B2158

VOLATILE ORGANIC COMPOUND EMISSION TEST REPORT

OF THE

BUCKEYE TERMINALS

WOODHAVEN, MICHIGAN TRANSPORT LOADING TERMINAL

ON THE

JOHN ZINK VAPOR COMBUSTION UNIT

NOVEMBER 13, 2013

Terminal Info:

Buckeye Terminals
20755 West Rd
Woodhaven, MI 48183
Contact: Mike Barrett
Phone: (734) 676-6509

Tester Information:

Jordan Technologies, Inc.
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JORDAN® TECHNOLOGIES

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DECLARATION OF ACCURACY

Certification of sampling procedures by the team leader of the personnel conducting the sampling procedures and compiling the test report:

"I certify that the sampling procedures were performed in accordance with the approved test plan and that the data presented in this report are, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below."

Signature: ____________ Printed Name of Person Signing: Troy Hardin

Title: Technician, Environmental Testing Division Date: 12/2/13

Certification of test report by the senior staff person at the company who is responsible for checking the test report:

"I certify that this test report and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the test information submitted. Based on my inquiry of the person or persons who performed sampling and analysis relating to the performance test, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below."

Signature: James Stamm Printed Name of Person Signing: James Stamm, P.E.

Title: Sr. Environmental Engineer Date: 12/9/13

Deviations from SOP

1. No deviations noted during testing

EXECUTIVE SUMMARY

The Buckeye Terminals facility in Woodhaven, Michigan is a bulk transport loading facility for Gasoline and Fuel Oil Products.

The products are bottom loaded into transport tankers and the displaced hydrocarbon vapors are balanced to a JOHN ZINK VAPOR COMBUSTION UNIT (VCU).

This facility was source tested for air emissions on November 13, 2013. The purpose of this test was to confirm proper operation of the VCU and verify compliance with applicable VOC (Volatile Organic Compound) air emission requirements

The Gasoline Terminal Air Emission Source Test was conducted in accordance with procedures established, and the test methods referenced, in the Code of Federal Regulations; CFR 40, Part 60, Subpart XX and CFR 40, Part 63, Subpart BBBBBB. Specific procedures used include:

EPA TEST METHOD	MEASUREMENT
Method 2A	Inlet Vapor Volume into VCU
Method 2B	Exhaust Vapor Volume from VCU
Method 10	Exhaust CO Concentration
Method 3A	Exhaust CO_2 Concentration
Method 21	Potential Leak Sources (500 PPM Leak Rate)
Method 25 B	Inlet and Outlet VOC Concentrations
40 CFR 60 Subsection 60.503 (d)	Transport Loading Maximum Backpressure

The results of this air emission test demonstrate that this source is in compliance with the applicable Federal and Local requirements. A summary of the data is presented below:

TEST PARAMETER	MEASURED VALUE	REQUIRED VALUE
VOC Emissions	8.59 mg/liter	10 mg/liter

The Method 21 Leak Test was performed on the day prior to testing. A portable LEL meter was calibrated using a 500 PPM methane calibration gas. The meter was used to check for leaks around all fittings, flanges, valves as well as any other exposed potential leak source. No leaks were found in excess of 500 ppm.

TERMINAL OPERATION AND DESCRIPTION

Light petroleum products are bottom loaded at four loading bays at the Buckeye Terminals Woodhaven, Michigan terminal. .

The terminal is equipped to load Regular Gasoline fuel products onto transports.

The truck loading rack is equipped with vapor recovery hoses positioned at the transport loading positions for hook up to the Vapor Combustion System. All trucks that load must connect the vapor recovery hose before loading liquid product.

The vapor hoses have individual check valves that prevent unused hoses from leaking any vapors. The vapor pipe manifold connects the vapor hoses to the VCU. The vapor pipe system also employs a liquid condensate accumulator, flame arrester and pressure/vacuum relief valve upstream from the VCU.

NOTE: The terminal is not currently actively loading gasoline products on a daily basis. Two tanker trucks were hired to load and pump off product for the test day to achieve the 80,000 gallons. The VCU was operated while using natural gas as an assist combustion gas.

VAPOR COMBUSTION UNIT DESCRIPTION

A brief description of the vapor combustion unit (VCU) process is presented below. For a detailed description, please consult the manufacturer's equipment manual.

The VCU consists of the following components:

- Vertical combustion stack with louvers to allow discharge of secondary combustion air
- Primary air blower
- Non-flashback burner assembly
- Pilot burner
- Various electric and mechanical controls required for proper and safe operation.

The incoming hydrocarbon vapors from the truck loading facility are mixed with primary combustion air and then ignited by a natural gas (propane) fueled pilot burner. Secondary combustion air is mixed with the combustion products as they continue through the firebox and ultimately vent to the atmosphere at the top of the vertical stack.

The VCU has an interlock to prevent the venting of vapors to the VCU prior to it being in an operating mode. When a tank truck enters the loading rack, a vapor line is attached to the tank truck to move hydrocarbon vapors to the VCU.
Before the truck can be loaded, the VCU must provide a signal indicating that it is ready to receive vapors.

When the interlock is satisfied, the VCU turns on and purges the stack with the primary combustion air blower. This step is a safety requirement to remove any residual vapors that may be present in the stack before lighting the pilot. Once the pilot is lit and proven, the VCU returns the required "Ready to Load" signal to the truck load rack. As the truck loads liquid gasoline, the displacement pressure pushes the hydrocarbon vapors from the truck to the VCU for combustion. The vapor pipe contains a small condensate accumulator to prevent any thermal condensation liquid to reach the burner assembly and also a flame arrester for safety. A moderate increase in vapor line pressure opens a flow control valve allowing the vapors to pass to the burner of the VCU.

During the operation of the VCU, the primary combustion air blower introduces fresh air to the hydrocarbon/air vapor mix in front of the burner. The vapors are passed through the burner assembly and oxidized. The VCU stack is sized to contain the vapor combustion zone in which the vapor combustion continues as the combustion products mix with secondary combustion air and vent through the top of the stack.

MEASUREMENT AND DATA ANALYSIS

The following methods were completed as part of the test protocol:

- Method 2A and 2B - vapor volume measurement.
- Method 10 – CO/ CO_2 concentration
- Method 21 – System leak detection
- Method 25B – Hydrocarbon concentration (NDIR is capable of separating methane from other hydrocarbons)

Transport loading pressure was monitored as described in sub-section 60.503 (d) (i.e., 18" water column gauge test). All sampling procedures conformed to procedures outlined in New Source Performance Standards (NSPS), 40 CFR 60, Subpart XX – Section 60.503 – Test Methods and Procedures and Subpart BBBBBB. A total of 92,700 gallons of accountable gasoline were loaded during the six-hour period.

All vapor collection equipment, including fittings, vents and hoses were tested using the Method 21 test. This test is required by 40 CFR 63 Subpart BBBBBB requirements (prior to beginning the test). Any readings equal to or greater than 500 PPM as methane would have been considered a leak and noted and repaired prior to beginning the test. No leaks were observed during the test.

Transports were tested for system backpressure after being connected to the VCU using the procedures in 40 CFR 60 section 60.503(d). A Dwyer Magnehelic Pressure Gauge was connected to the transport vapor hose connection. Pressure readings were recorded on the truck loading data sheets. All loading bays were tested.

Method 21 leak detection testing was conducted on any gasoline truck whose emissions showed obvious signs of leaks using sight, sound, and smell as an indication. In accordance with Subpart BBBBBB, Section 63.110902(a)(1)(i), any leak equal to or greater than 500 ppm vol. methane was considered a leak. Failed transport truck would have been classified as a failed leak test. No vehicles failed during the test.

In addition, any truck that loads a distillate fuel was excluded from the VOC emission calculations. If a previous product load was gasoline then that truck may be included as a switch load situation.

USEPA method 25B was used to monitor the exhaust VOC measurements from the VCU. The non-dispersive infrared analyzer (NDIR) was calibrated on propane and the full-scale range is 0 - 1,000-PPM volume. Protocol 1 gases were used to calibrate the analyzer. The exhaust VOC sample was collected through a heated sample line that was automatically regulated to 360° F $\pm$ 25°F. This feature prevents any water and soluble VOC condensation in the exhaust sample line.

A non-dispersive infrared analyzer, turbine flow meter, inlet vapor thermistor and inlet pressure transducer were connected to the VCU vapor inlet pipe to collect all test data. Inlet VOC flow meter temperature and pressure are used for standardizing volumes during data reduction.

Method 25B was also used to measure inlet VOC concentration. A continuous sample was taken through non-heated Teflon tubing from the turbine meter to the NDIR analyzer. Primary Standard gases were used to calibrate the inlet VOC analyzer. This analyzer operated on a 0-100% volume propane full-scale range.

Both VOC non-dispersive analyzers were calibrated using propane and nitrogen mixtures of approximately 0%, 25%, 50%, and 85% of full scale. A full calibration will be performed immediately prior to the start of the test. During the test, hourly drift checks will be performed using the 0% and 50% span gas to document acceptable span and zero drift. All pertinent field calibration data was made available for local onsite test observers.

Field data was monitored continuously and recorded every 5 minutes for printout as a test data point. The data is captured in a PLC and exported to an IBM compatible laptop computer running Wonderware software. The data monitored over the test period includes time, ambient temperature, inlet meter temperature, barometric temperature, flow meter static pressure, inlet hydrocarbon concentration, exhaust hydrocarbon concentration, exhaust CO and CO_2 concentrations, and inlet flow rate. All of the accumulated data is downloaded into an Excel spreadsheet to calculate:

- standardized inlet flow rate
- calculated exhaust flow rate
- inlet hydrocarbon mass
- exhaust hydrocarbon mass

At the end of testing, an Excel spreadsheet calculates the total mass of hydrocarbons emitted from the VCU during testing. The volume of accountable liters loaded during the test is then used to calculate the mass of hydrocarbons per liter of gasoline loaded. The inlet and exhaust mass of hydrocarbons is also used to calculate the VCU's destruction efficiency.
Copies of the transport loading rack sheets, hydrocarbon analyzer strip charts, and computer printouts will be attached as Appendices to the final test report.

Per CFR 40 Part 60 Method 25A Section 8.5 (referenced by Method 25B): response time testing will be performed three times on the measurement system at the calibration valve assembly and the average results will be reported.

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AIR QUALITY DIV.

TEST EQUIPMENT

Quantity	Item
2	Thermistor Temperature Probes (turbine meter standardization, ambient)
1	Allen Bradley PLC, IBM compatible Laptop Computer, Wonderware software, Excel software data reduction package
1	Portable LEL Gas Analyzer (Method 21 Leak Testing) RKI Instruments Eagle Portable Gas Detector (0-500 or 0-10,000 PPM)
1	Variable Differential Pressure Transducer (turbine meter standardization) Setra Model: 264
1	Digital Barometer (turbine meter standardization) Setra Model: 270
1	American Meter Co. 8" Turbine Flow Meter (Method 2A Testing)
1	Strip Chart Recorder: Yokogawa DX1000N Six Channel Paperless Recorder
2	VOC Gas Analyzers (Method 25B): Horiba VIA 510 NDIR Analyzer
1	CO/CO_2 Gas Analyzer (Method 10 and Method 3A) Horiba VIA 510 Gas Analyzer with, Horiba Gas Sample Conditioner
1	Heated Sample Line (360° F ± 25° F)
1	Stack probe assembly
2	Dwyer Magnehelic Pressure Gauge Model #2030 (40 CFR 60.503 (d) testing)

All equipment specifications are shown in Appendix B along with available calibration and accuracy information.

EXAMPLE CALCULATIONS

A. Terminology:

T_a = Ambient Temperature (° Celsius).

P_b = Barometric Pressure (mm Hg).

L = Total accountable volume of liquid dispensed from all controlled racks during the test period (Liters).

CO_e = Carbon Monoxide Concentration in Exhaust Stack (ppm volume).

CO_{2e} = Carbon Dioxide Concentration in Exhaust Stack (ppm volume).

HC_e = TOC Concentration in Exhaust Stack (ppm volume).

HC_i = TOC Concentration in Combustor Inlet (Volume %) .

V_i = Inlet Volume of air-hydrocarbon mixture to the combustor (m^3).

V_e = Exhaust volume from the combustor (m^3).

V_{es} = Standardized exhaust volume from the combustor (m^3, 20° C, 760 mmHg).

T_i = Temperature at process unit inlet metering position (° Celsius).

P_i = Pressure at processing unit inlet metering position (mm Hg.).

M_i = Mass of TOC input to combustor during test period (milligrams).

M_e = Mass of organic carbon exhausted during test period (milligrams).

K1 = Calibration Gas Factor (3 for propane C_3H_8).

K2 = 1.83×10^6 mg/m^3 = Standard Density of Propane (C_3H_8).

H = Total Test Time (Hour).
454,000 = Conversion Factor mg/lb.

3.785 = Conversion Factor Liter/Gallon.

264.2 = Conversion Factor Gallon / cubic meter

B. Standardize Flow Volume:

$$V_{is} = V_i \times \frac{(0.3858^\circ \text{ K/mm Hg}) \times (P_i + P_b)}{(T_i + 273.2^\circ \text{ K})} \quad (\text{meter}^3)$$

Where: $0.3858 = (273.2 + 20)\ ^{\circ}K/760$ mm Hg

C. Calculate Mass of Inlet Hydrocarbon: **(Formula A)**

$M_i = (K2) \times (V_{is}) \times (HC_i) \times (10^{-2})$ (mg)

Where: 10^{-2} = the required conversion from vol % to vol fraction

D. Calculate Combustor Exhaust Flow Volume: **(Formula B)**

$$V_{es} = \frac{V_{is} \times (K1) \times (HC_i) \times (10^4)}{[(K1) \times (HC_e)] + CO_{2e} + CO_e - 300} \quad (m^3)$$

Where: 10^4 = conversion factor from vol % to ppm volume
Note: analyzer automatically compensates for ambient CO_2 concentrations.

E. Calculate Mass of Exhaust Hydrocarbon: **(Formula C)**

$M_e = (10^{-6}) \times (K2) \times (V_{es}) \times (HC_e)$ (mg)

Where: 10^{-6} = the conversion factor from ppm-volume to vol fraction

F. Calculate Hydrocarbon Emission Rate:

$$M_e/L = \frac{\text{Sum of all 5 second } M_e \text{ calculations}}{\text{Liters of Accountable Gasoline Loaded}} \quad \text{(mg/liter)}$$

$$M_e/H = (M_e/L)\frac{\text{mg}}{\text{liter}} \times \frac{1 \text{ lb}}{454{,}000 \text{ mg}} \times \frac{3.785 \text{ liter}}{1 \text{ gal}} \times \frac{\text{Accountable gals}}{\text{Total Test Time}} \quad \text{(lb/hr)}$$

G. Efficiency Calculation:

Efficiency = [(1-outlet mg) / (inlet mg)] x 100% (%)

H. Example calculation for a typical five-minute interval:

This is an example calculation only and not an interval from this test. This is intended to clarify the computer method for arriving at the TOC inlet mass data for each test interval.

Barometric Pressure	= 759.36 mm Hg
Flow Pressure	= 14.355 mm Hg
Ambient Temperature	= 15.1° C
Inlet Temperature	= 11.2° C
TOC Inlet Concentration	= 13.9 volume %
TOC Outlet Concentration	= 19.9 ppm

Volume in	= 18.0 m^3
Milligrams in	= 4,597,633 mg
Exhaust Stack Volume	= 2,630.7 m^3
Milligrams Emitted	= 95,975.32 mg
Carbon Monoxide out	= 8.2 ppm
Carbon Dioxide out	= 2,828.0 ppm

Please Note: All data fields are rounded to two places following the decimal point for display purposes only.

1) Therefore for this calculation:

	17.95	lowest possible value before rounding for display
V_i =	**18.0**	**value displayed (After rounding)**
	18.05	highest possible value before rounding for display
	13.85	lowest possible value before rounding for display
TOC_i = 13.9		**value displayed (After rounding)**
	13.95	highest possible value before rounding for display

2) Using Formula A above to calculate M_i:

Lowest Value	$(1.83 \times 10^6) \times (0.1385) \times (17.95)$	= 4,549,517.3mg
TOC inlet mass (M_i)	$(1.83 \times 10^6) \times (0.1390) \times (18.0)$	= 4,578,660.0 mg
Value Calculated by Computer		**= 4,597,633.0 mg***
Highest Value	$(1.83 \times 10^6) \times (0.1395) \times (18.05)$	= 4,607,894.2 mg

* NOTE: The value printed for M_i by the computer for this interval is 4,597,633. While this is not the result produced from entering the printed values for HC_i and V_i into Formula A, it is the result produced by the calculation carried out on the stored computer data, **PRIOR TO ROUNDING FOR DISPLAY.**

The computer calculates the results for Combustor Exhaust Volume and Exhaust Mass with the same data reduction method seen above with Combustor Inlet Volume and Inlet Mass.

3.) Using Formula B Above:

$$\text{Combustor Exhaust Volume} = \frac{(18) \times (3) \times (13.9) \times (10{,}000)}{[(3) \times (19.9)] + (2{,}828) + (8.2)}$$

$$= 2{,}592 \text{ m}^3$$

4.) Using Formula C Above:

$$\text{HC Mass Emitted} = (0.000001) \times (1.83 \times 10^6) \times (2{,}630.7) \times (19.9)$$

$$= 95{,}802.2 \text{ mg}$$

DATA SUMMARY

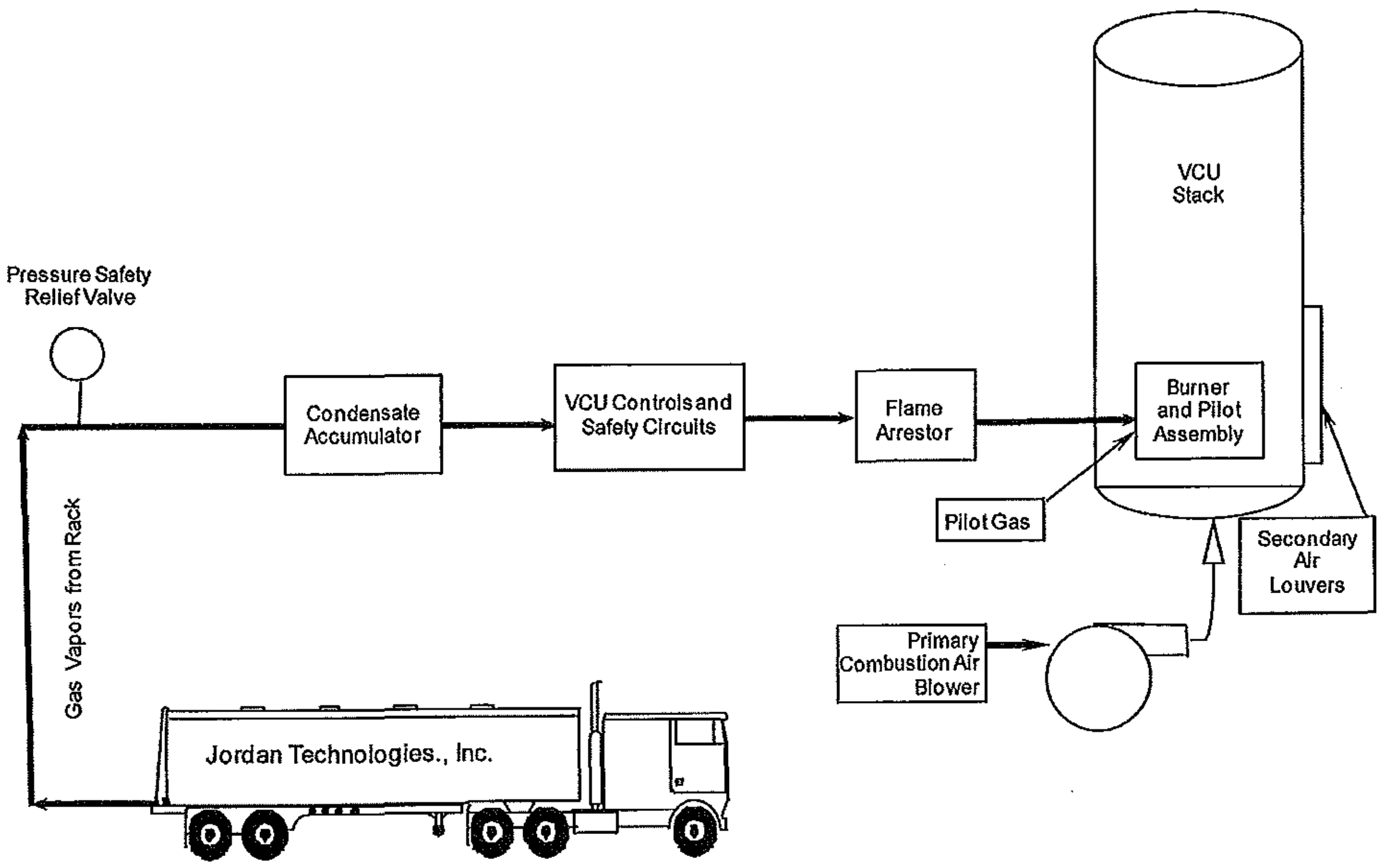
TERMINAL DESCRIPTION	Buckeye Terminals Woodhaven, Michigan
VAPOR CONTROL UNIT TYPE	John Zink VCU
TEST DATE	November 13, 2013
TEST PERIOD	06:56 – 12:56 6 hrs
AVERAGE AMBIENT TEMPERATURE	33.35^{o} F
AVERAGE OUTLET CONCENTRATIONS:	
VOC	41.9 ppm volume
CO	242.28 ppm volume
CO_2	0.80 volume %
AVERAGE INLET CONCENTRATION	9.29 volume % (as propane equivalent)
TOTAL MILLIGRAMS OF VOC EMITTED	2,805,844.5 mg VOC
TOTAL PETROLEUM LOADED	86,326 gallons 326,743.9 Liters
ACCOUNTABLE PETROLEUM LOADED	86,326 gallons 326,743.9 Liters
AVERAGE HYDROCARBON EMISSIONS (Calculated with Total Loaded Product)	8.59 mg/liter 1.05 lb/hr
AVERAGE HYDROCARBON EMISSIONS (Calculated with Accountable Product Loaded)	8.59 mg/liter 1.05 lb/hr
NUMBER OF TRUCKS LOADED	8
NUMBER OF LEAKING TRUCKS	0
VOLUME OF LEAKING TRUCKS	0 gallons
MAXIMUM PRESSURE AT TRUCK VAPOR HOSE	10.0" H_20
UNIT EFFICIENCY	97.78%
Analyzer Response Time	<10 sec.

Findings

An emission test was performed on November 13, 2013 on the vapor combustion unit (VCU) located at the Buckeye Terminal in Woodhaven, Michigan. The purpose of this test was to confirm proper operation of the VCU and verify compliance with applicable VOC (Volatile Organic Compound) air emission requirements.

The emission test consisted of a six hour sample event during normal facility operations. The results of the performance test showed an average hydrocarbon emissions rate of 8.59 mg/l. The demonstrated emission rate meets the facility limit of 10 mg/l.

3.0 VAPOR COMBUSTION UNIT (VCU) – SCHEMATIC



4.2 TEST EQUIPMENT LAYOUT