QUALITY ROASTING, LLC

PARTICULATE STACK TEST REPORT

for

EU-ROASTER-1 and EU-ROASTER-2

at

Quality Roasting, LLC
135 S. Bradleyville Road
Reese, Michigan

Test Dates: October 30-31, 2024

Report Date: December 27, 2024

Report Due Date: December 30, 2024

Prepared by:

Environmental Partners, Inc.
305 Hoover Boulevard, Suite 200
Holland, Michigan 49423

EPI
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Report Certification:

Air emissions testing was performed under my observation and in conjunction with the production operations on October 30-31, 2024 at Quality Roasting's Reese, Michigan facility. This report presents the testing results and operational data collected during the testing. The data presented herein are believed to be a true and accurate representation of individual roaster stack conditions observed during the compliance testing exercise.

Bruce H. Connell

Principal

Environmental Partners, Inc.

Bruce H. Connell

December 27, 2024

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1.0 INTRODUCTION AND PURPOSE OF THE TEST PROGRAM

A compliance test program was conducted at the Quality Roasting processing facility located in Reese, Michigan on October 30-31, 2024. The purpose of the test program was to verify the particulate emission rates (PM filterable) for EU-ROASTER-1 (tested October 30, 2024) and EU-ROASTER-2 (tested October 31, 2024).

The test program was conducted in accordance with the test plan dated August 26, 2024, and confirmed by Andrew Riley of the Michigan Department of Environment, Great Lakes, and Energy (EGLE) dated October 4, 2024. A copy of the test plan and the EGLE confirmation is included in Appendix A.

The process evaluated is regulated by the Michigan issued Permit-to-Install No. 61-20B, issued November 29, 2023. The testing was conducted to satisfy special condition number V.1 of FG-PROCESS and to confirm compliance with special condition numbers I.1 and I.2 of FG-PROCESS (presented in the following table).

Table 1 – FG-PROCESS Emission Limits

Pollutant	Limit	Time Period / Operating Scenario	Equipment	Monitoring / Testing Method	Underlying Applicable Requirements
1. PM Filterable	1.31 pph	Hourly	EU-ROASTER-1 (2 stacks combined)	SC V.1	R 336.1205, R 336.1331(1)(c)
2. PM Filterable	5.44 pph	Hourly	EU-ROASTER-2 (2 stacks combined)	SC V.1	R 336.1205, 40 CFR 52.21(c) and (d)

The overall compliance test program was coordinated by Mr. Bruce Connell, of Environmental Partners, Inc. The compliance test program was performed by The Stack Test Group. Plant operations were coordinated by Mr. Jason Kain, Quality Roasting. The compliance test program was witnessed by Ms. Amy Beaver, EGLE-AQD and Mr. Ben Witkopp, EGLE-AQD.

2.0 PROCESS AND CONTROLS SYSTEMS DESCRIPTION

The Quality Roasting Reese, Michigan facility processes soybeans utilizing heat and pressure to extract soybean oil and soybean meal. Both by-products are utilized in the agricultural industry as protein nutrients in animal feed.

The soybean roasters (EU-ROASTER-1 and EU-ROASTER-2) utilize heat to soften the soybeans, which are later extruded and pressed to extract the oil. The hot combustion air passes upwards through the soybeans and is exhausted through a pair of cyclones, operating in parallel. As the hot air passes through the soybeans smaller size particulate matter can become entrained in the air stream. The cyclones are used to remove particulate from the airstream. The removed particulate is returned to the next stage of the processing step while the air stream is discharged to the atmosphere. For each roaster, stack testing was conducted in each exhaust stack simultaneously, post cyclone, and the hourly emission rates added together for a total hourly emission rate.

In accordance with Special Condition IV.3 of FG-PROCESS, the process is limited in production capacity by the capacity of the four screw presses, which is 100 tons of soybean meal per 24 hours per press (400 tons per day for the process). The capacity of the two roasters exceeds the capacity of the process. Therefore PTI#61-20B established production process limit of 168.0 tons of soybeans processed per day for EU-ROASTER-1 and 351.5 tons of soybeans processed per day for EU-ROASTER-2.

Hourly emission limits for EU-ROASTER-1 and EU-ROASTER-2 were established based on a restriction for the soybean inlet airlock motor frequency for each unit. For EU-ROASTER-1, this inlet air lock motor frequency is fixed at 22 Hz, while the inlet air lock motor frequency for EU-ROASTER-2 is set at 46 Hz. The hourly emission rates were set for each roaster based the limitations for each roaster. The material throughput for each unit was monitored based on the inlet air lock motor frequencies during testing.

3.0 TEST METHODOLOGIES

Three one-hour test runs were performed at the outlet of each roaster cyclone. Each roaster was tested separately, with the exhaust to EU-ROASTER-1 tested on October 30, 2024 and the exhaust stacks to EU-ROASTER-2 tested on October 31, 2024. All tests were conducted in accordance with USEPA Methods 1-5 for filterable particulate matter, as described in the *Code of Federal Regulations, Title 40, Part 60, Appendix A*. Descriptions of these methods are as follows:

USEPA Method	Description
1	Sample and Velocity Traverses for Stationary Sources
2	Determination of Stack Gas Velocity and Volumetric Flow Rate
3	Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight
4	Determination of Moisture Content in Stack Gases
5	Determination of Particulate Matter Emissions From Stationary Sources

Three separate one-hour test runs were performed utilizing USEPA Methods 1 - 5 for each roaster. Each roaster is equipped with two exhaust stacks, each following a cyclone dust collection unit. Therefore, testing of each roaster was conducted on each exhaust stack simultaneously, in order to determine the total particulate emission rates. Each parameter is being reported in grams/dscfm and lbs/hr.

Specific test locations, volumetric flow rates, and concentrations of oxygen, carbon dioxide and moisture in the exhaust streams will be determined in accordance with Methods 1 through 5. Velocity measurements will be made in accordance with USEPA Methods 1 and 2. Molecular weight and moisture determinations will be made in accordance with USEPA Methods 3 and 4. Due to yaw angles in each exhaust stack test location, straightening vanes have been installed after each cyclone and prior to the test ports.

The filterable particulate loading rates (PM-filterable) associated with each roaster was calculated from the exhaust stack for each test run, and computing the arithmetic average of the three emission rates. For each roaster, the particulate loading rates from the representative stacks have been added together for comparison against the permit limits.

3.1 Volumetric Flow Rate Determination – USEPA Methods 1 - 4

The volumetric flow rate within each exhaust stack was determined following USEPA Methods 1 through 4. Velocity measurement points were selected in accordance with USEPA Method 1. Gas stream velocities were determined using a Type-S pitot tube and inclined manometer in accordance with USEPA Method 2.

Two velocity measurements were made at each test location for each one-hour test run, one just before and one just after each test. The completion of the first and second test runs were reasonably temporally coincidental to the start of the subsequent test runs, therefore the ending velocity measurement for the previous test run was utilized as the beginning velocity measurement for the subsequent test run.

Concentrations of carbon dioxide were determined using the instrumental analyzer technique in accordance with USEPA Method 3A. Gas stream moisture contents were determined by passing the exhaust sample gas through a series of four chilled impingers containing pre-measured amounts of absorbing solution, followed by an impinger containing silica gel. Volumetric determinations were made of moisture gain, and equivalent water vapor volumes were determined in accordance with USEPA Method 4.

3.2 Particulate Emissions Determination – USEPA Methods 5 / 202

The procedures outlined in USEPA Method 5 were followed to determine filterable particulate emissions in the post-controlled exhaust streams of each roaster.

For each roaster, each test run consisted of velocity measurements taken from 24 points, 12 points across each to the two test ports, set in the same horizontal plane at 90° apart with respect to each other. At the same time, an isokinetic air stream was drawn from each point and passed through a filter holder where entrained particulate matter was collected. At the conclusion of each test run, the particulate collection filter was removed, dried and post-weighed to determine the mass of particulate collected per dry standard cubic foot of gas sampled by the sample train. The collected particulate collection rate was then extrapolated to determine the hourly emission rate of filterable particulate discharged per hour of operation.

A summary of testing maybe found in section 5.0.

4.0 PRESENTATION OF PRODUCTION DATA

The EGLE-AQD stack test approval letter, dated October 4, 2024, requested that the process be operated at greater than 90% of maximum production rate. The process throughput is set by the Roaster inlet airlock, which dictates soybean delivery to the front end of the Roaster.

It has been confirmed that for EU-ROASTER-1, the inlet motor set point of 22 Hz for the inlet airlock correlates to a soybean meal throughput rate, at the screw presses, of approximately 5.39 tons of soybean meal per hour. For EU-ROASTER-2, the inlet motor frequency set point of 46 Hz has been correlated to a soybean meal throughput rate of 11.50 tons of soybean meal per hour. Assuming soybeans contain 77% - 79% soybean meal, the screw press data would correlate to soybean loading rates at the roasters of 7.0 tons per hour and 15.1 tons per hour respectively.

During each test run, roaster inlet airlock frequency was recorded at five (5) minute intervals. This data is located in Appendix B. Table 2 presents an average roaster inlet airlock motor frequency (in Hz) for each test run and the corresponding calculated production soybean loading rate (tons per hour).

Table 2 – Soybean Inlet Airlock Frequency and Loading Rates

Process		**Test 1**	**Test 2**	**Test 3**
EU-ROASTER-1	Motor frequency (Hz)	22.092	22.088	22.084
	Soybean Loading Rate (tph)	7.03	7.03	7.02
EU-ROASTER-2	Motor frequency (Hz)	46.183	46.41	46.43
	Soybean Loading Rate (tph)	15.0	15.1	15.1

Based on this information, it is believed that on the days of testing, the roasters were demonstrating maximum equivalent loading rates.

5.0 PRESENTATION AND DISCUSSION OF TEST RESULTS

The following tables display a summary of the results for the compliance test program.

Table 3
EU-Roaster –1 Stack Test Summary
Quality Roasting
Reese, Michigan
Test Date: October 30, 2024

Parameter	**1**	**2**	**3**	**Avg**
Start Time	08:21	10:08	11:47	
Stop Time	09:28	11:17	12:52	
East Stack Test Data				
Volumetric Flow Rate (acfm)	9,026	8,822	9,239	9,029
Moisture Content (%)	5.29%	5.54%	5.25%	5.36%
Stack Temperature (°F)	230.9	224.0	234.6	229.8
Volumetric Flow Rate (dscfm)	6,352	6,252	6,467	6,357
Filterable PM (lbs/hr)	0.829	1.307	0.648	0.928
West Stack Test Data				
Volumetric Flow Rate (acfm)	8,874	8,350	9,210	8,811
Moisture Content (%)	4.75%	5.04%	4.82%	4.87%
Stack Temperature (°F)	208.7	201.0	213.0	207.6
Volumetric Flow Rate (dscfm)	6,489	6,158	6,684	6,444
Filterable PM (lbs/hr)	0.998	0.981	0.783	0.921
Combined Particulate Emissions Rate				
Filterable PM (lbs/hr) - East	0.829	1.307	0.648	0.928
Filterable PM (lbs/hr) - West	0.998	0.981	0.783	0.921
Total PM (lbs/hr)	**1.827**	**2.288**	**1.431**	**1.849**
Permit Limit (lbs/hr)				**1.31**

Table 4
EU-Roaster –2 Stack Test Summary
Quality Roasting
Reese, Michigan
Test Date: October 31, 2024

Parameter	1	2	3	Avg
Start Time	08:20	10:15	12:30	
Stop Time	09:42	11:18	13:32	
East Stack Test Data				
Volumetric Flow Rate (acfm)	11,016	10,898	10,681	10,865
Moisture Content (%)	4.52%	4.25%	4.27%	4.35%
Stack Temperature (°F)	227.0	229.4	230.5	229.0
Volumetric Flow Rate (dscfm)	7,862	7,773	7,581	7,739
Filterable PM (lbs/hr)	1.184	1.304	1.411	1.300
West Stack Test Data				
Volumetric Flow Rate (acfm)	9,158	9,645	9,588	9,464
Moisture Content (%)	4.30%	4.63%	4.58%	4.50%
Stack Temperature (°F)	203.4	202.5	206.6	204.2
Volumetric Flow Rate (dscfm)	6,787	7,133	7,051	6,990
Filterable PM (lbs/hr)	0.529	0.687	0.655	0.624
Combined Particulate Emissions Rate				
Filterable PM (lbs/hr) - East	1.184	1.304	1.411	1.300
Filterable PM (lbs/hr) - West	0.529	0.687	0.655	0.624
Total PM (lbs/hr)	**1.713**	**1.991**	**2.066**	**1.924**
Permit Limit (lbs/hr)				**5.44**

The emissions results indicate that EU-ROASTER-1 may have exceeded its hourly permit limit while EU-ROASTER-2 test results indicate that the unit was emitting within its hourly permit limit.

Both of these test results are unexpected. The permit limits for the individual presses were developed through a series of engineering evaluations performed in March 2023. These engineering evaluations measured emission rates at both high and low soybean loading rates in order to develop a sliding scale that was used to set the operating production metric for each roaster and which would correlate to their respective emission limits. Therefore, for each unit to have opposite results relative to their respective emission limits indicates that one of the units was potentially not operating properly and therefore creates questions relative to the validity of the tests.

In retrospect we offer the following discussion points:

1. Roaster 1 Equipment

The data from the EU-ROASTER-1 compliance test shows that the measured air flow rates (acfm) in each stack averaged 11% lower during the compliance stack test than were observed during an engineering evaluation performed in March of 2023.

Particulate emissions from EU-ROASTER-1 are controlled by two cyclones operating in parallel. A cyclone relies on centrifugal forces to capture particulate effectively. With a lower than typical air flow rate the expected result is typically an increase in particulate emissions. Since the only air flow to the cyclone is provided by the roaster combustion process, we believe that EU-ROASTER-1 may not have been operating at a satisfactory level on the day of testing.

Based on the air flow rates measured for EU-ROASTER-1 it is requested that EU-ROASTER-1 be retested following a full mechanical review of the unit. The Consent Order (2024-15) requires testing be completed within 180 days from the date of the consent order (October 4, 2024) which corresponds to April 2, 2025. We believe that a mechanical evaluation of the roaster can be performed in a timely fashion so that testing could be completed and a subsequent test report completed by April 2, 2025.

On December 26, 2024, EU-ROASTER-1 was taken off-line and once cooled it was opened for an inspection of the air perforation plate. This plate lays horizontally the length of the roasting chamber and contains approximately nine (9) 1/8-inch holes per square inch of surface area. The combustion flame, located at the front of the roaster is located below the perforation plate and the heated combustion air rises through the plates to heat the soybeans.

The soybeans rest on top of the plate. Hot air from the combustion chamber below the surface blows upward through the holes to create a hot air fluidized bed of soybeans which is the roasting process. The top of the perforation plate houses a chain system which drags the roasting soybeans along the length of the plate, all the while they continue to pop due to the air blowing through the holes. It is this hot combustion air that is released through the two cyclones and to the exhaust stack.

On December 26, 2024 EU-ROASTER-1 was taken off-line and opened up to inspect for possible plugging of the perforated holes. A view of the perforated plate estimates that approximately 80% of the holes were found to be at least partially plugged with as many as 50% of the holes being at significantly plugged including some with just a pin-hole of an opening to completely plugged.

It is believed that this plugging resulted in a reduced air flow rate being exhausted through the cyclones, impacting the effectiveness of the control unit to remove particulate. After considerable operating hours of heating, the loose dust / debris plugging the perforated plate hardens requiring the use of a high-pressure washer to clean out the perforated plate.

It is believed that EU-ROASTER-1 maybe more susceptible to this plugging situation since it is the first unit to receive cracked soybeans. The cracked soybean diverter is located above EU-ROASTER-1 and only after the inlet holding bin for Roaster 1 is filled do the cracked soybeans get diverted to EU-ROASTER-2. It is believed that smaller pieces and loose debris tend to drop out at the first drop-off chute, which is EU-ROASTER-1, as opposed to moving down the delivery conveyor that heads towards EU-ROASTER-2. Therefore, plugging of the perforated plate is rarely observed in EU-ROASTER-2.

2. Exhaust Stack Changes

After completing the roaster evaluations in March 2023, the permit application process required changes in the exhaust stack configurations to pass facility-wide NAAQS modeling for PM2.5 and PM10. These changes included decreasing the stack exit diameters from 36" to 28" to increase the exit velocities and increasing stack heights for EU-ROASTER-1 from 45 feet to 61 feet (15-foot increase) to reduce ground level concentrations.

Both of these changes were intended to theoretically increase the dispersion of the discharge over a greater geographical area and thereby reduce the ground level impact concentrations. It is now thought that the process changes to the stacks may have altered the roasters performance by placing added back pressures on the systems, that could have had an impact on the particulate emission rates.

Increased back pressure coupled with the reduced volumetric air flow rates may have resulted in a portion of the particulate being retained within the lower portion of the stack during the testing procedure and be reflective of an artificially increased concentration at the test port elevation. In other words, the concentration sampled at the test port elevation may not be reflective of what is being released from the stack to the atmosphere.

In summary, we request to retest EU-ROASTER-1 following a mechanical review of the unit. Review of the roaster and retesting to be complete by April 2, 2025 to comply with paragraph 10 of Consent Order 2024-15.