Fogo De Chao Restaurants
92-50 59th Avenue, Elmhurst, Queens

Commercial Charcoal Broiler
Particulate Matter <10 Microns
Emission Test Report

Project No. 4835

Test Dates: September 30, 2022 and
October 18, 2022

Prepared for:

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Date submitted:

November 2022

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1.0 Introduction

AirNova, Inc. performed an Emission Test Program for a Commercial Charcoal Broiler at the Fogo De Chao Restaurant located at 92-50 59th Street in Queens, New York on September 30, 2022 and October 18, 2022. The purpose of this test program was to demonstrate compliance with the requirements of Title 15 of the Rules of the City of New York, Chapter 37 *Emission Reduction Technologies for Char Broilers*. This regulation requires that testing be performed for the emission control device associated with the Charcoal Broiler to demonstrate that it is capable of reducing emissions of Particulate Matter <10 Microns (PM-10) by 75%. The control device is a Molitron Spray Mist unit. This demonstration was conducted to satisfy the control requirements of §37-05 of the Rule.

All emission sampling was performed in accordance with EPA Reference Methods 5 and 202 with modifications specified herein due to access limitations.

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2.0 Test Location Description

Emission testing was performed for one (1) Molitron Spray Mist emission control device utilized to control emissions from a Commercial Charcoal Broiler at this facility. Due to the configuration of the exhaust ducting associated with the device, all emission determinations were performed at the final exhaust stack associated with the unit. In order to determine the removal efficiency of PM-10, emission testing was performed both while the device was in operation and while the device was not in operation. A single one (1) hour test run was performed in determination of PM-10 emissions under each operating scenario. In this manner the PM-10 removal efficiency was determined.

Emissions from the control device are exhausted to atmosphere at rooftop level through a section of vertical rectangular ducting. As the test location does not meet the minimum requirements of EPA Reference Method 1 for the selection of sampling ports and traverse points, all sampling was performed utilizing a total of six (6) traverse points located as close as possible to the center of the duct.

A full description of the sampling and analytical methodologies that were utilized in the determination of PM-10 emissions is provided in Section 4.0 of this test report.

3.0 Test Results Summary

A complete summary of results for the Emission Test Program is provided in this section. Emission sampling was conducted on September 30, 2022 while the Charcoal Broiler was operated under Maximum Normal Operating Conditions (MNOC) while cooking typical lean beef product normally prepared by the facility. Emission sampling was also conducted on October 18, 2022 while the Charcoal Broiler was operated under MNOC while cooking hamburger patties (fatty meat) as specified by the regulation, though this is not a beef product that Fogo De Chao would typically prepare.

Fogo De Chao
Charcoal Broiler
Emission Test Program
Summary of Results Tables

Table 3-1
Fogo De Chao
Charcoal Broiler
Emission Test Program
Test Results Summary

Lean Beef Product		
Test Condition	**Uncontrolled**	**Controlled**
Test Date	09/30/22	09/30/22
Test Period	0753-0853	0932-1032
Temperature (°F)	92	97
Moisture Content (%)	1.8	1.9
Velocity (fps)	60.7	58.2
Flow Rate (ACFM)	6,241	5,992
Flow Rate (DSCFM)	5,926	5,627
PM-10 Emission Rate (lb/hr)	0.122	0.044
Reduction (%)		63.9
Fatty Beef Product		
Test Condition	**Uncontrolled**	**Controlled**
Test Date	10/18/22	10/18/22
Test Period	0810-0910	1001-1101
Temperature (°F)	111	104
Moisture Content (%)	1.4	1.2
Velocity (fps)	52.4	52.0
Flow Rate (ACFM)	5,394	5,355
Flow Rate (DSCFM)	4,856	4,890
PM-10 Emission Rate (lb/hr)	0.718	0.266
Reduction (%)		63.0

Standard Conditions: 68°F, 29.92 in. Hg

3.1 Test Results Conclusion

The Charcoal Broiler did not satisfy the control requirements to reduce PM-10 by 75% during either testing event. However, under worse-case conditions while cooking hamburger patties as specified in the regulation, that the restaurant does not serve, reducing PM-10 emissions by 75% would have resulted in an emission rate of 0.180 lb/hr, using an uncontrolled emission rate of 0.718 lb/hr as determined during the October testing. The controlled PM-10 emission rate of 0.180 lb/hr with fatty beef product as specified in Title 15 of the Rules of the City of New York, Chapter 37, is at least 4 times greater than the controlled PM-10 emission rate of 0.044 lb/hr as demonstrated with lean beef product that Fogo De Chao would normally cook as an operating establishment. Therefore, it can be concluded that the control device is acceptable for Fogo De Chao's normal operating standards and offerings.

4.0 Sampling and Analytical Methodology

Sampling in determination of PM<10 microns was performed in accordance with a combined EPA Reference Method 5/202 sampling train. Prior to sampling, the sample train was leak checked at 15 in. Hg vacuum to ensure that all sample train components were leak free. During sampling, gas samples were isokinetically extracted from the exhaust stack and passed through a stainless steel nozzle, a glass-lined probe and a quartz fiber filter, all maintained at a temperature of 248°F ±25°F. The gas sample then passed through an impinger train consisting of four (4) glass impingers immersed in an ice bath. Isokinetic sampling and flow rate adjustment were performed manually using a calculator program based upon Section 8.7.1 of the Reference Method. The sampling train consisted of the following apparatus connected in series:

- Stainless steel nozzle
- Quartz glass probe
- Tared quartz glass fiber filter contained in a glass filter holder with a Teflon frit and maintained at a temperature of 248°F ±25°F
- Connecting glassware from behind the front half filterable particulate housing
- Method 23 type condenser connecting directly to 1st impinger
- 1st Impinger: empty, stemless water dropout/knockout impinger
- 2nd Impinger: empty, modified Greenburg-Smith impinger
- CPM Teflon filter/glass filter assembly with direct-contact thermocouple
- 3rd Impinger: modified Greenburg-Smith impinger containing 100ml of H_2O
- 4th Impinger: modified Greenburg-Smith impinger containing 250g of silica gel (<68°F)

The first and second impingers were placed in a water bath maintained at ≤85°F and >65°F. The third and fourth impingers were placed in an ice/water bath so that the exit temperature of the fourth impinger was <68°F. This criteria was met by placing an insulated partition within the impinger box that creates two zones. The first zone contained impingers 1 & 2 and the second zone contained the ice bath for impingers 3 & 4. A recirculation pump for the EPA Method 23 type condenser was placed in the first zone as specified in EPA Reference Method 202. If the system needed colder water to maintain the

condenser to <85°F, the pump was moved to the second zone while maintaining a temperature >65°F.

The CPM filter met the strict requirements of EPA Reference Method 202 Section 7.1.1. The requirements include: 1) being a Teflon membrane without organic binders, 2) meeting the ASTM Method D2986 dioctyl phthalate (DOP) efficiency requirement of 99.95% with 0.3um particles, and 3) providing test data to document filter efficiency. The CPM filter was maintained at >65°F and ≤85°F and kept as close at possible to 85°F.

All of the CPM sampling train glassware was cleaned prior to the start of the test program consistent with Section 8.4 of EPA Reference Method 202. All glassware was scrubbed with soap and tap water then rinsed in the following order: tap water, deionized water (ASTM Type1 equivalent), acetone, and Hexane. Silicone grease was not utilized in any portion of the sampling train assembly.

Before sampling, a leak-check of the entire sampling train was conducted at 15 in. Hg vacuum to ensure that all sampling components were leak free (<0.02 ACFM). During sampling, the following information was recorded at each traverse point:

- Stack temperature
- Dry gas meter temperature
- Stack gas pressure differential
- Differential pressure across the orifice meter
- Sample box temperature
- Impinger temperature
- CPM filter assembly temperature

A minimum sample volume of 35 DSCF was collected during each test run. At the conclusion of sampling, a leak check was performed from the nozzle at the maximum vacuum encountered during the test run. The sample was then recovered. The nozzle, probe liner and front half of the filter holder were washed with acetone and the washes were retained in an amber glass jar with a Teflon-lined lid. The glass fiber filter was recovered and placed in a petri dish. The filterable sample fraction consisted of the acetone wash of these components and the glass fiber filter mass gain. The filterable sample fraction was

combined with the condensible sample fraction to represent total particulate matter.

A nitrogen purge was conducted immediately following the sample train leak-check. The 1st impinger stem was removed and replaced with a long stem modified Greenburg-Smith impinger stem. The stem was immersed in the condensed water at least 1 centimeter (0.4 inches) in order to perform the nitrogen purge. If needed, water was added (ASTM Type 1 equivalent) to a recorded volume needed to reach the 1cm immersion level. The condenser was reconnected in order to purge nitrogen through the entire CPM system (EPA Reference Method 202 Figure 2). The sample train underwent the pressurized nitrogen purge prior to sample recovery as detailed in Sections 8.5.3.1 and 8.5.3.3 of EPA Reference Method 202. Prior to the sample train purge, a purged in-line filter was attached to the nitrogen supply line.

The CPM system was purged at >14 liters per minute. During the purge, the CPM Teflon filter assembly was maintained at ≤85°F and >65°F.

The impinger contents were subsequently measured for volume increase to within 1ml. The impinger 3 catch was discarded after its pick-up volume was recorded. The silica gel was recovered and the moisture gain was determined by weight to within 0.5 grams.

The 1st and 2nd impinger catch were retained in a glass sample jar with a Teflon-lined lid. The following glassware was rinsed 2 times with ASTM Type 1 equivalent water and added to the same jar: the back half of the filter holder, EPA Method 23 type condenser, impingers 1 & 2 with connecting glassware and the front half of the CPM Teflon filter assembly.

After the water rinses, the same glassware was rinsed one time with acetone and two times with hexane. All rinses were placed in one glass sample jar with a Teflon-lined lid (separate from the aqueous sample jar).

The CPM Teflon filter was recovered and placed into its respective petri dish for transportation to the laboratory. The samples were maintained at ≤85°F during shipping.

Analysis of the front half acetone rinse sample analysis was conducted utilizing Teflon baggies for

the analysis of each liquid sample fraction. The CPM analysis was conducted according to EPA Reference Method 202. Additionally, Teflon baggies were utilized for the ultra-low mass analysis of each liquid sample fraction (Alternate Method 005).

Field reagent blanks, a Field Train Proof Blank (FTPB) and a Field Train Recovery Blank (FTRB) were collected in accordance with the Method. One field reagent blank of 300ml of degassed, deionized, ultra-filtered water, 300ml of acetone and 300ml of hexane were collected in separate glass sample jars for each reagent in accordance with Section 9.8 of EPA Reference Method Reference 202. A FTPB, as specified in Section 8.5.4.10 of the Method, was performed on the CPM glassware prior to conducting the emission test in accordance with Section 9.9 of EPA Reference Method 202.

A FTRB was collected for the emission source after the second test run in accordance with Section 9.10 of EPA Reference Method 202. The resulting analytical data was used for blank corrections (not to exceed the maximum allowed) of the test runs for the emission source. The sample train was assembled as if it were used for testing. Prior to the purge, 100ml of degassed, deionized, ultra filtered water was added to the first impinger. The assembled sample train was then purged as described in Sections 8.5.3.2 and 8.5.3.3 of the Method and the blank sample fractions were recovered as described in Section 8.5.4 of the Method.

Laboratory data was then entered into a spreadsheet software program to calculate filterable and condensible particulate matter concentrations (gr/DSCF) and mass emissions (lb/hr).

5.0 Appendix Glossary