RICE NESHAP STACK TEST REPORT

Report Title:	RICE NESHAP STACK TEST REPORT FOR THE VERIFICATION OF CARBON MONOXIDE EMISSIONS FROM A DIESEL-FUELED COMPRESSION IGNITION ENGINE-GENERATOR SET
Report Date:	December 11, 2018
Test Date:	October 24, 2018

Facility Information	
Name	A&L Iron and Metal
Street Address	2000 Milbocker Rd
City, County	Gaylord, Otsego
SRN	N7508

Permit and Emission Unit Information	
Michigan Permit to Install	173-08
Administrative Consent Order	EPA-5-18-133(a)-MI-04 (draft)
Emission Unit:	EUGENERATOR

Testing Contractor	
Company Mailing Address	Derenzo Environmental Services 39395 Schoolcraft Road Livonia, Michigan 48150
Phone	(734) 464-3880
Project No.	1808003B

N7508_TEST - 20181024

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

RICE NESHAP STACK TEST REPORT FOR THE VERIFICATION OF CARBON MONOXIDE EMISSIONS FROM A DIESEL FUELED COMPRESSION IGNITION ENGINE

A&L IRON AND METAL

Test Date: October 24, 2018

1.0 INTRODUCTION

A&L Iron and Metal (A&L Iron) owns and operates a metal shredding and recycling facility located in Gaylord, Otsego County, Michigan. The facility is powered by a General Electric locomotive diesel compression-ignition engine (CI RICE) that drives an electricity generator. The engine is subject to the emission standards and testing requirements in Title 40 of the Code of Federal Regulations Part 63 Subpart ZZZZ *National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines* (40 CFR Part 63 Subpart ZZZZ) as an existing non-emergency, non-black start CI stationary RICE with a power output greater than 500 horsepower (hp), located at an area source of hazardous air pollutant (HAP) emissions.

Pursuant to 40 CFR Part 63 Subpart ZZZZ, an owner/operator of an existing non-emergency, non-black CI RICE >500 hp at an area source of HAP emissions must:

- Install an oxidation catalyst emission control system.
- Reduce carbon monoxide (CO) emissions by 70% or more, or reduce CO to an outlet concentration of 23 ppmvd at 15% oxygen.

A&L Iron has equipped the existing engine with an oxidation catalyst and is submitting this test report for the verification of its carbon monoxide (CO) destruction efficiency. Emissions were measured on the inlet and outlet of the catalyst in the exhaust gas stream.

In accordance with 40 CFR Part 63 Subpart ZZZZ, a Notification of Intent to conduct a performance test was submitted on September 11, 2018 to the Administrator to resolve the violation that is currently being addressed by USEPA Region 5 through the issuance of an Administrative Consent Order.

The emission testing presented in this test report was performed by Derenzo Environmental Services (DES). This test report has been prepared in accordance with the Michigan Department of Environmental Quality, Air Quality Division (MDEQ-AQD) *Format for Submittal of Source Emission Test Plans and Reports* (March 2018).

The exhaust gas sampling and analysis was performed using procedures specified in the Notice of Intent dated September 11, 2018 that was submitted to USEPA and MDEQ-AQD. Mr. Jeremy Howe and Ms. Sharon LeBlanc of the MDEQ-AQD were on-site to observe the compliance testing.

1.1 Purpose and Objectives of Testing

DES was contracted to perform the CI RICE genset CO emissions testing specified in 40 CFR Part 63 Subpart ZZZZ. Installation and operation of the existing General Electric model 7FDL16 CI RICE genset is described in MDEQ-AQD PTI No. 173-08.

The emission testing procedures presented in this test report were performed to satisfy the requirements of 40 CFR §63.6603(a), which states:

> *If you own or operate an existing stationary RICE located at an area source of HAP emissions, you must comply with the requirements in Table 2d to this subpart and the operating limitations in Table 2b to this subpart that apply to you.*

Table 2d of Subpart ZZZZ specifies that non-emergency generator CI RICE performance tests can be conducted to demonstrate CO:

- Emissions exhausted from the CI RICE emission control oxidation catalyst are reduced to 23 parts per million by volume dry (ppmvd) at 15% oxygen (O_2); or
- Emission reduction achieved by the CI RICE emission control oxidation catalyst is 70% or more.

The emission testing was performed by DES representatives Blake Beddow, Clay Gaffey, and Jory VanEss on October 24, 2018.

1.2 Project Contacts and Report Certification

Questions regarding this emission test report should be directed to:

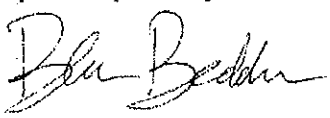
Blake Beddow
Environmental Consultant
Derenzo Environmental Services
39395 Schoolcraft Rd.
Livonia, MI 48150
(734) 464-3880
bbeddow@derenzo.com

Mr. Brian Miller
Operations Manager
A&L Iron and Metal
2000 Milbocker Rd
Gaylord, MI 49735
989-732-5900
bmiller@alironandmetal.com

This test report was prepared by Derenzo Environmental Services based on the emission measurements and field sampling data collected by DES. Facility process and operating data were collected and provided by representatives of A&L Iron and Metal.

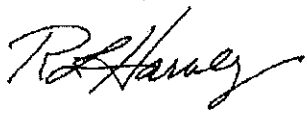
I certify that emission testing was performed in accordance with the specified USEPA reference test methods as described in the Notification of Intent to Test unless noted in this report. I believe that the data and information presented in this report are true, accurate and complete.

Report Prepared By:



Blake Beddow
Environmental Consultant
Derenzo Environmental Services

Reviewed By:



Robert Harvey, P.E.
General Manager
Derenzo Environmental Services

I certify that the facility and emission units were operated at maximum routine operating conditions for the test event. Based on information and belief formed after reasonable inquiry, the statements and information in this report are true, accurate and complete.

Responsible Official Certification:

Brian Miller
Operations Manager
A&L Iron and Metal

2.0 SUMMARY OF TEST RESULTS

The exhaust gas from the diesel-fueled CI RICE genset is routed to an oxidation catalyst for the control of CO and hydrocarbons in the exhaust gas. In order to determine the CO destruction efficiency, the exhaust gas was sampled prior to the oxidation catalyst (inlet) and after the catalyst (outlet). The compliance testing performed October 24, 2018 consisted of three (3) one-hour test periods during which the inlet and outlet gas streams were sampled and analyzed simultaneously. During each test period the inlet gas stream was sampled for an equal amount of time at twelve (12) points. The catalyst outlet gas stream is divided into three (3) vertical stacks. Each stack was sampled for a twenty (20) minute period during each one-hour test period.

Instrumental analyzers were used to measure concentrations of CO and O_2 (on a dry gas basis) in the catalyst inlet and exhaust gas. The CI RICE genset typically operates between 50 and 60% of its rated capacity of 2.6 MW. The testing was performed while the CI RICE genset was operated at maximum achievable load, which is the maximum electricity demand for the facility. During the emission testing the average recorded generator output was 2,261 kW (2.3 MW).

Table 2.1 below presents a summary of the compliance test results. Table 2.2 presents a summary of the emission unit operating conditions recorded during the test periods.

The test results verify compliance with the 40 CFR Part 63 Subpart ZZZZ emission standard to achieve an emission reduction of 70% or more using an oxidation catalyst.

Table 2.1. Summary of compliance test results

EUGENERATOR Catalyst	CO Concentration (ppmvd)	Oxygen Content (% vol, dry)	CO Concentration (ppmvd @15% O_2)	Emission Standard
Inlet	339	14.7	333	--
Outlet	43	14.7	42	--
Destruction Efficiency	87%	--	87%	>70%

Table 2.2. Summary of emission unit operating conditions

Emission Unit ID	Operating Hours[†]	Average Output (kW)	Catalyst Inlet (°F)	Pressure Drop Catalyst ("H_2O)
EUGENERATOR	8,214	2,261	655	1.0

[†] Engine run hour meter reading at the beginning of Test 1

3.0 SOURCE DESCRIPTION

3.1 Emission Unit Location and Description

The A&L Iron facility is located at 2000 Milbocker Rd in Gaylord, Otsego County, Michigan. The diesel fueled CI RICE genset is a General Electric model 7FDL16 locomotive RICE connected to an electricity generator. The engine has a manufacture date of 1978 and a horsepower rating of approximately 3,506 hp. The generator has a rated maximum output of 2.6 MW.

3.2 Rated Capacities, Type and Quantity of Raw Materials Used

The CI RICE genset typically operates between 50 and 60% of its rated capacity of 2.6 MW. The testing was performed while the CI RICE genset was operated at maximum achievable load, which is the maximum electricity demand for the facility. During the emission testing the average recorded generator output was 2,261 kW (2.3 MW).

Appendix 1 provides operating data recorded by A&L Iron representatives.

3.3 Emission Control System Description

The exhaust gas from the CI RICE is directed to an EST Diesel Oxidation/VOC Silencer/Converter. The emission control system reduces (oxidizes using a catalyst) CO and other hydrocarbon emissions prior to the release to the ambient air.

The CI RICE exhaust gas provides the heat necessary to initiate the catalytic reaction (an additional heat source is not used to preheat the gas prior to the catalyst).

The temperature at the catalyst inlet and pressure drop across the catalyst were monitored throughout the test periods to verify that the catalyst operating parameters are within the proper ranges as required by 40 CFR Part 63 Subpart ZZZZ. Table 2b to Subpart ZZZ specifies that for existing CI RICE with a power output greater than 500 HP, the catalyst:

- Must be maintained such that the pressure drop across the catalyst does not change more than 2 inches of water from the pressure drop across the catalyst that was measured during the initial performance test.

- Inlet temperature must be maintained between 450 and 1350°F.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

This section provides a summary of the exhaust gas sampling and analytical procedures that were used during the test event.

4.1 Testing Location and Sampling System

A continuous sample of the CI RICE exhaust gas was obtained from the inlet and the outlet of the emission control catalyst. During each simultaneous, one-hour pollutant sampling period, a continuous sample of the CI RICE exhaust gas stream was extracted from the each sampling location using a stainless steel probe connected to a Teflon® heated sample line. The sampled gas was conditioned by removing moisture prior to being introduced to the instrumental analyzers.

The oxidation catalyst inlet sample location is a rectangular plenum at the engine exhaust that is approximately 13.5 inches by 28 inches. This sampling location does not meet USEPA Method 1 requirements. Therefore, sampling was performed using a 12 point-grid across the rectangular cross section pursuant to Section 8.1.2 of USEPA Method 7E and Table 1-1 to USEPA Method 1. The sample points were configured in a 4-by-3 grid as presented in Appendix 2.

The catalyst outlet was sampled concurrently with the inlet. The catalyst exhaust gas is released to atmosphere by three (3) separate exhaust stacks. For each one-hour test period, the sampling time was split equally between the three (3) exhaust points (20 minutes per stack). Concentration data collected when the sampling probe was moved between exhaust stacks was removed from the test run average. Data was considered valid when the sample probe has been in place for at least twice the system response time.

Appendix 2 provides diagrams of the sampling locations.

4.2 Exhaust Gas Oxygen and CO Concentration (USEPA Methods 3A and 10)

The O_2 content and CO concentration in the RICE exhaust gas stream (inlet and outlet of catalyst) was measured continuously throughout each one-hour test period in accordance with USEPA Methods 3A and 10. For the catalyst inlet a Servomex 1440D oxygen analyzer with a paramagnetic sensor was used to measure the O_2 content; CO concentration was measured using a Thermo Environmental Instruments (TEI) Model 48i non-dispersive infrared (NDIR) analyzer. For the catalyst outlet a California Analytical Instruments (CAI) Model ZRE4 NDIR/zirconia analyzer was used to measure the O_2 and CO concentrations.

Instrument response for each analyzer was recorded on an ESC Model 8816 data logging system that monitored the analog output of the instrumental analyzers continuously and logged data as one-minute averages. Prior to, and at the conclusion of each test period, instrument calibration

was verified using appropriate calibration gases to determine accuracy and system bias (described in Section 5.1 of this document).

Appendix 3 provides field data sheets and calculations.

Appendix 4 provides raw (one-minute average) instrumental analyzer response data for each test period.

5.0 QUALITY ASSURANCE PROCEDURES

5.1 Instrument Calibration and System Bias Checks

At the beginning of each day, initial three-point instrument calibrations were performed by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the appropriate upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and verifying the instrument response against the initial instrument calibration readings.

The instrument analyzers were calibrated with USEPA Protocol 1 certified O_2 and CO concentrations in nitrogen and zeroed using nitrogen. A STEC ten-step gas divider was used (as needed) to obtain intermediate calibration gas concentrations.

5.2 Sampling System Response Time Determination

The response time of the sampling system was determined prior to the compliance test program by introducing upscale gas and zero gas, in series, into the sampling system using a tee connection at the base of the sample probe. The elapsed time for the analyzer to display a reading of 95% of the expected concentration was determined using a stopwatch.

The CAI Model ZRE4 analyzer exhibited the longest system response time at 105 seconds. Results of the response time determinations were recorded on field data sheets. For each test period, test data were collected once the sample probe was in position for at least twice the maximum system response time.

5.3 Gas Divider Certification (USEPA Method 205)

The STEC 10-step gas divider was used in the field to obtain appropriate calibration span gases. The 10-step gas divider was NIST-certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step gas divider delivers calibration gas values of 0 to 100% in (10% increments) of the USEPA Protocol 1 calibration gas that is introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of the 10-step gas divider.

The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.4 Determination of Exhaust Gas Stratification

A stratification test was performed for the CI RICE exhaust stacks. The stainless steel sample probe was positioned at sample points correlating to 16.7, 50.0 (centroid) and 83.3% of each stack diameter. Pollutant concentration data were recorded at each sample point for a minimum of twice the maximum system response time.

The recorded concentration data for each catalyst exhaust stack indicated that the measured O_2 concentrations did not vary by more than 5% of the mean across the stack diameters. Therefore, the CI RICE exhaust gas for EUGENERATOR was considered to be unstratified in each stack and the compliance test sampling was performed at a single sampling location within each exhaust stack of the CI RICE.

The catalyst inlet sampling location did not meet the USEPA Method 1 spacing requirements. Therefore, it was treated as a stratified stack using a 12 point-grid across the rectangular cross section pursuant to Section 8.1.2 of USEPA Method 7E and Table 1-1 to USEPA Method 1.

Appendix 5 presents test equipment quality assurance data (instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results).

6.0 DISCUSSION OF TEST RESULTS

6.1 Results Summary and Comparison to Emission Standard

Table 6.1 presents the operating data and air pollutant emission measurement results for each one-hour test period.

Catalyst CO destruction efficiency was calculated for each test period by comparing the average measured CO concentration at the catalyst outlet to the average measured CO concentration at the catalyst inlet.

Destruction Efficiency, $DE = 1 - [C_{CO\text{-}out} / C_{CO\text{-}in}]$

The measured CO reduction across the catalyst averaged 87%. This is greater than (in compliance with) the 40 CFR Part 63 Subpart ZZZZ emission standard that requires the catalyst emission control system achieve a CO emission reduction of at least 70%.

Engine operating data and air pollutant emission measurement results for each one-hour test period are presented in Table 6.1.

6.2 Operating Conditions During the Compliance Test

Operating data were recorded in 15-minute increments during each one-hour sampling run. The emissions testing was performed while the CI RICE genset was operated at maximum electricity demand for the facility. The generator had an electricity output ranging between 2,029 and 2,577 kW during compliance testing as determined by A&L Iron personnel.

Catalyst inlet temperature during all (3) test periods ranged between 470 and 782°F. Table 2b of 40 CFR Part 63 Subpart ZZZZ specifies that the catalyst inlet temperature must be maintained between 450 and 1350°F for a CI RICE.

The pressure drop across the catalyst ranged from 0 to 2 inches of water column (in.H_2O) for each test period and averaged 1 in.H_2O. Table 2b of 40 CFR Part 63 Subpart ZZZZ specifies that the catalyst must be maintained such that the pressure drop across the catalyst does not change by more than 2 inches of water from the pressure drop across the catalyst that was measured during the initial performance test.

The engine operating hours (run hour meter) were recorded at the beginning of the first sampling run.

Operating data are provided in Appendix 1.

6.3 Variations from Normal Sampling Procedures or Operating Conditions

The testing for all pollutants was performed in accordance with USEPA methods and the approved test protocol. The genset was operated at maximum load (maximum electricity demand for the facility).

The permanently-installed catalyst inlet temperature monitor was not functional during the test periods. Catalyst inlet temperature was hand recorded every fifteen (15) minutes during each one-hour test period from a pyrometer that was wired into the catalyst thermocouple for the test event.

During the second test run the CI RICE was overloaded due to "un-shreddable" material loading in the shredder. This caused the catalyst inlet CO emissions to spike above the span on the instrument at 11:24 AM. The second test run was aborted though the data are included in the instrument output data in Appendix 4. Bias checks were performed on the instruments prior to starting the third test run.

During the fourth test run "un-shreddable" material was again introduced to the shredder. This time the engine shut down at 14:33, and the test was paused. The engine was restarted and restored to the appropriate load and the fourth test run resumed at 15:18.

Table 6.1. Measured CO concentration and destruction efficiency for the CI RICE catalyst inlet and exhaust gas streams

Test Number Test Date Test Period (24-hr)[1]	1 10/24/18 0932-1042	3 10/24/18 1206-1314	4 10/24/18 1350-1513, 1518-1537	Three Test Average
Genset Operating Parameters				
Generator output (kW)	2,272	2,109	2,404	2,261
Catalyst Data				
Inlet Temperature (°F)	844	852	872	856
Pressure Drop (in.H_2O)	1.0	1.0	1.0	1.0
Exhaust Gas Measurements (Inlet)				
Oxygen content (%vol, dry)	13.2	15.1	15.7	14.7
CO concentration (ppmvd)	327	344	347	339
CO concentration (ppmvd 15% O_2)	251	351	395	333
Exhaust Gas Measurements (Outlet)				
Oxygen content (%vol, dry)	13.1	15.4	15.5	14.7
CO concentration (ppmvd)	48.3	41.3	40.3	43.3
CO concentration (ppmvd 15% O_2)	36.5	44.4	43.9	41.6
Catalyst CO Destruction Efficiency				
Measured CO DE (%)	85	87	89	87
Emission Standard (%)[2]	--	--	--	70

Notes

1. Each test period is comprised of 60 minutes of data. Recorded data while the probe is moved between exhaust stacks are removed from the data set. Test 2 was aborted when the CO inlet concentration exceeded the instrument span due to an engine overload. Test 4 was paused for 5 minutes due to an engine shutdown.
2. 40 CFR Part 63 Subpart ZZZZ emission standard requires that the CI RICE emission control catalyst achieve a CO emission reduction of 70% or greater.

APPENDIX 1

ENGINE OPERATING RECORDS

Internal Combustion Engine
Process Operating Data

Facility: A&L Iron and Metal
Location: Gaylord, MI
Date: 10/24/18

Unit ID: EUGENERATOR
Operating Hours: 8,214

Test 1		Generator Output (kW)	Catalyst Inlet Temp. (°F)	Press. Drop Catalyst (in. water)
Start Time	9:32	2,231	778	2
	9:47	2,253	750	2
	10:02	2,373	774	2
	10:17	2,332	626	1
	10:32	2,344	755	1
Stop Time	10:43	2,096	647	0

Test 2		Generator Output (kW)	Catalyst Inlet Temp. (°F)	Press. Drop Catalyst (in. water)
Start Time	12:06	2,030	575	2
	12:21	2,037	475	0
	12:36	2,041	480	0
	12:51	2,029	733	1
Stop Time	13:16	2,407	765	1

Test 3		Generator Output (kW)	Catalyst Inlet Temp. (°F)	Press. Drop Catalyst (in. water)
Start Time	13:50	2,538	470	0
	14:05	2,577	545	1
	14:20	2,409	782	1
	14:35	2,473	560	1
	14:50	2,357	773	0
Stop Time	15:35	2,069	703	0

Process Operating Data

Facility Name: A & L IRON AND METAL
Location: GAYLORD, MI
Test Date: 10/24/18

9:32 ~~AM~~ START TIME
END TIME

Engine ID: EU-GENERATOR
Serial No.:
Operating Hrs.: 8214

TEST NO. 1
Start Time: 9:32

	Generator Output (kw)	Catalyst Inlet Temp (°F)	Pressure Drop Cat. (in. water)	
0 min	2231 0	778 / 780	2	
15 min	2253	750 / 775	2	
30 min	2373	775 / 778	2	
45 min	2832	626 / 630	1	
60 min	2844	755 / 760	1	
Stop Time: 10:43	2096	647 / 650	0	

TEST NO. 2
Start Time: ~~11:10~~ 12:06

	Generator Output (kw)	Catalyst Inlet Temp (°F) 575 / 578	Pressure Drop Cat. (in. water)	
0 min	~~2030~~ 2030	762 / 765	2	
15 min	2037	475 / 478	0	
30 min	2041	480 / 483	0	
45 min	2029	733 / 740	1	
60 min	2407	765 / 768	1	
Stop Time: 1:16				

TEST NO. 3
Start Time: 1150

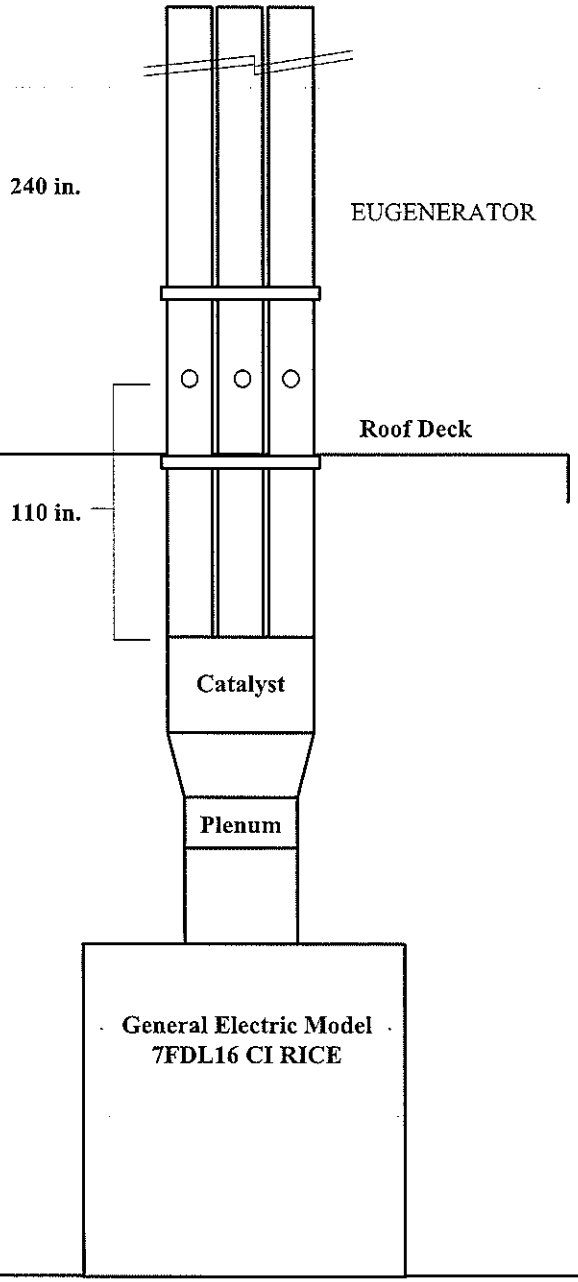
	Generator Output (kw)	Catalyst Inlet Temp (°F)	Pressure Drop Cat. (in. water)	
0 min	2538	470 / 475	0	
15 min	2577	545 / 548	1	
30 min	2709	782 / 788	1	
Resume 3:05 to 3:10 45 min	2473	560 / 562	1	
60 min	2857	773 / 775	0	
Stop Time: ~~3:35~~ 3:35	2069	703 / 705	0	

Operator Initials: _____

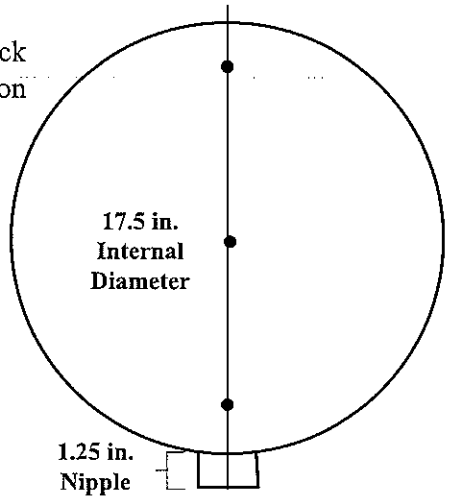
Note - Operating hours are recorded at the beginning of the first test.

APPENDIX 2

SAMPLING LOCATION DIAGRAM



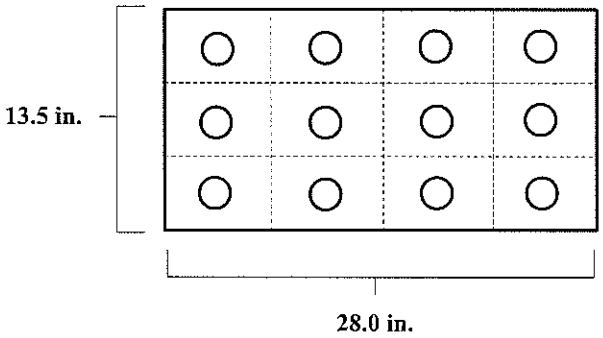
Exhaust Stack
Cross-Section



USEPA Method 7E Stack Gas
Stratification Test Points

Pt. #	in.
1	2.92
2	8.75
3	14.58

Plenum
Cross-Section



11/1/18	**A&L Iron and Metal Exhaust Sampling Locations**		
	Scale None	Sheet 1 of 1	Derenzo Environmental Services