SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

- PROTOCOL -

DETERMINATION OF PARTICULATE AND REACTIVE ORGANIC GASEOUS EMISSIONS FROM RESTAURANT OPERATIONS

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SOURCE TESTING AND ENGINEERING BRANCH

APPLIED SCIENCE AND TECHNOLOGY

RESTAURANT TESTING PROTOCOL

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RESTAURANT TESTING PROTOCOL

1.0 OVERVIEW AND APPLICABILITY

The South Coast Air Quality Management District has jurisdiction over the emissions of pollutants into the air from a variety of sources in Los Angeles County, Orange County, Riverside County and the non-desert portion of San Bernardino County. This area exceeds the national and state standards for PM10 and ozone. To address those and other pollutants, the SCAQMD developed a twenty-year Air Quality Management Plan (AQMP) to clean up the air in the basin. Measure #88-C-3 (now #90A-C-2) of the AQMP proposes to reduce the emissions of volatile organic compounds (VOC) and particulate matter (PM) from commercial charbroilers by 90%. In addition, the June 1988 amendment to District Rule 219 ("Equipment Not Requiring a Written Permit") requires that charbroiling equipment be permitted. Currently, only charbroilers need permits, but the SCAQMD is developing a comprehensive "restaurant rule" (Rule 1138) to regulate PM and VOC emissions from restaurants.

Charbroilers generate particulate matter emissions when the food being charbroiled expires fluids which come into contact with the heating source. The fluids also vaporize or partially oxidize into volatile organic compounds that are emitted into the atmosphere. These emissions contribute to the production of suspended particulate matter and photochemical smog, both of which have demonstrated adverse health effects. Similar emissions are produced by a wide variety of cooking equipment.

This protocol has been developed to ensure standardization of compliance testing procedures. It is applicable to all restaurant appliances, with or without control devices, venting their emissions through any stack. Most restaurants vent their exhaust from their charbroiler, deep fat fryers, griddle, stove-top and various other restaurant cooking appliances to the same exhaust stack. The difficulty in regulating charbroilers and any restaurant appliance exclusively arises when

they are all operated simultaneously and the emissions are vented together; the testing of the charbroiler cannot be independent of the other restaurant appliances. Also, the wide variety of food being cooked will have varying amounts and types of expired fluids, primarily consisting of fats and natural juices.

2.0 DEFINITIONS

For the purposes of this test protocol, the following definitions apply:

CHARBROILER means a cooking device composed of the following three major components: a grated grill, a high-temperature radiant surface and a heating source. The heating source heats the high-temperature radiant surface, which provides the heat to cook the food resting on the grated grill. This includes, but is not limited to broilers, grill charbroilers, flamebroilers and direct-fired barbecues.

DEEP FAT FRYER means an appliance used to cook food by immersion in hot oil or grease (fat).

GROOVED GRIDDLE means a griddle with milled grooves in the cooking surface to provide the cooked meat with an appearance and flavor similar to that imparted by direct meat-firing.

HOURS OF OPERATION are those hours beginning from the time an appliance is started (gas/heat source turned on) until the appliance is secured (gas/heat source turned off).

PARTICULATE MATTER (PM) means any material, except uncombined water, which exists in a finely divided form as a liquid or solid at standard conditions.

PROCESS WEIGHT is the pre-cooking weight of all products cooked during the test period. If actual weight is not possible, it is acceptable to average five units of each product type, given that each piece is of similar size, composition and weight. Process weight is listed in terms of each product in the product mix.

PRODUCT MIX is the listing of all product types cooked during the testing period.

RESTAURANT refers to any stationary establishment which cooks food for sale directly to consumers.

SOLID PARTICULATE MATTER means particulate matter which exists as a solid at standard conditions.

VOLATILE ORGANIC COMPOUNDS (VOC) is any volatile compound of carbon, excluding methane, carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, ammonium carbonate and exempt compounds. EXEMPT COMPOUNDS are any of the following compounds which have been determined to be non-precursors of ozone:

Chlorodiflouromethane (HCFC-22)

Dichlorotriflouroethane (HCFC-123)

Tetraflouroethane (HCFC-134a)

Dichloroflouroethane (HCFC-141b)

Chlorodiflouroethane (HCFC-142b)

3.0 SAMPLING AND ANALYTICAL METHODS

3.1 Particulate Matter

Sample the exhaust isokinetically following District Method 5.1 (refer to *South Coast Air Quality Management District Source Test Manual*, Method 5.1, "Determination of Particulate Matter Emissions from Stationary Sources Using a Wet Impingement Train"). The minimum testing time of 60 minutes and 72 minutes is recommended. Use a stainless steel or glass probe and nozzle and a District Method 5.1 train. An additional straight tube impinger (empty bubbler) may be placed in the front of the train [See Figure 1]. Perform organic extraction and particulate matter analysis on the probe and nozzle, the filter and the impingers using a modified District Method 5.1. The change in analysis methods involves using methylene chloride as a wash in addition to water and is detailed in Appendix C. All stopcock grease must be completely removed from joints following proper laboratory procedure before recovering the samples with methylene chloride. (WARNING: methylene chloride produces dangerous fumes and appropriate safety measures should be taken during its use.) IMPORTANT: If the sample is not analyzed within 48 hours, it should be re-covered and stored at 4^{o}C until analysis can be completed. Analysis should be completed within two weeks.

3.2 Volatile Organic Compounds

The Method 25.1 sampling apparatus consists of two evacuated eight-liter tanks, each equipped with flow controllers, condensate traps, vacuum gauges, minihelics and probes [See Figure 2].

Collect integrated VOC gas samples using District Method 25.1 with the modification defined in the following paragraph.

In order to sample the gaseous organics in a reproducible manner, it is necessary to remove the large particles of grease from the sample. This can be accomplished by using a combination of glass wool and screen filters in series after the nozzles to capture the large grease drops,

and prevent the drops from entering the TCA apparatus [See Figure 3]. The glass wool should be packed with a density of 0.107 g/cm^3. The screen filter should be glass fiber that can remove particulates with an aerodynamic diameter of 0.45 microns. Gloves should be worn when assembling the filters to prevent oils on hands from biasing the organics measured. The TCA set-up is in Figure 2, while the suggested filter assembly is in Figure 3.

3.3 Flow Rate & Process Weight

3.3.1 Stack Flow Rate Measurements

Measure the flow rate during the isokinetic, traversed particulate sampling as specified in Section 2.7 of District Method 5.1 (refer to *South Coast Air Quality Management District Source Test Manual*). For calculating the stack velocity, use the average of the flow rates measured at each point sampled during the test.

3.3.2 Process Weight Measurements

The process weight is the weight of products that are cooked during the sampling time. Any food item cooked on any equipment vented to the outside through the exhaust stack must be counted and reported. Separate the product into food types, i.e. number of hamburgers, number of skinned chicken pieces, number of unskinned chicken pieces, etc. Specify the tally , grouping items if necessary, after testing is completed. Fat content from the supplier should also be noted when available. Also note other information that would demonstrate and identify the product being cooked, such as supplier, grade, etc. Measure an exact weight of each food type cooked, prior to cooking. It is acceptable to evaluate an average unit weight (average of at least 7 typical units), as long as every piece is of similar size, composition and weight. The standard deviation of the meat product weight should not exceed 6% the average unit weight. To determine the process weight of each food type,

multiply the number of units cooked by the average pre-determined weight per unit. The total process weight is the sum of all individual process weights.

Finally, obtain and report a daily meat production rate in order to calculate a pounds emissions per day value.

4.0 TESTING PROCEDURES

4.1 Set-Up

Follow stack and port set-up in District Method 1.1 (refer to *SCAQMD Source Test Manual*). Perform a cyclonic flow check and document that it is less than 20^{o}, by District Method 1.1.

If either the ducting, cooking equipment or control device are new, condition the entire set-up before testing. To condition, allow normal cooking to occur for one week while all the equipment (including the control device) is in normal operation. Normal cleaning may occur during this conditioning time.

4.2 Pre-Test

Leak check both the TCA and the PM train separately according to District Method 25.1 and Method 5.1, respectively. Prepare sampling apparatus, including connecting clean filter assembly to the TCA. Leak check the entire apparatus, making sure the TCA sample flow valves are tightly closed and the flow rate control valves are fully open. Weigh the product to be cooked or determine the average weights per each food type in the product mix. If not already in use, allow the cooking device to warm-up according to the manufacturer's instructions.

4.3 Test

Conduct the particulate testing over a minimum period of 60 minutes (72 minutes recommended) and under the maximum loading condition of the cooking equipment. In a restaurant setting, the normal lunch period (11 am to 2 pm) and the normal dinner period (6 pm to 9 pm) will be considered maximum loading conditions, unless a specific restaurant has special operating times or unusual peak hours.

Perform the TCA testing over a minimum of 60 minutes during the particulate testing period. Start the TCA sampling after the particulate matter sampling begins and end before the particulate matter sampling ends. Carefully note the TCA start and end time, as well as initial and final vacuum readings.

Sampling rate should be determined according to standard method 25.1 requirements, noting that the temperature where the sample is being taken is not the stack temperature. It is acceptable to use 70^{o}F as the sample temperature when using Table 25.1-1.

Normal cleaning may occur during testing, but should be carefully noted and reported.

During the test, record the specific items that are being cooked, the quantity and the cooking devices involved. These records are to be kept for any cooking device in operation that is vented to the stack being tested.

Field data sheets to be used for the particulate and the VOC tests are included in Appendix A.

4.4 Post-Test

After the test, leak check both setups, as done in the pre-test check. Tally the weight of all the food cooked during the sampling time using the methods described in Section 3.3 of this report. Obtain from restaurant manager the quantities and types of food cooked during the entire day.

5.0 CALCULATIONS

Carry out all calculations to at least one digit beyond that of acquired data, then round off after the final calculations to four significant digits. Round off all numbers according to ASTM E380-82 procedures. Use the calculation sheets in Appendix B.

5.1 Process Weight Calculations

Using the data acquired during testing, determine the process weights for individual product types. Include the weight of each item cooked, or show the weights of the five or more units used to determine an average unit weight. Indicate the pounds per unit type cooked during the sampling period. Calculate the total pounds of product cooked per hour. Report the individual and total pounds cooked during the sample period, individual and total pounds cooked per hour and individual and total pounds cooked during the entire day.

5.2 Particulate Matter Calculations

Use the calculation sheets in Appendix B to determine pounds per hour emission rate of solid particulate matter (EE) and the particulate matter concentration in grains per dry standard cubic foot (BB). Isokinetic sampling rates must also be between 90% and 110% in order for the test to be valid.

Report the volume flow rate (dscfm), the total PM solid emission rates (lbs/hr) and the PM sample concentrations (gr/dscf).

5.3 VOC Calculations

Use the calculation sheets in Appendix B to determine pounds per hour emission rate of VOC. Report VOC emissions in both parts per million and pounds per hour as CH_2 (molecular weight = 14.0).

5.4 Pounds per Day Calculations

Calculate the pounds per day value for both the particulate matter and the VOC using the following equation:

$$\text{Total Daily Emissions} = \frac{\text{Hourly Emissions}}{\text{Total Hourly Process Wt}} \times \text{Total Daily Process Weight}$$

$$= \frac{\text{PM (lb/hr)}}{\text{Product (lb/hr)}} \times \text{Product (lb/day)}$$

$$= \frac{\text{VOC (lb/hr)}}{\text{Product (lb/hr)}} \times \text{Product (lb/day)}$$

Report PM and VOC emission rates in lbs/day.

5.5 Efficiency of the Control Device

If testing included the inlet and outlet testing of control device, calculate the destruction efficiency for PM and ROGs using the following equation:

$$\text{Destruction Efficiency} = \frac{\text{Inlet Mass Emission Rate - Outlet Mass Emission Rate}}{\text{Inlet Mass Emission Rate}} \times 100\%$$

Use the form provided in Appendix B.

6.0 REPORTING

A formal report shall be submitted in the format outlined in Chapter II of the *SCAQMD Source Test Manual*. If deviations occur between the manual and this protocol, follow this protocol.

All compliance certification reports shall include the following:

1. QA/QC procedures followed for all measuring equipment, including calibration test data.
2. QA/QC procedures followed for all sampling and analysis equipment, including calibration test data.
3. Chain of custody for samples.
4. Field notes and data sheets.
5. Calculations/averaging sheets/printouts.

7.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

The Quality Assurance/Quality Control guidelines are outlined in the *SCAQMD Source Test Manual*. Follow these guidelines unless otherwise specified in this protocol:

1. Chain-of-Custody and calibration documents must be submitted for all restaurant testing.

2. Trip blanks of the Method 5.1 PM train and the Method 25.1 TCA trays should accompany the sampling apparatuses and the Chain-of-Custody. These trains and trays should also be analyzed if the sample is suspect of contamination.

3. The cooking equipment should be maintained according to manufacturer's instructions.

4. The prefilter assemblies should be cleaned and the filter mediums should be replaced with clean material after each test.

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APPENDIX A FIELD DATA SHEETS

Use the following sheets (attached) when collecting field data:

a) Particulate Matter

b) VOC Emissions

APPENDIX B CALCULATION SHEETS

Use the following sheets (attached) in performing calculations:

a) Particulate Matter

b) VOC Emissions

c) Efficiencies of Control Devices

APPENDIX C MODIFIED METHOD 5.1 ANALYTICAL PROCEDURE

Attached is a flowchart detailing the recovery and analytical procedure for the analysis of the modified method 5.1 train used for charbroiler emissions sampling.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

EFFICIENCY OF THE CONTROL DEVICE CALCULATIONS

Test Number: _____ Date: _____

Processed by: _____

Type of Control Device _____

Manufacturer of Control Device _____

Model Name/Number of Control Device _____

Calculations:

Inlet sample emission rate of PM (IPM) = _____ lb/hr

Inlet sample emission rate of VOC (IVOC) = _____ lb/hr

Outlet sample emission rate of PM (OPM) = _____ lb/hr

Outlet sample emission rate of VOC (OVOC) = _____ lb/hr

$$\text{Efficiency} = \frac{(\text{Inlet} - \text{Outlet})}{\text{Inlet}} * 100\%$$

$$\text{Efficiency PM} = \frac{\text{IPM} - \text{OPM}}{\text{IPM}} * 100\% = \frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_} * 100\% = \_\_\_\_\_\%$$

$$\text{Efficiency VOC} = \frac{\text{IVOC} - \text{OVOC}}{\text{IVOC}} * 100\% = \frac{\_\_\_\_\_ - \_\_\_\_\_}{\_\_\_\_\_} * 100\% = \_\_\_\_\_\%$$