

## Source Test Procedure **ST-3**

### **BULK PLANTS EMISSION FACTOR DETERMINATION**

(Adopted January 20, 1982)

**REF: Regulation 8-6-301, 8-39-301**

#### **1. APPLICABILITY**

- 1.1** This procedure is used to quantify the emission factor of non-methane organic carbon (NMOC) emitted during the transfer of organic liquid at bulk plants. This procedure shall apply to the transfer into, or out of, tanker trucks, cargo tanks, railcars, storage tanks, and transportable containers. It is applicable to the determination of compliance with Regulation 8-6-301 and 8-39-301.

#### **2. PRINCIPLE**

- 2.1** During transfer operations at a bulk plant, all possible emission points are checked for vapor leaks. The volume of organic liquid transferred is recorded and the mass of NMOC vapors emitted are quantified. The emission factor of the vapor recovery system is calculated from these parameters and is expressed in units of pounds of NMOC per 1,000 gallons of organic liquid transferred.
- 2.2** For bulk plants equipped with an adsorption or balance-type vapor recovery system (VRS), either a Non-Dispersive Infrared (NDIR) or Flame Ionization Detector (FID) hydrocarbon analyzer may be used to quantify the non-methane organic carbon (NMOC) concentrations. For adsorption vapor recovery systems, the adsorbent bed outlets shall be the only allowable emission points. For balance-type vapor recovery systems, the apparent path of least resistance of venting to the atmosphere shall be determined. This vent shall be the only allowable emission point during the test, with other vent(s) either sealed or manifolded to this vent.
- 2.3** For bulk plants utilizing an incinerator-type processing unit, a FID shall be used to quantify the hydrocarbon concentrations and the incinerator outlet shall be the only allowable emission point.
- 2.3.1** FID may be used for the measurement of Total Organic Carbon (TOC) provided that the product of the percentages of CO<sub>2</sub> and H<sub>2</sub>O vapor in the gas stream do not exceed 100. In this event, the applicable EPA Reference Method shall be used.
- 2.4** The methane content of the sample shall be determined by either (a) integrated sampling and GC/FID analysis using EPA Method 18 or BAAQMD Laboratory Method 17 or (b) directing a portion of the conditioned sample through a bed of activated carbon, for NMOC adsorption, prior to the hydrocarbon analyzer.

### 3. RANGE AND SENSITIVITY

- 3.1 The minimum and maximum measurable concentrations, as butane (C<sub>4</sub>), with the NDIR analyzer are 0.1% and 100%, respectively.
- 3.2 The minimum measurable concentrations, expressed as methane, with the FID analyzer is 5 ppmv. Maximum concentrations of 100% may be achieved with the use of a sample dilution system.
- 3.3 The minimum sensitivity of both the NDIR and FID shall not exceed two (2.0) percent of full scale.

### 4. INTERFERENCES

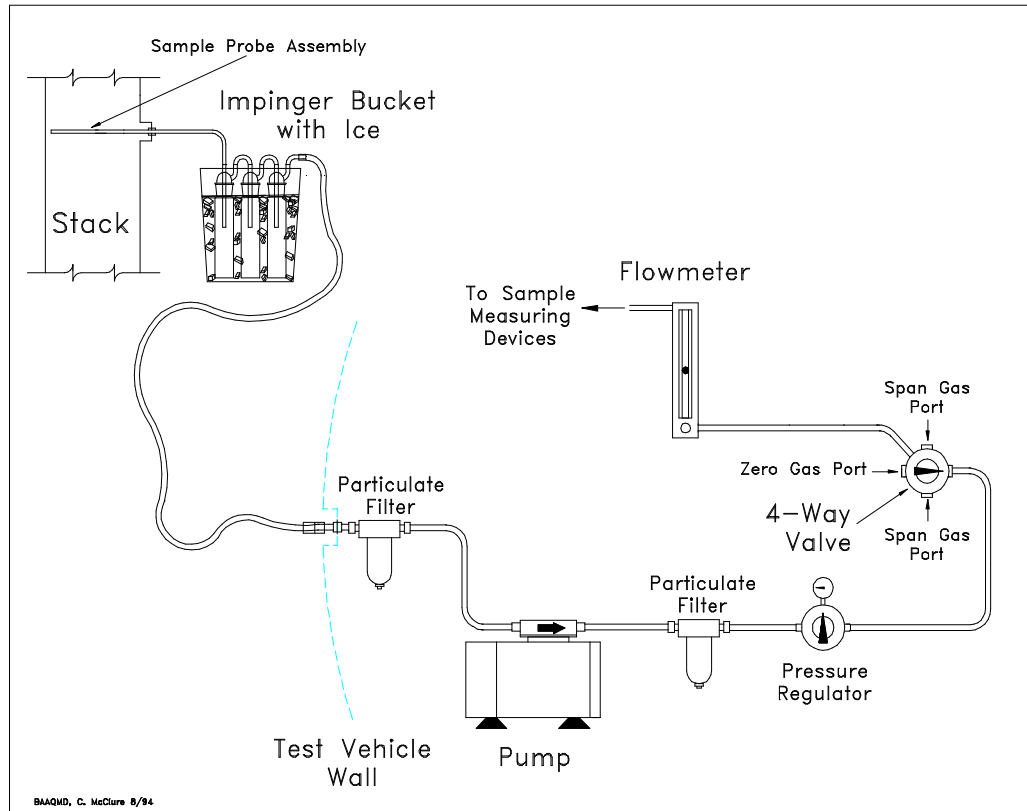
- 4.1 Fugitive Emissions. The presence of liquid or vapor leaks which exceed the definitions of liquid leak or vapor leak, in the appropriate regulation, shall be quantified and included in the determination of the emission factor.
- 4.2 FID NMOC Measurement. FID response factors vary between hydrocarbons. For single compound measurements a span gas containing a known concentration of the specific compound shall be used. For multiple compound samples propane (C<sub>3</sub>) shall be used as a span gas to minimize deviation from a one-to-one FID response factor.
- 4.3 FID Methane Measurement. Prior contamination of the activated carbon imposes a bias toward lower NMOC results. This bias shall be minimized by establishing a zero methane base-line response. Methane determination shall require the response time be sufficient to allow for the residence time of sample gas in the carbon adsorber.

### 5. APPARATUS

- 5.1 Combustible Gas Detector. Use a Bacharach Instrument Company Model 0023-7356, or equivalent, calibrated with methane.
- 5.2 Rotary Gas Meter. Use a Roots Meter Model 3M125, or equivalent, to measure the exhaust volume from the P/V relief valve on balance-type vapor recovery systems. The meter shall be equipped with a thermometer and pressure gauge on the inlet and a sample tap on the outlet. The maximum allowable pressure drop across the meter shall be 0.05 inches of water column (inches H<sub>2</sub>O) at a flowrate of 30 SCFH. The thermometer shall have a range of 0 - 150 °F and be accurate to within 2 °F. For incinerator-type processing units an appropriately sized gas meter shall be used to measure the inlet volume to the incinerator.
- 5.3 Bag Stock. Use appropriately sized bag stock, of at least two mil. thickness, to transfer any emissions from the P/V relief valve to the rotary gas meter, if applicable.

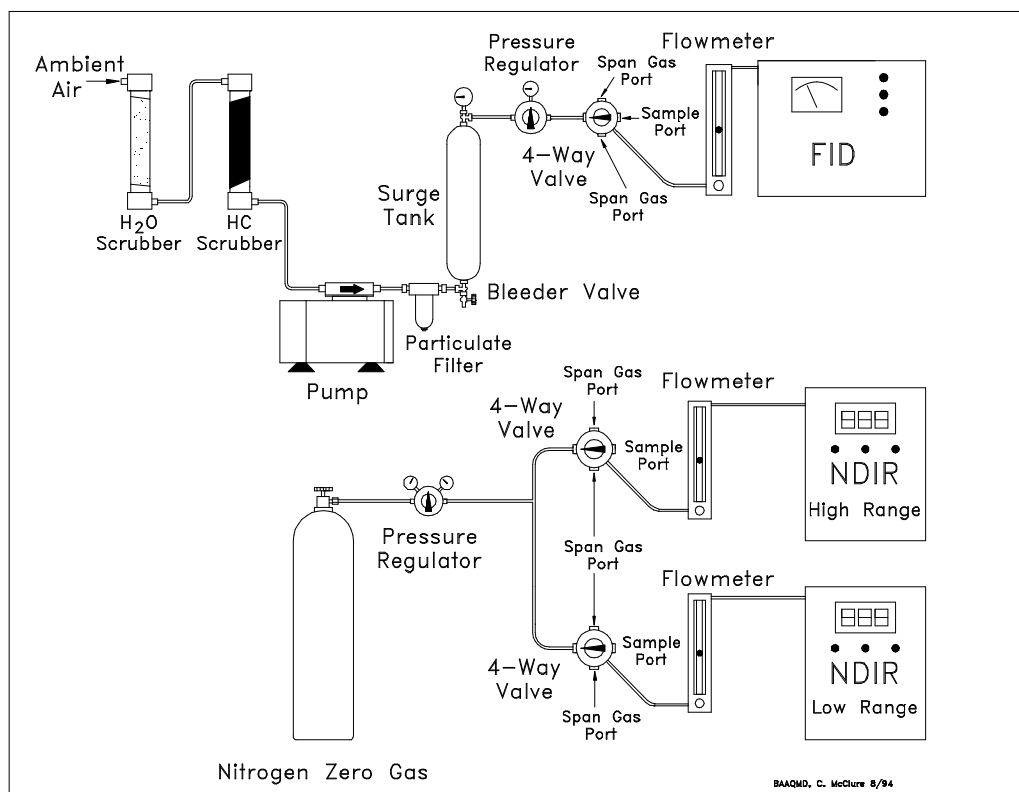
- 5.4** Flexible Tubing. Use 3 inch ID, flexhast tubing, or equivalent, to connect the bag stock to the rotary gas meter.
- 5.5** Non-Dispersive Infrared Hydrocarbon Analyzer. Use a Summit Analyzers Inc., model 703, or equivalent, to continuously measure the hydrocarbon concentration of the vapors emitted from the outlet of the non-incinerator vapor recovery unit.

**Figure 3-1**  
**Sample Conditioning System**



- 5.6** FID Hydrocarbon Analyzer. Use a FID which meets, or exceeds, the minimum specifications set forth in EPA Method 25 to continuously measure the NMOC concentration from the outlet of the vapor recovery unit. For incinerator-type processing units a second analyzer (an NDIR may be used) shall be used to continuously quantify the inlet concentration.
- 5.7** Carbon Dioxide Analyzer. Use a non-dispersive infrared gas analyzer (in accordance with Source Test Procedure ST-5) to continuously monitor the carbon dioxide concentration of the exhaust from the incinerator.
- 5.8** Carbon Monoxide Analyzer. Use a non-dispersive infrared gas analyzer (in accordance with Source Test Procedure ST-6) to continuously monitor the carbon monoxide concentration of the exhaust from the incinerator.

- 5.9** Strip chart Recorder. Use a strip chart recorder or data logger, compatible with the hydrocarbon analyzer, to continuously record the output from the analyzer.
- 5.10** Differential Pressure Device. Use a differential pressure measuring device to measure the pressure drop across the rotary gas meter. If a mechanical pressure gauge is used the incremental graduations shall not exceed 0.1 inches of H<sub>2</sub>O and the minimum accuracy shall be two percent of full scale. If an electronic pressure sensor is employed the full scale range shall not exceed ten inches H<sub>2</sub>O with a minimum accuracy of 0.5 percent of full scale. A full scale range of 20 inches is acceptable, provided that the minimum accuracy is 0.25 percent of full scale.

**Figure 3-2****Zero Air Systems**

- 5.11** Sample Conditioning, Zero Air, and Span Gas System. Assemble this system as shown in Figures 3-1, 3-2, 3-3 and 3-4. The conditioning system provides clean, dry, particulate-free sample flow to the analyzer(s). The zero air system provides clean, dry atmospheric air for analyzer calibration. The span gas system provides known concentrations of the appropriate gas required to span the analyzer(s). All sample or span gas contacting surfaces shall be constructed of Teflon, stainless steel, or borosilicate glass.
- 5.12** Particulate Filter. Use a Balston Type 95 holder with a Grade B filter, or equivalent, on the sample system.

- 5.13 Sample Pumps. Use leak free, Teflon lined diaphragm pumps capable of a minimum free-flow rating of 43 liter/minute (1.5 SCFM).
- 5.14 Back Pressure Regulator. Use a back pressure regulator capable of maintaining sample pressure, to the analyzer, at 5 psig while venting unused sample.
- 5.15 Connections. All sample contacting lines shall be Teflon, stainless steel, or borosilicate glass.
- 5.16 Dryer/Deodorizer. Use beds of silica gel and activated charcoal to remove moisture and hydrocarbons from the inlet to the zero air system.
- 5.17 Barometer. Use a mercury, aneroid, or equivalent capable of measuring atmospheric pressure to within 1 millimeter of mercury (0.04 inches of mercury).
- 5.18 Span Gas. All span gases used to calibrate the analyzers shall be traceable to the National Institute of Standards and Technology-Standard Reference Materials (NIST-SRM).

## 6. PRE-TEST PROCEDURES

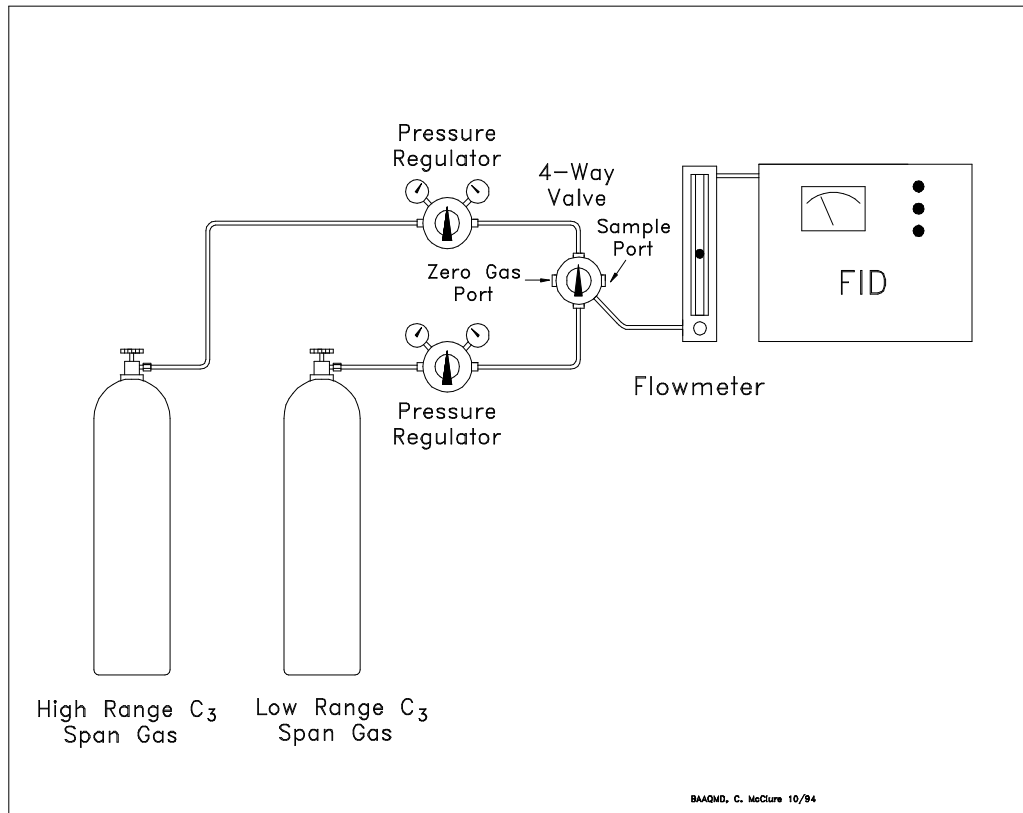
- 6.1 During transfer operations at the bulk plant, direct measurements of hydrocarbon concentrations and the volume of hydrocarbons vented shall be made. The overall condition of the facilities, especially the absence of leaks, shall be evaluated both visually and with the combustible gas detector at the locations listed in subsections 6.2 and 6.3. The mass emissions from leaks exceeding the allowable standard of the applicable rule shall be quantified.
  - 6.1.1 For incinerator-type processing units the carbon dioxide (CO<sub>2</sub>), total organic carbon (TOC) and carbon monoxide (CO) concentrations from the incinerator outlet shall be measured. The TOC concentration and volume at the incinerator inlet shall also be measured.
  - 6.1.2 The exhaust volume from the P/V relief valve may be directed to the rotary gas meter using bag stock. If the rotary gas meter is connected between the storage tank and P/V relief valve the following procedures shall be followed:
    - (a) Measure and record the pressure in the storage tank headspace.
    - (b) After installing the rotary gas meter and prior to starting the test, allow sufficient time to reestablish the headspace pressure measured in Section 6.1.2(a), or sixty (60) minutes, whichever is less.

**6.2** Storage Tanks. Check the P/V valve(s) to insure proper operation.

- 6.2.1** Check piping at all joints.
- 6.2.2** Check the general storage tank area.
- 6.2.3** Check for unintended openings (leaks).

**Figure 3-3**

**FID Span Gas System**



**6.3** Loading Facilities.

- 6.3.1** Check the transfer pump packing gland.
- 6.3.2** Check all hoses and valves.
- 6.3.3** Check the connection between the tank truck and the loading rank, if applicable.

**6.4** Any vapor leak exceeding 100 percent of the lower explosive limit on the combustible gas detector measured at a probe distance of 2.5 cm (1 inch) is unacceptable. Any liquid leak exceeding 3 drops per minute is unacceptable. The mass emission resulting from leaks exceeding these limits shall be quantified and included in the calculation of the emission factor.

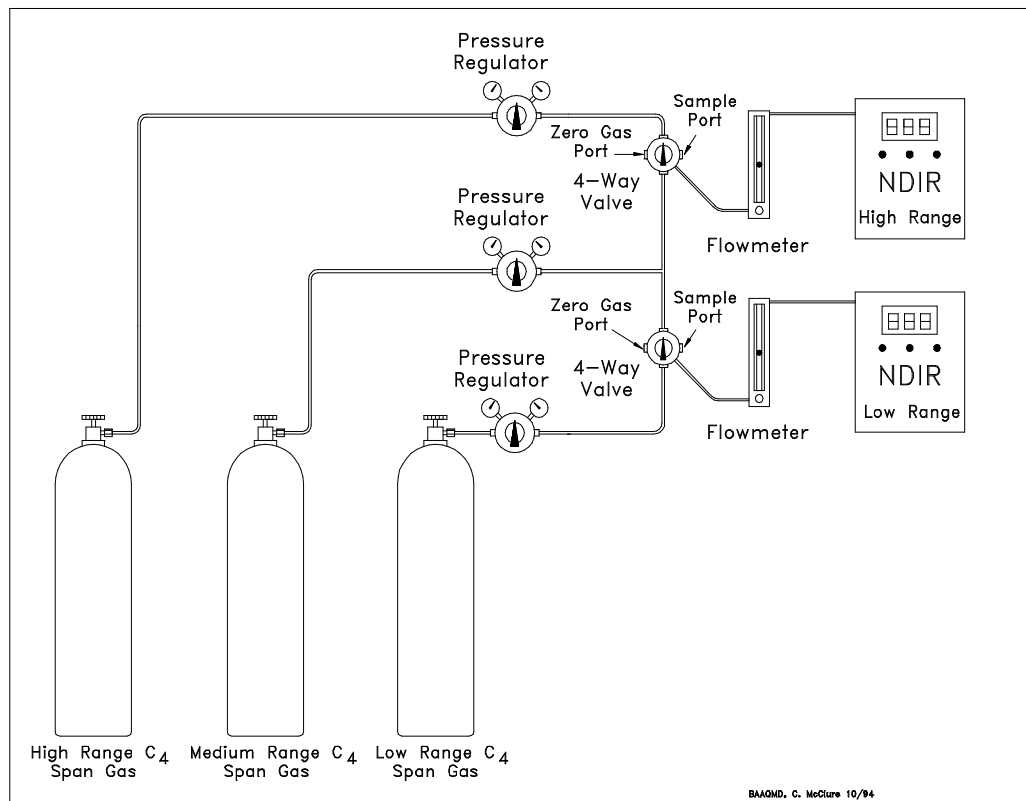
**6.5** Zero and span the analyzer(s) in accordance with manufacturer's recommendations.

## 7. TESTING

- 7.1** Test during an organic liquid transfer operation.
- 7.2** Record the initial rotary gas meter(s) reading.
- 7.3** For non-incinerator type systems measure, with the hydrocarbon analyzer, the hydrocarbon concentration of the exhaust volume from the outlet of the vapor recovery system.
- 7.3.1** For incinerator-type processing units, measure the hydrocarbon, CO, and CO<sub>2</sub> concentrations at the outlet of the incinerator and the hydrocarbon concentration and gas volume at the inlet to the incinerator.

**Figure 3-4**

### NDIR Span Gas System



- 7.4** During the transfer, check the inspection points listed in 6.2 and 6.3 with the combustible gas detector.
- 7.5** Record the temperature of the exhaust at the gas meter(s) every 5 minutes during the transfer operation.

- 7.6** Determine the methane concentration by either (a) passing a portion of the sample stream through the activated carbon scrubber to adsorb non-methane hydrocarbons prior to the analyzer or (b) collecting integrated samples for laboratory analysis.
- 7.7** If auxiliary fuel is used to maintain an incinerator temperature, the total volume of auxiliary fuel consumed during the test shall be recorded.
- 7.8** Record the total volume of organic liquid transferred.

## 8. POST TEST PROCEDURES

- 8.1** Record the final rotary gas meter reading(s).

## 9. CALCULATIONS

- 9.1** The corrected volume discharged through the storage tank pressure/vacuum valve(s) due to the transfer of organic liquid shall be determined as follows:

$$V_{es} = \frac{[V_m][530] \left[ P_b + \left( \frac{P_s}{13.6} \right) \right]}{[T_m][29.92]} \quad \text{[Equation 9-1]}$$

Where:

- $V_{es}$  = The volume discharged through P/V valve, SCF
- $V_m$  = The uncorrected rotary meter volume, ACF
- $P_b$  = The barometric pressure, inches of mercury
- $P_s$  = The gauge pressure at inlet of rotary meter, inches of water column
- $T_m$  = The average temperature at inlet of rotary meter, °R
- 530 = Standard temperature, °R
- 13.6 = The conversion factor from inches H<sub>2</sub>O to inches of mercury, inches of water column per inch of mercury
- 29.92 = Standard barometric pressure, inches of mercury

- 9.2** The corrected volume discharged from the incinerator due to the transfer of organic liquid shall be calculated as follows:

$$V_{es} = \frac{V_{is} [(k)(HC_i)]}{[(k)(HC_e) + (CO_{2e}) + (CO_e) - 300]} \quad \text{[Equation 9-2]}$$



Where:

- $V_{es}$  = The exhaust gas volume, SCF  
 $V_{is}$  = The inlet gas volume to the incinerator, SCF  
 $k$  = The calibration gas factor, 3 = Propane, 4 = Butane  
 $HC_i$  = The average inlet hydrocarbon concentration, ppmv  
 $HC_e$  = The average outlet hydrocarbon concentration, ppmv  
 $CO_{2e}$  = The average outlet carbon dioxide concentration, ppmv  
 $CO_e$  = The average outlet carbon monoxide concentration, ppmv  
 300 = The ambient carbon dioxide concentration, ppmv

Note: If a more accurate ambient concentration can be measured, it may be substituted for the 300 ppmv used in the above equation.

If auxiliary fuel was introduced into the incinerator during the test, the volume recorded, pursuant to Section 7.7, shall be corrected to the appropriate carbon number and included in the quantity  $V_{is}$ .

**9.3** The outlet volume from each carbon bed shall be calculated as follows:

$$V_{es} = \frac{[V_m][P_b][530]}{[T_m][29.92]} + \frac{[V_b][N][530]}{[T_a]} \quad \text{[Equation 9-3]}$$

Where:

- $V_{es}$  = The outlet gas volume from the carbon bed, SCF  
 $V_m$  = The uncorrected volume from the turbine meter, ACF  
 $P_b$  = The average barometric pressure during the test, inches of mercury  
 $V_b$  = The average post regeneration back flow through the turbine meter, ACF  
 $N$  = The number of post regeneration back flows during the test  
 $T_m$  = Average temperature through the turbine meter, °R  
 $T_a$  = Average ambient temperature during post-regeneration back flows, °R  
 530 = Standard temperature, °R  
 29.92 = Standard barometric pressure, inches of mercury

The total outlet volume of the adsorption unit is the sum of volumes of the carbon beds.

- 9.4** The mass of NMOC hydrocarbons emitted from the P/V valve(s), carbon bed outlets, or incinerator shall be calculated as follows:

$$W_{es} = \frac{[V_{es}][HC_{es}][MW]}{[386.9][100]} \quad \text{[Equation 9-4]}$$

Where:

- $W_{es}$  = The weight of NMOC emitted from the vapor recovery system during the test pounds
- $V_{es}$  = The outlet gas volume from the VRU, SCF
- $HC_{es}$  = The average outlet concentration from the VRU, % NMOC, as C<sub>4</sub>
- $MW$  = The molecular weight of the span gas used, pounds per pound-mole
- 386.9 = The molar volume, cubic feet per pound-mole
- 100 = The conversion factor from decimal fraction to percent

- 9.5** The emission factor (lbs of NMOC/1,000 gallons transferred) shall be calculated as follows:

$$E_{es} = \frac{[W_{es}]}{[G]} \times [1000] \quad \text{[Equation 9-5]}$$

Where:

- $E_{es}$  = The emission factor of the VRU, pounds per thousand gallons
- $W_{es}$  = The total outlet weight of NMOC, pounds
- $G$  = Total organic liquid loaded during the test, gallons

## 10. REPORTING

- 10.1** Results shall be reported as shown in Form 3-1 for balance systems, Form 3-2 for incineration systems or Form 3-3 for carbon adsorption systems.





**Form 3-3**

<p><b>Distribution:</b></p> <p>Firm Permit Services Enforcement Services Technical Services Planning Requester DAPCO</p>	<p><b>BAY AREA AIR QUALITY MANAGEMENT DISTRICT</b></p> <p><i>939 Ellis Street San Francisco, California 94109 (415) 771-6000</i></p> <p><b>Summary of Source Test Results</b></p>	<p>Report No.: _____</p> <p>Test Date: _____</p> <p>Test Times:</p> <p>Run A: _____</p> <p>Run B: _____</p> <p>Run C: _____</p>
<b>Source Information</b>		<b>BAAQMD Representatives</b>
Firm Name and Address	Firm Representative and Title	Source Test Engineers
	Phone No. (     )	
Permit Conditions:	Source:	Permit Services Division/Enforcement Division
	Plant No.                      Permit No.	Test Requested By:
	Operates                      Hr/Day &                      Day/Yr	
Operating Parameters:		<u>Organic Liquid Loaded During Test, Gallons:</u>
	Gasoline:                      Diesel:                      AV Gas:                      Jet A:                      Other:                      Total:	
Applicable Regulations:		VN Recommended:

**Sources Test Results and Comments: CARBON ADSORPTION SYSTEMS**

Bed #1                      Bed #2                      System

- Inlet Volume, SCF
- Purge Air, avg per cycle, SCF
- Backflow, avg per cycle, SCF
- Number of Cycles, total
- Inlet NMOC Concentration, %, avg. as C<sub>4</sub>
- Inlet NMOC Weight , pounds
  
- Outlet Volume, SCF
- Outlet NMOC Concentration, ppmv , avg. as C<sub>4</sub>
- Outlet Weight, pounds
- Emission Factor, pounds per 1,000 gallons
- Efficiency, weight percent
- Maximum System Pressure, Inches H<sub>2</sub>O

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