Results of the July 17-18, 2024 Compliance Tests on the EU-Dryer, EU-Raw Material and EU-Dried Material Stacks at the Aymium Facility Located in Gwinn, Michigan

September 2024

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BARR

Report Certification

Certification of Sampling Procedures:

I certify under penalty of law that the sampling procedures were performed in accordance with the approved test plan and that the data presented in this test report are, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below.

1) An EPA Protocol nitrogen dioxide (NO_2) gas was inadvertently used to span the nitrogen oxide (NO_x) analyzer. System bias calibrations were performed with an EPA Protocol NO_x gas similar to concentrations observed in the stack gas stream.

Ryan Pantzke

Ryan Pantzke
Sr. Air Quality Scientist
Barr Engineering Co.

September 5, 2024
Date

Certification of Analytical Procedures:

I certify under penalty of law that the analytical procedures were performed in accordance with the requirements of the test methods and that the data presented for use in the test report were, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below

Richard Berg

Richard Berg
Senior Air Quality Technician
Barr Engineering Co.

September 5, 2024
Date

Certification of Analytical Procedures:

I certify under penalty of law that the analytical procedures were performed in accordance with the requirements of the test methods and that the data presented for use in the test report were, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below

Tim Russell
Vice President
Barr Engineering Co.

September 5, 2024
Date

Certification of Test Report by Owner or Operator of Emission Facility:

I certify under penalty of law that the information submitted in this test report accurately reflects the operating conditions at the emission facility during this performance test and describes the date and nature of all operational and maintenance activities that were performed on the process and control equipment during the month prior to the performance test. Based on my inquiry of the person or persons who performed the operational and maintenance activities, the information submitted in this test report is, to the best of my knowledge and belief, true, accurate, and complete. All exceptions are listed and explained below.

Dan Hendrickson

Dan Hendrickson
Plant Manager
Aymium

9/4/2024

Date

Executive Summary

Barr Engineering Co. (Barr) performed emissions tests on the EU-Dryer (SV-EXHAUST), EU-Raw Material baghouse (SV-BH 666), and EU-Dried Material baghouse (SV-BH 667) at the Aymium facility located in Gwinn, Michigan. Testing was performed July 17-18, 2024 to demonstrate compliance with the permitted emission limits outlined in Permit to Install 24-12A. Testing was performed on the EU-Dryer (SV-EXHAUST) for the determination of particulate matter (PM), particulate matter less than 10 microns (PM_{10}), nitrogen oxides (NO_X), carbon monoxide (CO), volatile organic compounds (VOC), hydrogen chloride (HCl) and methanol (MeOH) emissions. Testing was performed on the EU-Raw Material (SV-BH 666) and EU-Dried Material (SV-BH 667) baghouses for the determination of PM and PM_{10}. An opacity determination was made at each source by a certified visible observer.

Test results and applicable limits are presented in the following table.

Table ES-1 Executive Summary Table

TEST PARAMETER Methods 1-4, 5, 7E, 9, 10, 25A, 202 and 320	EU-Dryer	EU-Raw Material	EU-Dried Material
Stack Vent ID	SV-EXHAUST	SV-BH 666	SV-BH 667
Test Date	7/17/24	7/18/2024	
Volumetric Airflow Rates			
ACFM	66,800	33,200	43,100
SCFM	41,200	31,900	36,800
DSCFM	35,400	31,400	35,900
Particulate Matter			
PM Emission Rate (Filterable), lb/hr	9.6	0.109	0.38
PM Emission Rate (Filterable), lb/1000 lb gas	0.054	0.00077	0.0023
PM/PM_{10} Emission Rate (Filterable + Condensables), lb/hr	10.1	--	0.68
PM (Filterable) Emission Limit, lb/hr	*11.45*	*4.22*	*4.52*
PM_{10} Emission Limit, lb/hr	*20.5*	*4.22*	*4.52*
PM (Filterable) Emission Limit, lb/1000 lb exhaust gas	*0.09*	*0.017*	*0.016*
Nitrogen Oxides (NO_X)			
Concentration, ppm (dry basis)	17.0	--	--
Emission Rate, lb/hr	4.5	--	--
Nitrogen Oxides (NO_X) Emission Limit, lb/hr	*46.2*	--	--
Carbon Monoxide (CO)			
Concentration, ppm (dry basis)	127	--	--
Emission Rate, lb/hr	20.3	--	--
Carbon Monoxide (CO) Emission Limit, lb/hr	*23.1*	--	--
Volatile Organic Compounds (VOC)			
Concentration, ppm (wet basis)	11.9	--	--
Emission Rate, lb/hr	3.5	--	--
Volatile Organic Compounds Limit, lb/hr	*23.1*	--	--
Hydrogen Chloride			
Emission Rate, lb/hr	<0.42	--	--
Hydrogen Chloride Emission Limit, lb/hr	*2.1*	--	--
Methanol			
Emission Rate, lb/hr	1.6	--	--
Visible Emissions			
% Opacity	0	0	0
Opacity Limit, % Highest 6-minute average	*20*	*10*	*10*

(1) Stack temperatures were below 85 degrees Fahrenheit, collection of condensables assumed to be with filterable PM.
(2) All PM is assumed to be less than or equal to 10 microns (PM_{10}).

1 Introduction

Barr performed emissions tests on the EU-Dryer (SV-EXHAUST), EU-Raw Material baghouse (SV-BH 666), and EU-Dried Material baghouse (SV-BH 667) at the Aymium facility located in Gwinn, Michigan. Testing was performed July 17-18, 2024 to demonstrate compliance with the permitted emission limits outlined in Permit to Install 24-12A. Testing on the EU-Dryer (SV-EXHAUST) was performed for the determination of PM, PM_{10}, NO_x, CO, VOC, HCl and MeOH emissions. Testing was performed on the EU-Raw Material (SV-BH 666) and EU-Dried Material (SV-BH 667) baghouses for the determination of PM and PM_{10}. An opacity determination was made at each source by a certified visible observer.

A test plan was submitted to the Michigan Department of Environmental Quality, Great Lakes, and Energy (EGLE) on May 23, 2024 and approved in an email on July 9, 2024. Email communication related to the testing, copies of the stack testing protocol and the approval are in Appendix J.

Ryan Pantzke of Barr lead the test team. Dan Hendrickson of Aymium provided the coordination of the Barr test team with facility operations. Joseph Scanlan and Amy Beaver of EGLE were on site to witness testing activities. A list of project participants is provided in Appendix K.

Testing consisted of three one-hour runs at each source for each pollutant required except for PM/PM_{10} on the EU-Dryer (SV-Exhaust). A fourth PM/PM_{10} test run was performed after it was determined issues in the EU-Dryer process was potentially causing elevated emissions and was not representative of normal operating conditions. EGLE staff on-site approved conducting a fourth run and approved that test results would be the average of runs 2-4. Data from all four test runs are provided in this report.

Particulate matter emissions were determined using Method 5 or Modified Method 5, and Method 202 with the assumption that all particulate matter is less than or equal to PM_{10}. A one-hour opacity test was performed on each source using Method 9. Methods 7E and 10 were used on the EU-Dryer (SV-Exhaust) to determine NO_x and CO while Method 320 was used for HCL and MeOH.

Test results are presented in the following section. Field data and laboratory data along with supporting documentation are in the appendices.

Table 1-1 Emission Source Information

Source	Control Equipment	Stack Vent	Rated Capacity	Applicable Rule
EU-Dryer	Multiclones and Thermal Oxidizer	SV-Exhaust	24 dry tons/hr 25 MMBTU/hr (Natural Gas) 44 MMBTU/hr (wood dust	Permit to Install 24-12A
EU-Raw Material	CE-BH 666	SV-BH 666	48 green tons/hr	Permit to Install 24-12A
EU-Dried Material	CE-BH 667	SV-BH 667	24 green tons/hr	Permit to Install 24-12A

2 Results Summary

Pollutant emission rate results are reported in pound per hour (lb/hr). PM is also reported in pound per 1000 lb exhaust gas (lb/1000 lb exhaust gas). Emission rates are provided in the Executive Summary and in the results tables. Applicable emission limits are provided in the Executive Summary table.

2.1 EU-Dryer (SV-Exhaust)

Results of the July 17, 2024 testing on the EU-Dryer exhaust stack (SV-EXHAUST) are provided in Tables 1-3. Table 1 summarizes the test results for PM/PM_{10} emission rates and opacity. Visible emissions readings were performed during test run one. All readings were zero percent opacity. Table 2 summarizes NO_X, CO and VOC concentrations and emission rates. All three pollutants are below permitted emission rate limits. Table 3 summarizes the HCl and MeOH emissions. HCl is under permitted limits while MeOH has no limit listed in the permit.

A fourth PM/PM_{10} test run was conducted due to process issues causing possible elevated PM/PM_{10} emissions. No other difficulties were noted during the testing.

2.2 EU-Raw Material (SV-BH 666)

Testing for PM/PM_{10} and opacity on the EU-Raw Material baghouse (SV-BH 666) was performed on July 18, 2024 and visible emission readings were performed on July 17, 2024. Results are summarized in Table 4. The visible emissions were determined while the unit was operating at normal conditions. All readings were zero percent opacity.

No difficulties were noted during the testing.

2.3 EU-Dried Material (SV-BH 667)

Testing on the EU-Dried Material baghouse (SV-BH 666) was performed on July 18, 2024 for PM/PM_{10} and visual emission readings were performed on July 17, 2024. Results are summarized in Table 5. Visible emissions were determined while the unit was operating at normal conditions. All readings were zero percent opacity.

No difficulties were noted during the testing.

3 Process Description

Aymium produces high value biocarbon and biohydrogen products that are used in the production of metals, energy, crops and the purification of water and air. The products are produced using a combustion-free thermochemical process that separates the components of biomass into biocarbon, biohydrogen and water. The process creates excess energy and water that is recycled back int the system.

The drum dryer system used during normal drying operations may burn softwood or hardwood chips, corn stover, switch grass, sawdust (raw material) and/or natural gas or biogas. The burner is fired with natural gas during start-up and can also continue with natural gas or biogas during normal operation. Emissions from the dryer are controlled by a multiclone and thermal oxidation system and gases are vented to the atmosphere through the EU-Dryer exhaust stack (SV-EXHAUST). Emissions from the EU-Raw Material process equipment are controlled by baghouse (CE-BH 666). The gas stream is then exhausted through the EU-Raw Material baghouse stack (SV-BH 666).

The dried feedstock material from the dryer is conveyed through a metering bin and then into the process heater where the feedstock is carbonized. Carbonized feedstock is then cooled and densified. Densified pellets are optionally dried and finished product is packaged prior to shipping. Emissions from the process heater are reused as process fuel before ultimately being controlled by the thermal oxidation system and vented to the atmosphere through the EU-Dryer exhaust stack (SV-EXHAUST). The process heater emissions and the collected emissions from EU-Dried Material process equipment are controlled by baghouse (CE-BH 667).

Process operating data can be found in Appendix I.

4 Stack Testing Procedures and Methods

Testing was performed from ports meeting EPA Method 1 criteria. The Method 1 criteria are listed in the table below. Sample port location and traverse point detail are provided in Figures 1-6.

Table 4-1 EPA Method 1 Criteria

Stack Vent Numbers	Distance to Upstream Disturbances (Diameters)	Distance to Downstream Disturbances (Diameters)	Number of Ports	Number of Points
EU-Dryer	3.0	17.0	2	24
EU-Raw Material	2.0	14.0	2	24
EU-Dried Material	4.4	2.2	2	24

Volumetric airflow determinations were performed in accordance with Method 2 (40 CFR Part 60, Appendix A) using an S-type pitot tube and an oil manometer.

The stack gas composition and molecular weight was determined by Method 3A (40 CFR Part 60, Appendix A) with a Servomex 1440 O_2/CO_2 analyzer at the EU-Dryer (SV-Exhaust). Stack gas conditions at the EU-Raw Material (SV-BH 666) and EU-Dried Material (SV-667) were assumed to be ambient conditions.

Stack gas moisture content was determined by the performance of Method 4 in conjunction with the EPA Method 5 tests (40 CFR Part 60, Appendix A).

Filterable particulate matter concentration and emission rate was determined in accordance with Method 5 (40CFR Part 60, Appendix A). Particulate matter concentration at the EU-Dryer (SV-EXHAUST) and EU-Dried Material (SV-BH 667) include condensable particulate matter collected in the back half of the sample train using Method 202 (40 CFR Part 51, Appendix M). Stack gas temperatures on the EU-Raw Material (SV-BH 666) were below 85 degrees Fahrenheit, therefore, Modified Method 5 was utilized for the determination of particulate matter using an unheated probe and filter system.

Determination of opacity of visual emissions was performed in accordance with Method 9 (40 CFR Part 60, Appendix A). One 60-minute observation was performed at each source. The visible emissions observer's certification is provided in Appendix H.

NO_x concentration was determined by EPA Method 7E (40CFR Part 60, Appendix A) using an API 200EH analyzer. Filtered stack gas was delivered through a heated sample line to a sample chiller and directed to the analyzers. The API analyzer was inadvertently spanned using an EPA protocol nitrogen dioxide (NO_2) calibration gas. System bias calibrations was determined with an EPA protocol NO_x gas with concentrations like those observed in the stack gas stream. Results are biased corrected using this gas.

CO concentration was determined by EPA Method 10 (40 CFR Part 60, Appendix A) with a Thermo Environmental Model 48i gas filter correlation analyzer.

VOC concentration was determined by Method 25A (40CFR Part 60, Appendix A) with Thermo model 51i-HT flame ionization detector analyzer calibrated with propane.

Analyzers were calibrated with EPA protocol gasses and instrument data was recorded on an electronic data acquisition system. Instrument output data and calibration gas certifications are in Appendix F and G, respectively.

HCl and MeOH were measured by EPA Method 320 (40 CFR Part 60, Appendix A) using a MAX-iR Fourier-Transform Infrared (FTIR) analyzer. Sample gas was transported through a heated stainless-steel probe and heated glass fiber filter and heat traced Teflon sample line to the instrument. The detection limit is determined by taking three times the standard deviation of the rolling average of ten consecutive readings. Concentrations are measured on a "wet basis".

The FTIR instrument uses a ZnSe beam splitter, 9.98-meter multi-pass gas cell, and mercury cadmium telluride (MCT) detector. The gas cell is composed of nickel-coated aluminum with gold-coated mirrors. The gas cell temperature was operated at 191 ° Celsius. FTIR signal intensity, detector linearity, instrument resolution, and instrument frequency precision parameters were all within specifications. Daily leak checks were performed and met method criteria. Ethylene gas transfer standard certified to +/-1.0% was used as the calibration transfer standard (CTS). The path length of the MAX-iR is fixed at 9.98 meters. CTS gas measurement verifies that path length has not changed and that the instrument is performing correctly. Path length stability was verified by analyzing the ethylene spectra before and after testing resulting in a path length stability within 5%. NIST traceable gases of HCl and MeOH were used to perform spike recoveries which met the 70 – 130% method requirements.

The software utilized with the FTIR instrument records data approximately once every minute and the required minimum samples per test run were collected. FTIR output data and quality assurance information are provided in Appendix E along with supporting data.

Tables

TABLE 1

PARTICULATE MATTER TEST RESULTS

EU-Dryer (SV-Exhaust)

Parameter	Run 1	Run 2	Run 3	Run 4	Average[1]
Test Date	7/17/2024	7/17/2024	7/17/2024	7/17/2024	---
Test Period	0855 - 0957	1204 - 1306	1410 - 1513	1537 - 1639	---
Test Duration, min	60	60	60	60	60
Average Stack Temperature, °F	378	365	370	352	362
Average Moisture Content, %V/V	14.4	14.5	14.4	13.3	14.1
Particulate Loading, g					
PM - Filterable	0.13799	0.02930	0.11001	0.06361	0.06764
Organic CPM	0.00023	0.00025	0.00045	0.00054	0.00037
Inorganic CPM	0.00147	0.00230	0.00395	0.00463	0.00309
Air Flow Rate					
acfm	73,000	68,500	68,700	63,100	66,800
scfm	44,200	42,100	42,000	39,500	41,200
dscfm	37,900	36,000	36,000	34,200	35,400
Sample Volume					
acf	36.50	35.67	35.10	33.66	34.81
dscf	34.85	33.97	33.54	32.11	33.21
Isokinetic Variation, %	98.4	100.8	99.6	100.4	100.3
Particulate Matter Concentration, gr/dscf					
PM - Filterable	0.061	0.013	0.051	0.031	0.031
Organic CPM	0.00010	0.00011	0.00020	0.00026	0.00019
Inorganic CPM	0.00065	0.00105	0.00182	0.00222	0.00170
Primary PM - All Fractions [2]	0.062	0.014	0.053	0.033	0.033
Particulate Matter Emission Rate, lb/hr					
PM - Filterable	19.8	4.1	15.6	9.0	9.6
Organic CPM	0.033	0.035	0.063	0.076	0.058
Inorganic CPM	0.21	0.32	0.56	0.65	0.51
Primary PM - All Fractions[2]	20.1	4.5	16.2	9.7	10.1
PM - lb/1000 lb gas	0.105	0.023	0.087	0.053	0.054
Visible Emissions, % Opacity	0	---	---	---	0

1. Results are average of runs 2-4
2. Assume Primary PM (all fractions) is equal to PM_{10} emissions

CPM = Condensable particulate matter

Table 3

HYDROGEN CHLORIDE and METHANOL TEST RESULTS

EU-Dryer (SV-Exhaust)

Parameter	Run 1	Run 2	Run 3	Average
Test Date	7/17/2024	7/17/2024	7/17/2024	---
Test Period	0855-0955	1204-1304	1410-1510	---
Volumetric Flow Rates				
SCFM	44,200	42,100	42,000	42,800
Moisture, %	14.4	14.5	14.4	14.4
Speciated Concentration by Method 320, ppmv				
Hydrogen Chloride	< 0.39	< 2.27	< 2.60	< 1.75
Methanol	2.9	7.5	12.8	7.7
Speciated Emissions by Method 320, lb/hr				
Hydrogen Chloride	< 0.10	< 0.54	< 0.62	< 0.42
Methanol	0.64	1.6	2.7	1.6

*Run results listed as "<" indicate that the compound was below the detection limit

*Flow and moisture data obtained from Method 5 sampling

TABLE 4

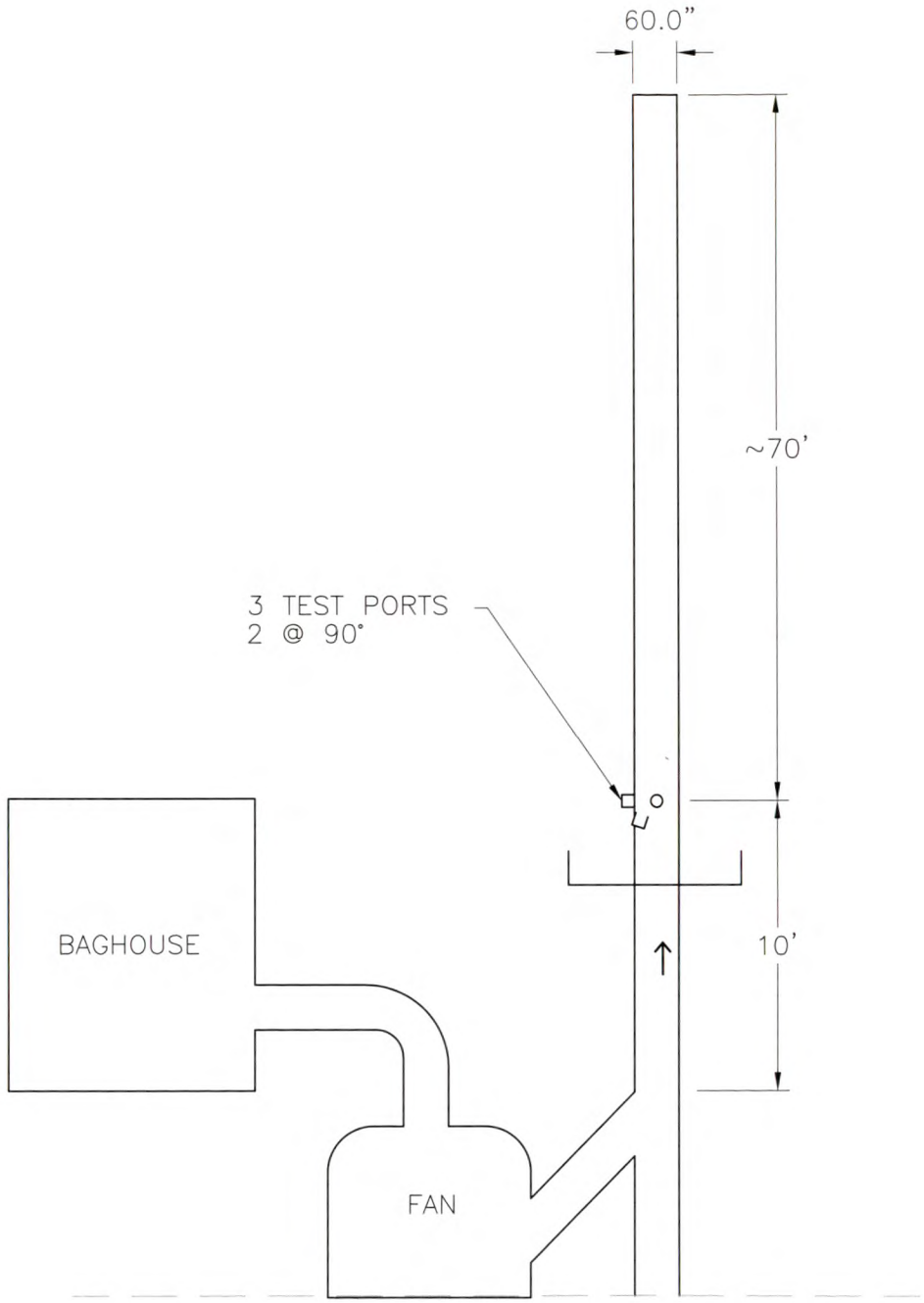
PARTICULATE MATTER TEST RESULTS

EU-Raw Material (SV-BH 666)

Parameter	Run 1	Run 2	Run 3	Average
Test Date	7/18/2024	7/18/2024	7/18/2024	---
Test Period	0759 - 0902	0932 - 1035	1053 - 1155	---
Test Duration, min	60	60	60	60
Average Stack Temperature, °F	69	73	74	72
Average Moisture Content, %V/V	1.9	1.6	1.7	1.8
Particulate Loading, g				
PM - Filterable	0.00156	0.00102	0.00111	0.00123
Air Flow Rate				
acfm	33,400	33,800	32,500	33,200
scfm	32,300	32,400	31,100	31,900
dscfm	31,600	31,900	30,600	31,400
Sample Volume				
acf	48.64	49.50	47.87	48.67
dscf	47.35	47.62	45.74	46.90
Isokinetic Variation, %	99.8	99.5	99.7	99.7
Particulate Matter Concentration, gr/dscf				
PM - Filterable[1]	0.00051	0.00033	0.00037	0.00041
Particulate Matter Emission Rate, lb/hr				
PM - Filterable[1]	0.138	0.090	0.098	0.109
PM - lb/1000 lb gas	0.00096	0.00063	0.00071	0.00077
Visible Emissions, % Opacity	0.0	---	---	0.0

1. Assume Filterable PM is equal to PM_{10} emissions

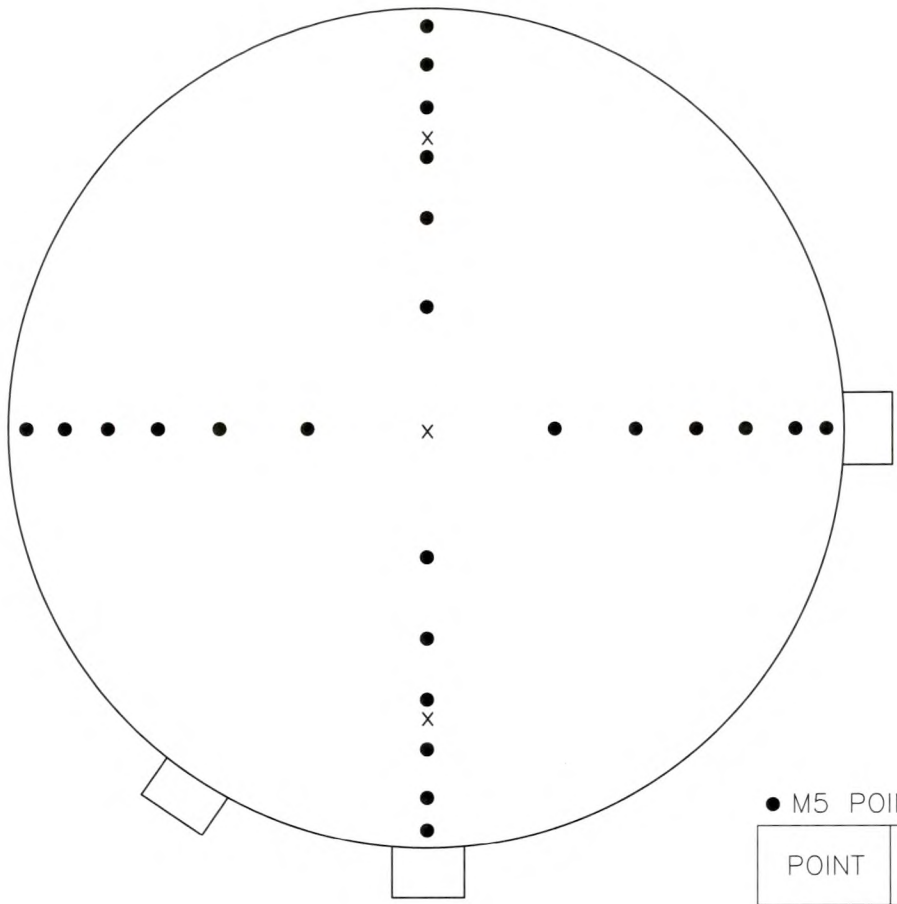
Figures



TEST PORT LOCATIONS
AYMIUM
GWINN, MICHIGAN
EU DRYER STACK (SV–EXHAUST)

NOT TO SCALE

FIGURE 1



● M5 POINTS

POINT	INSERTION DEPTH IN "
1	1.28
2	4.02
3	7.09
4	10.64
5	15.00
6	21.34
7	38.66
8	45.00
9	49.36
10	52.91
11	55.98
12	58.72

x ANALYZER POINTS

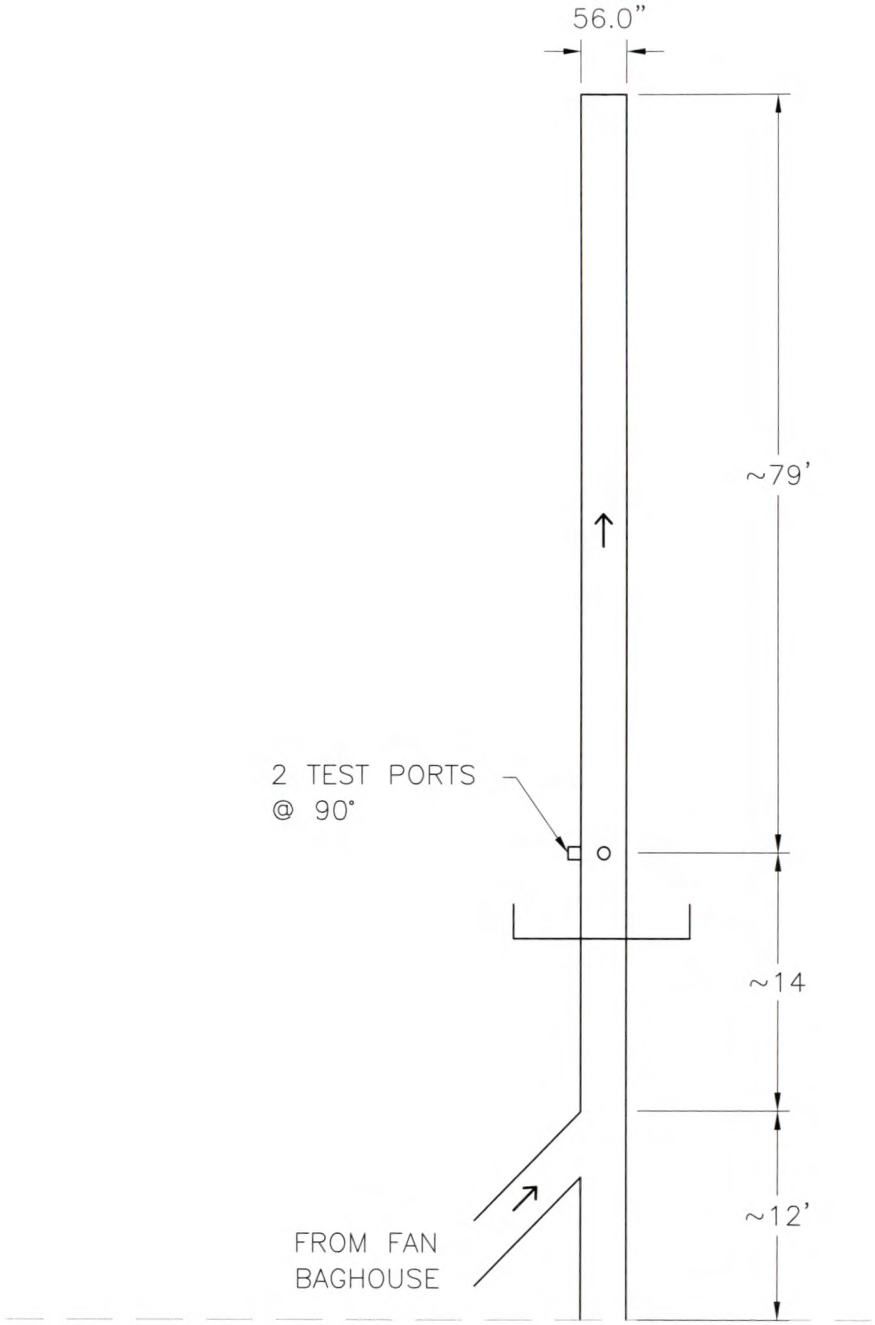
POINT	INSERTION DEPTH IN "
1	10.00
2	30.00
3	50.00

NO. OF TEST PORTS	2
PORT LENGTH	6.0"
PORT DIAMETER	6"
NO. OF TRAVERSE POINTS	3/24
DUCT DIAMETER	60.0"

TRAVERSE POINT LOCATIONS
AYMIUM
GWINN, MICHIGAN
EU DRYER STACK (SV–EXHAUST)

NOT TO SCALE

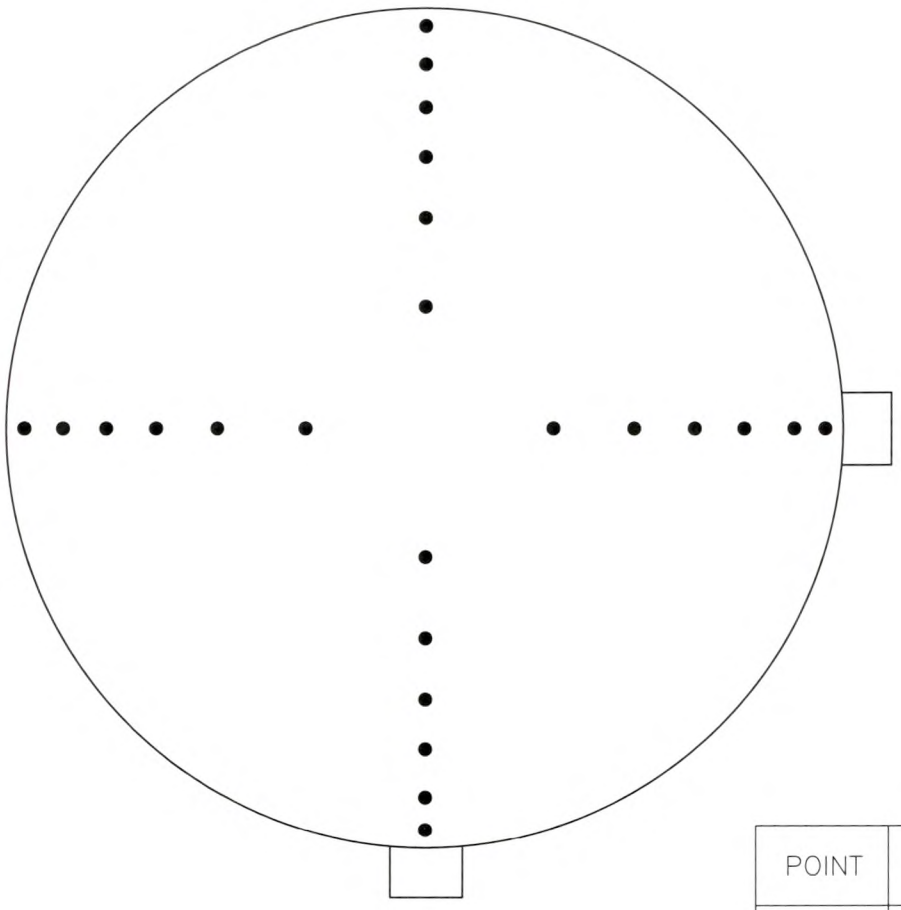
FIGURE 2



TEST PORT LOCATIONS
AYMIUM
GWINN, MICHIGAN
EU RAW MATERIAL STACK (SV–BH666)

NOT TO SCALE

FIGURE 3



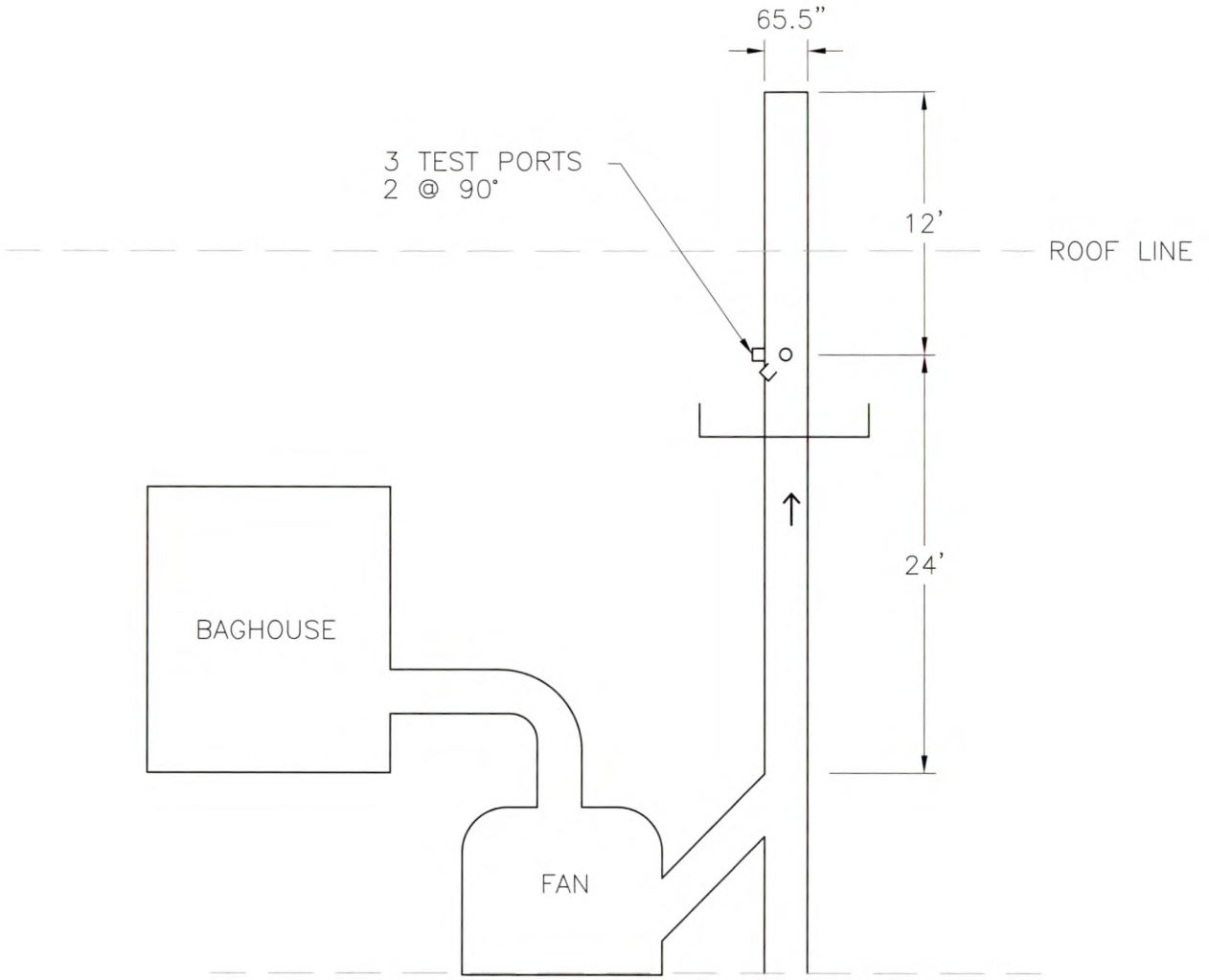
NO. OF TEST PORTS	2
PORT LENGTH	6.0"
PORT DIAMETER	6"
NO. OF TRAVERSE POINTS	24
DUCT DIAMETER	56.0"

POINT	INSERTION DEPTH IN "
1	1.19
2	3.75
3	6.61
4	9.93
5	14.00
6	19.92
7	36.08
8	42.00
9	46.07
10	49.39
11	52.25
12	54.81

TRAVERSE POINT LOCATIONS
AYMIUM
GWINN, MICHIGAN
EU RAW MATERIAL STACK (SV–BH666)

NOT TO SCALE

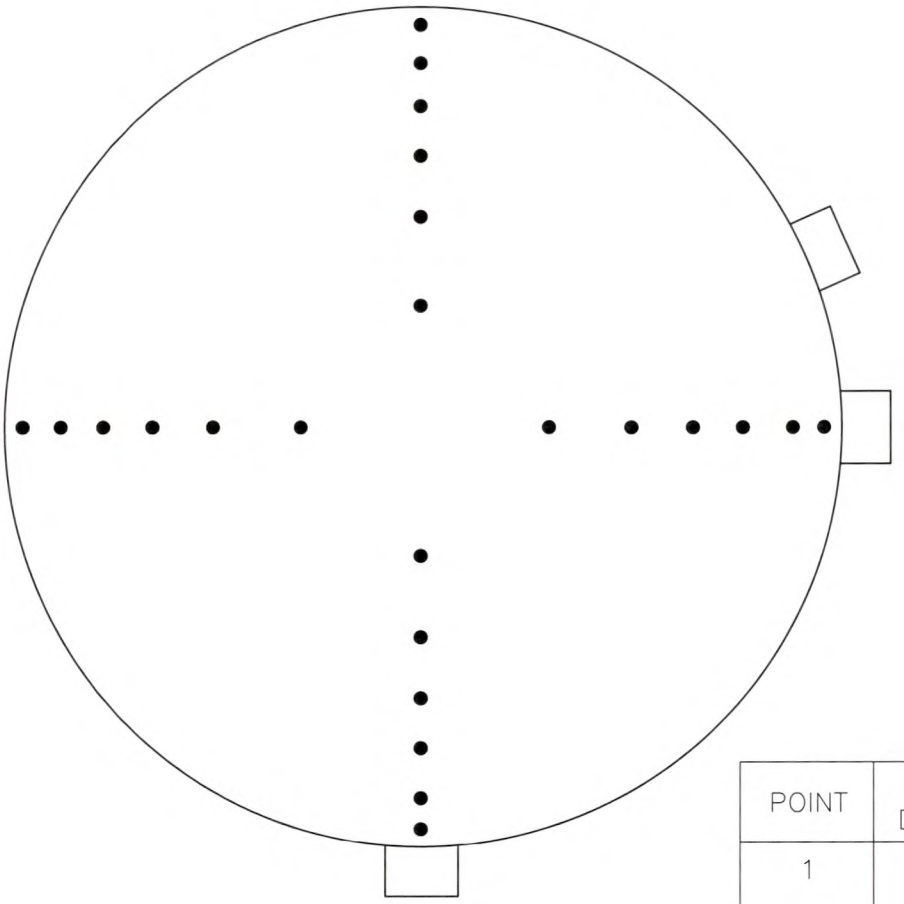
FIGURE 4



TEST PORT LOCATIONS
AYMIUM
GWINN, MICHIGAN
EU DRIED MATERIAL STACK (SV–BH667)

NOT TO SCALE

FIGURE 5



NO. OF TEST PORTS	2
PORT LENGTH	6.25"
PORT DIAMETER	6"
NO. OF TRAVERSE POINTS	24
DUCT DIAMETER	65.5"

POINT	INSERTION DEPTH IN "
1	1.39
2	4.39
3	7.74
4	11.61
5	16.38
6	23.30
7	42.20
8	49.13
9	53.89
10	57.76
11	61.11
12	64.11

TRAVERSE POINT LOCATIONS
AYMIUM
GWINN, MICHIGAN
EU DRIED MATERIAL STACK (SV–BH667)

NOT TO SCALE

FIGURE 6