BTEC Inc.

LRF #1 & 2 Emissions Test Report

Prepared for:

Severstal Dearborn, LLC

Dearborn, Michigan

Severstal Dearborn, LLC
14661 Rotunda Drive
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Project No. 13-4438.00
October 16, 2013

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BTEC Inc.

Executive Summary

BT Environmental Consulting, Inc. (BTEC) was retained by Severstal Dearborn, LLC (Severstal) to evaluate air pollutant emission rates from the two Ladle Refining Facilities (LRF 1 & 2) at the Severstal facility located in Dearborn, Michigan. The test project consisted of evaluating exhaust gas flowrates, filterable particulate matter (PM), and manganese emissions. Testing for this project was conducted from August 20th through August 22nd, 2013.

The test program consisted of six tests at each LRF stack, approximately 96 minutes in duration, while the ladle refining facilities were operating under normal conditions. Sampling was performed utilizing United States Environmental Protection Agency (USEPA) reference test methods. The average results of the emissions test program are summarized by Table 1.

Table 1
Overall Emission Summary

Test Parameter	LRF #1		LRF #2	
	Limit	Results	Limit	Results
Filterable Particulate Matter (PM)	6.8 lb/hr	0.72 lb/hr	3.87 lb/hr	0.49 lb/hr
Filterable Particulate Matter (PM)	0.005 gr/dscf	0.001 gr/dscf	0.005 gr/dscf	0.001 gr/dscf
Total Manganese (Mn) [1]	NA	5.91×10^{-3} lb/hr	NA	4.84×10^{-3} lb/hr
Total Manganese (Mn) [1]	NA	9.21×10^{-6} gr/dscf	NA	9.42×10^{-6} gr/dscf

[1] Please note that despite high values being determined for manganese in the front half of the full field blanks conducted at each of the LRF stacks, the values presented in Table 1 represent uncorrected test run results

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1.0 Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Severstal Dearborn, LLC (Severstal) to evaluate air pollutant emission rates from the two (2) exhaust stacks associated with the Ladle Refining Facilities (LRF 1 & 2) at the Severstal facility located in Dearborn, Michigan. The test project consisted of evaluating exhaust gas flowrates, filterable particulate matter (PM) and Manganese emission rates. Testing for this project was conducted from August 20th through August 22nd, 2013.

The following BTEC professionals participated in conducting this study: Ken Lievense, Matthew Young and Todd Wessel, Project Managers; and Paul Molenda and Paul Draper, Environmental Technicians. Mr. Thomas Maza with the Michigan Department of Environmental Quality was onsite to witness the test program.

The purpose of the project was to evaluate the exhaust gas flow rates, PM concentrations, manganese concentrations and calculate the resultant emission rates from two independent exhaust stacks. The emissions data will be utilized for compliance and engineering purposes. Mr. Ted Bishop, and Mr. James Earl with Severstal's Environmental Engineering department, provided the on-site coordination for this project.

2.0 Process Description

The purpose of the LRFs is to prepare the steel for casting through final temperature and chemistry adjustments. The LRFs receive molten steel from the basic oxygen furnace (BOF). The steel is reheated by electricity and, if necessary, manganese or other alloys are added to achieve the required alloy composition. Emissions from LRFs are controlled by their own individual pulse-jet baghouses, each equipped with a bag leak detection system that continuously monitors the particulate matter loading in the exhaust to ensure proper operation.

3.0 Sampling and Analytical Methodologies

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

(1) Measurement of exhaust gas velocity, molecular weight, and moisture content; and,
(2) Measurement of filterable particulate matter and Manganese using Methods 5 and 29.

Descriptions of sampling and analytical methodologies by category are summarized by Sections 3.1 through 3.2, respectively.

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 40 CFR 60, Appendix A:

Method 1 - *"Location of the Sampling Site and Sampling Points"*
Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flow rate"*

Method 3 - *"Determination of Molecular Weight of Dry Stack Gas" (Fyrite)*
Method 4 - *"Determination of Moisture Content in Stack Gases"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2 (see Figures 1-2 for exhaust stack traverse point diagrams). 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.

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 PM sampling train (see figure 3 for a schematic of the sampling train) and passed through (i) two impingers each with 100 ml of a 5% HNO_3 / 10% H_2O_2 solution (ii) an empty impinger, (iii) and an impinger filled with approximately 300 grams of silica gel. Exhaust gas moisture content is then determined gravimetrically.

3.2 Select Metals (USEPA Methods 5/29)

40 CFR 60, Appendix A, Method 29, *"Determination of Metals Emissions From Stationary Sources"* was used to measure predetermined metals concentrations and calculate appropriate emission rates (see Figure 3 for a schematic of the sampling train). Six test runs were conducted on each LRF under normal operating condition. The Method 5 sampling was completed in conjunction with the Method 29 metals sampling.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consisted of (1) a borosilicate glass nozzle, (2) a glass probe, (3) a set of four Greenburg-Smith (GS) impingers with the first two with 100 ml of a 5% HNO_3 / 10% H_2O_2 solution (ii) an empty impinger, (iii) and an impinger filled with approximately 300 grams of silica gel, (4) a length of sample line, and (5) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

Note that the Method 29 impingers that normally contain a potassium permanganate ($KMnO_4$) solution (which is analyzed for mercury emissions) were omitted from the sampling train because mercury was not being tested for. This was done to prevent potential contamination with the results for manganese during the testing.

Upon completion of the final leak test for each test run, the filter was recovered, and the nozzle and the front half of the filter holder assembly were brushed and triple rinsed with 100 ml of 0.1N HNO_3. The rinses were collected in a pre-cleaned sample container and prepared for transport.

The back half of the filter housing and first two impingers were a triple rinsed with 100 ml of 0.1N HNO and placed in a clean sample container. The third impinger (empty) was not rinsed for this test program.

BTEC labeled each container with the test number, test location, and test date, then marked the level of liquid on the outside of the container. Train blanks were taken at each source in addition to blank samples of the filter, acetone, DI water, O.1N HNO3, and 5% HNO3 / 10% H2O2 solutions were collected. The samples were curried by Maxxam Analytics (Maxxam) personnel to Maxxam's laboratory in Mississauga, Ontario to be analyzed.

4.0 Test Results

The results of the emissions test program are summarized by Table 1. Please note that the emission estimates are based on uncorrected laboratory analytical data. No attempt was made to reduce the analytical test run results to account for reagent blanks or field blank results.

Table 1
Overall Emission Summary

Test Parameter	LRF #1		LRF #2	
	Limit	Results	Limit	Results
Filterable Particulate Matter (PM)	6.8 lb/hr	0.72 lb/hr	3.87 lb/hr	0.49 lb/hr
Filterable Particulate Matter (PM)	0.005 gr/dscf	0.001 gr/dscf	0.005 gr/dscf	0.001 gr/dscf
Total Manganese (Mn) [1]	NA	5.91×10^{-3} lb/hr	NA	4.84×10^{-3} lb/hr
Total Manganese (Mn) [1]	NA	9.21×10^{-6} gr/dscf	NA	9.42×10^{-6} gr/dscf

[1] Please note that despite high values being determined for manganese in the front half of the full field blanks conducted at each of the LRF stacks, the values presented in Table 1 represent uncorrected test run results

Field and computer generated data for each test run are available in Appendix A, as well as all other applicable field data. Equipment calibration information is presented in Appendix B. Example calculations for equations used to determine emission rates are presented in Appendix C. Laboratory analysis is available in Appendix D. Process data and Method 9 visible emission reading data are available in Appendix E and Appendix F, respectively.

5.0 Audit Sample

An audit sample for USEPA Method 29 was sent to Maxxam Analytics. All audit sample results were acceptable. Audit sample results are available in Appendix D.

Limitations

The information and opinions rendered in this report are exclusively for use by Severstal Dearborn, LLC. BTEC will not distribute or publish this report without Severstal's consent except as required by law or court order. BTEC 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: Brandon Chase

Brandon Chase
Staff Environmental Engineer

This report was reviewed by:

Matthew Young
Project Manager

Tables

Table 2
Ladle Refining Facility #1 Particulate Matter and Manganese Emission Rates

Company	Servestal NA						
Source Designation	LRF1						
Test Date	8/20/2013	8/20/2013	8/20/2013	8/21/2013	8/21/2013	8/21/2013	
Meter/Nozzle Information	P-1	P-2	P-3	P-4	P-5	P-6	Average
Meter Temperature Tm (F)	91.0	105.5	101.1	91.8	106.6	102.4	99.7
Meter Pressure - Pm (in. Hg)	29.6	29.5	29.5	29.5	29.5	29.5	29.5
Measured Sample Volume (Vm)	83.6	65.9	77.7	73.7	73.2	74.1	74.7
Sample Volume (Vm-Std ft3)	79.1	60.7	72.1	69.5	67.3	68.6	69.5
Sample Volume (Vm-Std m3)	2.24	1.72	2.04	1.97	1.90	1.94	1.97
Condensate Volume (Vw-std)	1.537	1.264	1.504	1.561	1.518	1.679	1.510
Gas Density (Ps(std) lbs/ft3) (wet)	0.0740	0.0740	0.0740	0.0739	0.0739	0.0739	0.0739
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	5.96	4.58	5.44	5.26	5.08	5.19	5.25
Total weight of sampled gas (m g lbs) (dry)	5.89	4.52	5.37	5.18	5.01	5.11	5.18
Nozzle Size - An (sq ft.)	0.000627	0.000601	0.000601	0.000623	0.000623	0.000623	0.000616
Isokinetic Variation - I	99.7	100.3	101.3	99.7	100.2	100.9	100.4
Stack Data							
Average Stack Temperature - Ts (F)	138.8	136.2	147.4	149.0	148.9	133.0	142.2
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.6	28.6	28.6	28.6	28.6	28.6	28.6
Stack Gas Specific Gravity (Gs)	0.989	0.988	0.988	0.988	0.987	0.987	0.988
Percent Moisture (Bws)	1.91	2.04	2.04	2.20	2.21	2.39	2.13
Water Vapor Volume (fraction)	0.0191	0.0204	0.0204	0.0220	0.0221	0.0239	0.0213
Pressure - Ps ("Hg)	29.4	29.4	29.4	29.4	29.4	29.4	29.4
Average Stack Velocity -Vs (ft/sec)	23.8	23.3	22.4	22.8	23.3	22.9	23.1
Area of Stack (ft2)	63.6	63.6	63.6	63.6	63.6	63.6	63.6
Exhaust Gas Flowrate							
Flowrate ft^3(Actual)	90,972	88,972	85,601	87,156	89,032	87,306	88,173
Flowrate ft^3 (Standard Wet)	78,826	77,437	73,122	74,260	75,875	76,395	75,986
Flowrate ft^3 (Standard Dry)	77,323	75,857	71,627	72,630	74,200	74,570	74,368
Flowrate m^3 (standard dry)	2,190	2,148	2,028	2,057	2,101	2,112	2,106
Total Particulate Weights (mg) [1]							
Total Nozzle/Probe/Filter	5.9	5.5	5.1	4.8	6.0	3.0	5.1
Total Metals Weights (ug) [1]							
Front Half Manganese	70.5	38.5	46.7	39.9	25.4	20.6	40.3
Back Half Manganese	2.59	1.12	2.46	1.60	1.90	1.10	1.80
Totals	73.09	39.62	49.16	41.50	27.30	21.70	42.06
Particulate Concentration							
lb/1000 lb (wet)	0.002	0.003	0.002	0.002	0.003	0.001	0.002
lb/1000 lb (dry)	0.002	0.003	0.002	0.002	0.003	0.001	0.002
mg/dscm (dry)	2.6	3.2	2.5	2.4	3.1	1.5	2.6
gr/dscf	0.0012	0.0014	0.0011	0.0011	0.0014	0.0007	0.0011
Particulate Emission Rate							
lb/ hr	0.77	0.91	0.67	0.67	0.88	0.43	0.72
Front Half Manganese Concentrations							
lb/1000 lb (wet)	2.61E-05	1.85E-05	1.89E-05	1.67E-05	1.10E-05	8.75E-06	1.67E-05
lb/1000 lb (dry)	2.64E-05	1.88E-05	1.92E-05	1.70E-05	1.12E-05	8.88E-06	1.69E-05
mg/dscm (dry)	3.15E-02	2.24E-02	2.29E-02	2.03E-02	1.33E-02	1.06E-02	2.02E-02
gr/dscf	1.38E-05	9.80E-06	1.00E-05	8.86E-06	5.83E-06	4.63E-06	8.81E-06
Front Half Manganese Emission Rate							
lb/ hr	9.15E-03	6.39E-03	6.16E-03	5.53E-03	3.72E-03	2.97E-03	5.66E-03
Back Half Manganese Concentrations							
lb/1000 lb (wet)	9.57E-07	5.39E-07	9.97E-07	6.71E-07	8.24E-07	4.67E-07	7.43E-07
lb/1000 lb (dry)	9.69E-07	5.46E-07	1.01E-06	6.81E-07	8.35E-07	4.74E-07	7.53E-07
mg/dscm (dry)	1.16E-03	6.52E-04	1.21E-03	8.13E-04	9.97E-04	5.66E-04	8.98E-04
gr/dscf	5.06E-07	2.85E-07	5.27E-07	3.55E-07	4.36E-07	2.47E-07	3.93E-07
Back Half Manganese Emission Rate							
lb/ hr	3.36E-04	1.86E-04	3.25E-04	2.22E-04	2.78E-04	1.59E-04	2.51E-04
Total Manganese Concentrations							
lb/1000 lb (wet)	2.70E-05	1.91E-05	1.99E-05	1.74E-05	1.18E-05	9.22E-06	1.74E-05
lb/1000 lb (dry)	2.73E-05	1.93E-05	2.02E-05	1.77E-05	1.20E-05	9.36E-06	1.76E-05
mg/dscm (dry)	3.26E-02	2.31E-02	2.41E-02	2.11E-02	1.43E-02	1.12E-02	2.11E-02
gr/dscf	1.43E-05	1.01E-05	1.05E-05	9.21E-06	6.26E-06	4.88E-06	9.21E-06
Total Manganese Emission Rate							
lb/ hr	9.49E-03	6.58E-03	6.49E-03	5.76E-03	4.00E-03	3.13E-03	5.91E-03

[1] Note: Lab analysis weights have not been corrected to account for PM and Mn weights found in either full Field Blank train or reagent blanks.

Table 3
Ladle Refining Facility #2 Particulate Matter and Manganese Emission Rates

Company	Severstal						
Source Designation	LRF 2						
Test Date	8/19/2013	8/20/2013	8/20/2013	8/20/2013	8/22/2013	8/22/2013	
Meter/Nozzle Information	P-1	P-2	P-3	P-4	P-5	P-6	Average
Meter Temperature Tm (F)	90.1	90.8	95.0	99.9	86.5	96.5	93.1
Meter Pressure - Pm (in. Hg)	29.5	29.5	29.5	29.5	29.4	29.4	29.5
Measured Sample Volume (Vm)	51.6	84.8	80.4	52.7	90.8	101.4	76.9
Sample Volume (Vm-Std ft3)	48.6	79.8	75.1	48.8	85.8	94.1	72.1
Sample Volume (Vm-Std m3)	1.38	2.26	2.13	1.38	2.43	2.67	2.04
Condensate Volume (Vw-std)	0.802	1.410	1.594	0.934	1.886	2.065	1.448
Gas Density (Ps(std) lbs/ft3) (wet)	0.0741	0.0740	0.0739	0.0740	0.0739	0.0739	0.0740
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.66	6.02	5.67	3.68	6.48	7.11	5.44
Total weight of sampled gas (m g lbs) (dry)	3.63	5.95	5.59	3.64	6.40	7.02	5.37
Nozzle Size - An (sq. ft.)	0.000392	0.000392	0.000374	0.000392	0.000374	0.000392	0.000386
Isokinetic Variation - I	99.7	99.9	100.7	100.1	100.2	100.2	100.1
Stack Data							
Average Stack Temperature - Ts (F)	141.5	153.5	164.4	163.5	150.4	158.6	155.3
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.7	28.6	28.6	28.6	28.6	28.6	28.6
Stack Gas Specific Gravity (Gs)	0.990	0.989	0.988	0.989	0.988	0.988	0.988
Percent Moisture (Bws)	1.62	1.73	2.08	1.88	2.15	2.15	1.93
Water Vapor Volume (fraction)	0.0162	0.0173	0.0208	0.0188	0.0215	0.0215	0.0193
Pressure - Ps ("Hg)	29.3	29.3	29.3	29.3	29.2	29.2	29.3
Average Stack Velocity -Vs (ft/sec)	43.8	42.7	43.5	42.5	42.3	42.2	42.8
Area of Stack (ft2)	28.1	28.1	28.1	28.1	28.1	28.1	28.1
Exhaust Gas Flowrate							
Flowrate ft^3(Actual)	73,787	71,958	73,233	71,497	71,249	71,125	72,142
Flowrate ft^3 (Standard Wet)	63,454	60,688	60,692	59,332	60,189	59,296	60,608
Flowrate ft^3 (Standard Dry)	62,426	59,635	59,430	58,219	58,894	58,023	59,438
Flowrate m^3 (standard dry)	1,768	1,689	1,683	1,649	1,668	1,643	1,683
Total Particulate Weights (mg) [1]							
Total Nozzle/Probe/Filter	3.8	2.3	6.6	4.1	4.8	3.5	4.2
Total Metals Weights (ug) [1]							
Front Half Manganese	38.2	30.0	49.0	43.9	29.6	19.3	35.0
Back Half Manganese	5.72	3.74	2.56	1.96	12.70	1.02	4.62
Totals	43.92	33.74	51.56	45.86	42.30	20.32	39.62
Particulate Concentration							
lb/1000 lb (wet)	0.002	0.001	0.003	0.002	0.002	0.001	0.002
lb/1000 lb (dry)	0.002	0.001	0.003	0.002	0.002	0.001	0.002
mg/dscm (dry)	2.8	1.0	3.1	3.0	2.0	1.3	2.2
gr/dscf	0.0012	0.0004	0.0014	0.0013	0.0009	0.0006	0.0010
Particulate Emission Rate							
lb/ hr	0.65	0.23	0.69	0.65	0.44	0.29	0.49
Front Half Manganese Concentrations							
lb/1000 lb (wet)	2.30E-05	1.10E-05	1.91E-05	2.63E-05	1.01E-05	5.98E-06	1.59E-05
lb/1000 lb (dry)	2.32E-05	1.11E-05	1.93E-05	2.66E-05	1.02E-05	6.06E-06	1.61E-05
mg/dscm (dry)	2.77E-02	1.33E-02	2.31E-02	3.18E-02	1.22E-02	7.24E-03	1.92E-02
gr/dscf	1.21E-05	5.80E-06	1.01E-05	1.39E-05	5.32E-06	3.16E-06	8.39E-06
Front Half Manganese Emission Rate							
lb/ hr	6.51E-03	2.98E-03	5.15E-03	6.95E-03	2.70E-03	1.58E-03	4.31E-03
Back Half Manganese Concentrations							
lb/1000 lb (wet)	3.44E-06	1.37E-06	9.96E-07	1.17E-06	4.32E-06	3.16E-07	1.94E-06
lb/1000 lb (dry)	3.48E-06	1.39E-06	1.01E-06	1.19E-06	4.38E-06	3.21E-07	1.96E-06
mg/dscm (dry)	4.15E-03	1.65E-03	1.20E-03	1.42E-03	5.23E-03	3.83E-04	2.34E-03
gr/dscf	1.81E-06	7.23E-07	5.26E-07	6.20E-07	2.28E-06	1.67E-07	1.02E-06
Back Half Manganese Emission Rate							
lb/ hr	9.75E-04	3.71E-04	2.69E-04	3.10E-04	1.16E-03	8.35E-05	5.28E-04
Total Manganese Concentrations							
lb/1000 lb (wet)	2.64E-05	1.24E-05	2.01E-05	2.75E-05	1.44E-05	6.30E-06	1.78E-05
lb/1000 lb (dry)	2.67E-05	1.25E-05	2.03E-05	2.78E-05	1.46E-05	6.38E-06	1.80E-05
mg/dscm (dry)	3.19E-02	1.49E-02	2.43E-02	3.32E-02	1.74E-02	7.62E-03	2.15E-02
gr/dscf	1.39E-05	6.52E-06	1.06E-05	1.45E-05	7.61E-06	3.33E-06	9.42E-06
Total Manganese Emission Rate							
lb/ hr	7.48E-03	3.35E-03	5.42E-03	7.26E-03	3.85E-03	1.66E-03	4.84E-03

[1] Note: Lab analysis weights have not been corrected to account for PM and Mn weights found in either full Field Blank train or reagent blanks.

Figures

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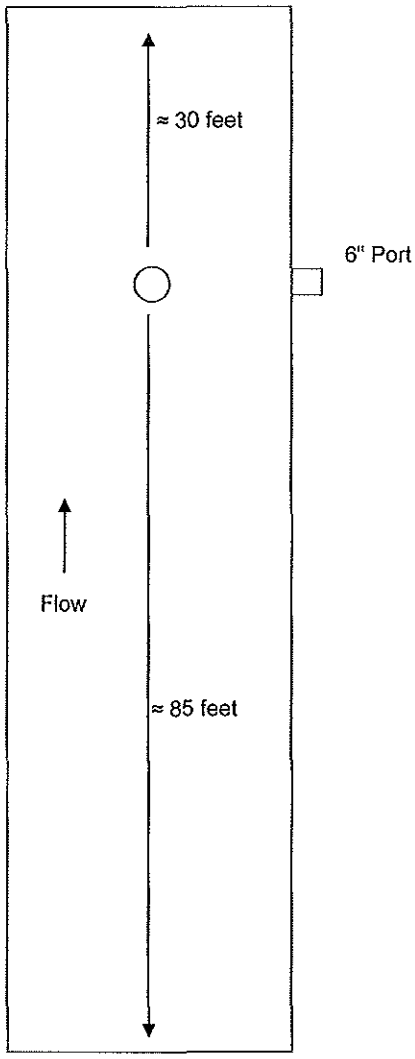
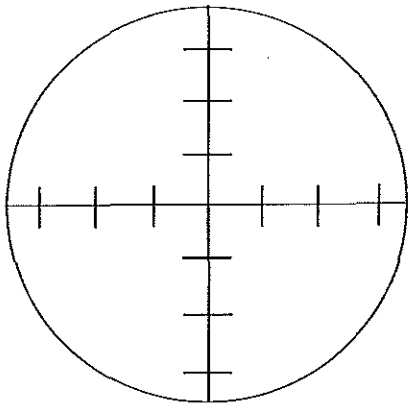
diameter = 108 inches





Not to Scale

Points	Distance "
1	4.8
2	15.8
3	32.0
4	76.0
5	92.2
6	103.2

Figure No. 1

Site: **LRF #1** **Severstal Dearborn, LLC** **Dearborn, Michigan**	**Sampling Date:** **August 20th-22nd, 2013**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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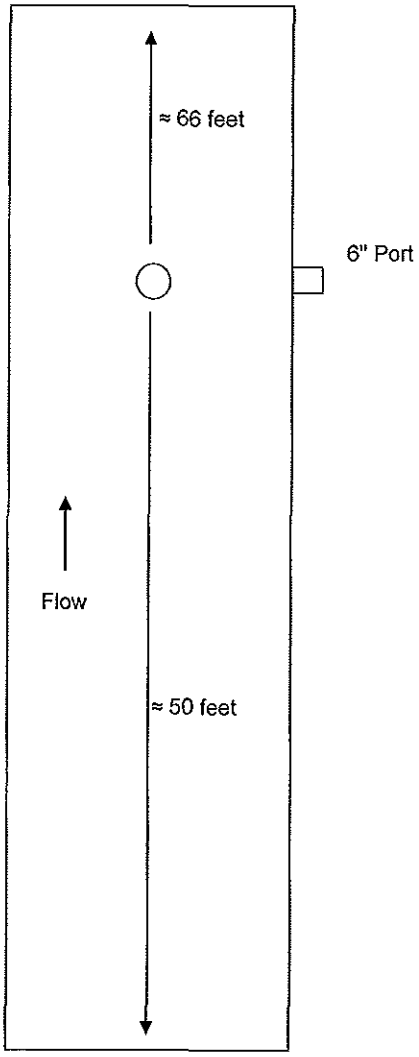
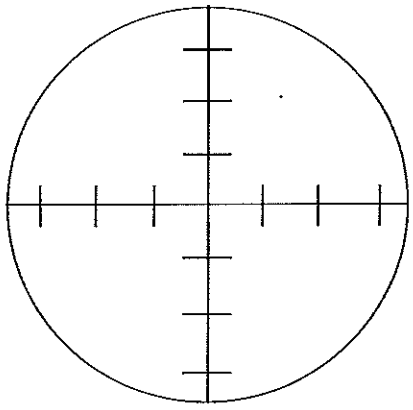
diameter = 71.75 inches





Not to Scale

Points	Distance "
1	3.2
2	10.5
3	21.2
4	50.5
5	61.3
6	68.6

Figure No. 2

Site: **LRF #2** **Severstal Dearborn, LLC** **Dearborn, Michigan**	**Sampling Date:** **August 20thy- 22nd, 2013**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

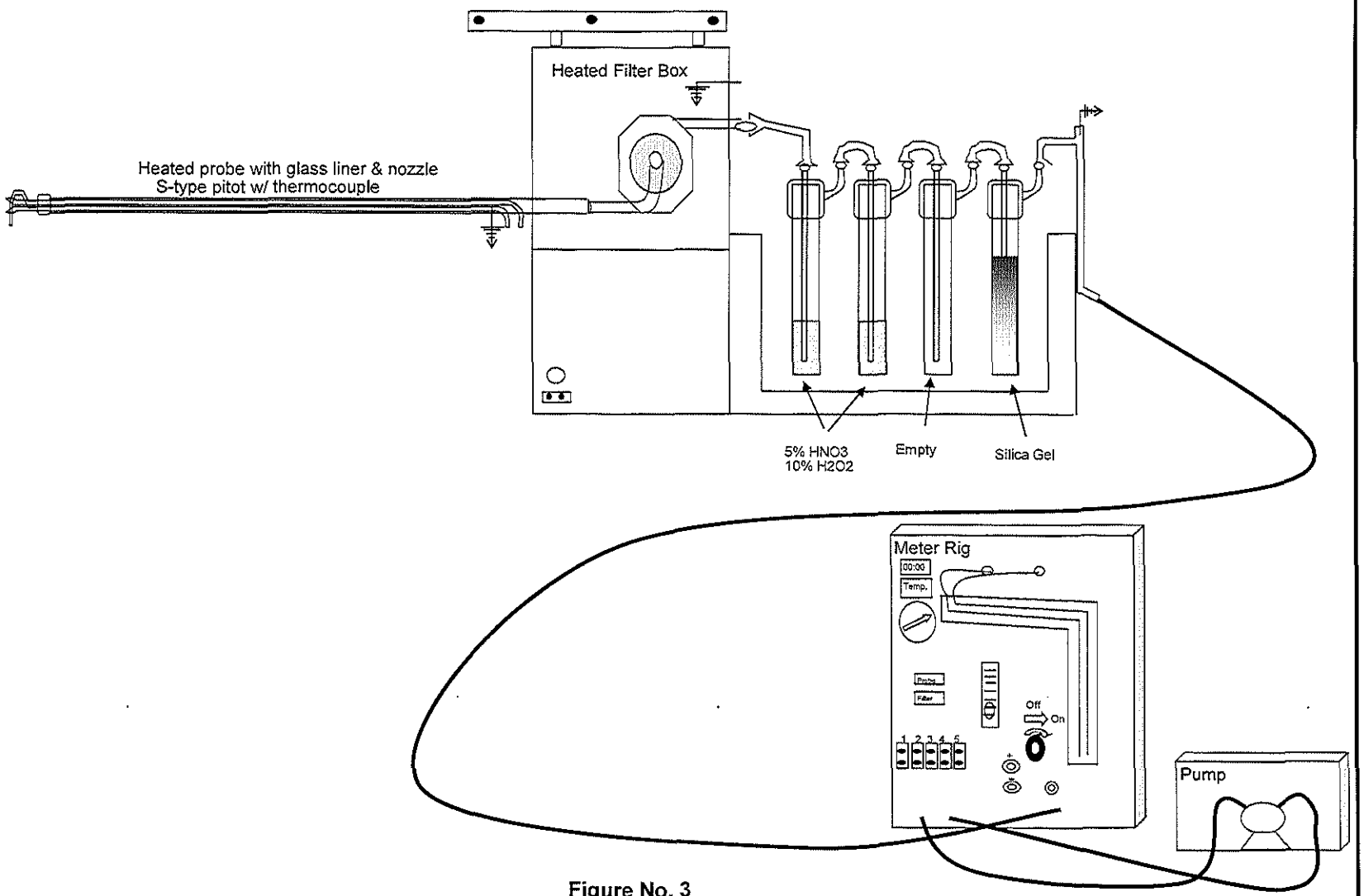


Figure No. 3

Site: USEPA Method 5/29 Sampling Train Severstal Dearborn, LLC Dearborn, MI	Sampling Date: August 20-22nd, 2013	BT Environmental Consulting, Inc. 4949 Fernlee Ave Royal Oak, Michigan 48073