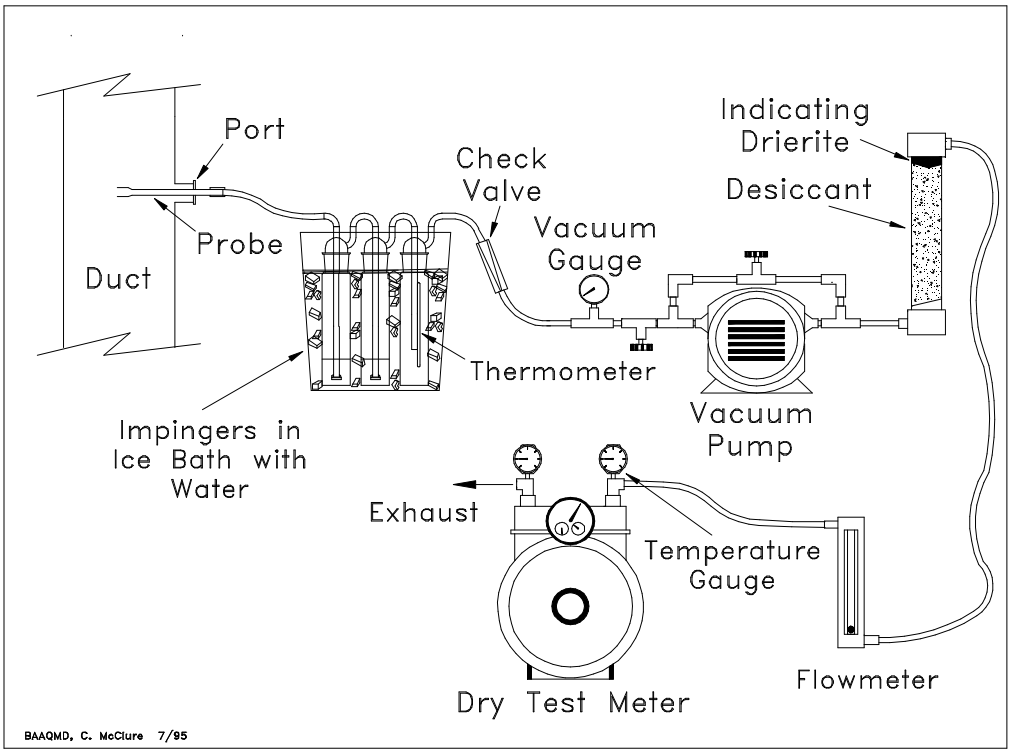
6.2 The sampling train is assembled as shown in Figure 23-1. Equipment identification is recorded on the test data sheet, Form 23-2.

6.3 It is recommended, but not required that the sampling train be leak-tested before sampling by turning on the pump, plugging the probe and adjusting the pump inlet vacuum to 15" Hg. The leak rate through the dry test meter shall not exceed 0.02 CFM.

6.4 Record the initial meter reading before sampling commences.

Figure 23-1

Water Vapor Sampling Train



7. SAMPLING

7.1 The pump is started and the flow rate adjusted to approximately 0.5 CFM. Maintain a steady sampling rate throughout the test period.

7.2 Sample for thirty minutes or until at least 20 ml of condensate have collected in the first impinger.

7.3 At five-minute intervals, record the following on Form 23-2:

Test meter temperature

Flow rate

Saturation temperature (from third impinger)
Pump inlet vacuum

7.4 Record the barometric pressure.

8. POST-TEST PROCEDURES

8.1 Clean, dry and weigh the impingers.

9. CALCULATIONS

9.1 Standard dry sample volume at 70 ^{o}F, 29.92 inches Hg:

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

Where:

17.71 = A constant correcting to 70 ^{o}F and 29.92 inches Hg
V_O = Standard sample volume, SDCF
P_b = Barometric pressure, inches of mercury
T_m = Average meter temperature, ^{o}R
V_m = Uncorrected meter volume, ft^3

9.2 Stack gas water vapor content:

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

Where:

W = Total condensate, grams
$\%H_2O$ = % water vapor
P_{sat} = Water saturation pressure, inches Hg determined from average saturation temperature
P_i = Pump inlet vacuum, inches Hg
0.0474 = A constant for correcting to standard conditions

10. REPORTING

10.1 These values are determined as auxiliary data for other procedures and shall be reported with those test results.

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Form 23-1

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

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Form 23-2

Source Test Data Sheet

Plant # _____ Source I.D. _____ Sample Type _____ Process Cycle _____ Duct Size _____ Duct Shape _____ Duct Pressure _____ Assumed %H_20 _____

Run # _____ Temp Meter # _____ Mag. Gauge # _____

Date: _____ Box ΔH@ _____ Meter (Y) _____

Nozzle Diameter _____ Pitot Tube I.D., Cp _____ Gas System _____ Pbar, Barometer _____ Leak Test Rate _____ Time @ Point _____ # of Points _____ 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. ^0F	ΔP "H_20	Angle of Flow	Traverse Point I.D.	ΔP "H_20	Duct Temp. ^0F	Vs FPS	Time (minutes)	Meter Rate CFH	Meter Temp. ^0F	Meter Volume Ft^3	Train Vacuum "Hg	Sat'd Gas Temp. ^0F

Post Run Impinger Catch (ml) = _____

Assumed O_2 = _____

Assumed CO_2 = _____

Post Run Calculated %H_2O = _____

Source Test Team _____

Comments: _____