

**SOURCE TEST REPORT  
2019 PARTICULATE AND METALS  
METALS TECHNOLOGIES, INC.  
RAVENNA DUCTILE IRON (RDI) FACILITY  
RAVENNA, MICHIGAN**

Prepared For:

**Metal Technologies, Inc.**  
1401 S. Grandstaff Drive  
Auburn, IN 46706

Prepared By:

**Montrose Air Quality Services, LLC**  
1371 Brummel Avenue  
Elk Grove Village, Illinois


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### REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and presented in this document were carried out by me or under my direction and supervision. I hereby certify that, to the best of my knowledge, Montrose operated in conformance with the requirements of the Montrose Quality Management System and ASTM D7036-04 during this test project.

Signature:  Date: 10/24/2019

Name: James Christ Title: Client Project Manager

I have reviewed, technically and editorially, details calculations, results, conclusions, and other appropriate written materials contained herein. I hereby certify that, to the best of my knowledge, the presented material is authentic, accurate, and conforms to the requirements of the Montrose Quality Management System and ASTM D7036-04.

Signature:  Date: 10/24/2019

Name: Roy Slick Title: Reporting/QC Specialist



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## 1.0 PROJECT OVERVIEW

### 1.1 GENERAL

Montrose Air Quality Services, LLC (Montrose), located at 1371 Brummel Avenue, Elk Grove Village, Illinois was contracted by Metal Technologies, Inc. to conduct an air emissions test program at the Ravenna Ductile Iron facility located in Ravenna, Michigan. The specific objectives of the test program were to determine compliance with the source testing limitations of the Michigan Department of Environmental Quality, Permit # MI-RQP-N5866-2014b, and 40 CFR Part 63, Subpart EEEEE - National Emission Standards for Hazardous Air Pollutants for Iron and Steel Foundries, as applicable. The following test locations were tested and pollutants determined:

**TABLE 1-1  
 SUMMARY OF TEST PROGRAM**

Unit ID/ Source Name(s)	Activity/ Pollutants	Test Methods
FG-MELT	PM, NO <sub>x</sub> , CO, Pb, VOC, Cr	1, 2, 3/3A, 4, 5, 7E, 10, 18, 25A, 29
FG-MELT	VE/FE	9 or 22
SV-INOCULATION	PM, NO <sub>x</sub> , CO, Pb, VOC, Cr	1, 2, 3/3A, 4, 5, 7E, 10, 18, 25A, 29
SV-INOCULATION	VE	9
FG-SAND	PM, CO, Cr	1, 2, 3/3A, 4, 5/29, 10
FG-SAND	VE	9
EU-CLEAN	PM	1, 2, 3, 4, 5
EU-CLEAN	VE	9

Testing was performed on September 10 through September 12 and October 7 through 8, 2019. Coordinating the field portion of the test program were:

Dan Plant – Metal Technologies, Inc

James Christ – Montrose Air Quality Services, LLC

### 1.2 METHODOLOGY

EPA Methods 5 and 29 were used to determine the concentration of particulate matter (PM), chromium (Cr) and lead (Pb) at the FG Sand, FG Melt and SV Inoculation test locations. Lead concentrations were not determined at the FG Sand Location. n Methods 5/29, sample gas was withdrawn isokinetically from the stack and PM was collected in a glass lined probe and on a quartz fiber filter. Cr and Pb were collected in a glass lined probe, on a quartz fiber filter and in a series of chilled impingers charged with metals absorbing solutions



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The mass of Cr and Pb, collected within the sample train, combined with the volume of dry gas withdrawn from the test location was used to calculate the Cr and Pb concentration. Analysis of the samples for PM was conducted by Montrose at their facility located in Elk Grove Village, Illinois. Analysis of samples for Cr and Pb was conducted by ElementOne, Inc. at their laboratory located in Wilmington, North Carolina.

Method 5 was used to determine the concentration of PM at the EU Clean test location. In Method 5, a sample of the gas stream was withdrawn isokinetically from the test location, and the PM in the sample gas was collected in a heated, glass-lined probe and on a heated, glass fiber filter. The weight of PM collected with the sample train, combined with the volume of dry gas withdrawn from the test location, was used to calculate the PM concentration.

Method 9 was used to determine the opacity of emissions at the applicable test locations. The opacity was determined by a certified observer from Montrose positioned with a line of sight perpendicular to the plume direction. The observer viewed the plume with the sun oriented in the 140° sector of the observer's back. A minimum distance equal to three times the height of the stack was maintained between the observer and the smoke plume. The observer's line of sight did not include more than one plume. Opacity data sheets may be found in the process data section of the Appendix.

EPA Methods 3A, 7E, 10 and 25A were used to determine the concentrations of carbon dioxide (CO<sub>2</sub>), oxygen (O<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO) and volatile organic compound (VOC) at each applicable test location. Results for NO<sub>x</sub> and CO were determined on a "dry" basis and reported in units of parts per million (ppm) and in units of pounds per hour (lb/hr). Results for VOC are reported on a "wet" basis as hexane and reported in units of ppmwv, and in units of lb/hr.

To convert the concentrations to mass flow rates, the volumetric flow rate of gas through each test location was determined using EPA Methods 1, 2 and 4.



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**1.3 EXECUTIVE SUMMARY**

**TABLE 1-2  
EXECUTIVE SUMMARY**

Unit ID	Emission Parameter	Units of Measurement	Permit Limits	Results
FG-MACT EEEEE (SV-MELT-01)	PM – Preheat and Melt	gr/dscf	0.005	0.000467
FG-MACT EEEEE	FE	%	20	3.16
FG-MACT EEEEE (SV-SAND-02)	PM – Pouring	gr/dscf	0.010	0.00507
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	PM	lb/1,000lb exhaust gas	0.01	0.00171
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	PM	lb/hr	2.5	0.408
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	CO	lb/hr	15.1	4.27
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	VOC	lb/hr	4.4	2.55
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	NO <sub>x</sub>	lb/hr	3.1	0.0245
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	Lead	lb/hr	0.07	00.00374
FG-MELTING (SV- INOCULATION-05 & SV-MELT-01)	total Cr	lb/hr	0.000876	0.000556
FG-SAND (SV- SAND-02)	PM	lb/1,000lb exhaust gas	0.01	0.00962
FG-SAND (SV- SAND-02)	PM	lb/hr	6.0	4.65
FG-SAND (SV- SAND-02)	CO	lb/hr	98.5	35.2
FG-SAND (SV- SAND-02)	total Cr	lb/hr	0.00168	0.000915
FG-SAND (SV- SAND-02)	Opacity	%	5	0.00
EU-CLEAN (SV- CLEAN-03)	PM	lb/1,000lb exhaust gas	0.01	0.000745
EU-CLEAN (SV- CLEAN-03)	PM	lb/hr	2.2	0.188
EU-CLEAN (SV- CLEAN-03)	Opacity	%	5	0.00



#### 1.4 PARAMETERS

The following parameters were determined at the FG Melting and SV Inoculation test locations:

- gas temperature
- gas velocity
- carbon dioxide concentration
- oxygen concentration
- moisture concentration
- filterable particulate matter concentration
- nitrogen oxides concentration
- opacity of emissions
- fugitive emissions (FG Melt only)
- carbon monoxide concentration
- volatile organic compounds concentration
- chromium concentration
- lead concentration

The following parameters were determined at the FG Sand test location:

- gas temperature
- gas velocity
- carbon dioxide concentration
- oxygen concentration
- moisture concentration
- filterable particulate matter concentration
- opacity of emissions
- carbon monoxide concentration
- chromium concentration

The following parameters were determined at the EU-Clean test location:

- gas temperature
- gas velocity
- carbon dioxide concentration
- oxygen concentration
- moisture concentration
- filterable particulate matter concentration
- opacity of emissions





## 1.5 QUALITY STATEMENT

Montrose is qualified to conduct this test program and has established a quality management system that led to accreditation with ASTM Standard D7036-04 (Standard Practice for Competence of Air Emission Testing Bodies). Montrose participates in annual functional assessments for conformance with D7036-04 which are conducted by the American Association for Laboratory Accreditation (A2LA). All testing performed by Montrose is supervised on site by at least one Qualified Individual (QI) as defined in D7036-04 Section 8.3.2. Data quality objectives for estimating measurement uncertainty within the documented limits in the test methods are met by using approved test protocols for each project as defined in D7036-04 Sections 7.2.1 and 12.10. Additional quality assurance information is presented in the report appendices.

## 1.6 RESULTS

A complete summary of test results is presented in Tables 2-1 through 2-5. The first run on the FG-SAND location was scrapped after the lab technician accidentally dropped the first impinger during the sample recovery. An additional run, run 4 was ran to complete the set of 3 runs. Analysis of the PM at the FG-SAND were above the permitted limits. Additional runs (runs 5 – 7) were performed during a second mobilization. Both sets of results are reported.

Testing was performed according to Test Plan No. 023AS-552303-PP-50. The procedures outlined in that document were followed except where noted.

Cyclonic flow determinations were made at all test locations. All locations passed the criteria as specified in Method 1, section 11.4. Results can be found in the Field Data section of the appendix.

An integrated gas sample was collected in a Tedlar bag from the exhaust of all the Method 5 sampling trains for the analysis of O<sub>2</sub> and CO<sub>2</sub>. Results of the analysis showed that all the locations emitted essentially ambient air, as such, a molecular weight of 29.0 as allowed by EPA Method 2, Section 8.6 was used in all volumetric calculations. Results for the Tedlar bags can be found in the analyzer section of the appendix.

EPA TNI SSAS audit samples were purchased and analyzed for Pb and Cr. All analytes have been evaluated comparing the reported result to the acceptance limits generated using the criteria in the TNI SSAS Tables. All results were acceptable. The audit sample report can be found in the Laboratory Appendix.



**2.0 SUMMARY OF RESULTS**

**TABLE 2-1  
 SUMMARY OF FG MELTING RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Average</b>
Date	9/11/2019	9/11/2019	9/11/2019	
Start Time	7:51	10:20	12:32	
Stop Time	9:43	12:11	14:24	
<b>Gas Conditions</b>				
Temperature (°F)	136	149	151	<b>145</b>
Volumetric Flow Rate (acfm)	65,600	66,400	66,200	<b>66,100</b>
Volumetric Flow Rate (scfm)	57,000	56,340	56,100	<b>56,470</b>
Volumetric Flow Rate (dscfm)	55,750	55,000	54,800	<b>55,200</b>
Carbon Dioxide (% dry)	0.0	0.0	0.0	<b>0.0</b>
Oxygen (% dry)	20.9	20.9	20.9	<b>20.9</b>
Moisture (%)	2.23	2.43	2.26	<b>2.31</b>
<b>Filterable PM Results</b>				
Concentration (grains/dscf)	0.000315	0.000308	0.000778	<b>0.000467</b>
Emission Rate (lb/hr)	0.151	0.145	0.365	<b>0.220</b>
Emission Rate (lb/1000)	0.000599	0.000585	0.00148	<b>0.000887</b>
<b>Pollutant Results</b>				
Nitrogen Oxides Concentration (ppmdv)	0.389	0.391	0.314	<b>0.365</b>
Nitrogen Oxides Emission rate (lb/hr)	0.155	0.154	0.123	<b>0.144</b>
Carbon Monoxide Concentration, C (ppmdv)	9.76	10.3	11.8	<b>10.6</b>
Carbon Monoxide Emission rate, E (lb/hr)	2.37	2.46	2.83	<b>2.56</b>
Total Hydrocarbon Concentration, C (ppmwv)	1.81	2.04	2.24	<b>2.03</b>
Total Hydrocarbon Emission rate, E (lb/hr)	1.38	1.545	1.689	<b>1.54</b>
Chromium Concentration (ug/dscm)	1.42	1.39	1.34	<b>1.38</b>
Chromium Emission Rate (lb/hr)	0.000296	0.000286	0.000275	<b>0.000286</b>
Lead Concentration (ug/dscm)	8.77	11.9	10.7	<b>10.5</b>
Lead Emission Rate (lb/hr)	0.00183	0.00245	0.00220	<b>0.00216</b>



**TABLE 2-2  
 SUMMARY OF FG MELTING OPACITY RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Run 4</b>	<b>Run 5</b>	<b>Run 6</b>
Date	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019
Start Time	8:29	8:46	10:41	10:59	13:03	13:15
Stop Time	8:35	8:52	10:47	11:05	13:09	13:21
<b>Opacity Results</b>						
Average (%)	0.00	0.00	0.00	0.00	0.00	0.00
Maximum (%)	0.00	0.00	0.00	0.00	0.00	0.00
Minimum (%)	0.00	0.00	0.00	0.00	0.00	0.00

**TABLE 2-3  
 SUMMARY OF FG MELTING FUGATIVE EMISSIONS RESULTS**

<b>Test Parameters</b>	<b>East Vent Run 1</b>	<b>East Vent Run 2</b>	<b>East Vent Run 3</b>	<b>West Vent Run 1</b>	<b>West Vent Run 2</b>	<b>West Vent Run 3</b>
Date	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019
Start Time	8:03	10:38	12:55	8:03	10:38	12:55
Stop Time	9:03	11:38	13:55	9:03	11:38	13:55
<b>Opacity Results</b>						
Average (%)	4.79	2.71	3.13	2.71	2.08	3.54
Maximum (%)	10.0	10.0	10.0	10.0	10.0	10.0
Minimum (%)	0.00	0.00	0.00	0.00	0.00	0.00



**TABLE 2-4  
SUMMARY OF SV INNOCULATION RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Average</b>
Date	9/11/2019	9/11/2019	9/11/2019	
Start Time	7:51	10:20	12:32	
Stop Time	9:43	12:11	14:24	
<b>Gas Conditions</b>				
Temperature (°F)	97.4	108	110	<b>105</b>
Volumetric Flow Rate (acfm)	57,000	56,100	56,400	<b>56,500</b>
Volumetric Flow Rate (scfm)	53,000	51,150	51,300	<b>51,820</b>
Volumetric Flow Rate (dscfm)	51,900	50,000	49,600	<b>50,500</b>
Carbon Dioxide (% dry)	0.0	0.0	0.0	<b>0.0</b>
Oxygen (% dry)	20.9	20.9	20.9	<b>20.9</b>
Moisture (%)	2.15	2.32	3.37	<b>2.61</b>
<b>Filterable PM Results</b>				
Concentration (grains/dscf)	0.000409	0.000408	0.000481	<b>0.000433</b>
Emission Rate (lb/hr)	0.182	0.175	0.205	<b>0.187</b>
Emission Rate (lb/1000)	0.000776	0.000775	0.000913	<b>0.000822</b>
<b>Pollutant Results</b>				
Nitrogen Oxides Concentration (ppmdv)	0.147	0.386	0.308	<b>0.280</b>
Nitrogen Oxides Emission rate (lb/hr)	0.0548	0.138	0.109	<b>0.101</b>
Carbon Monoxide Concentration, C (ppmdv)	6.73	9.00	7.67	<b>7.80</b>
Carbon Monoxide Emission rate, E (lb/hr)	1.52	1.96	1.66	<b>1.71</b>
Total Hydrocarbon Concentration, C (ppmwv)	1.50	1.83	1.68	<b>1.67</b>
Total Hydrocarbon Emission rate, E (lb/hr)	1.07	1.26	1.16	<b>1.16</b>
Chromium Concentration (ug/dscm)	1.55	1.52	1.21	<b>1.43</b>
Chromium Emission Rate (lb/hr)	0.000302	0.000284	0.000226	<b>0.000271</b>
Lead Concentration (ug/dscm)	6.35	10.6	8.04	<b>8.34</b>
Lead Emission Rate (lb/hr)	0.00123	0.00199	0.00149	<b>0.00157</b>





**TABLE 2-5**  
**SUMMARY OF SV INNOCULATION OPACITY RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Run 4</b>	<b>Run 5</b>	<b>Run 6</b>
Date	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019	9/11/2019
Start Time	8:29	8:45	10:41	10:59	13:03	13:15
Stop Time	8:35	8:51	10:47	11:05	13:09	13:21
<b>Opacity Results</b>						
Average (%)	0.00	0.00	0.00	0.00	0.00	0.00
Maximum (%)	0.00	0.00	0.00	0.00	0.00	0.00
Minimum (%)	0.00	0.00	0.00	0.00	0.00	0.00



**TABLE 2-6  
SUMMARY OF FG-MELT & SV INNOCULATION RESULTS (COMBINED)**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Average</b>
Date	9/11/2019	9/11/2019	9/11/2019	
Start Time	7:51	10:20	12:32	
Stop Time	9:43	12:11	14:24	
<b>Combined Filterable PM Results</b>				
Concentration (grains/dscf)	0.000724	0.000716	0.00126	<b>0.000900</b>
Emission Rate (lb/hr)	0.333	0.320	0.570	<b>0.408</b>
Emission Rate (lb/1000)	0.00137	0.00136	0.00239	<b>0.00171</b>
<b>Combined Pollutant Results</b>				
Nitrogen Oxides Concentration (ppmdv)	0.537	0.777	0.622	<b>0.645</b>
Nitrogen Oxides Emission rate (lb/hr)	0.210	0.292	0.233	<b>0.245</b>
Carbon Monoxide Concentration, C (ppmdv)	16.5	19.3	19.5	<b>18.4</b>
Carbon Monoxide Emission rate, E (lb/hr)	3.90	4.43	4.49	<b>4.27</b>
Total Hydrocarbon Concentration, C (ppmwv)	3.1	3.63	3.68	<b>3.49</b>
Total Hydrocarbon Emission rate, E (lb/hr)	2.33	2.64	2.68	<b>2.55</b>
Chromium Concentration (ug/dscm)	2.97	2.90	2.56	<b>2.81</b>
Chromium Emission Rate (lb/hr)	0.000598	0.000570	0.000501	<b>0.000556</b>
Lead Concentration (ug/dscm)	15.1	22.5	18.8	<b>18.8</b>
Lead Emission Rate (lb/hr)	0.00306	0.00444	0.00370	<b>0.00374</b>



**TABLE 2-7  
 SUMMARY OF EU-CLEAN RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Average</b>
Date	9/10/2019	9/10/2019	9/10/2019	
Start Time	7:35	14:16	16:20	
Stop Time	13:41	15:55	17:59	
<b>Gas Conditions</b>				
Temperature (°F)	97.8	105	107	<b>103</b>
Volumetric Flow Rate (acfm)	63,700	62,300	62,200	<b>62,700</b>
Volumetric Flow Rate (scfm)	59,100	56,910	56,700	<b>57,550</b>
Volumetric Flow Rate (dscfm)	57,670	55,400	55,200	<b>56,100</b>
Carbon Dioxide (% dry)	0.0	0.0	0.0	<b>0.0</b>
Oxygen (% dry)	20.9	20.9	20.9	<b>20.9</b>
Moisture (%)	2.39	2.76	2.64	<b>2.60</b>
<b>Filterable PM Results</b>				
Concentration (grains/dscf)	0.000371	0.000154	0.000652	<b>0.000392</b>
Emission Rate (lb/hr)	0.183	0.0733	0.308	<b>0.188</b>
Emission Rate (lb/1000)	0.000704	0.000293	0.00124	<b>0.000745</b>

**TABLE 2-8  
 SUMMARY OF EU-CLEAN OPACITY RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Run 4</b>	<b>Run 5</b>	<b>Run 6</b>
Date	9/10/2019	9/10/2019	9/10/2019	9/10/2019	9/10/2019	9/10/2019
Start Time	7:55	8:03	14:36	14:50	16:30	16:40
Stop Time	8:01	8:09	14:42	14:56	16:36	16:46
<b>Opacity Results</b>						
Average (%)	0.00	0.00	0.00	0.00	0.00	0.00
Maximum (%)	0.00	0.00	0.00	0.00	0.00	0.00
Minimum (%)	0.00	0.00	0.00	0.00	0.00	0.00



**TABLE 2-9  
 SUMMARY OF FG-SAND RESULTS**

<b>Test Parameters</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Run 4</b>	<b>Average</b>
Date	9/10/2019	9/10/2019	9/12/2019	
Start Time	15:26	17:50	7:23	
Stop Time	17:20	19:42	9:14	
<b>Gas Conditions</b>				
Temperature (°F)	128	129	117	<b>124</b>
Volumetric Flow Rate (acfm)	130,500	133,400	129,000	<b>131,000</b>
Volumetric Flow Rate (scfm)	115,000	117,430	115,900	<b>116,110</b>
Volumetric Flow Rate (dscfm)	109,830	112,200	111,400	<b>111,100</b>
Carbon Dioxide (% dry)	0.0	0.0	0.0	<b>0.0</b>
Oxygen (% dry)	20.9	21.0	20.9	<b>20.9</b>
Moisture (%)	4.56	4.53	3.89	<b>4.33</b>
<b>Filterable PM Results</b>				
Concentration (grains/dscf)	0.0132	0.0120	0.0106	<b>0.0120</b>
Emission Rate (lb/hr)	12.4	11.5	10.2	<b>11.4</b>
Emission Rate (lb/1000)	0.0252	0.0229	0.0203	<b>0.0228</b>
<b>Pollutant Results</b>				
Carbon Monoxide Concentration, C (ppmdv)	63.8	78.9	74.7	<b>72.5</b>
Carbon Monoxide Emission rate, E (lb/hr)	30.6	38.6	36.3	<b>35.2</b>
Chromium Concentration (ug/dscm)	2.17	1.83	2.60	<b>2.20</b>
Chromium Emission Rate (lb/hr)	0.000892	0.000768	0.00108	<b>0.000915</b>





**TABLE 2-10**  
**SUMMARY OF FG-SAND OPACITY RESULTS**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Run 4</b>
Date	9/10/2019	9/10/2019	9/10/2019	9/10/2019
Start Time	12:52	13:02	15:26	15:37
Stop Time	12:58	13:08	15:32	15:43
<b>Opacity Results</b>				
Average (%)	0.00	0.00	0.00	0.00
Maximum (%)	0.00	0.00	0.00	0.00
Minimum (%)	0.00	0.00	0.00	0.00

<b>Test Parameters</b>	<b>Run 5</b>	<b>Run 6</b>	<b>Run 7</b>	<b>Run 8</b>
Date	9/10/2019	9/10/2019	9/12/2019	9/12/2019
Start Time	18:00	18:10	8:06	8:14
Stop Time	18:06	18:16	8:12	8:20
<b>Opacity Results</b>				
Average (%)	0.00	0.00	0.00	0.00
Maximum (%)	0.00	0.00	0.00	0.00
Minimum (%)	0.00	0.00	0.00	0.00



**TABLE 2-11  
 SUMMARY OF FG-SAND RESULTS – PM RETEST**

<b>Test Parameters</b>	<b>Run 5</b>	<b>Run 6</b>	<b>Run 7</b>	<b>Average</b>
Date	10/7/2019	10/8/2019	10/8/2019	
Start Time	15:40	7:55	9:55	
Stop Time	17:06	9:34	11:33	
<b>Gas Conditions</b>				
Temperature (°F)	115	109	114	<b>112</b>
Volumetric Flow Rate (acfm)	125,900	116,500	120,300	<b>120,900</b>
Volumetric Flow Rate (scfm)	115,200	108,290	110,900	<b>111,460</b>
Volumetric Flow Rate (dscfm)	110,810	103,700	106,700	<b>107,100</b>
Moisture (%)	3.84	4.24	3.81	<b>3.96</b>
<b>Filterable PM Results</b>				
Concentration (grains/dscf)	0.00471	0.00517	0.00532	<b>0.00507</b>
Emission Rate (lb/hr)	4.47	4.59	4.87	<b>4.65</b>
Emission Rate (lb/1000)	0.00894	0.0098	0.0101	<b>0.00962</b>

**TABLE 2-12  
 SUMMARY OF FG-SAND OPACITY RESULTS – PM RETEST**

<b>Test Parameters</b>	<b>Run 1</b>	<b>Run 2</b>	<b>Run 3</b>	<b>Average</b>
Date	10/7/2019	10/7/2019	10/8/2019	
Start Time	15:45	8:15	10:07	
Stop Time	15:57	8:37	10:19	
<b>Opacity Results</b>				
Average (%)	0.00	0.00	0.00	<b>0.00</b>
Maximum (%)	0.00	0.00	0.00	
Minimum (%)	0.00	0.00	0.00	



### **3.0 TEST PROCEDURES**

#### **3.1 METHOD LISTING**

The test methods found in 40 CFR Part 60; Appendix A were referenced for the test program. The following individual methods were referenced:

- Method 1 Sample and velocity traverse for stationary sources
- Method 2 Determination of stack gas velocity and volumetric flow rate (type S pitot tube)
- Method 3A Determination of carbon dioxide and oxygen concentrations in emissions from stationary sources (Instrumental Analyzer Procedure)
- Method 4 Determination of moisture content in stack gases
- Method 5 Determination of particulate emissions from stationary sources
- Method 7E Determination of nitrogen oxides emissions from stationary sources (Instrumental analyzer method)
- Method 9 Visual Determination of the Opacity of Emissions from Stationary Sources
- Method 10 Determination of carbon monoxide emissions from stationary sources (Instrumental analyzer method)
- Method 25A Determination of total gaseous organic concentration using a flame ionization analyzer
- Method 29 Determination of Metals Emissions from Stationary Sources

#### **3.2 METHOD DESCRIPTIONS**

##### **3.2.1 Method 1**

Method 1 was used to determine the suitability of the test location and to determine the sample points used for the volumetric flow rate determinations. The test location conformed to the minimum requirements of being located at least 2.0 diameters downstream and at least 0.5 diameters upstream from the nearest flow disturbance.

The FG Melt test location was a round, vertical stack with a diameter of 58.5 inches. Twelve points were sampled at each of the two test ports. The test location was approximately 2.3 diameters downstream and approximately 5.1 diameters upstream from the nearest flow disturbances. A cross section of the sampling location, showing the sample points, can be found in Figure 1 of the Appendix.

The SV Inoculation test location was a round, vertical stack with a diameter of 52 inches. Twelve points were sampled at each of the two test ports. The test location was approximately 4.9 diameters downstream and approximately 5.7 diameters upstream from the nearest flow disturbances. A cross section of the sampling location, showing the sample points, can be found in Figure 2 of the Appendix.



The FG Sand test location was a round, vertical stack with a diameter of 83 inches. Twelve points were sampled at each of the two test ports. The test location was approximately 2.6 diameters downstream and approximately 4.6 diameters upstream from the nearest flow disturbances. A cross section of the sampling location, showing the sample points, can be found in Figure 1 of the Appendix.

The EU-Clean test location was a round, vertical stack with a diameter of 59 inches. Twelve points were sampled at each of the two test ports. The test location was approximately 2.9 diameters downstream and approximately 7.3 diameters upstream from the nearest flow disturbances. A cross section of the sampling location, showing the sample points, can be found in Figure 4 of the Appendix.

### **3.2.2 Method 2**

EPA Method 2 was used to determine the gas velocity at the test location using an “S” type pitot tube and incline oil manometer. The manometer was leveled and “zeroed” prior to each test run. The sample trains were leak checked before and after each run by pressurizing the positive or “high” side, of each pitot tube and creating a 3 in. H<sub>2</sub>O deflection on the manometer. The leak check was considered valid if the manometer remained stable for 15 seconds. This procedure was repeated on the negative side by generating a vacuum of at least 3 in. H<sub>2</sub>O. The velocity head pressure and gas temperature were then determined at each point specified in Method 1. The static pressure of the duct was measured using water filled U-tube manometer. In addition, the barometric pressure was measured and recorded. A diagram of the Method 2 apparatus is shown in Figures 6 and 7 as part of the Methods 5 and 5/29 sampling trains.

### **3.2.3 Methods 3A, 7E, 10 and 25A**

The O<sub>2</sub>, CO<sub>2</sub>, NO<sub>x</sub>, CO, and VOC concentrations at the applicable test locations were determined using EPA Methods 3A, 7E, 10, and 25A. For the O<sub>2</sub>, CO<sub>2</sub>, and CO samples, the integrated sampling procedure was used to determine the concentration of O<sub>2</sub>, CO<sub>2</sub>, and CO at the applicable test locations. In Methods 3A and 10, an integrated sample was collected in a Tedlar bag from the exhaust of the Method 5 sampling trains. The Tedlar bag was analyzed according the requirements outlined in Methods 3A and 10.

For NO<sub>x</sub> and THC sample gas was withdrawn from the test locations at a constant rate through a stainless-steel probe, a glass fiber filter, and a Teflon sample line. The probe, filter and sample line were operated at a temperature of 250°F to prevent the condensation of moisture. The sample was then split into two portions.

The first portion of the sample gas passed through an M & C Type EC gas cooler system. The gas cooler is designed to unobtrusively lower the dew point of the sample gas to 35°F, thus removing the moisture. The dry gas was then vented to the NO<sub>x</sub> analyzer. Results from the analyzer was determined on a “dry” basis. The second portion of the sample gas was sent directly to a flame ionization analyzer (FIA) for the determination of the VOC concentration. The FIA was fueled with hydrogen.





The analyzers that were used for this project is listed in the table below.

**TABLE 3-1  
 PROJECT ANALYZERS**

Parameter	Manufacturer	Model Number	Operating Principle	Units Reported	Range to be used
Oxygen	Servomex	1440	Zirconium Oxide	%	0-20.95
Carbon Dioxide	Servomex	1440	Infrared	%	0-9.91
Nitrogen Oxides	Teledyne	T200	Chemi-luminescence	ppm	0-50.42
Carbon Monoxide	Teledyne	T300	Infrared, Gas Filter Correlation	ppm	0-88.83
Total Hydrocarbon	J.U.M. Engineering	3-500	Flame Ionization	ppmw	0-45.55

Each analyzer, except the FIA was calibrated with zero nitrogen and at least two known concentrations of the appropriate gas constituent in a balance of nitrogen. The FIA was calibrated with three known concentrations of hexane in a balance of air. Each calibration gas was certified according to EPA Protocol 1 procedures.

Prior to sampling, a calibration error test was performed for each analyzer. The zero and high-range calibration gases for each constituent was introduced directly into each analyzer. Each analyzer was then adjusted to the appropriate values. The mid-range gas was then introduced to each analyzer and the measured values were recorded. The measured values for each calibration gas was then compared to the calibration gas values and the differences was less than the method requirement of two percent of the span value.

A calibration error test was also conducted on the FIA. EPA protocol mixtures of hexane in a balance of nitrogen were used for all calibrations. The zero and high range calibration gases were introduced into the sampling system prior to the filter and the FIA was adjusted to the appropriate values. Mid-range and low range calibration gases were then introduced into the sampling system and the response of the FIA was compared to the cylinder gas value. In both cases the difference in response was less that the minimum requirement of five percent of the calibration gas value.

A sample system bias check was then performed by introducing the zero and mid-range calibration gases into the sampling system prior to the filter. The gas was drawn through the entire sampling system. The measured responses were then compared to the calibration error test values to determine the bias in response due to the sampling system. The sampling system bias was less than the method requirement of five percent of the span value. In addition, the system response time was determined by measuring the time required for each analyzer to reach 95 percent of its high-range calibration gas value.



After each test run the instrument drift for each analyzer was determined by introducing the zero and mid-range calibration gases into the sampling system prior to the filter. The gas was drawn through the entire sampling system. The measured responses were then compared to the values from the previous test run to determine the analyzer drift. For all test runs, the analyzer drift was less than the method requirement of three percent of the span value. A diagram of the sampling system is shown in figure 5 of the appendix.

#### **3.2.4 Method 4**

The moisture content at the test location was determined using Method 4. A known volume of sample gas was withdrawn from the source and the moisture was condensed and measured. The dry standard volume of the sample gas was then compared to the volume of moisture collected to determine the moisture content of the sample gas. A diagram of the Method 4 apparatus is shown in Figure 6 and 7 as part of the Methods 5 and 5/29 sampling trains.

To condense the water vapor, the gas sample passed through a series of impingers. For charged as outlined in Methods 5 and 5/29. After exiting the impinger system, the sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 inches Hg. The sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum higher than the value expected during the run. A leak check was considered valid if the leak rate was less than 0.02 cubic feet per minute.

The volume of dry gas exiting the gas condenser system was measured with a dry gas meter. After leaving the dry gas meter, the sample stream passed through an orifice used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane, oil manometer. The gas meter reading, gas meter inlet and outlet temperatures, gas meter static pressure and pump vacuum were recorded for each sample point.

After the test run, the sample train was leak checked at the highest vacuum encountered during the test run. The tests were considered valid since the leak rate was less than 0.02 cfm. The amount of water collected in the condenser system was measured gravimetrically. The net weight gain of water was converted to a volume of wet gas and then compared to the amount of dry gas sampled to determine the moisture content.

#### **3.2.5 Method 5**

Method 5 was used to determine the PM concentration at the test location. A sample of the gas stream was withdrawn isokinetically from the stack and the particulate matter in the sample gas stream was collected in a glass probe and on a glass fiber filter. The weight of PM collected combined with the volume of dry gas withdrawn from the stack was used to calculate the PM concentration. A diagram showing the major components of the Method 5 sampling train is shown in Figure 6 of the Appendix.

Prior to testing, the components were washed using detergent and then rinsed with tap water, de-ionized water, and acetone. After drying, all components were sealed with parafilm or Teflon tape.



The sample probe consisted of a glass liner and glass nozzle. Sample gas passed through the nozzle and probe assembly and then through a glass fiber filter heated to 248°F (+/- 25°F). After exiting the filter, the sample gas passed through the four-impinger condenser system. The first and second impingers each contained 100 ml of water. The third impinger was empty and the fourth contained a known weight of silica gel to absorb any remaining water vapor. The dry gas exiting the moisture condenser system then passed through a sample pump and a dry gas meter to measure the gas volume. After leaving the dry gas meter, the sample stream passed through an orifice used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane, oil manometer.

Quartz fiber filters were used as the substrate for the particulate sampling. The filter was loaded into a glass filter holder with a Teflon support screen that was prepared in the same manner as the other components of the sample train. Prior to the test run, the filter was desiccated for at least 24 hours and then weighed to the nearest 0.0001g until a constant weight was achieved. The weight of the filter was considered constant only when two consecutive weights taken at least six hours apart were within 0.0005g of each other.

The probe was thoroughly pre-cleaned with acetone and the probe wash saved as a quality assurance check. The condenser system was then prepared as outlined in Method 4. The sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 inches Hg. A leak check was considered valid if the leak rate was less than 0.02 cfm or four percent of the average sample rate. When not in operation inside the stack, the nozzle was sealed with Teflon tape.

The probe tip was then placed at each of the sample points determined in Method 1. The velocity at the sample point was determined using Method 2. Sample gas was withdrawn from the source at a rate such that the velocity at the opening of the nozzle matched the velocity of the stack gas at the sample point (isokinetically). The gas velocity pressure ( $\Delta P$ ), gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure ( $\Delta H$ ) and pump vacuum were recorded for each sample point.

After the test run, the train was leak checked at a vacuum greater than the highest vacuum encountered during the test run. The condensate weight gain of the impinger contents was determined as outlined in Method 4 and discarded. The probe liner and nozzle were washed with acetone and the rinse saved in a 250 ml glass jar equipped with a Teflon lined lid. Teflon tape was used to seal the filter assembly. The filter was removed from the filter holder and sealed in a plastic petri dish once testing was completed.

Analysis of the samples for PM was performed at the Montrose laboratory located in Elk Grove Village, Illinois. Each probe rinse was transferred to a tared beaker, evaporated to dryness, desiccated for 24 hours and weighed to a constant weight. Each filter was desiccated for 24 hours and weighed to a constant weight. The weight-gain of the probe rinse and filter from a test run yield the total weight of particulate collected. To eliminate interference in establishing a constant weight, both the analytical balance and the desiccators were equipped with an ion generating polonium strip designed to eliminate static electricity that may collect on the samples.



### 3.2.5 Method 5/29

Methods 5 and 29 were used to determine the PM, chromium and lead concentrations at the applicable test locations in a combined sample train. A sample of the gas stream was withdrawn isokinetically from the stack and the PM in the sample gas stream was collected in a glass probe liner and on a quartz filter. The metals were collected in the glass probe liner, on the quartz filter and in a series of chilled impingers. A diagram of the Method 5/29 sampling train is shown in Figure 7 of the Appendix.

To prevent contamination, all components of the sample train were glass or Teflon with no metal connections. Prior to testing all components were washed with hot tap water then hot soapy water, rinsed three times with tap water and then rinsed three times with de-ionized, ultra-filtered (DIUF) water. All glassware was then soaked for a minimum of four hours in a 10% nitric acid solution. After soaking, the glassware was rinsed three times with DIUF water and then rinsed with acetone. After drying, all components were sealed with parafilm.

The sample probe used consisted of a glass liner and glass nozzle. The liner was housed in a heated sheath maintained at a temperature of 248°F (+/- 25°F). Sample gas passed through the nozzle and probe assembly and then through a quartz fiber filter heated to 248°F (+/- 25°F). After exiting the filter, the sample gas passed through a four impinger condenser system. The first and second third impingers each contained 100 ml of a 10% hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>)/5% nitric acid (HNO<sub>3</sub>) solution. The third impinger was initially empty. The fourth impinger contained a known amount of silica gel to capture any remaining water vapor. The dry gas exiting the moisture condenser system then passed through a sample pump and a dry gas meter to measure the gas volume. After leaving the dry gas meter, the sample stream passed through an orifice, which was used to meter the flow rate through the sample train. The pressure drop across the orifice was measured with an incline plane oil manometer.

Prior to the test run the filter was weighed to the nearest 0.0001g until a constant weight was achieved. The weight of the filter was considered constant only when two consecutive weights taken at least six hours apart were within 0.0005g of each other. The filter was then loaded into a glass filter holder with a Teflon support screen that was prepared in the same manner as the other components of the sample train. The probe was thoroughly cleaned with acetone and the probe wash saved as a quality assurance check. The condenser system was then loaded as outlined above. After assembly, the sample train was leak checked prior to the test run by capping the probe tip and pulling a vacuum of at least 15 in. Hg. A leak check was considered valid if the leak rate was below 0.02 cubic feet per minute.

The probe tip was placed at the first of the sample points determined in Method 1. The velocity at the sample point was determined using Method 2. Sample was withdrawn from the source at a rate such that the velocity at the opening of the nozzle matched the velocity of the stack gas at the sample point (isokinetically). During the test run the train was moved to each of the Method 1 sample points. The sample time at each point was calculated based on the number of sample points and the total run time. The gas velocity pressure ( $\Delta P$ ), stack temperature, gas meter reading, gas meter inlet and outlet temperatures, gas meter orifice pressure ( $\Delta H$ ), probe and filter temperatures, and pump vacuum was recorded for each sample point.





After the test run the train was leak checked at the highest vacuum encountered during the test run. The probe liner and nozzle were washed with acetone and the rinse saved. After sampling, the sample train was transferred to the on-site laboratory for recovery. The quartz filter was removed from the filter holder, transferred to a petri dish and sealed. The front half of the sample train (consisting of the nozzle, probe liner and filter holder) was brushed with a non-metallic brush and additionally rinsed with 0.1 N HNO<sub>3</sub> and the rinse saved in a 125ml trace clean sample jar. The contents of the first three impingers were recovered and saved in a 500 ml trace clean sample jar. The impingers were then rinsed with 100 ml of 0.1N HNO<sub>3</sub>, and the rinses added to the sample jar.

Analysis of the PM samples was performed at the Montrose laboratory located in Elk Grove Village, Illinois. The acetone probe rinses were transferred to a tared, glass beaker, evaporated to dryness, desiccated for 24 hours and weighed to a constant weight. The quartz filters were desiccated for 24 hours and weighed to a constant weight. The weight gain of the probe rinse and glass fiber filter yield the total weight of particulate collected.

Analysis of the MHAPs samples was performed by ElementOne located in Wilmington, North Carolina.

### **3.2.6 Method 9**

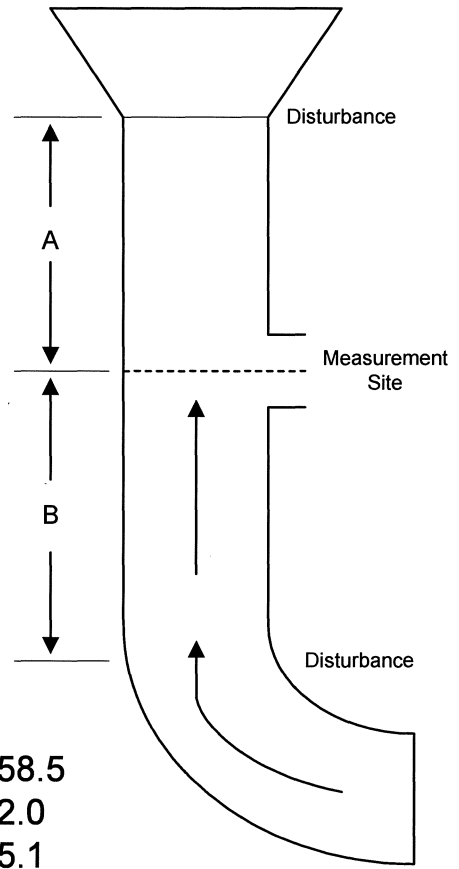
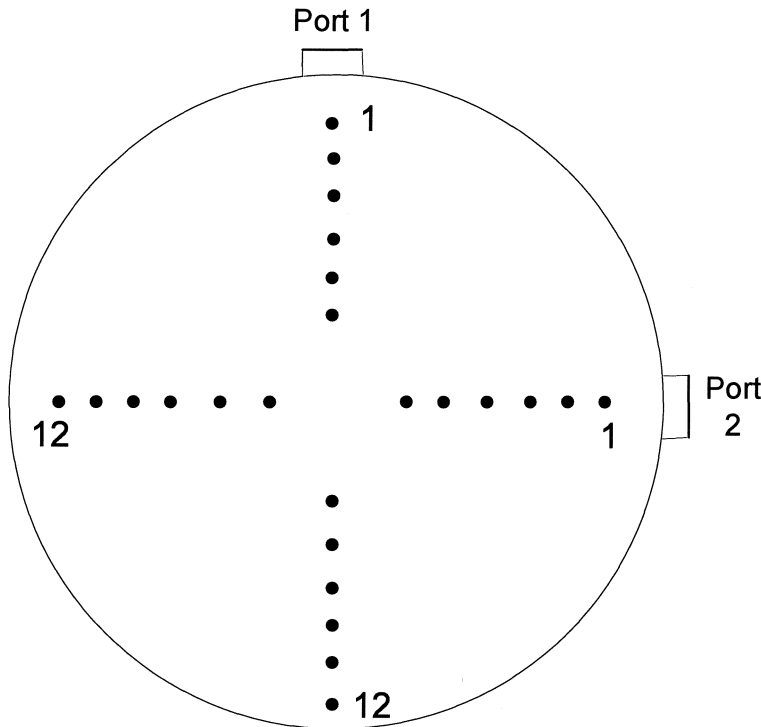
The opacity of emissions from the applicable test locations was determined according to Method 9. A certified observer positioned with a line of sight perpendicular to the plume direction determined the opacity. The observer viewed the plume with the sun oriented in the 140° sector of the observer's back. A minimum distance equal to three times the height of the stack was maintained between the observer and the smoke plume. The observer's line of sight did not include more than one plume.

Readings were taken at 15-second intervals. Between readings, the observer looked away from the plume to rest his eyes. Wind speed and direction were recorded as well as descriptions of the plume, background and weather conditions.

Method 9 was used to determine the fugitive emissions (FE) from the building openings associated with FG-Melt location. The certified observer identified vents and performed opacity observations on the identified vents. Five, six-minute FE readings will be taken at each identified opening or vent.



## **APPENDIX A FIGURES**



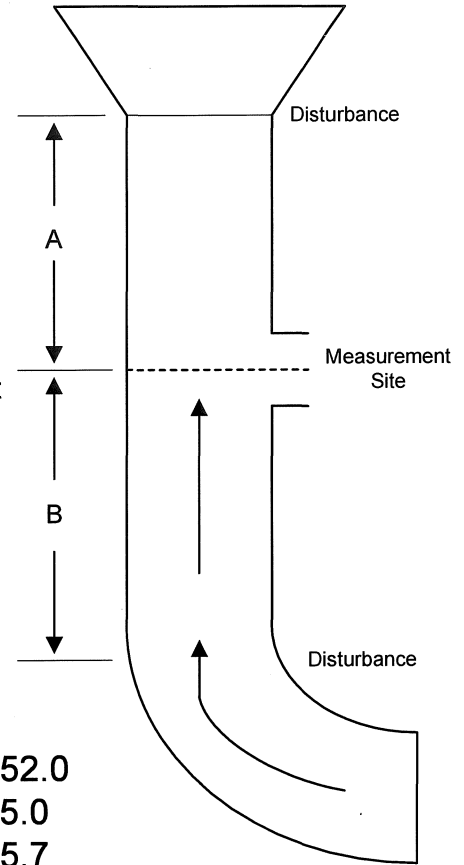
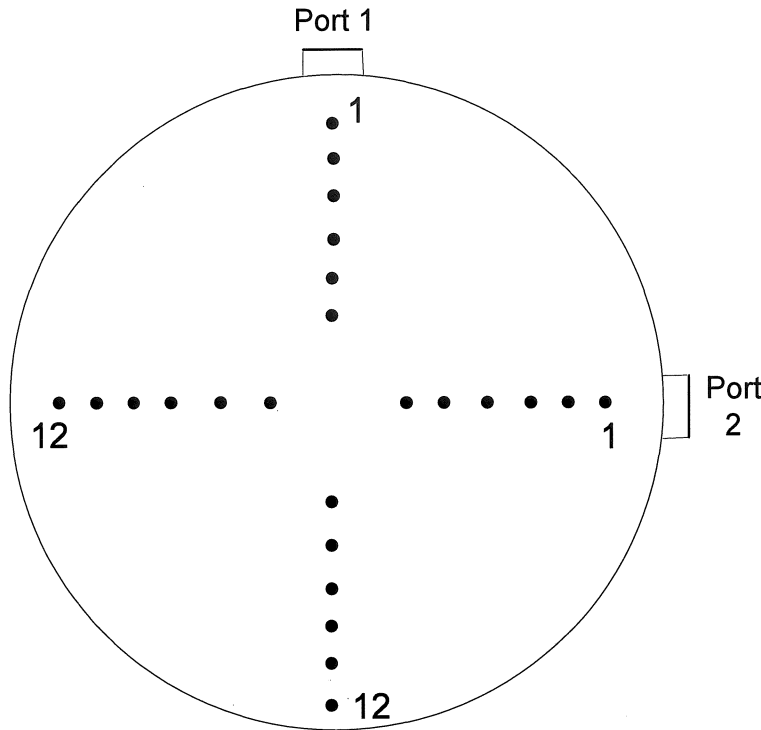
Diameter (in.)	58.5
Port Length (in.)	2.0
Distance A (Duct Diameters)	5.1
Distance B (Duct Diameters)	2.3

<u>Point</u>	<u>Distance From Wall (in.)</u>
1	1.3
2	3.9
3	6.9
4	10.4
5	14.6
6	20.8
7	37.7
8	43.9
9	48.1
10	51.6
11	54.6
12	57.3

Cross Section of FG-Melt  
Metal Technologies, Inc.

Figure 1





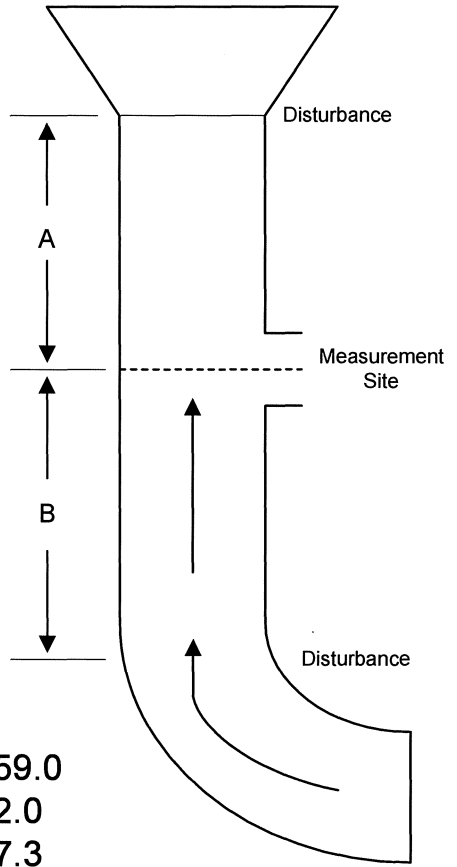
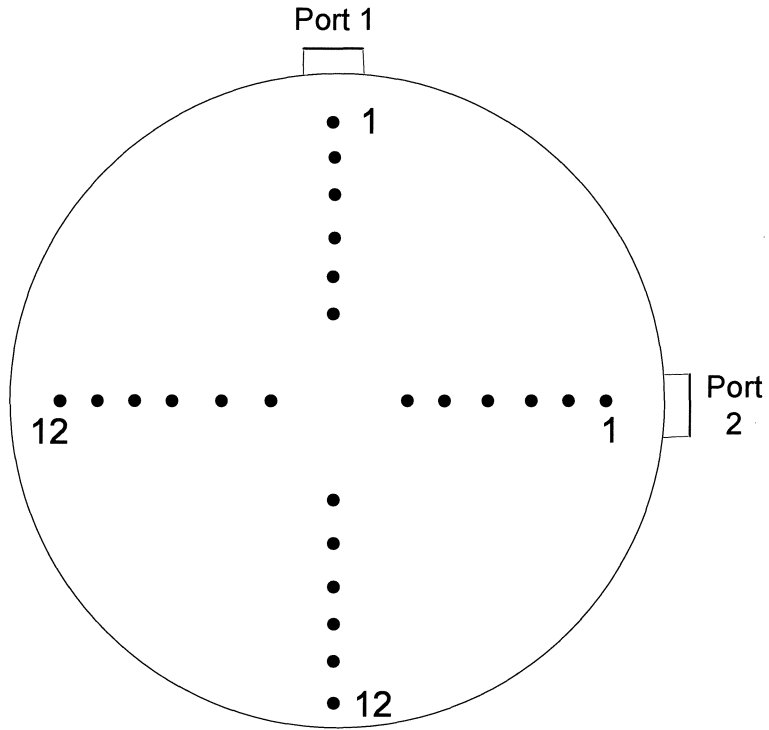
Diameter (in.)	52.0
Port Length (in.)	5.0
Distance A (Duct Diameters)	5.7
Distance B (Duct Diameters)	4.9

<u>Point</u>	<u>Distance From Wall (in.)</u>
1	0.6
2	3.0
3	5.6
4	8.7
5	12.5
6	18.0
7	33.1
8	38.5
9	42.3
10	45.4
11	48.0
12	50.4

Cross Section of SV-Inoculation  
Metal Technologies, Inc.

Figure 2





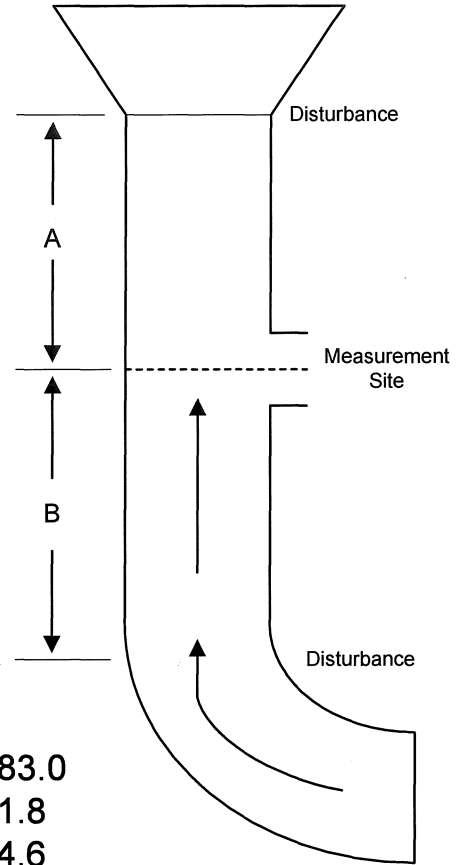
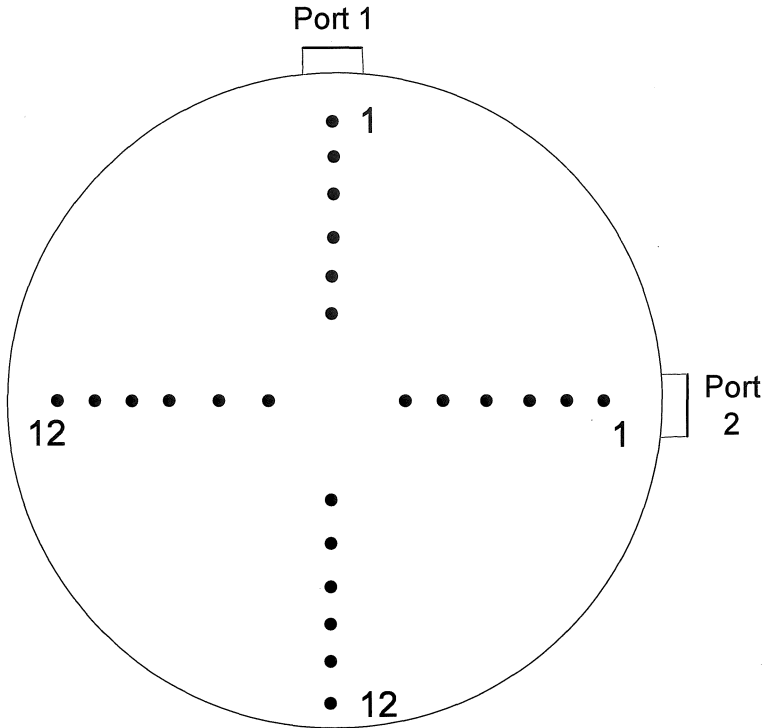
Diameter (in.)	59.0
Port Length (in.)	2.0
Distance A (Duct Diameters)	7.3
Distance B (Duct Diameters)	2.9

<u>Point</u>	<u>Distance From Wall (in.)</u>
1	1.3
2	4.0
3	7.0
4	10.5
5	14.8
6	21.0
7	38.0
8	44.3
9	48.5
10	52.0
11	55.1
12	57.7

Cross Section of EU-Clean  
Metal Technologies, Inc.

Figure 3





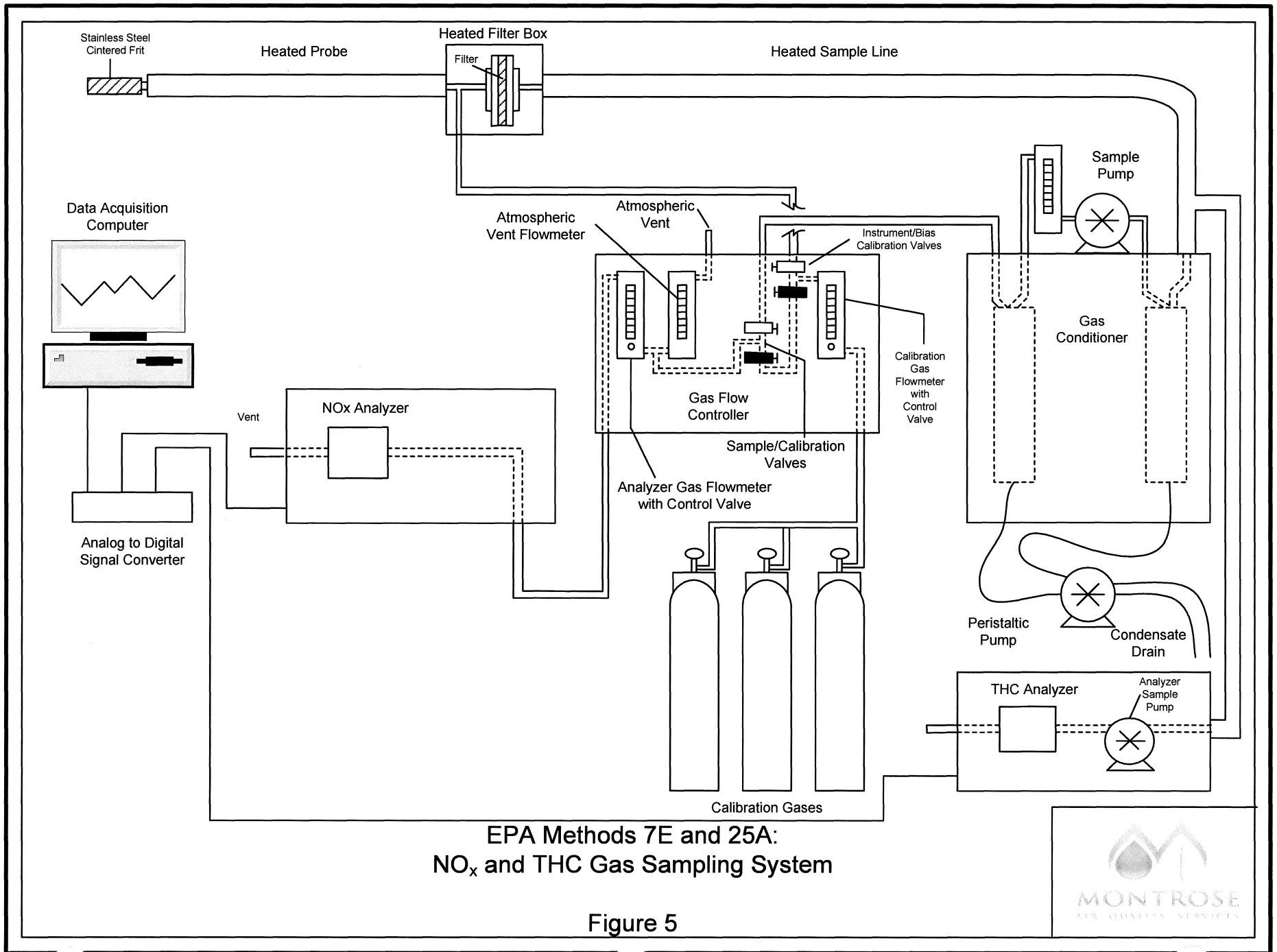
Diameter (in.)	83.0
Port Length (in.)	1.8
Distance A (Duct Diameters)	4.6
Distance B (Duct Diameters)	2.6

<u>Point</u>	<u>Distance From Wall (in.)</u>
1	1.8
2	5.6
3	9.8
4	14.7
5	20.8
6	29.5
7	53.5
8	62.3
9	68.3
10	73.2
11	77.4
12	81.2

Cross Section of FG-Sand  
Metal Technologies, Inc.

Figure 4



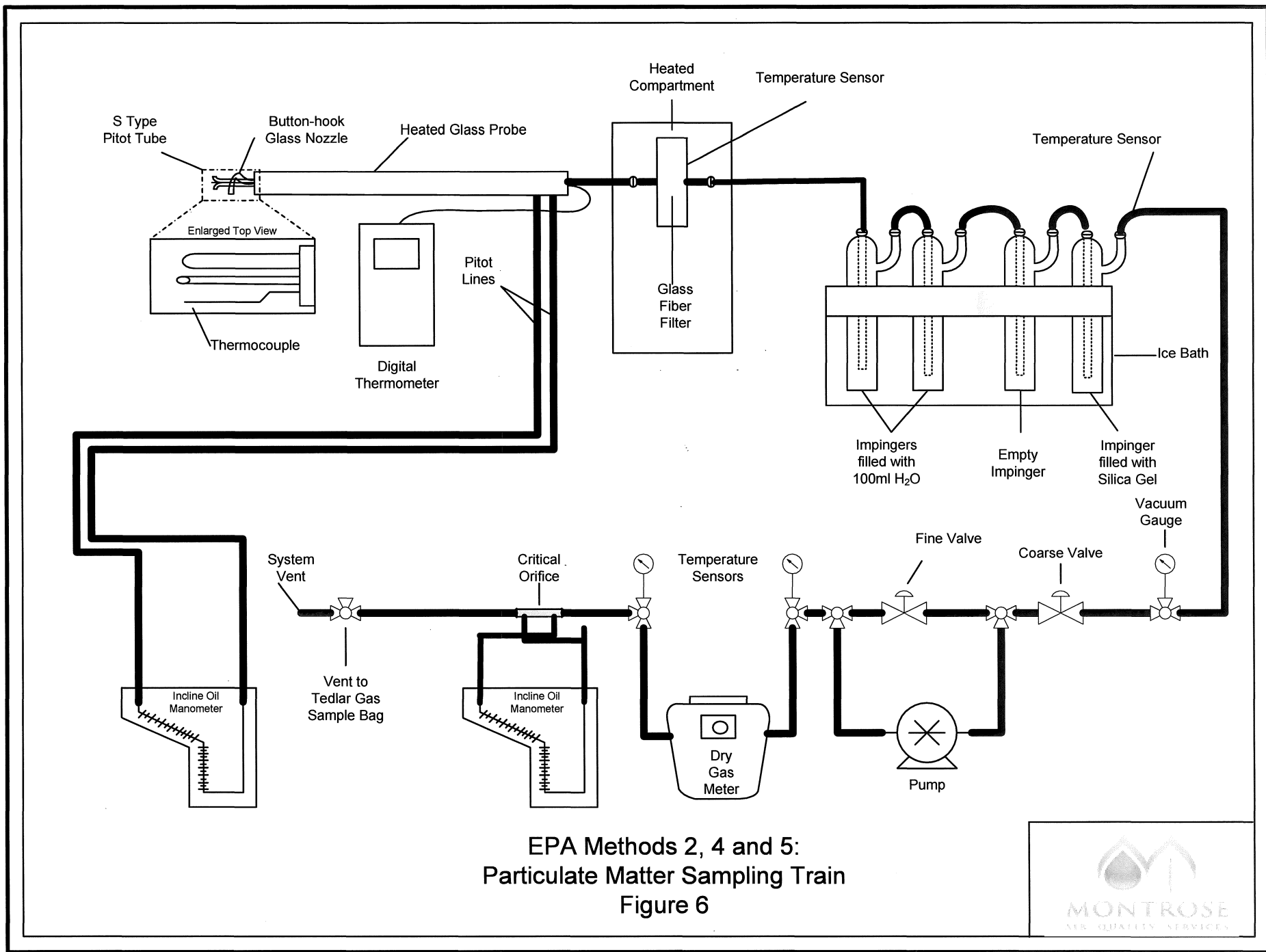


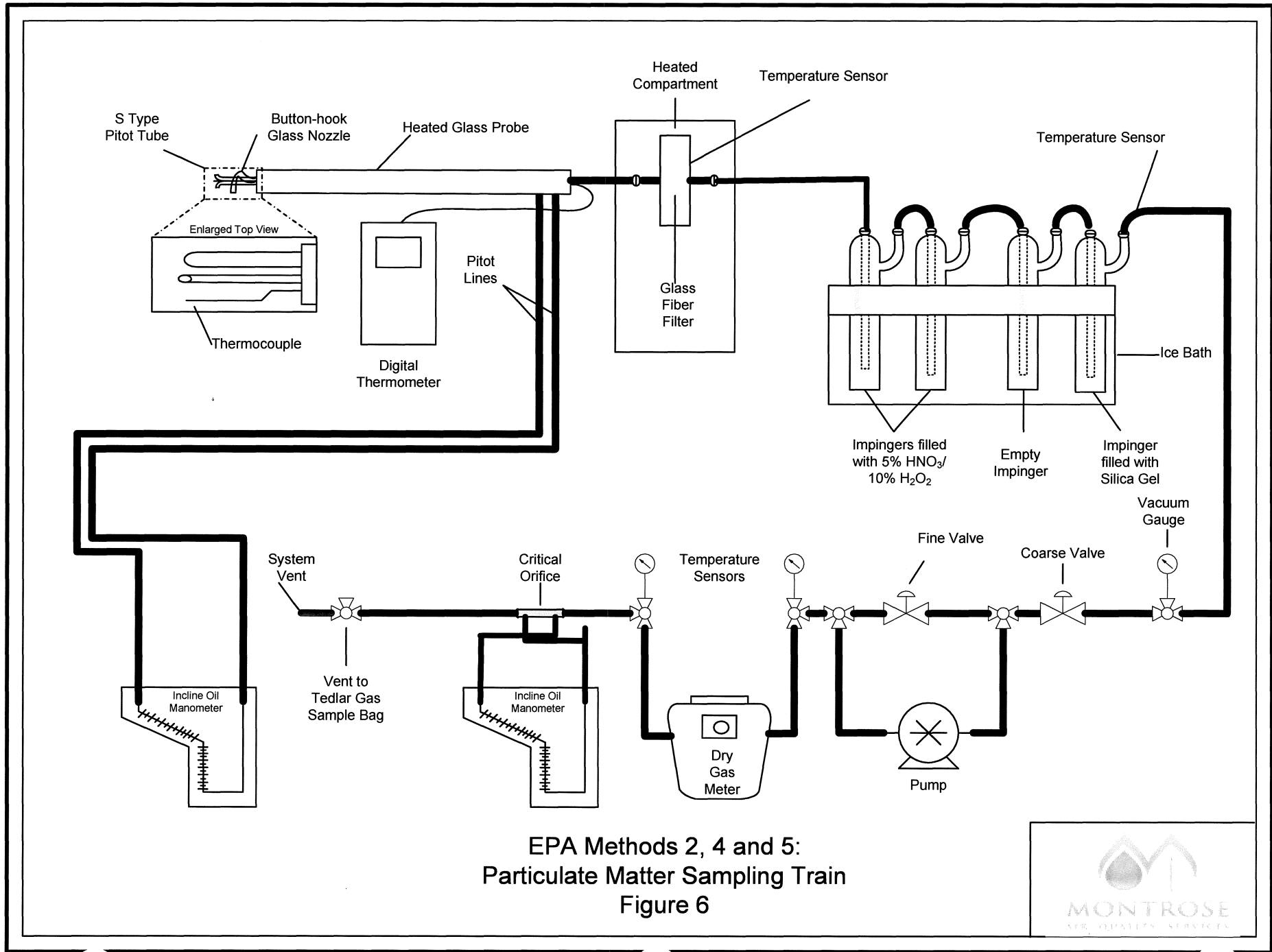
EPA Methods 7E and 25A:  
NO<sub>x</sub> and THC Gas Sampling System

Figure 5









EPA Methods 2, 4 and 5:  
Particulate Matter Sampling Train  
Figure 6

