MONTROSE
AIR QUALITY SERVICES

FG-BDSV05 Hydrogen Cyanide, Benzene, Toluene, and Phenol Emissions Test Summary Report

Prepared for:

Blue Diamond Casting LLC

125 Sturm Road
Pigeon, Michigan 48755

Project No. 049AS-460765
January 17, 2019

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Executive Summary

Montrose Air Quality Services, LLC (MAQS) was retained by Blue Diamond Casting LLC (BDC) to conduct an engineering evaluation of air pollutant emission rates from one exhaust stack at the BDC facility located in Pigeon, Michigan. The purpose of the emissions test program was to measure hydrogen cyanide (HCN), benzene, toluene, and phenol concentrations and emission rates from the FG-BDSV05 exhaust stack. Testing for this project was conducted on November 14, 2018.

Sampling was performed utilizing United States Environmental Protection Agency (USEPA) methods. The emissions test program included:

(1) Measurement of exhaust gas flowrates and HCN concentrations using Methods 1, 2, 3, 4, and OTM-29 and,
(2) Measurement of benzene, toluene, and phenol concentrations using a modified version of Method 18.

The results of the emissions test program are summarized by Table E-1.

Table E-1
Overall Test Results Summary
FG-BDSV05

Test Date	Pollutant	Test Method	Average Emission Rate (lbs/hr)
11/14/18	HCN	OTM-29	<0.01
11/14/18	Benzene	18	0.40
11/14/18	Toluene	18	0.48
11/14/18	Phenol	18	0.46

*Benzene, toluene, and phenol emissions measured using sorbent tubes and FTIR analysis meeting the QA/QC requirements of Method 18 (see report in Appendix D for detailed descriptions)

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1.0 Introduction

Montrose Air Quality Services, LLC (MAQS) was retained by Blue Diamond Casting LLC (BDC) to conduct an engineering evaluation of air pollutant emission rates from one exhaust stack at the BDC facility located in Pigeon, Michigan. The purpose of the emissions test program was to measure hydrogen cyanide (HCN), benzene, toluene, and phenol concentrations and emission rates from the FG-BDSV05 exhaust stack. Testing for this project was conducted on November 14, 2018.

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(1) Measurement of exhaust gas flowrates and HCN concentrations using Methods 1, 2, 3, 4, and OTM-29 and,
(2) Measurement of benzene, toluene, and phenol concentrations using a modified version of Method 18.

1.1 Project Contacts

A list of project participants is included below:

Facility Information:
Blue Diamond Casting LLC
125 Sturm Road
Pigeon, Michigan 48755

Project Contact:
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EHS Director
Blue Diamond Steel Casting, LLC
125 Sturm Road
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2.0 Process Description

Emission units exhausted through stack SV-05. EU-SHELL2POUR: This unit includes the pourline, shot separator, and shot cooler. All activities are controlled by a 50,000 cfm baghouse (BH-18). EU-SHELL2COOL: The shell cooling room encloses cast molds on a conveyor and is

controlled by baghouses BH-19A and BH-19B, 30,000 dscfm each. EU-SHELL2SAND: The shell sand system includes the mechanical reclaim, dumper, shakeout conveyor, shot sand screen, vibramill, bucket elevators, torch stations, and sand tanks. The sand system is controlled by a 40,000 cfm baghouse (BH-17).

3.0 Sampling and Analytical Methodologies

Sampling and analytical methodologies for the emissions test program can be separated into three categories as follows:

(1) Measurement of exhaust gas velocity, molecular weight, and moisture content;
(2) Measurement of HCN concentration using Method OTM 29; and,
(3) Measurement of benzene, toluene, and phenol concentration using USEPA Method 18.

Testing for HCN concentrations using Method OTM-29 consisted of triplicate 96-minute test runs. Method 18 testing for concentrations of benzene, toluene, and phenol concentrations consisted of triplicate test runs ranging from 101 to 113 minutes.

3.1 Exhaust Gas Velocity, Molecular Weight, and Moisture Content

Measurement of exhaust gas velocity, molecular weight, and moisture content were conducted using the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - "Sample and Velocity Traverses for Stationary Sources"
- Method 2 - "Determination of Stack Gas Velocity and Volumetric Flowrate"
- Method 3 - "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources" (Fyrite)
- Method 4 - "Determination of Moisture Content in Stack Gases"

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2 (see Figure 1 for a schematic of the sampling location). An S-type pitot tube with a thermocouple assembly, calibrated in accordance with Method 2, Section 4.1.1, was used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The S-type pitot tube dimensions were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

A cyclonic flow check was performed at the sampling location. The existence of cyclonic flow is determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. If the average of the absolute values of the flow angle is greater than 20 degrees, cyclonic flow exists. The null angle was determined to be less than 20 degrees at each sampling point.

Molecular weight was determined according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers.

Carbon dioxide and oxygen content were analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the HCN sampling train and passed through the impinger configuration (see Figure 3). Exhaust gas moisture content was then determined gravimetrically.

3.2 HCN (OTM 29)

USEPA Other Test Method 29, *"Sampling and Analysis for Hydrogen Cyanide Emissions from Stationary Sources"* was used to measure Hydrogen Cyanide concentrations and calculate Hydrogen Cyanide emission rates (see Figure 2 for a schematic of the sampling train). Triplicate 96-minute test runs were conducted.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a borosilicate glass nozzle, (2) a borosilicate glass probe liner, (3) a heated borosilicate or quartz glass filter holder containing a pre-weighed 90-mm diameter filter with Teflon filter support, (4) three modified Greenburg-Smith (GS) impingers with the standard tip filled with 100 mL of 6N NaOH solution, (5) a fourth modified GS impinger containing approximately 300 g of silica gel desiccant, (6) a length of sample line, and (7) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

A sampling train leak test was conducted before and after each test run. After completion of the final leak test for each test run the nozzle, probe, and filter holder were brushed and triple rinsed with acetone and the filter was recovered and placed in a petri dish. Since analysis of particulate matter was not needed the samples were discarded following procedures for proper disposal of potentially hazardous materials.

After recording the pH and weighing the first two impingers, the contents were poured into container No. 1. The impingers and connecting glassware were then triple rinsed with 0.1N NaOH and the rinse was added to container No. 1. After recording the pH and weighing the third impinger, the contents were poured into container No. 2. The impinger and connecting glassware were then triple rinsed with 0.1N NaOH and the rinse was added to container No. 2. The liquid level in the sample containers was marked and they were both sealed and labeled for lab analysis.

A full field blank train was assembled, leak checked, and the probe heated for the duration of one sample run; no gas was passed through the train other than during leak checks. At the completion of the test run, the field blank train was leak checked and recovered the same as the actual sample trains. In addition to the field blank, a reagent blank of the 0.1N NaOH was collected.

In addition to the field and reagent blank samples, a single sampling train was assembled and a spiked aliquot added to the first impinger. The spiked train was also recovered the same as the other trains. All samples were couriered to Enthalpy Analytical for laboratory analysis. Sample and QA analytical results are presented in the Enthalpy report included in Appendix D.

3.3 Benzene, Toluene, and Phenol (Method 18)

Benzene, toluene, and phenol concentrations and emission rates were measured using the procedures of U.S. EPA Method 18 codified at Title 40, Part 60 of the Code of Federal Regulations. Emissions samples were concentrated onto MAQS's MAX™ AS002 tri-matrix thermal desorption tubes (TDTs). TDT samples were collected using a MAX Analytical MAX™ Sampler System. The sampling manifold was equipped with ¼" stainless steel heated transfer lines and was configured to collect spiked and unspiked TDT samples concurrently using a small diaphragm pump. Sample flow rates were monitored and controlled using calibrated mass flow controllers (MFCs). TDT samples were desorbed and analyzed using a MAX™ GC-FTIR.

GC-FTIR data was collected using a MAX™ Analytical GC-FTIR gas analyzer. The MAX™ was equipped with a resistive heated GC column coupled to an FTIR detector with a temperature controlled, 5.11 meter multipass gas cell maintained at 191°C. All data was collected at 4 cm-1 resolution. Each spectrum was derived from the co-addition of 14 scans, with a new data point generated approximately every 2.5 seconds.

Samples were thermally desorbed to the GC utilizing a heated TDT desorber and nitrogen (N2) carrier gas. Gas flow was controlled using an MFC to deliver a constant flow rate to the TDT and to the column. Sample split and/or focusing will not be performed. All contents of the TDT passed through the GC and were analyzed in the FTIR gas cell.

At the beginning of each sample analysis, the gas cell was pulled down below 0.005 atm by a roughing pump to clear the gas cell for the next sample. The vacuum valve stayed open until after completion of the isothermal program to eliminate as much of the water from the sample as possible. The valve was closed for the remainder of the sample analysis.

QA/QC procedures followed US EPA Method 18. TDT sample flow rates were controlled by calibrated MFCs and the flows were monitored on a second by second basis.

4.0 Test Results

Overall emission test results for this test project are presented in Table 1.

Table 1
Overall Test Results Summary
FG-BDSV05

Test Date	Pollutant	Test Method	Average Emission Rate (lbs/hr)
11/14/18	HCN	OTM-29	<0.01
11/14/18	Benzene	18	0.40
11/14/18	Toluene	18	0.48
11/14/18	Phenol	18	0.46

*Benzene, toluene, and phenol emissions measured using sorbent tubes and FTIR analysis meeting the QA/QC requirements of Method 18 (see report in Appendix D for detailed descriptions)

Detailed emissions test measurements and results are summarized by Tables 2 and 3. Field and computer generated data and field notes are available in Appendix A. Equipment calibration information is presented in Appendix B. Example calculations for equations used to determine emission rates are presented in Appendix C. Laboratory analytical results and the FTIR/Method 18 reports are presented in Appendix D. Process data collected by Blue Diamond is included in Appendix E.

MEASUREMENT UNCERTAINTY STATEMENT

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose Air Quality Services, LLC, (MAQS) personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, MAQS personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of our Quality Manual and ASTM D 7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

Limitations

All testing performed was done in conformance to the ASTM D7036-04 standard. The information and opinions rendered in this report are exclusively for use by MSC. MAQS will not distribute or publish this report without MSC's consent except as required by law or court order. MAQS accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

This report was prepared by: _____

Jacob Young
Staff Engineer

This report was reviewed by: _____

Randal J. Tysar
District Manager

Tables

Table 2
FG-BDSV05 Benzene, Toluene, Phenol, and Hydrogen Cyanide Emission Rates
Blue Diamond Steel
Pigeon, Michigan
BTEC Project No. 049AS-460765
Sampling Date: November 14, 2018

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	11/14/2018	11/14/2018	11/14/2018	
Test Run Time	10:12-12:05	12:55-14:36	15:25-17:06	
Test Run Duration (min)	113	101	101	
Outlet Flowrate (dscfm)	133,993	131,523	131,728	**132,415**
Outlet Flowrate (scfm)	134,565	132,095	132,295	**132,985**
Resin Poured (lbs)	189	378	567	
Benzene Concentration (Method 18, ppmv)	0.21	0.22	0.31	**0.25**
Benzene Emission Rate (Method 18, lbs/hr)	0.34	0.36	0.49	**0.40**
Benzene Emissions (Method 18, lbs)	0.64	0.60	0.83	**0.69**
Benzene Emission Rate (Method 18, lbs/lb resin)	0.0034	0.0016	0.0015	**0.0022**
Toluene Concentration (Method 18, ppmv)	0.22	0.25	0.30	**0.25**
Toluene Emission Rate (Method 18, lbs/hr)	0.43	0.46	0.56	**0.48**
Toluene Emissions (Method 18, lbs)	0.81	0.78	0.94	**0.84**
Toluene Emission Rate (Method 18, lbs/lb resin)	0.0043	0.0021	0.0017	**0.0027**
Phenol Concentration (Method 18, ppmv)	0.23	0.22	0.26	**0.24**
Phenol Emission Rate (Method 18, lbs/hr)	0.44	0.42	0.51	**0.46**
Phenol Emissions (Method 18, lbs)	0.83	0.71	0.85	**0.80**
Phenol Emission Rate (Method 18, lbs/lb resin)	0.0044	0.0019	0.0015	**0.0026**
Hydrogen Cyanide Concentration (Method OTM-29, ppmv)	< 0.01	< 0.01	< 0.01	< **0.01**
Hydrogen Cyanide Emission Rate (Method OTM-29, lbs/hr)	< 0.01	< 0.01	< 0.01	< **0.01**
Hydrogen Cyanide Emissions (Method OTM-29, lbs)	< 0.01	< 0.01	< 0.01	< **0.01**
Hydrogen Cyanide Emission Rate (Method OTM-29, lbs/lb resin)	< **0.00007**	< **0.00003**	< **0.00002**	< **0.00004**

scfm = standard cubic feet per minute
dscfm = dry standard cubic feet per minute
ppmv = parts per million on a volume-to-volume basis
lb/hr = pounds per hour

Table 3
Method OTM-29 HCN Emission Test Results Summary

Company	**Blue Diamond**			
Source Designation	**Dust Collector**			
Test Date	**11/14/2018**	**11/14/2018**	**11/14/2018**	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	77.6	85.3	89.3	84.0
Meter Pressure - Pm (in. Hg)	29.8	29.8	29.8	29.8
Measured Sample Volume (Vm)	34.3	34.2	34.8	34.5
Sample Volume (Vm-Std ft3)	33.1	32.5	32.9	32.9
Sample Volume (Vm-Std m3)	0.94	0.92	0.93	0.93
Condensate Volume (Vw-std)	0.141	0.141	0.141	0.141
Gas Density (Ps(std) lbs/ft3) (wet)	0.0744	0.0744	0.0744	0.0744
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	2.48	2.43	2.46	2.46
Total weight of sampled gas (m g lbs) (dry)	2.47	2.42	2.45	2.45
Nozzle Size - An (sq. ft.)	0.000136	0.000136	0.000136	0.000136
Isokinetic Variation - I	93.1	93.1	94.0	93.4
Stack Data				
Average Stack Temperature - Ts (F)	74.7	78.0	83.3	78.7
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.8	28.8	28.8	28.8
Stack Gas Specific Gravity (Gs)	0.994	0.994	0.994	0.994
Percent Moisture (Bws)	0.42	0.43	0.43	0.43
Water Vapor Volume (fraction)	0.0042	0.0043	0.0043	0.0043
Pressure - Ps ("Hg)	29.8	29.8	29.8	29.8
Average Stack Velocity -Vs (ft/sec)	46.4	45.8	46.4	46.2
Area of Stack (ft2)	49.2	49.2	49.2	49.2
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	136,993	135,317	136,834	136,381
Flowrate ft^3 (Standard Wet)	134,565	132,095	132,295	132,985
Flowrate ft^3 (Standard Dry)	133,993	131,523	131,728	132,415
Flowrate m^3 (standard dry)	3,794	3,724	3,730	3,750
Total HCN Weight (ug)				
Sample Catch	14	12	14	13
Blank correction	0	0	0	0
Total	14	12	14	13
Total HCN Concentration				
lb/1000 lb (wet)	0.000	0.000	0.000	0.000
lb/1000 lb (dry)	0.000	0.000	0.000	0.000
mg/dscm (dry)	0.0	0.0	0.0	0.0
Total HCN Emission Rate				
lb/ hr	0.007	0.007	0.007	0.007

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Figures

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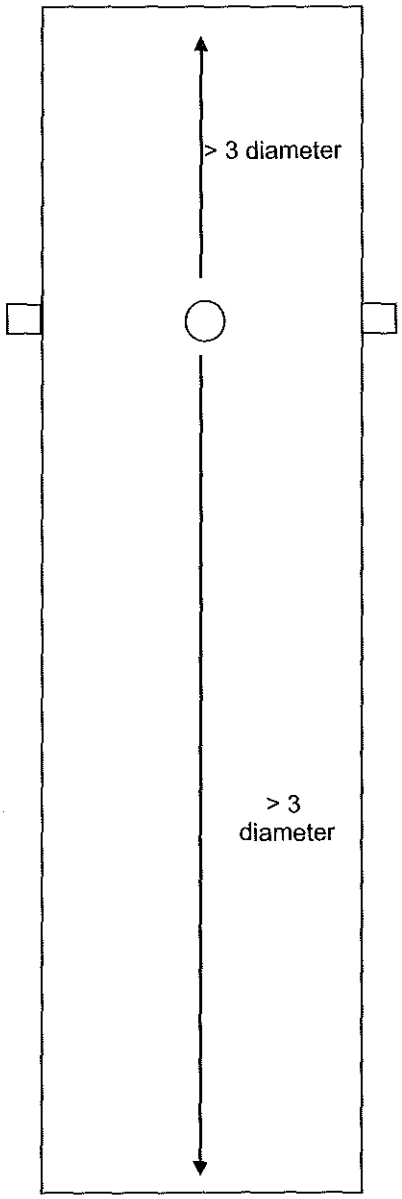
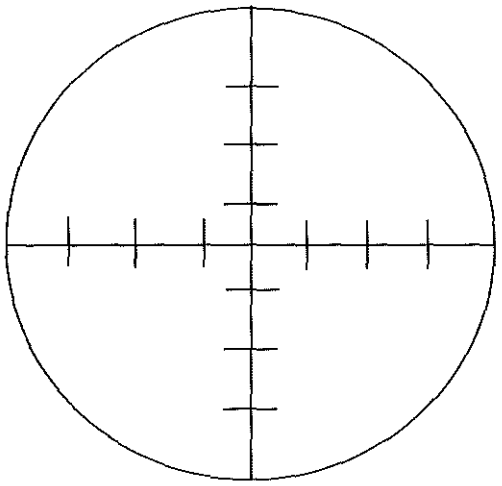
diameter = 95"





Not to Scale

Points	Distance "
1	2.0
2	6.4
3	11.2
4	16.8
5	23.8
6	33.8
7	61.2
8	71.3
9	78.2
10	83.8
11	88.6
12	93.0

Figure 1

Site: **SV-05** **Blue Diamond Casting** **Pigeon, Michigan**	**Sampling Dates:** **November 14, 2018**	**Montrose Air Quality Services, LLC** **4949 Fernlee** **Royal Oak, Michigan**

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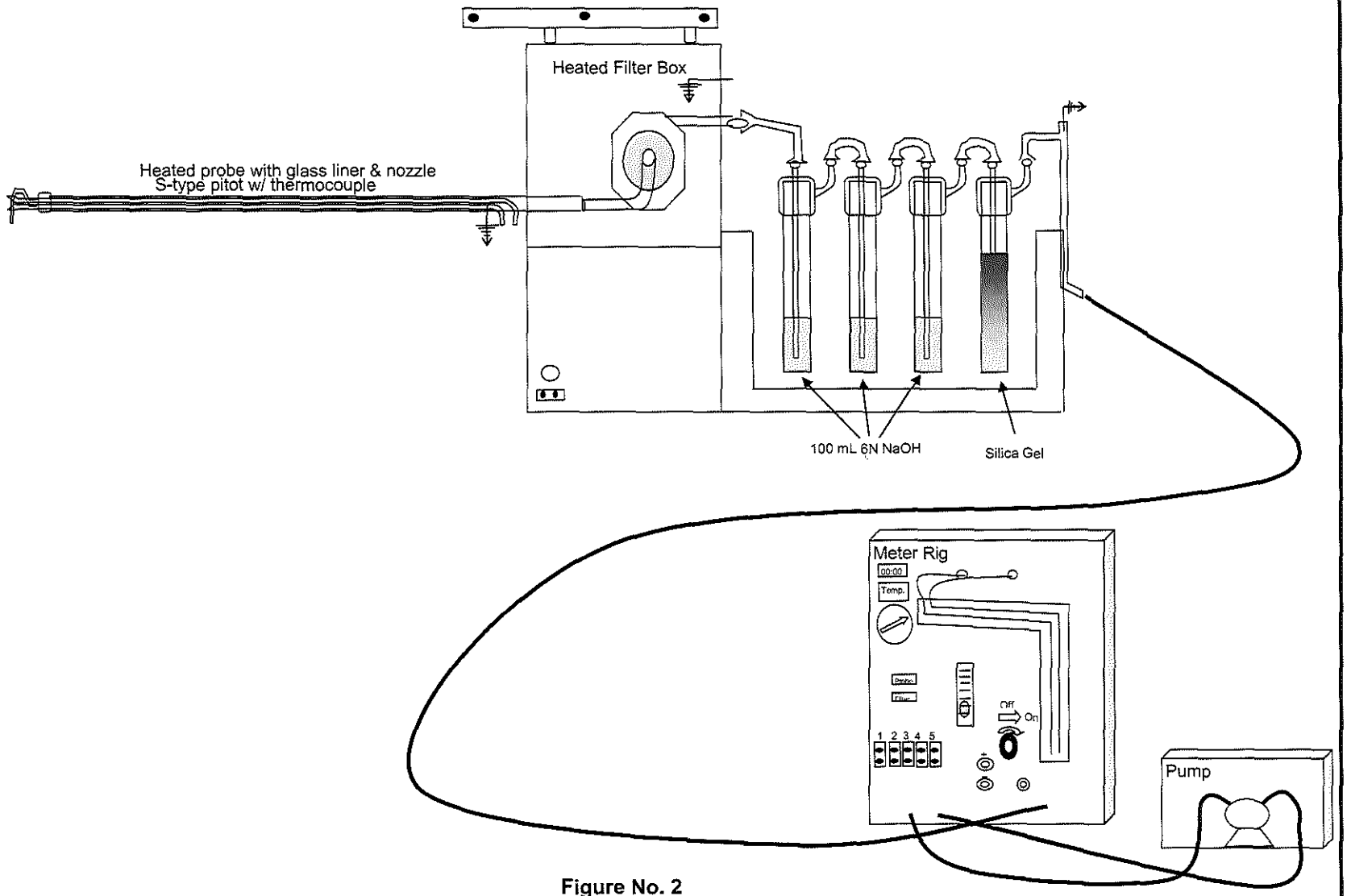

Figure No. 2

Site: **Other Test Method 29 (OTM 29)** **Blue Diamond** **Pigeon, Michigan**	**Sampling Date:** **November 14, 2018**	**Monrose Air Quality Services, LLC** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**