

California Environmental Protection Agency



Vapor Recovery Test Procedure

Proposed: TP-201.1A

**Emission Factor For
Phase I Systems at Dispensing Facilities**

Adopted: April 12, 1996
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Amended: _____

The method is being amended. For ease of viewing, the method is shown as repealed text and proposed text.

**California Environmental Protection Agency
Air Resources Board**

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Phase I Systems at Dispensing Facilities**

1 APPLICABILITY

Definitions common to all certification and test procedures are in:

D-200 Definitions for Vapor Recovery Procedures

For the purpose of this procedure, the term "ARB" refers to the State of California Air Resources Board, and the term "ARB Executive Officer" refers to the Executive Officer of the ARB or his or her authorized representative or designate.

This procedure applies when it is necessary to determine a mass emission factor for the Phase I System rather than the volumetric efficiency determined by the application of TP-201.1. The operation of a vapor processor or vapor incinerator typically precludes the application of TP-201.1.

Warning:

When conducting any of the calibration, equipment installation and testing procedures presented in this test procedure it is imperative that all test personnel are acutely aware of the fact that gasoline is an extremely hazardous and inflammable material. When working around liquid gasoline and/or gasoline vapors in either a laboratory or industrial settings, a thorough and complete hazard analysis should be completed prior to the installation of any test equipment or the commencement of testing operations. Adequate ventilation must be provided to protect personnel from inhalation hazards associated with the chemical compounds found in gasoline and to reduce the concentration of combustible gases to less than 10% of the Lower Explosive Limit to minimize the risk of fire or explosion. All potential ignition sources for gasoline or gasoline vapors must be identified and the threat of fire or explosion must be eliminated.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

The purpose of this test procedure, TP-201.1A, is to determine the emission factor (in units of pounds of hydrocarbon emitted per 1000 gallons of gasoline transferred from cargo tank to storage tank, lb/kgal) for installations of Phase I vapor recovery systems (VRS) at gasoline dispensing facilities (GDF's). This test procedure is an alternative to TP-201.1, which is a volumetric efficiency test procedure.

During a fuel delivery, the volume of gasoline transferred from the cargo tank to the storage tank is determined. The mass of any gasoline vapors discharged from the vent(s) of the storage tank(s) and, if present, from the exhaust of the vapor processor or vapor incinerator unit is determined. The mass emission factor for the fuel transfer event is calculated from these determinations.

Typically vapor processor and vapor incinerator units at GDF's are designed and sized to control the gasoline vapor emissions associated with motor vehicle fueling operations (Phase II) and normal tank "breathing" losses caused by diurnal variations in ambient temperatures and pressures. Vapor processors and vapor incinerators designed and operated as part of the Phase II VRS, or as a storage tank pressure management system, are typically sized to control volumetric vapor flow rates much lower than those associated with the transfer of gasoline from a cargo tank to an underground storage tank which are on the order of 300 to 500 gpm.

As a result, Phase I system performance at a GDF is highly dependent on the efficient operation of the balance Phase I system created by the liquid and vapor connections established between the cargo tank and the storage tank. In fact, Phase I systems at GDF's equipped with Phase II vapor processors or vapor incinerators may be able to demonstrate compliance with the emission factor performance standard without relying on the additional control of vapors directed to the processor or incinerator. If a the vapor processor or incinerator achieves typical control efficiencies of 90 to 98%, then it may be possible to demonstrate that the mass of hydrocarbon emitted from the Phase II system processor or incinerator during a Phase I delivery is insignificant relative to the mass emitted at the tank vent(s).

As required to determine an emission related parameter and except where otherwise specified, the equipment and procedures specified in the following test methods shall be used.

EPA Method 2A Direct Measurement of Gas Volume Through Pipes and Small Ducts

EPA Method 2B Determination of Exhaust Gas Volume Flow Rate From Gasoline Vapor Incinerators

EPA Method 25A Determination of Total Gaseous Organic Compound Emissions Using a Flame Ionization Detector

EPA Method 25B Determination of Total Gaseous Organic Compound Emissions Using a Nondispersive Infrared Analyzer

3 BIASES AND INTERFERENCE

3.1 Bulk Delivery Vapor Leaks

Any vapor leak exceeding the LEL (2.1 volume % as propane), during the gasoline bulk delivery, precludes the use of this method. Vapor concentration is determined at a distance of 1 inch from any potential vapor leak source. Measurements are made using the equipment and procedures specified in EPA Method 21.

3.2 Cargo Tank Performance

Gasoline transfers performed using cargo tanks which do not meet the year round (daily) performance standards required by ARB Certification Procedure "CP-204, Certification Procedure for Vapor Recovery Systems of Cargo Tanks" preclude the use of this method.

4 SENSITIVITY, RANGE, AND PRECISION

The measurements of concentration and volumetric parameters required by TP-201.2 are well within the limits of sensitivity, range, and precision of the specified equipment.

5 EQUIPMENT AND SUPPLIES

5.1 Volume

A volume measuring device (meter) is required at each vent, including those equipped with pressure-vacuum relief valves and the exhaust of any vapor processor or vapor incinerator. The meter should be equipped with an automatic data gathering system that can differentiate direction of flow and record the volume vented in such a manner that this data can be correlated with contemporaneous data on the meter temperature and pressure and the hydrocarbon concentration of vapors passing through the meter. A sampling manifold shall be connected to the meter with taps for hydrocarbon (HC) concentration sampling, a thermocouple, and a pressure sensor connection.

Use a calibrated positive displacement meter or a turbine meter for measurement of volumetric flow. The error of the meter shall be less than 5% of the true volume over the entire range of flow rates for which the meter will be used.

Any volume meter that is installed in the vapor recovery system plumbing shall demonstrate conformance with the back pressure limit (BPL), specified below:

Meters with a manufacturer specified maximum flow rating of greater than or equal to 1000 CFH shall demonstrate:

$BPL \leq 1.10$ inches water column at a flow rate of 3,000 CFH or the maximum flow rating specified by the manufacturer, whichever is less, and $BPL \leq 0.05$ inches water column at a flow rate of 30 CFH.

Meters with a manufacturer specified maximum flow rating of less than 1000 CFH shall demonstrate:

$BPL \leq 0.70$ inches water column at a flow rate of 800 CFH and $BPL \leq 0.04$ inches water column at a flow rate of 16 CFH.

Meter(s) shall be equipped with the following equipment:

- (1) taps on the inlet and outlet sides for a differential pressure gauge with a full scale range of less than or equal to four times the back pressure limit to allow detection of a pressure drop greater than the BPL.

- (2) Couplings required to connect meters to the VRS at the tank vent lines, the exhaust of the vapor processor or the inlet of the vapor incinerator. Couplings shall be sized and constructed such that the test apparatus does not cause any significant increase in the pressure drop associated with flow through the systems tested.

5.2 Pressure

Use a pressure measuring device (e.g. transducer, liquid manometer or Magnahelic gauge) with a range selected to ensure that the pressure measured by the device are within 10 to 90% of the full scale range. More than one gauge shall be used, if necessary. Pressure measurement shall be conducted at the sample coupling attached to the inlet of each volume meter. The error of the pressure measuring device shall be no greater than 3% of the true pressure over the entire range of pressures to be measured by the device,

5.3 Temperature

Use a temperature measuring device (e.g. thermocouple, thermometer) with a design range suitable for the temperature being measured. Typically, a range of 0 to 200 ° F is suitable for use in this test procedure. Temperature measurement shall be conducted at the sample coupling attached to the inlet of each volume meter. The ambient temperature is also measured and recorded during the Phase I gasoline transfer. The error in the temperature measuring device shall be no greater than 4 degrees Fahrenheit or 1.5 % of the true temperature whichever is greater.

5.4 Hydrocarbon Concentration

The default mode of determining hydrocarbon (HC) concentrations in this procedure is a determination of non-methane hydrocarbon concentration as propane. Alternative test procedures for determining non-methane hydrocarbons (NMHC), methane (CH₄) and total hydrocarbon (THC) concentrations have been validated for some applications and may be used, subject to the approval of the ARB Executive Officer. Such procedures typically measure the concentration of two of the three classes of hydrocarbon species with the third being calculated by addition or subtraction. (e.g. NMHC +CH₄ = THC or THC – CH₄ = NMHC).

A wide variation in the concentrations from less than 100 ppm to greater than 80 % by volume may occur at the hydrocarbon measurement locations required by this test procedure (i.e., vapor processor or incinerator exhaust point, tank vent lines, and vapor incinerator inlet line) The wide range of concentration may require the use of an array of analyzers (typically two or three) with overlapping ranges.

The range and sensitivity of any hydrocarbon analyzer shall be selected such that the maximum concentration to be measured is no more than 98 percent of the range and the minimum concentration that must be quantified is not less than 2 percent of the range. Accurate and repeatable analysis over the range of concentrations measured shall be demonstrated by a successful multi-point laboratory calibration performed within six months prior to use of the analyzer for this test procedure and by zero, mid-span and high-span field calibration checks conducted on each day of testing. Documentation of such calibrations shall be kept on file permanently and made available to the ARB Executive Officer upon request.

Any sample that is extracted from within the VRS piping or storage tank shall be analyzed by using a non-destructive detection method. Non-destructive analysis is required so that the entire volume of sample extracted for analysis can be returned, unaltered to the VRS at the point from which it was withdrawn. Failure to accomplish 100% sample volume return can reduce the operating pressure of the VRS and result in an unacceptable low bias in the mass of emissions that must be accurately determined by this test procedure.

A Non-dispersive Infrared (NDIR) analyzer with selected filters and/or detectors which block methane measurement shall be used when the emission factor is to be calculated for non-methane hydrocarbon. When using an NDIR instrument for total hydrocarbon measurements, a dual filter/detectors design must be used to measure both non-methane hydrocarbon as propane and methane concentrations or the instrument filters and detectors must be designed such that total hydrocarbon as propane is measured.

Any sampling and analysis system using a flame ionization detector (FID) can not be designed so that 100% of the sample that is extracted for analysis can be returned, unaltered, to the sample point, because the operation of the FID significantly alters the portion of the sample which is analyzed. An analyzer with a FID may be used for the test when a measurement is for total hydrocarbon and there is no requirement for returning sample, unaltered, to the sample manifold (e.g. at a vapor processor or incinerator exhaust or for a vent line sleeve, if used). A FID analyzer may be capable of more accurate and repeatable measurements than an NDIR analyzer when the concentrations to be measured are less than several hundred ppm. One possible drawback to the FID analyzer is that the response time may be much greater than for an NDIR analyzer at comparable analyzer ranges. This can be problematic if the FID response must be correlated with other measurement devices with faster response times.

Hydrocarbon analysis required for TP-201.1A shall not be conducted using a combination of FID and NDIR instruments unless the applicant for certification has presented the ARB Executive Officer with written data and analysis demonstrating that any variations which exist in analyzer response times and/or the analyzer response to gasoline vapor concentrations do not result in an unacceptable level of bias or error in the test results.

5.5 Carbon Dioxide (CO₂) Concentration at Vapor Incinerator Exhaust

Use a NDIR analyzer for measurement of exhaust CO₂ concentrations. To the extent practical, the analyzer range and sensitivity shall be selected such that the maximum concentration measured is no more than 98 percent of the range and the minimum concentration that must be quantified is not less than 2 percent of the range. Accurate and repeatable analysis over the range of concentrations measured shall be demonstrated by a successful multi-point laboratory calibration performed within six months prior to use of the analyzer for this test procedure and by zero, mid-span and high span field calibration checks conducted on each day of testing.

5.6 Carbon Monoxide (CO) Concentration at Vapor Incinerator Exhaust

Use a NDIR analyzer for measurement of exhaust CO concentrations. To the extent practical, the analyzer range and sensitivity shall be selected such that the maximum concentration measured is no more than 98 percent of the range and the minimum concentration that must be quantified is not less than 2 percent of the range. Accurate and repeatable analysis over the range of concentrations measured shall be demonstrated by a

successful multi-point laboratory calibration performed within six months prior to use of the analyzer for this test procedure and by zero, mid-span and high span field calibration checks conducted on each day of testing.

5.7 Combustible Gas Detector

Use a combustible gas detector or explosimeter meeting the specifications required by EPA Method 21 or ARB test procedure "TP-204.3, Determination of Leak(s)", to quantify any vapor leaks occurring during the Phase I gasoline transfer.

5.8 Barometer

Use a mercury, aneroid, or equivalent barometer accurate to within 5 millimeters of mercury (0.2 inches of mercury) to determine ambient pressure during the Phase I gasoline transfer.

5.9 In-line Plumbing

Design goals for plumbing arrangements, regardless of GDF, are:

- (1) Minimize length of additional test piping installed at any sample points within the VRS.
- (2) Minimize pressure drop across in-line plumbing and the volume meter.
- (3) Return the entire volume of any sample extracted from the vapor return line to prevent a negative bias in the VRS pressure and the mass of pressure driven fugitive emissions.
- (4) Test apparatus plumbing shall be designed for easy adaptability to GDF configurations which may be encountered. Ball valves may be installed at the inlet and exhaust of volume meters in order to isolate the meter from the VRS in the event that the meter requires servicing during the test. Such ball valves shall be sized to match the size of the vapor return line and test apparatus plumbing.

5.10 Cargo Tank Fill Line and Vapor Return Line Couplers

The temperature and/or pressure or hydrocarbon concentration of the fluids in the cargo tank fill and vapor return lines is not necessary for determination of the mass emission factor for which this procedure is used. However, if deemed necessary, the volume of the vapor returned to the cargo tank may be estimated based on the volume of gasoline delivered to the storage tank(s). If this volume is to be corrected to standard conditions of temperature and pressure the following equipment will be required to accommodate temperature and pressure measuring devices.

- (1) Coupling for tank truck vapor return line with thermocouple and manometer, taps.
Coupling to be the same diameter as the vapor return line.

- (2) Coupling for tank truck fuel drop line with thermocouple tap. Coupling to be the same diameter as the fuel line.

6 CALIBRATION PROCEDURE

A record of all calibrations shall be maintained.

6.1 Analyzers

Follow the manufacturer's instructions concerning warm-up time and adjustments. On each test day prior to testing, zero the analyzer with a zero gas and span with known concentrations of calibration gas at levels which are 30 to 50% and 70 to 90 % of the highest concentration that is expected to be measured. The difference between the instrument response demonstrated during field calibration and the instrument response predicted from the biennial laboratory calibration curves (see Section 9, Quality Assurance) shall not exceed 2% of the instrument range.

Perform an intermediate zero and span calibration approximately 2 hours after the initial calibration and at any time a calibration drift is evident or suspected. Check for zero and span calibration drift at the end of the test period. All calibrations and adjustments shall be documented. To prevent the test data from being invalidated due to excessive zero or span drift, it is recommended that calibration checks be conducted every three to six hours.

6.2 Volume Meters

Positive displacement meters, and / or turbine meters used for TP-201.2 shall be calibrated on an annual basis against a bell type spirometer at flow rates representing 1 , 10 , 30, 60, and 90% of the meter capacity. The accuracy of the meter shall be 5% of the true volume measured over the range of flow rates encountered in application of this test procedure.

6.3 Pressure Measuring Device

Prior to and immediately following each day of testing record the pressure measuring device response to the pressure generated by a static pressure calibrator at 0, 20, 40, 60, 80, and 100% of the specified range of operation.

If necessary, adjust the instruments response in accordance with manufacturer's instructions. Provide a copy of these instructions and document the instrument response before and after adjustment in the Certification Test Report.

6.4 Temperature Measuring Device

Every six months check the accuracy of the thermocouple and temperature readout device using an ice bath, ambient air, and boiling water. This temperature check shall be performed by comparison to a NIST traceable mercury-glass thermometer.

Check the accuracy of the thermocouple and temperature readout device against an NIST traceable mercury-glass thermometer at ambient air temperature prior to and immediately following each day of testing.

If necessary, adjust the temperature readout in accordance with manufacturer's instructions. Provide a copy of these instructions and document the instrument response before and after adjustment in the Certification Test Report.

7 PRE-TEST PROTOCOL

7.1 Location of Test Site

Prototype systems will be located within 100 miles of Sacramento for testing. If the applicant for certification provides information demonstrating that a test site is not available within 100 miles of Sacramento, other locations may be accepted with written approval from the ARB Executive Officer.

7.2 Specification of Test, Challenge, and Failure Modes

General and System Specific challenge and failure operating mode scenarios may be required as part of the certification testing conducted to evaluate system compliance with the emission factor performance standard. In evaluating the certification application the ARB Executive Officer shall determine the necessity of challenge and failure mode testing. The evaluation shall include the following challenge and failure mode operating scenarios:

- (1) number of liquid transfer episodes,
- (2) volume and volumetric rate of liquid transfer,
- (3) storage tank capacities,
- (4) storage tank inventory volume prior to delivery, etc.

The applicant for certification shall provide the ARB Executive Officer with any system design, operation or test data that are needed to accomplish this evaluation. Challenge and failure operating mode operating scenarios in addition to those presented herein may be required by the ARB Executive Officer.

7.3 System and Facility Preparation

Vapor recovery system equipment and components shall be completely operational and no deliveries to any storage tanks involved in the test shall have occurred within the proceeding 36 hours.

The gasoline inventory in the storage tanks involved in the test shall be within the range required for the test as determined by the Challenge and Failure Mode testing evaluation required by section 7.2.

The evaluation performed by the ARB Executive Officer shall specify the final requirements for facility preparation. The guiding principle is that testing activities shall not significantly alter GDF or VRS operating conditions. The installation of test equipment can alter facility and system values for critical parameters (e.g. the release of pressure caused by opening the VRS plumbing to install test equipment at the tank vent or vapor processor or incinerator inlet). Therefore, final preparation procedures are specified herein. Alternate procedures may be used if approved in writing by the ARB Executive Officer. The approval shall be

based upon a the finding that the alternative procedures are as effective and that the procedures specified below are not compatible with the system to be tested.

Facility Preparation Procedures

(1) Install all required testing apparatus on the tank vent line(s), and if present, the vapor processor exhaust and vapor incinerator inlet lines and wait at least 16 hours before testing. Until then, provide conditions which minimally disturb facility and system operations due to the presence of such equipment for such time; or

(2) install all equipment and wait until system parameters that are perturbed by the installation of test equipment, such as pressure and hydrocarbon concentration have returned to within the normal operating range established by the preliminary evaluation of the VRS. Until then, provide conditions which minimally disturb facility and system operations due to the presence of such equipment.

8 TEST PROCEDURE

8.1 General Procedures and Preparations

8.1.1 Preparations

The facility and system shall be prepared to operate according to any specified test, challenge, and failure modes.

The test for gasoline transfers from cargo tanks to storage tanks shall be conducted under conditions that are as close as feasible to the conditions normally present at the GDF. A determination of normal conditions shall include evaluation of such parameters as the time of day that transfers occur, the Phase I operating procedures used by the cargo tank operator, the operating conditions of the Phase II VRS in the 36 hours proceeding the delivery, the pressure integrity of the vapor recovery systems prior to and during application of this test procedure and any other critical system parameters identified by the ARB Executive Officer in the preliminary evaluation.

8.1.2 Evaluation of Detection Limit for Vent Flows and Alternative Test Procedure

This test procedure cannot detect mass emission rates associated with volumetric flow rates that are below the starting threshold for the volume meters installed on VRS vents. A two inch rotary type positive displacement meter with a maximum flow rating of 3000 cubic feet per hour (cfh) is typically used for this test procedure. The starting threshold for measurement with this meter is typically near 30 cfh, or 1% of the maximum rated capacity. (Note: The emission factor associated with a failure to measure a flow rate of 30 scfh, at a HC concentration of 30% as propane during a 5000 gallon delivery lasting 10 minutes equates to an under reporting of the emission factor of approximately 0.03 lb/kgal.)

If the ARB Executive Officer determines that mass emission rates associated with pressure driven vapor leaks from closed PV valves installed on VRS vents will have a significant impact on the mass emission factor determined by this test procedure, and that such emission rates are not quantifiable using the this test procedure, then the vent

sleeve method presented in TP-201.2 shall be required to determine mass emissions at these test locations.

8.1.3 Evaluation of Necessity of Simultaneous Testing at Tank Vent Line and Vapor Processor or Vapor Incinerator Exhaust

There are some vapor recovery system designs which may necessitate the simultaneous testing of both the tank vent and the vapor processor (or vapor incinerator). Simultaneous testing of points 1 and 2 (or 2a and 2b) would be necessary if the system operating parameters are expected to result in fugitive leaks from the closed PV valve or measurable emission rates from an open vent valve that are of sufficient mass to significantly effect the mass emission factor determined by application of TP-201.1A.

Significant savings in cost and effort may be recognized by eliminating the simultaneous monitoring of both vent line and vapor processor (or vapor incinerator) emissions if such monitoring is deemed unnecessary by the ARB Executive Officer. Two situations in which simultaneous testing may be deemed unnecessary by the ARB Executive Officer are presented below.

1. The Phase I vapor recovery system is designed to maintain a constant vacuum in the storage tank vent line using a vapor processor (or vapor incinerator). As long as this vacuum is present, there will be no vent line emissions and the simultaneous monitoring of the vent PV valve may be deemed unnecessary.
2. Typically vapor processor and vapor incinerator units at GDF's are designed and sized to control the gasoline vapor emissions associated with motor vehicle fueling operations (Phase II) and normal tank "breathing" losses caused by diurnal variations in ambient temperature and pressure. Vapor processors and vapor incinerators designed and operated as part of the Phase II VRS, or as a storage tank pressure management system, are typically sized to control volumetric vapor flow rates at levels much lower than those associated with the transfer of gasoline from a cargo tank to an underground storage tank which are on the order of 300 to 500 gpm. As a result, Phase I system performance at a GDF is highly dependent on the efficient operation of the balance Phase I system created by the liquid and vapor connections established between the cargo tank and the storage tank.

Furthermore, if a high level of control efficiency (greater than 98%) has been established for the vapor processor or vapor incinerator then a typical volume of vapors passing through the Phase II system vapor processor or incinerator during a Phase I delivery would typically have an insignificant effect on the systems ability to meet the Phase I emission factor performance standard. In this situation the ARB Executive Officer may deem that it is unnecessary to quantify mass emissions from the vapor processor during the Phase I delivery. To support this determination the applicant shall propose, and the ARB Executive Officer shall approve, alternative test procedures to ensure that the vapor processor or incinerator performance during the Phase I delivery consistent with the preliminary evaluation conducted to determine the necessity of simultaneous testing. These alternatives should provide a procedure to ensure that the vapor volumes treated and control efficiency of the vapor processor or incinerator during testing are consistent with the preliminary evaluation.

8.1.1 Test Point 1 (Tank Vents) and / or Test Point 2 (Vapor Processor Exhaust)

In this section, the term "vent" and the specified procedures for testing vents shall also apply to any vapor processor with which such procedures are compatible. Any assist processor which is incompatible with the application of these procedures shall not be certified until the compatibility requirements of the certification procedures are met. Separate equipment and test procedures are specified elsewhere for vapor incinerators.

- (1) Remove any PV valve(s) that is (are) installed on the vent(s). Then install the coupler, volume meter and sample manifold and reinstall the PV Valve at the outlet of the sample manifold. Figures 4 and 5 depict the final installation. In these figures, elbows have been use to orient the meter in a horizontal flow direction. This is done to minimize the chance of contamination falling into the outlet of the meter and jamming the meter. A jammed meter can be detected by higher than normal pressure drop through the meter at normal volumetric flow rates. The differential pressure gauge installed across the meter is used for this purpose. Horizontal orientation is recommended but not required.

If a vapor processor is present, connect an additional coupler, meter and sample manifold to the exhaust of the vapor processor. Additional guidance on the direct measurement of flow through ducts which may be applicable to the vapor processor exhaust, can be found in EPA Method 2A.

- (2) Connect the temperature and pressure measuring devices and the HC analyzer sample lines and, if required, the sample return lines to the vent sampling manifold. Calibrate the measurement devices in accordance with section 6.
- (3) If required, Connect the couplers to the tank truck fuel and vapor return lines and connect the temperature and pressure measuring devices to these couplers. Calibrate the measurement devices in accordance with section 6.
- (4) Request that the cargo tank operator identify the volume of gasoline to be transferred from the cargo tank using shipping manifests, load rack receipts, etc. Instruct the cargo tank operator to gauge the storage tank(s) and confirm that adequate storage tank ullage is available to accept the full volume to be transferred from the cargo tank. Individually record the initial gasoline inventory volumes in each storage tank.
- (5) Instruct the cargo tank operator to connect tank truck fill and vapor return lines to the appropriate underground tank connections in accordance with the written procedure for the Phase I VRS. Ensure that there is no conflict between the normal delivery procedures established by the cargo tank owner/operator and those established by the applicant for Phase I VRS certification.
- (6) Check the cargo tank dome hatches, pressure relief valves and vapor return line connections with the combustible gas detector before and during the gasoline transfer. Record any measurements above 100 % of the LEL (2.1 % as propane).

- (7) Record the initial readings of all volume measuring devices installed for this test procedure.
- (8) Begin the transfer of gasoline from the cargo tank to the GDF storage tank in accordance with cargo tank owner/operator established normal procedure. Ensure that there is no conflict between the normal delivery procedures established by the cargo tank owner/operator and those established by the applicant for Phase I VRS certification.
- (9) Hydrocarbon concentrations and temperature and pressure measurements shall be recorded using strip chart recorders for the entire time period of the gasoline transfer operation. The volume measuring device readings are to be recorded at a minimum frequency of once every 15 seconds during the transfer.
- (10) Record the barometric pressure and ambient temperature at the start and the end of the test.
- (11) At the end of the gasoline transfer, disconnect the tank truck from the underground tank in accordance with manufacturers' instructions (normal procedure). Instruct the cargo tank operator to gauge the tank and record the reading. Individually record the gross volume of gasoline delivered to each storage tank. This may be determined by the cargo tank operators shipping papers or from the pre- and post- delivery tank inventories determined by manual or automated tank gauging.
- (12) Leave the storage tank vent, and if present, vapor processor (or vapor incinerator) testing apparatus in place. Continue recording hydrocarbon concentrations, temperatures, pressure and gas meter readings at the storage tank vent and/or the exhaust of any vapor processor or vapor incinerator at a minimum frequency of once per 5 minute interval. Continue recording data at this frequency for one hour after completion of the gasoline transfer or until the system returns to the conditions of pressure, HC concentration, and vapor processor (incinerator) and storage tank vent volumetric flow rates that were present just prior to the start of Phase I delivery operations.
- (13) At the end of the post delivery monitoring period record final reading of each volume measuring device installed for this test procedure.
- (14) Disconnect instrumentation from the vent(s) and if present, the vapor incinerator.

8.1.2 Test Point 2a (Vapor Incinerator inlet) and 2b (Vapor Incinerator exhaust)

8.1.2.1 General Sampling Parameters for Vapor Incinerators

Specific procedures are provided below for testing gasoline vapor incinerators due to the unique test procedure (EPA Method 2B) used to determine the exhaust volume for the vapor incinerator. Other types of assist processors, e.g. carbon adsorption beds, refrigerated condensers, and chemically selective permeation membranes are tested by the more conventional hydrocarbon sampling and analytical procedures specified in previous sections.

During TP-201.1A testing continuous measurements shall be recorded for the following system parameters shown in hexagon outlines in Figure 1:

HC	=	Hydrocarbon Concentration at inlet and exhaust test points
CO	=	Carbon Monoxide Concentration at exhaust test point
CO ₂	=	Carbon Dioxide Concentration at exhaust test point
V	=	Volume at inlet test point
P	=	Pressure in meter at inlet test point
T	=	Temperature in meter at inlet test point

8.1.2.2 Incinerator Sampling Parameters

An evaluation of incinerator design and operating parameters shall be conducted to determine specific testing protocols. The evaluation shall include specifications for appropriate data collection time intervals and appropriate ranges or capacities for devices used to determine temperature, pressure, concentrations, and volume. The time intervals specified for data averaging or intermediate mass emission calculations shall be chosen to provide calculated estimates of incinerator mass emissions factors which can be shown to be accurate to $\pm 10\%$ of the true emission factor, based on sound scientific and engineering principles. The concentration and volume measurements made at the incinerator inlet must be contemporaneous with the measurements of concentration made at the incinerator exhaust to produce an accurate result for the calculated exhaust volume. This is especially important during time periods when concentrations or volumetric flow rate are changing rapidly (e.g. cold start ups). The influence of instrument response times on the testers ability to identify contemporaneous data at the inlet and exhaust test points must also be evaluated.

Data for each parameter shall be collected and recorded for the appropriate time intervals determined as specified above. Collect and record incinerator data for all of the parameters required to make a determination of the incinerator exhaust volume as required by EPA Method 2B.

This test procedure also includes additional monitoring requirements for auxiliary fuel (if present) to expand the applicability of EPA Method 2B. Some vapor incinerators may use auxiliary fuel (typically natural gas, propane, or LPG) to accomplish faster ignition and more complete combustion of the gasoline vapors controlled by the incinerator. In this case it is necessary to quantify the additional incinerator exhaust volume associated with the combustion of the auxiliary fuel. The parameters that must be monitored are defined below:

- V_{in} = total inlet volume processed by vapor incinerator (SCF)
- V_{fvs} = inlet volume of gasoline vapors from the facility vapor space, storage tanks and vapor recovery system (SCF)
- V_{af} = inlet volume of auxiliary fuel (SCF)
- V_{exh} = vapor incinerator exhaust volume (SCF)
- N = number of carbon atoms in each molecule of calibration gas for analyzers used to determine concentration of gasoline vapors at the incinerator inlet and exhaust (normally propane, $N = 3$)
- N_{af} = number of carbon atoms in each molecule of calibration gas for analyzers used to determine concentration of auxiliary fuel at the incinerator inlet
- $[HC]_{fvs}$ = hydrocarbon concentration of inlet volume from the facility vapor space (volume fraction = volume % / 10^2)
- $[HC]_{af}$ = hydrocarbon concentration of auxiliary fuel (volume fraction = volume % / 10^2)
- $[HC]_{exh}$ = vapor incinerator outlet hydrocarbon concentration (volume fraction = ppm / 10^6)
- $[CO_2]$ = vapor incinerator outlet carbon dioxide concentration (volume fraction = ppm / 10^6)
- $[CO]$ = vapor incinerator outlet carbon monoxide concentration (volume fraction = ppm / 10^6)

8.1.2.3 Simplifying Assumptions for Incinerator Testing

Based on an engineering evaluation of a subject incinerator, the ARB Executive Officer may allow other data sources or simplifying assumptions to be used in place of actual sample collection and analysis. Monitoring of some or all of the auxiliary fuel parameters and other incinerator parameters may be deemed unnecessary if the applicant submits adequate justification based on the application of sound scientific and engineering principles and obtains prior written approval from the ARB Executive Officer. Possible simplifying assumptions for incinerator testing that may be given consideration by the ARB Executive Officer are presented below:

1. It may be possible to use concentration and hydrocarbon speciation data provided by the auxiliary fuel supplier in place of actual measurements for the $[HC]_{af}$ parameter.
2. For incinerators that are operated at a constant volumetric feed rate, the inlet volume of auxiliary fuel, V_{af} , may be accurately predicted based only on the incinerator operating time and the feed blower performance specifications and

operating parameters (inlet volumetric flow rate, fan speed, blower inlet pressure, etc.)

3. An engineering evaluation may demonstrate that the additional exhaust volume associated with the use of auxiliary fuel is insignificant (i.e. does not effect the incinerator mass emission factor by greater than 5%)
4. The monitoring of carbon monoxide may be eliminated in the application of EPA Method 2B if it can be shown that deleting the carbon monoxide concentration from the carbon balance equation used to calculate the incinerator exhaust volume does not result in a significant loss of accuracy (i.e. does not effect the incinerator mass emission factor by greater than 5%). Typically this simplification may be applied when the carbon monoxide concentration is much less than the carbon dioxide concentration in incinerator exhaust. (e.g. 50 ppmv CO << 2% by volume CO₂). Note that CO testing may still be required to develop a performance specification for time averaged carbon monoxide (CO) concentration in the incinerator exhaust stream as discussed in Section 8.4.1.
5. An engineering evaluation may demonstrate that the additional exhaust volume from the auxiliary fuel occurs in a fixed ratio ($R = V_{\text{exh},f(V_{\text{af}})} / V_{\text{exh},f(V_{\text{fvs}})}$) to the incinerator exhaust volume associated with combustion of vapors from the facility vapor space, storage tanks and VRS. In this case, the total exhaust volume ($V_{\text{exh},\text{total}}$) can be calculated from the exhaust volume determined by application of EPA Method 2B to the vapors entering the incinerator from the GDF vapor space ($V_{\text{exh},f(V_{\text{fvs}})}$) and the known value of R as follows:

$$V_{\text{exh},\text{total}} = [R + 1] \times V_{\text{exh},f(V_{\text{fvs}})}$$

Where:

$$V_{\text{exh},\text{total}} = V_{\text{exh},f(V_{\text{fvs}})} + V_{\text{exh},f(V_{\text{af}})}$$

And

$$R = \frac{V_{\text{exh},f(V_{\text{af}})}}{V_{\text{exh},f(V_{\text{fvs}})}}$$

8.1.2.4 Incinerator Visual Emissions

Visible emissions (except water vapor) from vapor incinerators are an indication of poor combustion.

No vapor incinerator shall discharge into the atmosphere any air contaminant, other than uncombined water vapor, for a period or periods aggregating more than three minutes in any one hour which as dark or darker in shade as that designated as No. 1 (one) on the Ringleman Chart, as published by the United States Bureau of Mines, or for any period of fifteen consecutive seconds or greater, any air contaminant, other than uncombined water vapor, which is as dark or darker in shade as that

designated as No. 2 (two) on the Ringleman Chart, as published by the United States Bureau of Mines

Should these levels of visible emissions from the vapor incinerator exhaust be detected, the control system is unacceptable and the problem must be corrected and an application made to the ARB Executive Officer for reconsideration for certification.

8.1.2.5 Incinerator Inlet Sample Location

The vapor incinerator inlet sample and temperature and pressure measurements must be taken from a sample manifold attached to the inlet side of the volume meter which has been inserted at a break in the inlet line. The installation of test equipment shall not interfere with the normal operation of the vapor incinerator. The total volume of sample taken from the incinerator inlet for the purpose of hydrocarbon concentration measurement must be returned, unaltered, to the sample manifold. This is necessary in order to avoid the risk of any bias in the system pressure or incinerator mass emission caused by application of this test procedure.

8.1.2.6 Incinerator Exhaust Sample Location

The vapor incinerator exhaust sample must be taken from the exhaust stack downstream of the burner far enough to permit complete mixing of the combustion gases. A sampling point which is at least eight stack diameters downstream of any flow disturbance, and two diameter upstream of any flow disturbance is desirable. Flow disturbances of concern include a bend, expansion, or contraction in the stack, the stack exhaust point, and the location of a visible flame.

If the "8 and 2 criteria" cannot be met, a sampling point which is at least two stack diameters downstream of any flow disturbance and one diameter upstream of any flow disturbance may be used. Any alternative sampling locations which do not meet these minimum criteria must be approved by the ARB Executive Officer on the basis of adequate justification, submitted by the applicant. This justification shall include analysis based on sound scientific and engineering principals, to demonstrate that an incinerator stack with sampling ports which meet the minimum criteria are not feasible for GDF installations of the certified VRS. In any event, the sample point shall be no less than one half diameter from the stack exit and one stack diameter above the high point of the visible flame and be at a point of maximum velocity head, normally the center of the stack.

(Further guidance on sampling locations for gaseous pollutant concentration measurement can be found in 40CFR Pt.60 App. A, Meth. 1 and App. B, Spec 2)

Note that any use of temporary stack extensions or other apparatus installed solely for the purpose of source testing shall not be allowed if there is evidence indicating that the quantity or chemical structure of the incinerator emissions will be altered by the presence of such apparatus.

8.1.2.7 Incinerator Performance Specifications

The vapor incinerator shall be evaluated and tested to determine any performance specifications that are deemed necessary by the ARB Executive Officer to ensure

that GDF installation of the certified VRS are operated in a manner consistent with the operation of the vapor incinerator during certification testing following TP-201.1A. The following performance specifications may warrant evaluation:

- (1) a performance specification for time averaged hydrocarbon concentration (as propane) in the incinerator exhaust stream and
- (2) a performance specification for time averaged carbon monoxide (CO) concentration in the incinerator exhaust stream and
- (3) performance specifications for other critical incinerator operating parameters such as: maximum and minimum volumetric vapor processing rates, exhaust stack temperatures, vapor feed blower fan speed and inlet pressure etc.

The results of evaluation and testing of the system shall be documented in the certification test report and shall include:

- (1) the identification of the critical incinerator operating parameters,
- (2) the performance specifications for the critical incinerator operating parameters, and
- (3) the specification of any necessary monitoring and alarm requirements for temperature, pressure, hydrocarbon and/or carbon monoxide concentration, feed blower operating parameters, and other critical incinerator operating parameters. indicating gauges, detection devices, and alarms

8.1.3 Cargo Tank Fill and Vapor Return Line Test Points

These additional test points are not necessary to determine the emission factor test result using this test procedure. However, the information may be deemed necessary by the ARB Executive Officer for the purpose of evaluating other aspects of the Phase I VRS. The temperature and pressure of vapors in the return line are used to estimate the standard volume of vapors returned to the cargo tank based on the volume of gasoline transferred to the storage tank. This estimation assumes a 1 to 1 volume ratio for the volume of vapor displaced from the storage tank to the volume of liquid transferred to the storage tank (i.e. there is no significant change in vapor volume due to vapor condensation or liquid evaporation during the transfer).

- (1) If required, connect the couplers to the tank truck fuel and vapor return lines and connect the temperature and pressure measuring devices to these couplers. Calibrate the measurement devices in accordance with section 6.
- (2) Temperature and pressure measurements shall be continuously recorded using strip chart recorders or manually recording at a minimum frequency of once each minute during the entire time period of the gasoline transfer operation.

8.2 General Sampling Parameters

During TP-201.1A testing periodic or continuous measurements shall be recorded for the following system parameters shown in hexagon outlines in Figure 1:

HC = Hydrocarbon Concentration

CO = Carbon Monoxide Concentration

CO₂ = Carbon Dioxide Concentration

V = Volume

P = Pressure

T = Temperature

9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

9.1 Analyzers

A comprehensive laboratory calibration shall have been conducted within the six month period proceeding the use of any analyzer for testing conducted using TP-201.1A. During the laboratory calibration the analyzer response to zero gas and a number (6 for instruments with a linear response and 10 if the analyzer response is non-linear) of known gas concentrations are recorded. The known gas concentrations (traceable to reference cylinders) and the observed analyzer response are used to produce a calibration curve or equation. Laboratory calibrations must be conducted using procedures that will produce analyzer calibrations that demonstrate equivalent accuracy and precision to laboratory calibrations that are conducted following ARB "SOP No. MLD 054, Standard Operating Procedure for the Multilevel Calibrations of Pollutant Gas Analyzers".

9.2 Calibration Gases

Calibration gases are classified into three types:

(1) **Standard Reference Materials**

These are primary standards to which all other standards shall be traceable. For any substance for which no standard reference material is obtainable, a calibration gas of the highest level of accuracy and precision obtainable shall qualify as a standard reference material, subject to approval by the ARB Executive Officer.

A standard reference material, which normally is kept at a main laboratory, qualifies as an intermediate standard and as a working standard, too.

(2) **Intermediate Standards**

These are secondary standards which shall be assayed versus the corresponding NIST-SRM once every six months with a concentration difference which is no more than one percent of the results for the NIST-SRM. An intermediate standard container which does not

meet its assay requirement shall be taken out of service. To re-enter service, the intermediate standard container shall be recharged and meet its assay requirement.

An intermediate standard, which normally is kept at a branch laboratory or a shop, qualifies as a working standard, too.

(3) Working Standards

These are tertiary standards which shall be assayed versus the corresponding intermediate standard before every test with a concentration difference which is no more than one percent of the results for the intermediate standard. A working standard container which does not meet its assay requirement shall be taken out of service. To re-enter service, the working standard container shall be recharged and meet its assay requirement.

A working standard normally serves for field calibration and testing.

A "Certificate of Analysis" from the gas supplier can be submitted in the Certification Test Report as evidence of compliance with the specifications above; regardless of such certificate, the tester is ultimately responsible for satisfying the requirements given above in the event that a certificate is contradicted by subsequent analysis of the contents of a certified gas container.

All calibrations shall be performed with a calibration gas of at least working standard quality. Any cylinder is to be recharged or taken out of service when the cylinder pressure drops to 10 percent of the original pressure.

Information on calibration gas cylinders shall be entered into a permanent log identifying each cylinder by serial number. Sufficient information shall be maintained to allow a determination of the compliance status of each calibration gas per these requirements; such information shall be recorded for each cylinder and shall include, but not be limited to: (1) the date put in service, (2) assay result (3) the dates the assay was performed, (4) the organization and specific personnel who performed the assay, and (5) the date taken out of service.

9.3 Volume Meters

Standard methods and equipment shall be used to calibrate the meters on an annual basis. The calibration curves are to be traceable to NIST standards. The error in the volume determined by the meter shall be less than 5% of the true volume over the entire range of flow rates for which the meter will be used during testing performed following TP-201.2.

10 RECORDING DATA

10.1 Methods of Recording

10.1.1 Strip Charts Required

The output response of all continuous monitoring instruments utilized to determine the values of the parameters identified in figure 1 shall be continuously recorded on ink and paper strip charts. The strip chart data shall include the instrument response during field calibrations required by this test procedure. These strip charts shall be available to the

ARB Executive Officer at any time during testing conducted following TP-201.1A and shall be included in the final test report submitted to the ARB Executive Officer. Manual logging of data from test equipment which are not equipped with a continuous instrument output (e.g. a volume totaling meter) may be used with the prior approval of the ARB Executive Officer.

10.1.2 Electronic Data

Electronic data logging and data reduction / manipulation is recommended during the testing conducted pursuant to TP-201.1A. The electronic data need not contain all intermediate values of the data recorded pursuant to Section 10.1.1. However, the average values of the sampled parameters and the total mass determined at each test point should be permanently recorded for each Phase I transfer episode. Furthermore, frequent intermediate values of the total mass emitted at test points 1, and 2 or 2b if present, should be recorded during the post transfer monitoring period. Frequent recording of intermediate values may be critical to any attempt to justify data manipulation procedures that are proposed to invalidate and repeat specific portions of the test rather than invalidating and repeating the entire test period necessary for satisfactory completion of TP-201.1A

10.2 Chain of Custody

Written data records must be kept during testing and persons in control of such data must be documented in a chain of custody record.

10.3 Necessary and Sufficient Data

Written data records must contain all information used to calculate and report final results.

10.4 Reconciliation of Reported Results to Recorded Data

The final results must be verifiable by recalculation from the written data records.

10.5 Permanent Records

These written data records must remain permanently on file and available for use by the Executive Officer of the Air Resources Board when requested.

11 CALCULATING RESULTS

Calculate mass emission factor results to the nearest 0.001 lb/kgal.

In this section, the term "vent" and the specified procedures for calculating results from vent data shall also apply to any assist processor exhaust with which such procedures are compatible. Procedures are also specified for incinerator type assist processors. Any assist processor which is incompatible with the application of these procedures shall not be certified until the compatibility requirements of the certification procedures are met.

11.1 General Nomenclature

Figure 1 illustrates some parameters specified in the calculations

11.1.1 Parameters

General parameters are listed below, other parameters are defined in the calculations or alternative procedures:

[HC] = hydrocarbon concentration
(volume fraction, i.e. ppm_v / 10⁶ or Volume % / 10²)

V_m = metered volume of gases and vapors,

P = meter pressure, and

T = meter temperature.

For each Phase I gasoline transfer episode:

G = volume of gasoline transferred, and

t = elapsed time during gasoline transfer.

11.1.2 Subscripts

Subscripts shall be used to distinguish parameters and modes of measurement, e.g.:

Subscripts are used to distinguish values for the same general parameter at differing test locations and times, e.g.:

P_(t,e,s) = value of parameter "P" at test point "t" for transfer episode "e" during the time interval "s".

Any or all of these subscripts may modify a parameter, and for consistency, subscripts will appear in the order (t,e,s) given above, e.g.:

P_(t,e) = value of parameter "P" at test point "t"; for transfer episode "e" and

P_t = value of parameter "P" at test point "t" for the entire test period.

11.2 Volume at Standard Conditions of Temperature and Pressure

Directly measured volumes (such as those directly measured for Test points 1, 2, and 2a) shall be standardized as follows:

$$V = V_m \times \left(\frac{528}{T} \right) \times \left[\frac{P_{\text{bar}} + \left(\frac{P}{13.6} \right)}{29.92} \right]$$

where:

V = volume corrected to standard conditions (ft^3).

V_m = measured volume (ft^3).

P_{bar} = barometric pressure (in. Hg).

P = meter pressure (in. water gauge).

T = meter temperature ($^{\circ}\text{R}$).

11.3 Concentration

Each measured concentration of gas and vapor shall be corrected for any analyzer zero and/or span drifts and shall be expressed as a volume fraction (i.e. volume % / 10^2 or ppm / 10^6).

11.4 Mass

HC mass emissions are calculated as the product of a volume (std. cu. ft.), a HC volume fraction (cu. ft. HC / cu. ft.), and a mass density (Lb. HC / std. cu. ft. HC). If the volumetric flow rate at the test point does not vary significantly with time then the time averaged HC concentration can be multiplied by the total volume for the time period to obtain an accurate total hydrocarbon mass for the time period. However, if the volumetric flow rate at the test point varies significantly with time, then incremental masses must be calculated from incremental volume and time averaged concentrations for subintervals of short enough duration that the flow rate is essentially constant for the subinterval. The incremental masses calculated in this manner for each subinterval must then be summed over the entire time period for which the total mass is to be determined. This is most readily accomplished through the use of electronic data acquisition and manipulation to calculate and sum incremental masses representing time periods on the order of several seconds.

Masses are calculated using the following equation:

$$m_t = V_t \times [\text{HC}]_t \times \left[\frac{\text{MW}}{385} \right]$$

where:

m_t = mass determined at test point t (lb)

V_t = volume determined at test point t corrected to standard conditions (ft^3).

$[\text{HC}]_t$ = hydrocarbon concentration of auxiliary fuel
(volume fraction = volume % / 10^2 or ppm / 10^6)

MW = molecular weight of HC analyzer calibration gas, e.g. 44 for propane (lb/lb-mole)

385 = standard volume (ft³) of one lb-mole of ideal gas at standard temperature and pressure (528°R and 29.92 in. Hg)

11.5 Volume Calculations

11.5.1 Volume for Test Points 1 and 2 (Vents and/or Assist Processor Exhaust)

This volume is directly measured and shall be standardized per section 11.2

11.5.2 Volume for Test Point 2b (Vapor Incinerator Exhaust)

The incinerator exhaust volume is calculated per EPA Method 2B. Note the possibility for simplifying assumptions described in Section 8.1.2.3

11.5.2.1 Preliminary Incinerator Outlet Volume Calculations

Before calculating the vapor incinerator outlet volume, calculate the following preliminary values:

(1) inlet volume from the facility vapor space (test point 4b)

Any inlet volume from the facility vapor space entering the vapor incinerator is directly measured and shall be standardized per Section 11.2.

(2) inlet volume of auxiliary fuel

If directly measured the inlet volume of auxiliary fuel entering the vapor incinerator shall be standardized per Section 11.2

(3) total inlet volume entering vapor incinerator

$$V_{in} = V_{fvs} + V_{af}$$

where:

V_{in} = total inlet volume entering vapor incinerator (SCF)

V_{fvs} = inlet volume from the facility vapor space (SCF)

V_{af} = inlet volume of auxiliary fuel (SCF)

11.5.4.2 Inlet Hydrocarbon Concentration

The combined inlet hydrocarbon concentration of gasoline vapors and auxiliary fuel shall be calculated using the following equation

$$[\text{HC}]_{\text{in}} = \frac{[(N_{\text{fvs}} \times [\text{HC}]_{\text{fvs}} \times V_{\text{fvs}}) + (N_{\text{af}} \times [\text{HC}]_{\text{af}} \times V_{\text{af}})]}{V_{\text{in}}}$$

where:

V_{in} = total inlet volume entering vapor incinerator (SCF)

$[\text{HC}]_{\text{in}}$ = combined hydrocarbon concentration at the vapor incinerator inlet (volume fraction)

N = number of carbon atoms in each molecule of calibration gas

$[\text{HC}]_{\text{fvs}}$ = hydrocarbon concentration of vapors from the facility vapor space at the vapor incinerator inlet (volume fraction)

$[\text{HC}]_{\text{af}}$ = hydrocarbon concentration of auxiliary fuel (volume fraction)

Note 1

The equation presented above for the combined hydrocarbon concentration at the vapor incinerator inlet, $[\text{HC}]_{\text{in}}$, is used when the hydrocarbon concentration of the auxiliary fuel, $[\text{HC}]_{\text{af}}$, is determined during certification testing using a hydrocarbon analyzer. Simplifying assumptions, which produce acceptable accuracy for the incinerator exhaust mass, can be made when standard auxiliary fuels such as natural gas, propane or liquefied petroleum gas, are used. The simplification involves the substitution of the carbon concentration of the auxiliary fuel for the terms $N_{\text{af}} \times [\text{HC}]_{\text{af}}$ in the equation above. The carbon concentration (i.e. $1 \times [\text{CH}_4] + 2 \times [\text{C}_2\text{H}_6] + 3 \times [\text{C}_3\text{H}_8] + \dots$) can be determined from a chemical analysis of the auxiliary fuel which may be available from the auxiliary fuel supplier.

Note 2

If no auxiliary fuel is used by the incinerator the equation for the inlet hydrocarbon concentration reduces to:

$$[\text{HC}]_{\text{in}} = N_{\text{fvs}} \times [\text{HC}]_{\text{fvs}}$$

11.5.4.3 Final Incinerator Exhaust Volume Calculations

Calculate the vapor incinerator exhaust volume using the following equation:

$$V_{\text{exh}} = \frac{V_{\text{in}} \times [\text{HC}]_{\text{in}}}{(N_{\text{exh}} \times [\text{HC}]_{\text{exh}}) + [\text{CO}_2] + [\text{CO}] - 0.0003}$$

where:

- V_{exh} = vapor incinerator outlet volume (SCF)
- V_{in} = total inlet volume entering vapor incinerator (SCF)
- $[\text{HC}]_{\text{in}}$ = combined hydrocarbon concentration at the vapor incinerator inlet
(volume fraction = % by volume / 10^2)
- N_{exh} = number of carbon atoms in each molecule of calibration gas for
the incinerator exhaust HC analyzer
- $[\text{HC}]_{\text{exh}}$ = vapor incinerator exhaust hydrocarbon concentration
(volume fraction = ppm / 10^6)
- $[\text{CO}_2]$ = vapor incinerator outlet carbon dioxide concentration
(volume fraction = % by volume / 10^2)
- $[\text{CO}]$ = vapor incinerator outlet carbon monoxide concentration
(volume fraction = ppm / 10^6)
- 0.0003 = assumed background concentration of CO_2
(volume fraction = ppm / 10^6)

11.6 Mass Emission Factor

The mass emission factor is calculated from the total volume of gasoline transferred from the cargo tank to the storage tank(s) and the HC mass emissions determined at the tank vent(s) and if present at the vapor processor or vapor incinerator exhaust. The calculation is performed as follows:

$$EF = \frac{(m_1 + m_2) \times 1000}{G}$$

where:

- EF = the Phase I VRS mass emission factor determined during the test
(units of pound HC per thousand gallons of gasoline transferred)
- G = the total volume of gasoline delivered to the storage tank(s) during the test
(units of gross gallons)
- m_1 = the mass emissions through the tank vent(s)
(units of pounds HC as propane)
- m_2 = the mass emissions through the vapor processor or vapor incinerator exhaust
(units of pounds HC as propane)

11.7 Volume of Vapor Returned to Cargo Tank Through Phase I Vapor Return Line

The volume for the vapor return line test point is not necessary for the emission factor determination for which this test procedure is designed. Further discussion on the determination of this parameter is included in TP-201.1.

The volume for the vapor return line test point is not directly measured and shall be calculated as follows:

$$V_{vr} = \left(\left(\frac{G}{7.481} \right) \times \left(\frac{528}{T} \right) \times \left(\frac{P_{bar} + \frac{P_m}{13.6}}{29.92} \right) \right) - V_1 - V_{2 \text{ or } 2a}$$

where:

V_{vr} = vapor return line volume corrected to standard conditions.

V_1 = vent line volume corrected to standard conditions.

$V_{2 \text{ or } 2a}$ = volume entering vapor processor or vapor incinerator corrected to standard conditions. (Note: The inlet volume to a vapor processor is not necessary to determine the emission factor for which this test procedure is applicable. Procedures for measuring or estimating the inlet volume to a vapor processor are not presented in this test procedure. An air mass balance based on the volume of air exiting the processor and the concentration of HC in the processor inlet and exhaust streams may provide an adequate estimate of the vapor processor inlet volume.)

G = gallons of gasoline transferred.

P_{bar} = barometric pressure (in. Hg).

P_m = final pressure in vapor return line (in. water gauge).

T = average temperature of gas stream in vapor return line ($^{\circ}R$).

12 REPORTING RESULTS

The following are required by Section 10 RECORDING DATA:

- (1) Chain of Custody
- (2) Necessary and Sufficient Data
- (3) Reconciliation of Reported Results to Recorded Data
- (4) Permanent Records

All results must be written and submitted on acceptable media as specified by the the ARB Executive Officer on a case-by-case basis for each report.

In cases of conflict between hard copy and electronic format, the hard copy shall be presumed correct, unless the ARB Executive Officer specifies otherwise in writing.

13 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure will produce results equivalent to those produced by TP-201.1A with precision and accuracy as good or better than obtainable through application of this test procedure.

- (1) Such approval shall only be granted on a case-by-case basis. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.
- (2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

14 REFERENCES

This section is reserved for future specification.

15 EXAMPLE FIGURES AND FORMS

15.1 Figures

Each figure provides an illustration of test implements which conform to the requirements of this test procedure; other test implements which so conform are acceptable, too. Any specifications or dimensions provided in the figures are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

Figures depicting the test apparatus used at the Phase I vapor return line are presented in TP-201.1

Note:

The following figures focus on volume measurements. Further details regarding hydrocarbon concentration measurements are provided in the figures for Phase II testing in TP-201.2; which may be appropriate if necessary modifications are made to address the differences between Phase I and Phase II testing procedures.

**Figure 1
Test Locations**

Figure 2
Vent Test Point 3
Single Vent (Volume Measurement)

Figure 3
Vent Test Point 3
Vents Connected by Manifold (Volume Measurement)

Figure 1
Test Locations

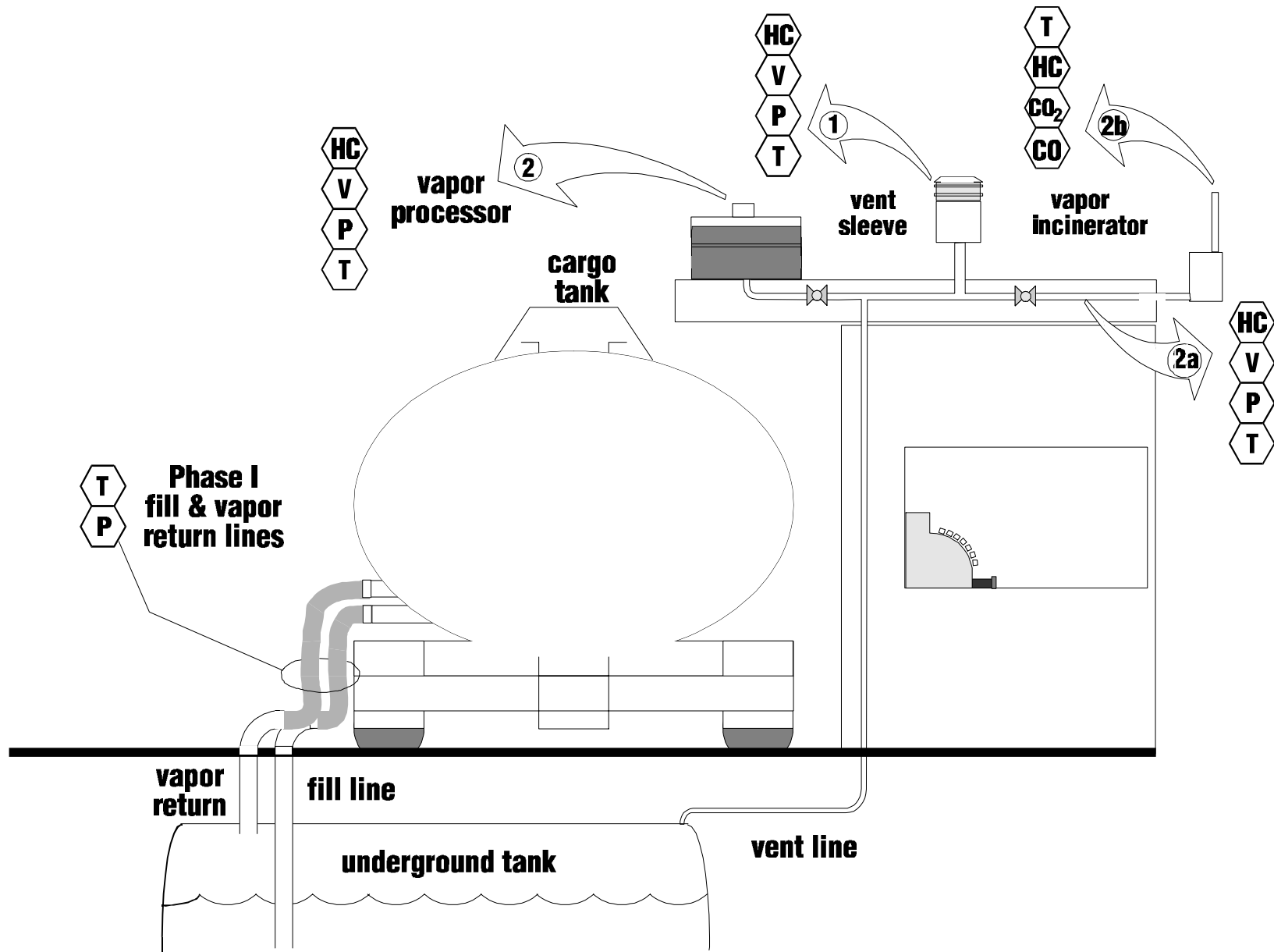
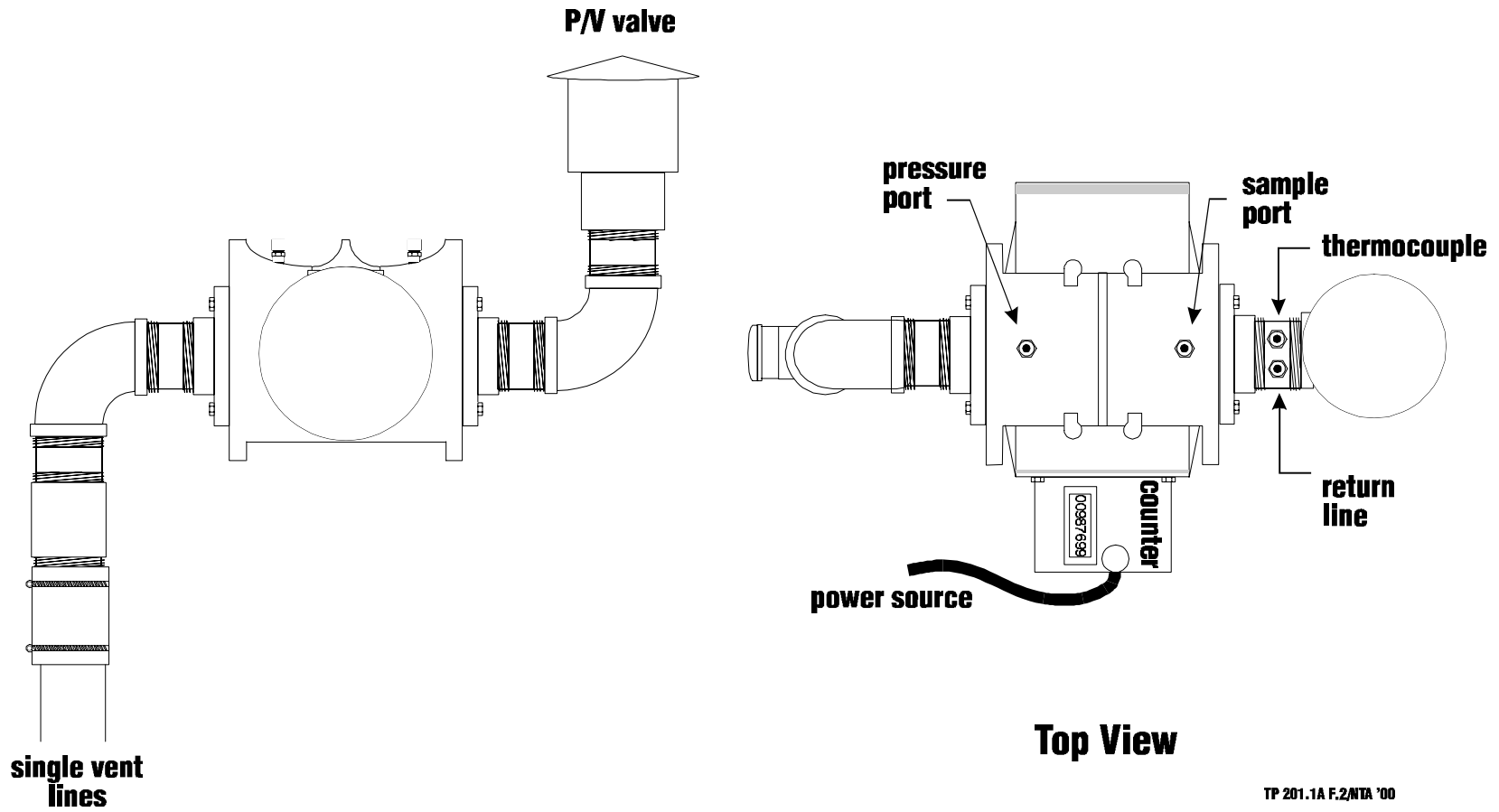
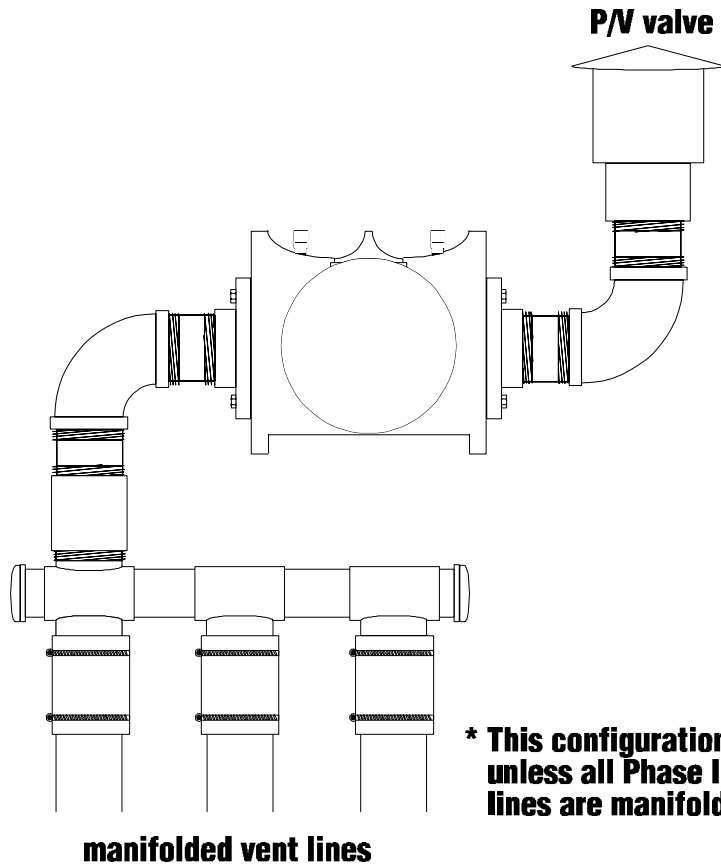


Figure 2
Test Point 3, Single Vent (Volume Measurement)

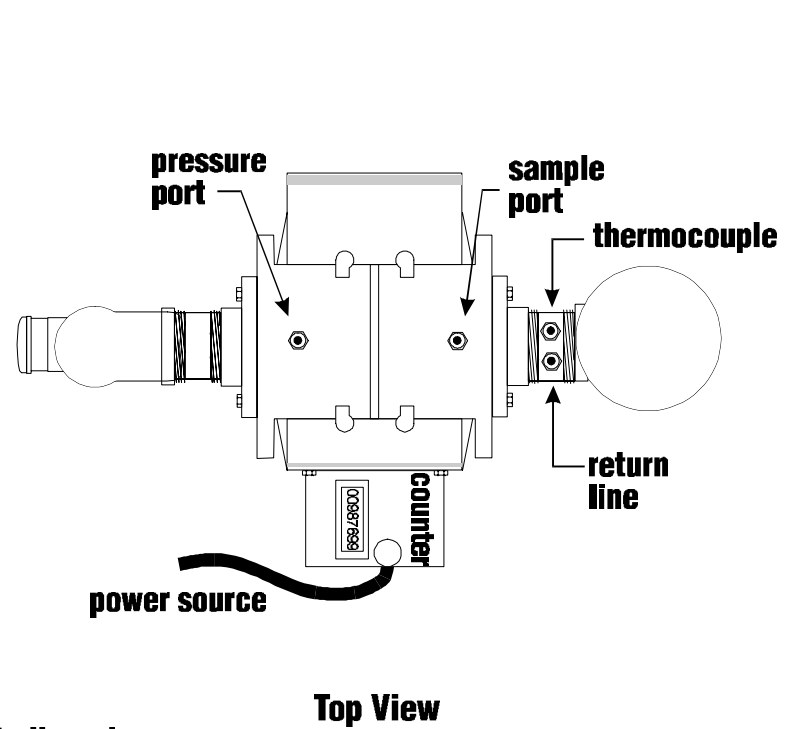


TP 201.1A F.2/NTA '00

Figure 3
Test Point 3, Vents Connected by Manifold (Volume Measurement)



*** This configuration is not allowed unless all Phase II vapor return lines are manifolded.**



TP 201.1A F3/NTA '00