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Semiannual RICE MACT Compliance Emissions Test Report

Upper Michigan Resources Corporation
F.D. Kuester Generating Station
Permit No. 35-17
EURICE1, EURICE2, EURICE3, EURICE4, EURICE5, EURICE6, EURICE7 Outlet Ducts
Negaunee, Michigan
October 1 and 2, 2019

Report Submittal Date
November 12, 2019

Project No. M193805

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1.0 EXECUTIVE SUMMARY

MOSTARDI PLATT conducted a formaldehyde emissions test program for Upper Michigan Energy Resources Corporation (UMERC) on October 1 and 2, 2019 at F. D. Kuester Generating Station on the Reciprocating Internal Combustion Engine (EURICE) 1, EURICE2, EURICE3, EURICE4, EURICE5, EURICE6, and EURICE7 Outlet Ducts in Negaunee, Michigan. The purpose of the test program was to meet compliance demonstration requirements for emission rates in accordance with Permit to Install 35-17 and the RICE MACT 40 CFR Part 63 Subpart ZZZZ. This report summarizes the results of the test program and test methods used.

The test locations, test dates, and test parameters are summarized below.

TEST INFORMATION		
Test Locations	**Test Date**	**Test Parameters**
EURICE1, 2, 3, and 4	October 1, 2019	Formaldehyde (CH_2O), Moisture (H_2O), and Oxygen (O_2)
EURICE5, 6, and 7	October 2, 2019	

F.D. Kuester Generating Station electric generation facility includes seven (7) Wärtsilä W18V50SG natural gas-fired, four stroke, lean burn, spark ignition reciprocating internal combustion engines (RICE) coupled to 19,260 kW electric generators, a 1,000 kW natural gas-fired emergency generator, and one natural gas-fired natural gas conditioning heater. The RICE electric generating unit engines utilize pipeline quality natural gas and are equipped with selective catalytic reduction (SCR) for nitrogen oxides (NOx) control and oxidation catalyst systems for carbon monoxide (CO), volatile organic compound (VOC), and organic hazardous air pollutant (HAP) control. Each RICE electric generating unit exhausts into an individual stack.

Selected results of the test program are summarized below. A complete summary of emission test results follows the narrative portion of this report.

TEST RESULTS			
Test Location	**Test Parameter**	**Emission Limit**	**Actual Test Result**
EURICE1	CH_2O	14 ppmvd @ 15% O_2	0.66 ppmvd @ 15% O_2
EURICE2			0.23 ppmvd @ 15% O_2
EURICE3			0.59 ppmvd @ 15% O_2
EURICE4			0.08 ppmvd @ 15% O_2
EURICE5			0.68 ppmvd @ 15% O_2
EURICE6			0.19 ppmvd @ 15% O_2
EURICE7			0.70 ppmvd @ 15% O_2

Operating Data as provided by the plant is included in Appendix A.

The identifications of the individuals associated with the test program are summarized below.

TEST PERSONNEL INFORMATION		
Location	**Address**	**Contact**
Test Coordinator	WEC Energy Group, Inc 231 W. Michigan Street Milwaukee, Wisconsin 53203	Mr. Justin Kowalski Senior Environmental Consultant 414-221-2265 justin.kowalski@wecenergygroup.com
Test Facility	Upper Michigan Energy Resources Corporation F.D. Kuester Generating Station 80 Eagle Mills Road Negaunee, Michigan 49866	
Testing Company Representative	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Mr. Stuart Sands Project Manager (630) 993-2100 (phone) ssands@mp-mail.com

The test crew consisted Messrs. N. Colangelo, J. Carlson, M. Lipinski, E. Ehlers, and S. Sands of Mostardi Platt.

2.0 TEST METHODOLOGY

Emission testing was conducted following the methods specified in 40CFR60, Appendix A and 40CFR63, Appendix A. Schematics of the test section diagrams and sampling trains used are included in Appendix B and C, respectively. Calculation nomenclature and example calculations are included in Appendix D. Reference method test data can be found in Appendix E.

The following methodology was used during the test program:

Method 3A Oxygen (O_2) Determination

Oxygen (O_2) concentrations were measured to determine emission concentrations in ppmvd corrected to 15% O_2 in accordance with Method 3A. Servomex analyzers were used to determine flue gas oxygen. All of the equipment used was calibrated in accordance with the specifications of the Method. Calibration data are presented in Appendix F and copies of gas cylinder certifications are included in Appendix G.

Method 320 Formaldehyde (CH_2O) and Moisture (H_2O) Determination

FTIR data was collected using an MKS MultiGas 2030 FTIR spectrometer.

The FTIR was equipped with a temperature-controlled, 5.11 meter multi-pass gas cell maintained at 191°C. Gas flows and sampling system pressures were monitored using a rotameter and pressure transducer. All data was collected at 0.5 cm^{-1} resolution. Each spectrum was derived from the coaddition of 62 scans, with a new data point generated approximately every one minute. Analyzer data for each run is present is Appendix E.

SAMPLING SYSTEM PARAMETERS				
MKS Serial #	**Sampling Line**	**Probe Assembly**	**Particulate Filter Media**	**Operating Temperatures**
110161896/ 018190669	100' 3/8" dia., heated Teflon	Heated 3', 3/8" dia. SS	0.01µ heated borosilicate glass fiber	191°C

QA/QC procedures followed US EPA Method 320. See below for QA/QC procedure details and list of calibration gas standards. All calibration gases were introduced to the analyzer and the sampling system using an instrument grade stainless steel rotameter. All QA/QC procedures were within the acceptance criteria allowance of the applicable EPA methodology. See Appendix F for FTIR QA/QC Data.

FTIR QA/QC PROCEDURES						
QA/QC Specification	**Purpose**	**Calibration Gas Analyte**	**Delivery**	**Frequency**	**Acceptance Criteria**	**Result**
M320: Zero	Verify that the FTIR is free of contaminants & zero the FTIR	Nitrogen (zero)	Direct to FTIR	pre/post test	< MDL or Noise	**Pass**
M320: Calibration Transfer Standard (CTS) Direct	Verify FTIR stability, confirm optical path length	Ethylene	Direct to FTIR	pretest	+/- 5% cert. value	**Pass**
M320: Analyte Direct	Verify FTIR calibration	Acetaldehyde, Methanol, SF6	Direct to FTIR	pretest	+/- 5% cert. value	**Pass**
M320: CTS Response	Verify system stability, recovery, response time	Ethylene	Sampling System	Daily, pre/post test	+/- 5% of Direct Measurement	**Pass**
M320: Zero Response	Verify system is free of contaminants, system bias	Nitrogen (zero)	Sampling System	pretest	Bias correct data	**Pass**
M320: Analyte Spike	Verify system ability to deliver and quantify analyte of interest in the presence of other effluent gases	Acetaldehyde, Methanol, SF6	Dynamic Addition to Sampling System, 1:10 effluent	Throughout testing – daily	+/- 30% theoretical recovery	**Pass**

Note: The determined concentrations from direct analyses were used in all system/spike recovery calculations.

CALIBRATION GAS STANDARDS				
Components	**Concentration (ppm)**	**Vendor**	**Cylinder #**	**Standard Type**
Ethylene	100.0	Airgas	CC477903	Primary +/- 2%
Acetaldehyde/ Methanol/SF6	201.1/212.1/ 5.099	Airgas	CC718237	Certified Standard-Spec +/- 2% Certified Standard-Spec +/- 5% (SF6)
Nitrogen	Zero Gas	Airgas	N/A	UHP Grade

Analyte Spiking
Acetaldehyde and methanol spiking was performed prior to testing to verify the ability of the sampling system to quantitatively deliver a sample containing acetaldehyde and methanol from the base of the probe to the FTIR. Analyte spiking assures the ability of the FTIR sampling system to recover volatile organics in the presence of effluent gas.

As part of the spiking procedure, samples were measured to determine native acetaldehyde and methanol concentrations to be used in the spike recovery calculations. The analyte spiking gases contained a low concentration of sulfur hexafluoride (SF_6). The determined SF_6 concentration in the spiked sample was used to calculate the dilution factor of the spike and thus used to calculate the concentration of the spiked Acetaldehyde and methanol. The spike target dilution ratio was 1:10 or less.

The following equation illustrates the percent recovery calculation.

$$DF = \frac{SF6(spk)}{SF6(direct)} \quad \text{(Sec. 9.2.3 (3) USEPA Method 320)}$$

$$CS = DF * Spike(dir) + Unspike(1 - DF) \quad \text{(Sec. 9.2.3 (4) USEPA Method 320)}$$

DF = Dilution factor of the spike gas
$SF_{6(dir)}$ = SF_6 concentration measured directly in undiluted spike gas
$SF_{6(spk)}$ = Diluted SF_6 concentration measured in a spiked sample
$Spike_{dir}$ = Concentration of the analyte in the spike standard measure by the FTIR directly
CS = Expected concentration of the spiked samples
Unspike = Native concentration of analytes in unspiked samples

Post Collection Data Validation
As part of the data validation procedure, reference spectra are manually fit to that of the sample spectra and a concentration is determined. The reference spectra are scaled to match the peak amplitude of the sample, thus providing a scale factor. The scale factor multiplied by the reference spectra concentration is used to determine the concentration value for the sample spectra. Sample pressure and temperature corrections are then applied to compute the final sample concentration. The manually calculated results are then compared with the software-generated results. The data is then validated if the two concentrations are within ± 20% agreement. If there is a difference greater than ± 20% the spectra are reviewed for possible spectra interferences or any other possible causes leading to incorrectly quantified data.

Detection Limit

The detection limit of each analyte was calculated following Annex A2 of ASTM D6348-12 procedure using spectra that contained similar amounts of moisture and carbon dioxide.

Analyte	Detection Limit (ppmv wet)	Detection Limit (%v)
Formaldehyde	**0.2**	**-**
Moisture	**-**	**0.1**

QA/QC data are found in Appendix F. Copies of gas cylinder certifications are found in Appendix G. All concentration data were recorded on a wet, volume basis. The sample and data collection followed the procedures outlined in Method 320.

3.0 TEST RESULT SUMMARIES

Upper Michigan Energy Resources Corporation
F. D. Kuester Generating Station
EURICE1 Outlet Duct

Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/01/19	09:28	10:30	10.33	15.0	11.6	0.90	1.01	0.64	0.0015	169.78	0.26
2	10/01/19	10:46	11:47	10.23	15.0	11.6	0.89	0.99	0.63	0.0015	169.83	0.26
3	10/01/19	12:01	13:03	10.29	15.0	11.6	1.01	1.12	0.71	0.0017	169.78	0.29
Average				10.28	15.0	11.6	0.93	1.04	0.66	0.0016	169.79	0.27

Upper Michigan Energy Resources Corporation
F. D. Kuester Generating Station
EURICE 2 Outlet Duct

Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/01/19	10:14	11:34	9.79	15.0	11.4	0.40	0.44	0.27	0.0007	167.55	0.11
2	10/01/19	11:53	12:55	9.55	15.0	11.3	0.26	0.28	0.17	0.0004	167.38	0.07
3	10/01/19	13:07	14:09	9.71	15.0	11.3	0.36	0.40	0.25	0.0006	167.40	0.10
Average				9.68	15.0	11.3	0.34	0.37	0.23	0.0006	167.44	0.09

Upper Michigan Energy Resources Corporation
F. D. Kuester Generating Station
EURICE3 Outlet Duct

Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/01/19	14:17	15:17	10.38	15.0	11.2	0.95	1.06	0.65	0.0016	169.40	0.26
2	10/01/19	15:32	16:34	10.40	15.0	11.2	0.86	0.96	0.59	0.0014	169.20	0.24
3	10/01/19	16:49	17:50	10.36	15.0	11.2	0.78	0.87	0.53	0.0013	169.10	0.22
Average				10.38	15.0	11.2	0.87	0.97	0.59	0.0014	169.23	0.24

Upper Michigan Energy Resources Corporation
F. D. Kuester Generating Station
EURICE 4 Outlet Duct

Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/01/19	15:20	16:20	10.06	15.0	11.1	0.11	0.12	0.07	0.0002	165.78	0.03
2	10/01/19	16:35	17:36	10.07	15.0	11.1	0.13	0.15	0.09	0.0002	165.75	0.04
3	10/01/19	17:52	18:52	9.93	15.0	11.1	0.10	0.11	0.06	0.0002	165.65	0.03
Average				10.02	15.0	11.1	0.11	0.13	0.08	0.0002	165.73	0.03

Upper Michigan Energy Resources Corporation F. D. Kuester Generating Station EURICE Unit 5 Outlet Duct												
Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/02/19	08:48	09:50	9.94	15.0	11.4	0.98	1.09	0.68	0.0016	166.08	0.27
2	10/02/19	10:06	11:08	9.96	15.0	11.4	0.94	1.04	0.65	0.0016	166.50	0.26
3	10/02/19	11:28	12:30	9.95	15.0	11.4	1.02	1.13	0.70	0.0017	165.98	0.28
Average				9.95	15.0	11.4	0.98	1.09	0.68	0.0016	166.18	0.27

Upper Michigan Energy Resources Corporation F. D. Kuester Generating Station EURICE Unit 6 Outlet Duct												
Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/02/19	09:35	10:37	9.85	15.0	11.5	0.27	0.30	0.19	0.0005	169.08	0.08
2	10/02/19	10:50	11:52	9.89	15.0	11.4	0.26	0.29	0.18	0.0004	169.33	0.07
3	10/02/19	12:10	13:11	9.85	15.0	11.5	0.27	0.30	0.19	0.0005	169.20	0.08
Average				9.86	15.0	11.5	0.27	0.30	0.19	0.0004	169.20	0.08

Upper Michigan Energy Resources Corporation F. D. Kuester Generating Station EURICE Unit 7 Outlet Duct												
Test No.	Date	Start Time	End Time	H_2O%	O_2% Correction	O_2%, dry	Formaldehyde, ppmvw	Formaldehyde, ppmvd	Formaldehyde, ppmvd @ 15% O_2	Formaldehyde lb/mmBtu	Heat Input mmBtu/hr	Formaldehyde, lb/hr
1	10/02/19	13:58	15:00	9.91	15.0	11.4	1.07	1.19	0.74	0.0018	165.80	0.29
2	10/02/19	15:17	16:19	9.80	15.0	11.3	0.98	1.08	0.66	0.0016	165.80	0.27
3	10/02/19	16:33	17:34	9.81	15.0	11.4	1.03	1.14	0.71	0.0017	165.78	0.28
Average				9.84	15.0	11.4	1.03	1.14	0.70	0.0017	165.79	0.28

4.0 CERTIFICATION

MOSTARDI PLATT is pleased to have been of service to Upper Michigan Energy Resources Corporation. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

CERTIFICATION

As project manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results, and the test program was performed in accordance with the methods specified in this test report.

MOSTARDI PLATT

Stuart T. Sands — Project Manager

Scott W. Banach — Quality Assurance

APPENDICES

Appendix A – Plant Operating Data

F.D. Kuester Generating Station
RICE MACT Compliance Emissions Testing
Summary of Operating Data
October 1 & 2, 2019

EURICE1				
10/1/2019				
Method 3A and 320				
Start Time	*928*	*1046*	*1201*	
End Time	*1030*	*1147*	*1303*	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,885	18,890	18,877	**18,884**
Engine natural gas use (pound/hour)	6,791	6,793	6,791	**6,792**
SCR/Oxidation catalyst inlet temperature) (deg F)	725	724	724	**724**
Pressure drop across the oxidation catalyst (PSI)	0.14	0.14	0.14	**0.14**

EURICE2				
10/1/2019				
Method 3A and 320				
Start Time	*1014*	*1153*	*1307*	
End Time	*1134*	*1255*	*1409*	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,868	18,864	18,868	**18,867**
Engine natural gas use (pound/hour)	6,702	6,695	6,696	**6,698**
SCR/Oxidation catalyst inlet temperature) (deg F)	729	730	728	**729**
Pressure drop across the oxidation catalyst (PSI)	0.12	0.12	0.12	**0.12**

EURICE3				
10/1/2019				
Method 3A and 320				
Start Time	*1417*	*1532*	*1649*	
End Time	*1517*	*1634*	*1750*	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,875	18,869	18,875	**18,873**
Engine natural gas use (pound/hour)	6,776	6,768	6,764	**6,769**
SCR/Oxidation catalyst inlet temperature) (deg F)	733	734	735	**734**
Pressure drop across the oxidation catalyst (PSI)	0.12	0.12	0.12	**0.12**

EURICE4				
10/1/2019				
Method 3A and 320				
Start Time	1520	1635	1752	
End Time	1620	1736	1852	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,872	18,872	18,874	**18,873**
Engine natural gas use (pound/hour)	6,631	6,630	6,626	**6,629**
SCR/Oxidation catalyst inlet temperature) (deg F)	734	734	735	**734**
Pressure drop across the oxidation catalyst (PSI)	0.11	0.11	0.10	**0.11**

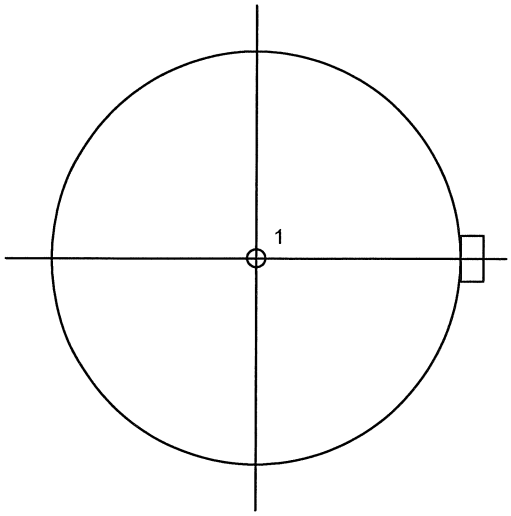
EURICE5				
10/2/2019				
Method 3A and 320				
Start Time	*848*	*1006*	*1128*	
End Time	*950*	*1108*	*1230*	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,874	18,865	18,871	**18,870**
Engine natural gas use (pound/hour)	6,643	6,660	6,639	**6,647**
SCR/Oxidation catalyst inlet temperature) (deg F)	730	730	730	**730**
Pressure drop across the oxidation catalyst (PSI)	0.12	0.12	0.12	**0.12**

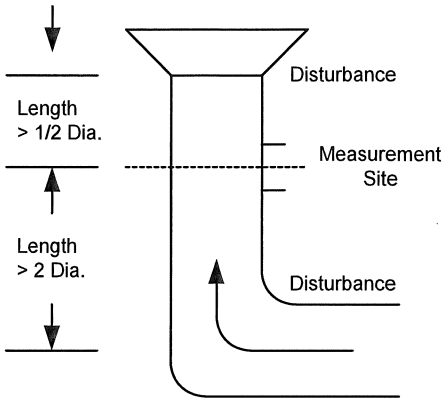
EURICE6				
10/2/2019				
Method 3A and 320				
Start Time	*935*	*1050*	*1210*	
End Time	*1037*	*1152*	*1311*	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,915	18,915	18,908	**18,913**
Engine natural gas use (pound/hour)	6,763	6,773	6,768	**6,768**
SCR/Oxidation catalyst inlet temperature) (deg F)	725	726	727	**726**
Pressure drop across the oxidation catalyst (PSI)	0.12	0.12	0.12	**0.12**

EURICE7				
10/2/2019				
Method 3A and 320				
Start Time	*1358*	*1517*	*1633*	
End Time	*1500*	*1619*	*1734*	
	Run 1	**Run 2**	**Run 3**	**Average**
Engine (kW)	18,868	18,877	18,864	**18,870**
Engine natural gas use (pound/hour)	6,632	6,632	6,631	**6,631**
SCR/Oxidation catalyst inlet temperature) (deg F)	732	732	732	**732**
Pressure drop across the oxidation catalyst (PSI)	0.11	0.11	0.11	**0.11**

Appendix B - Test Section Diagrams

GASEOUS TRAVERSE FOR ROUND DUCTS

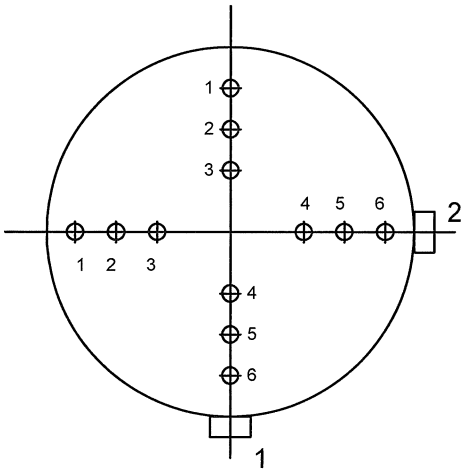


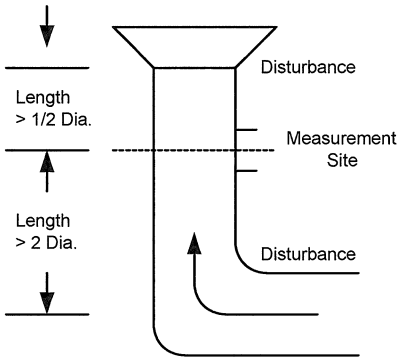


Job:	Upper Michigan Energy Resources Corporation F.D. Kuester Generating Station
Date:	October 1 and 2, 2019
Test Location:	EURICE1, EURICE2, EURICE3, EURICE4, EURICE5, EURICE6, EURICE7 Outlet Ducts (identical)
Duct Diameter:	5.29 Feet
Duct Area:	21.979 Square Feet
No. Points Across Diameter:	1
No. of Ports:	1
Port Length:	8.0 Inches

GASEOUS TRAVERSE FOR ROUND DUCTS

(Preliminary O_2 Traverse)





Job:	Upper Michigan Energy Resources Corporation F.D. Kuester Generating Station
Date:	October 1 and 2, 2019
Test Location:	EURICE1, EURICE2, EURICE3, EURICE4, EURICE5, EURICE6, EURICE7 Outlet Ducts (identical)
Duct Diameter:	5.29 Feet
Duct Area:	21.979 Square Feet
No. Points Across Diameter:	1
No. of Ports:	1
Port Length:	8.0 Inches

Appendix C - Sample Train Diagram

USEPA Methods 3A and 320 – Sample Train Diagram